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SUBJECT: LER 90-012-00:on 900826,overspeed trip of steam-driven auxiliary feedwater pump during testing.W/901120 ltr.

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Southern California Edison Company

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November 20, 1990

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Subject: Docket No. 50-361
30-Day Report
Licensee Event Report No. 90-012
San Onofre Nuclear Generating Station, Unit 2

Pursuant to 10 CFR 50.73(d), this submittal provides the required 30-day written Licensee Event Report (LER) for an occurrence involving the steam-driven auxiliary feedwater pump. Neither the health nor the safety of plant personnel or the public was affected by this occurrence.

If you require any additional information, please so advise.

Sincerely,

R W Krieger

Enclosure: LER No. 90-012

cc: C. W. Caldwell (USNRC Senior Resident Inspector, Units 1, 2 and 3)

J. B. Martin (Regional Administrator, USNRC Region V)

Institute of Nuclear Power Operations (INPO)

IE22
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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 1

Title (4)

OVERSPEED TRIP OF STEAM-DRIVEN AUXILIARY FEEDWATER PUMP DURING TESTING DUE TO WATER ACCUMULATION IN THE STEAM SUPPLY

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
0 8	2 6	9 0	9 0	0 1 2	0 0	1 1	2 0	9 0		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)	___ Other (Specify in		
//////////////////////		___ 20.405(a)(1)(iii)	X 50.73(a)(2)(i)	___ 50.73(a)(2)(viii)(A)	Abstract below and		
//////////////////////		___ 20.405(a)(1)(iv)	___ 50.73(a)(2)(ii)	___ 50.73(a)(2)(viii)(B)	in text)		
//////////////////////		___ 20.405(a)(1)(v)	___ 50.73(a)(2)(iii)	___ 50.73(a)(2)(x)			

LICENSEE CONTACT FOR THIS LER (12)

Name	TELEPHONE NUMBER
R. W. Krieger, Station Manager	AREA CODE 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	//////
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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 10/21/90, with Unit 2 at 100% power, while verifying the alignment of main steam leads, Operations personnel found steam trap F-207 isolation valve MU-1257 closed, contrary to its required position. MU-1257 had been closed while Unit 2 was in Mode 5 to apply a nitrogen blanket on steam generator (SG) E-088 and had not since been reopened. Due to this misalignment, F-207 was isolated, resulting in water accumulation in the steam supply piping to the auxiliary feedwater pump (AFWP) turbine (AFWPT). This water accumulation was determined to have caused the AFWPT (which supplies motive power to AFWP P-140) to trip on overspeed (110% of nominal speed) during recent tests performed at minimum flow. It is uncertain what effect the water accumulation would have had on 2P-140 operability under actual accident conditions; however, since SCE's evaluation of this occurrence could not assure automatic starting of the AFWPT under actual conditions, SCE considers the reliability of P-140 during an automatic start to have been degraded during the period MU-1257 was closed. Although the pump would have been capable of performing its safety function following operator reset from an overspeed trip due to water entrainment in the steam supply, SCE cannot assure that P-140 fully met Technical Specification 3.7.1.2 and 3.8.1.1 requirements for automatic operation in Modes 1-3 (Unit 2 entered Mode 3 on 8/26/90) during the period when MU-1257 was closed.

The misalignment of MU-1257 occurred due to a deficiency in the SG nitrogen blanketing procedure. This procedure required closure of MU-1257 to establish nitrogen blanketing of the steam generator but did not include a provision to reopen MU-1257 during restoration. In addition, the design of the AFWPT did not adequately provide for the possibility of an influx of water during an automatic start (without overspeed trip).

Prompt action was taken to restore proper alignment of the steam trap. P-140 was tested and returned to operable status on 10/23/90. The SG nitrogen blanketing procedure and other appropriate procedures will be amended as necessary. This event will be reviewed with appropriate personnel. Design enhancements to address water entrainment in the AFWPT steam supply piping are under evaluation.

