ENCLOSURE 2

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

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Report No.:	50-361/98-18 50-362/98-18
Licensee:	Southern California Edison Co.
Facility:	San Onofre Nuclear Generating Station, Units 2 and 3
Location:	5000 S. Pacific Coast Hwy. San Clemente, California
Dates:	November 9 through December 18, 1998
Inspectors:	J. J. Russell, Resident Inspector J. G. Kramer, Resident Inspector
Approved By:	L. J. Smith, Acting Chief, Branch E Division of Reactor Projects

ATTACHMENT: Supplemental Information

EXECUTIVE SUMMARY

San Onofre Nuclear Generating Station, Units 2 and 3
NRC Inspection Report 50-361/98-18; 50-362/98-18

Operations

- A faulty temperature control unit, an incorrectly set electrical demand switch, and noncondensable gases rendered Chiller E335 inadvertently inoperable for 20 consecutive days in August 1998. Similarly, a miswired low chilled water temperature cutout switch or a combination of noncondensable gases, oil in the refrigerant, and an electrical demand setting of 80 percent rendered Chiller E335 inoperable for 22 consecutive days in September 1998. The time periods for these inoperabilities exceeded the Technical Specifications Limiting Condition for Operation 3.7.10 allowed outage time and was identified as an apparent violation (Section O8.1.b.3).

- The emergency chilled water system operating procedure specified that the electrical demand be limited to 80 percent, which reduced chiller capacity below that assumed in design bases document. The failure to translate the design basis requirement for emergency chiller capacity in the operations procedures for setting electrical demand contributed to emergency Chiller E 335 in operability during August and September 1998. This failure was identified as a noncited violation of 10 CFR Part 50, Appendix B, Criterion III, "Design Control." However, this deficiency alone did not render the emergency chiller inoperable. This nonrepetitive, licensee-identified and corrected violation is being treated as a noncited violation consistent with Section VII.B.1 of the NRC Enforcement Policy (Section 08.1.b.5).

- Operators demonstrated poor awareness of the effects of compressor oil pump operation on a standby emergency chiller. Operators operated the oil pump with the compressor in standby for greater than the time allowed by procedure in attempts to lower a high oil level. The inspectors identified this as a failure to follow a procedure required by Technical Specification 5.5.1.1.a. Since the licensee implemented appropriate corrective actions, no response was required (Section O8.2).

Maintenance

- Postmaintenance testing, as prescribed by operations work control, for scheduled emergency chiller maintenance was not adequate because work that affected the start circuit for the chiller was not tested. This deficiency was identified as a noncited violation of 10 CFR Part 50, Appendix B, Criterion V, consistent with Section VII.B.1 of the Enforcement Policy. This deficiency contributed to inoperability of Chiller E335 for 22 days in September 1998 (Section O8.1.b.2).

- Maintenance personnel demonstrated poor control of lifted leads and of emergency chiller switch settings. An instrumentation and control (I&C) technician failed to properly reconnect wires to an emergency chiller low temperature cutout switch, rendering the chiller inoperable. The failure to follow procedure was identified as a noncited violation of Technical Specification 5.5.1.1.a, consistent with Section VII.B.1 of the Enforcement Policy. During the same maintenance activity, the chiller was left with an improper thermostat setting and the sequence for the low chilled water and low

refrigerant temperature chiller trips was not in accordance with procedural recommendations. These deficiencies reflected inattention to detail by an I&C technician (Section M8.1).

Engineering

- Engineering personnel demonstrated poor assessment of equipment operability and understanding of information contained in a vendor manual. A flawed operability assessment when an emergency chiller could not achieve design cooling resulted in an inadvertent inoperability of the chiller for approximately 20 days during August 1998. The failure of engineers to take appropriate actions to demonstrate operability of the Train B emergency chiller, as specified by the corrective action program, was identified as a noncited violation of 10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Action," consistent with Section VII.B.1 of the Enforcement Policy. Had the licensee implemented the vendor manual recommended performance monitoring of the chillers, the buildup of noncondensable gases in the refrigerant during August and September 1998 could have been detected (Section E8.1).

- An engineering evaluation of Chiller E335 operability from September 3 to 25 was generally thorough. However, some of the reasons for the chiller inoperability, including introduction of oil and noncondensable gases into the refrigerant, were not completely understood by the licensee until questioned by the inspectors (Section E8.2).

- Licensee use of equipment specific configurations and human reliability analysis in the risk assessment associated with the inadvertent Train B chiller inoperability was a strength. The overall increase in risk because of the inoperable chiller was potentially risk significant (Section E8.3).

Report Details

Summary of Plant Status

Units 2 and 3 operated at essentially 100 percent power during this inspection period.

