LICENSEE EVENT REPORT (LER)

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

Title (4)

UNIT 1 CV-305 AND FCV-1112 SINGLE FAILURE DEFICIENCY WITH HOT LEG RECIRCULATION

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 0	1 2	8 9	8 9	0 2 5	0 0		1 1	1 3	8 9		0 5 0 0 0

OPERATING MODE (9)	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10CFR (Check one or more of the following) (11)			
1	___ 20.402(b)	___ 20.405(c)	___ 50.73(a)(2)(iv)	___ 73.71(b)
POWER LEVEL (10) .0 9 0	___ 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 Abstract below and in text)
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//////////////////////	___ 20.405(a)(1)(v)	___ 50.73(a)(2)(iii)	___ 50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

Name	TELEPHONE NUMBER AREA CODE
H. E. Morgan, Station Manager	7 1 4 3 6 8 - 6 2 4 1

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 October 12, 1989, at approximately 1445, as part of the review following the report of the susceptibility of CV-517 and CV-518 (Containment Spray System flow restricting valves; see LER 89-024, Docket No. 50-206) to a common cause loss of instrument air subsequent to a design basis accident, it was also determined that the primary Hot Leg Recirculation (HLR) function is susceptible to a loss of instrument air to pneumatically operated valves CV-305 and FCV-1112. Both valves are designed to open with instrument air applied to the valve operator and close when the air is vented. The Primary HLR flow path requires both CV-305 and FCV-1112 to be open. On a loss of instrument air, CV-305 and FCV-1112 would fail closed, thus preventing primary HLR flow. A concurrent failure of the alternate HLR path could result in loss of all HLR capability, resulting in a condition where boron precipitation in the core region could possibly occur.

Extensive review of the licensing history of CV-305 and FCV-1112 has not identified the basis on which their configuration was accepted. Accordingly, SCE has chosen to upgrade the valves to eliminate their dependence on the Instrument Air System (IAS). To implement this upgrade, Unit 1 was shutdown on November 1, 1989, to install a nitrogen backup supply to the IAS for CV-305 and FCV-1112.

The root cause of this event is attributed to weaknesses in the licensing support to San Onofre, as discussed in detail in SCE's October 3, 1988, letter to the NRC regarding this subject. The corrective actions identified in that submittal are also applicable to the causes of this event.

Plant: San Onofre Nuclear Generating Station
Unit: One
Reactor Vendor: Westinghouse
Event Date: 10-12-89
Time: Approximately 1445

A. CONDITIONS AT TIME OF THE EVENT:

Mode: 1, Power Operation

B. BACKGROUND INFORMATION:

Safety Injection System:

The Safety Injection System (SIS) [BQ] is designed to mitigate core damage resulting from overheating following a loss of coolant accident (LOCA). Initially after a LOCA, the SIS injects borated water from the Refueling Water Storage Tank (RWST) through the SIS header and into the three Reactor Coolant System (RCS) [AB] loops (Loop A, Loop B, and Loop C) via separate SIS lines.

Following depletion of the RWST, the Recirculation System (RS) [BP] provides core cooling for extended periods following design basis accidents and is initiated after a sufficient quantity of water has accumulated in the containment sump. Two recirculation pumps take suction from the containment sump and discharge to a common header, through the Recirculation Heat Exchanger, to the suction of the charging pumps [CB,P] for recirculation to the RCS and to the suction of the refueling water pumps for recirculation to the containment spray system. Recirculation of the RCS is by means of Cold Leg Recirculation (CLR) or Hot Leg Recirculation (HLR) as described below.

Cold Leg Recirculation:

CLR flow is from the containment sump by means of either of two containment recirculation pumps and a recirculation heat exchanger to the suction of the charging pumps. The charging pumps then provide this flow to the RCS cold legs (loops A, B, or C) via three cold leg flow control valves (FCVs) (FCV-1115D, E, and F). The FCVs are pneumatically operated by either instrument air or Backup Nitrogen System (BNS) [LE]. These valves are used to regulate the flow into their respective cold legs (see figure 1).

