LICENSEE EVENT REPORT (LER)

Facility Name (1)	Docket Number (2)	Page (3)
SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 2	0 5 0 0 0 3 6 1	1 of 1 0

Title (4)

AUXILIARY FEEDWATER PUMP GRAVITY FEED LUBE OIL COOLING SYSTEM PIPING MIS-ASSEMBLY

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
Month	Day	Year	Year	Sequential Number	Revision Number	Month	Day	Year	Facility Names	Docket Number(s)
									NONE	0 5 0 0 0
1 1	2 3	8 9	9 0	0 1 5	0 1	0 1	1 8	9 1		0 5 0 0 0

OPERATING MODE (9)	3	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10CFR (Check one or more of the following) (11)					
POWER LEVEL (10)	0 0 0	___ 20.402(b)	___ 20.405(c)	___ 50.73(a)(2)(iv)	___ 73.71(b)		
		___ 20.405(a)(1)(i)	___ 50.36(c)(1)	___ 50.73(a)(2)(v)	___ 73.71(c)		
		___ 20.405(a)(1)(ii)	___ 50.36(c)(2)	___ 50.73(a)(2)(vii)	XX Other (Specify in Abstract below and in text)		
		___ 20.405(a)(1)(iii)	___ 50.73(a)(2)(i)	___ 50.73(a)(2)(viii)(A)			
		___ 20.405(a)(1)(iv)	___ 50.73(a)(2)(ii)	___ 50.73(a)(2)(viii)(B)			
		___ 20.405(a)(1)(v)	___ 50.73(a)(2)(iii)	___ 50.73(a)(2)(x)			

VOLUNTARY

LICENSEE CONTACT FOR THIS LER (12)

Name	TELEPHONE NUMBER AREA CODE
R. W. Krieger, Station Manager	7 1 4 3 6 8 - 6 2 5 5

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFAC-TURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFAC-TURER	REPORTABLE TO NPRDS

SUPPLEMENTAL REPORT EXPECTED (14)		Expected Submission Date (15)	Month	Day	Year
___ Yes (If yes, complete EXPECTED SUBMISSION DATE)	XX NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

On 12/4/90, with Unit 2 at 100% power, during a routine annual auxiliary feedwater pump (AFWP) gravity feed lube oil cooling system (GFLOCS) functional test, the GFLOCS storage tank contents drained into the AFWP 2P-504 motor bearings in less than the required 30 minutes. This system is not required for normal lubrication and was installed pursuant to Full Term Operating License (FTOL) Condition 2.C(25) to environmentally qualify the motor driven AFWPs for the environment which would result in the unlikely event of a high energy steam line break (HELB) inside the AFWP room.

A subsequent investigation revealed that the GFLOCS supply line to the AFWP outboard end motor bearing had been installed incorrectly following a motor inspection during the previous refueling outage (11/89). SCE's investigation into the cause of this event has identified several deficiencies in our maintenance, maintenance restoration, and post-maintenance retest processes. These deficiencies collectively contributed to the incorrect reassembly of the GFLOCS and subsequent failure to detect this condition by either post-maintenance verification or retest. Corrective actions to prevent recurrence include: training, program audit, program and policy reviews/changes, and procedure changes.

SCE's current analysis shows that even without the GFLOCS, bearing temperatures would have remained sufficiently low such that the AFWP 2P-504 motor would operate satisfactorily during and after a HELB event. Therefore, the motor driven AFWPs are environmentally qualified for the HELB environment without dependance on the GFLOCS and, SCE concludes that this event has no direct safety significance. This information is being submitted as a voluntary LER because installation of the GFLOCS was included in a FTOL Condition, and because of the programmatic implications of the event.

