U.S. NUCLEAR REGULATORY COMMISSION

OFFICE OF NUCLEAR REACTOR REGULATION

NRC Inspection Report: 50-277/90-200 License Nos: DPR-44
50-278/90-200 DPR-56

Dockets: 50-277
50-278

Licensee: Philadelphia Electric Company
Peach Bottom Atomic Power Station
Route 1, Box 208
Delta, Pennsylvania 17314

Facility Name: Peach Bottom Atomic Power Station, Units 2 and 3

Inspection Conducted: February 5 through 16, and
February 26 through March 2, 1990

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EXECUTIVE SUMMARY

A Nuclear Regulatory Commission (NRC) inspection team conducted this safety system functional inspection (SSFI) from February 5 through February 16 and February 26 through March 2, 1990, to assess the operational readiness of the emergency service water (ESW) and high-pressure coolant injection (HPCI) systems. The SSFI team focused on the utility's ability to integrate system and component design, design control, operations, surveillance and testing, and maintenance into cohesive programs that support system operational readiness.

ESW SYSTEM

The team identified a concern regarding the operability of the ESW system based on significant weaknesses in design, design control, system operations, and surveillance testing.

As a result of this review, the SSFI team concluded that the licensee had not performed adequate analysis or testing to demonstrate operability of two of the three ESW modes (closed cooling modes). The team was particularly concerned that the ESW system lacked actual field test information to validate the design basis flow calculations in its normal mode (open loop). A complete network analysis performed by Bechtel in 1984 had indicated that the ESW system could not meet original design flows to the pump room coolers for the emergency core cooling system (ECCS). The licensee's engineering reevaluation of temperature limitations in the ECCS pump rooms, however, resulted in lower than the original system demands, indicating that the maximum cooling loads could be met. The reevaluation did not allow any temperature margin in several of the ECCS pump rooms. Documentation reviewed by the team indicated that licensee engineers were concerned about the lack of field verification of the calculated flow values. Although the engineers were aware of the weaknesses of the ESW system, both operations and engineering personnel failed to recognize the safety significance of the concern, and the licensee failed to take prompt and appropriate corrective action. In addition, some modifications to the system were not supported by adequate engineering and safety evaluations. Certain modifications actually reduced the flow capacity of the ESW system in the closed cooling mode.

The SSFI team determined that the ESW system, in its existing configuration, had not been shown capable of performing its required safety functions for the following reasons:

- Appropriate testing had not been performed to demonstrate that the ESW system could meet its design performance requirements with two units in operation.

- Although surveillance tests were capable of demonstrating that designated parameters were satisfied, the parameters chosen were not capable of verifying ESW system performance.

- Calculations had not been performed to determine acceptable net positive suction head for the ESW booster pumps and to correlate the controlled throttling of the pump discharge valve with system flow requirements and pump suction pressure.

- Safety evaluations were not performed to determine the impact of two modifications to ESW system operation: the isolation of the reactor building closed cooling water (RBCCW) system and throttling the booster pump discharge valves.

- The operating procedure for closed loop operations did not include adequate instructions concerning positioning of the ESW booster pump discharge valves and the emergency cooling tower (ECT) inlet valve.

- The ECT fans and associated controls and equipment were not verified to meet requirements for performing safety-related functions.

- Technical staff performing surveillance tests observed by team members failed to adhere to procedural requirements and exhibited a lack of understanding concerning the use of surveillance procedures covering the installation and use of appropriate instrumentation.

HPCI SYSTEM

The SSFI team determined that the HPCI system is capable of performing its required safety functions. However, the team identified problems with maintenance, modification, and design controls which indicated the need for increased management attention to ensure continued reliable operation of the HPCI system. The team's conclusions were based on the following observations:

- Threaded fasteners on the hydraulic oil flanges and the steam chest cover of the HPCI pumps were of improper size and lacked material designations.

- Existing fusing practices on the auxiliary oil pump, condensate pump, and vacuum pump did not meet original design configuration. The fusing arrangement was not analyzed to determine the impact of a 10 CFR Part 50, Appendix R plant shutdown following a fire, on the operability of the auxiliary pumps.

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1.0 INSPECTION OBJECTIVE AND SCOPE

Nuclear Regulatory Commission (NRC) staff performed an announced safety system functional inspection (SSFI) to verify the functionality of the emergency service water (ESW) and the high-pressure coolant injection (HPCI) systems at the Peach Bottom Atomic Power Station, Units 2 and 3.

The primary objective of the SSFI was to assess the operational readiness of the HPCI and ESW systems by determining whether:

- The systems are capable of performing the safety functions required by their design basis.
- Testing is adequate to demonstrate that the systems could perform all of the safety functions required.
- System maintenance (with emphasis on pumps and valves) is adequate to ensure system operability under postulated accident conditions.
- Operator and maintenance technician training is adequate to ensure proper operations and maintenance of the system.
- Procedural adequacy (e.g., accessibility and labelling of valves) relating to the selected systems to ensure proper system operation under normal and accident conditions.
- Management controls including procedures are adequate to ensure that the safety systems will fulfill the safety functions required by their design bases.

The SSFI team reviewed system descriptions; the Updated Final Safety Analysis Report (UFSAR); equipment sizing calculations; documentation pertaining to system protection, controls, and interlocks; equipment specifications; modification packages (MPs); licensee event reports (LERs); related test and operating procedures; and one-line diagrams, elementary diagrams, and equipment layout drawings.

In addition, the team reviewed operating and administrative control procedures, reviewed selected operator status logs and control room system files, performed walkdowns of systems and plant areas, and conducted interviews with licensed and non-licensed operations personnel and system engineers regarding the HPCI and ESW systems.

2.0 DETAILED INSPECTION

2.1 Emergency Service Water System

The ESW system and its associated emergency cooling tower (ECT) are common to Units 2 and 3 and provide cooling water to diesel generator heat exchangers, emergency core cooling system coolers, and reactor building closed cooling water heat exchangers during loss of offsite power. The main system components that are supplied with ac power are two ESW pumps, two ESW booster pumps, one emergency cooling tower (ECT) pump, and three emergency cooling tower fans.

2.1.1 ESW Mechanical Design

The SSFI team reviewed the available design information for the three modes of ESW system operation to determine whether ESW system design parameters used in the various safety analyses and referenced in the Final Safety Analysis Report (FSAR) and Technical Specifications were adequately supported by analyses. The team found that the licensee did not have adequate analyses to demonstrate operability of the two alternate ESW modes. The team also was concerned that the licensee had not demonstrated operability of the normal ESW cooling mode because of little or no design margin calculated for the ESW system in this mode and insufficient field test information to validate the design input assumptions.

Although the licensee did not have a design basis document for the ESW system, the team was able to reconstruct the design requirements for the ESW system through interviews with the licensee's engineering staff and through review of several licensee documents, such as Bechtel calculation "Emergency Service Water Pump Head Requirement," dated December 4, 1968; "Bechtel Calculation to Determine ESW System Pressure Loss," dated May 12, 1971; and "The ESW System Network Analysis," dated May 1984.

The ESW system at Peach Bottom serves both Units 2 and 3, and is designed, under a loss-of-offsite power condition, to provide cooling water to the heat exchangers for the unit with a loss-of-coolant (LOCA) accident, as well as to provide cooling water to the heat exchangers of the other unit that needs to be shut down. To reliably accomplish this function, the following three modes of ESW operation have to be considered: (1) the normal ESW system operation - utilizing the ESW pumps, (2) the ESW cooling tower mode - utilizing the ESW pumps, booster pumps, and fans, and (3) the ECW cooling tower mode - utilizing the cooling tower pump, booster pumps, and fans.

During normal ESW system operation, each of the two ESW pumps was designed to provide all of the required cooling water to the emergency core cooling system (ECCS) heat exchangers. The source of water is the Conowingo pond, with ESW discharge back to the Conowingo pond. In the event the pond is lost as a source of cooling water, the ESW system can be reconfigured into its closed loop modes of operation by closing its intake gates (one gate for each of the two ESW pumps) to isolate the system from the Conowingo pond. In the closed-loop configuration, the ESW system can be operated in either the ESW or the ECW cooling tower modes of operation. In the ESW cooling tower mode, the cooling water path is from the ESW pump to the heat exchangers through the ESW booster pump to the emergency cooling tower and back to the ESW pump suction. In the ECW cooling tower mode, the ECW pump takes suction on the cooling tower basin and sends water through the ECCS heat exchangers. The water is then returned to the cooling tower by the ESW booster pump.

The SSFI team reviewed the Bechtel calculation for emergency service water pump head requirements (dated December 4, 1968) and found that:

- The ESW pumps were purchased with no margin for pump head. The calculation recommended that the pumps be purchased for a capacity of 8,750 gpm at a head of 96 feet. Instead, the pumps were purchased for a capacity of 8000 gpm at a head of 96 feet.

- The calculation used the friction loss factor for new pipe although the instructions to the calculation stressed the need to be conservative by using the system friction loss based on aged pipe.

- The calculation did not consider the elevation of the discharge spillover, which would have added approximately 24 feet of static head to the required total head of the pump.

- The calculations did not address the emergency cooling tower mode of operation in which an ESW pump operates in series with the ESW booster pump. There was no provision in the calculation for booster pump suction requirements.

