ENCLOSURE

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

Inspection Report: 50-382/95-16

License: NPF-38

Licensee: Entergy Operations, Inc.
P.O. Box B
Killona, Louisiana

Facility Name: Waterford Steam Electric Station, Unit 3

Inspection At: Waterford 3

Inspection Conducted: July 31 through August 10, 1995

Inspectors: Mr. S. J. Campbell, Resident Inspector
Ms. V. L. Ordaz, Resident Inspector

Approved: Gregory A. Pick for 10/27/95
P. H. Harrell, Chief, Project Branch D — Date

Inspection Summary

Areas Inspected: A special, announced inspection to review an event related to degraded essential chilled water (ECW) flow below design and accident flows.

Results:

- The inspectors concluded that the Technical Specification (TS) 3.7.12 limiting condition for operation (LCO) action statement for the ECW system was not exceeded while ECW Loop A was inoperable between April 16 and 17, 1995, as a result of the licensee failing open Recirculation Valve CHW-129A. Additionally, TS 3.0.3 LCO action statement was not violated because redundant ECW Loop B remained operable during this period (Section 4.1).

- The licensee measured the ECW Loop A total flow to be 570 gpm on May 8, 1995, which was above the design flow of 510 gpm and above the accident flow of 481 gpm (Section 4.3).

- The licensee identified, during special testing of ECW Loop B on May 25, 1995, that the ECW valves for two air handling units (AHUs) were not positioned in accordance with procedures. The licensee confirmed that this condition did not impact subloop flow and promptly returned the valves to the appropriate positions. The inspectors considered that the mispositioned valves were not safety significant because of the minimal impact on subloop flow and concluded that the mispositioned valves were two examples of a noncited violation of TS 6.8.1.a (Section 4.4).

- The licensee measured the ECW Loop B total flow to be 320 gpm on June 1, 1995, which was below the design flow of 510 gpm and below the accident flow of 481 gpm. The licensee concluded that the degraded flow condition was caused by ECW Pump Discharge Valve CHW-115B not being returned to the exact throttled position needed to obtain the required flows (Section 4.5).

- The inspection identified a violation that resulted from two examples of inadequate transfer of design information into procedures as required by 10 CFR Part 50, Appendix B, Criterion III. Specifically, the inspectors confirmed the licensee's finding that the Safeguards Pump Rooms A and B AHU design capacities were not properly translated into Procedure OP 100-014, Revision 2, "Technical Specification Compliance." In addition, the licensee identified that throttled ECW Pump Discharge Valve CHW-115B restricted ECW system flow below design and accident flows and that periodic tests did not assure the valve was returned to a position required to obtain the minimum flow requirements. This licensee-identified and corrected violation is being treated as a noncited violation consistent with Section VII.B.1 of the "General Statement of Policy and Procedure for NRC Enforcement Actions," (Enforcement Policy) (60 FR 34381; June 30, 1995) (Sections 4.4 and 4.5).

- The licensee's decision to delay special testing of ECW Loop A using ECW Pump AB until the refueling outage was acceptable. Performing the test before the refueling outage may adversely impact plant operation as a result of changing the electrical power supply alignment for Pump AB (Section 4.6).

- During the special testing performed on the individual AHUs for ECW Loops A and B, the licensee identified that three AHUs had blocked ECW flow. The licensee concluded that this blockage resulted from the higher than normal ECW flow created by fully opening the throttled ECW pump discharge valves on both loops. The high flow caused rust and coagulated biocide to block and degrade ECW flow and rendered the three AHUs inoperable (Sections 4.7 and 4.8).

- The inspectors reviewed the licensee evaluation of Generic Letter 89-13, "Service Water System Problems Affecting Safety-Related Equipment," which addressed periodic testing of open and closed loop systems. The inspectors confirmed that chemistry controls had been invoked since the ECW system was placed in service and that periodic ECW flow testing was not required by regulation. Nevertheless, the licensee developed comprehensive corrective actions to periodically test, inspect and sample the ECW system (Section 4.9).

- Although the inspectors concluded that the engineering evaluation to assess the degradation of the ECW Loop B flow below the accident and design flows without a Safeguards Pump Room B AHU was acceptable, the inspectors identified that neither the licensee's design basis documents nor the Updated Final Safety Analysis Report (USAR) reflected the actual cooler capacities and heat loads. As a result, the actual values never received a formal, documented 10 CFR 50.59 evaluation. An inspection followup item was opened to assess the licensee action to correct the discrepancy (Section 5.2).

- The inspectors experienced difficulty, while auditing the engineering evaluation, because the derivation of the heat loads was not provided in the evaluation. The inspectors were concerned whether the licensee's review of the evaluation was comprehensive because the heat load derivations were not available to verify the engineering evaluation results during the review process (Section 5.2).

- The inspectors concluded that the engineering evaluation used a poor assumption in crediting operator action in opening ECW Pump Discharge Valve CHW-115B because the annunciator response procedure for high room temperature alarm did not provide instructions to perform this task (Section 5.2).

- The inspectors concluded that the plant manager demonstrated thorough, aggressive and proactive effort by demanding that an ECW system flow test be performed on both ECW loops. Because of these complex special tests, the licensee had self-identified numerous deficiencies associated with the ECW system. The licensee took prompt and immediate corrective action to resolve the deficiencies and had established effective, comprehensive and proactive long-term corrective actions to preclude recurrence of these issues (Section 6).

Summary of Inspection Findings:

- Two noncited violations were identified (Sections 4.4 and 4.5).
- Inspection Followup Item 382/9516-01 was opened (Section 5.2).

DETAILS

1 OVERVIEW

NRC Inspection Report 50-382/95-04 discussed the licensee's chronology of events associated with repeated ECW operational problems between April 3 and April 20, 1995. The problems included inadvertent tripping of ECW chillers and ECW pumps and stroke time testing failures of Recirculation Valves CHW-129A, -129B, and -129AB.

This NRC special inspection was performed to document the facts surrounding these events, to assess the licensee's response to the events, and to determine their regulatory significance. The inspectors reviewed (1) the sequence of events, (2) the original preoperational testing of the ECW system, (3) the adequacy of the licensee's processes and procedures which caused this event, (4) the adequacy of the engineering evaluation to justify continued operability of the ECW system with degraded flows, and (5) the licensee's immediate and long-term corrective actions.

