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REGION I

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50-278/91-31

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Licensee: Philadelphia Electric Company (PECO)
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Facility Name: Peach Bottom Atomic Power Station and PECO Nuclear Group Headquarters

Inspection At: Delta, Pennsylvania and Wayne, Pennsylvania

Inspection Conducted: October 15, 1991 - January 7, 1992

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Inspection Summary: See the Executive Summary

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EXECUTIVE SUMMARY

In July 1991, the NRC and the licensee identified weaknesses in the licensee's ability to monitor the emergency service water (ESW) system's performance and to assure its continued availability through troubleshooting and testing. A management meeting was held with the licensee on August 27, 1991, to discuss these ESW system problems and the licensee's long-term plans to resolve them. The licensee's general plan for corrective action was to optimize ESW system flow by minimizing the throttling of individual room cooler flows and to go from a two room cooler configuration to one room cooler configuration, wherever appropriate.

The objective of this special inspection was to review the adequacy of the licensee's corrective actions to the previously identified ESW system problems and to verify the ability of the ESW system to perform its intended safety function, prior to the startup of Unit 3 from its fall 1991 outage. In parallel with this inspection effort, the NRC staff prepared a safety evaluation report (SER) concerning the design of the ESW system at the Peach Bottom Atomic Power Station and its ability to perform its safety function. The SER was issued on December 23, 1991.

The inspectors verified that the licensee's ongoing ESW system tests were demonstrating adequate coolant flows to the components. Considerable improvement has been made by the licensee in monitoring, testing, and trending ESW system flows as demonstrated by the improved system performance since July 1991. There was close coordination of related activities between the licensee's site and corporate engineering personnel. A good level of management attention was dedicated to assure timely and effective completion of this effort. The inspectors concluded that the ESW system was configured as described in the SER of December 23, 1991, and they verified that the test control methodology and acceptance criteria were adequate to verify the ESW system design requirements, as included in the SER.

Although a good initial verification of the ESW system performance capability was performed through comprehensive testing, the ability of the licensee's program to detect degradation through long term trending and the system's ability to perform its intended safety function during summer months with elevated inlet water temperatures remains to be verified. The licensee is fully committed to complete these technical verifications in an effective, timely and comprehensive manner.

1.0 Background

The licensee's emergency service water (ESW) system consists of two pumps and a piping network which routes ESW flow to the emergency diesel generator (DG) air, jacket and lube oil coolers and the Unit 2 and Unit 3 ring headers. ESW flow to the ring headers also provides cooling to the Unit 2 and 3 emergency core cooling system (ECCS) and reactor core isolation cooling (RCIC) room coolers, the residual heat removal (RHR) pump seal coolers and the core spray (CS) pump motor oil coolers when the normal service water system is unavailable.

The NRC conducted a safety system functional inspection (SSFI) in early 1990 which identified significant weaknesses with the licensee's engineering analyses, maintenance, and testing of the ESW system. Subsequent testing by the licensee confirmed that the Unit 2 system was not providing adequate cooling water flow in all cases. The licensee took corrective actions to establish acceptable flows before startup from an on-going outage. In the fall of 1990, a followup inspection team determined that, in general, the licensee had identified and implemented effective corrective actions in response to the SSFI.

A modification concerning Unit 2 ring header piping and valve replacement was completed in March 1991. A similar modification had been performed at Unit 3 in 1989. The licensee demonstrated satisfactory post modification testing for both units. However, in July 1991, as noted in NRC Inspection Report 50-277 and 50-278/91-21, the NRC and the licensee identified weaknesses in the licensee's ability to monitor ESW system performance and to assure continued system availability through troubleshooting and testing (Unresolved Item 91-21-001). In one instance, the licensee determined that the ESW flow to the Unit 3 DG was 543 GPM, which was much less than the required flow of 735 GPM. A management meeting was held with PECO in NRC Headquarters on August 27, 1991 to discuss these ESW system problems and the licensee's long-term plans to resolve these problems. The licensee's general plan for corrective action was to optimize ESW system flow by minimizing the throttling of individual room cooler flows.

This special NRC inspection was to review the adequacy of the licensee's actions to resolve previously identified ESW system problems and to verify the ability of the ESW system to perform its intended safety function, prior to the startup of Unit 3 from its fall 1991 outage. The inspection was announced during an NRC conference call on October [illegible] 1991 with the licensee. The on-site entrance meeting was held on October 16, 1991.

