UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
611 RYAN PLAZA DRIVE, SUITE 400
ARLINGTON, TEXAS 76011-4005

May 6, 2003

Harold B. Ray, Executive Vice President
San Onofre, Units 2 and 3
Southern California Edison Co.
P.O. Box 128, Mail Stop D-3-F
San Clemente, California 92674-0128

SUBJECT: SAN ONOFRE NUCLEAR GENERATING STATION NRC SPECIAL TEAM INSPECTION REPORT 50-361/03-07; 50-362/03-07

Dear Mr. Ray:

On March 14, 2003, the NRC completed a special team inspection at your San Onofre Nuclear Generating Station, Units 2 and 3, facility. The enclosed report documents the inspection findings which were discussed on April 7, 2003, with Mr. R. Waldo and other members of your staff.

This inspection examined the degradation and failure of internally mounted auxiliary contacts in safety-related linestarters that were identified through two surveillance test valve failures on August 30, 2002, and January 18, 2003. The inspection focused on the root cause analysis, extent of condition review, and corrective actions performed in response to the equipment deficiencies. The team identified one finding that is characterized as an unresolved item pending the licensee's completion of all Unit 2 risk dominant linestarter inspections.

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).

Should you have any questions concerning this inspection, we will be pleased to discuss them with you.

Sincerely,

/RA/

Claude E. Johnson, Chief
Project Branch C
Division of Reactor Projects

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

Enclosure:
NRC Inspection Report
50-361/03-07; 50-362/03-07

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

Gary L. Nolff
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

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

James D. Boyd, Commissioner
California Energy Commission
1516 Ninth Street (MS 34)
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

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 **(ATH)**
DRS Director **(DDC)**
Senior Resident Inspector **(CCO1)**
Branch Chief, DRP/C **(KMK)**
Senior Project Engineer, DRP/C **(WCW)**
Staff Chief, DRP/TSS **(PHH)**
RITS Coordinator **(NBH)**
B. McDermott **(BJM)**
SONGS Site Secretary **(SFN1)**
Dale Thatcher **(DFT)**

ADAMS: ☐ **Yes** ☐ No Initials: __cej__
☐ **Publicly Available** ☐ Non-Publicly Available ☐ Sensitive ☐ Non-Sensitive

R:_SO23\2003\SO2003-07RP-CCO.wpd

RIV:DRS/EMB	RI:DRP/D	SPE:DRP/C	C:DRP/C	D:DRP
JLTaylor	GGWarnick	WCWalker	CEJohnson	ATHowell
/RA/	***E - CEJohnson***	***/RA/***	***/RA/***	***/RA/***
4/28/03	5/5/03	5/5/03	5/6/03	5/6/03

OFFICIAL RECORD COPY T=Telephone E=E-mail F=Fax

ENCLOSURE

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

Dockets:	50-361; 50-362
Licenses:	NPF-10; NPF-15
Report No.:	50-361/03-07; 50-362/03-07
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:	March 10-14, 2003
Team Leader:	G. Warnick, Resident Inspector, Palo Verde Nuclear Generating Station
Inspector:	J. Taylor, Reactor Inspector, NRC Region IV
Approved By:	Claude E. Johnson, Chief, Project Branch C

ATTACHMENT 1: Supplemental Information

ATTACHMENT 2: Special Inspection Team Charter

Summary of Findings

San Onofre Nuclear Generating Station
NRC Inspection Report 50-361/03-07; 50-362/03-07

IR 05000361/2003-007, 05000362/2003-007; 03/10-14/2003; San Onofre Nuclear Generating Station, Units 2 and 3; Special Team Inspection Report.

This report covers a special inspection that assessed the licensee response and corrective actions related to safety-related linestarter degradation that occurred due to the improper use of trichloroethane based cleaners during maintenance activities. This inspection identified one unresolved item with potential safety significance greater than Green. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," Revision 3, dated July 2000.

A. Inspector Identified and Self-Revealing Findings

Cornerstone: Mitigating Systems

- TBD. A violation of 10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Action," was identified for failure to promptly identify and correct safety-related linestarter degradation that occurred due to improper use of trichloroethane based cleaners during linestarter maintenance.

  This finding is unresolved pending completion of all Unit 2 risk dominant linestarter inspections. This finding is greater than minor since the damage caused by improper maintenance practices to safety-related linestarters, if left uncorrected, could lead to a more significant safety concern (i.e., failure of a risk significant valve to perform its safety function), and it affected the reactor safety mitigating system cornerstone objective. The finding was also determined to have potential safety significance greater than very low safety significance since the results of the remaining Unit 2 risk dominant valves have not been obtained (Section 3.4).

