



**UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
611 RYAN PLAZA DRIVE, SUITE 400
ARLINGTON, TEXAS 76011-8064**

July 19, 2002

Harold B. Ray, Executive Vice President
Southern California Edison Co.
San Onofre Nuclear Generating Station
P.O. Box 128
San Clemente, California 92674-0128

**SUBJECT: SAN ONOFRE NUCLEAR GENERATING STATION SPECIAL INSPECTION
REPORT 50-361/02-08; 50-362/02-08**

Dear Mr. Ray:

On April 26, 2002, the NRC completed a special inspection at your San Onofre Nuclear Generating Station (SONGS). The enclosed report presents the results of this inspection which were discussed with Mr. Nunn and other members of your staff.

The inspection examined activities associated with a loss of offsite power to SONGS, Unit 3, on February 27, 2002, which resulted from maintenance activities in the San Diego Gas & Electric portion of the switchyard. The inspection focused on the root cause and extent of the condition of the event, the corrective actions taken, and your staff's actions immediately following the event. The inspectors reviewed selected procedures and records, observed restoration and evaluation activities, and interviewed plant personnel. As a result of this event, the NRC has developed a sequence of events, assessed the risk significance of the overall event, and assessed the quality of response of your plant staff and managers. The long-term actions to prevent recurrence will be evaluated separately.

Based on the results of this inspection, the NRC has identified a finding that involved the failure by plant personnel to provide adequate oversight of switchyard maintenance activities. Licensee compensatory measures are in place while long-term corrective actions are being implemented. This finding was evaluated under the risk significance determination process as having very low safety significance.

The NRC has increased security requirements at SONGS in response to terrorist acts on September 11, 2001. Although the NRC is not aware of any specific threat against nuclear facilities, the NRC issued an Order and several threat advisories to commercial power reactors to strengthen licensees' capabilities and readiness to respond to a potential attack. The NRC continues to monitor overall security controls and will issue temporary instructions in the near future to verify by inspection the licensee's compliance with the Order and current security regulations.

In accordance with 10 CFR 2.790 of the NRC's "Rules of Practice," a copy of this letter and its enclosure will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/adams.html> (the Public Electronic Reading Room).

Sincerely,

/RA/ by Phil Harrell acting for

Claude Johnson, Chief
Project Branch C
Division of Reactor Projects

Dockets: 50-361
50-362
Licenses: NPF-10
NPF-15

cc w/enclosure:
Chairman, Board of Supervisors
County of San Diego
1600 Pacific Highway, Room 335
San Diego, California 92101

Gary L. Nolf
Power Projects/Contracts Manager
Riverside Public Utilities
2911 Adams Street
Riverside, California 92504

Eileen M. Teichert, Esq.
Supervising Deputy City Attorney
City of Riverside
3900 Main Street
Riverside, California 92522

Joseph J. Wambold, Vice President
Southern California Edison Company
San Onofre Nuclear Generating Station
P.O. Box 128
San Clemente, California 92674-0128

David Spath, Chief
Division of Drinking Water and
Environmental Management
California Department of Health Services
P.O. Box 942732
Sacramento, California 94234-7320

Michael R. Olson
San Onofre Liaison
San Diego Gas & Electric Company
P.O. Box 1831
San Diego, California 92112-4150

Ed Bailey, Radiation Control Program Director
Radiologic Health Branch
California Department of Health Services
P.O. Box 942732 (MS 178)
Sacramento, California 94234-7320

Steve Hsu
Radiologic Health Branch
State Department of Health Services
P.O. Box 942732
Sacramento, California 94327-7320

Mayor
City of San Clemente
100 Avenida Presidio
San Clemente, California 92672

Robert A. Laurie, Commissioner
California Energy Commission
1516 Ninth Street (MS 31)
Sacramento, California 95814

Douglas K. Porter, Esq.
Southern California Edison Company
2244 Walnut Grove Avenue
Rosemead, California 91770

Dwight E. Nunn, Vice President
Southern California Edison Company
San Onofre Nuclear Generating Station
P.O. Box 128
San Clemente, California 92674-0128

Southern California Edison Co.

