UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
612 EAST LAMAR BLVD, SUITE 400
ARLINGTON, TEXAS 76011-4125

December 19, 2008

EA-08-296

Ross T. Ridenoure,
Senior Vice President and
Chief Nuclear Officer
Southern California Edison Company
San Onofre Nuclear Generating Station
P.O. Box 128
San Clemente, CA 92674-0128

SUBJECT: FINAL SIGNIFICANCE DETERMINATION FOR A WHITE FINDING AND NOTICE OF VIOLATION - SAN ONOFRE NUCLEAR GENERATING STATION - NRC SPECIAL INSPECTION REPORT 05000361/2008013; 05000362/2008013

Dear Mr. Ridenoure:

On December 11, 2008, the U.S. Nuclear Regulatory Commission (NRC) completed a special inspection at your San Onofre Nuclear Generating Station facility. This inspection examined activities associated with deficient electrical connections with the potential to adversely affect the safety function of multiple safety systems used for accident mitigation. The NRC's initial evaluation satisfied the criteria in NRC Management Directive 8.3, "NRC Incident Investigation Program," for conducting a special inspection. The basis for initiating this special inspection is further discussed in the inspection charter, which is included in this report as Attachment 2. The determination that the inspection would be conducted was made by the NRC on July 21, 2008, and the inspection started on August 4, 2008.

The enclosed special inspection report documents the inspection results, which were discussed on November 5 and December 11, 2008 with you and other members of your staff. The inspection examined activities conducted under your license as they relate to safety and compliance with the Commission's rules and regulations and with the conditions of your license. The team reviewed selected procedures and records, observed activities, and interviewed personnel.

The enclosed report documents one finding that was determined to be of low to moderate safety significance (White). As described in Sections 2.1.5 and 3.4, of this report, the NRC concluded that the failure to establish appropriate instructions in March 2004 for replacement of the Unit 2 safety-related Battery 2B008 output breaker resulted in the battery being inoperable between March 2004 and March 25, 2008. Specifically, on March 25, 2008, following failure of a battery voltage surveillance activity it was identified that loose electrical connections associated with the battery output breaker were the cause of the failed surveillance. This finding does not represent an immediate safety concern because of the corrective actions you have taken that involved tightening the loose battery breaker connections and verifying all other battery output breaker connections were tight following identification of the loose electrical connection. The safety

significance of this finding was assessed on the basis of the best available information, including influential assumptions, using the applicable Significance Determination Process and was determined to be White (i.e., low to moderate safety significance). Attachment 3 of this report provides a detailed description of the NRC's risk assessment.

This finding was determined to involve a violation of NRC requirements. You are required to respond to this letter and should follow the instructions specified in the enclosed Notice when preparing your response. In addition, we will use the NRC Action Matrix to determine the most appropriate NRC response to this issue, and we will notify you by separate correspondence of that determination.

Following a discussion of the preliminary safety significance of this finding during the exit briefing on November 5, 2008, a phone call was held between Michael Hay, Branch Chief, Division of Reactor Projects, and Ed Scherer, Manager, Nuclear Regulatory Affairs, on November 13, 2008. During this call Mr. Scherer indicated that Southern California Edison does not contest the characterization of the risk significance of this finding, and that you have declined to further discuss this issue at a Regulatory Conference or provide a written response. Accordingly, the NRC is issuing this final significance determination for the inspection finding.

This report also discusses seven NRC identified findings that were determined to be of very low safety significance. Of concern is that these findings were identified by the NRC following your review of the events prior to our announced special inspection indicating your evaluations lacked the rigor necessary to identify these performance deficiencies. Your ability to effectively identify and evaluate problems has been, and continues to be, a concern to the NRC. This concern was documented in the past two NRC assessment letters dated March 3 and September 2 of 2008. These seven findings will be assessed during our end of cycle assessment along with other findings identified during calendar year 2008 to assess your progress in addressing the substantive cross-cutting issue in problem identification and resolution. The NRC will continue to focus our inspections in this area and evaluate if additional actions are warranted until sustained improvements are recognized.