TABLE OF CONTENTS

Report Details

1 SPECIAL INSPECTION ACTIVITIES

The team conducted a special inspection to better understand the magnitude and significance of the degradation and failure of Square D linestarters due to the chemical cleanser (Inhibisol) which affected safety-related systems and may also affect risk significant nonsafety-related systems. The team also reviewed the maintenance controls in place and the potential for a common cause failure. Two surveillance test failures and one maintenance cyclic testing failure occurred (i.e., the 20-cycle functional test which was performed on all inspected linestarters exhibiting evidence of chemical attack). Additionally, 42 linestarters were replaced due to evidence of chemical attack on the plastic auxiliary contact case. There have been no surveillance test failures associated with this problem on Unit 2 to date. At the close of this inspection, 14 linestarters have been inspected on Unit 2 with no failures noted.

The team evaluated the potential safety implications related to the linestarter degradation and failures. The team used Inspection Procedure 93812, "Special Inspection Procedure," to conduct the inspection and gather information regarding equipment and personnel performance. The team reviewed procedures, corrective action documents, and design and maintenance records for the equipment of concern; conducted field observations; and interviewed plant personnel during the course of the inspection.

2 DESCRIPTION OF EVENT AND CHRONOLOGY

2.1 Event Summary

On August 30, 2002, Unit 3 low pressure safety injection (LPSI) Pump 3P016 mini-recirculation Valve 3HV8163 failed to open. Subsequent analysis determined that the plastic housing on an auxiliary contact contained within the associated linestarter was degraded. The licensee determined that the cause was due to the past use of excessive amounts of a chemical cleaning solvent (Inhibisol). The licensee believes that the cleaning solvent caused the plastic to physically break down and, over time, small amounts of the plastic had come loose and interfered with the electrical contacts.

San Onofre utilizes reversing linestarters manufactured by Square D to operate the motors on safety-related motor-operated valves in both directions to open and close the associated valve. The linestarter consists of two relays (contactors) that provide 480 volt power to the motor and provide power for auxiliary contacts associated with interlock and seal-in functions. The interlock function provides a means to avoid energizing both open and closed relays at the same time. The seal-in function keeps the relay energized until the valve has completed its stroke. All reversing linestarters have interlock auxiliary contacts. San Onofre has 86 safety-related Square D linestarters per unit; there are a total of 172 safety-related linestarters at San Onofre.

In response to this failure, San Onofre developed a plan to inspect other safety-related linestarters installed in Units 2 and 3. In October 2002, San Onofre completed the

inspection of 19 additional linestarters. Based on this sample inspection, 2 of 19 linestarters had evidence of chemical attack (i.e., cloudy plastic contact housing); however, both were found to be functional.

On January 18, 2003 (during the Unit 3 outage), Unit 3 quench tank sample containment isolation Valve 3HV0514 failed to open on demand. Examination of the contact revealed that a similar chemical attack had occurred.

On February 10, 2003, an additional auxiliary contact failed on the Unit 3 Train A LPSI header stop valve (3HV9328) during maintenance cycle testing. The maintenance cycle testing (20-cycle functional test) of the auxiliary contact resulted in a failure of the contact to operate on the 20th cycle.

On Unit 3, all 86 linestarters have been inspected with two surveillance test failures noted and one maintenance cycle testing failure. There were 42 linestarters replaced due to evidence of chemical attack on the plastic auxiliary contact case. There have been no surveillance test failures associated with this problem on Unit 2 to date. On Unit 2, 14 linestarters have been inspected with no failures noted; however, one linestarter had evidence of chemical attack on the plastic auxiliary contact case. The licensee has developed a risk informed plan to complete the remaining Unit 2 linestarter inspections.

2.2 Preliminary Risk Significance of Event

Refer to Charter (Attachment 2) for risk significance.

2.3 Sequence of Events

The team developed a detailed sequence of events and organizational response timeline. The timeline included applicable events and actions related to the usage and control of solvent based cleaners in electrical maintenance applications. The team's review satisfied the activities associated with Special Inspection Team Charter Scope Items 1 and 2.

April 1984

The linestarter preventive maintenance (PM) Procedure SO23-I-9.13, "480 VAC Linestarter Maintenance," Revision 0, was issued. The procedure required the use of cleaning solvents on linestarters but had no caution regarding potential for damage to plastic components within the linestarter. Also, the procedure did not require visual inspection of internally mounted auxiliary contact assemblies.

Pre-1989

Trichloroethane (TCE)-based cleaners, including Inhibisol, was used liberally to clean safety-related components. The cleaning methods used allowed the cleaners to come in contact with plastics that were susceptible to chemical degradation.