Plant: San Onofre Nuclear Generating Station
Unit: Two
Reactor Vendor: Combustion Engineering
Event Date: 8/26/90

A. CONDITIONS AT TIME OF THE EVENT:

Mode: 3, Hot Standby
RCS Temperature: 350 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 initiated in response to an emergency feedwater actuation signal (EFAS) [JE], which is initiated by a low SG level signal. The AFWS is comprised of electrically-driven pump [P] P-141, which normally is aligned to supply only E-089, electrically-driven pump P-504, which normally is aligned to supply only E-088, steam turbine-driven pump P-140, which can supply either SG, and associated valves and piping. AFW pump turbine (AFWPT) K-007 [TRB] provides the motive power for AFW pump (AFWP) P-140.

AFWPT K-007 can be supplied steam from either E-088 via isolation valve HV-8201 [ISV] and check valve MU-003 or from E-089 via isolation valve HV-8200 and check valve MU-005. The steam lines from these two sources are combined into a common line downstream of the check valves. Steam is then directed to the AFWPT via trip/throttle valve HV-4716 and governor valve SV-4700. During normal plant operation, HV-8201 is maintained closed to minimize chatter of MU-003 and MU-005.

Steam traps F-207 and F-209 [TRP] remove condensed steam from portions of the main steam piping upstream of HV-8201 and HV-8200, respectively (F-209 also removes condensed steam from portions of main steam piping downstream of HV-8200). MU-1257 isolates F-207 from the main steam piping upstream of HV-8201, and MU-1258 isolates F-209 from the main steam piping upstream of HV-8200. In addition, three drain lines off the common steam supply piping to K-007 are installed with in-line flow orifices (FO-8252, FO-8253, and FO-8254) to continuously extract any condensed steam which may accumulate in the common line. These condensation removal features are provided since during normal plant operation, K-007 is in the standby mode. (See Figure 1.)

The purpose of maintaining the K-007 steam supply piping relatively free of condensation is to avoid the accumulation of water in piping low points. However, the AFWPT is similar to a design which has been vendor tested to operate satisfactorily with water present in the steam supply. Test results show that the decrease in turbine speed which occurs when water passes through the turbine causes its governor valve to open wider, and the resulting increase in speed when the water has cleared the turbine is limited by the governor to approximately 110% of nominal. The vendor tests were conducted

with the overspeed trip setpoint at 125% of nominal, thus permitting continued AFWP operation. However, the overspeed trip setpoint specified for the installed components was 110%, which is very close to the overspeed which occurred during the test with water entrained in the steam. When the AFWPT is not fully loaded (as it is during testing), speed control by the governor may allow an increased overspeed and a trip is more likely. With the pump fully loaded, as it would be if required for delivery to the SGs, a trip as a result of water in the steam supply would be less likely.