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Dr. Raymond Waldo
Southern California Edison Company
San Onofre Nuclear Generating Station
P. O. Box 128
San Clemente, California 92674-0128

A. Edward Scherer
Southern California Edison
San Onofre Nuclear Generating Station
P.O. Box 128
San Clemente, California 92674-0128

Electronic distribution by RIV:
 Regional Administrator **(EWM)**
 DRP Director **(KEB)**
 DRS Director **(ATH)**
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 Branch Chief, DRP/C **(CEJ1)**
 Senior Project Engineer, DRP/C **(RVA)**
 Staff Chief, DRP/TSS **(PHH)**
 RITS Coordinator **(NBH)**
 Scott Morris **(SAM1)**
 SONGS Site Secretary **(SFN1)**
 Dale Thatcher **(DFT)**

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ENCLOSURE

U.S. NUCLEAR REGULATORY COMMISSION

REGION IV

Dockets: 50-361
50-362

License: NPF-10
NPF-15

Report: 50-361/02-08
50-362/02-08

Licensee: Southern California Edison Co.

Facility: San Onofre Nuclear Generating Station, Units 2 and 3

Location: 5000 S. Pacific Coast Hwy.
San Clemente, California

Dates: April 22-26, 2002

Inspector: R. V. Azua, Senior Project Engineer
Project Branch C
Division of Reactor Projects

Approved By: C. E. Johnson, Chief, Project Branch C
Division of Reactor Projects

ATTACHMENTS: 1. Supplemental Information
2. Event Timeline

SUMMARY OF FINDINGS

San Onofre Nuclear Generating Station, Units 2 and 3
NRC Inspection Report 50-361/02-08; 50-362/02-08

IR05000361-02-08, IR05000362-02-08: 04/22/2002-04/26/2002; Southern California Edison; San Onofre Nuclear Generating Station, Units 2 and 3; Special Inspection.

The inspection was conducted by a regional reactor inspector. This inspection identified one Green finding. The significance of the issues is indicated by their color (Green, White, Yellow, Red) using IMC 0609, "Significance Determination Process."

Cornerstone: Initiating Events

A. Self-Identified Finding

- Green. On February 27, 2002, the licensee, contrary to procedural expectations, failed to provide adequate oversight of switchyard maintenance activities which resulted in a complete loss of offsite power to Unit 3. Specifically, the licensee's procedure for controlling maintenance activities in the switchyard, Technical Procedure SO123-V.2.10, "Switchyard Work Performance," Revision 3, had a stated goal to control work within the switchyard, especially when the work may adversely effect unit availability. Contrary to this stated goal: (1) the licensee allowed San Diego Gas & Electric personnel to perform Breaker Failure Local Backup relay testing on the de-energized Southwest Bus of the of the San Diego Gas & Electric portion of the San Onofre Nuclear Generating Station's switchyard without this activity having been reviewed by the Switchyard Oversight Committee; and (2) the licensee allowed San Diego Gas & Electric relay technician to perform this activity without any oversight or precautionary brief, even though only one remaining bus was available to provide offsite power to Unit 3. The San Diego Gas & Electric relay technician, due to misunderstanding the limits set forth in the work request, exceeded the authorized work scope and chose to test the cross bus trip signal between the southwest bus and the southeast bus. While performing this activity, the technician failed to isolate the relay from the rest of the bus. Subsequently, the resulting signal tripped all the breakers connected to the southeast bus, including the Unit 3 main transformer breaker and Unit 3 reserve auxiliary transformer breakers. This caused the Unit 3 main turbine/generator to trip, the reactor tripped, plus both emergency diesel generators and auxiliary feedwater started.

This finding was evaluated under the risk significance determination process as having very low safety significance since there was no actual loss of safety function, i.e., the emergency diesel generators started successfully and the reactor coolant pumps continued to operate with power from Unit 2. The licensee placed this issue in their corrective action program as Action Request 020201440-5 (Section 5.0).

Report Details

1. Background

The 230 kV switchyard is located in the owner controlled area of the San Onofre Nuclear Generating Station (SONGS) facility. Power generated by the Units 2 and 3 main generators (22 kV) is stepped up through each unit's main transformer to 230 kV and transmitted through the switchyard for transmission to the grid. The 230 kV southeast and southwest buses, located in the switchyard at SONGS, are owned and operated by San Diego Gas and Electric (SDG&E) and transmit the power generated by Unit 3 to the grid.

During normal power operations, the Unit 3 main generator provides power to the non-Class 1E 6.9kV buses, through the Unit 3 unit auxiliary transformer. The four Unit 3 reactor coolant pumps are powered from these buses. When the plant is shut down, or when the Unit 3 unit auxiliary transformer is not available, these buses are powered from the switchyard through the Unit 3 reserve auxiliary transformer. The buses can also be powered from the Unit 2 reserve auxiliary transformer when it is not in use to power the Unit 2 reactor coolant pumps.