April 1989

The licensee recognized that these cleaners were being used improperly and that controls were needed to prevent damage to equipment containing plastics. Manual M-36609, "Consumables Manual," Revision 9, was changed to state that TCE SHALL NOT be used on plastics. The manual also gave guidance on the approved method for use of the cleaner (i.e., spray on cloth, then wipe component). Additionally, linestarter PM Procedure SO23-I-9.13 was revised to say cleaning solvents should be used sparingly to avoid damage to plastic components.

February 1994

The licensee performed an evaluation of NRC Information Notice (IN) 93-76, "Inadequate Control of Paint and Cleaners for Safety-Related Equipment," and determined that the programs in place were sufficient to avoid similar problems to those discussed in the notice.

December 1996

The licensee identified relay and socket degradation on a Class 1E inverter. It was further identified that the degradation was caused by excessive application of a chemical cleaner.

August 30, 2002

Unit 3 LPSI Pump 3P016 Mini-Recirculation Valve 3HV8163 failed to open during surveillance testing.

September 5, 2002

Laboratory analysis of the suspect internal auxiliary contact determined chemical attack of the switch housing had caused misoperation of the switch. The failed internal auxiliary contact was coated with carbon-oxygen indicative of hydrocarbon plastic. The failure mechanism is the deposition of plastic residue on the contact from the deterioration of the plastic switch bodies due to chemical attack. The chemical attack was due to the past use of excessive amounts of a chemical cleaning solvent (Inhibisol) during linestarter PMs.

September 24 - October 18, 2002

The licensee inspected approximately 10 percent of the linestarters in the plant (19 of 172). Of the 19 linestarters inspected, two contacts, 3BE26 and 2BZ13, showed signs of chemical degradation. A plan was developed to inspect all safety-related linestarters.

October 2002

Procedural steps were added to the linestarter maintenance procedure to provide guidance stating not to directly spray electrical components.

January 18, 2003

Unit 3 quench tank sample isolation Valve 3HV0514 failed to open during surveillance testing.

January 20, 2003

Maintenance Order 03011267000 was planned for corrective maintenance on Valve 3HV0514, where it was recognized that the failure was potentially due to chemical attack of the linestarter internal auxiliary contacts.

February 5, 2003

Subsequent evaluation determined that the auxiliary contact on the associated linestarter for Valve 3HV0514 did not operate. Examination of the contact revealed that a similar chemical attack had occurred.

February 10, 2003

A Unit 3 Train A LPSI header stop Valve 3HV9328 auxiliary contact failed during maintenance cyclic testing on the 20th test cycle.

March 4, 2003

Testing of all remaining auxiliary contacts in Unit 3 linestarters was completed. The balance of Unit 2 linestarters will be inspected by September 2003, with the exception of those that cannot be inspected on-line. Those linestarters that require shutdown conditions will be inspected during the 2004 spring outage.

March 7, 2003

The licensee took action to prohibit the use of all TCE-based cleaners for electrical applications.

3 ROOT CAUSES OF LINESTARTER FAILURES

3.1 Root Cause Evaluation Review

a. Inspection Scope

The team evaluated immediate and long-term corrective actions that the licensee has taken, or plans to take, in response to the root cause determination of chemically

induced failure of the linestarter auxiliary contacts. Databases, procedures, and action requests (ARs) were some of the documents used to verify linestarter inspection/auxiliary contact replacement and other corrective actions. The team also interviewed licensee staff and observed some of the linestarter contactors and auxiliary switches that had been replaced. This activity satisfied Special Inspection Team Charter Scope Item 3.

b. Findings

The licensee's immediate corrective action for the failure of Valve 3HV8163 to open on August 30, 2002, was replacement of Linestarter 3BRA16. The valve was returned to operability on August 31, 2002, within the Technical Specification allowable outage time. An Apparent Cause Evaluation was initiated under AR 020801672. The licensee initiated a laboratory analysis of the suspect internal auxiliary contact from the linestarter and concluded that excessive use of cleaning solvents during previous preventive maintenance activities had caused the misoperation of the contacts. The failure mechanism is the deposition of plastic residue on the contact from the deterioration of the plastic switch bodies due to chemical attack. An inspection of an additional 19 (>10 percent of 172) linestarters was performed during the period from September 24 to October 18. Of these 19 inspections, two auxiliary contacts showed signs of chemical attack. All of the auxiliary contacts from this sample were test operated 20 times with no failures and then the contacts were replaced. At some point in the inspection, test operation of the contacts was shifted to being performed prior to visual contact inspection. Early inspection methods were such that a true as-found condition could not be identified and documentation of identified corroded contacts lacked details to provide useful data for cause evaluation. The licensee decided to inspect and replace all of the remaining affected linestarters' auxiliary contacts by April 4, 2004. Overall, the team determined that the root cause evaluation was comprehensive and thorough.