After his arrival onsite on April 4, 1995, the new plant manager was informed of these operational problems through occasional briefings or during the plan of the day meetings and became concerned that these repeated problems were not being adequately resolved. As a result, the plant manager familiarized himself with the ECW system by performing a system walkdown on April 8, 1995. During the walkdown, the plant manager found that the system material condition was poor and did not meet his expectations. Consequently, he requested that the system engineers perform a walkdown of the system and develop a prioritized material condition list of other safety and nonsafety-related systems. NRC Inspection Report 50-382/95-04 noted that the repeated operational problems also prompted the resident inspectors, on April 20, 1995, to perform a walkdown of the ECW system where they found the same poor material conditions. This walkdown was performed independent of the licensee, but at approximately the same time that the system engineers performed their walkdown.

On April 16, 1995, the licensee identified that Recirculation Valve CHW-129A was oscillating. As corrective action, the licensee placed the valve in the fail-safe open position as listed in Procedure SPO-46E, "Preoperational Test of the Chilled Water System." Procedure SPO-46E provided the required ECW valve lineup to obtain optimum flows during accident and normal operating conditions. However, the licensee later discovered that leaving the valve open caused excessive pump recirculation flow, which significantly reduced the subloop flows to the safety-related AHUs.

Since opening the valve reduced the subloop flow, rather than provide optimum flow to the AHUs, the plant manager questioned the validity of the preoperational test procedure. The plant manager thought that Procedure SPO-46E should have specified that Recirculation Valve CHW-129A modulate with flow demand rather than being failed open. Further, with the knowledge that the ECW system had not been flow tested for 10 years, the plant manager questioned the system engineer on what periodic testing was normally performed. The system engineer stated that a monthly chiller operability test required by TS 3.7.12 verified the flow through the chiller and the outlet temperature. The licensee performed the monthly operability test in accordance with Procedure OP 903-063, Revision 8, "Chilled Water Pump Operability Verification." The plant manager questioned whether the monthly test provided an acceptable means to verify ECW loop and subloop flows and requested that a test be developed to verify the accuracy of Procedure SPO-46E.

Despite the plant manager's desire to reperform a preoperational test, some licensee managers indicated that a system flow test exceeded the scope of test requirements and were initially reluctant to perform further testing. Through the plant manager's persistence, the engineers developed a flow balance test for ECW Loop A on the premise that if ECW Loop A passed then the remaining ECW system flow balancing would be acceptable.

On May 8, 1995, the licensee performed a test of ECW Loop A using ECW Pump A and found that the total flow (570 gpm) was greater than the design flow (510 gpm). As a result, the licensee's staff acquired a decreased sense of urgency to perform the special tests on the remaining ECW loop. Since the ECW Loop A maximum flows were acceptable, the licensee's staff believed that it was very likely that the ECW Loop B flows would be acceptable. Nevertheless, the plant manager was not satisfied that the validity of the preoperational test procedure was confirmed and insisted that personnel complete flow testing on the remaining ECW loop. Over a 3-month period, engineers developed and implemented detailed special test procedures to perform complex ECW loop flow balance testing using different alignments of ECW Pumps A, B, and AB to ECW Loops A and B.

On May 25, 1995, during the special flow balance testing performed with ECW Pump AB aligned to ECW Loop B, the licensee found that the existing throttle position of ECW Pump Discharge Valve CHW-115AB restricted the total flow of the ECW system below the required design flow of 510 gpm. The licensee measured the actual flow at 480 gpm, which was essentially equal to the accident flow of 481 gpm. Additionally, the licensee discovered during the test that the two cooling coils in Safeguards Pump Room B AHU AH-2B had blocked and low flow, respectively. The licensee repositioned the cooling coil discharge valves and found that subloop flows slightly increased. The licensee thought that the cooling coil discharge valves were sensitive to changes in flow with a small change in valve position and decided to perform valve sensitivity tests.

On June 1, 1995, during the special flow balance testing performed with ECW Pump B aligned to ECW Loop B, the licensee determined the total system flow was 320 gpm, which was 63 percent of the design flow of 510 gpm and less than the accident flow of 481 gpm. The licensee again found that the throttled position of ECW Pump Discharge Valve CHW-115B restricted the total ECW loop flow. The licensee immediately amended their engineering evaluation to include the degraded flow and concluded that the degraded ECW loop would sufficiently remove accident heat loads. A discussion of the adequacy of this engineering evaluation is provided in Section 5.

On July 24, 1995, while performing the valve sensitivity tests on AHU AH-2B cooling coil discharge valves, the licensee found that AHU flow significantly increased when the valves were fully opened and returned to the original position. A bulk chemistry sample of the ECW system found that rust and sediment caused the blockage. Additionally while performing special flow tests of individual AHUs using ECW Pump B on ECW Loop B, the licensee discovered that sediment and rust blocked flow through the High Pressure Safety Injection Pump Room AB AHU AH-21B cooling coil. The licensee flushed the sediment and rust and restored flow through the AHU by manipulating the associated cooling coil discharge valves.

On July 25, 1995, while performing special flow testing of individual AHUs using ECW Pump A on ECW Loop A, the licensee discovered that sediment and rust blocked flow through mechanical equipment room AHU AH-26A cooling coil. The licensee cleared the sediment and rust from the system to restore flow by manipulating the associated cooling coil discharge valve.

2 SYSTEM DESCRIPTION

The ECW system is a closed loop system that provides 42°F chilled water to AHUs that cool spaces containing nonsafety and safety-related equipment, during normal plant operation; however, the nonsafety-related loads are isolated during an accident. There are three chillers (Trains A, B, and AB) and three pumps (Trains A, B, and AB) for the ECW system. The swing train components (Train AB) can be aligned to replace either Trains A or B components for system redundancy. However, only two chillers are operated at the same time.