I. Operations

O8 Miscellaneous Operations Issues (92700)

O8.1 (Closed) Licensee Event Reports 50-361; 362/98-020-00 and 98-021-00: emergency chilled water (ECW) inoperable because of faulty temperature control unit and ECW inoperable because of an incorrectly wired switch.

a. Inspection Scope

The inspectors reviewed the circumstances concerning two periods of inadvertent inoperability of Units 2 and 3 Train B ECW, as pertains to operations. The inspectors reviewed Procedure SO23-1-3.1, "Emergency Chilled Water System Operation," Temporary Change Notice 10-2, and Design Bases Document SO23-800, "Auxiliary Building Chilled Water System," Revisions 0 and 2. The inspectors reviewed portions of Work Action Request (WAR) C-9802021 and a work schedule for implementing this WAR prepared on August 13, 1998. The inspectors reviewed portions of the chiller vendor manual, Technical Manual SO23-410-7-164-2, "Operating Instructions for Carrier Centrifugal Refrigeration Machines," Revision 2. The inspectors also interviewed operators and operations management personnel.

b. Observations and Findings

b.1 Sequence of Events

As described in the licensee event reports, Chiller E335, Train B emergency chiller (common to both units), was inadvertently inoperable for 20 continuous days in August 1998 and for 22 continuous days in September 1998.

- On August 6, Chiller E335 was operated to support a monthly control room essential air cleanup system surveillance. Operators observed that the chilled water temperature leaving the chiller decreased to approximately 51°F; however, the normal chilled water outlet temperature was 43°F. Operators considered Chiller E335 operable; however, they generated an action request (AR) to have engineering assess operability.

- On August 26, operators removed Chiller E335 from service for scheduled maintenance and declared the emergency chiller inoperable.

- On August 28, I&C technicians replaced the temperature control unit. Operators performed a postmaintenance test that demonstrated satisfactory performance and declared Chiller E335 operable.

- On August 31, operators removed Chiller E335 from service for scheduled maintenance.

- On September 3, an I&C technician disconnected the leads from a low temperature chilled water cutout switch, in order to perform a dynamic calibration of the switch setpoint. During the dynamic calibration, the I&C technician stopped the calibration after hearing the emergency chiller make a rumbling noise.

- On September 4, operators declared Chiller E335 operable after verifying that the chiller continued to operate satisfactorily; however, the operators did not start Chiller E335.

- On September 25, Chiller E335 failed to start when operators attempted to perform a monthly control room essential air cleanup system surveillance. Subsequently, the licensee determined that the I&C technician had incorrectly wired the low chilled water temperature cutout switch for Chiller E335, and the postmaintenance test failed to detect the error. This error rendered Chiller E335 inoperable from September 4 to 25.

- During troubleshooting on and after September 25, the licensee determined that noncondensable gases present in Chiller E335 from August 6 to September 25 degraded the capability of the chiller condenser. In October 1998, as part of the operability review, the licensee determined that Chiller E335 had been degraded from August 6-26, because of several factors: (1) a faulty temperature control unit, (2) an incorrectly set electrical demand switch in the control circuit, and (3) the presence of noncondensable gases in the refrigerant. The licensee determined that these factors combined with a 51°F chilled water outlet temperature rendered Chiller E335 inoperable under design bases load conditions.

b.2 Postmaintenance Testing

Chiller E335 was removed from service for scheduled maintenance on August 31. WAR C-9802021 and a work schedule prepared on August 13 directed that Chiller E335 be operated in accordance with Procedure SO23-1-3.1 to verify operability following the maintenance. Concurrent with the operability test, a dynamic calibration of low chilled water and low refrigerant temperature cutout switches was scheduled to be performed.

The design chilled water outlet temperature for Chiller E335 is 43°F. The low chilled water temperature cutout switch has a nominal setpoint of 38°F. The switch contacts are normally closed above 38°F and normally open below 38°F. When the switch contacts open, the chiller compressor trips and the chiller shuts down. The switch contacts were installed in the start circuit for the chiller, such that the chiller would not start manually or automatically with the contacts open. During the dynamic calibration, an I&C technician disconnected the wires from the low chilled water temperature cutout switch and installed a jumper to disable the switch cutout from tripping the chiller. Because of personnel error, an I&C technician had reterminated the switch wires

incorrectly. In addition, although the dynamic calibration affected contacts in the chiller start circuit, the postmaintenance test did not test the capability of the start circuit to start the emergency chiller. Failing to provide instructions for postmaintenance testing appropriate to the circumstances was a violation of 10 CFR Part 50, Appendix B, Criterion V, "Instructions, Procedures, and Drawings."