3.2 Operability and Risk Assessments

a. Inspection Scope

The team reviewed PRA Report PRA-03-001, "SONGS Unit 2 Risk Impact of Linestarter Increased Failure Probability Due to Chemical Attack," that was used to develop the inspection schedule for the remaining Unit 2 valves and to justify continued Unit 2 plant operations. The team also reviewed the work sequence associated with the failure of Valve 3HV0514 on January 18, 2003, and the influence on Unit 2 restart considerations from a plant trip in early February. This activity satisfied Special Inspection Team Charter Scope Item 4.

b. Findings

The team concluded that the remaining schedule for the Unit 2 valves and the PRA basis that was used to develop the plan were adequate based on the assumed failure rate.

Corrective maintenance for Valve 3HV0514 was planned on January 20 where it was recognized that the failure was potentially due to chemical attack of Inhibisol, similar to the failure of Valve 3HV8163 on August 30, 2002. Troubleshooting of the Valve 3HV0514 failure did not occur until February 5, which confirmed the failure mechanism and common cause aspects applicable to all safety-related linestarters on site. Licensee response following the common cause identification treated the linestarter issue with more urgency. In fact, all remaining linestarters on Unit 3 were considered emergent items and worked into the outage schedule. The team observed that the urgency of the issue could have been recognized earlier when the opportunity presented itself with the failure of the valve on January 18. Consequently, an opportunity was missed to identify the full extent of condition of potential operability issues with the Unit 2 linestarters following a plant trip on February 1.

3.3 Operating Experience

a. Inspection Scope

The team reviewed the licensee's use of operating experience related to chemical damage to plastic electronic components. Documents reviewed included NRC Information Notices and 10 CFR Part 21 Notices, licensee ARs, and results of industry operating experience searches. This activity satisfied Special Inspection Team Charter Item 4.

b. Findings

The team reviewed the licensee's response to NRC IN 93-076, "Inadequate Control of Paint and Cleaners for Safety Related Equipment." In 1993, a licensee experienced failure of control switches due to use of solvent cleaner. This event was documented in IN 93-076. The IN discussed the bonding of plastic switch parts due to action of a commercial cleaning solvent and reiterated the requirements of Appendix B to 10 CFR Part 50 establishing quality assurance requirements and control of materials and processes used on safety-related equipment. Following review of IN 93-076, the licensee determined that the programs in place were sufficient to avoid similar problems to those discussed in the notice. Further, the Inhibisol cleaner used by the licensee included a warning that stated the cleaner was not for use on plastics and rubbers. During the recent investigation, the licensee noted that a more thorough evaluation would have concluded that corrosive cleaners should not be authorized for general use on electrical and electronic components, and use of the cleaners should have been discontinued at that time.

The team reviewed licensee evaluation of other NRC, licensee, and industry experience with cleaner problems to determine if there was additional experience applicable to other electrical equipment. The team determined that the licensee had not appropriately used operating experience prior to the linestarter failure in August 2002 to address potential performance issues in their use of cleaners on electrical equipment.

3.4 Corrective Actions Associated With Linestarter Degradation and Failure

a. Inspection Scope

The team reviewed the licensee's corrective actions to determine whether actions taken were adequate to correct adverse effects introduced during maintenance of the Square D linestarters and restore equipment condition for the linestarter degradation within appropriate expectations. This activity satisfied Special Inspection Team Charter Scope Items 2, 5, and 6.

b. Findings

The team concluded that the corrective actions implemented by the licensee when this problem was self-revealed in August 2002 were adequate to correct the equipment degradation and ensure that no further degradation would result from the use of TCE-based cleaners. Additionally, the licensee has modified the preventive maintenance on safety-related linestarters to provide for inspection of the internal auxiliary contacts to ensure that degradation resulting from any other cause can be identified.

Introduction. A finding was identified in that the licensee missed several opportunities to identify and correct the linestarter degradation. This finding has a potential safety significance greater than very low significance. This finding is unresolved pending completion of all Unit 2 risk dominant linestarter tests by the licensee and subsequent NRC inspection and evaluation of these results.

