APPENDIX B

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

Inspection Report: 50-361/94-16
50-362/94-16

Licenses: NPF-10
NPF-15

Licensee: Southern California Edison Co.
23 Parker Street
Irvine, California

Facility Name: San Onofre Nuclear Generating Station, Units 2 and 3

Inspection At: San Onofre, San Clemente, California

Inspection Conducted: May 23-27, 1994

Inspectors: E. Ford, Senior Resident Inspector
Division of Reactor Projects

P. Qualls, Reactor Inspector
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Division of Reactor Projects

Approved: John Hillist for W. P. Ang, Chief, Plant Systems Branch
Division of Reactor Safety

7/12/94
Date

Inspection Summary:

Areas Inspected (Units 2 and 3): A routine, announced, inspection of licensee corrective actions performance focused on the operations functional area and its resolution of problems related to high pressure injection pump failures was conducted. The licensee's use of industry operating experiences was also inspected.

Results (Units 2 and 3):

Operations Performance

- Two high pressure safety injection pumps, HPSI Pumps 3P018 and 3P019, were damaged. Pump 3P018 was damaged when it was operated without a flow path (deadheaded). Pump 3P019 was damaged when it was operated in an excess flow (runout) condition.

- The operators involved in the HPSI pump damage lacked a questioning attitude to assure that appropriate conditions existed prior to and during operation of the pumps. Procedural prerequisites were not met prior to starting the pumps.

- Furthermore, the operating crew simultaneously performed multiple operations with the high pressure injection system without adequately anticipating the effect on the equipment involved (Section 2.1).

Corrective Actions

- Corrective actions for the Pump 3P019 damage were too narrow and did not include corrective actions for operator performance, procedural adherence, and the effect of the performance of multiple evolutions with the system. The licensee had not performed a human performance evaluation of the pump events (Section 2.2).

- The licensee's corrective action program was fragmented, cumbersome, and burdened the individual worker with the task of determining which process or form was appropriate to use to report a condition adverse to quality (Section 3.1).

Use of Operating Experience

- The independent safety engineering group (ISEG) had performed its required functions, including a search for similar pump experiences (although none was available). ISEG personnel were involved in the root cause evaluation, although this practice could challenge their independence (Section 4.2).

- The licensee appropriately used probabilistic risk assessment (PRA) and individual plant evaluation (IPE) results to determine that the extended maintenance of Pump 3P019 was of minor safety significance (Section 3.1).

Maintenance and Engineering Efforts

- The final restoration of Pump 3P019 required a long time because the pump vendor's procedure was insufficient for setting up the pump balance drum. (Section 4.2).

Procedural Implementation and Adequacy

- The licensee was performing multiple simultaneous evolutions using the HPSI system. These evolutions were in progress prior to the completion of pump (system) alignment procedure prerequisites. This resulted in pump runout flow conditions for two of the three HPSI pumps, causing severe damage to one of the pumps. Procedures were not implemented to properly control activities (Section 2.1).

- The licensee failed to include adequate quantitative criteria in procedures for HPSI pump operation, including pump discharge pressure and flowrate limits. This also contributed to the conditions which resulted in pump damage (Section 5.3).

- Procedural adherence was highlighted as a sitewide problem in a late 1993 licensee QA report (Section 3.2).

Summary of Inspection Findings:

- Violation 362/9416-01 was opened because the licensee started performing the procedural steps of Procedure SO123-0-23, Log No. 3-93-191, without completing Prerequisite Steps 3.7.7 and 3.7.8. (Section 2.1).

- Violation 362/9416-02 was opened because licensee procedures for operating the HPSI pumps were inadequate (Section 5.3).

- Unresolved Item 362/9402-02 was closed (Section 6.1).