Inspection personnel consisted of various NRC headquarters, regional, and contractor personnel. In addition to the various inspection activities at Peach Bottom Units 2 and 3, reviews were conducted at the licensee's Chesterbrook engineering offices concerning the development of the acceptance criteria in the ESW test procedures. Also, the inspectors reviewed the licensee's Valley Forge Testing facility to assess its role in providing accurate test instrumentation.

The inspection consisted of a detailed assessment of the ESW system design. The following licensee activities, which monitored the system's performance and determined its ongoing ability to meet design requirements, were reviewed:

1. use of flow instrumentation,
2. test activities, and
3. trending of ESW system performance.

Certain ESW system modifications being implemented or evaluated were reviewed for their applicability. Also, the ESW heat exchanger performance testing activities being conducted in response to Generic Letter 89-13 were reviewed for any impact on ESW system operability.

2.0 Assessment of ESW System Design

In an October 30, 1991 submittal the licensee provided information to the NRC staff concerning the design and as-built condition of the ESW system. As part of this inspection, additional design information was obtained through visits to the Peach Bottom site and the licensee's Chesterbrook engineering offices during October 1991. Based on this information, on December 23, 1991, the NRC staff provided a Safety Evaluation Report (SER) of the ESW system common to Peach Bottom, Units 2 and 3. The SER included a comprehensive discussion and evaluation of the bases for the flow acceptance criteria for the ESW cooled components and concluded that the licensees' acceptance criteria were acceptable.

The licensee has established acceptance criteria for ESW flow rate testing based on the calculated minimum flow rate for each component assuming a 5% instrument error as summarized below.

Area and Equipment Cooled by ESW	Number of Coolers		Minimum Required Flow/Cooler
	Installed	Required	
HPCI Room (1 Room/Unit)	2/Room	1/Room	24.4 GPM
RCIC Room (1 Room/Unit)	2/Room	1/Room	21.1 GPM
CS Room (2 Rooms/Unit)	2/Room	1/Room	14.0 GPM
RHR Room (4 Rooms/Unit)	2/Room	1/Room	32.0 GPM
RHR Pump Seal (4 Pumps/Unit)	1/Pump	1/Pump	5.0 GPM
Diesel Generator (4 DGs/2 Units)	Each DG has one air, lube oil and jacket water cooler	Same as installed	735.0 GPM

ESW flow to the CS motor oil cooler was determined to be adequate through heat transfer testing. ESW flow is satisfactory provided the testing demonstrates that CS motor oil can be maintained below 150 degree F, assuming 90 degree F cooling water.

The room heat load calculations demonstrated that, with the minimum flow specified, a single room cooler can adequately remove the heat generated in each room.

The ESW system design was reviewed to assure that the as-built configuration is consistent with the design requirements and evaluation as described in the aforementioned SER. The inspectors concluded that the ESW system was configured in accordance with the system description as discussed in the SER.

3.0 Flow Instrumentation

The instrumentation used to measure ESW system flow is important since it provides the basis for determining ESW equipment and system operability. In establishing the required flows for various ESW cooled equipment, the licensee has included a margin of 5% for instrument accuracy.

The Controlotron 990 instrument used is an external clamp-on, portable flowmeter utilizing transit-time techniques with the appropriate transducers. The inspectors verified that this instrument system has a worst case accuracy of 3% for this application.

The inspector reviewed the specific ultrasonic flow instrumentation (Controlotron 990) being used during routine procedure RT-B-033-600-2, "Flow Test of ESW to ECCS Coolers and DG Coolers". A laboratory calibration of an instrument at the licensee's Valley Forge Testing Lab and its field application at the Peach Bottom plant were observed. No unacceptable items were noted and the inspectors concluded that the instruments were appropriate for ESW system flow measurement. This review was performed prior to the ESW flow test on November 12-14, 1991.

A separate in-plant review included a walkdown of portions of the ESW system (ECCS pump rooms, diesel generator area and ESW ring header piping) where specific piping locations or dedicated spool pieces had been designated for the temporary installation of the Controlotron instruments. For those areas reviewed, the transducer locations were appropriate given the limitations of the piping system.

The inspectors concluded that there was sufficient assurance that the accuracy of these instruments would be $\pm 5\%$ while measuring ESW flow rates.

4.0 ESW System Test Activities

The licensee performed several tests to demonstrate that the available ESW flow was consistent with the required flow discussed in the December 23, 1991 SER. The tests were as follows:

1. Special Procedure 1421, ESW System Flow Balance Test,
2. Routine Test RT-B-033-600-2, Flow Test of ESW to ECCS Coolers and DG Coolers, and
3. Surveillance Test 6.7.4-2/3, Core Spray Motor Oil Cooler Heat Transfer Capability.