Description. The team observed that the licensee missed several opportunities from plant and industry operating experience to recognize the need for an extent of condition review to identify any equipment degradation that occurred throughout the plant due to improper use of cleaning solvents. In April 1989, the licensee recognized that TCE-based cleaners were being used improperly and that controls needed to be implemented to prevent future damage to equipment containing plastics. The licensee reviewed IN 93-76, "Inadequate Control of Paint and Cleaners for Safety Related Equipment," and determined that the programs in place were sufficient to avoid similar problems to those discussed in the notice. In December 1996, the licensee identified relay and socket degradation on a Class 1E inverter. It was further identified that the degradation was caused by excessive application of a chemical cleaner. In each of these instances the licensee did not consider effects on plant equipment that may have resulted from past improper use of TCE-based cleaners. This oversight is revealing itself presently with the recent linestarter failures and contact degradation identified.

Analysis. The finding was determined to be more than minor since the damage caused by improper maintenance practices to safety-related linestarters, if left uncorrected, would lead to a more significant safety concern (i.e., failure of a risk significant valve to perform its safety function) and it affected the reactor safety mitigating system cornerstone objective. The finding was also determined to have potential safety significance greater than very low safety significance since the results of inspection of the remaining Unit 2 risk dominant valves have not been obtained. The licensee

determined the risk dominant valves through PRA methods. Specifically, a Fussell-Vessely Risk Importance analysis was performed to determine the relative risk reduction associated with the population of uninspected valves. The remaining valves that dominate risk include containment emergency sump Valves 2HV9303 and 2HV9305, auxiliary feedwater Valves 2HV4712 and 2HV47123, and saltwater cooling Valve 2HV6495.

Enforcement. 10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Action," states, in part, that measures shall be established to assure that conditions adverse to quality, such as defective material and equipment, are promptly identified and corrected. In the case of significant conditions adverse to quality, measures shall assure that the cause of the condition is determined and corrective action taken to preclude repetition. Contrary to the above, the licensee missed several opportunities to recognize the need for an extent of condition review to promptly identify and correct defective material and equipment that occurred throughout the plant due to repetitive improper use of TCE-based cleaners. This finding is identified as Unresolved Item 361;362/2003007-01, "Failure To Promptly Identify and Correct Linestarter Degradation," pending completion of all Unit 2 risk dominant linestarter inspections.

3.5 Human Performance and Procedural Aspects

a. Inspection Scope

The team reviewed the licensee's response to the linestarter degradation and failures to determine the extent that any human performance or procedural aspects may have contributed to the linestarter conditions identified. This activity satisfied Special Inspection Team Charter Scope Items 6.

b. Findings

There are indications that TCE-based cleaners were potentially not being controlled in accordance with procedural guidelines, and Inhibisol could have been used more liberally than allowed. The team was unable to determine whether all of the chemical attack of the internal auxiliary contacts occurred prior to 1989, when the cleaner was used liberally, or if some of the damage occurred after 1989, when the restrictions on the use of Inhibisol were in effect. The team did identify one example where it is possible that chemical attack of an auxiliary contact took place between 1994 and February 2003.

The licensee identified relay and socket degradation on a Class 1E inverter in December 1996. It was further identified that the degradation was caused by excessive application of a chemical cleaner. The team was not able to determine when the damage occurred. The corrective actions taken by the licensee were to retrain electricians and test technicians on the proper use of the cleaners and add a caution to affected procedures.

The team reviewed the sequence of changes to Procedure SO123-I-9.13 and determined that the licensee missed opportunities to prevent further possible auxiliary contact failures. As early as February 2, 1989, procedural changes were made to

provide guidance on the approved method for use of the Inhibisol cleaner (i.e., spray on cloth, then wipe component), but it was not until Temporary Change Notice (TCN) 3-5, Revision 3, on March 7, 2003, that TCE-based cleaner use was completely prohibited. Additionally, the team reviewed approximately 50 percent of 46 other SO123 and SO23 series procedures dealing with various other plant equipment which had Inhibisol precautions and determined they had been revised appropriately.

These examples represent missed opportunities to ban the use of Inhibisol to ensure that no further damage to equipment could occur. The licensee continued the use of Inhibisol in electrical applications since they determined that the cleaner, if used properly, was a better alternative than other cleaners used in the industry.

4 EXTENT OF CONDITION

4.1 Impact of Potential Linestarter Relay Failures on Plant Systems

a. Inspection Scope

The team evaluated databases, ARs, and Maintenance Action Items to determine the types of failure mechanisms, modes, and causes for linestarter auxiliary contact failures. The team interviewed engineering and maintenance personnel to receive a full understanding about actual work practices in effect at different times and maintenance personnel awareness of possible problems with TCE-based cleaner use. The team primarily looked at control of TCE-based cleaner use back to 1984. This activity satisfied Special Inspection Team Charter Items 5, 7, 9, and 10.

b. Findings

The team concluded that adequate consideration was given to evaluating the extent of condition when the condition revealed itself over the past months and that the problem was primarily isolated to specific safety-related Square D linestarters. Possible problems with other plant electrical equipment subject to TCE degradation has been addressed by comprehensive applicable procedure review and revision.