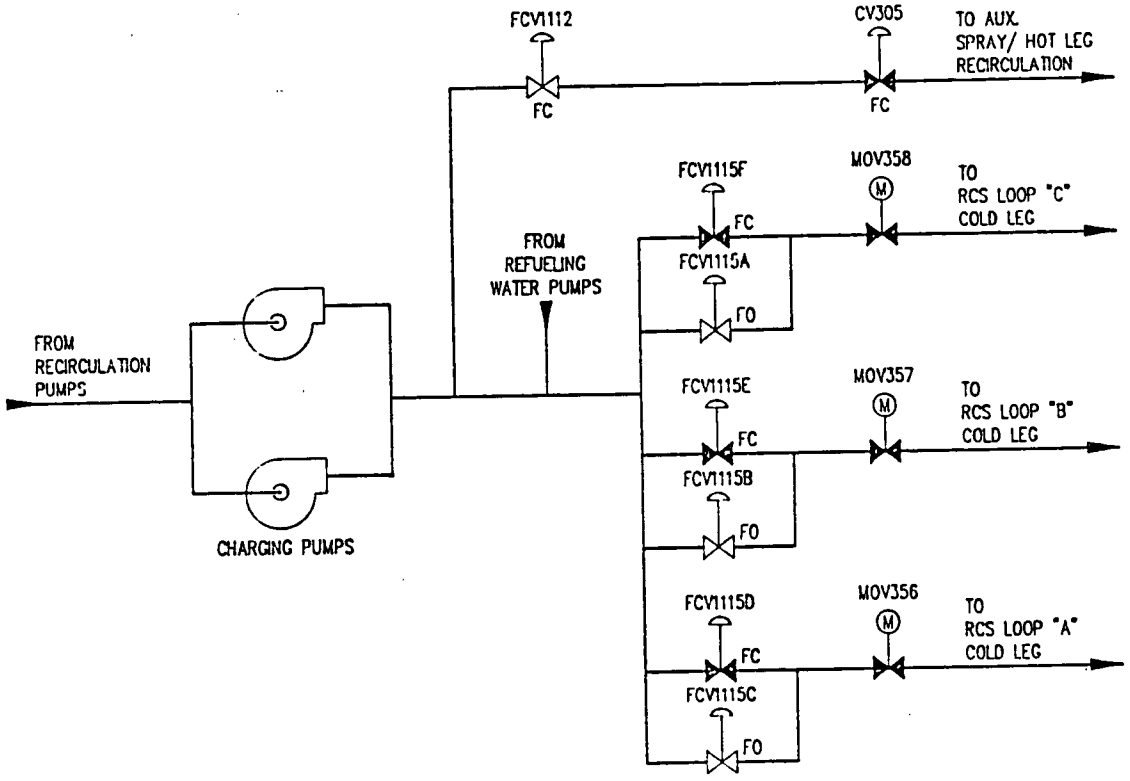

FIGURE 1

Hot Leg Recirculation:

For a postulated LOCA in one of the RCS hot legs, once the core has been re-flooded, the CLR flow path delivers borated water from the SI and RS to the reactor downcomer, up through the core and out the ruptured hot leg. However, for a postulated LOCA in one of the cold legs, the CLR flow path results in borated water preferentially flowing around the reactor downcomer and out the ruptured cold leg without passing through the core. Flow to the core is limited to that flow which is required to make up for boil-off in the core, and to maintain an equal static head between the downcomer and core regions. A lack of mixing of the fresh injection water and the water in the core would result in the accumulation of boric acid in the core region until saturation concentrations are reached, and boric acid begins to precipitate out of solution. HLR is the currently accepted method of preventing boron precipitation in the core during long term cooling following a cold leg LOCA. HLR is accomplished by either a primary flow path or an alternate flow path as described below.

Primary HLR:

The primary HLR flow path uses the recirculation pumps and heat exchanger. From here flow is directed to the charging pumps which discharge to FCV-1112 (charging flow control valve) and CV-305 (pressurizer auxiliary spray valve) to the pressurizer and into RCS loop B hot leg (see figure 1). FCV-1112 is a normally open valve to allow charging flow to the RCS for inventory control. CV-305 is a normally closed valve which is required to be open for HLR. Both valves are pneumatically operated and designed to open with instrument air applied to the valve operator and close when instrument air is vented from the valve operator.

Alternate HLR:

The primary HLR flow path is susceptible to a single active failure because there are points where flow passes through a single valve. To protect against the consequences of such a single active failure, an alternate HLR flow path is provided. Recirculated coolant from the discharge of the refueling water pumps enters the Residual Heat Removal (RHR) heat exchanger outlet. Coolant then flows in the reverse direction through the RHR heat exchangers, through a bypass line around the east RHR pump, and into the loop "C" hot leg (see figure 2).

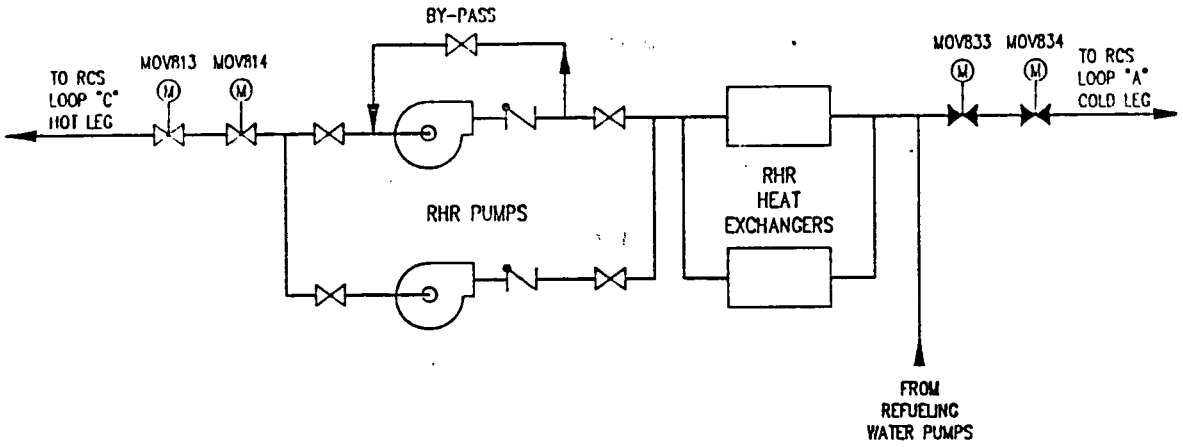

FIGURE 2

HLR Requirement:

In March 1975, the NRC requested information concerning the potential for boron precipitation during long term cooling subsequent to a LOCA. In July 1975, SCE responded, crediting HLR flow via the pressurizer auxiliary spray path (i.e., charging system valves FCV-1112 and CV-305) as preventing post-LOCA boron precipitation. Current analysis shows that HLR must be initiated within 15 hours post-LOCA to perform this function.