The seven NRC identified findings were determined to be of very low safety significance (Green). The findings were determined to involve violations of NRC requirements. Because of their very low safety significance and because they were entered into your corrective action program, the NRC is treating these findings as noncited violations consistent with Section VI.A.1 of the NRC Enforcement Policy. If you contest these noncited violations, you should provide a response within 30 days of the date of this inspection report, with the basis for your denial, to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington DC 20555-0001; with copies to the Regional Administrator, U.S. Nuclear Regulatory Commission Region IV, 612 E. Lamar Boulevard, Suite 400, Arlington, Texas, 76011-4125; the Director, Office of Enforcement, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001; and the NRC Resident Inspector at the San Onofre Nuclear Generating Station facility.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter, its enclosure, and your response (if any) will be made 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/

Elmo E. Collins
Regional Administrator

Docket Nos. 50-361
50-362

License Nos. NPF-10
NPF-15

Enclosure 1: Notice of Violation
Enclosure 2: Inspection Report 05000361/2008013; 05000362/2008013
Attachment 1: Supplemental Information
Attachment 2: Special Inspection Charter
Attachment 3: Significance Determination Evaluation

cc w/Enclosure:
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SUNSI Review Completed: mch ADAMS: x Yes □ No Initials: mch
x Publicly Available □ Non-Publicly Available □ Sensitive x Non-Sensitive

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RIV:DRS/PSB2	DRS/EB1	SRI:DRP/D	SRA	ACES
MBaquera	SGraves	GWarnick	DLoveless	MHaire
/RA/	***/RA/***	***/RA – E/***	***/RA/***	***/RA/ by wbj***
12/9/08	12/9/08	12/10/08	12/12/08	12/15/2008
C:DRP/D	ACES	NRR	D:DRP	OE
MCHay	KSFuller	MAshley	DChamberlain	NHilton
/RA/	***/RA/***	***/RA/***	**/RA/**	***/RA/***
12/13/2008	12/10/2008	12/16/2008	12/15/2008	12/17/2008
RA				
EECollins				
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12/19/2008				

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NOTICE OF VIOLATION

Southern California Edison Company
San Onofre Nuclear Generating Station

Docket No. 50-361
License No. NPF-10
EA-08-296

During an NRC inspection completed on December 11, 2008, a violation of NRC requirements was identified. In accordance with the NRC Enforcement Policy, the violation is listed below:

> 10 CFR Part 50, Appendix B, Criterion V, "Instructions, Procedures, and Drawings," states, in part, that activities affecting quality shall be prescribed by documented instructions, procedures, or drawings of a type appropriate to the circumstances and shall be accomplished in accordance with these instructions, procedures, or drawings. Instructions and procedures shall include appropriate quantitative or qualitative acceptance criteria for determining that important activities have been satisfactorily accomplished.
>
> Contrary to the above, in March 2004, the licensee engaged in activities affecting quality that were not prescribed by documented instructions or procedures of the type appropriate to the circumstances. Specifically, maintenance and work control personnel failed to develop appropriate instructions or procedures, and failed to include quantitative or qualitative steps to ensure the maintenance activities on safety-related 125 Vdc station battery Breaker 2D201 had been satisfactorily completed. The work plan described in Maintenance Order 03100406000 was incomplete and lacked the steps necessary to ensure that electrical connection fasteners on Breaker 2D201 upper stud to bus bar connections were properly installed. This failure resulted in the Unit 2 safety-related Battery 2B008 being inoperable between March 2004 and March 25, 2008.
>
> This violation is associated with a White significance determination process finding.