Plant: San Onofre Nuclear Generating Station
Unit: Two
Reactor Vendor: Combustion Engineering
Event Date: 11-23-89

A. CONDITIONS AT TIME OF THE EVENT:

Mode: 3, Hot Standby
RCS Temperature: 398°F

B. BACKGROUND INFORMATION:

1. Auxiliary Feedwater (AFW) System (AFWS):

The AFWS [BA] provides a source of feedwater to steam generators (SGs) [SG] E-088 and E-089. The AFWS is manually controlled during normal plant startup and shutdown and automatically initiates in response to an emergency feedwater actuation signal (EFAS) [JE], which is initiated by a low SG level signal. The AFWS is comprised of two electrically-driven pumps [P] 2P-141 and 2P-504, steam turbine-driven pump 2P-140, and associated valves and piping.

2. AFWP Motor Bearing Lubrication

Normal Bearing Lubrication/Cooling

The AFW pump (AFWP) motor bearings are air cooled split sleeve oil lubricated journal bearings mounted in the motor's end housings. The end housings contain an oil reservoir and conventional oil slinger rings to provide oil to the bearings during all operating conditions. The bearings are normally cooled by the circulation of air within the AFWP room.

Gravity Feed Lube Oil Cooling System (GFLOCS)

INSTALLATION OF THE GFLOCS

The AFWS was initially designed to withstand the effects of a postulated steam line break inside the AFWP room. In order to accomplish this qualification, the AFWP motors were fitted with cast iron bearings. In 1982, late in plant startup, the AFWP motor bearings were replaced with babbitt bearings due to an AFWP motor failure associated with the cast iron bearings. Environmental qualification data were not available to demonstrate AFWP motor babbitt bearing operability under the high temperature which had been conservatively calculated to result following a high energy line break (HELB) in the AFW? room. As a result, a 1985 design change was implemented to include a Quality Class III non-safety related Seismic Category 2/1 GFLOCS on each AFWP motor. This late addition to the

design of the plant was performed pursuant to Full Term Operating License (FTOL) Condition 2.C(25).

GFLOCS DESIGN

The GFLOCS provides a once-through supplemental cool oil supply to the motor bearings, with overflow to a drain tank. The GFLOCS is isolated from the pump room environment. Its major components include a roof-mounted supply tank, an in-line fusible link actuated valve, flow control orifices in the motor bearing housings, a lube oil drain tank and a pressure equalizing line between the storage tank and the drain tank. In the remote event of a HELB in the AFWP room, the fusible link actuated valve in the lube oil supply line will open on high room temperature and lube oil will gravity flow from the lube oil storage tank to the motor bearings. The flow rate is controlled by an in-line flow orifice in each bearing housing. The lube oil overflow from the bearing housing then drains into the lube oil drain tank. Sufficient oil supply is provided to allow cool lube oil to flow through the bearing until operator action can be credited to isolate the break (within 30 minutes).

The top of each AFWP motor bearing housing (two bearings - a motor outboard end bearing opposite the drive end, and a motor inboard end bearing located on the pump drive end) has three openings in a line parallel to the rotor shaft. Oil supply piping from the GFLOCS is connected to the center opening, which is fitted with a flow control orifice. An equalization line (vent) is connected to the outermost opening of each bearing housing. The equalization piping is further connected to the air space in all of the oil containing components (i.e., supply tank, bearing housing, and drain tank) to avoid the creation of loop seals in the flow path. The remaining opening is fitted with an oil ring inspection plug.

C. DESCRIPTION OF THE EVENT:

1. Event:

On 12/4/90, with Unit 2 at 100% power, during a routine annual AFWP GFLOCS functional test, the GFLOCS storage tank contents drained into the AFWP 2P-504 motor bearings in 2 minutes and 18 seconds rather than the required 30 minutes. A subsequent investigation revealed that the GFLOCS supply line to the outboard end motor bearing was installed in the bearing housing opening which is utilized for the oil inspection plug, rather than the opening containing the flow control orifice. Consequently, the oil flow rate was much greater than designed, thus emptying the supply tank in less than the minimum 30 minutes. Appropriate repairs were made and the AFWP was returned to service on 12/6/90.

