Southern California Edison Company

SAN ONOFRE NUCLEAR GENERATING STATION

P. O. BOX 128

SAN CLEMENTE, CALIFORNIA 92674-0128

R. W. KRIEGER
STATION MANAGER

TELEPHONE
(714) 368-6255

January 7, 1991

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

Subject: Docket No. 50-361
30-Day Report
Licensee Event Report No. 90-016
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 an automatic reactor trip. 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. 90-016

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

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 0 7

Title (4)

UNIT 2 AUTOMATIC REACTOR TRIP DUE TO NON-1E UNINTERRUPTIBLE POWER SYSTEM FAILURE

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)
1 2	0 6	9 0	9 0	0 1 6	0 0	0 1	0 7	9 1	NONE	0 5 0 0 0
										0 5 0 0 0

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

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

___ 20.402(b)	___ 20.405(c)	X 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 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)	

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	MANUFACTURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS
B	E E	C A P	X 9 9 9	Y	X	B U	A S U	S 2 5 0	Y
X	A B	3 3	G 0 8 0	Y					

SUPPLEMENTAL REPORT EXPECTED (14)		Expected Submission Date (15)	Month	Day	Year
XX Yes (If yes, complete EXPECTED SUBMISSION DATE)	___ NO		1 0	3 1	9 1

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

At 2200 on December 6, 1990, Unit 2 automatically tripped from 100% power on a reactor protection system loss of load (LOL) signal. The LOL signal was caused by a turbine trip, which occurred as a result of a momentary loss of power from the non-1E uninterruptible power system (UPS), momentarily de-energizing bus Q-069. Emergency Feedwater Actuation System (EFAS) 1 and EFAS 2 actuations properly occurred. One 6.9 KV bus did not automatically transfer to offsite power following the trip, de-energizing 2 reactor coolant pumps (RCPs); two other RCPs continued to provide forced circulation. Approximately 1 to 2 minutes following the trip, a complete loss of power on Q-069 occurred. Appropriate actions were initiated in accordance with procedures to compensate for the operation of control systems which were affected by the loss of power on Q-069. One main steam safety valve for each steam generator may have lifted for a short time and properly reseated. Bus Q-069 power was restored at 2220 via the manual bypass switch. Recovery of the plant otherwise proceeded normally.

It is postulated that failure of 1) a capacitor in the non-1E UPS inverter output and 2) a transistor in the static switch transfer logic control circuit combined to cause the loss of power on bus Q-069 (both at the onset of the event and at 1-2 minutes post-trip). The root cause evaluation is continuing.

The failed capacitor was replaced, and the static switch was rebuilt with new parts. The manufacturer of the non-1E UPS determined that the design of the capacitor which failed is defective; therefore, all such capacitors will be replaced with capacitors of an upgraded design. Failed electronic parts will undergo failure analysis; additional corrective actions will be implemented as necessary based on the results of the analysis. SCE will consider implementing a design change to reduce the likelihood of a reactor trip due to loss of power on Q-069.

Plant: San Onofre Nuclear Generating Station
Unit: Two
Reactor Vendor: Combustion Engineering
Event Date: 12-6-90
Time: 2200

A. CONDITIONS AT TIME OF THE EVENT:

Mode: 1, Power Operation

B. BACKGROUND INFORMATION:

1. Non-1E Uninterruptible Power System (UPS) [EE]:

Non-1E instruments and control systems are energized by non-1E instrument bus [BU] Q-069. Q-069 is supplied power from either UPS inverter [INVT] Y-012 (normal source) or 480 VAC load center B-12 [EC, SWGR] (alternate source). On a loss of power from the inverter, the non-1E UPS static switch [ASU] automatically transfers bus Q-069 to the alternate source without power interruption. Q-069 can also be energized directly from B-12 via a manual bypass switch [HS].

2. Reactor Coolant Pump (RCP) Power Supply:

Two 6.9 KV buses [EA] supply power to the four RCPs [AB, P] (two RCPs on each bus). During normal power operation, the RCP buses are energized by the output of the main generator [EL]. In response to a turbine [TA, TG] trip, the RCP buses are automatically transferred from the generator output to offsite power [FK].

The logic for automatic energization of an RCP 6.9 KV bus from offsite power does not allow automatic closure of the bus supply circuit breaker [52] unless the breaker is in its racked-in position. When the breaker is racked-in, a mechanical linkage operates a switch contact [33] which signals the breaker closure logic that the breaker is racked-in.