The licensee initiated the following corrective actions to prevent recurrence: (1) add a postmaintenance test requirement to start the chiller after a dynamic calibration and (2) assess the adequacy of the retest program and evaluate the committee that met to approve retest requirements. This nonrepetitive, licensee-identified and corrected violation is being treated as a noncited violation, consistent with Section VII.B.1 of the NRC Enforcement Policy (50-361; 362/98018-01).

b.3 Technical Specifications

The licensee determined that Chiller E335 was inadvertently inoperable from August 6 to 26, and from September 3 to 25 (periods of 20 days and 22 days, respectively). Unit 3 was in Mode 1 operation for this entire period. Unit 2 was in Mode 1 for 22 consecutive days in August and the first 15 of the 22 consecutive days in September. Technical Specification Limiting Condition for Operation 3.7.10 directs that, with one train of ECW inoperable, each unit shall restore the train to operability in 7 days. If the train is not restored by the end of the 7 days, then the limiting condition for operation requires operators to place the unit in Mode 3 in 6 hours and be in Mode 5 in 36 hours. Because operators were not aware that Train B ECW was inoperable, these completion times were not complied with, which resulted in an apparent violation of Technical Specification Limiting Condition for Operation 3.7.10 (50-361; 362/98018-02).

The inspectors verified that Train A ECW remained operable throughout the 2-month period. Operations had declared Train A ECW inoperable from September 15 to 16, because of an air leak on the expansion tank, which caused the tank to fill with water and pressure to decrease. Also, the operators had declared the Train A Emergency Diesel Generator (EDG) 2G002 (the power source Chiller E336, Train A emergency chiller) inoperable on September 15 because the fuel transfer pump was returned to service without the required inservice test. As discussed below, the Train A chiller and the Train A EDG were shown operable throughout the period the Train B emergency chiller was inoperable.

b.4 Train A Operability Assessments

For the occurrence with the Train A expansion tank full of water, the expansion tank pressure increased to approximately 15 psig, which was the hydrostatic pressure that resulted from 70 feet of water in the chilled water piping above the expansion tank. The chilled water pump required approximately 4 psig suction pressure to avoid cavitation from a loss of net positive suction head. This 15 psig hydrostatic pressure exceeded the 4 psig required suction pressure. The chilled water pump would have provided 54 psig discharge pressure, given an expansion tank at 15 psig. The 54 psig discharge pressure would have been sufficient to pump chilled water throughout the chilled water piping. The licensee demonstrated, via analysis in AR 980900850, that some gas

pockets and separation of water from gas may have occurred on the chilled water pump suction side high points; however, the licensee determined that the chilled water flow would have been sufficient to collapse or mix these gas pockets, such that flow through all sections of piping would be maintained. Consequently, the inspectors found that the Train A emergency chilled water system could perform its intended function under these conditions.

A second occurrence resulted with Train A chilled water powered by EDG 2G002, which was declared inoperable because both fuel transfer pumps were inoperable. Each EDG has two fuel transfer pumps that transfer fuel from the EDG fuel storage tank to the day tank. On September 15, one EDG fuel transfer pump (Pump 2P096) was removed from service for maintenance. Subsequently, this fuel transfer pump was declared operable, and the second EDG fuel transfer pump (Pump 2P093) was removed from service for maintenance. While the second fuel transfer pump was removed from service, engineers decided that the retest for the first fuel transfer pump should have included an inservice test because the pump had been decoupled from its motor during the maintenance. Consequently, for a period of time, operators declared both fuel transfer pumps inoperable. The first fuel transfer pump passed an inservice test that was subsequently administered. Since one fuel transfer pump had remained available, the inspectors found that the fuel transfer system for EDG 2G002 could perform its intended function.

b.5 Electrical Demand

Train B Chiller E335 had an electrical demand setting on the control module that could limit the amount of current that the chiller compressor motor would draw. Prior to September 25, Procedure SO23-1-3.1 directed operators, during prestart checks of the chiller, to set electrical demand to 80 percent. This electrical demand setting of 80 percent limited the Chiller E335 to 85 percent of nameplate capacity and contributed to Chiller E335 inoperability during August and September 1998 because this limited the capacity of the chiller.

Setting the electrical demand to 80 percent was not referenced in any design documents, and the licensee could not present a bases for this setting. The vendor manual stated that the variable electrical demand limited chiller capacity during colder periods, so that the chiller would not unnecessarily consume electrical power. The design bases for Chiller E335, as stated in Design Bases Document SO23-800, indicated that the chiller would provide 4.8×10^6 BTU/hour cooling. However, Procedure SO23-1-3.1 limited the chiller capacity to approximately 4.1×10^6 BTU/hour when the electrical demand was set at 80 percent. While less than the design basis specification, the licensee stated that the limited chiller capacity was still sufficient to cool design basis heat loads, if the chiller was functioning properly. 10 CFR Part 50, Appendix B, Criterion III, "Design Control," states, in part, that the design bases for components shall be correctly translated into procedures. The failure to translate design basis requirements for chiller capacity into operations procedures for setting electrical demand is a violation of NRC requirements. Upon discovery of this condition, the licensee revised Procedure SO23-1-3.1 to require setting electrical demand at 100 percent. The inspectors found this corrective action satisfactory. This

nonrepetitive, licensee-identified and corrected violation is being treated as a noncited violation, consistent with Section VII.B.1 of the NRC Enforcement Policy (50-361; 362/98018-03).