Pursuant to the provisions of 10 CFR 2.201, Southern California Edison is hereby required to submit a written statement or explanation to the U.S. Nuclear Regulatory Commission, ATTN.: Document Control Desk, Washington, DC 20555-0001 with a copy to the Regional Administrator, Region IV, and a copy to the NRC Resident Inspector at the facility that is the subject of this Notice, within 30 days of the date of the letter transmitting this Notice of Violation (Notice). This reply should be clearly marked as a "Reply to a Notice of Violation; EA-08-296," and should include for each violation: (1) the reason for the violation, or, if contested, the basis for disputing the violation or severity level; (2) the corrective steps that have been taken and the results achieved; (3) the corrective steps that will be taken to avoid further violations and (4) the date when full compliance will be achieved. Your response may reference or include previous docketed correspondence, if the correspondence adequately addresses the required response. If an adequate reply is not received within the time specified in this Notice, an order or a Demand for Information may be issued as to why the license should not be modified, suspended, or revoked, or why such other action as may be proper should not be taken. Where good cause is shown, consideration will be given to extending the response time.

If you contest this enforcement action, you should also provide a copy of your response, with the basis for your denial, to the Director, Office of Enforcement, United States Nuclear

Regulatory Commission, Washington, DC 20555-0001.

Because your response will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's document system (ADAMS), accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html, to the extent possible, it should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the public without redaction. If personal privacy or proprietary information is necessary to provide an acceptable response, then please provide a bracketed copy of your response that identifies the information that should be protected and a redacted copy of your response that deletes such information. If you request withholding of such material, you must specifically identify the portions of your response that you seek to have withheld and provide in detail the bases for your claim of withholding (e.g., explain why the disclosure of information will create an unwarranted invasion of personal privacy or provide the information required by 10 CFR 2.390(b) to support a request for withholding confidential commercial or financial information). If safeguards information is necessary to provide an acceptable response, please provide the level of protection described in 10 CFR 73.21.

Dated this 19 day of December 2008

U.S. NUCLEAR REGULATORY COMMISSION

REGION IV

Docket:	50-361, 50-362
Licenses:	NPF-10, NPF-15
Report No.:	05000361/20078013; 05000362/2008013
Licensee:	Southern California Edison Co. (SCE)
Facility:	San Onofre Nuclear Generating Station, Units 2 and 3
Location:	5000 S. Pacific Coast Hwy. San Clemente, California
Dates:	August 4 through December 11, 2008
Team Leader:	G.G. Warnick, Senior Resident Inspector, Project Branch D, DRP
Team:	M.T. Baquera, Reactor Inspector, Plant Support Branch , DRS S.T. Graves, Reactor Inspector, Engineering Branch 1, DRS
Accompanying Personnel:	G.B. Skinner, Electrical Contractor (Beckman)
Approved By:	Elmo Collins, Regional Administrator

SUMMARY OF FINDINGS

IR 05000361/2008013, 05000362/2008013; 08/04/2008 – 12/11/2008; San Onofre Nuclear Generating Station, Units 2 and 3;

The report covered a 5-day period (August 4 – August 8, 2008) of onsite inspection, with in-office review through December 11, 2008, by a special inspection team consisting of one senior resident inspector, two reactor inspectors, and one electrical contractor. Eight findings were identified. The significance of most findings is indicated by its color (Green, White, Yellow, or Red) using Inspection Manual Chapter 0609, Significance Determination Process. Findings for which the significance determination process does not apply may be Green or be assigned a severity level after NRC's management review. 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.

Summary of Event

The NRC conducted a special inspection to better understand the circumstances surrounding deficient electrical connections. In accordance with NRC Management Directive 8.3, "NRC Incident Investigation Program," it was determined that these deficient electrical connection events potentially involved multiple failures in systems used to mitigate the effects of an actual event, involved potential adverse generic implications, and had sufficient risk significance to warrant a special inspection.

A. NRC-Identified and Self-Revealing Findings

Cornerstone: Initiating Events

- Green. The team identified a Green noncited violation of 10 CFR Part 50.65(a)(4) involving the failure to adequately assess the increase in risk and effectively implement risk mitigation actions for emergent maintenance activities. Specifically, on March 25 and March 26, 2008, the licensee failed to consider the risk associated with the increased likelihood of an initiating event during emergent work on energized safety-related 125 Vdc battery breakers. This issue was entered into the licensee's corrective action program as Nuclear Notification 200196248.