Our investigation has determined that the incorrect connection of the GFLOCS lines occurred during post-maintenance re-assembly of the motor during the previous Unit 2 refueling outage which was completed on 11/10/89. This event was originally reported on January 3, 1991, as a condition prohibited by the plant's Technical Specifications. However, based on our current analysis of this event as described in Section F below, it is concluded that operation of the GFLOCS is not required to meet design basis requirements. Therefore, the mis-assembly of the GFLOCS did not render AFWP 2P-504 inoperable. However, because installation of the GFLOCS was performed pursuant to a FTOL Condition, and because we recognize the programmatic implications of this event, this information is being submitted as a voluntary LER.

2. Inoperable Structures, Systems or Components that Contributed to the Event:

None.

3. Sequence of Events:

DATE	ACTION
10/18/89	Commenced maintenance on AFWP 2P-504.
11/10/89	Maintenance on AFWP 2P-504 completed.
11/23/89	Unit entered Mode 3 at 2206.
12/4/90	AFWP 2P-504 removed from service to allow for planned maintenance and testing. AFWP 2P-504 motor GFLOCS functional test failed.
12/6/90	AFWP 2P-504 returned to service.

4. Method of Discovery:

The GFLOCS failed to supply 30 minutes of lubricating oil as required during the routine annual functional test of the system.

5. Personnel Actions and Analysis of Actions:

Maintenance personnel performing the test promptly notified appropriate personnel, corrective actions were implemented, and the AFWP was returned to service within the allotted TS time limits.

6. Safety System Responses:

Not applicable.

D. CAUSE OF THE EVENT:

SCE's investigation into the cause of this event has identified several deficiencies in our maintenance, maintenance restoration, and post-maintenance retest processes. These deficiencies collectively contributed to the incorrect reassembly of the GFLOCS and subsequent failure to detect this condition by either post-maintenance verification or retest. The elements of our programs which were deficient are discussed below.

1. PROCEDURAL DEFICIENCY

The GFLOCS was installed in Unit 2 in 1985. Prior to installation, the design change package was routed to Maintenance Engineering to access any impact on maintenance procedures. Maintenance Engineering then identified the need to develop Maintenance Procedure SO23-I-8.158, "Motors - AFWP Lube Oil Cooling System Refueling Interval Functional Test," to functionally test the GFLOCS. However, Maintenance Engineering failed to identify the impact of the design change on the Maintenance Procedure SO23-I-4.70, "Motor - Auxiliary Feedwater Pump Motor Overhaul." Consequently, the AFWP motor procedure does not provide appropriate steps which support the correct re-installation of the GFLOCS piping.

In addition, this design change package was also routed to Station Technical. However, at the time this design change was routed, a specific review of the Retest Manual was not required by the document review process. Therefore, Station Technical did not identify the impact of the design change as to the need to perform a GFLOCS functional test following any motor maintenance which may affect the GFLOCS operability.

2. MAINTENANCE PLANNING DEFICIENCY

Per Procedure SO123-I-1.7, "Maintenance Order Preparation, Use and Scheduling," the Maintenance Planner is responsible for reviewing the maintenance activity to determine the corrective action and the associated planning required to ensure that adequate instructions are provided. These instructions address: 1) equipment disassembly, repair, and reassembly, 2) post-maintenance verification, and 3) post-maintenance functional testing if appropriate. To accomplish this, the Planner may perform a walkdown at the job site in order to better understand the task to be performed depending on the nature of the task and the Planner's previous experience with similar tasks. The Planner then consults technical manuals, drawings, procedures and/or maintenance history, as applicable. The Planner also conducts a search to determine if an approved procedure exists to perform the maintenance activity. The Planner then develops appropriate repair instructions, orders the appropriate replacement parts, and prepares appropriate post-maintenance verification instructions based on either an approved procedure, good work practices and/or vendor repair manual guidance. He then consults the Retest Manual and the

maintenance verification testing procedure to obtain proper post-maintenance functional testing. The Station Technical Cognizant Engineer will also be contacted if the other resources are not adequate to specify proper retest.

In preparing for the AFWP 2P-504 motor inspection, the Planner failed to recognize the significance of the GFLOCS piping that would have to be removed in order to disassemble the motor bearing housings. Therefore, he did not prepare maintenance order (MO) instructions which adequately incorporated the needed verification step to ensure that the GFLOCS piping was independently verified as having been installed correctly.