Also, on September 30, operators had started the Train A Chiller E336 with the electrical demand set at 80 percent; however, the motor current slightly exceeded the nameplate value, indicating that electrical demand switch was not properly limiting current. The licensee calibrated the electrical demand for Train A Chiller E336 and verified that the electrical demand for Train B Chiller E335 met specifications. Although the vendor manual did not have a recommended calibration interval for operational settings, such as electrical demand, the licensee had calibrated electrical demand on 6-year intervals. From August 28 to 31, the inspectors determined that I&C technicians had set electrical demand at 100 percent for Chiller E335 after replacing the temperature control unit. Although this setting met the design bases and maintenance procedure requirements, the inspectors noted that the setting conflicted with the requirements specified in Procedure SO23-1-3.1. Consequently, the inspectors found that control of chiller electrical demand was poor and contributed to the noncited violation of design control since the maintenance and operations procedures conflicted.

c. Conclusions

Postmaintenance testing, as prescribed by operations work control, for scheduled emergency chiller maintenance was not adequate because work that affected the start circuit for the chiller was not tested. This deficiency was identified as a noncited violation of 10 CFR Part 50, Appendix B, Criterion V, consistent with Section VII.B.1 of the Enforcement Policy. This deficiency contributed to inoperability of Chiller E335 for 22 days in September 1998.

A faulty temperature control unit, an incorrectly set electrical demand switch, and noncondensable gases rendered Chiller E335 inoperable for 20 consecutive days in August 1998. Similarly, a miswired low chilled water temperature cutout switch or a combination of noncondensable gases, oil in the refrigerant, and an electrical demand setting of 80 percent rendered Chiller E335 inoperable for 22 consecutive days in September 1998. The time periods for these inoperabilities exceeded the Technical Specifications Limiting Condition for Operation 3.7.10 allowed outage time and was identified as an apparent violation.

The emergency chilled water system operating procedure specified that the electrical demand be limited to 80 percent, which reduced chiller capacity below that assumed in design bases document. The failure to translate the design basis requirement for emergency chiller capacity in the operations procedures for setting electrical demand contributed to emergency Chiller E 335 in operability during August and September 1998 was identified as a noncited violation of 10 CFR Part 50, Appendix B, Criterion III, "Design Control." However, this deficiency alone did not render the emergency chiller inoperable. This nonrepetitive, licensee-identified and corrected violation is being treated as a noncited violation consistent with Section VII.B.1 of the NRC Enforcement Policy.

O8.2 Chiller Oil Pump Operation

a. Inspection Scope (92700)

The inspectors reviewed the circumstances surrounding operators lowering Chiller E335 oil level. The inspectors reviewed AR 980900388 and portions of Procedure SO23-1-3.1 and interviewed station technical personnel.

b. Observations and Findings

On September 7, 1998, operators noted that, with Chiller E335 in standby, compressor oil level was out-of-sight high in the upper sight glass. Chiller E335 has both upper and lower bulls-eye sight glasses vertically aligned to indicate compressor oil level. Procedure SO23-1-3.1, step 6.1.10.3, directed for compressor oil level out-of-sight high that operators run the lube oil pump for approximately 15 seconds to separate refrigerant from oil and then recheck the oil level. Operators followed this procedure step and confirmed that the oil level lowered within the top sight glass and met the specification of Procedure SO23-1-3.1, which required the oil level to be less than the top sight glass and above one-half of the lower sight glass. Subsequently, operators ran the oil pump a second time for approximately 3-4 minutes, which decreased the oil level to approximately seven-eighths of the lower sight glass.

Operators generated AR 980900388, which documented the oil pump starts and recommended procedure changes to incorporate operating the oil pump for 3-3½ minutes in order to more completely lower the oil level. Engineers rejected the procedure change during the AR disposition because the additional oil pump operation introduced oil into the cooler and degraded Chiller E335 performance (refer to Section E8.2). The inspectors found that the operators involved failed to recognize that excessive oil pump operation, with Chiller E335 in standby, could degrade chiller performance when the chiller was started.

The licensee initiated the following corrective actions to correct this deficiency: (1) changed Procedure SO23-1-3.1 to emphasize the limits on oil pump operating time and frequency with the chiller in standby, (2) scheduled additional operator training in chiller dynamics, and (3) initiated a Level 3 event report to assess corrective actions for operators failing to correctly interpret what "approximately" meant. Failure to follow Procedure SO23-1-3.1 violated Technical Specification 5.5.1.1.a; however, the inspectors found the corrective actions for this deficiency to be adequate, consequently no response to the violation is required (50-361; 362/98018-04).

c. Conclusions

Operators demonstrated poor awareness of the effects of compressor oil pump operation on a standby emergency chiller. Operators operated the oil pump with the compressor in standby for greater than the time allowed by procedure in attempts to lower a high oil level. The inspectors identified this as a failure to follow a procedure required by Technical Specification 5.5.1.1.a. Since the licensee implemented appropriate corrective actions, no response was required.