The team also reviewed the "Emergency Cooling Water System No. 48" final calculation (dated December 22, 1971), which was performed to obtain the ESW system flow requirements after construction of the ESW system was completed. The team found that this calculation assumed that the ESW pump can provide 44 feet of head to the suction of the ESW booster pump. The licensee was not able to determine the justification for this assumption.

The SSFI team reviewed the Bechtel "Emergency Service Water System" calculation (dated May 25, 1971), which was performed to prove that the installed pumps could provide the required system flow. The required system flow was derived through summation of various required flows to the individual heat exchangers and was found to be 6376 gpm, which was lower than the pump design flow of 8000 gpm. The calculations indicated that, at a flow rate of 6376 gpm, the emergency service water pump could produce a head of 104 feet, which is sufficient for both static and dynamic resistances of the system. The calculation assumed balanced flows. However, for the system as configured in the plant, the flow is not balanced.

The team also reviewed the Bechtel "Emergency Service Water System Network Analysis" dated July 1984. This was the most recent analysis performed by Bechtel to determine the effect on flow to the individual ECCS room coolers due to a loss of control air to the safeguard coolers isolation valves. The licensee had considered the effect of a loss-of-air event on the ESW system performance because the air system at Peach Bottom was not safety-related. The analysis indicated that loss of air would cause both ECCS room coolers to be placed in service, although only one of the two room coolers would be effective in reducing the room temperature because only one of the two ECCS room cooler fans would receive an initiating signal during a design basis accident. The team was concerned because this analysis indicated that the ESW pumps could not deliver the design flow to most of the components in the normal cooling mode and that, under certain conditions, there could be reduced net positive suction head for the ESW booster pump when the ESW system was operated in either of the cooling tower modes. The team further found that:

- The new ECCS room temperatures had little or no design margin for HPCI, core spray, and the residual heat removal rooms.

- The Bechtel analysis did not fully account for the effect of corrosion and erosion of the ESW piping on the system flow.

- The analysis did not take into account the fouling of heat exchangers and piping and its effect on both ESW flow and heat exchanger performance.

- The analysis made reference to qualification temperatures based on preliminary calculations.

Bechtel's analysis showed that, in the worst case, the flow to several unit coolers was 37 percent of the design flow. Bechtel concluded that, with a loss of air and unbalanced system flow, the ESW pump was capable of delivering approximately 6440 gpm to the system. The analysis compared the increased room temperatures with the preliminary equipment qualification temperatures and concluded that the ESW system was still functional because all room temperatures would satisfy equipment qualification temperatures.

However, the SSFI team was unable to determine from the Bechtel analysis whether Bechtel had assumed that the reactor building closed cooling water (RBCCW) heat exchangers (HXs) were in service for the purpose of calculating ECCS room temperatures. The team was informed by the licensee that the ECCS room temperatures were calculated with RBCCW HXs in service. However, since RBCCW HX can receive a significant portion of the ESW flow when in service (approximately 40 percent of total ESW flow), the team determined that it was important that this factor be clearly identified in the report. Additionally, the team could not understand why the RBCCW HX would be considered for the ESW system performance analysis in 1984. The RBCCW system was required to be isolated based on a 1979 safety evaluation that found the system not to be seismically qualified.

The team considered that inadequate design control and the lack of a suitable testing program by the licensee had allowed a potentially significant design deficiency in the ESW system to go unrecognized by engineering and operations personnel. While system analyses performed in 1984 had shown that calculated flow values could minimally meet calculated load demands, and field tests to verify the analytical results were recommended by Bechtel in 1984 and by PECO engineers in 1989, no such integrated ESW system field test had been performed prior to this inspection. In addition, the licensee modified the system in 1988 by replacing two-inch piping on Unit 2, and in 1989, by increasing the size of the Unit 3 ring header. The licensee's failure to identify ESW system flow deficiencies from initial plant startup to 1983, and the failure to initiate corrective action once the ESW system flow deficiency was assessed in 1983 is a potential violation of the requirements of 10 CFR Part 50, Appendix B Criterion XVI (50-277/90-200-01; 50-278/90-200-01). Based on the team's findings, the licensee initiated immediate corrective actions to assess the capability of the ESW system. Preliminary plans to this effect were presented to the team at the conclusion of the inspection.

The team was unable to review calculations for the two ECW cooling tower modes of operation because the licensee had not yet performed calculations to determine the design requirements for the ESW system in those two modes. However, after review of available design information associated with the system in these two modes, the team noted that the licensee had completed modifications to the ESW system operations without adequately evaluating the effect of such modifications on the operability of the ESW system.

- The licensee had not calculated the effect of throttling the ESW booster pump discharge valve on the system flow. Operators were directed to throttle the discharge valve to prevent tripping the ESW booster pumps during low suction pressure. The team was concerned that throttling close the discharge valve to 75 percent could reduce ESW flow to the point that the ECCS coolers would receive less than the design flow.

- The ESW system design had been changed in 1979 by isolating the reactor building closed cooling water (RBCCW) system from the ESW system. This change in the plant configuration was necessary to isolate the seismically designed ESW system from the nonseismically designed RBCCW system. This change resulted in the reduction of ESW flow to the suction side of the ESW system booster pumps.

The licensee may make changes to the facility as described in the FSAR pursuant to 10 CFR 50.59. The licensee must maintain records that include a written safety evaluation to determine whether an unreviewed safety question was introduced by the change. The licensee completed the above modifications, which changed the ESW and RBCCW systems from those described in the FSAR without performing appropriate safety evaluations. This is a potential violation of the requirements of 10 CFR 50.59 (50-277/90-200-02; 50-278/90-200-02).

2.1.2 ESW Electrical Design

The team reviewed the power source and distribution system for the ESW system as well as the design documentation for the motors and loads needed for the ESW system equipment. The team found minor discrepancies between the design basis calculations and the regulatory requirements. However, these discrepancies did not affect the operability of the ESW system.

Design basis documents, such as essential calculations, should be controlled in accordance with Section III, "Design Control," and Section V, "Instructions, Procedures, and Drawings," of 10 CFR Part 50, Appendix B, and ANSI Standard N45.2.11-1974, "Quality Assurance Requirements for the Design of Nuclear Power Plants."

The following discrepancies were identified:

- The coordination diagram, Figure 1 of sheet 16 of the coordination study, calculation E-4, did not show that the load center transformer was properly protected for a ground fault of 1002 amperes for 2 seconds in accordance with the ANSI standard. Further investigation showed that this protection was adequately provided by relay 151 N, which was not shown in the coordination diagram. The licensee stated that the graphs of calculation E-4 will be revised to indicate that adequate transformer protection is provided.

- The SSFI team reviewed the protection documentation for the ESW pump, ESW booster pump, and ECW pump and found that documentation of motor protection against current overloads and short circuits, and coordination of protective relay settings versus motor starting inrush current were not properly shown in the calculations or were entirely missing. Important parameters, such as the motor accelerating time and the motor stall time (which relates to the period of time that the motor is able to withstand the high level of starting current) were not included in the original coordination graphs. This information is important to ensure that the motor will trip during the starting and running periods before exceeding the limits to prevent damage to the motor. It also is important to ensure that spurious tripping will not occur during motor acceleration. The team also found instances where that the calculations were unchecked, references were not provided, and some assumptions were not stated or validated. The preliminary rough calculation performed by the licensee to answer the team's concerns indicated that adequate relaying protection was being provided, and that no spurious trips could be present during the motor accelerating period. The licensee committed to formalizing the revisions to the calculations performed during the inspection.

- The team could not determine from the control diagram for the ECT fan motors, drawing E-347, whether proper undervoltage protection for the ECT fans was provided. The licensee initiated a search and was able to find switchgear vendor information which demonstrated that this protection was provided by devices internal to the breaker.

- The team examined the control circuit for the sluice gate valves and found that a potential existed for the overload protection to be spuriously bypassed by an accidental ground fault. While this constituted a design shortcoming, it was eventually determined that there was no safety impact because sufficient time would be available for operation of the valves by hand if the motor operators became inoperative. Therefore, the operational capability of the ESW system would not be affected.

2.1.3 ESW Instrumentation and Control Design

The SSFI team reviewed the ESW system electrical schematic diagrams and instrument calibration records, the valve and pump manual, and automatic controls, indication, alarms, protective relaying and interlocks, and the power supplies for motors and control circuits.

The inspection team reviewed the control logic of the redundant ESW pumps, Trains A and B, and noted the following:

- The logic circuitry design would initiate and maintain an automatic start signal to the standby pump upon loss of the operating ESW pump. If the standby pump were tripped manually or automatically after it was initially started, it would be difficult to restart. The 4.16kV breakers for the ESW pumps are provided with antipump logic circuitry designed to prevent cycling of the circuit breaker between the closed and tripped position when closing and trip signals exist concurrently. The details of this design problem were issued as part of Information Notice Number 75, 1988. Because the automatic start signal is continually maintained and this feature seals in the antipump circuit, attempts to close the breaker for the standby pump would be prevented without altering the control logic. The team was concerned that this unique design feature associated with the ESW pumps would unnecessarily confuse the operators if the second ESW pump was needed. The inspectors verified that control room operators were unaware of this design feature. The licensee agreed that applicable alarm response cards and off-normal operating procedures will be revised to include information for operators on how to reset and restart the pumps.