Single Failure Criteria For HLR:

In December 1976, a single failure analysis of the emergency core cooling system (ECCS) was completed which identified system modifications to eliminate single point failures in the HLR flow path. In March 1977, an alternate HLR flow path was identified as an interim modification to provide HLR in the event of a LOCA in one of the cold legs and the single failure of one of the valves in the primary HLR flow path. This interim modification was installed prior to restart, and the NRC accepted this as a long-term solution in October 1978 (documented in NRC letter to SCE, dated, October 16, 1978, re: ECCS Single Failure Modifications). At that time, the IAS at Unit 1 was credited for providing air to all ECCS components following a pipe break in containment.

Backup Nitrogen Systems (BNS):

The BNS are seismically qualified automatic backups for the non-safety related Instrument Air System (IAS) [LD]. These BNSs are utilized for selected safety related components (e.g., pneumatic valves) that are required to support the safe shutdown and accident mitigation functions of Unit 1. Each of the BNSs is comprised of nitrogen cylinders, valving, pressure regulator(s), check valves and interconnecting piping between these components, the IAS (normally), and the supplied component(s). When the IAS pressure drops below the BNS pressure regulator set point, the BNS provides the required backup for maintaining operating pressure to the supplied component(s). Normally, check valves are installed to prevent nitrogen from flowing into the IAS via the IAS supply line and, alternately, instrument air from flowing into the BNS.

Other Features of the Air System Supporting HLR:

There are three normal air compressors, powered from redundant safety related busses which supply the IAS. Additionally, the auxiliary air compressor, also powered from a safety related bus, would start automatically on low pressure to supply the redundant air header portion of the air system. Thus, the redundant air header, which serves in part, FCV-1112 and CV-305, is a highly reliable source of instrument air. However, the IAS is non-safety related, Seismic Category B, and therefore not normally credited for design basis accident mitigation.

Long Term Seismic Upgrade Program:

San Onofre Unit 1 was evaluated for seismic adequacy as part of the NRC's Systematic Evaluation Program (SEP). SCE upgraded the plant to a 0.67g ground acceleration seismic criteria. The upgrade was done in two parts. During the first part, The Return To Service Program, all systems necessary to bring the plant to a safe hot standby condition were upgraded. During the second part, The Long Term Service Program, all accident mitigation systems and cold shutdown systems were also upgraded. The HLR flow path was seismically upgraded as part of the Long Term Service Program. However, a BNS was not installed for either CV-305 or FCV-1112 as part of the HLR system upgrade.

C. DESCRIPTION OF THE EVENT:

1. Event:

On October 12, 1989, at approximately 1445, as part of the review following the report of the susceptibility of CV-517 and CV-518 (Containment Spray System flow restricting valves; see LER 89-024, Docket No. 50-206) to a common cause loss of instrument air subsequent to a design basis accident, it was also determined that the primary HLR function is susceptible to a loss of instrument air. The specific components involved are pneumatically operated valves CV-305 and FCV-1112. Both valves are designed to open with instrument air applied to the valve operator and close when instrument air is vented from the valve operator. The Primary HLR flow path requires both CV-305 and FCV-1112 to be open. On a loss of instrument air, CV-305 and FCV-1112 would fail closed, thus preventing HLR primary flow. A concurrent failure of the alternate HLR path could result in loss of all HLR capability, resulting in a condition where boron precipitation in the core region could possibly occur. Based on a safety evaluation which was performed to assess the safety significance of this configuration, SCE considered that it was acceptable to operate Unit 1 until the end of October 1989 (see section F, "Safety Significance of the Event").

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

   Not applicable.

3. Sequence of Events:

   Not applicable.

4. Method of Discovery:

   The susceptibility of the primary HLR to a loss of IAS was discovered during a review being performed in response to a previous finding, reported in LER 89-024, Docket No. 50-206.

5. Personnel Actions and Analysis of Actions:

   Not applicable.

6. Safety System Responses:

   Not applicable.

D. CAUSE OF THE EVENT:

Immediate Cause:

A BNS was not provided to CV-305 or FCV-1112 when the HLR flow path was upgraded as part of the Long Term Service (LTS) seismic program.

Root Cause:

The root cause of this event is attributed to weaknesses in the licensing support to San Onofre, as discussed in detail in SCE's October 3, 1988, letter to the NRC regarding this subject. After performing a thorough historical search of the design and licensing history of this issue, SCE has been unable to determine what basis was developed to support the absence of a BNS for these valves. Our inability to substantiate the acceptability of the existing design for these valves is considered a weakness in the licensing support to the operation of San Onofre Nuclear Generating Station (SONGS), Unit 1.

E. CORRECTIVE ACTIONS:

1. Corrective Actions Taken:

   a. Unit 1 was shutdown on November 1, 1989, to install a nitrogen backup supply to the IAS for CV-305 and FCV-1112.

b. The Failure Mode and Effects Analysis (FMEA) conducted on various BNS used for safety related valves has been revalidated and no additional discrepancies or appropriate enhancements were identified other than noted below under G.2, "Additional Information".

2. Planned Corrective Actions:

a. The corrective actions identified in SCE's October 3, 1988, submittal (and in several LER's which have identified other related issues) to the NRC concerning engineering and technical work are also applicable to the root cause of this condition.

b. The response to Generic Letter 88-14, "Instrument Air Supply System Problems Affecting Safety-Related Equipment", dated August 8, 1989, is currently being prepared and will be submitted to confirm the acceptability of the pneumatic supply to all pneumatic valves that are used in a safety related application.