Normally, two chillers and their respective chilled water pumps are in service to meet the cooling requirements. However, the plant was designed such that one ECW train would remove the heat loads for the safety-related equipment being serviced, e.g., upon a loss of a redundant train. A minimum required flow through the chiller ensures adequate ECW cooling. The minimum flow through the chiller is maintained by directing a portion of the chiller discharge flow to the suction of the chilled water pumps through Recirculation Valves CHW-129A, -129B, or -129AB when total system flow is low. A flow transmitter, located downstream of the chiller discharge, and a process analog controller generates a signal based on flow to position the valves to maintain the required flow. The chillers facilitate the transfer of heat from ECW to component cooling water while lowering the discharge temperature of the chilled water below the supply temperature of the component cooling water. The cool ECW is pumped to the cooling coils of the AHUs located throughout the plant.

The ECW suction and discharge headers for the system are piped so that any two ECW chillers can be connected to the chilled water loads. The chilled water loads are separated into three loops. ECW Loops A and B are safety related. The third loop, the non-nuclear safety (NNS) loop, is not safety related.

During normal plant operation, two ECW pumps take suction from three independent and redundant loop suction lines and discharge through the related ECW chiller to three loop supply lines. The suction and discharge lines are connected by a header that allows any two of the three chillers and their associated chilled water pumps to supply the loops. Water is discharged to the supply loops at a constant temperature and rated flow to the subloops.

Each loop supplies ECW to AHUs located on a subloop. The ECW flows through the AHU cooling coils while an AHU fan blows air past the cooling coil to cool the room. The room temperature is maintained by adjusting ECW flow, and the ECW flow to the cooling coils is regulated by flow control valves, which receive a room temperature input to modulate the valve open or close. After flowing through the subloop, ECW is returned to the pump suction through the suction line.

During an accident and following a safety injection actuation signal, the two ECW chillers aligned for normal operation and their associated ECW pumps are automatically started if not already running. Each ECW chiller and pump will supply one of the two safety-related loops while the NNS return and supply valves close to isolate the NNS loop.

Attachment 2 depicts the relative positions of major ECW components.

3 EBASCO DESIGN CALCULATION AND PREOPERATIONAL TEST PROCEDURE SPO-46E

On April 27, 1976, the architect-engineer (Ebasco Corporation) performed a design calculation to determine the expected accident heat loads in safety-related rooms and to determine the required AHU cooling capacities needed to cool the rooms under these heat load conditions. Prior to plant construction, the total heat load and cooler capacities were listed in the USAR. In 1982, Ebasco revised the calculation to incorporate higher heat loads using cooling capacities that reflected the actual plant design. The calculation also developed the ECW flows, based on the actual heat removal capability of the AHUs, needed to remove these heat loads to maintain safety-related equipment operable. The total calculated ECW accident flow, with a 10 percent margin, was 481 gpm as demonstrated by Ebasco Calculation 5T, Revision 2, "Water Chillers."

Procedure SPO-46E was performed between October and November 1983 to balance the system flows and to confirm that the ECW system met accident, normal operating, and design flows. The correct flow balance was determined by testing the system in three modes: (1) maximum, (2) accident, and (3) normal. The maximum mode valve lineup had the system aligned with every safety-related valve open, the NNS loop isolated, and Recirculation Valves CHW-129A, -129B, and -129AB fully opened. The accident mode valve lineup was identical to the maximum mode except that upstream manual valve to the control room and mechanical equipment room AHUs was throttled. The normal mode valve lineup was identical to the maximum mode except that two ECW pumps were aligned on one loop and the NNS loops were included.

The ECW system was flow balanced by pumping water through the piping and positioning selected valves to obtain the optimum flow needed for all three modes. After these positions were set, the manual valves were locked and the position recorded in Procedure SPO-46E, Attachment 8.5.3. The valve positions were determined by measuring the total stem height to a reference point on the valve or by moving the valve disc indicator arrow to reference points on the valve body called notches. After the test was completed, Procedure SPO-46E determined the design flow as 510 gpm. Consequently, the licensee revised the ECW chiller design flow listed in Ebasco Design Specification 1564.747, "Water Chillers," page 4, from 500 to 510 gpm.

4 SEQUENCE OF EVENTS

4.1 Recirculation Valve CHW-129A Oscillations

As documented in NRC Inspection Report 50-382/95-04, the licensee noted that on April 16, 1995, while preparing to perform periodic inservice testing of AHU AH-12 Flow Control Valve CHW-603, Recirculation Valve CHW-129A began to oscillate and caused ECW Chiller A to trip on low flow. The licensee referenced the preoperational test procedure and determined that the fail-safe position for the valve was full open. The licensee failed the valve open to prevent the chiller from tripping and restarted the chiller. However, on April 17, 1995, the operators noted that the total flow of ECW Loop A increased to approximately 630 gpm as individual flow control valves for AHU loads automatically opened. The shift supervisor became concerned that ECW Pump A would eventually run out, as a result of the increased flow, and contacted the system engineer.

After investigating, the system engineer found that excessive flow through the opened recirculation valve may significantly reduce ECW subloop flows to safety-related AHUs and, as a result, render ECW Loop A inoperable. Condition Report (CR) 95-0287 was initiated to document the high flow condition, and Site Directive W4.101, "Operability/Qualification Confirmation Process," was entered to perform an additional investigation.

During additional investigation on April 17, 1995, the operators throttled Manual Recirculation Valve CHW-131A, located downstream of Recirculation Valve CHW-129A, one notch from closed and noted that the recirculation flow decreased. The licensee checked the effect of throttling Manual Recirculation Valve CHW-131A had on subloop flows. When ECW Subloop A flows were recorded, the licensee found that the total loop flow (436 gpm) was below the minimum flow assumed in the accident analysis (i.e., 481 gpm). As a result of the low flow, the licensee performed a design engineering evaluation to determine if a 436 gpm flow would adequately cool safety-related rooms subjected to accident heat loads. Upon evaluation, design engineering concluded that even though the system flow was below the minimum accident flow, the rooms would be cooled under accident heat load conditions. As a result, design engineering concluded that ECW Loop A remained operable with Manual Recirculation Valve CHW-131A throttled and Recirculation Valve CHW-129A failed open. The licensee determined that the failed open valve had rendered ECW Loop A inoperable for 38 hours until the manual recirculation valve was throttled.