Attachment:

- Attachment - Persons Contacted and Exit Meeting

## DETAILS

### 1 INTRODUCTION (IP 40500, 90700, 92904)

NRC personnel performed an inspection that focused on the operations functional area to assess the effectiveness of the licensee's corrective actions program and to verify that the licensee had adequately implemented the corrective actions program with respect to the failures of two high pressure safety injection pumps. An effective program would include identifying, resolving, and preventing problems which have occurred elsewhere in the industry and measures to prevent recurrence of plant problems. The team used a performance-based approach in evaluating the effectiveness of the licensee's programs as they applied to the failure. Within this context, the inspection included observations in the control room and equipment spaces, a review of operational activities, an evaluation of the maintenance process controls and engineering support, feedback of operational events, and corrective action implementation. The inspection was conducted in accordance with the guidance of Inspection Procedure 40500, "Effectiveness of Licensee Controls in Identifying, Resolving, and Preventing Problems"; Procedure 90700, "Feedback of Operational Experience Information at Operating Power Reactors"; and Procedure 92904, "Followup - Plant Support."

The inspection included a review of hardware and personnel performance-related problems and the effectiveness of the licensee's process to identify and correct deficiencies. The inspectors utilized documentation reviews, personnel interviews, and direct observations to evaluate the licensee's programs.

#### 1.1 Background

The high pressure injection system (HPSI) is comprised of two pumps (3P017 and 3P019, Train A and Train B, respectively) and Swing Pump 3P018, along with the associated valves and piping. The pumps would normally provide borated water from the RWST to the reactor vessel, if needed. Minimum flow recirculation was provided for the pumps to the RWST via check valves and the normally open, in-series, motor-operated Valves HV9348 and HV9347. During November 1993, a time period when the plant was being refueled, and the pumps were not required for emergency core cooling service, two of the three pumps were damaged due to improper operation while using the pumps for other evolutions. The first pump (3P018) was damaged when poor communications among the operations staff regarding clearance boundary status and the position of Valve HV9347 resulted in running the pump without a discharge flowpath. The second pump (3P019) was damaged when the effects of parallel flow paths, resulting from performing multiple evolutions, were insufficiently anticipated and the pump was subjected to runout conditions.

1.2 Circumstances of Pump Failures

On November 3, 1993, with the plant defueled, Pump 3P018 was stopped when it was discovered that steam was coming from the suction relief valve. Subsequently, the minimum flow recirculation path to the RWST was found isolated (Valve HV9347 had been inadvertently left shut). This resulted in the pump having been run for approximately 45 minutes with no discharge flow path when operators failed to maintain adequate control over the valve's position during maintenance activities.

A licensee inspection on the following day confirmed internal pump damage. As previously reported in NRC Inspection Report 50-361/93-38; 50-362/93-38, the damage resulted from excessive temperatures and involved the rotating bundle (the multistage pump impeller), the pump and motor bearings, and the pump seal. The licensee later repaired or replaced, as necessary, the affected components and restored operability of the pump prior to it being required for mode change.

Pump 3P019 also failed during November 1993. The pump failure was initially observed during a containment sump check valve test on November 25, 1993, when low pump discharge pressure, low flow, and high vibration were noted. The pump was determined by the licensee to have been previously damaged shortly after Pump 3P018 was damaged. However, the pump was considered operable for the purpose of providing a boration flow path, which was the only requirement for the system at that time.

Upon inspection, the failure of Pump 3P019 was characterized by significant wear between the pump impellers and the wearing rings (the stationary components associated with each of the nine pump stages), which normally have no mechanical contact. Following the failure, grooves 30 mils deep were observed in both the impeller and wearing ring surfaces. Also, the radial bearings at each end of the shaft were found to be tight and were not providing enough freedom of movement to allow any contact between the impellers and wearing rings. The maintenance and engineering efforts expended on this pump continued for several months as the licensee continued to search for a conclusive resolution to post-repair hot bearing problems. This pump was not required by Technical Specifications to be operable during this period and the licensee's analysis showed no significant PRA impact.

## 2 OPERATIONS PERFORMANCE

### 2.1 Procedural Adherence

The inspectors reviewed the licensee's activities associated with operating the HPSI pumps when the pumps were damaged. At the time that Pump 3P018 was damaged, the licensee was attempting to use the system to fill the refueling cavity, while maintaining valves lined up for a hydrotest. The inspectors noted that during the performance of multiple evolutions using this system, the licensee started the pump with no flow path and extensive damage to the pump ensued. The NRC previously cited the licensee for failure to follow

procedures, associated with this event, in NRC Inspection Report 50-361/93-38; 50-362/93-38.