F. SAFETY SIGNIFICANCE OF THE EVENT:

A limited probabilistic risk assessment was performed to compare the probability of core melt with and without backup nitrogen for the primary path HLR valves, considering potential common-cause failures and no backup means of preventing boron precipitation in the core. The results of this analysis indicate that the lack of backup nitrogen for these valves does not result in a significant increase in the overall probability of core melt for SONGS 1. Specifically, the probability of core melt due to a cold leg LOCA and loss of both HLR flow paths was determined to be 5.85E-05 per year. The probability of core melt assuming backup nitrogen is available was determined to be 2.37E-05 per year. This change in risk is small compared with the base SONGS 1 risk for LOCAs of 3.3E-04 per year.

Additionally, a Westinghouse analysis has been completed which demonstrates that reflux condensation in the Steam Generators (S/Gs) will prevent boron precipitation in the core during long term cooling. Reflux condensation occurs when RCS forced circulation is lost. Over time, steam will form in the core region and will rise from the core into the S/Gs. The steam will then condense in the S/Gs and will flow back down the hot leg, traveling down the outer fuel assemblies and rising through the center of the core. This circulating flow is of sufficient magnitude that RCS mixing in the core region occurs and boron precipitation is prevented.

It can therefore be concluded that the failure to provide CV-305 and FCV-1112 with backup nitrogen was of little safety significance.

G. ADDITIONAL INFORMATION:

1. Component Failure Information:

Not applicable.

2. Charging Flow Control Valves (FCVs) FCV-1115 D, E, and F:

During the HLR design basis review, the BNS design for the charging flow control valves FCVs-1115 D, E, and F, which provide an injection pathway for CLR (see Part B, Background Information for a discussion of CLR) was reviewed.

It was determined from this review that these valves, even though provided with a BNS, would not be able to perform their safety function in the event of a loss of IAS in combination with the loss of Train "B" control power. Specifically, upon a loss of Train "B" control power, the solenoid valves which switch the air and/or nitrogen to FCV-1115 D, E, and F, coincident with the loss of the IAS, nitrogen to the FCV's would be isolated, resulting in FCV-1115 D, E, and F closure and isolation of cooling flow to the cold leg via this flow path. However, parallel RCP seal injection valves FCV-1115 A, B, and C would fail open on a loss of IAS. As a result, a reduction in cold leg recirculation flow would occur.

The existing configuration of this system was evaluated by SCE and the NRC as part of their review of Systematic Evaluation Program (SEP), Topic VI-7.C.2, Failure Mode Analysis (Emergency Core Cooling System). The results of the review are documented in the Integrated Plant Safety Assessment, NUREG-0829 dated December 1986. A thorough review of the licensing history of this system, which included the SEP and IPSAR, was recently performed in order to determine the design and licensing basis for cold leg recirculation. Thus far, this review has failed to identify the basis upon which this configuration was considered acceptable. SCE has concluded that continued research efforts in this area is unlikely to result in a significantly better understanding of the original requirements. Therefore, regardless of whether the licensing history would support the acceptability of the current design, SCE is installing design changes to eliminate the identified vulnerability. This modification is being installed during the current outage.

3. Previous LERs for Similar Events:

Recent LERs reporting similar design and design control related conditions:

Unit 1 (Docket No. 50-206)

LER 1-86-007, Revision 1, reported a single failure susceptibility of the RPS.

LER 1-87-015, Revision 1, reported that certain ESF systems were susceptible to single failure.

LER 1-88-001 reported that several components requiring environmental qualification were not included in the administrative controls for the environmentally qualified equipment. Additionally, other components were found to be in an unqualified configuration.

LER 1-88-006, Revision 1, reported a condition where the Unit 1 backup nitrogen systems (as designed, installed and operated) did not satisfy the licensing and design basis for the systems.

LER 1-88-009, Revision 1, reported a condition in which the emergency diesel generators could have exceeded an intended electrical load limit.

LER 1-88-016 reported a condition in which the south refueling water pump may not have started as required.

LER 1-88-017 reported a condition in which the auxiliary feedwater storage tank minimum volume requirements for accident mitigation may have been inadequate.

LER 1-88-019 reported that design deficiencies existed in automatic controls of the electrical power distribution system.

LER 1-88-020 reported that design requirements of NUREG-0737 had not been fully implemented in the design of the steam generator wide-range level indication system.

LER 1-89-003 reported a condition in which the failure mode of Component Cooling Water was non-conservative with respect to design requirements due to inadequate single failure analysis.

LER 1-89-004 reported that due to a design deficiency associated with diesel generator load sequencing logic, the automatic response capability of one of the two trains of safety-related components during a postulated SISLOP scenario may be lost.

LER 1-89-007 reported single failure susceptibility of the Reactor Protection System in the event of a Reactor Coolant Pump locked rotor.

LER 1-89-008 reported the remote possibility of a single failure which could divert cooling water from the Containment Spray System to the Containment Fire Suppression System during recirculation, thus reducing the effectiveness of the Containment Spray System.

LER 1-89-011 reported various conditions resulting in a reduction in Safety Injection delivery to the Reactor Coolant System below that assumed during certain accident scenarios.

LER 1-89-013 reported that the Power Operated Relief Valves were not included in the Inservice Testing program for their Overpressure Mitigation System function.

LER 1-89-022 reported that the Technical Specifications governing the Overpressure Mitigation System permitted non-conservative plant operation.

LER 1-89-024 reported a condition that could result in a reduction in containment spray flow thereby, reducing the effectiveness of the Containment Spray System.