AFWPT STEAM SUPPLY DRAIN SYSTEM

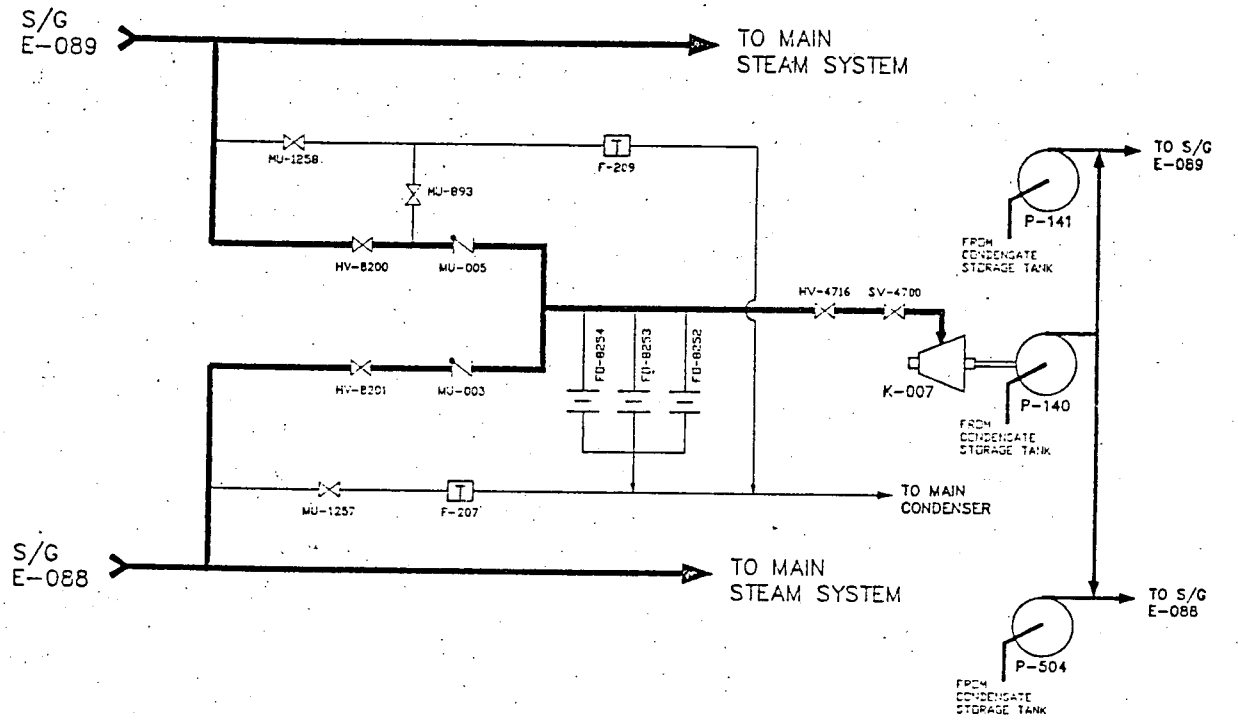

FIGURE 1

2. Technical Specification (TS) requirements:

TS 3.7.1.2, "Auxiliary Feedwater System", requires that all three AFW pumps be operable in Modes 1-3. With one AFW pump inoperable, the required AFW pumps must be restored to operable status within 72 hours or the plant must be shutdown to Mode 3 within the next 6 hours and Mode 4 within the following 6 hours.

TS 3.8.1.1, "A.C. Sources", Action c.2 requires that in Modes 1-3, with one emergency diesel generator (EDG) [EK] inoperable, P-140 must be operable or returned to operable status within 2 hours. Otherwise, the plant must be shutdown to Mode 3 within the next 6 hours and Mode 5 within the following 30 hours.

3. SG Nitrogen Blanket:

During shutdown (non-steaming) conditions, a nitrogen blanket is applied to the SGs to prevent contact with air and minimize corrosion. Prior to initiating a SG nitrogen blanket, the SG and associated main steam leads are first isolated (including the closure of MU-1257 and MU-1258) to prevent the escape of nitrogen from the SG.

C. DESCRIPTION OF THE EVENT:

1. Event:

On 8/23/90 (with Unit 2 in Mode 5), MU-1257 and MU-1258 were closed to apply a nitrogen blanket to SG E-088. On 8/24/90, the nitrogen blanket was removed in preparation for plant startup. However, MU-1257 and MU-1258 remained closed. On 8/26/90, Unit 2 entered Mode 3.

On 8/27, 8/29, and 9/26 successful tests were performed on P-140 in accordance with Technical Specification surveillance procedures. On each of these occasions, the testing procedures permitted measures to be taken which coincidentally assisted in the removal of condensate accumulation from the AFWPT steam supply piping. As a result, there was no indication of the reduced reliability of P-140 due to MU-1257 being closed. Permitting the removal of condensate prior to testing represented a missed opportunity to identify the misalignment of MU-1257.

On 9/26, P-140 was removed from service for routine maintenance. While returning the pump to its normal alignment, normally open valve MU-1258, which performs a function identical to MU-1257, was found closed. MU-1258 was promptly opened. The fact that MU-1258 was closed had no safety significance because the associated isolation valve (HV-8200) is maintained normally open, precluding condensation buildup in the steam supply header. However, this represented a missed opportunity to identify that MU-1257 on the alternate supply header was also misaligned. The Unit 3 MU-1258 valve was checked and found open. However, neither the Unit 2 nor the Unit 3 MU-1257 was checked at that time (as would be expected from a thorough investigation of the misalignment), nor was an operability assessment of that condition performed. (The Operations procedure governing the discovery of a misaligned valve does not currently require that an operability assessment be performed.)