3. MAINTENANCE EXECUTION DEFICIENCY

a. Inadequate Piece-Part Marking:

Maintenance Division personnel utilize a number of methods to assist them in ensuring that disassembled components have been reassembled correctly. One of these methods is to mark component pieces, as the component is being disassembled. An example would be to temporarily label adjacent pipes, so that they may be reinserted in their original positions. In this event, the marking used by the craftsmen was ineffective in preventing incorrect reassembly of two of the three adjacent pipes located on the end of the motor away from the pump.

This work was performed under the provisions of Maintenance Procedure S023-I-4.70. This procedure directs maintenance workers to mark and/or tag all pieces and/or sections associated with the removal of all piping and vent tubing interferences, and is intended to assist in the correct installation during reassembly. The procedural guidance in this area, however, is not explicit enough so as to ensure that the marked pieces are properly correlated to their reassembly points. Notwithstanding this procedural deficiency, the piping was marked in this case. However, the marking used by the craftsman was ineffective in preventing incorrect reassembly of two of the piping connections.

b. Failure to Update Procedure:

Maintenance personnel recognized during this activity that the motor procedure did not properly address the GFLOCS. However, this fact did not prevent the motor inspection from proceeding; thus it was not considered necessary to revise the procedure in order to complete the maintenance work. Maintenance policy in this regard requires that procedural deficiencies that are recognized during the course of a work activity be identified and corrected. Had this expectation been met in this case, the

importance of verifying reinstallation of the GFLOCS may have been recognized.

4. POST-MAINTENANCE VERIFICATION DEFICIENCY

Per Procedure SO123-I-1.7, upon receipt of a MO for action, the Maintenance Foreman reviews the package and discusses any questions or problems with the Planner. The Foreman shall also conduct an adequate pre-work briefing with the responsible crew. Upon completion of the maintenance activity, the Foreman is also responsible for inspecting the work site for cleanliness and ensuring that the work activities and testing required prior to the release of the clearance/permission and necessary documentation are accurate and complete.

At the completion of the AFWP motor inspection, the foreman verified restoration by visually checking the AFWP motor for complete assembly. Even though the foreman was aware of the GFLOCS and had included a discussion on installation of the bearing anti-rotation pins which serve as GFLOCS flow control orifices in his pre-work briefing to the maintenance crew, he failed to verify that the GFLOCS piping had been correctly installed.

5. POST-MAINTENANCE TESTING DEFICIENCY

In order to ensure operability upon completion of maintenance, post-maintenance testing (i.e., some form of functional testing) must be considered. The post-maintenance testing of the AFWP 2P-504 motor in the MO work plan required Maintenance to request Operations to run the pump and visually inspect the motor for signs of oil leakage and abnormal vibration. Both the test required page of the MO and the operability test section of the WAR required performance of in-servi testing as defined in Engineering Procedure SO23-V-3.4.1 "AFW Inservice Pump Test". Thus, the post maintenance testing and operability testing adequately tested the pump, but did not include adequate actions to ensure the motor's GFLOCS was properly restored and capable of performing its design function.

As indicated above in Section D.1, causal factors were that neither the Retest Manual nor the AFWP motor overhaul procedure had been updated to reflect the design change modification that had installed the GFLOCS as an auxiliary support system. In addition, during MO planning, the Planner had failed to identify this support system as providing an important function whose operability needed to be functionally tested.

E. CORRECTIVE ACTIONS:

1. Corrective Actions Taken:

a. The AFWP 2P-504 GFLOCS piping mis-assembly at the outboard motor bearing housing was corrected, and the system was satisfactorily tested.

b. Each of the remaining three motor-driven AFWPs on both Units 2 and 3 have been inspected and verified to be properly configured. In addition, a flow test has been satisfactorily performed on each AFWP motor's GFLOCS since the last maintenance activity affecting the lube oil piping.

c. The post-maintenance retest program was revised on 1/11/91 to require GFLOCS testing following any maintenance which may have affected this system's performance.

d. The design change document review process now specifically requires consideration of the impact on the Retest Manual.