On February 12, 2002, SDG&E's Electric Construction and Maintenance Department submitted a request to the licensee's work control organization to switch out the 230 kV southwest bus for 2 consecutive days (Tuesday, February 26 and Wednesday, February 27, 2002). The purpose of the bus outage was to allow the installation of three new capacitive coupled voltage transformers (CCVTs) on the southwest bus. This activity had also been previously discussed and reviewed by the licensee's Switchyard Oversight Committee.

On February 20, 2002, the System Protection Maintenance Senior Operations Technician at SDG&E's Electric Construction and Maintenance Department submitted a request to trip-test the 230 kV southwest bus differential and breaker failure protection on February 27. It was determined that the maintenance effort associated with the replacement of the CCVTs afforded a good opportunity for this activity to be performed. However, due to the short notice involved in this request submission, the licensee's Switchyard Oversight Committee, which meets the second week of every month, did not have the opportunity to review this added activity. This was contrary to the expectations of Technical Procedure S0123-V-2.10, "Switchyard Work Performance," which stated that: "Any work in the switchyard that would effect unit availability should be reviewed and coordinated by the Switchyard Oversight Committee." On February 26, the relay technician was informed of his assignment to perform the trip relay testing. The relay technician had 17 years of experience in switchyard maintenance; however, he had not performed this particular activity at the SONGS switchyard before.

On February 27, 2002, all the transmission lines from the SDG&E territory, Unit 3 Reserve Auxiliary Transformer, and Unit 3 main transformer were aligned to the southeast bus. Unit 3 was operating at 99.9 percent power.

2. Event Description

On February 27, 2002, the SDG&E relay crew arrived on site to begin work. In accordance with plant Procedure S0123-V-2.10, "Switchyard Work Performance," they contacted licensee operations personnel and received approval to enter the switchyard. Following a walkthrough of the southwest bus, the relay technician was given permission to proceed to calibrate and trip-test the 230 kV southwest bus section circuit breakers. Due to the complexity of these circuit breaker failure schemes, which include a multitude of trip outputs, the relay technician proceeded to research available diagrams and documents to prepare to perform breaker failure trip-testing. The inspector noted during the review that the relay technician's work request documentation (Line Equipment Request S0230WB1) did not provide any procedural guidance other than to list the circuit breakers that were to be tested, relying heavily on the skill of the craft. Specifically, the line equipment request stated briefly, "trip test 230kV General Circuit Breakers (GCBs) 6112, 6122, 6132, 6142, 6152, 6162, 6172, and 6182 via 230kV SW Bus differential relays and breaker failure relays, leaving all other GCBs closed." However, upon having completed his research, the relay technician opted to perform portions of the trip relay test by cross-tripping from the southeast bus breaker failure relays.

At 10:24 a.m., the technician prepared to cross-trip the southwest bus from the southeast Bus 4122 circuit breaker failure relay (not listed in the line equipment request). At 10:43 a.m., the relay technician actuated the 4122 circuit breaker failure relay, which sent a trip signal to the southeast 230 kV bus breakers. The resulting signal tripped all the breakers connected to the southeast bus, including the Unit 3 main transformer breaker and the Unit 3 reserve auxiliary transformer breakers. As a result, the Unit 3 main turbine/generator tripped, the reactor tripped, both emergency diesel generators started, and auxiliary feedwater started. However, per plant design, the 1E buses automatically transferred to their Unit 2 1E sources, so the output breakers to the emergency diesel generators did not close. In addition, all Unit 3 auxiliary loads transferred to the Unit 2 reserve auxiliary transformer as designed. This included all four reactor coolant pumps which continued to run.

3. Event Response

The inspector reviewed the licensee's actions immediately following the event. Control room operator actions following the reactor trip were in accordance with emergency response procedures for the conditions that were present at the time. In addition, good communication and coordination between the licensee's operations department and SDG&E contributed to the timely recovery of offsite power to Unit 3 (32 minutes). No issues were identified.