5 RISK SIGNIFICANCE OF EVENT

5.1 Safety Implications of Failures

a. Inspection Scope

The team reviewed the Maintenance Rule determinations performed by the licensee for the failures of Valves 3HV8163 and 3HV0514. The team performed interviews with engineering personnel and reviewed surveillance test records and corrective action documents to determine if the failures represented a loss of safety function and to understand the safety implications of the failures. This activity satisfied Special Inspection Team Charter Scope Item 8.

b. Findings

LPSI Pump 3P016 mini-recirculation Valve 3HV8163 failed to open during the restoration phase of Surveillance Operating Instruction SO23-3-3.30.1, "Train B Safety Injection Valve Test," Attachment 2, Revision 5. The normal operating valve position is de-energized open to support safety injection actuation. Valve 3HV8163 does not need to open to satisfy the safety function since the valve is already in the required position. Quench tank gas sample isolation Valve 3HV0514 failed to open while performing Surveillance Operating Instruction SO23-3-3.30.10, "Nuclear Sampling System Online Valve Test," Attachment 3, Revision 8. The normal valve position is closed. Valve 3HV0514 is a containment isolation valve and must be closed to satisfy the safety function. There are no safety functions that Valve 3HV0514 is required to satisfy in the open position. In summary, neither of these valve stroke failures constituted Maintenance Rule functional failures since the failure mode did not result in the loss of a safety function.

6 EXIT MEETING SUMMARY

The team presented the inspection results to Mr. Waldo and other members of licensee management at an exit meeting on April 7, 2003. The licensee acknowledged the findings presented.

The team asked the licensee whether or not 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

D. Bockhorst, Manager, Maintenance Engineering - Electrical Controls
D. Breig, Manager, Maintenance Engineering
J. Fee, Manager, Maintenance
S. Genschaw, Manager, Senior Project Manager, Maintenance
G. Gruning, Supervisor, Electrical Maintenance
D. Nunn, Vice President, Engineering and Technical Services
A. Scherer, Manager, Nuclear Oversight and Regulatory Affairs
T. Vogt, Manager, Operations
R. Waldo, Station Manager

ITEMS OPENED

Opened

361; 362/2003007-01	URI	Failure To Promptly Identify and Correct Linestarter Degradation (Section 3.4)

LIST OF DOCUMENTS REVIEWED

Procedures:

SO123-I-1.3,	"Work Activity Guidelines," Revision10, TCN 4
SO123-I-1.16	"Administration of the Authorized Consumables Manual," Revision 1
SO123-I-1.28.1	"Electrical Distribution Grounding Guide," Revision 0, TCN 2
SO123-I-4.1	"Inspect and Lube Model 1003 Thunderbolt Station Sirens," Revision 4, TCN 4
SO123-I-6.7	"Limitorque Model SMB-000, SMB-00 and SB-0 Disassembly, Inspection, Repair, Assembly and Adjustment," Revision 1, TCN 2
SO123-I-6.7.1	"Limitorque Model SMC-04 Disassembly, Inspection, Repair, Assembly and Adjustment," Revision 0, TCN 1
SO123-I-9.5	"Electrical Inspection of Limitorque Actuators," Revision 5, TCN 1
SO123-I-9.8	"ITE 4.16 KV Circuit Breaker Inspection and Repair," Revision 6

SO123-I-9.9	"Square 'D' and Westinghouse Type DS Circuit Breaker Inspection and Testing," Revision 3, TCN 1
SO123-I-9.11	"480 V Load Center and Transformer Inspection and Cleaning," Revision 2, TCN 6
SO123-I-9.12	"Motor Control Center Cleaning, Inspection and Meggar Test," Revision 4, TCN 6
SO1-I-9.13	"480 VAC Linestarter Inspection, Coil and Power Contact Replacement," Revision 3, TCN 4
SO123-I-9.13	"Linestarter 480 VAC Linestarter Inspection Coil and Contact Replacement," Revision 0, TCN 11 (converted to SO123 from SO1)
SO123-I-9.13	"480 VAC Linestarter Inspection Coil and Power Contact Replacement," Revision 3, TCNs 3, 4, 5 (12/02)
SO23-II-11.163	"Inverter Inspection and Cleaning," Revision 0, TCN 3
SO23-II-11.167	"Turbine Supervisory Systems Tests and Calibration," Revision 1, TCN 6
SO23-II-11.179	"Pressurizer Proportional Heater SCR Power Control Test," Revision 1, TCN 2
SO23-II-11.191	"C and D Battery Charger Test/Calibration," Revision 1, TCN 2
SO23-II-11.253	"ICW51A Power Relay Test and Calibration," Revision 0, TCN 1
SO123-II-11.177	"Protective Relays and Devices Testing and Calibration," Revision 2
SO123-II-11.185	"Inverters Y001, 2, 3 & 4 for Vital Buses Test/Calibration," Revision 1, TCN 4