II. Maintenance

M8 Miscellaneous Maintenance Issues (92700)

M8.1 Maintenance of Emergency Chiller E335

a. Inspection Scope

The inspectors reviewed the circumstances concerning two periods of inadvertent inoperability of Units 2 and 3 Train B ECW, as pertains to maintenance. The inspectors reviewed Licensee Event Reports 50-361; 362/98-020-00 and 98-021-00. The inspectors reviewed Procedure SO23-II-8.25 and interviewed I&C technicians, as well as maintenance supervisors. The inspectors reviewed portions of Procedure SO123-II-15.3, "Temporary System Alteration and Restoration Form," Revision 7, and portions of Technical Manual SO23-410-7-164-2, Revision 2.

b. Observations and Findings

b.1 Lifted Lead Control

On September 3, 1998, an I&C technician disconnected the leads from the Chiller E335 low chilled water temperature cutout switch, as instructed by Procedure SO23-II-8.25, in order to perform a dynamic calibration of the switch setpoint (nominally 38°F) and reset point (nominally 48°F). As directed by Procedure SO23-II-8.25, a day shift I&C technician jumpered out the low refrigerant temperature and low chilled water temperature cutouts and disconnected the wires from both of these switches. A swing shift I&C technician continued with the calibration by lowering thermostat temperature, until the refrigerant switch actuated. When the thermostat was lowered further, to provide approximately 38°F chilled water temperature (nominal switch setpoint), the chiller began to make loud, rumbling noises. In addition, cooler pressure lowered to about 30 psi, the minimum cooler pressure allowed by Procedure SO23-II-8.25. The I&C technician decided to back out of the calibration and restore the chiller.

Procedure SO23-II-8.25, step 6.3.3, directed that the wires removed from the low chilled water temperature cutout switch be reconnected. The low chilled water temperature switch contact is normally closed above switch setpoint (chilled water temperature above 38°F) to allow operation. The low chilled water temperature switch contact opens to either trip the chiller and prevent chiller automatic and manual start, when the switch is below setpoint (chilled water temperature below 38°F). The switch has four connection points for the two wires. The technician reconnected the wires to the connection point screws that corresponded to a closed contact by using a voltmeter to establish these points. The technician then reported to operations work control that he was unable to complete the dynamic calibration.

The licensee determined that, on September 25, when Chiller E335 failed to start, the I&C technician had connected the wires to the wrong screws. The low temperature cutout switch had changed state, such that the I&C technician had unknowingly

connected the wires to the normally open contacts. The emergency chiller had not tripped because the reset point of the switch had not been reached. The failure to reconnect the low temperature cutout switch wires did not meet the requirements of Procedure SO23-II-8.25, step 6.6.3; consequently, the failure to properly implement a procedure recommended in Regulatory Guide 1.33 was a violation of Technical Specification 5.5.1.1.a.

As described in Procedure SO123-II-15.3, the inspectors noted that the licensee controlled jumpers and lifted leads connected or disconnected during maintenance activities in three primary ways: (1) used an alteration form, (2) controlled in a procedure, or (3) verified by a test or other indication that would demonstrate adequate restoration. The I&C technician's activities described above were controlled by procedure, as allowed by the lifted lead and jumper program. The inspectors found that, to an extent, the technician demonstrated poor skill-of-the-craft by not recognizing that the low temperature switch may have changed state. The inspectors also found that, to an extent, the program for controlling lifted leads and jumpers was weak. The exact location of jumpers and positions that leads were lifted from was not required to be recorded as work progressed when these activities were controlled by procedure and when a functional test would be performed. Both the procedure weakness and personnel error contributed to the violation described above.

Following identification of this deficiency, the licensee implemented the following corrective actions: (1) conducting a site-wide standdown on November 20 to discuss this occurrence with all site personnel, (2) requiring the use of an alteration form for all jumpers and lifted leads as an interim measure, while conducting a review of their program for controlling lifted leads (3) assessing the adequacy of the alteration form, and (4) reviewing the occurrence for disciplinary action. The inspectors found these corrective actions adequate. This nonrepetitive, licensee-identified and corrected violation is being treated as a noncited violation, consistent with Section VII.B.1 of the NRC Enforcement Policy (50-361; 362/98018-05).

b.2 Thermostat and Temperature Switch Settings

Procedure SO23-II-8.25 directed that personnel: (1) lower the chiller thermostat setting until the low refrigerant and low chilled water temperature switches actuated, (2) raise the chiller thermostat setting to check the reset points of the switches, and (3) return the chiller thermostat to the position corresponding to 43°F. The chiller thermostat was controlled by a dial on the temperature control module. However, no markings existed on the dial face or the panel on which the dial was mounted to identify the correct setting. When the I&C technician attempted the dynamic calibration on September 3, the procedure step that returned the chiller thermostat to 43°F had been marked "NA," and the chiller thermostat was left at a lower setting. Based on review of data for the operation of the chiller on September 4, the inspectors found that operations had corrected the chiller thermostat setting after noting a low chilled water temperature during operation.