The inspectors observed various aspects of these ESW system test activities. A discussion of the significant inspector observations is provided below.

4.1 ESW System Flow Balance Using Special Procedure 1421

The purpose of this procedure was to balance the flow to all ESW cooled components and optimize ESW system flow by minimizing the throttling of individual room cooler flows. The licensee achieved this balancing and optimizing by a deliberate process whereby room cooler outlet throttle valves were fully opened one at a time, while assuring adequate design ESW flows in other affected parallel paths.

SP 1421 also verified the availability of required ESW flows during the newly realigned single cooler operation for the ECCS or RCIC rooms. Analysis had shown that only one room cooler was necessary to meet the original design (Refer to Section 6.1 for details). The second room cooler was permanently isolated in a standby condition based on the results this test.

Testing per SP 1421 was begun in August and completed in October 1991. The inspectors observed the last portion of SP 1421 in October 1991. Licensee personnel demonstrated good control during testing and appropriate review of test results. Various action items were identified for further evaluation to improve ESW system performance. For example, while most ECCS room cooler flow margins were greater than 20%, the Unit 2 RCIC room cooler flow margin was only 9%. This item was closely monitored during the periodic ESW flow test RT-B-033-600-2 which is discussed below.

4.2 Routine Test RT-B-033-600-2 - Flow Test of ESW to ECCS Coolers and DG Coolers

After completing the balancing and optimization of ESW system flows per SP 1421 in October 1991, the licensee performed procedure RT-B-033-600-2 monthly to verify adequate flows to DG coolers, ECCS and RCIC room coolers and RHR pump seal coolers. The inspectors witnessed and reviewed the results of the October and November tests and they also reviewed the results of the December test. Additionally,

* The valve lineups were reviewed and no discrepancies were noted.

* The plant personnel were proficient in the setup and use of the flow instrumentation. Also, the licensee had incorporated requirements into procedure RT-B-033-600-2 to measure pipe diameter and wall thickness.

* ECCS ring header flow was compared to the sum of the individual room cooler flows to evaluate the reliability of the ultrasonic flow instrumentation. Good correlation existed with only 1-3% variation between readings.

* Test personnel were knowledgeable in the performance of the test.

* The test was well coordinated.

* The monthly tests generally verified that adopting single room cooler operation and fully opening all room cooler throttle valves had increased flow margins for ESW cooled components. Flow margins were generally greater than 20% with the Unit 2 RCIC room cooler exhibiting the least margin of about 10%.

The licensee had presented the October test results to the NRC staff on November 6,1991, at NRC headquarters, describing their efforts to improve ESW system performance. The inspectors monitored and verified that the licensee continued to assess adequate ESW system performance during the November and December tests.

4.3 Surveillance Test ST 6.7.4-2/3 - Core Spray Motor Oil Cooler Heat Transfer Capability

The purpose of this procedure is to demonstrate the ability of the CS motor oil coolers to maintain the temperature of the CS motor oil below 150°F when the ESW inlet temperature is 90°F. This acceptance criterion assures detection of degradation before reaching the thrust bearing alarm point of 194°F and the absolute maximum allowable actual bearing temperature of 250°F. If the oil temperature were determined to be greater than 150°F, an engineering evaluation for operability would be conducted promptly using the actual ESW inlet temperature in lieu of 90°F.

The inspectors reviewed the latest test results for Unit 2 and 3 CS pumps. The highest bearing temperature from the two sets of data was 139°F. Discussions with the ESW system engineer indicated that no significant problems had been observed with the performance of this procedure in the past year.

4.4 Heat Transfer Tests

During this inspection several heat transfer tests were performed on Unit 3 ECCS and RCIC room coolers. The licensee's engineering staff is developing a computer program to predict heat exchanger performance and degradation based on measured temperatures and mass flow rates from these tests. The licensee is using this data to validate and benchmark the heat exchanger performance computer program. Preliminary results of the RHR and CS room cooler data indicated that the calculated fouling factors per the heat exchanger performance computer model were 0.002 and 0.0005, respectively, which reflected clean cooler conditions. Based on these observations, the inspectors concluded that ESW system operability was adequately demonstrated during these tests.

5.0 Trending ESW System Performance and Corrective Actions

In July 1991, the NRC identified that the licensee did not require recording of "as found" data for the ECCS and RCIC room coolers. Therefore, no as-found data was available for trending system performance. The inspectors reviewed the licensee's corrective actions in this area by witnessing actual tests and discussing/reviewing test results with the ESW system engineer.