On 10/6/90 and 10/16/90 AFW pump turbine (AFWPT) K-007 tripped on overspeed during the performance of testing. Following these two occurrences, extensive investigations were performed to identify the cause of the overspeed trips. Possible causes investigated included: 1) malfunction of the electric governor, 2) malfunction of the hydraulic portion of the governor, 3) water

accumulation from the steam supply line causing speed oscillations, 4) incorrect trip setpoint, 5) malfunction of the trip/throttle valve, and 6) deficiencies in the trip linkages. Replacement and inspection of various installed components, including the governor, were performed. Pump and turbine vendor representatives were also consulted and the turbine vendor was onsite for troubleshooting.

The investigation to determine the presence of water accumulation in the steam supply included extensive checks (including thermographic inspections) to assure that the orificed drain lines attached to the K-007 steam supply piping were functioning properly; no problems with these orificed drain lines were identified. Informal direction by Engineering was provided to check the alignment of the K-007 steam supply drain system. Although the expectation was that this task was to encompass checking the steam traps upstream of HV-8201, the verbal communication was not specific, and this action was not properly verified to have been completed.

During the course of these investigations, P-140 was started 13 times. Twelve of the starts were satisfactory; the other start was unsatisfactory, but the cause of the failure was attributed to the attached special test instrumentation. The condition causing the overspeed trips was believed to have been corrected with the repair and replacement of governor components; nevertheless, an interim accelerated test program for P-140 was initiated to confirm the acceptability of the corrective actions. Similar to the operability testing conducted earlier, the accelerated testing program inadvertently permitted the removal of condensation accumulation from the AFWPT steam supply piping. This also represented a missed opportunity to identify the misalignment of MU-1257.

On 10/21/90, while performing a test in accordance with the accelerated test program, P-140 again tripped on overspeed. An excessive amount of moisture was observed streaming from the turbine exhaust during the test. In response to this observation, all steam traps associated with the main steam leads were checked for proper alignment. During performance of this alignment check, MU-1257 was found closed.

SCE's evaluation of the misalignment determined that the accumulated water in the piping associated with F-207 caused K-007 to trip on overspeed (110% of nominal speed) during the testing performed at low (minimum) flow of P-140. It is uncertain what effect the water accumulation would have had on P-140 operability under accident conditions. However, since the evaluation of this occurrence could not confirm satisfactory operation of the AFWPT in such an event, SCE considers that the reliability of P-140 during an automatic start was degraded during the period MU-1257 was closed.

In addition, between 8/23 and 10/21, there were separate periods during which the Train A EDG, the Train B EDG, and one AFW discharge valve were each removed from service for routine maintenance.

Although the pump would have been capable of performing its safety function following operator reset from an overspeed trip due to water entrainment in the steam supply, SCE cannot assure that P-140 fully met Technical Specification 3.7.1.2 and 3.8.1.1 requirements for automatic operation in Modes 1-3 during the period when MU-1257 was closed.

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

None

3. Sequence of Events:

DATE	TIME	ACTION
8/23	1400	Nitrogen blanket applied to SG E-088. (MU-1257 and MU-1258 closed.)
8/24	1340	Nitrogen blanket removed and SG E-088 returned to operability. (MU-1257 and MU-1258 remained closed.)
8/26	2225	Unit 2 entered Mode 3.
8/27	1705	Performed successful start of P-140 in accordance with (IAW) TS surveillance.
8/29	0120	Unit 2 entered Mode 1.
8/29	0940	Performed successful start of P-140 IAW TS surveillance.
9/26	1120	Performed successful start of P-140 IAW TS surveillance.
10/6	0838	P-140 started for stroke test of HV-4716; K-007 trips on overspeed; P-140 declared inoperable.
10/7	1325	Performed successful start of P-140. P-140 declared operable at 1650. Initiated accelerated test program (ATP).
10/8-11	N/A	Performed successful daily starts of P-140 IAW ATP.
10/16	1420	Started P-140 IAW ATP; trips on overspeed; pump declared inoperable.
10/19	0350	Performed successful start of P-140. P-140 declared operable at 0820. Reinitiated ATP.
10/20	N/A	Performed 3 successful starts of P-140 IAW ATP.

DATE	TIME	ACTION
10/21	0935	P-140 started IAW ATP; tripped on overspeed. P-140 declared inoperable. Water was noted streaming from the turbine exhaust. Control room directed that steam trap alignments be verified.
10/21	1400	MU-1257 found closed; it was subsequently opened, returning F-207 to service.
10/23	0315	P-140 declared operable.