ARs:

020801672
961200145
030101366

Maintenance Work Orders:

02101776000, 02101761000, 02081919000, 02101826000, 02101773000, 03011267000
99090866000, 99091963000, 99090865000, 980201386, 980200588, 97070945000
95110718000, 95110665000, 95031278001, 95050628000, 95040334001, 95090795001,
95110619000, 95110617000, 94040112001, 94040112000, 93071913000, 93072269000,
93111006000, 93072083000, 93070611000, 920300054001, 92030054001, 92111737000
91112322001, 91112322000, 90103179001

Nonconformance Reports:

911100128
940400002

Other Documents:

Drawings:

Square “D” 1A12-02690-10A17 (S023-302-4-2-179-3, SCE-0354)

LIST OF ACRONYMS USED

AR	action request
CFR	Code of Federal Regulations
IN	information notice
LPSI	low pressure safety injection
PM	preventive maintenance
PRA	probabilistic risk assessment
NRC	Nuclear Regulatory Commission
TBD	to be determined
TCE	trichloroethane
TCN	temporary change notice
URI	unresolved item

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
611 RYAN PLAZA DRIVE, SUITE 400
ARLINGTON, TEXAS 76011-4005

ATTACHMENT 2

February 28, 2003

MEMORANDUM FOR: Gregory Warnick, Resident Inspector
Palo Verde Nuclear Generating Station (Team Lead)

FROM: Arthur T. Howell III, Director, Division of Reactor Projects ***/RA/***

SUBJECT: SPECIAL INSPECTION AT SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3, TO EVALUATE THE FAILURE OF AUXILIARY CONTACTS IN SAFETY-RELATED LINESTARTERS

In response to our initial evaluation of the Square D linestarter auxiliary contact degradation issue involving safety-related systems, a Special Inspection Team is being chartered. You are hereby designated as the Special Inspection Team Leader. Joseph Taylor, Reactor Inspector from the Engineering and Maintenance Branch, Division of Reactor Safety, will assist you in this inspection effort.

A. Basis

On August 30, 2002, Unit 3 LPSI Pump 3P016 Mini-Recirculation Valve 3HV8163 failed to open. Subsequent analysis determined that the plastic housing on an auxiliary contact contained within the associated linestarter was degraded. The licensee determined that the cause was due to the past use of excessive amounts of a chemical cleaning solvent (Inhibisol). The licensee believes that the cleaning solvent caused the plastic to physically break down and, over time, small amounts of the plastic had come loose and interfered with the electrical contacts.

San Onofre utilizes reversing linestarters manufactured by Square D to operate the motors on safety-related motor-operated valves in both directions to open and close the associated valve. The linestarter consists of two relays (contactors) that provide 480 volt power to the motor and provide power for auxiliary contacts associated with interlock and seal-in functions. The interlock function provides a means to avoid energizing both open and closed relays at the same time. The seal-in function keeps the relay energized until the valve has completed its stroke. All reversing linestarters have interlock auxiliary contacts. San Onofre has 86 ac safety-related Square D linestarters per unit; there are a total of 172 safety-related linestarters at San Onofre.

In response to this failure, San Onofre developed a plan to inspect other safety-related linestarters installed in Unit 3. In October 2002, San Onofre completed the inspection of 19 additional Unit 3 linestarters. Based on this sample inspection, 2 of 19 linestarters had evidence of chemical attack (i.e., cloudy plastic contact housing); however, both were found to be functional. Each linestarter with evidence of chemical attack was cycled 20 times to determine functionality and was then replaced.

On January 18, 2003 (during the Unit 3 outage), Unit 3 Quench Tank Sample Containment Isolation Valve 3HV0514 failed to close on demand. Examination of the contact revealed that a similar chemical attack had occurred.

On February 10, 2003, an additional auxiliary contact failed on the Unit 3 Train A LPSI header stop valve (3HV9328) during cyclical testing. The maintenance cyclical testing (i.e., the 20-cycle functional test described above) of the auxiliary contact resulted in a failure of the contact to operate on the 20th cycle. The auxiliary contact failure would have affected the valve in the open direction. The safety function of the valve is to open and close (normal position of the valve is closed).