  This finding is greater than minor because the licensee's risk assessment failed to consider that the maintenance activities on the 125 Vdc breakers could increase the likelihood of initiating events. The finding is of very low safety significance based on a senior reactor analyst bounding risk estimation that assuming the performance deficiency resulted in operating the plant in an elevated risk configuration during emergent maintenance activities for a 24-hour period. The finding has a crosscutting aspect in the area of human performance associated with resources for the failure to provide appropriate risk management tools by maintaining complete, accurate, and up-to-date procedures [H.2(c)] (Sections 2.1.4 and 3.4).

Cornerstone: Mitigating Systems

- Green. The team identified a Green noncited violation of Technical Specification 5.5.1.1 involving the failure of an electrical maintenance supervisor to follow procedures after notification that Battery 2B008 terminal voltage was less than the TS required value of 129 Vdc. Specifically, the supervisor failed to notify the control room shift supervisor after being informed of a failed battery surveillance activity. The failure to follow procedures resulted in more than a two hour delay in entering the required 2-hour technical specification action statement. This issue was entered into the licensee's corrective action program as Nuclear Notification 200196248.

  The finding is greater than minor because it is associated with the equipment performance attribute of the mitigating systems cornerstone and affects the associated cornerstone objective to ensure the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. The finding is of very low safety significance based on a senior reactor analyst risk estimation assuming the performance deficiency resulted in operating the plant with an inoperable 125 Vdc battery for an additional period of 2.42 hours. The cause of the finding is related to the crosscutting element of human performance associated with decision making because personnel did not make safety significant decisions using a systematic process when faced with uncertain and unexpected plant conditions to ensure safety was maintained. This included the failure to formally define the authority and roles of the electrical maintenance supervisors for decisions affecting nuclear safety [H.1(a)] (Sections 2.1.2 and 3.1).

- Green. The team identified a Green noncited violation of Technical Specification 5.5.1.1, for the failure of electrical maintenance personnel to follow Procedure SO123-XX-1, "Action Request/Maintenance Order Initiation and Processing," Revision 20. Specifically, following identification of a failed 125 Vdc battery surveillance, troubleshooting activities were performed without a maintenance order and control room authorization. This issue was entered into the licensee's corrective action program as Nuclear Notification 200196248.

  The finding is greater than minor because it would become a more significant safety concern if left uncorrected in that more significant consequences could occur if work control procedures are not followed when performing maintenance on safety-related structures, systems, and components. The finding affected the mitigating systems cornerstone. The finding is of very low safety significance based on a senior reactor analyst estimation assuming the performance deficiencies resulted in operating the plant with an inoperable 125 Vdc battery for a period of 2.42 hours while troubleshooting activities were conducted. The finding has a crosscutting aspect in the area of human performance associated with decision making because the electrical maintenance personnel did not make safety significant decisions using a systematic process, especially when faced with uncertain or unexpected plant conditions [H.1.(a)] (Sections 2.1.2 and 3.2).

- Green. The team identified a Green noncited violation of Technical Specification 5.5.1.1, for the failure of electrical maintenance personnel to follow Procedure SO123-XX-5, “Work Authorizations,” Revision 17. Specifically, work to correct the identified degraded electrical condition was initiated prior to having an appropriately authorized maintenance order. This issue was entered into the licensee’s corrective action program as Nuclear Notification 200196248.

  The finding is greater than minor because it would become a more significant safety concern if left uncorrected in that more significant consequences would occur if work control procedures are not followed when performing maintenance on safety-related structures, systems, and components. The finding affected the mitigating systems cornerstone. Using the Manual Chapter 0609, "Significance Determination Process," Phase 1 Worksheets, the finding is determined to have very low safety significance because it was not a design or qualification deficiency, did not result in a loss of safety function, and did not screen as potentially risk significant due to external events. The finding has a crosscutting aspect in the area of human performance associated with work practices because the licensee did not perform adequate pre-job briefings and did not properly document the maintenance activities [H.4(a)] (Sections 2.1.3 and 3.3).