4. Method of Discovery:

In response to the excessive amount of moisture which was observed streaming from the turbine exhaust during the test on 10/21/90, control room personnel directed that all steam traps associated with the main steam leads be checked for proper alignment. During performance of this alignment check, MU-1257 was found closed.

5. Personnel Actions Taken:

Upon discovery of the valve misalignment, prompt action was taken to open MU-1257 and place steam trap F-207 in service. Condensation in the piping associated with F-207 was drained (blown down).

6. Safety System Responses:

Not applicable

D. CAUSES OF THE EVENT:

1. ROOT CAUSE:

Procedural Deficiency:

Prior to entering Mode 4, steam trap F-207 isolation valve MU-1257 and steam trap F-209 isolation valve MU-1258 were closed as part of the procedurally directed valve alignment required for the application of a nitrogen blanket to SG E-088. The procedure governing the SG nitrogen blanket, however, neither directed the operator to reopen MU-1257 and MU-1258 as a part of the restoration, nor did it direct the operator to a specific step of another procedure to insure they were reopened.

Further investigation identified that the procedure writer's guide does not contain adequate guidance in this regard. The root cause, therefore, is that the writer's guide does not contain guidance that valves aligned in a procedure must be restored in that procedure or explicit reference made to appropriate steps in another procedure to accomplish realignment of the valves.

2. CONTRIBUTING CAUSES:

Design Deficiency:

The design of the turbine driven AFW pump did not adequately provide for the possibility that the Auxiliary Feedwater pump turbine would experience an ingress of water during an automatic start (such as might occur as a result of a clogged or, as in this case, an inadvertently isolated steam line drain). This design deficiency was a significant contributory cause since it rendered 2P-140 vulnerable to failure due to expected plant anomalies (such as a clogged steam line trap).

Design Review Deficiency:

In 1986, the alignment of the normally open AFWPT steam supply valves (HV-8200 and HV-8201) was modified such that one of the valves was placed in the closed position. Although the significance of proper operation of steam trap F-207 was recognized when the steam supply valve was closed, the need to periodically monitor the status of the trap was not identified during the review of this change.

E. CORRECTIVE ACTIONS:

1. Corrective Actions Taken:

a. A complete alignment verification of the main steam lines was performed; no other valves were found to be mispositioned.

b. Proper operation of the K-007 steam supply drain system traps was verified using thermographic inspection.

c. P-140 was satisfactorily tested and returned to operable status on 10/23/90. In addition, an interim accelerated test program for P-140 was initiated to confirm the acceptability of the corrective actions. This program has confirmed that P-140 operates satisfactorily with the condensation removal system properly aligned and in operation.

d. The importance of periodically checking the status of the K-007 steam supply drain system has been stressed to operators.

e. A memorandum was issued to Operations personnel which discussed equipment malfunctions. The memo stressed that personnel be cognizant of activities such as system alignments and plant status changes that could contribute toward identification of the cause of equipment malfunctions.

2. Planned Corrective Actions:

a. A program will be developed to require a periodic check of the appropriate portions of the K-007 steam supply drain system. As interim corrective action, a check of steam drains associated with K-007 will be performed as part of the monthly inservice pump test.

b. The SG nitrogen blanketing procedure will be amended to correct any cases in which valves are manipulated to initiate the blanket but are not repositioned to their normal position at the conclusion of the evolution.

c. The procedure writer's guide will be amended to ensure adequate controls are contained in procedures to realign valves to their normal positions following the completion of evolutions.

d. Appropriate procedures that align systems for shutdown activities, such as nitrogen blanketing, will be reviewed to ensure that proper restoration alignment requirements are included.

e. An engineering study will be initiated to determine the feasibility of modifications to reduce AFW pump turbine vulnerability to water ingress. If additional measures are determined to be feasible, modifications will be implemented in the Cycle 7 refueling for each unit.

f. This event will be reviewed with appropriate Operations personnel, emphasizing the need for thorough investigations and operability assessments of affected components when a valve misalignment is identified. The procedure governing the discovery of a valve misalignment will be modified to ensure an operability assessment of affected components is performed.