- The power circuitry for the ESW pumps logic was common to both trains A and B, resulting in the degradation of independence between trains. Furthermore, cross wiring between the logic circuitry networks of trains A and B created a condition in which wiring of the logic circuitry for both trains was terminated on adjacent control switch terminals, violating the intent of the separation criteria of document 22A1421, "Electrical Equipment Separation for Safeguards Systems." Although the licensee had performed an analysis to demonstrate that a single failure of common devices that would disable both trains is not likely, this analysis did not account for gross failure of the switch, which could be caused by a fire or other external event. This item remains unresolved pending an NRC review of the licensee's evaluation to determine the impact of catastrophic switch failure on system operability (50-277/90-200-03; 50-278/90-200-03).

The SSFI team reviewed the electrical circuits for the ECW tower system and found that controls and associated cables for the ECW tower fans were not seismically qualified. Some equipment was classified as safety related and other equipment was classified as not safety related. The team's review of drawings 6280-E-347, "Electrical Schematic Diagram Emergency Cooling System Cooling Tower Fans," Revision 7, and 6280-E-346, "Electrical Schematic Diagram Emergency Cooling System Cooling Tower Fan Inlet Valves," Revision 7, indicated that the controls and associated cables to the ECW cooling tower fans were not seismically qualified. Section 10.24.2.4 of the Peach Bottom FSAR requires the ECW system to be operable during a loss of offsite power and after a seismic event. Although the team determined that, based on the design documents, all emergency cooling tower equipment appeared to be operable after a loss of offsite power, the team concluded that adequate documentation did not exist to show that the ECW cooling tower fan controllers could withstand a seismic event.

The failure of ECW fans following a seismic event would result in loss of both modes of the closed cooling operation of the ESW system, which constitutes the plant heat sink when the normal heat sink, Conwingo pond, is unavailable. The licensee stated that documentation verifying the seismic qualification of the subject equipment will be developed. This item remains unresolved pending NRC review of such documents (50-277/90-200-04; 50-278/90-200-04).

The team also reviewed the records and procedures used to routinely conduct instrument calibrations to determine whether the setpoints were set correctly and whether instrument accuracy was adequate for the use of the instrumentation. The team found that the calibrations were conducted according to procedures without discrepancies, and that the procedures were adequate for the calibrations performed.

2.2 High-Pressure Coolant Injection System

2.2.1 HPCI Mechanical Design

The SSFI team reviewed the available design documents to determine whether HPCI system design parameters used in the various safety analyses and referenced in the FSAR and Technical Specifications were adequately supported by calculations or analyses. Although the team determined that the HPCI system was adequately designed, the team found that the HPCI gland seal condenser is a nonsafety-related component. As a result, the team was concerned that failure of the condenser could affect the HPCI system capability to meet its functional requirements. The gland seal condenser associated with the HPCI pump condenses the gland sealing steam, to prevent the steam from entering the room. Since the gland seal condenser is not environmentally qualified on the shell side where it is connected to the turbine seal leak-off connections, the team was concerned that, during a design basis accident, the integrity of the shell could be lost and the steam from the turbine shafts could leak into the HPCI room and raise the room temperature. Although FSAR Section 6.4.1 indicates that failure of the gland seal condenser does not prevent the HPCI system from fulfilling its core cooling objective, consideration was apparently not given to the increase in room temperature that would result from the gross failure of the gland steam condenser. Based on the team's concerns, the licensee calculated the maximum room temperature following a condenser failure, and determined that the room temperature would be maintained at less than 150°F, which would assure continued system operation.

The team reviewed calculations to ensure that vortexing would not be caused by the HPCI pump at either the suppression pool or the condensate storage tank. Calculation ME-378, "Determination of Vortex Limit for ECCS Pumps Taking Suction on Suppression Pool," dated March 14, 1989, showed that the level at which vortexing would occur is well below the low water level alarm of the suppression pool. The team considered this to be acceptable protection against vortexing when taking suction from the suppression pool.

However, calculation 18247-M-035, "Condensate Storage Tank - Minimum Water Level to Prevent Vortex Formation," dated February 20, 1990, showed that the present low suction setpoint associated with the condensate storage tank was below the level at which vortexing would occur. The calculation showed that a water level of 6 feet 9 inches from the bottom of the condensate storage tank is required to prevent vortex formation and that the present low suction transfer setpoint from the condensate storage tank to the suppression pool is 5 feet 3 inches, per Technical Specification Table 3.2.B. The 6-foot 9-inch value includes an allowance for a 35-second transfer of the pump suction from the condensate storage tank to the suppression pool.

The licensee stated that, even though the HPCI pump would be vortexing for approximately 2 minutes until the suction transfer to the suppression pool is complete, there would be no damage expected to the pump from this short duration of vortexing. The team agreed with the licensee's assessment.

The team reviewed the licensee's station blackout procedure and found that the temperature requirement to shift suction from the suppression pool to the condensate storage tank could subject the HPCI pump to cavitation. Procedure SE-11, Revision 2, "Station Blackout," Paragraph 16.b, directs the operator to transfer the HPCI pump suction to the condensate storage tank when the torus temperature reaches 200°F. Bechtel calculation MO-1, Revision 4, dated November 2, 1989, "Maximum Torus Temperature Allowed (Assuming no Torus Back Pressure) for the ECCS Systems," determined that cavitation of the HPCI pump would begin at a torus temperature of 196°F. Therefore, the team was concerned that the 200°F value in procedure SE-11 was above the maximum temperature for adequate net positive suction head for the HPCI pump. The licensee agreed that the 200°F transfer point for the HPCI pump was unsatisfactory and said it would revise procedure SE-11 to indicate 190°F in lieu of 200°F. This commitment is considered to be an open item (50-277/90-200-05; 50-278/90-200-05).

The team also found a discrepancy in calculation 18247-M-034, which was performed to support a General Electric (GE) specification 22A1330AB requirement that the total condensate reserve storage capacity for both HPCI and reactor core isolation cooling systems, be 135,000 gallons per unit. However, the condensate storage tank had only 99,137 gallons available. The licensee said that the original specification of 135,000 gallons dedicated reserve for the HPCI and reactor core isolation cooling systems corresponded to 8 hours of system operation, making up decay heat boil off and inventory shrink. The 135,000 gallons was based on the reactor and core models of the late 1960's. However, the team found that a recent analysis performed by GE using present day GE models indicated that a capacity of 140,694 gallons is needed to ensure 8 hours of satisfactory system operation.

The licensee did not consider the condensate storage tank inventory discrepancy to be a safety concern. The condensate storage tank is not required to be seismically qualified and the torus is available as a safeguard source of water for the HPCI system accident response. However, the available water volume in the condensate storage tank for safe shutdown may impact other analyses (e.g., safe shutdown for Appendix R). The licensee and GE reviewed the Peach Bottom Fire Protection Plan and the Station Blackout Analyses, and concluded that the ability to safely shut down the reactor is not affected by this volume discrepancy. Although there now appears to be no significant safety concern in this area, the team considered that the licensee failed to recognize a long-standing design deficiency.

2.2.2 HPCI Electrical Design

The team reviewed the power source and distribution system for the ESW system as well as the design documentation for the motors and loads for the equipment that is needed for the HPCI system. This was a limited review because of the relatively small number of components that are required to function in order to render the HPCI system operable. With the exception of the steam supply inboard containment isolation valve MO-15, the HPCI system does not depend on ac power. This isolation valve is normally in the open position, therefore, it does not need to operate to allow the HPCI function. All other valves and auxiliary systems, including controls and instrumentation and power, are from the dc onsite power system.

During its review of drawing E26, Revision 42, the team noted that, because a portion of feeder to panel 2PPC connecting fuse box 2AD17 to fuse box 2CD19, did not have a dedicated fuse protection, it appeared to be unprotected against overloads. The licensee responded that the likelihood of short circuit between the positive and negative wires was precluded because the cable conductors are run in separate conduits and are very short in length. The team considered this explanation to be adequate.

The team reviewed the one-line diagram, drawing E-26, Sheet 1, for plant dc power and found that 35-ampere fuses were being used to protect the #10 AWG cable feeder. This fuse size appeared to be too large for proper branch circuit protection. The licensee indicated that presently available fuses for 250V dc were 35 ampere rating and larger and that no fuses rated below 35 ampere were commercially available for operation at 250 volts. The lack of commercially available fuses in the lower level amperage and 250 volt rating motivated the use of a larger fuse than would normally have been provided. The team agreed that voltage rating was more important than ampere rating, and that the overload protection in the starter should afford adequate protection for the cable.

2.2.3 HPCI Instrumentation and Control Design

The team reviewed the electrical schematic diagrams, instrument calibration and functional test records to determine whether the automatic and manual controls, indications, alarms, and interlocks were adequate to meet the requirements of the FSAR and Technical Specifications. The review included an evaluation of the control circuit fuse coordination, motor-operated valve limit switch and torque switch application, and instrument setpoint accuracies. The instrumentation and control for the HPCI system appeared to be inadequate for concerns regarding fuse selection and sizing.