The engineering evaluation documented that the original plant design basis for the ECW system listed in Ebasco Calculation 5T contained a 10 percent margin for accident flow. In their engineering evaluation, the licensee removed the margin and determined the minimum accident flow as 438 gpm. The licensee assumed that the 436 gpm flow would increase and exceeded the minimum accident flow as AHU flow control valves fully open during an accident. The inspectors concluded that the licensee's evaluation and assumptions were acceptable.

The inspectors reviewed equipment out-of-service logs and determined that the 72-hour shutdown LCO required by TS 3.7.12 was not exceeded when ECW Loop A was inoperable for 38 hours. The inspectors also verified that TS 3.0.3 LCO, which requires that operators place the plant in HOT STANDBY within 7 hours if both ECW loops are inoperable, was not violated because the inspectors confirmed that ECW Loop B remained operable but degraded during this period.

4.2 Special Testing to Verify Recirculation Valve CHW-129A Operation

On May 5, 1995, the licensee performed Special Test Procedure 001134807, Section 10.1 to check the controller response for Recirculation Valve CHW-129A. This testing found that air trapped in the impulse leg of the flow controller tubing caused the recirculation valve to oscillate. The licensee concluded that two high point vents, specific to the design of the recirculation valve, caused the air to be trapped in the tubing. The air was vented, and ECW chiller and ECW Pump A restarted. Subsequently, the licensee fully opened Manual Recirculation Valve CHW-131A and confirmed that the response check of recirculation valve was satisfactory. As a long-term corrective action, the system engineer initiated Modification Request CHW-004 to change the flow controller high point vent design.

4.3 Special Testing to Verify ECW Loop A Maximum Flow Using Pump A

On May 8, 1995, the licensee performed Special Test Procedure 001134807, Section 10.2 to determine the maximum flow through ECW Loop A using ECW Pump A. The licensee aligned the valves using the maximum flow lineup specified in Procedure SPO-46E as a guide. After the valve alignment was completed, the test was started, and the licensee verified that the 570 gpm loop flow exceeded the 510 gpm design flow.

During the special test, the system engineer departed from the valve lineup specified in Procedure SPO-46E, in that Recirculation Valve CHW-129A was operable and not full open. Operable meant that the valve modulated open and close to maintain minimum flow through the chiller at 300 gpm. The valve opened as total ECW flow decreased below 300 gpm and fully closed as total

ECW flow increased above 300 gpm. The inspectors questioned the acceptability of maintaining the recirculation valve operable during the special test since the preoperational test originally required this valve be fully opened. The licensee stated that the maximum flow noted in the preoperational test would be impossible to obtain with the recirculation valve full open because of the excess recirculation flow and, therefore, concluded that the valve lineup of the original preoperational test procedure must have been incorrect. Also, the licensee indicated that they were unable to resolve this discrepancy because of a lack of historical records on the preoperational test methodology.

Based on this observation, the inspectors noted that the AHUs were vulnerable to low ECW subloop flows when the recirculation valve inadvertently failed open and questioned whether procedures addressed this vulnerability. The licensee stated that Standing Instruction 95-04 would direct the operators to throttle the applicable Manual Recirculation Valves CHW-131A, -131B, or -131AB in the event that Recirculation Valves CHW-129A, -129B, or -129AB failed open. However, the operators did not know the appropriate throttle position for the manual recirculation valves required to maintain acceptable ECW subloop flows and requested that design engineering determine this position.

As a result, design engineering initiated an interoffice memo dated July 6, 1995, which provided guidance for the required operator actions if Recirculation Valves CHW-129A, -129B, or -129AB inadvertently failed. This guidance did not specify a throttle position for Manual Recirculation Valves CHW-131A, -131B, or -131AB but required that the manual recirculation valve be closed and the control room AHU flow control valves be failed open on the affected ECW loop to provide acceptable subloop flows. However, the operators preferred that the memo instructions be proceduralized and, as a result, decided to cancel the standing instruction and declare the affected ECW loop inoperable when the recirculation valve failed open. The licensee planned to change Procedure OP 100-014 to include guidance from the engineering memo. The inspectors concluded these actions were acceptable.

4.4 Special Testing to Verify ECW Loop B Flows Using ECW Pump AB

On May 25, 1995, the licensee performed Special Test Procedure 01135688, Revision 0, to determine the maximum flow through ECW Loop B using ECW Pump AB. Also, the special test helped engineers determine the correct fail-safe position for Recirculation Valve CHW-129B and an acceptable throttle position for Manual Recirculation Valve CHW-131B should the Recirculation Valve CHW-129B fail open. The special test used the preoperational test procedure as a guide for the valve lineup. The special test determined that the total ECW Loop B flow was 480 gpm, which was almost identical to the accident flow of 481 gpm. As a result, the operators fully opened the ECW Pump Discharge Valve CHW-115AB, which was previously throttled one notch from closed in accordance with the preoperational test procedure, and flow increased to approximately 565 gpm.

After opening the ECW pump discharge valve, the licensee noted a low flow on the Safeguards Pump Room B subloop. Upon investigation, the licensee found that the throttle valve for the emergency feedwater and charging pump room AHU (CHW-823) was full open and not in the 3/8-inch throttled position specified in the preoperational test procedure. In addition, the licensee noted that Procedures OP 002-004, Revision 7, "Chilled Water System," and OP 903-062, Revision 6, "Chilled Water System Valve Lineup," required the valves to be full open. The licensee also noted that the return valve for the Safeguards Pump Room B AHU (CHW-846) was 1/2-turn more closed than the position listed in Procedures OP 002-004 and OP 903-062. The licensee modified the valve positions in the special test procedure to match Procedures OP 002-004 and OP 903-062 and confirmed that these mispositioned valves did not cause the low flow in the Safeguards Pump Room B subloop.