On Unit 3, all 86 linestarters have been inspected with 2 surveillance test failures noted and one maintenance cyclic testing failure (i.e., the 20-cycle functional test which was performed on all linestarters exhibiting evidence of chemical attack). There were 42 linestarters replaced due to evidence of chemical attack on the plastic auxiliary contact case. The licensee is developing the inspection plan for Unit 2 and has indicated that the plan will be risk informed and will be prioritized to emphasize the more risk significant components. There have been no surveillance test failures associated with this problem on Unit 2 to date. On Unit 2, 10 linestarters have been inspected with no failures noted; however, one linestarter had evidence of chemical attack on the plastic auxiliary contact case.

The incremental conditional core damage probability for this event is between 2.5E-6 and 4E-5. The risk is associated with the increased failure rate of those linestarters that showed visual signs of chemical attack. The affected motor-operated valves were assumed to be the population of 32 identified by the licensee by February 9, 2003. Although 10 additional motor-operated valves were later identified to be affected, the senior reactor analyst determined that the calculated incremental core damage frequency would be essentially unchanged.

The calculated failure rate was then substituted for the baseline failure rate for each of the modeled motor-operated valves in the PRA models. Three of the four containment sump suction valves and an auxiliary feedwater pump discharge valve dominated the change in risk. The range indicates the difference between the results using the licensee's model and a bounding evaluation using the plant specific SPAR model.

A Special Inspection Team is being dispatched to better understand the magnitude and significance of the degradation of these Square D linestarter failures due to the chemical cleanser (Inhibisol) which affected safety-related systems and may also affect risk significant nonsafety-related systems. The team is also tasked with gaining a better

understanding of the maintenance controls in place and the potential for a common cause failure. The team is expected to perform fact-finding in order to address the following items.

B. Scope

1. Develop a complete sequence of events that led to the identification of the degradation of the linestarters. Specifically, identify the extent of use and method of application of the cleanser Inhibisol. Also, determine if (pre-1989) use of Inhibisol was the cause of, or a contributor to the mechanical interlock failure of, linestarters in 1998 (refer to NRC Inspection Report 50-362/98-05).

2. Determine whether the licensee's corrective actions for the mechanical interlock failure of linestarters should have reasonably identified the failure mechanism caused by the application of Inhibisol.

3. Review the licensee's root cause evaluation determination for completeness and accuracy. Independently verify key assumptions and facts.

4. Evaluate the licensee's operability and risk assessments. Assess applicable industry operating experience, if any involving use of Inhibisol, and other similar cleaners used in safety-related applications.

5. Determine, by sampling, if degradation from Inhibisol is affecting other equipment important to safety.

6. Determine if, prior to the August 30, 2002, discovery of the condition, there were appropriate controls in place to conduct maintenance activities on these Square D linestarters, specifically the method of cleaning linestarters.

7. Evaluate and determine the potential for common cause failure.

8. Determine whether the failures of Valves 3HV8163, 3HV0514, and 3HV9328 represent Maintenance Rule preventable functional failures. Assess the safety implications of these failures.

9. Review the event to determine whether there are any generic implications.

10. Review and assess the licensee's immediate and long-term corrective actions, including the priority for addressing safety-related linestarters as well as considering the impacts, if any, on risk significant nonsafety-related equipment and equipment important to safety with regard to this type of degradation.

C. Guidance

Inspection Procedure 93812, "Special Inspection," provides additional guidance to be used by the Special Inspection Team.

This memorandum designates you as the Special Inspection Team Leader. Your duties are described in Inspection Procedure 93812. Safety concerns identified that are not directly related to the event should be reported to the Region IV office for appropriate action.

You will report to the site, conduct an entrance, and begin inspection on Monday, March 10, 2003. Tentatively, the inspection should be completed by close of business March 14, 2003, with a report documenting the results of the inspection issued within 30 days of the completion of the inspection. However, if additional time is required, inform Region IV management as soon as possible. While the team is on site, you will provide daily status briefings to Region IV management.

This Charter may be modified should the team develop significant new information that warrants review. Should you have any questions concerning this Charter, contact Claude Johnson, Chief, Project Branch C, Division of Reactor Projects, at (817) 860-8282.

cc:
E. Merschoff
T. Gwynn
R. Lorson, EDO
D. Chamberlain
H. Berkow, NRR
C. Carpenter, NRR
C. Osterholtz
C. Johnson
C. Marschall
D. Loveless