Southern California Edison Company

SAN ONOFRE NUCLEAR GENERATING STATION

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June 3, 1992

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

Subject: Docket No. 50-361
Supplemental Report
Licensee Event Report No. 90-016, Revision 1
San Onofre Nuclear Generating Station, Unit 2

Reference: Letter, R. W. Krieger (SCE) to USNRC Document Control Desk, dated January 7, 1991

The referenced letter provided Licensee Event Report (LER) No. 90-016, (Revision 0), for an occurrence involving an automatic reactor trip due to a non-1E uninterruptible power system failure. The enclosed supplemental LER provides additional information concerning the cause and corrective actions taken. 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, Rev. 1

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)

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LICENSEE EVENT REPORT (LER)

Facility Name (1)	Docket Number (2)	Page (3)
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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 1 6	0 1	0 6	0 3	9 2	NONE	0 5 0 0 0
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OPERATING MODE (9)	1	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10CFR (Check one or more of the following) (11)					
POWER LEVEL (10)	1 0 0	___ 20.402(b)	___ 20.405(c)	X 50.73(a)(2)(iv)	___ 73.71(b)		
//////////////////////		___ 20.405(a)(1)(i)	___ 50.73(a)(2)(i)	___ 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
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	MANUFACTURER	REPORTABLE TO NPRDS	//////	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	//////
B	E I 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
___ Yes (If yes, complete EXPECTED SUBMISSION DATE) ___ XX NO				

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 non-1E instrument 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 was determined that failure of a capacitor in the non-1E UPS inverter output caused the loss of power on bus Q-069. The manufacturer of the non-1E UPS determined that the design of the capacitor which failed was defective; therefore, all such capacitors in the Unit 2 and 3 non-1E UPSs have been replaced with an upgraded model. The Unit 2 and 3 instrument busses powered by the non-1E UPS have also been modified to prevent a total power loss to critical systems (i.e., feedwater, turbine governor, and control element drive mechanism systems) in the event of similar failures, thus reducing the likelihood of plant trips.

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 transferred to 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 Con tributed 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 a capacitor [CAP] in the constant voltage transformer (CVT) [XFMR] section of the non-1E UPS phase "A" inverter output had failed.

It has been determined that the most likely cause of the non-1E UPS failure was due to a capacitor short circuit at the phase "A" inverter output. The inverter CVT capacitor short circuited, resulting in the initial disturbance and eventual loss of the inverter output. A pre-existing transistor intermittent fault 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 most likely cause for the intermittent transistor failure was attributed to dust and dirt accumulation on the printed circuit board which is mounted in a dust prone environment. The dust and dirt was found to be conductive (measured at about 1 mega-ohm per inch). The capacitor failure was due to age degradation of the low quality dielectric material used in the capacitor fabrication (refer to Section G.1 below for details).

E. CORRECTIVE ACTIONS TAKEN:

1. 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. All remaining Unit 2 and 3 non-1E UPS original design CVT capacitors have been replaced with capacitors of the improved design.

3. To prevent circuit board dust and dirt accumulation, the preventive maintenance program has been modified to require periodic cleaning of the non-1E UPS cabinet internals during each refueling outage.

4. The preventive maintenance program has been modified to require replacement of the CVT capacitors every third refueling outage.

5. The Unit 2 and 3 instrument busses powered by the non-1E UPS have also been modified to prevent a total power loss to critical systems (i.e., feedwater, turbine governor, and control element drive mechanism systems) in the event of similar failures, thus reducing the likelihood of plant trips.

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 was 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 has two capacitor cells connected in series such that a single cell short circuit failure will not cause the inverter output to drop to zero.

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.

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 (e.g., 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.

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 was 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 investigation has determined the anomalous information to be the result of an instrument sensitivity limitation. Change of state input signal transitions may be delayed by as much as 25 milliseconds before being recognized, therefore, input pulses of less than 25 millisecond durations may not be sensed by the SOE recorder. Corrective action was not deemed necessary due to the infrequent occurrence of this type event and the limited benefit that could be achieved by improving instrument sensitivity.

As a result of this anomaly, appropriate personnel will be trained on this issue in order to obtain a better understanding of the SOE recorder limitations when utilized as a post-trip review investigative tool.