Unit 2 (Docket No. 50-361)

LER 2-88-008, Revision 1, reported various conditions resulting in the component cooling water system being outside its design basis due to design control program deficiencies.

LER 2-88-010 reported a condition in which both emergency chillers were rendered inoperable as a result of not addressing freon level as a critical design parameter.

LER 2-88-017 reported that a spent fuel pool siphon event occurred as a result of the failure to transfer the design intent to utilize administrative controls on certain locked valves.

LER 2-88-034 reported a condition involving safety related Component Cooling Water System valves being susceptible to seismically-induced common mode failures.

4. Results of NPRDS Search:

Not applicable.

Southern California Edison Company

SAN ONOFRE NUCLEAR GENERATING STATION

P. O. BOX 128

SAN CLEMENTE, CALIFORNIA 92672

H. E. MORGAN
STATION MANAGER

TELEPHONE
(714) 368-6241

November 13, 1989

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

Subject: Docket No. 50-206
30-Day Report
Licensee Event Report No. 89-025
San Onofre Nuclear Generating Station, Unit 1

Pursuant to 10 CFR 50.73(d), this submittal provides the required 30-day written Licensee Event Report (LER) for an occurrence involving the Reactor Coolant Hot Leg Recirculation System. Neither the health and safety of plant personnel or the public was affected by this occurrence.

If you require any additional information, please so advise.

Sincerely,

H E Morg

Enclosure: LER No. 89-025

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
1/1

Southern California Edison Company

SAN ONOFRE NUCLEAR GENERATING STATION

P. O. BOX 128

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STATION MANAGER

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November 13, 1989

U. S. Nuclear Regulatory Commission
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30-Day Report
Licensee Event Report No. 89-025
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LICENSEE EVENT REPORT (LER)

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

Title (4)

UNIT 1 CV-305 AND FCV-1112 SINGLE FAILURE DEFICIENCY WITH HOT LEG RECIRCULATION

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
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									NONE	0 5 0 0 0
1 0	1 2	8 9	8 9	--- 0 2 5	--- 0 0	1 1	1 3	8 9		0 5 0 0 0

OPERATING MODE (9)	1
POWER LEVEL (10)	0 9 0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10CFR (Check one or more of the following) (11)

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LICENSEE CONTACT FOR THIS LER (12)

Name	TELEPHONE NUMBER AREA CODE
H. E. Morgan, Station Manager	7 1 4 3 6 8 - 6 2 4 1

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

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS

SUPPLEMENTAL REPORT EXPECTED (14)	Expected Submission Date (15)	Month	Day	Year
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IE22

Plant: San Onofre Nuclear Generating Station
Unit: One
Reactor Vendor: Westinghouse
Event Date: 10-12-89
Time: Approximately 1445

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Mode: 1, Power Operation

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Following depletion of the RWST, the Recirculation System (RS) [BP] provides core cooling for extended periods following design basis accidents and is initiated after a sufficient quantity of water has accumulated in the containment sump. Two recirculation pumps take suction from the containment sump and discharge to a common header, through the Recirculation Heat Exchanger, to the suction of the charging pumps [CB,P] for recirculation to the RCS and to the suction of the refueling water pumps for recirculation to the containment spray system. Recirculation of the RCS is by means of Cold Leg Recirculation (CLR) or Hot Leg Recirculation (HLR) as described below.

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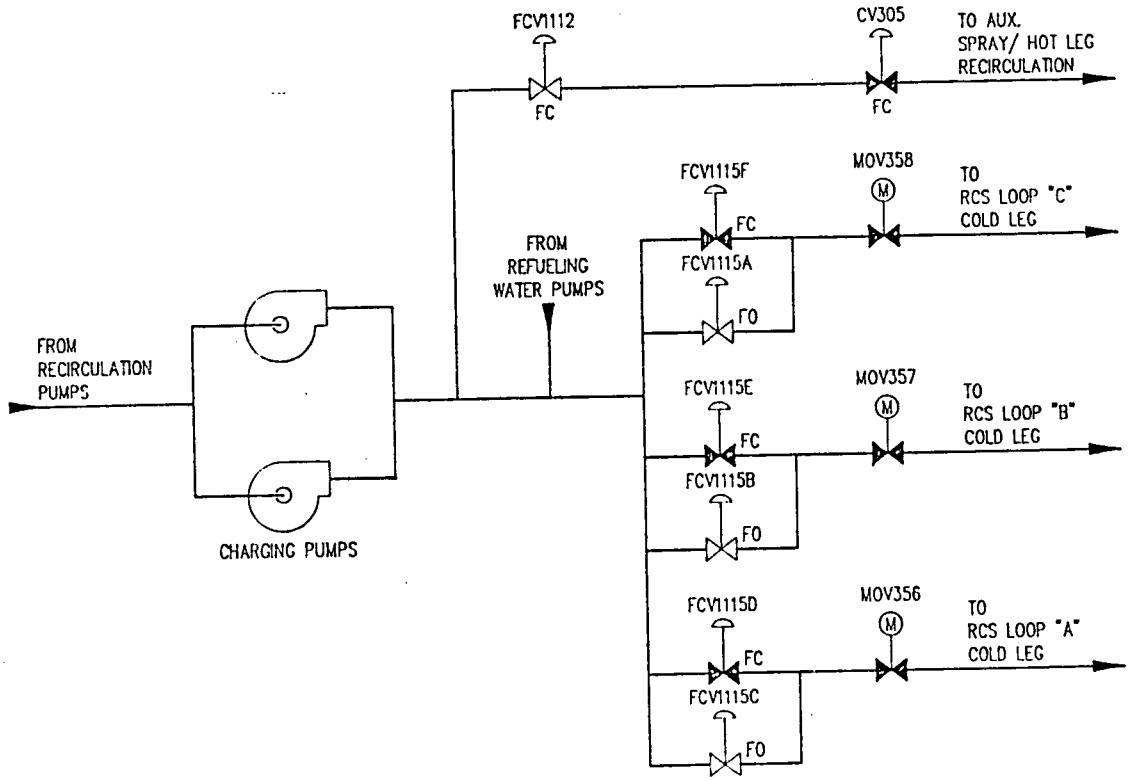