The team also reviewed the motive and control power fuse protection for the HPCI dc pump motors in the 125V and 250V dc circuits. Three auxiliary pumps are associated with each of the two HPCI pumps. Two of these pumps, the gland seal condenser condensate and vacuum pumps, are not safety related. The third pump, the auxiliary oil pump, is safety-related and is used during initial HPCI pump startup for supplying control oil to the HPCI turbine control unit and for supplying bearing oil to the HPCI bearings. The team found that the fuse sizing coordination for short circuit protection of the gland seal condenser condensate and vacuum pumps was modified in response to 10 CFR 50 Appendix R requirements to accommodate alternate shutdown capability following a fire. The new design did not provide selectivity to ensure that a short circuit induced fault would only blow the fuse close to the fault without blowing the fuse upstream. For example, the 125V dc control power supply positive phase for the gland seal condensate pump motor had a 12A fuse in series with a 15A fuse. This configuration did not provide selectivity to ensure that only one of the fuses would blow on short circuit fault current in the control circuit. The fuse manufacturer's guidelines for fuse coordination indicated that a two to one ratio between fuses in series is needed, thus both the 15A and 12A fuses were likely to fail.

Although the operators would be able to regain control power to these pumps even if both the 15A and 12A fuses had blown, the operators would not be able to maintain operability of the pumps because the power to the motors themselves could not be regained. In addition, the team was concerned that at the time the auxiliary oil pump controls are transferred to the alternate 125V dc power control circuit, two 15A fuses on the feeders would then be in parallel, capable of supplying 30 amperes of current. However, 30 amperes appeared to exceed the ampacity of the control circuit conductor size of No. 14 AWG or less resulting in the loss of the auxiliary oil pump. On the basis of the team's finding the licensee prepared nonconformance reports to initiate corrective actions. This item remains unresolved pending NRC review of the completed corrective actions (50-277/90-200-06; 50-278/90-200-06).

The team reviewed the HPCI system alarms on drawing 6280-M-S-36, sheets 19 and 26, Revision 62, and found that the licensee did not have bypassed or loss-of-status indication for the motor power to HPCI valves 23-17, 19, 21, 14, 16, 24, 25, 57, and 58. The team was particularly concerned that a loss of motor power to HPCI valves MO-14 and 19 would not be annunciated in the control room. These valves are required to open in order for the HPCI system to function. MO-14 is the steam inlet valve to the HPCI turbine and MO-19 is the HPCI discharge valve.

Additionally, the team's review of design input document M-20593, Revision 1, dated April 3, 1985, for the alternate control station modification, referenced Regulatory Guide (RG) 1.47, "Bypassed and Inoperable Status Indication." RG 1.47 requires that bypassed or inoperable status of equipment be indicated in the control room. However, the licensee had not followed RG 1.47 because inoperable status alarms were lacking for loss of 250V dc power to valves 23-17, 19, 21, 14, 16, 24, 25, 57, and 58 and control switches S23A-S17, S19, and S72 in the "locked-out-in-stop" position.

Also, the team was concerned that the annunciator for the loss of motor power to the auxiliary oil pump might not invoke a timely response from the operators because it is the common alarm to detect loss of motor power to the gland seal condenser condensate pump and the gland seal condenser blower. Prompt attention is required for loss of motor power to the auxiliary oil pump because it provides lubrication initially for the HPCI turbines and also provides control oil to the HPCI stop and control valves. These valves control the startup time of the HPCI turbine, which must meet a 25 second criterion.

The licensee stated that PECO was not committed to implement the requirements of RG 1.47 at the Peach Bottom power station. The implementation of the RG 1.47 requirement for modification M-20593 was an engineering initiative not supported by departmental procedures. The licensee stated, however, that a consistent policy will be developed and incorporated into engineering procedures.

The team also reviewed a sample of the records of the routinely conducted instrument setpoint calibrations for instrumentation associated with the HPCI system to determine whether the records adequately demonstrated setpoint accuracy. The team found that calibrations had been as required by procedures, that the procedures were adequate, and that no significant discrepancies existed.

The team also reviewed a sample of surveillance test records to determine whether the tests checked the logic functions from the initiating source to the actuation device. For the cases in which the initiation was from a coincidence logic, the team reviewed only one channel. The team determined that the tests reviewed were adequate and met the surveillance requirements.

2.3 Other Related Electrical Systems

The team also reviewed other electrical systems which provide ac or dc power to either the ESW or the HPCI or that could affect the reliability of ac or dc power to these systems.

2.3.1 Emergency Diesel Generators (EDGs) Loading

The team reviewed modification package 2123A, dated February 2, 1990, and found that a recalculation of the loading conditions for the EDGs showed a substantial increase in previously estimated loads that were the basis for the values given in FSAR Tables 5.5.2. Newly calculated loading conditions resulted in considerable reduction of the previously established design margins for the EDGs.

The team also noted that, in the event the operators had to restart the RHR pumps on a loaded diesel generator, they would have to reduce the bus loads to 1400 kW because of the existing diesel design margin. The licensee is now in the process of revising the operating procedures and associated training for this event.

2.3.2 Electrical Protection Systems

The team reviewed various electrical protection devices for the ac and dc systems to determine their ability to protect the ac and dc power sources. Although the team concluded that the existing protection systems could adequately provide the required protection, the team had the following concerns:

- The ability of the dc ground fault detection system to detect grounds was questionable because the supporting calculations could not be found. The licensee performed calculations to demonstrate that the system would operate successfully.

  The ground fault detection scheme consists of a relay and indicating lights. If a ground fault occurred, the relay would be energized and cause the alarm indicating lights in the control room to identify the location of the fault, and which system is affected, i.e., either the positive, negative, or neutral bus system. The calculations performed by the licensee during the inspection show that the system operates successfully even with high resistance faults up to about 10,000 ohm in value, which complies with industry-accepted practice (e.g., EPRI Power Plant Electrical Reference Series, DC Distribution System Manual, page 9-19). The licensee committed to formalizing the calculations performed during the inspection.

- The team's review indicated that the EDG ground fault protection would not be bypassed during accident conditions, as expected by current industry practice. The team was initially concerned that this condition might subject the EDG to increased spurious trips. However, the licensee's calculation performed during the inspection indicated that there should be no concerns with undue spurious trips.

- The EDG grounding system was a high-impedance type system, consisting of a grounding resistor connected between the stator, or neutral point, and ground. The grounding resistor was rated for 30 amperes for 10 seconds. If a fault occurred, the potential of the generator neutral would become elevated relative to ground. When the fault was at the generator terminals or outside the generator winding, the fault value was 30 amperes. When the relay was energized, it tripped the generator circuit breaker and the associated diesel engine. Contrary to current practice in nuclear generating stations, the tripping function of the relay would not be bypassed during accident conditions. The licensee's calculation showed that the combination current transformer and time delay overcurrent relay would provide for fault detection and would operate down to 6 amperes of fault current; thus providing protection for 80 percent of the generator winding. The 6-ampere level was considered sufficiently high to prevent undue tripping under conditions of third harmonic current flow. The team requested that the rating of the grounding resistor be verified for its ability to continuously withstand a current of 6 amperes, which was the threshold level of detection. The licensee contacted the resistor manufacturer and confirmed that the resistor was able to carry 6 amperes indefinitely.

Concerns regarding the adequacy of protection coordination in case of a ground fault in the diesel generator winding for the case of low-level faults were alleviated by the licensee's calculation. However, the following observations were made by the team:

- Small magnitude ground fault currents (less than 6 amperes) would be undetected by the EDG protective relay; the resulting voltage unbalance could be harmful to the motors or activate the zero sequence protection provided by the engineered safety feature (ESF) breaker. Also, for fault currents below 6 amperes, the feeder ground fault protection could be activated if faults occurred inside the generator winding. The ground fault protection could be activated if the voltage unbalance was of sufficient magnitude to provide for a large enough capacitive charging current flow to trip the zero sequence relay.

- No calculation or analysis existed for the case of unbalanced voltage. However, the licensee's preliminary rough calculation indicated that the voltage unbalance would be about 14.25 percent, which was low enough to preclude any concerns regarding the feeder ground fault protection.

2.3.3 Voltage Regulation for Control Circuits

The team reviewed calculation E-13, Revision 2, performed to demonstrate that the motor control center (MCC) contactor coil would receive sufficient voltage to operate when coils for the control circuits fed from control transformers at the MCC were energized (picked up). The minimum pick-up voltage was established by the manufacturer as 85 percent of nominal voltage. Although some of the calculation methodology was not correct and some of the assumptions were not properly supported, the team concluded that the discrepancies were not sufficient to disable any control circuits for the ESW and HPCI systems because the design margin for the control circuits was adequate.

2.3.4 Improper Documentation of Design Basis Calculations

The team found discrepancies between the design basis calculations and the regulatory requirements, such as Sections III and V of Appendix B to 10 CFR Part 50 and ANSI N45.2.11-1974. Many of the calculations were found to be deficient in terms of proper referencing, substantiation of assumptions, methodology, proper checking/verification, and control. For example, calculations E-3 and E-4 were not properly controlled, as evidenced by the originals being used for everyday consultation and by revisions being indicated with red pen, and without proper checking or traceability. In addition, references to the relay characteristic curves were missing, the relay device numbers were not shown, and the main coordination graphs did not have a checked signature. The licensee committed to review and revise calculations E-3 and E-4 to address the team's comments.