The inspectors also noted that the vendor manual and Procedure SO23-II-8.25 recommended that the low refrigerant temperature switch be set such that, as

refrigerant and chilled water temperature lowered, the low chilled water temperature switch would actuate before the low refrigerant temperature switch. This was because the low refrigerant temperature switch had to be locally reset, while the low chilled water switch would reset when chilled water temperature was 48°F and a 15-minute time delay had been met. The inspectors found that on September 3 the I&C technician achieved the low refrigerant temperature switch setpoint before he had achieved the low chilled water temperature switch setpoint, as he was lowering the thermostat. This indicated that the switch setpoints were not left in accordance with the recommendations noted above. The inspectors found that, on September 3, when the I&C technicians informed operators that Chiller E335 was restored from maintenance, two settings were left in nonrecommended positions, indicating poor attention to detail.

c. Conclusions

Maintenance demonstrated poor control of lifted leads and of emergency chiller switch settings. An I&C technician failed to properly reconnect wires to an emergency chiller low temperature cutout switch, rendering the chiller inoperable. The failure to follow procedure was identified as a noncited violation of Technical Specification 5.5.1.1.a, consistent with Section VII.B.1 of the Enforcement Policy. During the same maintenance activity, the chiller was left with an improper thermostat setting and the sequence for the low chilled water and low refrigerant temperature chiller trips was not in accordance with procedural recommendations. These deficiencies reflected inattention to detail by an I&C technician.

III. Engineering

E8 Miscellaneous Engineering Issues (92700)

E8.1 Engineering Assessment and Support of Emergency Chiller E335

a. Inspection Scope

The inspectors reviewed the circumstances concerning two periods of inadvertent inoperability of Units 2 and 3 Train B ECW, as pertains to engineering. The inspectors reviewed Licensee Event Reports 50-361; 362/98-020-00 and 98-021-00. The inspectors reviewed portions of Procedure SO123-XX-1, "Action Request/Maintenance Order Initiation and Processing," Revision 9, Issue 2. The inspectors reviewed portions of Technical Manual SO23-410-7-164-2 and Procedure SO23-1-3.1. The inspectors reviewed data for Chiller E335 operation at various times from February 1997 until September 1998 and interviewed station technical and design engineers and supervisors.

b. Observations and Findings

b.1 Operability Assessment

On August 6, 1998, operators started Chiller E335 to support a control room essential air cleanup system surveillance. Operators generated AR 980800326 because Chiller E335 was maintaining 51°F outlet chilled water temperature, instead of the design 43°F. The cognizant engineer performed an operability assessment, approved by an acting supervisor, which concluded the chiller remained operable. The engineer concluded in the operability assessment that 51°F chilled water outlet temperature was acceptable to cool the actual loads on the chiller. However, the operability assessment did not address increased loading on the chiller that would result from a design basis accident condition (one unit in a loss of coolant accident and the other shutting down). The licensee subsequently determined that noncondensable gases in the refrigerant and problems with the temperature control unit had rendered the chiller inoperable on August 6. The inadvertent inoperability remained until August 26, when Chiller E335 was declared inoperable for scheduled maintenance, which included replacing the faulty temperature control unit.

Procedure SO123-XX-1, step 6.6.2.2.5, states, in part, that to accept a condition as-is and justify that the configuration continues to satisfy design requirements, a nonconformance report is required. The operability assessment was not accomplished in accordance with Procedure SO123-XX-1. Utilization of a nonconformance report, in principle, would have caused increased engineering attention to the design of the chiller and the effect of the degradation on the chiller. The failure to promptly identify and correct a condition adverse to quality is a violation of 10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Action." The licensee had implemented corrective actions that included: (1) developing a station technical reading assignment, (2) counseling personnel involved, and (3) considering enhancing standard questions used during operability assessments. This nonrepetitive, licensee-identified and corrected violation is being treated as a noncited violation, consistent with Section VII.B.1 of the NRC Enforcement Policy (50-361; 362/98018-06).

b.2 Vendor Information

The inspectors noted that the chiller vendor manual recommended that a set of operating logs be taken when operating the chiller in order to be able to detect degradation in chiller performance. The recommended logs included chilled water temperature entering and leaving the chiller, refrigerant temperatures and pressures, and component cooling water temperatures entering and leaving the chiller. The inspectors determined that Procedure SO23-1-3.1 did not require operators to monitor any of these parameters in order to analyze for performance degradation.