4. Root Cause Analysis

The inspector reviewed the licensee's root cause analysis, prepared by the licensee for this event. The inspector also interviewed a number of licensee personnel and reviewed licensee's procedures and other documentation related to this event. Based on this review, the analysis was found to be thorough, identifying a number of causal factors

that contributed to the event. In addition, the inspector reviewed the licensee's process for developing the root cause analysis and determined that the licensee had performed this root cause analysis in accordance with established procedures. The inspector also verified that the personnel involved in developing the root cause analysis were qualified to perform this effort.

The following is a list of causal factors that contributed to the loss of offsite power to Unit 3:

- A. Southern California Edison (SCE) did not take effective measures to ensure switchyard work was performed without impact to continued power generation. This was due to:
 - Inadequate SCE switchyard work control program/procedures.
 - San Onofre operations department relied on standard SCE and SDG&E switchyard practices and procedures to eliminate risk from switchyard trip- testing. A contributing factor to this was the fact that previous switchyard work activities were performed without error by SDG&E personnel using SDG&E procedures.
- B. SDG&E relay crew prepared to trip-test the Southwest breaker failure relays with cross-tripping from the southeast bus breaker failure relays violating the authorized work boundary. This was due to:
 - SDG&E relay crew did not fully understand the intended boundaries of the work plan and authorization
 - Personnel Error
- C. Portions of the 4122 circuit breaker failure relay that go to the southeast 230 kV bus were not fully isolated. This was due to:
 - SDG&E drawings for the San Onofre switchyard did not show the internal details of the Circuit Breaker 4122 Breaker Failure Backup Relay, which initiated the trip.
 - Inadequate research was conducted by the relay technician. He failed to reference SDG&E's Standard Practice 457.001, "System Protection Maintenance Procedure - Breaker Failure Protection."
- D. San Onofre on shift operators were not completely aware of the SDG&E work plan or expected control room alarms. This was due to:
 - Inadequate communication of information between on-shift operations personnel.

In addition, as part of their root cause analysis, the licensee reviewed industry event notifications. During this review, the licensee identified that INPO had issued a Just-In-Time Operating Experience, "Control of Switchyard Activities," Revision 2, dated May 2001. The licensee subsequently found this report to contain relevant information on work plan formality and oversight of work activities that could have helped prevent this event.

The inspector found that the licensee's conclusions were accurate and had identified all of the appropriate causal factors for the conditions that led to this event.

5.0 Finding

The most significant aspect of the licensee's conclusions was the failure to take effective measures to control maintenance activities in the switchyard.

The licensee's procedure for controlling maintenance activities in the switchyard, Technical Procedure S0123-V-2.10, "Switchyard Work Performance," Revision 3, had a stated goal to control work within the switchyard, especially when the work may adversely effect unit availability. However, the procedure failed to provide any guidance regarding plant expectations that testing or maintenance procedures should be complied with and should not be altered without communicating with the licensee.

The inspector agreed with the licensee's assessment that plant personnel placed too much confidence in the standard SCE and SDG&E switchyard practices and procedures to eliminate risk from switchyard trip-testing. This overconfidence was apparent in the fact that site personnel did not provide a cautionary brief to the relay technician even though the southeast bus remained as the only source of offsite power to Unit 3 while the relay testing was being performed. It was also apparent in the fact that licensee personnel did not question the relay technician on how he planned to accomplish the relay testing, even though all that was stipulated in Line Equipment Request S0230WB1 (the only procedural guidance provided to the relay technician) were the numbers of the circuit breakers that were to be tested.

It was also noted that the SDG&E relay technician was only given one day of notice that he was to perform the trip relay test. This required him to prepare for the test while at the site. He then performed the research for the test by using the SDG&E drawings describing the system interaction; however, they did not show the details of the relay contacts necessary to identify all circuits affected by the relays. Finally, the relay technician compounded the problem by not referencing SDG&E's Standard Practice 457.001, "System Protection Maintenance Procedure - Breaker Failure Protection," which provided the missing data.

Lastly, as it was stated previously, the decision by SDG&E to submit a request to trip-test the 230 kV southwest bus differential and breaker failure protection was done on February 20. This was after the Switchyard Oversight Committee had convened to review planned switchyard maintenance activities that were scheduled to be performed on February 27. This was contrary to the guidance provided in Technical Procedure S0123-V-2.10 and was another missed opportunity in which the licensee could have

identified the increased failure potential of this activity. Thus, contrary to the goals and expectations set forth in Technical Procedure SO123-V-2.10, the licensee failed to provide adequate oversight of switchyard maintenance activities.