2.4 Operations

Deficiencies and weaknesses were found in the general areas of system configuration and system operation versus design requirements and conformance of plant operating documents and design drawings to actual plant configuration.

2.4.1 Operational Programs

The SSFI team reviewed operational programs for night orders, control of temporary plant alterations and operator aids, as well as selected plant status aids such as the equipment status list, the control room information book, and the system status file. No deficiencies or weaknesses were noted in these programs.

The licensee employed an Operations Manual which delineated the conduct of operations in administrative and technical areas, and appeared to be adequate for guidance in correct operational practices.

The operator aids program, administered under Section OM-9 of the Operations Manual, appeared to be an area of strength. Operator aids were in widespread use, were generally well controlled with regard to the scope of information provided and needed for posting, and were periodically verified to be in place as required. The use of operator aids for control room panels was coordinated with the plant simulator so that inconsistencies would not develop. If unauthorized operator aids were found, personnel were directed to remove them and to inform the Shift Technical Advisor (STA).

The team observed uncontrolled copies of electrical drawings placed at one breaker cubicle to facilitate maintenance and testing activities. As a corrective measure, the licensee inspected all HPCI-associated MCCs and removed the uncontrolled drawings from these cubicles. The licensee also stated that additional corrective actions will be taken by issuing a memorandum to all supervisors prohibiting the use of uncontrolled documents in the field, and that the proper use of procedures and drawings would be included in the technical staff's training program. This commitment is considered to be an open item (50-277/90-200-07; 50-278/90-200-07).

2.4.2 Operations Procedures

The team reviewed the licensee's trip response procedures applicable to the HPCI and ESW systems and noted no deficiencies. The team also reviewed applicable alarm response procedures (ARPs), check-off lists (COL), drawings, and station blackout procedure SE-11 and conducted system walkdowns using drawings and COLs.

The licensee previously used alarm response cards (ARCs) to govern alarm response in the control room and at selected local panels, and was in the process of revising and upgrading these to ARPs. The team found several deficiencies regarding the licensee's use of these procedures:

- Discrepancies were identified between the setpoint values engraved on the control room annunciator windows and the values of the setpoints used in the ARCs/ARPs for windows 20C204B(B-3, C-3, and A-4) and 20C226(A-4). In addition, similar discrepancies were noted for the alarms on the alternative shutdown panel. The licensee stated that setpoint information that was not related to technical specification limits will be removed from all control room annunciator windows and the alternative shutdown panel.

- During walkdown of the Unit 2 alternative shutdown panel, outdated ARCs were observed in a holder located on the face of the panel next to the HPCI controls. Current ARPs were located in a procedure notebook in the panel area. The team reviewed the actions required by the superseded ARCs and determined that no degradation of safety would have occurred if an operator had erroneously used the superseded cards. The licensee corrected this deficiency by removing the holders from the panels of both Units 2 and 3.

The team also found discrepancies between the drawings and check-off lists (COLs) for HPCI and ESW systems as well as between the documentation and the actual field installation for system vent and drain valves on Units 2 and 3. For example, valves were shown on the COL as being closed when they should have been shown as closed and capped, valves shown on the COL should have been shown on the drawings, and valves shown on the drawings did not exist in the field. The licensee initiated corrective actions to correct the documents. Most of the discrepancies were noted on Unit 2, which was in the process of a drawing walkdown and update program. No unsafe conditions were noted in the plant as a result of the documentation discrepancies.

During a walkdown of the ESW system in the emergency cooling tower (ECT) area, the inspection team observed that valve HV 0-48-11211A, ESW to ECT vent valve, was in the open position when it was required to be closed by the system COL and the system drawing. The open valve would have diverted a small portion of the flow from the ECT riser to the sump area during operation of the ECT, but the sump pumps would have returned the water to the ECT basin. A review of the currently applicable COL for the system, which was conducted in April 1989, verified the valve to be in the closed position. The licensee immediately placed the valve in the correct position and initiated an operations incident report to determine the cause and duration of the condition. The licensee's report was not completed at the close of the inspection. This item remains unresolved pending NRC review of the licensee's incident report and subsequent corrective actions (50-277/90-200-08; 50-278/90-200-08).

The inspection team conducted a walkdown of Appendix 4 to Station Blackout Procedure SE-11, which directed activities outside the control room for taking manual control of HPCI and reactor core isolation cooling. These activities included lifting leads in the cable spreading room, blocking doors to provide a ventilation pathway, and adjusting the control system for the HPCI turbine. The licensee selected an employee to accompany the team and simulate the activities directed by the procedure. The following deficiencies were observed by the team:

- The licensee had not prestaged tools, meters, door blocks, and other materials to expedite conduct of the required activities. Some delay was experienced initially in retrieving the appropriate tools, and suitable door blocks in sufficient quantity were not available.

- The employee simulating the performance of the procedure was unfamiliar with the specified actions required to adjust the control system for the HPCI turbine. The actions involved adjusting a null-voltage potentiometer in close proximity to an operating turbine while observing a portable voltage meter attached to a panel some distance away. The team observed that two individuals may be more appropriate for this action. Additionally, no cautions were present in the procedure concerning the potential for excessive radiation exposure.

The licensee stated that a human factors review of the station blackout procedure will be performed. The necessary tools and equipment for performance of the actions outside the control room will be prestaged. The appropriate individuals to perform the actions will be designated and training will be provided. This commitment is considered to be an open item (50-277/90-200-09; 50-278/90-200-09).

Procedure SO 48.1.B, "Emergency Cooling Water System Startup," provided instructions to start up the ECW system and provide an alternate heat sink in the event that the normal heat sink became unavailable.

The procedure contained notes and precautions advising the operator that sufficient suction pressure to the ESW booster pumps may not be available if less than the design flow path was in service for ESW. If a booster pump trip occurred because of low suction pressure, the procedure provided steps to restore the ESW booster pumps to operation by throttling the manual pump discharge gate valves or by throttling the ESW inlet valve and then restarting a booster pump. The team found the following deficiencies in the procedural guidance which could adversely affect system heat removal capability and prevent it from being able to meet its function during accident conditions:

1. In step 3.2 and note No. 2 the procedure erroneously identified the reactor building closed cooling water (RBCCW) system as being part of the design ESW flow path.

2. Step 4.2 of the procedure directed the operators to line up the ESW to the RBCCW heat exchangers. A 1979 safety evaluation determined that the RBCCW is not seismically qualified. Therefore, the isolation of this system from the ESW flow path is essential to the continued operability of the seismically qualified ESW system.

3. The procedure allowed the automatic starting booster pumps to trip prior to throttling discharge valves to a position that would assure continued booster pump operations.

4. Step 4.8.4 did not instruct operators how to recognize that the booster pump discharge valve in the throttled position is 25 percent open.

The team considered that the procedure was contrary to the previous licensee design to maintain the RBCCW system isolated from the ESW, and that the procedure did not assure continued operation of the emergency cooling water system because it allowed the automatic starting booster pumps to trip prior to adjusting to flow conditions necessary to maintain the system operable. This item remains unresolved pending NRC review of the licensee's corrective action (50-277/90-200-10; 50-278/90-200-10).

Operations Procedure AO 33.2, "ESW Manual Startup and Operations," noted that a flow path should be provided for the ESW pumps since minimum flow recirculation paths were not provided in the system design. The team reviewed surveillance test (ST) 6.3, "ESW Pump, Valve, Flow, Cooler," and found that Steps 18 and 21 contained requirements for starting and stopping ESW pumps A and B at shutoff head conditions in order to record pump discharge pressure, pump amps and vibration. The team was concerned that no caution to avoid pump damage was provided in ST 6.3 to indicate maximum running time under these conditions. The licensee stated that the procedure would be revised to incorporate the appropriate precautions, and agreed to review test procedures ST 13.21 and ST 13.21.1, "ECW Booster Pump and Emergency Cooling Tower Fan Operability," to determine whether similar revisions were necessary. This commitment is considered to be an open item (50-277/90-200-11; 50-278/90-200-11).

The team reviewed the test results of Special Procedure (SP) 630-2, "Integrated Test of the Unit 2 Emergency Cooling Water System," which was performed on April 8, 1989, and SP 630-3, "Integrated Test of the Unit 3 Emergency cooling Water System," which was performed on September 24, 1989. The purpose of the tests was to determine the capability of the system to deliver adequate flow to system components and to deliver adequate flow by gravity drain from the ECTs to the ESW/HPSW pump bays under closed-loop operation with the pump bays isolated from the Conowingo pond. The team identified the following deficiencies:

- Steps 47-50 of SP 630-2 and Steps 7.48-7.51 of SP 630-3 calculated the ESW pump flow and the ESW booster pump flow based on measuring pump differential pressures and determining flow rates from the pump head curves. The system was in a closed-loop mode of operation during this portion of the test and the ESW pump and ESW booster pump flows should have matched. The team found that the Unit 2 pump flows differed by 3800 gpm and the Unit 3 pump flows differed by 2000 gpm. This discrepancy was not noted in the test procedure as being questionable. The licensee concluded that the differences in flow rates resulted from several factors, including instrument tolerances for pressure gauges, use of pump curves to determine flow rates, instrument tolerances for bay level, and an inability to read small level changes with the indicators. The team concluded that the test was unsatisfactory to conclude that design flow requirements were maintained. The instrumentation which was used did not allow an accurate determination of system flow.