In addition, the chiller vendor manual provided saturation tables for refrigerant temperature and pressure to be used in order to detect noncondensable gases in the refrigerant. A refrigerant temperature 2°F below the saturation temperature for any given pressure was indicative of noncondensable gases. Licensee personnel had not utilized this information on September 3, nor during other past attempts at dynamic

calibration, when refrigerant pressure (limited to 30 psi) prevented completing the dynamic calibration. This information was not used until September 25 when a vendor representative suggested that noncondensable gases were present in the refrigerant. Noncondensable gases had degraded chiller performance for at least 2 months prior to September 25. The inspectors concluded that station technical engineers demonstrated weak performance monitoring of the chillers, in that personnel failed to make full use of the information available in the chiller vendor manual.

c. Conclusions

Engineering demonstrated poor assessment of equipment operability and understanding of information contained in a vendor manual. A flawed operability assessment when an emergency chiller could not achieve design cooling resulted in an inadvertent inoperability of the chiller for approximately 20 days during August 1998. The failure of engineers to take appropriate actions to demonstrate operability of the Train B emergency chiller, as specified by the corrective action program, was identified as a noncited violation of 10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Action," consistent with Section VII.B.1 of the Enforcement Policy. Had the licensee implemented the vendor manual recommended performance monitoring of the chillers, the buildup of noncondensable gases in the refrigerant during August and September 1998 would have been detected.

E8.2 Effect of Noncondensable Gases on Chiller Performance

a. Inspection Scope

The inspectors reviewed data of Chiller E335 performance to assess operability.

b. Observations and Findings

Licensee Event Reports 50-361; 362/98-020-00 and 98-021-00 described that the chillers have a 35 percent capacity margin and that the noncondensable gases degraded the chiller performance by 11 percent. The capacity margin was based on calculations of design load (one unit in a loss of coolant accident and one shutting down). The loads on the chiller were divided by the chiller capacity to determine the excess capacity the chillers possessed. The licensee based the 11 percent degradation on comparisons of chiller performance when equipment status as well as the presence of noncondensable gases was known.

The inspectors identified that chilled water exit temperature (as a function of time) data recorded for September 25, 1998, and chiller operation with control room essential air cleanup system loading contradicted either or both the 35 percent capacity margin or the 11 percent degradation resulting from the noncondensable gases. The inspectors noted that, in principle, for the chiller operation on September 25, the chiller should have had a 9 percent excess capacity for design loading. Specifically, operators had set the current limiter to 80 percent, which provided 85 percent available capacity. Since noncondensable gases were present, this 85 percent capacity should have been reduced to no lower than 74 percent chiller output (based upon the 11 percent

degradation). The 74 percent chiller output exceeded the 65 percent chiller output by 9 percent, which the licensee stated would maintain the chiller capability within design.

On September 25, Chiller E335 only achieved 49°F chilled water outlet temperature with significantly less than the design loading; however, the chiller should have easily achieved 43°F chill water outlet temperature. Normally, chiller operation provided for a relatively sharp drop in chilled water temperature in the first 10 to 20 minutes of chiller operation, as the chiller "worked" hard to lower the outlet temperature to the setpoint. After the setpoint was reached, the chiller would draw less amperage since it would be easier to maintain the chill water outlet temperature at the 43°F setpoint. In this instance, for the first hour (the extent of the chiller operation with current demand at 80 percent), the chiller operated at the maximum amperage for 80 percent electrical demand. Even though the temperature difference between setpoint and actual chilled water outlet temperature (43 versus 49°F) was not that great, the capability of the chiller unit was exceeded, as demonstrated by the controller continuing to generate a full open signal for the refrigerant guide vanes. Consequently, Chiller E335 had operated at maximum capacity for the conditions reported (74 percent) instead of functioning normally even though, in principle, the chiller capacity exceeded the design capacity (65 percent) by 9 percent.

In response to the above information, a reanalysis determined that the 11 percent degradation resulting from noncondensable gases was dependent on current available to the compressor motor and component cooling water temperature. The degradation would increase above 11 percent if the chiller was current-limited or component cooling water temperature was elevated. Consequently, for a current-limited setting of 80 percent, degradation resulting from noncondensable gases would exceed 11 percent. The licensee also stated that, for the inoperability from September 3 to 25, Chiller E335 would have been inoperable because of the noncondensable gases and the 80 percent current limited setting, independent of the miswired low temperature cutout switch.

On December 1 station technical engineers informed the inspectors that Chiller E335 oil pump operation on September 6 (as described in Section O8.2) had introduced approximately 1 gallon of oil into the Chiller E335 cooler. This oil had been absorbed by the refrigerant and, during Chiller E335 startup on September 25, had degraded Chiller E335 performance. The chiller was designed to remove oil in the refrigerant through a weep hole that directed oil separated from refrigerant by the action of the compressor to be returned to the oil reservoir. This would occur during the first 2 to 3 hours of Chiller E335 operation such that the performance degradation would correct itself.