This finding was evaluated under the risk significance determination process as having very low safety significance since there was no actual loss of safety function, i.e., the emergency diesel generators started successfully and the reactor coolant pumps continued to operate with power from Unit 2. The licensee placed this issue in their corrective action program as Action Request 020201440-5 (FIN 50-362/0208-01).

Overall, the inadequacy of the procedural guidance available to control maintenance activities in the switchyard, and the obvious overconfidence the licensee personnel had placed in the standard SCE and SDG&E switchyard practices and procedures, pointed to an inadequate SCE switchyard work control program. This inadequate program and associated inadequate procedures were the main contributor to this event.

6.0 Corrective Actions

The inspector reviewed the licensee's immediate corrective actions, implemented following the event, and the licensee's recommendations for long-term corrective actions.

Immediate Corrective Actions - The licensee re-established offsite power to Unit 3 within 32 minutes. The licensee then halted all maintenance activities in the switchyard and proceeded to change the locks at all entry points to the switchyard. The licensee then initiated Action Request 020201440-5.

The SONGS operations department initiated a Priority 1 Special Order, "Subject: SONGS Switchyard Interim Action," that provided specific guidance to operations personnel relating to maintenance or testing activities planned in the switchyard. The guidance listed circumstances under which the licensee would not be required to escort work crews into the switchyard. Specifically, work crews needed to provide the following:

- A detailed written work plan had been submitted in advance.
- The work activity had been evaluated and scheduled by Equipment Control and was in the night letter.
- A briefing was conducted with plant operations department.
- Work groups supply a worker and a checker.

SCE communicated these new requirements to SDG&E. Both organizations indicated a strong willingness to cooperate to avert any future disruptions of plant power operations. The licensee indicated that these interim actions will remain in place until permanent corrective actions have been developed and implemented.

Long-Term Corrective Actions - The licensee plans to perform the following:

- Switchyard detailed work plans will be reviewed and approved by SONGS operations department prior to commencement of work.
- Progressive Error Prevention will be applied when the consequences of a human error during switchyard work cannot be tolerated.
- SCE will formally request SDG&E to update their drawings for the SONGS switchyard that are used to review and approve detailed work plans.
- The SONGS Work Control Group Weekly Generation Asset Risk review will be amended to include planned switchyard work.
- This event and corrective actions will be reviewed with appropriate SONGS, SCE Grid Operation and Maintenance, and SDG&E personnel who work in the SONGS switchyard.
- Update INPO preliminary notification to recommend each utility perform a formal review of the INPO Just-in Time Operating Experience, "Control of Switchyard Activities," Revision 2.

This event, the licensee's root cause, and the subsequent corrective actions are documented in Action Request 020201440-5. The inspector concluded that the licensee's immediate corrective actions and the licensee's efforts for developing long-term corrective actions were appropriate. A future review of the final corrective actions will be required to assess overall effectiveness of the licensee's long-term actions.

7.0 Exit Meeting Summary

The inspectors presented the inspection results to Mr. R. Krieger, Mr. D. Nunn, and other members of licensee management at an exit meeting on April 26, 2002.

On May 23, 2002, the inspectors held a re-exit meeting with Mr. M. McBrearty and Ms. M. Carr. The licensee acknowledged the findings presented.

The inspectors asked the licensee whether any materials examined during the inspection should be considered proprietary. No proprietary information was identified.

ATTACHMENT 1

SUPPLEMENTAL INFORMATION

PARTIAL LIST OF PERSONS CONTACTED

Licensee

C. Anderson, Manager, Site Emergency Preparedness
D. Axline, Licensing Engineer
M. Carr, Manager, PRA Group
M. Cooper, Manager, Operations Equipment Control
C. Dube, Shift Manager
S. Gensha, Manager, Electrical Maintenance
K. Johnson, Assistant Manager, Operations
J. Kennel, Control Room Supervisor
R. Krieger, Vice President, Nuclear Generation
M. McBrearty, Licensing Engineer
D. Nunn, Vice President, Engineering and Technical Services
J. Osborne, Senior Engineer, Root Cause
M. Ramsey, Senior Engineer, Root Cause
A. Scherer, Manager, Nuclear Oversight and Regulatory Affairs
R. Waldo, Manager, Operations

ITEMS OPENED AND CLOSED

50-362/0208-01 FIN Failure to take effective measures to control maintenance activities in the switchyard.