- One portion of the test for Unit 3 specified an acceptance criterion of 17000 gpm for return flow from the ECT to the pump bay. The team found that a portion of the flow calculation used too high a flow rate for the ESW pump under the tested condition, since the emergency diesel generator coolers were valved out for this portion of the test. The acceptance criterion was not met. The licensee reviewed the test results and concluded that adequate flow was returned from the ECT to the pump bay to maintain level in the bay and that the acceptance criteria in the test was poorly stated.

- A portion of the tests determined the capability of the ESW booster pumps to remain in operation by throttling the pump discharge valves to prevent low suction pressure trip under system flow conditions less than design maximum. The test successively closed diesel generator cooler paths and adjusted discharge valve positions to maintain suction pressure in the desired range. The test did not establish flow conditions and discharge valve positions for the case in which RBCCW would be isolated and the diesel generator and ECCS cooler paths would be open, which would be the expected plant condition.

2.4.3 Operator Training

The team found lesson plans and simulator scenarios to be generally adequate in the depth of information presented and the correctness of the information as related to approved plant procedures. Several deficiencies in the training material regarding alarm setpoints for HPCI system components were noted by the team and were identified to the licensee for corrective action. The deficiencies were related to the deficiencies noted between the annunciator window labels and the alarm response procedures as discussed in Section 3.4.2. The simulator capabilities appeared to be adequate to provide operator training on the control room aspects of system operation and malfunction although the team noted that the ESW booster pumps low suction pressure trip conditions were not modeled on the simulator.

As part of the plant restart program, the licensee developed Operations Section Performance Standards as a means to define how certain operational activities are to be conducted or controlled. The performance standards were used by the simulator instructors to evaluate trainees. The performance criteria ranged from excellent to unsatisfactory and allowed an objective means of evaluating candidates for reactor operator as well as candidates for the senior reactor operator position. The team considered the use of these standards to be a strength.

2.5 Surveillance and Inservice Testing

The SSFI team reviewed the surveillance and inservice test program as implemented for the HPCI and ESW systems to ensure that the surveillance procedures used to verify system function were adequate.

2.5.1 Surveillance Test Procedures

The team found that surveillance test procedures reviewed lacked the necessary detail in some cases to verify that safety-related equipment and systems could accomplish their intended functions. For example, test procedure ST 13.21, "ECW Pumps, ECT Fan, ESW Booster Pump Operability IST," failed to establish acceptance criteria for pump running current, shutoff discharge pressure and suction pressure. The procedure also called for an improper flow alignment by including the reactor building closed cooling water system in the path. The RBCCW is required to remain valved out because of its lack of seismic capability. Additional examples of procedural inadequacies included the requirement for use of an electrical jumper, although the type and size of the jumper was not specified, and specifying a flow test to be performed at a nominal 150 psig reactor pressure, although Unit 2 Technical Specification 4.5.c.1.e required the test to be conducted at 150 psig steam pressure with no allowance for the use of nominal readings.

The licensee stated that a program with a scheduled completion date was now in place to evaluate and rewrite surveillance procedures. This item remains unresolved pending NRC review of the scope and the schedule of the licensee's program (50-277/90-200-12; 50-278/90-200-12).

2.5.2 Surveillance Test Review

The team reviewed the results of surveillance tests performed recently on the HPCI and the ESW systems and observed the performance of testing activities. The paragraphs below address deficiencies and concerns identified by the inspectors.

The licensee performed ST 10.1-3, "Unit 3 HPCI Flow Rate at 150 psig Steam Pressure," to satisfy the requirements of Technical Specification (TS) 4.5.C.1(3). The requirement called for the testing of the HPCI system flow rate at 150 psig steam pressure once per operating cycle. The HPCI pump was required to deliver at least 5000 gpm over a range of reactor pressure from 1000 psig to 150 psig to be considered operable. The surveillance test was last performed on November 26, 1989, at a reactor pressure of 160 psig in lieu of the required value of 150 psig. Thus, the test did not demonstrate the system to be operable at a 150 psig system pressure as required by the Technical Specifications.

The licensee stated that the change in the HPCI pump test parameters was allowed by the Plant Operations Review Committee (PORC), as discussed in PORC Position 24, dated April 15, 1989. The PORC position made the TS 4.5.C.1(3) requirement less limiting by changing the test parameter from 150 psig to a range of 150 psig to 170 psig system pressure. The change in the technical specification requirement was not supported by a documented safety evaluation, as required by 10 CFR 50.59, to determine whether an unreviewed safety question existed. Additionally, controlled copies of the technical specification did not reflect the subject change. Procedure ST 10.1-3 did not reference the PORC position. This matter was discussed with site operations and licensing managers. Subsequently, an engineering evaluation dated February 26, 1990 verified that performing the test at a system pressure up to 170 psig did not constitute an unreviewed safety question. This is considered to be another example in which the licensee failed to perform and document a safety evaluation as required by 10 CFR Part 50.59. A potential violation for the failure to perform such reviews is discussed in Section 2.1.1 of this report.

The team observed licensee activities during a portion of the performance of ST 21.5-2, "ESW Flow Test Through Room Cooler and RHR Pump Seal Cooler," on February 14, 1990. The following weaknesses, deficiencies and concerns were identified:

- The surveillance test crew performed steps out of sequence within the procedure, for example, step 4.d was performed before steps 4.a, b, and c. Administrative Procedure A-47, "Surveillance Test Procedures," requires that procedural steps shall be followed in sequence. Changes to and deviations from the procedural steps required a temporary procedure change to be performed in accordance with administrative procedure A-3.

- The surveillance test work copy was not completed as the test was performed. Additionally, core spray room coolers A, B, C, and D and residual heat removal room coolers had been previously tested without the working copy of the surveillance test procedure being signed off.

- The test crew used uncontrolled instructions that were not specified or referenced in the test procedure to set up their ultrasonic test (UT) instruments. The instructions contained average values for the piping outside diameter and wall thickness in the general area where the test crew had to attach the UT probes. However, the UT probes could be positioned anywhere around the pipe circumference or along the piping run where the insulation had been removed. This variable positioning coupled with average measurements for diameter and wall thickness could affect the measured flow and reduce the reliability of the test measurements.

° Administrative Procedure A-8, "Control of Locked Valves," and Administrative Procedure A-47, "Surveillance Test Procedures," identified the requirements for independent verification and specified that the individuals performing the independent verification should operate independently and should not be directly involved with the specific task to be verified. The inspection team observed that these requirements were not adhered to by the test crew and that independence was not achieved during the verification activities specified in the test procedure.

The performance of ST 6.7.4.2, "Core Spray Motor Oil Cooler Heat Transfer Capability," on February 16, 1990, appeared to be adequate, but a review of the completed test document revealed the following deficiencies:

° On Page 34, "Motor Oil and ESW Temperature Data - 'C' Core Spray Pump," the thrust bearing temperature at starting time was not recorded.

° On Page 35, "Motor Oil and ESW Temperature Data - 'D' Core Spray Pump," the thrust bearing temperatures at 0, 70, 80 minutes were not recorded.

° On Page 34, "Motor Oil and ESW Temperature Data - 'C' Core Spray Pump," the motor oil temperature at 60 minutes was missing and the data recorder initials were missing from starting time to the time of 120 minutes.

The team reviewed the documentation associated with ST 6.6F-2, "Core Spray A Loop Pump, Valve, Flow and Cooler Test - Unit 2," performed on February 16, 1990. The following deficiencies were found:

° The recorder's initials block in paragraph 78A, Step 77, was not filled in.

° Paragraph 79 requires the removal of a fluke meter from SORT-H 83A with and independent verification of the removal. There were no independent verification signoffs made.

In summary, during the observed performance of ST 21.5-2 the test crew disregarded the requirements of Administrative Procedure AP-47 by performing surveillance test steps out of sequence, by not initialling completed steps and by not adhering to independent verification requirements. Temporary procedure changes were not requested by the crew as required by administrative procedure AP-3 when the test cannot be accomplished in the sequence it is written. The test crew utilized uncontrolled instructions to install temporary flow instrumentation. A review of documentation of completed surveillance procedures for ST 6.7.4.2 and ST 6.6F-2, also indicated a lack attention to detail and a failure to conduct adequate reviews of test results. The general lack of adherence to procedural requirements was brought to the attention of plant management by the team. Criterion V of 10 CFR Part 50 Appendix B, requires that activities affecting quality be performed in accordance with appropriate procedures. The licensee's failure to adhere to procedural requirements was considered by the team to be a potential violation of 10 CFR Part 50 Appendix B, Criterion V (50-277/90-200-13; 50-278/90-200-13).

The licensee stated that corrective actions, in the form of training that emphasizes the importance of procedural adherence, and procedural improvements as needed, had been initiated prior to the end of the inspection.