The licensee did not know the reason for the discrepancies among the preoperational test procedure and the operating procedures regarding the throttle position for Valve CHW-823, and the licensee did not know how Valves CHW-823 and -846 became mispositioned. Because the valves were not positioned in accordance with the operational procedures, the inspectors concluded that the mispositioned valves were two examples of a TS 6.8.1.a violation. However, the inspectors noted that the mispositioned valves did not significantly impact ECW subloop flows and were, therefore, not considered safety significant deviations. Further, the licensee had identified and quickly corrected the discrepancy. Consistent with the guidance contained in Section VII.B.1 of the Enforcement Policy this is a noncited violation.

As part of the troubleshooting effort of checking the two individual AHU flows located in Safeguards Pump Room B, the licensee found that the total flow of AHU AH-2D was acceptable, but each of the two cooling coils in AHU AH-2B had little and no flow. The licensee assumed that the Safeguards Pump Room B cooling coil Discharge Valves CHW-840A and -840B were mispositioned. The operators opened the discharge valves approximately 1/2-turn and noted a slight increase in discharge flow. The system engineer left the valves in the different positions, stopped the test, and proceeded to the control room to discuss the flow discrepancies in the AHU AH-2B.

The system engineer discussed the low flows with the shift supervisor and the design engineering manager. While performing the operability determination, the shift supervisor concluded that Safeguards Pump Room B remained operable with one operable AHU because he thought the AHUs were 100 percent capacity. However, the design engineering manager remembered that the units were actually 50 percent capacity, as specified in Ebasco Calculation 5A, "Safeguards Pump Area." Upon further evaluation, the licensee determined that the shift supervisor had developed this incorrect assumption because Procedure OP 100-014, Step 5.2 listed the AHUs as 100 percent capacity. The licensee also checked ECW Loop A AHUs to determine if the they too were 50 percent capacity. A review of Safeguards Pump Room A AHU AH-2A and -2C designs confirmed that these units were 50 percent capacity.

The inspectors reviewed Procedure OP 100-014 and found that the procedure provided guidance on entering TS action statements whenever operators declared safety-related equipment inoperable. The inspectors noted that, in addition to the incorrect note regarding AHU capacity, the procedure also stated that each safeguards pump room required one of two AHUs. The inspectors questioned the licensee if any AHU in either Safeguards Pump Rooms A or B had been removed from service in excess of the allowed 72-hour outage time with reliance on the other room cooler for operability. The licensee reviewed previous equipment out-of-service logs and did not find an instance where the allowed outage time was exceeded.

10 CFR Part 50, Appendix B, Criterion III, requires that measures shall be established to assure that applicable regulatory requirements and design basis are correctly translated into procedures and instructions. The inspectors concluded that the licensee incorrectly translated the AHU design into the operational procedure, in that, the operational guidance provided in Procedure OP 100-014 incorrectly specified stated that the AHUs were 100 percent capacity. Although this incorrect information did not result in a violation of the TS LCO, the failure to accurately translate this design information into an operational procedure is an example of a violation of 10 CFR Part 50, Appendix B, Criterion III. However, because of the corrective actions taken to resolve the concern, this licensee-identified violation is being treated as a noncited violation consistent with Section VII.B.1 of the NRC Enforcement Policy.

The licensee initiated a CR to document their findings. As part of the CR action item, the licensee began an engineering evaluation to examine the original calculations performed by Ebasco on the AHUs. Additionally, the root cause committee requested that valve sensitivity tests be performed for Safeguards Pump Room B cooling coil Discharge Valves CHW-840A and -840B to determine the impact the change in valve position had on flow. The results of this testing is discussed in Section 4.7 below.

4.5 Special Testing to Verify ECW Loop B Flows Using ECW Pump B

On June 1, 1995, the licensee performed Special Test Procedure 01136204, Revision 0, to determine the maximum system flow through ECW Loop B using ECW Pump B. During the test, the system engineer noted that total ECW flow was approximately 320 gpm, which was only 63 percent of the design flow of 510 gpm. The system engineer recognized that the flow was much too low and proceeded to discuss the degraded flow condition with design engineers and the system engineering superintendent. After the discussion, the Engineering Department concluded that the ECW Pump Discharge Valve CHW-115B, which was throttled one notch from closed in accordance with the preoperational test procedure, restricted the system flow and requested that operations fully open the valve. When fully opened, the system flow increased above the accident flow requirements to approximately 580 gpm.

On August 9, 1995, the inspectors questioned the reason for positioning the valve one notch from closed. The licensee stated that the preoperational flow balance test determined that this position ensured optimum flow to the AHUs during all flow conditions. The inspectors reviewed preoperational flow balance Procedure SPO-46E and found that Attachment 8.5.3 required the ECW Pump Discharge Valves CHW-115A, -115B, and -115AB to be positioned one notch from closed by a punch mark. The inspectors questioned the significance of returning the valve exactly to the punch mark position.

The licensee was not certain that a punch mark indicated the exact flow balance valve position or that even a punch mark existed. Rather, they relied on a notch indicator on the valve body for returning the valve to the proper position. However, during recent testing the licensee found that it was difficult to return the valve to the position that provided the required design flows. This was partly because of the design of the valve, in that, the butterfly valve does not provide linear flow with a change in valve position. During the special tests of the system, the licensee noted that, as the position indicator was moved in small increments around the notch position, substantial ECW flow changes occurred. The licensee concluded that the system flow was very sensitive to small changes in valve position, therefore, returning the valve to the exact position required by the preoperational flow balance was difficult to repeat using the notch indicator.

In order to determine how often the throttle valve had been moved from the position set during preoperational testing, the inspectors interviewed operators to determine if the ECW Pump Discharge Valve CHW-115B had been previously repositioned. The licensee indicated that the operators occasionally repositioned the discharge valve while performing monthly Surveillance Task 021438, "Chiller Operability Test," and Procedure OP 903-063. The operators opened the valve during the tests to obtain a 510 gpm flow when flow could not be achieved by other means (i.e., aligning NNS loop, manipulating flow control valves, or bypassing AHUs).

The inspectors reviewed past surveillance tests and locked valve deviation sheets and found that prior to June 1995, the ECW Pump Discharge Valve CHW-115B was last deviated on May 12, 1995, to perform Procedure OP 903-063 under Work Authorization 01134151. However, Procedure OP 903-063 required that the ECW outlet flows be restored as required by the shift supervisor/control room supervisor by throttling the ECW Pump Discharge Valves CHW-115A, -115B, or -115AB, respectively. The inspectors noted that the procedure did not require that the valve be returned to the position set during flow balancing to obtain the design flows. Additionally, the inspectors reviewed Surveillance Task 021438 and found that it also did not provide any instructions for returning the discharge valve to its correct throttle position.