The inspectors noted that the licensee was trying to accomplish three evolutions simultaneously at the time that Pump 3P019 was damaged. The licensee was attempting to drain an RWST, was filling the HPSI pump minimum flow line, and was filling the refueling cavity. The combined flowrate of filling the refueling cavity and using the minimum flow-orifice bypass valve resulted in Pump 3P019 being damaged by excessive flow conditions. Pump 3P017 was also operated during the same evolution and was subjected to the same conditions, but was determined by the licensee to be undamaged. The inspectors noted that the procedure in use for draining the RWST, during the time that Pump 3P019 was damaged, was Procedure SO123-O-23, "Abnormal Alignments, Log No. 3-93-191." This procedure specified in the prerequisites (Steps 3.7.7 and 3.7.8), that Pumps 3P017 and 3P019 be aligned per Procedure SO23-3-2.7, "Safety Injection System Operation."

The record copy of Procedure SO123-O-23 that was used for the evolution had recorded that the procedural steps were started at 9:45 p.m. on November 3, 1993. The Pump 3P017 alignment procedure recorded that the alignment was completed at 11:15 a.m. on November 4, 1993, and the Pump 3P019 alignment procedure recorded that the its alignment was completed at 11:20 a.m. on November 4, 1993. Thus, the activity of draining the RWST and injecting water into the refueling cavity was performed concurrent with the prerequisite pump alignments. This resulted in flow for both Pumps 3P017 and 3P019, reaching pump runout conditions and causing damage to Pump 3P019. The failure to accomplish the prerequisites for Procedure SO123-O-23 for aligning Pumps 3P017 and P3019 in accordance with Procedure SO23-3-2.7 prior to commencing the process of draining the RWST is a violation of Technical Specification 6.8.1, in that procedure requirements were not implemented. This failure to implement procedures is Violation 362/9416-01.

The inspectors concluded that licensee management of multiple activities on the same components was, in this instance, not well controlled.

2.2 Operations Corrective Actions

The inspectors reviewed, in detail, the documented corrective actions for the activities resulting in the failure of Pump 3P019. The corrective actions were documented in Non-Conformance Report (NCR) 93110129, which was validated as complete on April 20, 1994 (approximately one month prior to the inspection). In the NCR, the licensee documented that Procedure SO23-3-2.7 guidance was not sufficient for ensuring the pump was operated within the normal design flows and directed that the procedure be revised to "provide detailed guidance for monitoring pump suction and discharge pressures to ensure HPSI pump flows do not exceed 900 GPM." The corrective actions appeared to the inspectors to be too narrow because they did not address any human performance issues, such as failure to follow procedures or control of multiple evolutions as noted in Section 2.1. The inspectors discussed with licensee management the concern regarding the

adequacy of the corrective actions for the operation of Pump 3P019. The licensee stated that they did not consider the review of the issue complete and would initiate an operations department experience report if they considered it necessary. The report results would determine if corrective actions concerning human performance would be required.

The inspectors noted that as of May 27, 1994, the licensee had not initiated a human performance evaluation (HPES) for the November 1993 runout event. While the inspectors recognized that the licensee did not commence troubleshooting and repair of the degraded pump until after the Unit 3 refueling outage, the vendor had concluded that the pump's damage was caused by runout in March 1994. Additionally, the nonconformance report, although still in draft form as of May 27, indicated that the pump damage was caused by runout. The inspectors concluded that the root cause of the damage involved the procedures and personnel performance, and that a human performance evaluation was appropriate. The licensee stated that a HPES would be performed if the final NCR indicated personnel or procedural problems. In general, the inspectors concluded that the licensee would be vulnerable to repeat occurrences if the issues were not resolved in a timely manner; however, a similar situation for the HPSI runout would likely not occur until the next refueling outage in January 1995.

### 2.3 Operability Requirements

The inspectors reviewed with the licensee the operability requirements for the HPSI pumps for the various plant operating modes in which the plant operated. The licensee demonstrated with test data that Pump 3P017 was operable throughout the time period in question. The licensee also demonstrated that Pump 3P018 was operable prior to a mode change which required two HPSI pumps.