FIGURE 1

Hot Leg Recirculation:

For a postulated LOCA in one of the RCS hot legs, once the core has been re-flooded, the CLR flow path delivers borated water from the SI and RS to the reactor downcomer, up through the core and out the ruptured hot leg. However, for a postulated LOCA in one of the cold legs, the CLR flow path results in borated water preferentially flowing around the reactor downcomer and out the ruptured cold leg without passing through the core. Flow to the core is limited to that flow which is required to make up for boil-off in the core, and to maintain an equal static head between the downcomer and core regions. A lack of mixing of the fresh injection water and the water in the core would result in the accumulation of boric acid in the core region until saturation concentrations are reached, and boric acid begins to precipitate out of solution. HLR is the currently accepted method of preventing boron precipitation in the core during long term cooling following a cold leg LOCA. HLR is accomplished by either a primary flow path or an alternate flow path as described below.

Primary HLR:

The primary HLR flow path uses the recirculation pumps and heat exchanger. From here flow is directed to the charging pumps which discharge to FCV-1112 (charging flow control valve) and CV-305 (pressurizer auxiliary spray valve) to the pressurizer and into RCS loop B hot leg (see figure 1). FCV-1112 is a normally open valve to allow charging flow to the RCS for inventory control. CV-305 is a normally closed valve which is required to be open for HLR. Both valves are pneumatically operated and designed to open with instrument air applied to the valve operator and close when instrument air is vented from the valve operator.

Alternate HLR:

The primary HLR flow path is susceptible to a single active failure because there are points where flow passes through a single valve. To protect against the consequences of such a single active failure, an alternate HLR flow path is provided. Recirculated coolant from the discharge of the refueling water pumps enters the Residual Heat Removal (RHR) heat exchanger outlet. Coolant then flows in the reverse direction through the RHR heat exchangers, through a bypass line around the east RHR pump, and into the loop "C" hot leg (see figure 2).

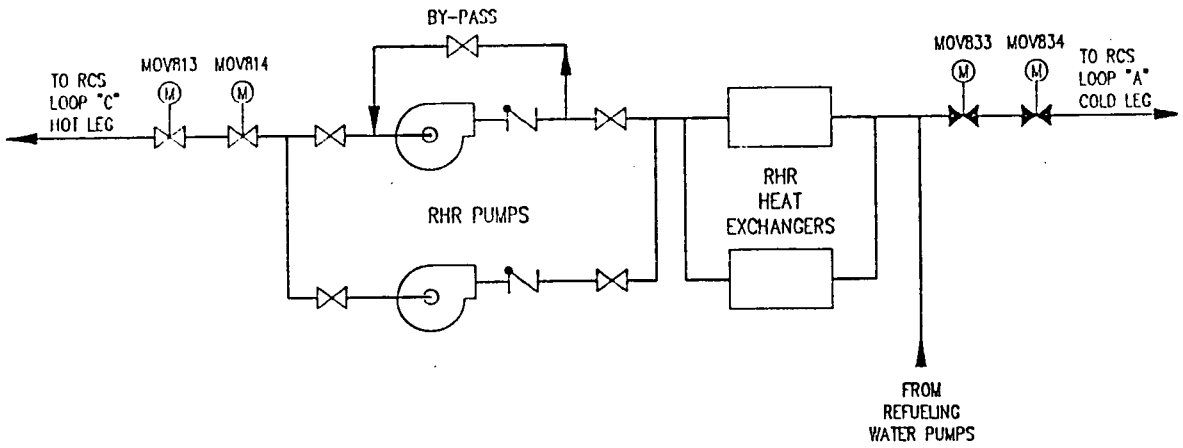

FIGURE 2

HLR Requirement:

In March 1975, the NRC requested information concerning the potential for boron precipitation during long term cooling subsequent to a LOCA. In July 1975, SCE responded, crediting HLR flow via the pressurizer auxiliary spray path (i.e., charging system valves FCV-1112 and CV-305) as preventing post-LOCA boron precipitation. Current analysis shows that HLR must be initiated within 15 hours post-LOCA to perform this function.

Single Failure Criteria For HLR:

In December 1976, a single failure analysis of the emergency core cooling system (ECCS) was completed which identified system modifications to eliminate single point failures in the HLR flow path. In March 1977, an alternate HLR flow path was identified as an interim modification to provide HLR in the event of a LOCA in one of the cold legs and the single failure of one of the valves in the primary HLR flow path. This interim modification was installed prior to restart, and the NRC accepted this as a long-term solution in October 1978 (documented in NRC letter to SCE, dated, October 16, 1978, re: ECCS Single Failure Modifications). At that time, the IAS at Unit 1 was credited for providing air to all ECCS components following a pipe break in containment.