As previously indicated, 10 CFR Part 50, Appendix B, Criterion III requires that the design basis be adequately translated into procedures and instructions. The inspectors concluded that the licensee incorrectly translated the ECW Pump Discharge Valves CHW-115A, -115B, and 115AB position, in that, Procedure OP 903-063 and Surveillance Task 021438 did not provide adequate operational guidance to return ECW Pump Discharge Valves CHW-115A,

-115B, and -115AB to a position that provided a design flow of 510 gpm. This is the second example of a violation of 10 CFR Part 50, Appendix B, Criterion III. This licensee-identified violation also is being treated as a noncited violation consistent with Section VII.B.1 of the NRC Enforcement Policy.

Because of the low flows identified in ECW Loop B and the discrepancies in Preoperational Test Procedure SPO-46E related to position of the Recirculation Valve CHW-129B, the licensee performed additional flow tests on AHUs for both ECW loops to determine if the ECW Pump Discharge Valve CHW-115A could be fully opened and to flow test ECW Loop A using ECW Pump AB. However, as indicated in Section 4.6, the licensee has decided to test ECW Loop A using ECW Pump AB during the next outage.

4.6 <u>Special Testing to Verify ECW Loop A Flows Using ECW Pump AB</u>

The licensee had scheduled flow testing of ECW Loop A using ECW Pump AB for the next refueling outage, which was scheduled to begin September 23, 1995. When inspectors questioned why testing in this configuration was delayed, the licensee explained that ECW Pumps A, B, and AB receive power from electrical Buses A, B, and AB, respectively, and that Bus AB is normally aligned to receive power from Bus B. A flow test of ECW Loop A using ECW Pump AB required that Bus AB be electrically aligned to Bus A and disconnected from Bus B. The activity required deenergizing all Bus AB electrical loads and reconnecting Bus AB to Bus A. The licensee stated that performing this dead bus transfer might induce electrical perturbations and cause adverse consequences to plant operations. Because of the potential plant impact, the licensee decided to delay in testing ECW Loop A using Pump AB. The inspectors concluded that delaying the test until the refueling outage was prudent.

4.7 <u>Special Testing to Perform ECW Flow Sensitivity Tests Through Individual AHUs on ECW Loop B Using ECW Pump B</u>

On July 24, 1995, Special Test Procedure 01136204, Revision 1, was performed to determine the flow through ECW Loop B AHUs using ECW Pump B and to determine the sensitivity of Safeguards Pump Room B cooling coil Discharge Valves CHW-840A and -840B. Additionally, the licensee aligned High Pressure Safety Injection Pump Room AB AHU AH-21B, which is located in Safeguards Pump Room A, to ECW Loop B for the test.

After verifying the alignment, the licensee performed the valve sensitivity test and found that flow through the Safeguards Pump Room B AHU cooling coil significantly increased after cycling the valves. The licensee returned the discharge valves to the position listed in Procedure SPO-46E. In order to determine what may have affected the AHU flow, the licensee obtained a bulk chemistry sample and found a significant increase in iron content and the presence of coagulated biocide, which was used as a corrosion inhibitor. The licensee concluded that these products collected in the discharge valve openings and degraded flow through AHU AH-2B and that the original throttle position specified in the preoperational test procedure was correct.

After completion of the flow sensitivity test, the licensee once again checked the flow through AHU AH-21B and found that it was totally blocked. The licensee opened the AHU cooling coil Discharge Valve CHW-853 in an attempt to re-establish flow. When the valve was opened, the sediment and rust flushed away which restored flow. The valve was returned to its original position. The licensee initiated CR 95-0620 to document the inoperable AHU.

The inspectors questioned the licensee if they planned to perform an engineering evaluation for inoperable AHU AH-21B. The licensee stated that Procedure OP 500-013, Revision 5, "Annunciator Response Procedure for Control Room Cabinet SA," provided instructions to address a loss of flow to ECW Loop A concurrent with an inoperable AHU. Additionally, the licensee stated that other Safeguards Pump Room A AHUs AH-2A and -2C had enough margin to cool the room without AHU AH-21B. The inspectors reviewed the procedure and Ebasco Calculation 5A performed on July 27, 1976. The inspectors confirmed that the procedure was acceptable and that the margin was addressed in the calculation. The inspectors concluded that an engineering evaluation was not required because a loss of the AHU had been adequately addressed in the procedure and in the calculation.

4.8 Special Testing to Determine ECW Flow Through Individual AHUs on ECW Loop A Using ECW Pump A

On July 26, 1995, the licensee performed Special Test Procedure 01136661, Revision 0, to test the flows through ECW Loop A AHUs using ECW Pump A. The licensee performed the test similar to the preoperational test procedure. During the test, the licensee found that the 500 gpm loop flow was below the 510 gpm design flow and lower than the 570 gpm as-left flow measured on May 8, 1995. As a result, the ECW Pump Discharge Valve CHW-115A was fully opened from the one notch from closed position, and the total system flow increased to more than 630 gpm.

The inspectors questioned why the ECW Loop A 500 gpm flow discovered on July 26, 1995, was lower than the as-left flow on May 8, 1995, and questioned if ECW Pump Discharge Valve CHW-115A had been previously manipulated. The licensee reviewed locked valve deviation lists to determine if ECW Pump Discharge Valve CHW-115A had been previously manipulated from the throttled position. The licensee found that the operators opened the valve on June 30, 1995, to obtain enough ECW loop flow to perform the ECW Pump A operability test. After performing the test, the operators returned the valve to the one notch from closed throttled position.

The inspectors concluded that after performing this test, the operators did not return the valve to the exact flow balance position set during preoperational testing. As a result, ECW Pump Discharge Valve CHW-115A position restricted the actual loop flow below the design flow. However, because the measured flow remained above the 481 gpm accident flow, the inspectors concluded the deficiency was not safety significant.