### 2.4 Conclusions

The inspectors concluded that the licensee failed to adhere to its procedures by not completing the required HPSI pump alignments prior to starting to drain the RWST. The inspectors concluded that for the failure of Pump 3P019, the licensee had not identified adequate corrective actions at the time of the inspection.

## 3 CORRECTIVE ACTIONS

### 3.1 Corrective Action Programs

The inspectors reviewed the licensee's corrective action (CA) program. The inspectors noted that the licensee utilized a number of CA reporting mechanisms, including non-conformance reports (NCRs), division investigation reports (DIRs), operations division experience reports (ODERs), station problem reports (SPRs), corrective action requests (CARs), problem review reports (PRRs), work orders, and less formally, E-Mail. The inspectors noted during discussions with licensee personnel that the licensee required that the

individual employee determine the proper reporting system for a plant problem and to report the problem using that system.

The inspectors also reviewed licensee Procedure SO123-XV-5, "Nonconforming Material, Parts, or Components." This was the licensee's procedure governing the NCR process. The inspectors noted that the procedure was 75 pages long and seemed cumbersome to use. The procedure required that the initiator of an NCR determine the specific equipment part number. When the inspectors asked licensee personnel to find the part number for HPSI Pump 3P019, the inspectors observed that the licensee had a difficult process for obtaining the part number. The inspectors concluded that many plant employees would hesitate or would not be able to properly complete an NCR. Several employees stated that upon identification of a potential problem, they would call or notify the system engineer by E-mail, discuss the problem, and ask him to generate the NCR if required. The inspectors expressed to licensee management the potential for plant equipment reportability and operability reviews not receiving prompt attention due to the difficulties built into the NCR process.

The inspectors reviewed the licensee's use of probabilistic risk assessment (PRA) information in evaluating the effects of the extended unavailability of Pump 3P019 during plant operation. The licensee demonstrated that the length of time the equipment had been in a maintenance status had minimal effect on the probability of a plant accident. The inspectors noted that the licensee routinely used PRA information to evaluate the effects of unavailable plant equipment.

### 3.2 Licensee Audits

The inspectors reviewed the licensee's quality assurance (QA) audit of the CA programs. The inspectors noted that the licensee's audit appeared to meet the program requirements. The inspectors reviewed the nuclear oversight division performance assessment report for the fourth quarter 1993. The inspectors noted that the licensee identified that procedural compliance was highlighted as a site-wide concern. This was an area of concern to the inspectors, in light of the violation identified in Section 2.1 of this report and in NRC Inspection Report 50-361/93-38; 50-362/93-38.

### 3.3 Conclusions

The inspectors concluded that the licensee's CA programs were complex and required plant employees to be able to properly evaluate potential deficiencies to determine the proper reporting mechanism. They also concluded that the licensee's NCR procedure was cumbersome to use. The inspectors concluded that the licensee was doing a good job applying the individual plant examination (IPE) results to evaluating plant problems. The inspectors were concerned with the adequacy of procedure compliance by the licensee and noted that QA had previously also documented a concern with the adequacy of procedural adherence sitewide.

## 4 USE OF OPERATIONAL EXPERIENCE

### 4.1 Vendor Involvement

Following the repairs of the damage to HPSI Pump 3P019, caused by the runout event, the licensee tested the pump and noted a high temperature on the outboard bearing (indicative of a balancing drum misalignment). The licensee again aligned the balancing drum and once again experienced high bearing temperature during testing. Subsequent to this second attempt, the licensee brought in a vendor representative to help resolve the licensee's difficulty in aligning the balancing drum. The vendor did not find anything that the licensee was doing improperly. The inspectors noted that the licensee appropriately brought in the vendor to help resolve the alignment problem.

### 4.2 Independent Safety Engineering Group (ISEG)

The inspectors reviewed the group's involvement in the investigations surrounding the HPSI pump failures. The review showed that ISEG had been deeply involved in the nonconformance report investigation of Pump 3P019.

ISEG is required by Technical Specification 6.2.3.3 to maintain surveillance of plant activities to provide independent verification that these activities are performed correctly. The inspectors' interview with the ISEG engineer who was involved with Pump 3P019 revealed that he was part of the root cause of failure team. The engineer was on the team to review the efforts to restore the pump to an operable condition and was not involved in the root cause of failure.