2.6 Maintenance

The SSFI team reviewed activities in the general areas of fastener control, replacement materials, maintenance practices, and spare parts.

2.6.1 Fastener Control, Replacement Material, and Maintenance Practices

The SSFI team reviewed the area of licensee control of original and replacement threaded fasteners (studs, nuts, bolts) during maintenance and modification activities, control of materials used for replacement fasteners and piping, and maintenance practices governing the removal and reinstallation of fasteners.

Replacement fasteners were installed in plant system components, especially in the HPCI system, over several years as a result of maintenance or modifications, but in a number of cases the material used could not be identified. The team found that the origin of some quality related piping and fasteners installed in the HPCI system could not be traced through maintenance request form (MRF) package records. The level of documentation contained in the MRFs was inconsistent. Some MRF packages contained copies of documents that traced the materials used, the signed off copies of procedures that were used, and the documentation of the closeout review, while other packages did not contain some or any of this documentation.

Procedure A-26, "Corrective and Preventive Maintenance, Revision 27," Step 7.6.2.4, required that copies of quality conformance data tags be included in completed MRF packages for all safety-related materials used. However, some of the MRF packages that were reviewed contained direct delivery system documentation instead of the required data tags. Although this documentation was considered by the team to be adequate to specify the quality requirements of the material used, fewer than half of the packages reviewed that required safety-related materials contained this form of documentation or the required data tags.

The team found that numerous studs had been fabricated from threaded rod at the plant site and installed in safety-related components without maintaining the original fastener size or type. Markings indicating fastener specification and grade were not transferred to fabricated studs when appropriate. The team also found cases in which installed fasteners could not be referenced to any known work package, and some pipe sections recently installed in the Unit 2 HPCI lube oil system via a MRF which did not have an associated material record.

The team also identified improperly sized (length and diameter) studs, nuts, and bolts in the HPCI system. On the basis of the team's findings, the system engineer initiated nonconformance reports (NCRs) for several of the instances that required an engineering evaluation to determine acceptability for continued operation of the HPCI turbines on Units 2 and 3. The team found the evaluation for overtorqued studs in the 100 psig oil line of the steam stop actuator relay valve to be marginally adequate. Based on the team's concern regarding apparent undersized and overtorqued studs installed in the HPCI steam chest cover flanges, the licensee undertook an evaluation to determine the effect on HPCI turbine operability, since the studs form part of the high-pressure steam boundary. This review was not completed at the close of the SSFI.

The team also found that inadequate maintenance practices or use of improper replacement fasteners led to numerous instances where studs, bolts, and nuts installed in plant piping systems and components did not have adequate thread engagement. The licensee investigated and determined that these conditions were not in accordance with manufacturer's standards.

The licensee did not have a general maintenance instruction or plant equipment specification that defined acceptable bolting practices and standards. Various requirements were contained in several site documents, such as the site piping specification (M-300) that identifies the correct fastener size and type for the various classes of ASME Code piping installed in the plant and formal maintenance procedures that identify bolt size, torque, and thread engagement. However, MRF packages that did not reference formal approved procedures for work did not provide specific guidance or reference to acceptable standards for size and thread engagement of studs, bolts, and nuts.

The licensee provided a draft version of Specification M-301 for torquing of flange bolts, and the team observed that the scope of the specification did not cover acceptable standards for fastener type, size, torque, and thread engagement for all plant piping and component configurations existing at the plant. Site craft training did not currently provide formal instruction regarding the subject practices; however, training material existed in draft form that will eventually be used to address that area.

Because of the deficiencies in documentation of maintenance activities associated with the HPCI system, the SSFI team could not precisely determine when the wrong size fasteners were installed. Interviews with maintenance personnel and responsible engineers indicated that this condition has been in existence for several years before the team brought it to the licensee's attention. Additionally, there was no assurance that the bolting problem is limited to the HPCI system. The 10 CFR Part 50, Appendix B, Criterion VIII, requires licensees to establish measures for the identification and control of materials and parts in order to prevent the use of incorrect or defective materials in the field. The licensee's apparent failure to implement an adequate program to identify and control the installation of fasteners in the field is contrary to the requirements of 10 CFR 50, Appendix B, Criterion VIII (50-277/90-200-14; 50-278/90-200-14).

2.6.2 Root Cause Analyses

The team reviewed the methodology used by Maintenance for root cause analyses. Root cause analyses by Maintenance were governed by MG-16.2-1, "Guideline for Equipment Failure Report."

The team found that no equipment failure reports (EFRs) had been generated for the ESW system, although several MRFs or groups of MRFs appeared to meet the criteria of Section 7.1 of MG-16.2-1 for initiation of EFRs. For example, there were 143 MRFs issued for work on the ESW system air-operated valves and their associated solenoid valves between the beginning of December 1987 and the end of 1989.

One root cause analysis had been initiated on the solenoid valves because of sticking, but it was initiated outside of the EFR program. Two reports were generated, one by a metallurgical laboratory and one by the manufacturer. The two reports were consistent in their determinations, and the one from the solenoid manufacturer contained recommendations. The reports addressed solenoid valve orientation and air quality as potential causal factors that could be common to several solenoid valves. The inspection team was unable to determine the nature and extent of any planned actions to address the manufacturer's recommendations, nor were follow-up actions specified by the licensee to resolve the concern for this potential common-mode failure that could block cooling to the EDGs and the ECCS room coolers. The team noted that the licensee's root cause analysis program may be inconsistent with existing procedure requirement, however, no items of safety significances were identified by the team.

Other MRFs that appeared to meet the criteria in MG-16.2-1 for an EFR where such reports were not initiated included out-of-specification ESW system valve stroke times, cooler plug leaks, and several check valve problems.

2.6.3 Control of Equipment Trouble Tags

Equipment trouble tags (ETTs) were used by the licensee to indicate deficiencies in plant equipment and to initiate corrective action based on the issuance of an MRF or an NCR. The team identified instances where ETTs were not removed after completion of an MRF to correct the deficiency. In addition, the team found some ETTs which had been installed for a year or longer without initiation of a corresponding follow-up NCR or MRF. Controlling procedures for MRFs required that ETTs be removed when the MRF was closed out; however, there was no mechanism available to track ETT numbers before an NCR or MRF was written to ensure that the condition was formally addressed. Personnel error allowed deficient conditions to be identified on a component but not translated or communicated to various site organizations for evaluation and disposition. The team was concerned that tags that were hung but which lacked follow-up could mislead plant personnel to believe that a deficient condition was properly addressed. The licensee stated that this condition will be evaluated for corrective actions as necessary.

2.6.4 Motor-Operated Valves

The SSFI team reviewed the licensee's practices for the control of torque switch settings on motor-operated valves (MOVs). The licensee had recently finished an extensive inspection, preventive maintenance, and testing program. The program involved a tear-down inspection of the motor operators; inspection of motor-operator components such as spring packs and gears; cleaning and renewing of lubricants; replacement of worn, improper and consumable parts; reassembly and testing. Torque switch setpoints were based on target, maximum and minimum thrust values. The minimum thrust values were based on assuring the valve will close against a design flow condition. The maximum thrust values considered the strength of the valve as well as the stall torque of the motor. Personnel were trained and experienced in use of the motor-operated valve analysis and test system (MOVATS) and they were knowledgeable of the Limitorque design and fabrication practices. All of the safety-related valves had been through this program before the start of the inspection. This program was considered by the inspection team to be a strength.

2.6.5 Spare Parts

The team assessed the method and documentation used to specify, obtain, and install parts used to perform safety-related maintenance, as well as the process of dedicating commercial-grade parts for safety-related applications, substitution evaluations, upgrades to the automatic reorder process for the warehouse, and training for the procurement engineers. The licensee's Procurement Engineering Group had made significant progress in the specification of spare parts used in maintenance during the past year.

During the past several months the licensee had required that all outside procurement items for maintenance go through the Procurement Engineering Group. Reorder of items stocked in the warehouse was included in the process. Items of this type were reviewed by the Procurement Engineering Group for accuracy of description, stock number, vendor, quality classification, and special requirements such as environmental qualification. The licensee characterized this review as being approximately 50 percent complete. The schedule was based on the need to reorder items to replace expended stock. Completion of this review of warehouse stock would strengthen the control of commodity items such as fasteners.

The inspection team reviewed dedication and substitution packages that were developed by the Procurement Engineering Group for spare parts used in the HPCI and ESW systems. The packages to dedicate commercial-grade parts for safety-related applications were based on the EPRI guidelines. The evaluations focused on identification of the key attributes of a part by assessing the function of the host component and how the part was related to that function. This was then used to establish technical code and standard requirements, receipt inspection requirements, and, in a few cases, post-work test requirements. The substitution packages were used to evaluate superseded parts and replacements for parts that were no longer available from the original manufacturer of the host component. The evaluations were based on the function of the host component and the design features of both the replacement and substitute parts related to that function. The dedication and substitution packages appeared to be complete and technically adequate. Almost all of the personnel performing evaluations to dedicate commercial-grade parts for safety-related application had recently attended an EPRI workshop on the dedication process. The broad availability of this training opportunity was considered to be a strength by the inspection team.