Based on licensee statements, the inspectors found that Chiller E335 was operable from August 28 to 31. Any additional Chiller E335 performance degradation, resulting from oil in the Refrigerant, had occurred after August 31. The inspectors also noted that operating the Chiller E335 compressor lube oil pump, in order to lower oil level with the chiller in standby, was not an action that was mentioned in the chiller vendor manual. However, 15 seconds of operation, as specified in Procedure SO23-1-3.1, should not adversely affect chiller performance.

Based on the above, the inspectors found that the retrospective evaluation of operability of Chiller E335, as stated in Licensee Event Report 50-361; 362/98-021-00, was accurate and generally thorough. However, the reasons for Chiller E335 inoperability from September 3 to 25 included more than the miswiring of the low chilled water temperature cutout switch. Independent of the switch miswiring, Chiller E335 was also inoperable because of the combination of noncondensable gases and oil in the refrigerant. The chiller performance degradation caused by the oil and noncondensable gases was compounded by the chiller electrical demand being set at 80 percent from September 3 to 25, but a setting of 100 percent would have still rendered Chiller E335 inoperable based on the effects of the oil and noncondensable gases in the refrigerant.

c. Conclusions

An engineering evaluation of Chiller E335 operability from September 3 to 25 was generally thorough. However, some of the reasons for the chiller inoperability, including introduction of oil and noncondensable gases into the refrigerant, were not completely understood by the licensee until questioned by the inspectors.

E8.3 Licensee Assessment of Risk

a. Inspection Scope

The inspectors reviewed the licensee assessment of the increase in risk that resulted from the inadvertent chiller inoperability. The inspectors reviewed NSG/PRA Report NSG-98-021, "The unavailability of Emergency Chiller SA1513ME335," dated October 23, 1998, and had discussions with licensee representatives.

b. Observations and Findings

The risk assessment determined that the Train B chiller inoperability during August and September 1998 increased the risk in Unit 2 by 8.9E-06 and Unit 3 by 9.6E-06. The licensee concluded that the increases in risk were small when using the criteria of Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis." The inspectors noted that the risk analysis was comprehensive in that specific plant configurations had been used to assess the impact of the chiller outage. Additionally, a human reliability analysis had been performed to evaluate the operator performance issues associated with the chiller inoperability.

The inspectors noted that Regulatory Guide 1.174 was intended to evaluate plant-specific changes to the licensing bases and not necessarily to evaluate the risk significance of plant configurations or events. In addition, the inspectors noted that, even when using Regulatory Guide 1.174, the overall risk bordered on the region of potential risk significance.

c. Conclusions

Licensee use of equipment specific configurations and human reliability analysis in the risk assessment associated with the inadvertent Train B chiller inoperability was a strength. The overall increase in risk because of the inoperable chiller was potentially risk significant.

V. Management Meetings

X1 Exit Meeting Summary

The inspectors conducted a status meeting with members of licensee management on November 13, 1998.

The inspectors presented the inspection results to members of licensee management at the exit meeting on December 18, 1998. The licensee acknowledged the findings presented.

The inspectors asked the licensee whether any materials examined during the inspection should be considered proprietary. No proprietary information was identified.

ATTACHMENT

SUPPLEMENTAL INFORMATION

PARTIAL LIST OF PERSONS CONTACTED

Licensee

D. Brieg, Manager, Station Technical
J. Fee, Manager, Maintenance
D. Herbst, Manager, Site Quality Assurance
R. Krieger, Vice President, Nuclear Generation
A. Scherer, Manager, Nuclear Regulatory Affairs
D. Nunn, Vice President, Engineering and Technical Services
T. Vogt, Plant Superintendent, Units 2 and 3
R. Waldo, Manager, Operations

INSPECTION PROCEDURE USED

IP 92700: On Site LER Review

ITEMS OPENED AND CLOSED

Opened

361; 362/98018-02	EEI	Technical Specification LCO completion times not complied with (Section O8.1.b.3)

Closed

361; 362/98-020-00	LER	ECW inoperable due to faulty temperature control unit switch (Section O8.1)
361; 362/98-021-00	LER	ECW inoperable due to incorrectly wired switch (Section O8.1)

Opened and Closed

361; 362/98018-01	NCV	inadequate postmaintenance test (Section O8.1.b.2)
361; 362/98018-03	NCV	emergency chiller capacity reduction not in accordance with design basis (Section O8.1.b.5)
361; 362/98018-04	VIO	failure to follow procedures (Section O8.2.b)

361; 362/98018-05 NCV failure to reconnect low temperature cutout switches (Section M8.1.b.1)

361; 362/98018-06 NCV failure to perform adequate operability assessment (Section E8.1.b.1)

LIST OF ACRONYMS USED

AR	action request
CFR	Code of Federal Regulations
ECW	emergency chill water
EDG	emergency diesel generator
I&C	instrumentation and control
NRC	Nuclear Regulatory Commission
PDR	Public Document Room
WAR	work action request