The licensee asserted that ISEG personnel should be on the team in order to observe the maintenance activities, but not to play an active part in the process. The engineer stated that he ensured that all potential causes of the maintenance difficulties, including those areas deemed important to ISEG, were explored, and that he independently reviewed the activities with his management. The inspectors concluded that ISEG personnel remained independent; however, the inspectors also concluded that the practice of placing them on the root cause of failure team challenged their ability to remain objective and separate from the process.

The licensee concluded that the maintenance procedure for setting up the balancing drum, per the vendor guidance, was insufficient. ISEG personnel ensured that the revised procedure included pre- and post-rotor installation measurements that could be used for balancing drum alignment. The inspectors concluded that this was a prudent action and that this met the ISEG responsibility for suggesting improvements to maintenance activities.

### 4.3 Station Technical Engineering

The lead organization in determining the root cause of failure of Pump 3P019 was station technical engineering. The inspectors reviewed its role in the use of operational experience feedback. This review revealed that the

licensee had a computer-based system to allow employees to search through databases for relevant industry information. This allowed the root cause of failure team to search for information relevant to aligning the balancing drum; however, none was available. Station technical engineers then called the other two nuclear power plants that use similar pumps to inquire if they had any maintenance problems with the pump alignment.

The inspectors concluded that the licensee's computer-based system can be easily used to search for operational experience, and that station technical engineers aggressively pursued all sources of information related to aligning the balancing drum.

### 4.4 Feedback of Operational Experience

The inspectors reviewed the licensee's operational experience program as it related to the November 1993 HPSI pump events. The inspectors concluded that feedback of operational experience activities related to the repair of HPSI pumps was appropriate.

### 4.5 Conclusions

The inspectors concluded that the licensee appropriately brought in the vendor to help resolve the alignment problem. The practice of involving ISEG personnel as part of the root cause of failure team, can challenge their ability to remain objective. Station technical engineers aggressively pursued all sources of information related to aligning the balancing drum.

## 5 PROCEDURAL ADEQUACY

The inspectors reviewed the procedures used to operate the HPSI pumps during November 1993, which ultimately led to the damage of HPSI Pumps 3P018 and 3P019. The review included the procedure for HPSI pump alignment to the system, the procedure for refilling the upper refueling cavity with a HPSI pump, and an abnormal alignment procedure for isolating refueling Water Storage Tank 3T005. The inspectors concluded that the procedures failed to include quantitative criteria for pump operation, which ultimately led to HPSI pump damage.

### 5.1 Swing HPSI Pump (3P018)

The high pressure injection system consists of two trains of injection using three high pressure pumps. Pump 3P018 is a swing pump and can be aligned to either train. On November 2, 1993, the licensee initiated a procedure for aligning the Unit 3 swing pump (3P018) from Train A to Train B in preparation for filling the reactor cavity. Following the realignment of the pump's suction and discharge valves and power supply, the procedure required pump operation for one hour while recirculating water back to the refueling water storage tank on the minimum flow orifice bypass. Because the licensee had failed to open a minimum flow block valve, the pump was operated for 45 minutes without any flow before an operator detected that the pump was

operating abnormally (see NRC Inspection Report 50-361/93-38; 50-362/93-38). The problem was detected when an operator observed steam in the room that was discharging from the pump's suction relief valve.

The inspectors reviewed the licensee's procedure for aligning the swing HPSI pump (Procedure SO23-3-2.7, Attachment 9). The inspectors noted that the procedure did not require verification of pump discharge pressure or flowrate to ensure proper operating conditions during the 1-hour run. The HPSI system has pressure gages in the discharge section of each pump; however, these gages were not normally aligned to the system because they were not seismically qualified. Additionally, the inspectors noted that because the procedure started the pump with the discharge valve open (the injection valves were closed), the seismically-qualified pressure gage in the Train B header, downstream of the check valve, did not provide an accurate indication of system pressure. The licensee stated that the long piping run between the pump and the injection valves tended to expand significantly upon pump start and would "lock in" a high pressure in the line behind (tilting-disc) check Valve MU017. Because the discharge header pressure gage was downstream of the check valve, it could not be used to determine if the system minimum flow bypass was available.