g. This event will be reviewed with appropriate Engineering personnel, emphasizing: 1) the need to formally direct investigatory actions (such as valve alignment verification) to ensure that those actions are effectively communicated and completed; and 2) the need to ensure appropriate compensatory actions are implemented when plant configurations are changed (such as when the position of HV-8201 was changed from normally open to normally closed).

h. SCE is continuing to review the root cause investigation activity that was undertaken following the overspeed trip of P-140 on 10/6/90, with emphasis on the acceptability of the formality, control, communications, and management involvement that took place. Corrective actions resulting in an improvement in the approach to performing investigations of similar events will be implemented, as appropriate.

i. Prior to this event, a review of the requirements, expectations, and work load of plant equipment operators (PEOs) was completed. This review concluded that the frequent monitoring of the components which are presently the focus of the operator round activity do not permit

adequate monitoring of other, seemingly less critical equipment (e.g., steam traps). This program will be enhanced to optimize the value of the PEO round inspections, and will ensure that a broad range of components are monitored at an appropriate frequency.

F. SAFETY SIGNIFICANCE OF THE EVENT:

The safety significance of this event was evaluated assuming that P-140 would fail to auto-start and deliver AFW when required (as discussed previously, it is uncertain whether P-140 would fail to start under accident conditions due to the amount of water which accumulated in the steam lines). This evaluation showed that, for the worst case events, RCS parameters would have been acceptable and offsite doses would have been within those allowed by 10CFR50 and 10CFR100.

RCS Parameters:

In general, post trip heat removal can be accomplished using either SG, or a combination of SGs. However, several design basis events require that heat removal be accomplished through a specific SG. These events include Steam Generator Tube Rupture (SGTR), Main Steam Line Break, and Feed Water Line Break (FLB).

The Standard Post Trip Action procedure, which provides immediate operator actions following a reactor trip, directs a verification that proper AFW flow has been established. Since AFW pump P-140 trip is annunciated in the control room; each of the design basis events was evaluated assuming that operator action to reset the turbine overspeed trip would re-establish flow from P-140 (restart attempts subsequent to water induced overspeed trips have always been successful since the accumulated water is expelled in the initial start attempt). Even if this action did not take place for up to 30 minutes, the design basis RCS parameters would not have been exceeded as discussed below.

The FLB was determined to be the most limiting accident with regard to RCS integrity. The FLB event, when coupled with a Loss of Offsite Power (LOP) and an inoperable EDG, could result in an inability to deliver AFW to the intact steam generator until after P-140 was restarted (or the motor driven pump associated with the operable EDG was realigned to the intact SG.) An evaluation was performed to determine the effect on the RCS of a FLB coupled with a delay in the delivery of AFW by 30 minutes. Applying realistic assumptions (i.e., modeling the blowdown from the broken feedline as a combination liquid/steam blowdown rather than entirely as a liquid, as assumed in the FSAR) indicates that an RCS cooldown would actually occur rather than a heatup as shown in the FSAR. Our evaluation showed that sufficient SG liquid inventory would be available without AFW and that the RCS temperature decrease would prevent RCS overpressurization (the peak RCS pressure reported in the safety analysis [2943 psia] would not be exceeded). Therefore, the consequences of a FLB would remain bounded by the existing design basis analysis.

Offsite Doses:

The SGTR was determined to be the most limiting accident with regard to radiological releases. In this analysis, it was assumed that P-140 received an autostart signal, oversped as a result of water ingress, and tripped. Further, only one motor driven AFW pump was assumed operable (the other was rendered unavailable by the assumed inoperable diesel generator). The operable motor driven AFW pump was assumed to be aligned to the affected SG. Under these conditions, the start of the cooldown would be delayed until operator action could be taken to reset and restart P-140 (or until the remaining motor driven AFW pump could be realigned to the intact SG). This would result in a slightly higher primary-to-secondary mass transfer and slightly higher secondary mass releases to atmosphere. However, since the actual SONGS 2 RCS specific activities during this period were less than 4% of the allowable TS values, and less than 1% of that assumed in the FSAR analysis, the potential radioactive releases from a SGTR event are bounded by those reported in the FSAR and are far below the limits of 10CFR100 and 10CFR50.

G. ADDITIONAL INFORMATION:

1. Component Failure Information:

   Not applicable

2. Previous LERs for Similar Events:

   None