- White. The team identified a White violation of 10 CFR Part 50, Appendix B, Criterion V, “Instructions, Procedures, and Drawings,” involving the failure to establish appropriate instructions for performing maintenance activities on safety-related 125 Vdc station battery Breaker 2D201. As a result, during replacement of the breaker in March 2004 electrical connection integrity was not adequate to ensure that the equipment would be able to perform its safety function. This condition existed for approximately four years. This issue was entered into the licensee’s corrective action program as Root Cause Evaluation 800121216.

  The finding is greater than minor because it is associated with the equipment performance attribute of the mitigating systems cornerstone and affects the associated cornerstone objective to ensure the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. The final significance determination performed by the senior reactor analyst and approved by the NRC significance and enforcement review panel determined the finding was of low to moderate safety significance (White). This finding has a crosscutting aspect in the area of human performance associated with resources because the licensee failed to establish adequate procedures and programs related to electrical connection integrity [H.2(c)] (Sections 2.1.5 and 3.5).

- SL-IV. The team identified a Severity Level IV noncited violation of 10 CFR Part 50.73 for the failure of the licensee’s regulatory compliance organization to submit a required Licensee Event Report within 60 days after discovering an event requiring a report. Specifically, compliance personnel failed to properly assess the past operability of the safety-related 125 Vdc Battery 2B008, which had been inoperable for greater than the technical specification allowed outage time. This issue was entered into the licensee’s corrective action program as Nuclear Notification 200059017.

The finding was determined to be applicable to traditional enforcement because the NRC's ability to perform its regulatory function was potentially impacted by the licensee's failure to report the events. The finding was determined to be a Severity Level IV violation in accordance with Section D.4 of Supplement I of the NRC Enforcement Policy.

The finding has a crosscutting aspect in the area of problem identification and resolution associated with CAP because the licensee failed to thoroughly evaluate problems such that the resolutions address causes and extent of conditions. This includes properly classifying, prioritizing, and evaluating for operability and reportability conditions adverse to quality [P.1(c)] (Sections 2.1.6 and 3.6).

- Green. The team identified a Green noncited violation of 10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Actions," for the licensee's failure to establish measures to assure that deficient electrical connections were promptly identified and corrected. The licensees measures were not adequate to assure that a long standing degraded electrical connection was identified for correction during three inspection opportunities associated with safety-related Breaker 3BD21, "Diesel Radiator Fan 3E550 Feeder Breaker," that occurred between June 2005 and April 2008. This issue was entered into the licensee's corrective action program as Nuclear Notification 200047962.

  The finding is greater than minor because it is associated with the equipment performance attribute of the mitigating systems cornerstone and affects the associated cornerstone objective to ensure the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. Using the Manual Chapter 0609, "Significance Determination Process," Phase 1 Worksheets, the finding is determined to have very low safety significance because the condition did not represent an actual loss of safety function of a single train for greater than its technical specification allowed outage time, and did not represent an actual loss of one or more risk-significant non-technical specification trains of equipment for greater than 24 hours. This finding has a crosscutting aspect in the area of problem identification and resolution associated with corrective action program because the licensee failed to thoroughly evaluate problems such that the resolutions address causes and extent of conditions. This includes properly classifying, prioritizing, and evaluating for operability and reportability conditions adverse to quality. This also includes, for significant problems, conducting effectiveness reviews of corrective actions to ensure that the problems are resolved [P.1(c)] (Section 3.7).

- Green. The team identified a Green noncited violation of Technical Specification 5.5.1.1 for the failure to establish written procedures for a loss or degradation of a safety-related electrical power source. Specifically, no procedural guidance was provided to operations personnel to combat and recover from a loss or degradation of a Class 1E 125 Vdc bus. This issue was entered into the licensee's corrective action program as Nuclear Notifications 20060584 and 200196248.