2.6.6 Plant Material Condition

The team observed that the HPCI and ESW hardware conditions were adequate and that the general area housekeeping was good. The team found, however, that some difficult access areas underneath the HPCI turbines and pumps and in the area of the ESW pumps contained an excess accumulation of lube oil and debris. Additionally, several unrestrained freewheeling trolleys used in maintenance activities were stored directly over safety-related equipment, such as the HPCI pumps and piping and the CRD pumps and piping. These items were brought to the licensee's attention, and appropriate actions were initiated by the licensee.

2.7 Design Baseline Reconstitution Program

The licensee was in the process of initiating a design baseline reconstitution program for the Peach Bottom and the Limerick facilities at the time of the inspection. The licensee planned to use the design baseline documents (DBDs) developed from the program to make operability determinations and to perform licensing evaluations, training, and other support functions with the intent of conducting all nuclear group activities within a known, approved, and currently licensed design baseline. The licensee identified 55 system documents and 20 topical documents to be developed by the program. The systems included all safety-related systems, systems important to safety, and systems important to efficient plant operation (e.g., condensate, main generator, traveling water screens, substation and transmission). The topical documents were divided into topical-physical (e.g., structural, containment, piping/supports/snubbers), topical-hazard/accident (e.g., external hazards, station blackout, design basis accidents), and topical-special component (e.g., sampling, annunciators, simulator).

The pilot phase of the program, which was begun in January 1990, included development of DBDs at Peach Bottom and Limerick for the HPCI system and the ESW system by June 1990, along with DBDs for four other safety-related systems. The DBD for the ECW system and ECT at Peach Bottom, which constitutes a third mode of operation under which emergency components are cooled upon loss of normal service water, was not scheduled until late 1992. The licensee planned to complete the last DBD of the overall program in late 1994, resulting in a total of 75 documents at each facility.

The inspection team observed that the ECW/ECT system DBD was not being developed in the same time frame as the ESW system document, which is not consistent with the importance of the system as identified by the SSFI inspection.

3.0 CONCLUSION

The inspection team identified significant concerns regarding the ability of the ESW system to perform its required safety functions. The concerns included deficiencies in system design and design control, safety analyses and documentation, applicable operating procedures, the performance of surveillance tests, and the evaluation of surveillance test results. The inspection team determined that the HPCI system met its design requirements. However, the team identified concerns regarding the HPCI system design change and modification controls and maintenance. The SSFI team also identified problems with the licensee's programs to recognize safety significant issues and to initiate prompt corrective actions. In response to the team findings, the licensee immediately initiated a safety evaluation to assess the operability of the ESW system at Unit 3.

4.0 UNRESOLVED ITEMS

Unresolved items are matters about which more information is required in order to determine whether they are acceptable, deviations or violations. Unresolved items identified are listed in Appendix A to this report.

5.0 EXIT MEETING

On March 8, 1990, an exit meeting was conducted at the site. Both PECO and NRC representatives at this meeting are indicated in Attachment B. During the exit meeting, the NRC inspectors summarized the scope and findings of the inspection.

APPENDIX A

Category of Findings

Item Number	Description	Section
Potential Violation 90-200-01	Licensee failed to initiate prompt and comprehensive actions to correct ESW system deficiencies.	3.1.1
Potential Violation 90-200-02	Licensee failed to perform, document and maintain records of written safety evaluations as required by 10 CFR 50.59.	3.1.1
Unresolved Item 90-200-03	Licensee will demonstrate that ESW pumps A and B manual start switches meet single failure criteria following catastrophic failure of either switch.	3.1.3
Unresolved Item 90-200-04	Licensee will demonstrate through acceptable documentation that the ECT fans are seismically qualified.	3.1.3
Follow-up Item 90-200-05	Licensee to revise station blackout procedure SE-11.	3.2.1
Unresolved Item 90-200-06	Licensee will provide documentation that the fusing of the HPCI support pump is of acceptable design.	3.2.2
Open Item 90-200-07	Licensee will implement training in the personnel use of procedures and training in the field in order to preclude the use of uncontrolled documents.	3.4.1
Unresolved Item 90-200-08	Licensee to establish root cause for leaving a normally closed vent valve in the open position.	3.4.2
Open Item 90-200-09	Licensee to make improvements to the station blackout procedure.	3.4.2
Unresolved Item 90-200-10	Licensee to develop a procedure that assures the startup and operation of the emergency cooling water system.	3.4.2
Open Item 90-200-11	Licensee to revise ESW pump test procedures to include appropriate cautions against overheating during operation against closed discharge valve.	3.4.2

Category of Findings (Cont.)

Item Number	Description	Section
Unresolved Item 90-200-12	Licensee will provide documentation showing the scope and schedule of the surveillance procedure rewrite program.	3.5.1
Potential Violation 90-200-13	Licensee failed to follow procedural requirements.	3.5.3
Potential Violation 90-200-14	Fasteners of the wrong sizes, types, torques and thread engagements, and of indeterminate material, were installed in safety-related applications.	3.6.1

APPENDIX B

Personnel Contacted	Organization
*Harry R. Abendroth	Atlantic Electric
M. Aldefer	Shift Technical Advisor
R. Andrews	PECO Operations Supervisor
R. Abary	PECO Electrical Engineering
R. Artus	PECO Simulator Training
*James A. Basilio Sr.	PECO Branch Head PBAPS Licensing Branch
*Paul Blackeston	PECO Engineer Licensing
*W. L. Bloomfield	PECO ISEG Engineer
*W. J. Boyer	PECO Electrical Plant Section Manager-Engineer
*Kennard M. Buddenbohn	Delmarva Power
*Walter R. Butler	NRC Project Director, PD 1-2, NRR
*J. M. Cockroft	PECO Support - QA
*Frank Cook	PECO Engineering Support NED
*John B. Cotton	PECO Support - OPS
*T. E. Cribbe	PECO Regulatory Engineer
*George Daebeler	PECO Technical Supervisor PBAPS
*G. F. Daereleu	PECO Support - Manager
*L. T. Doerflein	NRC Projects Section Chief
*Joan Dolezal	PECO NED, ESW System Engineer
*Don Falcone	PECO SLO Training
C. Fletcher	PECO Electrical Engineering
*David J. Foss	PECO Licensing Engineer
*Al Fulvio	PECO Senior Systems Engineer
*Brian Grimes	NRC Director, DRIS, NRR
J. Hill	PECO Instrumentation, HPCI System Engineer
*H. D. Honan	PECO Project Management
*John G. Hufnagel	PECO NED Branch Head BOP
M. Hyslop	PECO Mechanical Engineer
*James A. Isom	NRC Operations Engineer, NRC
G. John	PECO HPCI System Engineer
*W. V. Johnston	NRC Deputy Director, DRS, Region I
A. Jones	PECO Electrical Engineer
*J. A. Jordan	PECO Supervising Engineer, Reactor Systems
D. Keene	PECO Drawing Update Program
*Jerry A. Kernaghan	PECO Maintenance Engineer, Rotating Equipment
S. Kiesewetter	PECO Electrical Engineer
*Peter Koltay	NRC Team Leader
*J. E. Konklin	NRC Section Chief, RSIB, DRIS, NRR
J. Kovalchick	PECO Shift Technical Advisor
P. Kuhn	Bechtel, San Francisco
C. Kuo	Bechtel, San Francisco
*Wayne Lanning	NRC Branch Chief, RSIB, DRIS, NRR
*J. J. Lyash	NRC Senior Resident Inspector
J. W. Lyter	PECO Training
G. Maisel	PECO Training
*Eric Marcantoni	PECO ESW System Engineer, PBAPS
D. McClelland	PECO Training
*C. A. McNeill	PECO Executive Vice President
*D. R. Meyers	PECO Support - Technical PBAPS

Personnel Contacted	Organization
*F. J. Michaels	PECO EQ Branch Engineer
W. Mindick	PECO Electrical Engineer
*James E. Mitonan	PECO Maintenance I&C Engineer Supervisor
K. Patel	PECO ESW System Engineer
*J. Michael Pratt	PECO Manager Quality PBAPS
*Gary J. Reid	PECO Engineering Division
D. Robi	Becthel, San Francisco
J. Starosta	PECO Operations Support
E. Sawchuk	PECO ESW System Engineer
*Chris Schwarz	PECO Shift Manager
*Dennis R. Shaulis	PECO Performance and Surveillance Supervisor
D. Spanner	PECO NED, DBD Program
*R. C. Stott	PECO B.O.P. Reactor Engineer
*Gene Y. Suh	NRC NRR Project Manager
*Dennis Tauber	Public Service Electric & Gas
S. Thomas	PECO Civil Engineer
*D. J. Thompson, Jr.	PECO EQ Branch Head
*Tyrone S. Tonkinson	PECO NED, HPCI System Engineer
*David Torone	PECO Senior Engineer, NED
*Joe Tulskie	PECO NED, ESW System Engineer
R. Walker	PECO Electrical Engineer
*J. D. Wilcox	NRC Operations Engineer
J. Wilkes	PECO Electrical Apparatus Expert
*J. P. Wilson	PECO Outage Support

*Attended exit meeting on March 8, 1990.