e. The failure to assess the impact of the design change on the appropriate maintenance procedures does not require additional corrective actions. As described in LER 89-019 (Docket Number 50-206, July 1989), actions have been taken to preclude recurrence of failures to recognize design change impacts. Maintenance has revised their Maintenance Policy Guidelines to incorporate a formal review process for design document reviews in assessing maintenance procedure impacts.

f. A Retest Committee has been established to review the post-maintenance testing performed on certain safety-related systems including the AFWS. This review is performed for work done on any component which affects, or could potentially affect, system operability. The Retest Committee is comprised of supervision from several organizations, including Operations, Maintenance, and Station Technical.

g. A Human Performance Enhancement System (HPES) evaluation of this event has been completed. Pending issuance of the final HPES event evaluation report, preliminary findings have been incorporated into this LER.

2. Planned Corrective Actions:

a. The procedure governing the assembly and disassembly of AFWP motors will be modified by 1/31/91 to correctly reflect the current AFWP motor configuration including more specific direction regarding marking of the adjacent piping associated with the GFLOCS, and to specifically require verification of correct GFLOCS piping reassembly.

b. Nuclear Oversight Division (QA) will sample and audit appropriate Station mechanical maintenance procedures by 2/28/91 in order to verify that appropriate maintenance procedure and post-maintenance retest manual changes are being made following design changes.

c. The Quality Control (QC) organization will evaluate increasing its maintenance inspection points by 2/28/91 for those safety-related systems which are also subject to review by the Retest Committee.

d. This event will be reviewed with appropriate Maintenance personnel by 4/1/91, and will address requirements with respect to: 1) understanding work scope and component function, 2) procedure deficiency observation, 3) parts marking and reassembly, 4) verification of post-maintenance assembly, and 5) post-maintenance retesting.

e. This event will also be incorporated in SCE's 1991 Continuing Maintenance Training Program by 3/30/91 under the heading "Industry Event Training Lessons Learned."

f. Licensing documents will be updated by 2/15/92 to reflect the motor driven AFWP's environmental qualification without dependance on the GFLOCS.

F. SAFETY SIGNIFICANCE OF THE EVENT:

Original HELB calculations indicated that the AFWP room temperature and pressure would rise following a steam line break, stabilizing near 300°F and 3 psig. Based on this room response, it was expected that the nominal bearing temperature design limit would be exceeded after approximately 10 minutes of operation. The pump is required to remain functional beyond the 30 minutes assumed for operator action to isolate the break. To prevent the bearings from exceeding their design temperature limit, the GFLOCS was designed to provide cool lubricating oil to each bearing for the 30 minutes during which the AFWP was required to operate in conjunction with a HELB condition.

As a result of this event, SCE undertook a re-evaluation of the HELB generated environmental conditions and the capability of the motor bearings to operate satisfactorily in such an environment without a supplemental cooling oil supply. A reassessment of the original AFW pump room heat load calculation during the HELB blowdown identified considerable margin in the calculated mass flow rate into the room which resulted in a higher then appropriate predicted room temperature.

SCE performed transient heat transfer and hydrodynamic analyses of the motor bearing's performance during the HELB, using the newly calculated room temperature conditions. The current analyses indicate that the

bearings will function in the high temperature environment without any danger of seizure or excessive frictional load, without taking credit for cooling from the GFLOCS. These AFWP motor bearing heat transfer and hydrodynamic analyses will be finalized after issuance of this LER revision by 2/28/91.

SCE evaluated the effect on the operating AFWP at elevated temperatures for 30 minutes from the time of the HELB inside the AFWP room until the break is isolated. Based on this data, SCE has determined that without the GFLOCS the AFWP would remain operable during and after the steam line break. Therefore, SCE concludes that this event has no direct safety significance. Nonetheless, SCE considers the causes discussed in Section D above as significant lessons-learned for our maintenance program and, therefore, is taking appropriate corrective actions to preclude recurrence.

G. ADDITIONAL INFORMATION:

1. Component Failure Information:

   Not applicable.

2. Previous LERs for Similar Events:

   None.