After the flow increased, the licensee checked flow through the Control Room and Mechanical Equipment Room AHU AH-26A and found that rust and sediment also blocked the cooling coil flow. The sediment and rust was flushed away by opening the AHU cooling coil Discharge Valve CHW-241. The licensee restored the valve lineup and completed the test. This additional example of an inoperable AHU was documented in CR 95-0622.

4.9 Periodic Test Requirements for the ECW System

As a result of the degraded flows discovered on ECW Loop B and in the AHUs, the inspectors questioned whether the licensee had periodically tested the ECW loop flows. The licensee stated that there were no regulatory requirements to periodically test the ECW loop flows. The only testing required was that specified by TS 3.7.12 and Procedure OP 903-063, which required a monthly verification of the ECW cooler capacity and quarterly verification of the ECW pump capacity. Nevertheless, the inspectors were concerned that Generic Letter 89-13 indicated that the service water systems are required to be periodically tested.

Upon further evaluation, the inspectors determined that Generic Letter 89-13 only addressed periodic testing of open-loop service water systems. As indicated in Generic Letter 89-13, the periodic testing of closed-loop systems not having chemistry controls when the system was originally placed in service is addressed by the American Society of Mechanical Engineers OM-1987, Part 2, "Operating and Maintenance of Nuclear Plants." The inspectors verified that chemistry controls were invoked since the ECW system had been placed in service. Therefore, the inspectors confirmed that the licensee was correct in concluding that periodic flow testing of the closed-loop system was not required by regulation.

The inspectors also questioned how the corrosion products collected at the discharge valves. The licensee assumed that increased flows, as a result of opening the ECW Pump Discharge Valves CHW-115A, -115B, and -115AB during the special test procedures, flushed the corrosion products to the AHU cooling coil discharge valves. The licensee also concluded that the AHUs were not blocked prior to the performance of the special test. As a corrective action, the licensee planned to perform periodic ECW flow testing of selected AHUs, a visual inspection of the AHU cooling coils, a periodic sampling of ECW subloops, and removal of iron from the ECW system. More details about the long term corrective actions are discussed in Section 6.2. The inspectors concluded that these corrective actions were acceptable to preclude recurrence of the blocked flow.

5 REVIEW OF ENGINEERING EVALUATION

5.1 Background

The licensee performed an engineering evaluation to assess the safety significance of the degraded flow on ECW Loop B. The evaluation consisted of several assumptions and was comprised of three sections: (1) Mechanical, (2) Gothic Code, and (3) Electrical/Environmental Qualification.

The licensee evaluated the heat removal capacity of ECW Loop B AHUs under the identified degraded flow condition of 63 percent of the 510 gpm design flow. The AHUs included the Component Cooling Water Pump Room B, Emergency Feedwater Pump Room B, Control Room Mechanical Equipment Room Area B, Control Room Area B, and Charging Pump Room B. The evaluation also calculated the heat rise in Safeguards Pump Room B with the blocked flow of AHU AH-2B. For the affected rooms, the licensee used the design basis heat loads to determine the maximum ambient room temperature and evaluated the impact this temperature had on equipment operability.

The licensee obtained the design basis heat load values from an Ebasco calculation performed in 1982. In addition, the licensee assumed that the flow through ECW Loop B AHUs was 63 percent of the design flow and that operator action would re-establish ECW system design flow to the AHUs by opening ECW Pump Discharge Valve CHW-115B within 6 hours of the accident. The engineer incorporated the heat load and assumptions into the Gothic Computer Code, which generated maximum ambient room temperatures over a 30-day period following an accident.

The Gothic Code analysis revealed that only Safeguards Pump Room B would exceed the harsh environment environmental qualification temperature. Based on the environmental qualification evaluation, the licensee found that the pumps located in this room could operate at temperatures of up to 160°F for 30 days. The Gothic Code determined that the maximum room temperature without opening ECW Pump Discharge Valve CHW-115B was 147°F. Therefore, the licensee concluded that the degraded flow was sufficient to maintain safety-related equipment operable in Safeguards Pump Room B.

5.2 Inadequate Documentation of Design Basis

As previously indicated, the inspectors concluded that the overall results of the engineering evaluation was acceptable. However, as listed below, the inspectors identified several weaknesses in the engineering evaluation.

(1) The inspectors noted that the licensee used values for the design basis heat loads and AHU capacities that were different than specified in the USAR. USAR Table 9.4-14 stated that the expected heat load in Safeguards Pump Room B was 167,685 British thermal units (BTU) per hour and the cooling capacity of AHU AH-2B was 321,000 BTU per hour. The evaluation used a heat load of 348,050 BTU per hour and AHU AH-2B cooling capacity of 348,800 BTU per hour. The licensee stated that the USAR values were based on the original Ebasco design calculations that were performed prior to the construction of the ECW system. These design values were subsequently changed when Ebasco reperformed the calculation in 1982, but the USAR was not revised to reflect this change. The licensee stated that the discrepancy had been previously identified while establishing the plant design basis document for the

ECW system and had been tracked as open Item 001 in Design Basis Document 037.

The inspectors were concerned that the USAR did not reflect the actual design basis of the ECW system and questioned whether the licensee had performed a 10 CFR 50.59 evaluation of this change in the plant as described in the USAR to determine if an unreviewed safety question existed. Although a formal, documented evaluation could not be found, the licensee stated that an unreviewed safety question did not exist since the Ebasco calculation confirmed that the actual plant design could adequately remove accident heat loads. The inspectors were concerned that the licensee had not updated the USAR or the design basis document in a timely manner to reflect the actual design values. In addition, the inspectors were concerned that subsequent analysis and design modification review may not have used the correct design basis as reflected in the revised Ebasco calculations. Therefore, the licensee's correction of the USAR discrepancies will be followed as an inspection followup item (382/9516-01).