The finding is greater than minor because it is associated with the procedure quality attribute of the mitigating systems cornerstone and affects the associated cornerstone objective to ensure the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. Using the Manual Chapter 0609, "Significance Determination Process," Phase 1 Worksheets, the finding is determined to have very low safety significance because it was not a design or qualification deficiency, did not result in a loss of safety function, and did not screen as potentially risk significant due to external events. This finding was reviewed for crosscutting aspects and none were identified (Section 3.8).

B. Licensee-Identified Violations

None.

REPORT DETAILS

1.0 SPECIAL INSPECTION SCOPE

The NRC conducted a special inspection at San Onofre Nuclear Generating Station (SONGS) to better understand the circumstances surrounding deficient electrical connections with the potential to adversely affect the safety function of multiple safety systems used for accident mitigation.

The team used NRC Inspection Procedure 93812, "Special Inspection Procedure," to conduct the inspection. The special inspection team reviewed procedures, corrective action documents, operator logs, design documentation, and maintenance records for various deficient electrical connection issues. The team interviewed various station personnel regarding one event, in particular, which occurred on March 25, 2008, associated with a degraded 125 Vdc battery terminal voltage. The team reviewed the licensee's apparent and root cause evaluations (RCE), directed assessment reports (DAR), past failure records, extent of condition evaluations, immediate and long term corrective actions, and industry operating experience (OE). A list of specific documents reviewed is provided in Attachment 1. The charter for the special inspection is included as Attachment 2.

2.0 SPECIAL INSPECTION OBSERVATIONS

2.1 Battery Breaker Loose Connections

2.1.1 NRC Review of Licensee Evaluations

On March 25, 2008, electrical maintenance personnel identified that terminal voltage for Battery 2B008 was at 121.29 Vdc, which was below the Technical Specification (TS) limit of 129 Vdc. Troubleshooting discovered that loose bolts at the battery to breaker terminal connection on Breaker 2D201 was the cause for the degraded battery voltage. Operations personnel declared the battery inoperable and entered TS 3.8.4 Limiting Condition for Operation (LCO), Condition A, which required restoration of the DC electrical power subsystem within 2 hours. The licensee initiated repairs after TS LCO 3.8.4, Condition A, was entered. Since the degraded condition was not corrected within 2 hours, the licensee entered TS LCO 3.8.4, Condition B, to commence a plant shutdown. However, the plant shutdown was suspended 10 minutes after Condition B was entered when all repairs on Breaker 2D201 were completed and Battery 2B008 was declared operable. Over the next day, maintenance verified that other similar battery breaker bus bolts were tight.

The licensee performed an apparent cause evaluation (ACE) assignment for Action Request (AR) 080301117 to evaluate the March 25, 2008, events associated with the failed surveillance. The ACE identified that the degraded battery voltage on Battery 2B008 was caused by a degraded electrical connection that had developed as a result of the loose bolts on Breaker 2D201. The ACE also documented that the most probable cause for the loose connections occurred during installation of a new thermal trip device on the breaker in March 2004 using Maintenance Order (MO) 03100406000.
AR 080301117 also included a field support assignment, performed by engineering personnel, to create OE for communication to the industry. The field support assignment

stated the battery may not have been able to support its DC bus loads while the battery breaker connection was degraded. Despite the statements documented in the ACE and field assignments, regulatory compliance personnel concluded that there were no past operability concerns with the degraded battery breaker connection since they independently determined that the condition was "failed when found."

In July 2008, the NRC resident inspectors performed an initial review of AR 080301117 and questioned the conclusions of regulatory compliance personnel since information in the ACE and field support assignments provided information that contradicted the conclusions of the reportability assessment. The inspectors challenged the "failed when found" conclusion which prompted the licensee to reevaluate the potentially reportable condition.