3. Steam Bypass Control System (SBCS) [JI]:

The SBCS is provided to limit an increase in steam generator (SG) [SG] pressure which can occur following plant transients such as a turbine trip. The SBCS controls SG pressure by venting steam from the SGs to the main condenser [SG, COND]. The SBCS consists of four valves [V], associated piping, and control circuitry. A "Quick Open" signal is generated by the SBCS control circuitry to rapidly open all four valves in response to an abrupt decrease in steam flow, which occurs following a turbine trip. After the SBCS valves quick open, they modulate steam flow in order to maintain the SGs at setpoint pressure. The SBCS control circuitry is energized by Q-069.

C. DESCRIPTION OF THE EVENT:

1. Event:

At 2200 on December 6, 1990, Unit 2 automatically tripped from 100% power on a reactor protection system (RPS) [JC] loss of load (LOL) signal. The LOL signal was caused by a turbine trip, which occurred as a result of a momentary interruption in power to non-1E bus Q-069. Emergency Feedwater Actuation System (EFAS) [BA] 1 and EFAS 2 actuations occurred (as expected) due to the SG level "shrink" in response to the reactor trip; proper EFAS component response was verified. One 6.9 KV bus (A02) did not automatically transfer to offsite power following the trip, de-energizing two RCPs. The other 6.9 KV bus automatically transferred to offsite power; thus, the other two RCPs continued to provide forced reactor coolant circulation following the reactor trip.

As a result of the momentary loss of power on Q-069, SBCS control power was interrupted and the SBCS signal for the SBCS valves to "quick open" was not generated. However, when power was restored, the SBCS control system modulated the valves open to limit peak SG pressure and reduce pressure to the setpoint value (after which the SBCS valves closed).

Approximately 1 to 2 minutes following the trip, power to bus Q-069 was again interrupted, resulting in a complete loss of power to the non-1E loads. The resultant de-energization of the SBCS control circuitry prevented the valves from re-opening; as a consequence, SG pressure steadily increased during the next several minutes. Control room operators (utility, licensed) opened the atmospheric dump valves (ADVs) [SB] to reduce SG pressure. SG pressure peaked several seconds later at approximately the lift setpoint pressure of the first main steam safety valve (MSSV) [RV] for each SG; one MSSV for each SG may have briefly lifted and properly reseated.

Appropriate actions were taken in accordance with procedures to compensate for the operation of control systems which were affected by the loss of power on bus Q-069. Bus Q-069 was re-energized at 2220 from the alternate power source via the manual bypass switch. Post-trip plant recovery otherwise proceeded normally.

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

None.

3. Sequence of Events:

TIME	ACTION
2200	Unit 2 reactor tripped due to momentary de-energization of bus Q-069.
2202 (approx.)	Complete interruption in power to Q-069 occurred. Several minutes later, operators opened ADVs to control SG pressure; one MSSV for each SG may have lifted.
2220	Bus Q-069 re-energized by connection to the alternate source using the manual bypass switch.

4. Method of Discovery:

Control room indications and alarms alerted the operators to the reactor trip and de-energization of bus Q-069.

5. Personnel Actions and Analysis of Actions:

The operators responded properly to the reactor trip, verified proper operation of EFAS, and stabilized plant conditions in accordance with applicable procedures.

6. Safety System Responses:

The RPS and EFAS, and all actuated components operated as designed.

D. CAUSE OF THE EVENT:

1. Immediate Cause:

The reactor tripped on a LOL signal. A momentary interruption in phase "A" power to non-1E bus Q-069, coupled with a probable resultant disturbance to the other phases, resulted in a loss of power to the main turbine electronic governor [TG] which initiated a turbine trip and closure of the high pressure stop valves (HPSV) [ISV]. Closure of the HPSVs resulted in low hydraulic pressure in the associated unitized actuators [HCU], generating the LOL signal.

2. Root Cause:

Following the trip, an inspection of the non-1E UPS revealed that the inverter phase "A" output fuse [FU] was blown and the alternate source breaker to the static switch was tripped. Subsequent investigation found that the following components had failed: 1) a capacitor [CAP] in the constant voltage transformer (CVT) [XFMR] section of the non-1E UPS phase "A" inverter output, and 2) a transistor in the static switch transfer logic control circuit

board. Upon loss of inverter Y-012 output, this transistor initiates the static switch transfer of bus Q-069 from its normal source (inverter) to the alternate source. During the transfer sequence, the 2 sources are connected in parallel for a short moment (up to 1/2 cycle).