The inspectors reviewed the HPSI pump characteristic curve and noted that the pump produced approximately 3400 feet of head at shutoff conditions and approximately 2200 feet of head when operating on the minimum flow bypass. The inspectors concluded that the licensee's procedure for aligning the swing HPSI pump to the Train B header should have had provisions for verifying normal pump operating conditions, whether by aligning the nonseismically-qualified pressure gages and specifying quantitative acceptance criteria, or by using other means during the hour while on minimum flow. The inspectors considered this one example of a failure to prescribe procedures adequate to the circumstance which included quantitative acceptance criteria. This is the first example of a violation of 10 CFR 50, Appendix B, Criterion V (Violation 362/9416-02).

5.2 Train B HPSI Pump (3P019)

Less than 24 hours after damaging the swing HPSI pump, the licensee commenced aligning the Train A (3P018) and Train B (3P019) HPSI pumps to their respective injection headers. Additionally, the licensee intended to fill the upper refueling cavity with both HPSI pumps and to isolate and pump down the refueling Water Storage Tank 3T005. These evolutions were commenced concurrent with the alignment procedure. The inspectors reviewed these evolutions and concluded that the procedures did not provide adequate quantitative criteria for pump operation, and that this contributed to damaging Pump 3P019.

The licensee started both trains of HPSI pumps on November 3 at 11:30 p.m. and 11:40 p.m. The respective minimum flow orifice-bypass valves were opened and the pumps began recirculating back to the RWST for 1 hour, as required by the alignment procedures (SO23-3-2.7). The minimum flow orifice-bypass line was

designed to allow full flow (approximately 650 gallons per minute) to the RWST. At 11:50 p.m., the licensee commenced filling the upper refueling cavity (per Procedure S023-3-2.8) by opening two injection valves in each header. The combination of full minimum flow orifice-bypass flow to the RWST and injection flow into the upper refueling cavity exceeded the capacity of Pump 3P019 and caused damage identified by the licensee during testing on November 25, 1993.

The inspectors reviewed the procedures for pump alignment, filling the upper refueling cavity, and isolation and draindown of Refueling Water Storage Tank 3T005. The inspectors concluded that the procedures did not provide adequate quantitative guidance to prevent the HPSI pumps from being operated in a runout condition. These procedures did not have limits on pump operation such as flow, pressure, or motor amperage. The licensee had concluded that Pump 3P019 had been operated at greater than 1100 gallons per minute during the evolution and was the cause of the pump damage. The inspectors reviewed the licensee's non-conformance report on the pump. The report concluded that the basic design of the pump inlet section could not support the high flow rate and led to pump damage.

The inspectors noted that the procedure for filling the refueling cavity required the control operator to monitor pump amperage; however, the procedure did not prescribe a quantitative limit to ensure that the pump was not being operated in a runout condition. The licensee stated that the operator was expected to know the pump's normal operating parameters and believed that this was sufficient guidance. Following the inspectors' inquiries, the licensee compiled a table of pump flowrate versus motor amperage during a runout event. The licensee's table showed that pump motor amperage was not an effective parameter to monitor to prevent pump damage. If fact, motor amperage decreased as the pump approached a runout condition. The inspectors concurred that monitoring motor amperage was an ineffective parameter for preventing pump damage. The inspectors also noted that none of the procedures provided a quantitative limit on pump flowrate. The inspectors concluded that the lack of a pump flowrate limit led to damage of HPSI Pump 3P019. The inspectors considered this a second example of a failure to prescribe procedures adequate to the circumstance which included quantitative acceptance criteria. This is the second example of a violation of 10 CFR 50, Appendix B, Criterion V (Violation 362/9416-02).

5.3 Conclusion

The inspectors reviewed the vendor manual for pump operation guidance as contained in Procedure S023-933-68, Revision 6. The inspectors noted that the manual contained guidance for pump starting and operating that included steps for checking the suction and discharge pressure gages to ensure proper operation, and monitoring ammeter readings based on load factor to prevent pump operation at runout conditions. The inspectors concluded that although motor amperage was an ineffective parameter, based on the vendor's guidance, the licensee should have included other quantitative criteria, such as a flowrate limit, to prevent the pump from being operated at a runout condition.