The periodic ESW test procedure RT-B-033-600-2 has been substantially improved to make it effective for trending ESW performance.

* The data sheets have been revised to provide an "instant" trend for the engineer by incorporating the data from the previous test adjacent to the test data currently being taken.

* If the flow value is not within 10% of the value from the previous test, or if the flow data is within 10% of the acceptance criteria, then an ultrasonic flow verification (i.e., a second measurement) is required. This assures the engineer that the test reading is accurate.

* In the event that a parameter falls outside of its acceptance criterion, the procedure requires that an action request or equipment trouble tag be written and a retest be performed. A graph is also provided for preliminary operability determination. This graph compares room cooler temperature, river temperature, and room cooler flow against their respective limits. A final operability determination is made by engineering through calculations and analysis.

* The required frequency for the test performance was officially changed from quarterly to monthly.

During the test witnessing, the inspectors verified that the licensee had implemented the above procedure improvements. An isolated exception was noted after review of the November test data for the DG flows. The E/1 and E/4 DG flows increased to greater than 10% above their October values and an ultrasonic flow verification was not performed. However, in December the licensee performed an ultrasonic flow verification for the E/1 and E/4 DGs when their flows returned close to the October values.

The ESW system engineer is responsible for trending system parameters in accordance with the guidance established in procedure AG-62, "Plant Performance Monitoring Program Guide for Program Implementation, Data Acquisition, Trending and Analysis." DG flows, room cooler flows, seal cooler flows and ring header flows are trended from the periodic test data. If the data indicate a downward slope such that a parameter could decrease below the acceptance criteria prior to the next test, an action request would be initiated for corrective action. An example of this is the Unit 2 "A" RHR cooler where ESW flow degraded from 54 to 38 GPM between the October and November tests when dead clams were not fully flushed from the cooler after a planned chemical treatment in October. The standby cooler was placed into service prior to the December test and the fouled cooler was cleaned . The Unit 2 "A" RHR cooler flow during the December test was 57 GPM.

Since the ESW system has only operated in the current configuration (single room cooler and outlet throttle valves fully open) since September 1991, there is insufficient information to determine meaningful system trends. Also, the ability of the ESW system to perform its safety function in the new configuration with elevated ESW inlet temperatures in warm summer months, remains to be demonstrated. Based on the above, the inspectors concluded that the licensee had significantly improved the monitoring of the ESW system performance since July 1991.

6.0 ESW System Modifications

The licensee has implemented several modifications to optimize the ESW system effectiveness. The inspectors reviewed these modifications as detailed below.

6.1 Modification No. 5346 - Administrative Controls for Single Room Cooler Operation

The RHR, CS, HPCI and RCIC rooms were originally equipped with two full capacity room coolers in each room. Although not required, the second room cooler provided an automatic standby function in that it would operate following failure of the primary cooler fan. However, a postulated total loss of instrument air would allow air operated valves controlling flow to both coolers to fail open. The simultaneous flow to both coolers reduces flow to each cooler individually. Since persistent problems with marginal cooler flow had been encountered, the licensee revised the operational configuration of the ESW system to isolate one cooler in each of the above rooms and to provide the required cooling using the remaining cooler.

This modification was prepared and implemented in accordance with Administrative Procedure A-14, Rev. 19, "Plant Modifications." The inspectors reviewed Modification 5346 and determined that the licensee had completed the following items adequately:

* The change in the ESW system configuration was evaluated per 10CFR 50.59. Since the new configuration was consistent with the original design intent and increased flow to the operational room cooler, the change was found to be acceptable.

* The affected control room drawings had been updated.

* The affected existing plant procedures, including all check off lists, had been revised.

* A training package had been prepared to provide the pertinent modification details to operations personnel.

* A change request had been initiated to incorporate this modification into the next annual update of the FSAR.

A Modification Acceptance Test (MAT) had been prepared to verify the adequacy of the ESW system operation with single room coolers in the ECCS and RCIC systems. The MAT clearly identified the specific cooler in each room to be placed in operation while verifying that the other ECCS and RCIC room cooler was isolated. Based on an independent ESW system walkdown, the inspector verified the positions of valves, fan switches, and fan motor breakers with the exception of one concern in the Unit 2 "D" RHR pump room. The air operated inlet valve, AOV-2-33-2335G, for the operational room cooler 2GE058 was open with instrument air isolated. The above mispositioning was caused when the air supply valve was closed to isolate an air leak. This issue was discussed with the system engineer who promptly notified the shift supervisor. A licensee investigation was initiated on December 23, 1991, in accordance with site procedures to determine reportability/operability concerns and the root cause, and to implement effective corrective actions. This concern had minimal safety significance since AOV-2-33-2335G was in its proper position (open) to perform its safety function. Upon further review, the inspector determined that a similar problem concerning inadequate verification of a valve position had been the subject of a recent violation in NRC Inspection Report 50-277/91-30; 50-278/91-30. The licensee's response to this violation was pending at the time of this inspection. The licensee agreed to address this concern in their response to the NRC Inspection Reports 50-277/91-30 and 50-278/91-30.