Backup Nitrogen Systems (BNS):

The BNS are seismically qualified automatic backups for the non-safety related Instrument Air System (IAS) [LD]. These BNSs are utilized for selected safety related components (e.g., pneumatic valves) that are required to support the safe shutdown and accident mitigation functions of Unit 1. Each of the BNSs is comprised of nitrogen cylinders, valving, pressure regulator(s), check valves and interconnecting piping between these components, the IAS (normally), and the supplied component(s). When the IAS pressure drops below the BNS pressure regulator set point, the BNS provides the required backup for maintaining operating pressure to the supplied component(s). Normally, check valves are installed to prevent nitrogen from flowing into the IAS via the IAS supply line and, alternately, instrument air from flowing into the BNS.

Other Features of the Air System Supporting HLR:

There are three normal air compressors, powered from redundant safety related busses which supply the IAS. Additionally, the auxiliary air compressor, also powered from a safety related bus, would start automatically on low pressure to supply the redundant air header portion of the air system. Thus, the redundant air header, which serves in part, FCV-1112 and CV-305, is a highly reliable source of instrument air. However, the IAS is non-safety related, Seismic Category B, and therefore not normally credited for design basis accident mitigation.

Long Term Seismic Upgrade Program:

San Onofre Unit 1 was evaluated for seismic adequacy as part of the NRC's Systematic Evaluation Program (SEP). SCE upgraded the plant to a 0.67g ground acceleration seismic criteria. The upgrade was done in two parts. During the first part, The Return To Service Program, all systems necessary to bring the plant to a safe hot standby condition were upgraded. During the second part, The Long Term Service Program, all accident mitigation systems and cold shutdown systems were also upgraded. The HLR flow path was seismically upgraded as part of the Long Term Service Program. However, a BNS was not installed for either CV-305 or FCV-1112 as part of the HLR system upgrade.

C. DESCRIPTION OF THE EVENT:

1. Event:

On October 12, 1989, at approximately 1445, as part of the review following the report of the susceptibility of CV-517 and CV-518 (Containment Spray System flow restricting valves; see LER 89-024, Docket No. 50-206) to a common cause loss of instrument air subsequent to a design basis accident, it was also determined that the primary HLR function is susceptible to a loss of instrument air. The specific components involved are pneumatically operated valves CV-305 and FCV-1112. Both valves are designed to open with instrument air applied to the valve operator and close when instrument air is vented from the valve operator. The Primary HLR flow path requires both CV-305 and FCV-1112 to be open. On a loss of instrument air, CV-305 and FCV-1112 would fail closed, thus preventing HLR primary flow. A concurrent failure of the alternate HLR path could result in loss of all HLR capability, resulting in a condition where boron precipitation in the core region could possibly occur. Based on a safety evaluation which was performed to assess the safety significance of this configuration, SCE considered that it was acceptable to operate Unit 1 until the end of October 1989 (see section F, "Safety Significance of the Event").

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

   Not applicable.

3. Sequence of Events:

   Not applicable.

4. Method of Discovery:

   The susceptibility of the primary HLR to a loss of IAS was discovered during a review being performed in response to a previous finding, reported in LER 89-024, Docket No. 50-206.

5. Personnel Actions and Analysis of Actions:

   Not applicable.

6. Safety System Responses:

   Not applicable.

D. CAUSE OF THE EVENT:

Immediate Cause:

A BNS was not provided to CV-305 or FCV-1112 when the HLR flow path was upgraded as part of the Long Term Service (LTS) seismic program.

Root Cause:

The root cause of this event is attributed to weaknesses in the licensing support to San Onofre, as discussed in detail in SCE's October 3, 1988, letter to the NRC regarding this subject. After performing a thorough historical search of the design and licensing history of this issue, SCE has been unable to determine what basis was developed to support the absence of a BNS for these valves. Our inability to substantiate the acceptability of the existing design for these valves is considered a weakness in the licensing support to the operation of San Onofre Nuclear Generating Station (SONGS), Unit 1.

E. CORRECTIVE ACTIONS:

1. Corrective Actions Taken:

   a. Unit 1 was shutdown on November 1, 1989, to install a nitrogen backup supply to the IAS for CV-305 and FCV-1112.

b. The Failure Mode and Effects Analysis (FMEA) conducted on various BNS used for safety related valves has been revalidated and no additional discrepancies or appropriate enhancements were identified other than noted below under G.2, "Additional Information".

2. Planned Corrective Actions:

a. The corrective actions identified in SCE's October 3, 1988, submittal (and in several LER's which have identified other related issues) to the NRC concerning engineering and technical work are also applicable to the root cause of this condition.

b. The response to Generic Letter 88-14, "Instrument Air Supply System Problems Affecting Safety-Related Equipment", dated August 8, 1989, is currently being prepared and will be submitted to confirm the acceptability of the pneumatic supply to all pneumatic valves that are used in a safety related application.

F. SAFETY SIGNIFICANCE OF THE EVENT:

A limited probabilistic risk assessment was performed to compare the probability of core melt with and without backup nitrogen for the primary path HLR valves, considering potential common-cause failures and no backup means of preventing boron precipitation in the core. The results of this analysis indicate that the lack of backup nitrogen for these valves does not result in a significant increase in the overall probability of core melt for SONGS 1. Specifically, the probability of core melt due to a cold leg LOCA and loss of both HLR flow paths was determined to be 5.85E-05 per year. The probability of core melt assuming backup nitrogen is available was determined to be 2.37E-05 per year. This change in risk is small compared with the base SONGS 1 risk for LOCAs of 3.3E-04 per year.