It is postulated that the following scenario occurred: The inverter CVT capacitor short circuited, resulting in the initial disturbance and eventual loss of the inverter output. A pre-existing fault of the transistor in the static switch control board caused a two minute delay in the transfer to the alternate source. During the transfer, with the inverter and the alternate sources connected in parallel, the high short circuit current through the capacitor caused the inverter phase "A" output fuse to blow and the alternate source feeder breaker to trip. These last two occurrences resulted in a complete loss of power on bus Q-069.

The root cause evaluation is continuing in order to confirm that the failure of the capacitor and transistor are the causes of the non-1E bus de-energization. A supplemental LER will be submitted should this evaluation identify root cause information different than that described above.

E. CORRECTIVE ACTIONS:

1. Corrective Actions Taken:

The failed capacitor was replaced with a capacitor of an improved design. The static switch was rebuilt with new parts (including replacement of the transfer logic control circuit board).

2. Planned Corrective Actions:

a. The manufacturer of the non-1E UPS determined that the capacitors of the model which failed in this event are defective (see section G.1 for additional information); therefore, all capacitors of this defective model will be replaced with capacitors of an upgraded design. The UPS vendor has provided these capacitors only in non-1E inverters at Units 2 and 3.

b. The failed static switch control circuit board has been sent to the manufacturer for further failure analysis. In addition, the failed transistor and capacitor have been sent to an independent failure analysis laboratory to determine their failure mechanism. Any applicable corrective actions will be implemented based on the results of these failure analyses.

c. SCE will consider a design change to provide redundant power supplies to critical loads in order to reduce the likelihood of a reactor trip due to de-energization of Q-069.

F. SAFETY SIGNIFICANCE OF THE EVENT:

There is no safety significance to this event since all safety and protective systems operated in accordance with the design.

G. ADDITIONAL INFORMATION:

1. Component Failure Information:

The failed 13 microfarad capacitor (part no. CDE KBXK1056PI or SCI 020138), was manufactured by Cornell-Dublier Electric (CDE). In 1983, the manufacturer of the non-1E UPS, Solidstate Controls, Inc. (SCI) identified a generic manufacturing defect and inadequate design of this capacitor model (which were manufactured in 1981, 1982, and 1983). These deficiencies resulted in a high rate of capacitor short circuits.

SCI discontinued use of this capacitor in August 1983 and recommended their replacement with part no. SCI 020139, which is a dual capacitor design in one container. This dual capacitor design prevents a single capacitor short circuit from causing the inverter output to fail.

This information was detailed in a failure analysis report by SCI (dated August 1983). This report also identified 26 industry incidents attributable to capacitor failures, six of which resulted in a complete loss of power to the UPS bus, similar to the event described in this Licensee Event Report.

Until this event, SCE was unaware of the aforementioned history of defective capacitors. SCI indicated that they had informed both the NRC and customers who utilized the capacitors in Class 1E inverters of the high rate of capacitor failures in early 1985. SCI indicated to SCE that since SCE utilized the capacitors in a non-Class 1E system, SCE had possibly not been notified of the capacitor problems.

SCE has subsequently emphasized to SCI the need to be informed of defects in components utilized in any application at SONGS. SCE will perform a review of our vendor information program to identify possible enhancements; these enhancements will be implemented as appropriate.

The failed transistor was part of the static switch transfer logic control circuit board (part no. SCI PC201), manufactured by SCI.

2. Previous LERs for Similar Events:

There have been several events at SONGS involving the non-1E UPS (most recently LER 89-001 [Docket No. 50-362]); however, none of those events involved a failure similar to that which caused the event described in this report.

3. RCP Bus Transfer:

The cubicle for the Bus A02 offsite power supply breaker was inspected following the plant trip. The inspection revealed a bent linkage associated with the breaker position switch; this was determined to have prevented the automatic transfer of Bus A02. No cause for the bent linkage could be identified. The breaker position switch linkage was straightened, and proper operation of the automatic transfer scheme was verified. Our preliminary investigation was unable to determine the cause of the bent linakge. Our investigation into this aspect of the event is continuing; the results of which will be reported in a supplement to this LER.

4. Sequence of Events (SOE) Computer Printout:

The plant computer [ID] generates an SOE report for significant transients such as reactor trips. The SOE report provides information used to determine or confirm the cause of the transient. In this particular event, the SOE report contained information which is anomalous. Specifically, the SOE report recorded that the LOL trip occurred after four of the eight reactor trip breakers opened. However, SCE's post-trip review concluded that the reactor protection system responded to a LOL signal. Our preliminary investigation has been unable to determine the cause of the out-of-sequence record. It is believed that the LOL signal did not start the SOE recorder. Our investigation into this aspect of the event is continuing; the results of the investigation will be reported in a supplement to this LER.