The licensee will continue routine preventive maintenance for the isolated room coolers. A new procedure RT-B-033-640-2, "ECCS and RCIC Standby Room Cooler Flush," had been issued to perform a monthly flush on the isolated room coolers. Procedures were issued in January 1992, to return isolated cooler to service and to remove an operating cooler from service.

6.2 Modifications to the ESW Chemical Injection System

Modification 5277, "ESW Chemical Injection" was initiated in February 1991 to replace the chemical injection system tubing. In addition, the point of injection was changed to the point where NSW and ESW meet. The original point of injection was next to the NSW and ESW check valve (CHK-3-33-514) and the potential existed for deterioration of the check valve. Titanium was selected as a compatible material and subsequently used for all tubing replacement.

Modification Package for Mod 5277 including the Modification Acceptance Tests (MAT) was reviewed for each unit. The MAT included a hydrostatic test to verify system integrity and an operational test to verify proper chemical injection pump operation. The Unit 2 MAT was performed on October 28, 1991 and the system was accepted by operations on November 25, 1991. The Unit 3 MAT was performed on November 27 and the system was accepted by operations on December 13. The inspector witnessed portions of the Unit 3 MAT and reviewed the test results of the Unit 2 and 3 MATs. The testing and the results were acceptable. The procedure for placing the chemical injection system into service (CH-715) and the procedures for controlling the position of the ESW bypass valve lineup during the shutdown and startup of the chemical injection system (AO 33.1-2 and AO 33.1-3) were reviewed. Additionally, RT-B-033-600-2, "Flow Test of ESW to ECCS Coolers and Diesel Generator Coolers " was reviewed and verified that the licensee had revised the procedure to ensure that the ESW chemical injection system was removed from service prior to isolating the ESW piping from NSW. It was concluded that the licensee had implemented adequate controls to ensure proper operation of the ESW chemical injection system.

6.3 Permanent Instrumentation to Measure ESW System Flow

At the time of this inspection, the licensee was using temporarily installed ultrasonic flow instruments for the tests. The licensee indicated in several meetings that they were evaluating the installation of permanent ESW instrumentation for monitoring flow. A modification request for this installation had been issued on November 4, 1991. The licensee agreed to provide an updated status of this evaluation to the NRC by April 30, 1992.

7.0 Conclusions

The newly reconfigured ESW system is consistent with that described in the NRC Safety Evaluation Report dated December 23, 1991. The test control methodology and acceptance criteria were adequate to verify the design requirements detailed in the SER. It is apparent that the licensee has made significant progress in ESW system monitoring, testing, and trending. A good level of management attention was dedicated to this effort. Technical resolutions were comprehensive and effective. Pending resolution of potential enforcement actions, unresolved items 50-277/91-21-001 and 50-278/91-21-001 were not closed.

Although good progress has been noted thus far, sufficient information is not yet available to determine meaningful trends. The ESW system has only operated in the current configuration (single room cooler and outlet throttle valves fully open) since September 1991. It has not been challenged with the warm service water temperatures of the summer months. Therefore, continued management support and attention are required to assess the long term adequacy of the ESW system performance during seasonal and other varying operating conditions, using frequent monitoring, testing and trending.

8.0 Unresolved Item

An unresolved item is an item requiring additional information to determine whether it is acceptable, a deviation or a violation.

9.0 Management Meeting

An exit interview was conducted on January 7, 1992, with the attendees as noted in Appendix A, to brief licensee management regarding the inspection findings.

APPENDIX A

Persons Contacted

Philadelphia Electric Company (PECo)

* Greg Cranston, Nuclear Engineering/CB Manager
* A.D. Dycus, ISEG Superintendent
* Dave Foss, Regulatory Group Leader
* Ed Galligan, NE&SD System Engineer
* David Goodell, ESW System Engineer
* John Hufnagel, NESD Branch Head
* Dave Meyers, Technical Support
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