Additionally, a Westinghouse analysis has been completed which demonstrates that reflux condensation in the Steam Generators (S/Gs) will prevent boron precipitation in the core during long term cooling. Reflux condensation occurs when RCS forced circulation is lost. Over time, steam will form in the core region and will rise from the core into the S/Gs. The steam will then condense in the S/Gs and will flow back down the hot leg, traveling down the outer fuel assemblies and rising through the center of the core. This circulating flow is of sufficient magnitude that RCS mixing in the core region occurs and boron precipitation is prevented.

It can therefore be concluded that the failure to provide CV-305 and FCV-1112 with backup nitrogen was of little safety significance.

G. ADDITIONAL INFORMATION:

1. Component Failure Information:

Not applicable.

2. Charging Flow Control Valves (FCVs) FCV-1115 D, E, and F:

During the HLR design basis review, the BNS design for the charging flow control valves FCVs-1115 D, E, and F, which provide an injection pathway for CLR (see Part B, Background Information for a discussion of CLR) was reviewed.

It was determined from this review that these valves, even though provided with a BNS, would not be able to perform their safety function in the event of a loss of IAS in combination with the loss of Train "B" control power. Specifically, upon a loss of Train "B" control power, the solenoid valves which switch the air and/or nitrogen to FCV-1115 D, E, and F, coincident with the loss of the IAS, nitrogen to the FCV's would be isolated, resulting in FCV-1115 D, E, and F closure and isolation of cooling flow to the cold leg via this flow path. However, parallel RCP seal injection valves FCV-1115 A, B, and C would fail open on a loss of IAS. As a result, a reduction in cold leg recirculation flow would occur.

The existing configuration of this system was evaluated by SCE and the NRC as part of their review of Systematic Evaluation Program (SEP), Topic VI-7.C.2, Failure Mode Analysis (Emergency Core Cooling System). The results of the review are documented in the Integrated Plant Safety Assessment, NUREG-0829 dated December 1986. A thorough review of the licensing history of this system, which included the SEP and IPSAR, was recently performed in order to determine the design and licensing basis for cold leg recirculation. Thus far, this review has failed to identify the basis upon which this configuration was considered acceptable. SCE has concluded that continued research efforts in this area is unlikely to result in a significantly better understanding of the original requirements. Therefore, regardless of whether the licensing history would support the acceptability of the current design, SCE is installing design changes to eliminate the identified vulnerability. This modification is being installed during the current outage.

3. Previous LERs for Similar Events:

Recent LERs reporting similar design and design control related conditions:

Unit 1 (Docket No. 50-206)

LER 1-86-007, Revision 1, reported a single failure susceptibility of the RPS.

LER 1-87-015, Revision 1, reported that certain ESF systems were susceptible to single failure.

LER 1-88-001 reported that several components requiring environmental qualification were not included in the administrative controls for the environmentally qualified equipment. Additionally, other components were found to be in an unqualified configuration.

LER 1-88-006, Revision 1, reported a condition where the Unit 1 backup nitrogen systems (as designed, installed and operated) did not satisfy the licensing and design basis for the systems.

LER 1-88-009, Revision 1, reported a condition in which the emergency diesel generators could have exceeded an intended electrical load limit.

LER 1-88-016 reported a condition in which the south refueling water pump may not have started as required.

LER 1-88-017 reported a condition in which the auxiliary feedwater storage tank minimum volume requirements for accident mitigation may have been inadequate.

LER 1-88-019 reported that design deficiencies existed in automatic controls of the electrical power distribution system.

LER 1-88-020 reported that design requirements of NUREG-0737 had not been fully implemented in the design of the steam generator wide-range level indication system.

LER 1-89-003 reported a condition in which the failure mode of Component Cooling Water was non-conservative with respect to design requirements due to inadequate single failure analysis.

LER 1-89-004 reported that due to a design deficiency associated with diesel generator load sequencing logic, the automatic response capability of one of the two trains of safety-related components during a postulated SISLOP scenario may be lost.

LER 1-89-007 reported single failure susceptibility of the Reactor Protection System in the event of a Reactor Coolant Pump locked rotor.

LER 1-89-008 reported the remote possibility of a single failure which could divert cooling water from the Containment Spray System to the Containment Fire Suppression System during recirculation, thus reducing the effectiveness of the Containment Spray System.

LER 1-89-011 reported various conditions resulting in a reduction in Safety Injection delivery to the Reactor Coolant System below that assumed during certain accident scenarios.

LER 1-89-013 reported that the Power Operated Relief Valves were not included in the Inservice Testing program for their Overpressure Mitigation System function.

LER 1-89-022 reported that the Technical Specifications governing the Overpressure Mitigation System permitted non-conservative plant operation.

LER 1-89-024 reported a condition that could result in a reduction in containment spray flow thereby, reducing the effectiveness of the Containment Spray System.

Unit 2 (Docket No. 50-361)

LER 2-88-008, Revision 1, reported various conditions resulting in the component cooling water system being outside its design basis due to design control program deficiencies.

LER 2-88-010 reported a condition in which both emergency chillers were rendered inoperable as a result of not addressing freon level as a critical design parameter.

LER 2-88-017 reported that a spent fuel pool siphon event occurred as a result of the failure to transfer the design intent to utilize administrative controls on certain locked valves.

LER 2-88-034 reported a condition involving safety related Component Cooling Water System valves being susceptible to seismically-induced common mode failures.

4. Results of NPRDS Search:

Not applicable.