DOCUMENTS REVIEWED

The following documents were selected and reviewed by the inspector to accomplish the objectives and scope of the inspection and to support any findings:

PROCEDURES

NUMBER	DESCRIPTION	REVISION
SO123-V-2.10	Switchyard Work Performance	3
SO123-XV-50	Corrective Action Process	3
SO123-XV-50.39	Cause Evaluation Standards and Methods	2
SO123-XX-5	Work Authorizations	10
SO123-XX-5.1	Work Authorization Issue, Release and Modifications	5
SO23-XX-8	Critical Activities Work Process Manual	1

PROCEDURES

NUMBER	DESCRIPTION	REVISION
SO23-6-30	Switchyard Inspection and Operation	11
SO123-XX-4	SONGS Work Control	5
SO23-6-30	Operating Instruction, "230kV Circuit Breaker"	11

MISCELLANEOUS DOCUMENTS

TITLE/NUMBER	REVISION/ ISSUE DATE
Control Room Logs	02/26-27/02
San Diego Gas and Electric Standard Practice No. 457.001, Revision 1	02/08/89
SONGS Root Cause Evaluation (Action Request # 020201440-5) "SDG&E Switchyard BFBU Relay Testing Causes Loss of Offsite Power to Unit 3"	
San Diego Gas and Electric Incident Investigation, "Inadvertent Trip of 230kV Southeast Bus at San Onofre Substation - February 27, 2002"	03/13/02
Line Equipment Request No. SO230WB1	02/20/02
Units 1, 2 & 3 Acknowledgment of Information/ Special Order No. 1-02-003, "SONGS Switchyard Interim Action," Revision 2	04/04/02
Action Request # 000100457, "INPO SOER 99-1, Loss of Grid	01/07/00
Action Request # 010601263-1, "Southeast Phase A Potential Transformer Failed Isolating S-E Section of Switchyard"	06/24/01
Root Cause Guide	04/05/00

ATTACHMENT 2

EVENT TIMELINE

- 02/20/02 SDG&E work plan to install CCVTs on the west 230 kV bus on 2/26 & 2/27 is revised to include trip-testing of the west 230 kV bus
- 02/23/02 The California Independent System Operator approved the SDG&E 02/20/02 revised work plan
- 02/26/02 The SDG&E Relay Technician is made aware of the assignment to trip-test the SONGS southwest bus section on 02/27/02. The Relay Technician had performed similar tasks at other 230 kV substations, but had not performed this specific task at SONGS
- 02/27/02 The SDG&E work plan was approved for implementation by SCE on shift Operations personnel in the work authorization request group
- 02/27/02 The SONGS night shift control room operator talked to the SDG&E workers on the telephone prior to their entry for routine bus work
- 0630 Relay crew (Relay Technician and Relay Electrician) are given the assignment and job package to trip-test the SONGS southwest bus
- 0745 Relay crew arrives at the SONGS switchyard
- 0749 SDG&E issued hold authorization to the Kearny Relief Working Foreman to replace the southwest CCVTs
- 0800 Relay crew walked through the southwest bus clearance with the Kearny Relief Working Foreman
- 0815 Relay Technician was given the OK by grid control and accepted the OK to calibrate and trip-test the 230 kV southwest bus section circuit breakers via the southwest bus differential relays and southwest bus breaker failure relays, keeping all other (i.e., east bus) circuit breakers closed
- 0815 Relay crew begins research on bus differential trip-test.
- 0845 Relay crew began bus differential trip-test, marked and taped relay panels for improved identification, and called the SONGS control room to close Circuit Breakers 6112, 6152, and 6172
- 0900 Relay crew completed bus differential trip-testing
- 0930 Relay crew began research on the breaker failure trip-test
- 1000 Relay crew completed research on breaker failure trip testing

- 1015 Relay crew started breaker failure testing with southwest bus Circuit Breaker 6122 resulting in a trip to the southwest bus master breaker failure and lockout relay. SDG&E breaker failure relay actuation alarms are received in the SONGS control room
- 1024 SDG&E relay test crew prepares to cross-trip the southwest bus from the southeast bus circuit breaker 4122 breaker failure relay; Circuit Breaker 6122 is closed
- 1043 Relay crew actuates the Circuit Breaker 4122 breaker failure relay, sending a trip signal to the southeast 230 kV bus breaker
- 1043 Unit 3 is isolated from the grid and trips, resulting in Unit 3 being without offsite power for 32 minutes