Additionally, the inspectors concluded that the licensee's procedures should have had provisions for monitoring pump discharge pressures during all phases of pump operation to prevent the pump from being operated in a shutoff head condition. The inspectors concluded that the two examples of the licensee's failure to include quantitative acceptance criteria in the procedures for HPSI pump operation to be a violation of 10 CFR 50, Appendix B, Criterion V (Violation 362/9416-02).

## 6 FOLLOWUP - ENGINEERING

### 6.1 (Closed) Unresolved Item 362/9402-02

This item concerned the testing on November 25, 1993, of HPSI Pump 3P019. The licensee had identified that there was lower than expected discharge pressure and flowrate and high vibration. The licensee's subsequent investigation of the pump revealed significant wear between the pump impellers and the wear rings. Based on available information, the inspectors noted in NRC Inspection Report 362/94-02 that it could not be determined whether cavitation or gas binding had caused the pump damage. The inspectors had noted that the as-found radial tolerances between the rotating and stationary parts of the impeller were out of specification (too close) and that the axial tolerances were also too close. In addition, the bundle wearing rings experienced metallic deformation.

The licensee's evaluation for this damage stated in NCR 93110129 that the candidate root cause was the failure to provide flow limits in the operating instructions for the safety injection system and when using HPSI pumps for filling the reactor cavity. Flow limits would have ensured that pumps were not run under excessive flow conditions. During cavity fill and high volume sweeps on November 3 and 4, 1993, Pump 3P019 flowrate was estimated to be approximately 1100 gallons per minute (gpm) for approximately 1 1/2 hours. The high flow resulted in pump runout, subsequent rotating element damage, imbalance, and degradation of pump performance. The 1100 gpm flowrate is in excess of the vendor-recommended maximum limit of approximately 900 gpm for the HPSI pumps. It was concluded by the licensee that, based on vendor data and expectations, the high flows resulted in a net positive suction head that was below that required for the pump. The failure to provide adequate procedural guidance is addressed in Section 5.3.

ATTACHMENT

PERSONS CONTACTED AND EXIT MEETING

## 1. Persons Contacted

Licensee Personnel

D. M. Axline, Engineer, Onsite Nuclear Licensing
W. C. Boos, Coordination Supervisor, Operations
J. R. Clark, Manager, Chemistry
R. L. Erickson, Site Representative, San Diego Gas & Electric
M. M. Farr, Engineer, Onsite Nuclear Licensing
J. Gartland, Engineer, Independent Safety Engineering Group
G. Gibson, Supervisor, Onsite Nuclear Licensing
D. R. Hansford, Shift Superintendent, Operations
D. A. Herbst, Manager, Site Quality Assurance
M. A. Herschthal, Manager, Nuclear Systems Engineering
D. N. Irvine, Supervisor, Technical Support
P. J. Knapp, Manager, Health Physics
R. W. Krieger, Vice-President Nuclear Generation
W. C. Marsh, Manager, Nuclear Regulatory Affairs
D. E. Roberts, System Engineer
R. M. Rosenblum, Vice-President Engineering & Technical Services
P. Shaffer, Engineer, Safety Engineering
A. J. Thiel, Manager, Electrical Systems Engineering
T. J. Vogt, Plant Superintendent, Units 2 & 3
R. Waldo, Manager, Operations
D. A. Werntz, Engineer, Onsite Nuclear Licensing
M. A. Wharton, Manager, Nuclear Engineer and Design Group

NRC Attendees

W. P. Ang, Chief, Plant Systems Branch, Division of Reactor Safety
J. A. Sloan, Senior Resident Inspector, San Onofre Nuclear Generating Station
D. L. Solorio, Resident Inspector, San Onofre Nuclear Generating Station
H. J. Wong, Chief, Branch F, Division of Reactor Projects

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

## 2. Exit Meeting

An exit meeting was conducted on May 27, 1994. During this meeting, the inspectors summarized the scope and findings of the report. The licensee acknowledged the inspection findings identified in this report. The licensee did not identify as proprietary any information provided to, or reviewed by, the inspectors.