(2) During the review of the engineering evaluation assumptions, the inspectors experienced difficulty in determining the total heat load in the Safeguards Pump Room B. The engineering evaluation did not describe how the individual heat loads were calculated nor what assumptions were used to establish the total heat load values. The inspectors questioned the design engineer, who subsequently generated documentation to show how the total heat load value was calculated. The licensee stated that the evaluation was a summary of conclusions to justify operability and that the heat load derivations were not required to be listed. However, the inspectors expected that such a detailed engineering evaluation should include sufficient information for an independent reviewer to audit the evaluation without difficulty. In fact, the inspectors noted that seven individuals from different engineering departments reviewed and concurred on the evaluation and questioned how these individuals could verify these assumptions without this information present. The inspectors concluded that the engineering evaluation had insufficient documentation.

(3) The inspectors also noted that the licensee credited operator action to fully open the ECW Pump Discharge Valve CHW-115B to provide all the AHUs on ECW Loop B with design flow when the room temperature alarms annunciated in the control room. The inspectors noted that Procedure OP 500-014, "Annunciator Response Procedure Control Room Cabinet SB," provided instructions to align the ECW system to the cooler but did not provide guidance to fully open the discharge throttle valve to stabilize room temperature. The inspectors questioned the licensee whether this assumption was valid in light of this lack of guidance. The licensee stated that an operator would deduce, within 6 hours, that insufficient room cooling was caused by the throttled discharge valve. As a result, the operator would open the valve and allow sufficient ECW flow necessary to stabilize the room temperatures. Nevertheless, the

inspectors concluded that the annunciator response procedure lacked sufficient detail to credit operator action. Therefore, the assumption in the engineering evaluation was weak.

6 CORRECTIVE ACTIONS

Because of the degraded flow conditions identified as a result of the licensee's special testing, the licensee had implemented the following short- and long-term corrective actions to preclude recurrence.

6.1 Corrective Actions Addressing Degraded Total Flow

As a result of the special testing, the licensee found that the throttle position of ECW Pump Discharge Valves CHW-115A, -115B, -115AB restricted flow below the design flow of 510 gpm. These valve positions were promptly changed to the full open position to ensure flow would be maintained at or above the design flow requirements. Further, the licensee recognized that the ECW system required additional periodic flow testing to confirm that total system flows would be at or above the design flow of 510 gpm. As a result, the licensee initiated an action plan to develop periodic flow balance testing procedures. In an effort to continuously maintain maximum ECW flow through the safety-related loops, the licensee obtained approval for Modification Request CHW-006 to disconnect the NNS loop from the safety-related loops. Removal of the NNS loop provides more ECW flow to the safety-related AHUs and permits the licensee to fail open AHU flow control valves to allow total maximum flow through ECW safety loops.

6.2 Corrective Actions Addressing Degraded Flow through AHUs

The licensee found degraded ECW flow through three AHUs and promptly attributed the root cause to rust and coagulated biocide collecting at the cooling coil discharge valves. The licensee immediately restored AHU flow by cycling the discharge valves to flush out the material. The discovery of coagulated biocide and rust prompted the licensee to reevaluate ECW chemistry sampling controls and ECW system inspections. As a result, the licensee is developing an action plan for additional sampling of the ECW safety subloops and an action plan to remove iron from the ECW system. Further, the licensee plans to initiate a condition identification to periodically inspect selected AHU and ECW piping, valves, and other components for iron deposits and micro-biological induced corrosion. Additionally, the licensee plans to initiate a periodic task to verify that selected AHUs have adequate flows.

6.3 Corrective Actions Addressing Incorrect Design AHU Capacity in Procedure

The licensee identified that the design cooling capacity of Safeguards Pump Rooms A and B AHUs were incorrectly translated into Procedure OP 100-014, in that, the procedure listed the AHUs as 100 percent capacity rather than the actual 50 percent capacity. As a result, the licensee is currently revising Procedure OP 100-014 to reflect the appropriate design capacity.

6.4 Conclusions

The inspectors concluded that, because of aggressive and proactive efforts, such as a series of complex special tests, the licensee had self-identified numerous deficiencies associated with the ECW system. Furthermore, the licensee took prompt and immediate corrective action to correct the deficiencies and had developed comprehensive and proactive long-term corrective actions to resolve and preclude recurrence of these events.

ATTACHMENT 1

1 PERSONS CONTACTED

Licensee Personnel

*+R. Azzarello, Design Engineering Director
* H. Brodt, Design Engineering/Safety and Engineering Analysis
*+R. Burski, Nuclear Safety Director
*+G. Davie, Quality Assurance Manager
+ M. Ferri, Plant Modifications and Construction Director
+ C. Fugate, Operations
*+T. Gaudet, Licensing Supervisor
+ J. Hoffpauir, Maintenance Supervisor
+ J. Holman, Safety Analysis Manager
*+J. Hologa, Mechanical & Civil Design Manager
+ J. Johnston, Senior Staff Engineer Operational Experience Engineering
*+D. Keuter, Plant Operation General Manager
* J. Laque, System Engineering Supervisor
* J. Ledet, Security Superintendent
+ D. Litolff, Licensing
+ B. McDonald, System Engineer
+ J. O'Hern, Training Manager
* N. Pazooki, Design Engineering/Safety and Engineering Analysis
* B. Pendergrass, Licensing Shift Supervisor
+ P. Prasankumar, Manager Design Engineering Electrical-I&C
* M. Raines, Jr., Design Engineering-I&C-Environmental Qualification
*+J. Reese, Design Engineering
* J. Ridgel, Operational Experience Engineering/Acting Technical Service Manager
+ C. Talazac, Systems Engineer
* B. Thweatt, Design Engineering Mechanical Supervisor
*+D. Vinci, Licensing Manager

*Denotes technical exit meeting conducted on August 10, 1995
+Denotes final exit meeting conducted on August 18, 1995

The personnel listed above attended the exit meeting. In addition to these, the inspectors contacted other personnel during this inspection period.

2 EXIT MEETING

A technical exit meeting was conducted on August 10, 1995. A final exit meeting was conducted on August 18, 1995. During this meeting, the inspectors reviewed the scope and findings of the report. The licensee did not express a position on the inspection findings documented in this report. The licensee did not identify as proprietary any information provided to, or reviewed by, the inspectors.

ATTACHMENT 2

DIAGRAM OF ECW MAJOR COMPONENT RELATIVE POSITIONS