The inspectors observed that the purpose of ACE assignment for AR 080301117 was to determine the cause of the loose bolts and implement corrective actions to minimize the chance of recurrence. The evaluation identified that the cause of the loose connection was an individual performance error during installation of a new thermal trip device on the breaker in March 2004. Specifically, the evaluation determined that the electrician did not demonstrate the competency expected of maintenance personnel, in that, maintenance personnel are expected to correctly complete and accurately document all aspects of the job. The evaluation did, however, identify that the MO work plan steps did not specifically address torquing the breaker bolts and relied on "skill-of-the-craft" over detail and defense in depth to ensure successful torquing of the breaker bolts. However, no actions were taken to address the procedural inadequacies since it was concluded that it was not a current problem because greater emphasis had been placed on the identification and mitigation of critical steps in work plans since the 2003 timeframe that the MO was planned. The evaluation focused on the human performance aspects and determined that no current problem existed since the errors associated with Breaker 2D201 that occurred in 2004 was prior to several initiatives in maintenance to improve human performance. Consequently, the corrective actions identified consisted only of individual coaching and training to reinforce human performance expectations. Further, the inspectors observed that, in general, the licensee believed that the organization performed well in responding promptly to the failed surveillance, initiating the unit shutdown and immediate troubleshooting and corrective actions regarding the failed surveillance once the condition was discovered on March 25, 2008.

The inspectors determined that the licensee's evaluation of the condition in AR 080301117 for the loose battery breaker bolts was inadequate in that it failed to recognize the significance of the condition and address past operability and reportability. The inspectors determined that the degraded battery breaker connection issue was potentially safety significant. Additionally, the inspectors performed an extent of condition review and identified additional examples of loose electrical terminations on safety-related equipment. On July 21, 2008, the decision was made to perform a special inspection as a result of the follow up inspections performed by the inspectors.

As a result of the inspectors' identification of the inadequacies associated with AR 080301117, and the decision to perform a special inspection, the licensee performed RCE 800121216, "Inadequate Maintenance Activity Results in Loose Battery Breaker Connection in 2D201," and RCE 200059017, "Deficiencies Associated with the 2D201 Breaker Connection Reportablity Assessment," just prior to the commencement of the

special inspection. The RCEs were presented to the team for review at the beginning of the special inspection. The team was told that the RCEs represented a comprehensive and thorough evaluation of the events.

The team reviewed RCE 800121216 and observed that the licensee concluded that the causes associated with the loose battery breaker bolts were more programmatic rather than an individual performance error as previously identified in AR 080301117. Specifically, the licensee identified that the event was caused by inadequate procedure use, and inadequacies associated with work planning procedures and training when MO 03100406000 was planned in 2003. The evaluation also concluded that the underlying problems still exist presently as evidenced by recent events and evaluations, in addition to the substantive crosscutting issue in the area of human performance for failing to provide adequate procedures or work instructions described in NRC assessment letters dated March 3, 2008, and September 2, 2008.

The evaluation performed in RCE 200059017 concluded that the event was reportable. The evaluation was thorough with respect to deficiencies associated with the inadequate reportability review for AR 080301117. However, the sequence of events presented in the report was inaccurate (see timelines below). The evaluation also identified a previous failure to submit a licensee event report (LER) when required. The previous failure was identified by the NRC in 1997. The cause evaluation for the 1997 event found many of the same weaknesses in the reportability review process that were identified in RCE 200059017. However, the corrective actions from the 1997 event were either not implemented or were ineffective over the long term. The failure to implement corrective actions from the 1997 event contributed to the failure to adequately assess for reportability the degraded battery voltage event that occurred on March 25, 2008. Additionally, the licensee failed to identify corrective actions for some of the causes that were identified in the evaluation. One noteworthy example involved the identification that inadequate resources in the Compliance/Nuclear Regulatory Affairs Organization, contributed to ineffective management of corrective action backlogs, and may have been a potential underlying issue that resulted in the failure to perform an adequate reportability assessment.

The team concluded the RCEs were too narrowly focused on the specific issues associated with the failure to tighten the battery breaker bolts in 2004, and the inadequate reportability review for AR 080301117. Consequently, the evaluations lacked the rigor necessary to identify all performance deficiencies associated with the event for development of adequate corrective actions to address all root and contributing causes. The failure to thoroughly evaluate problems such that the resolutions address causes and extent of conditions has been previously identified during past NRC special inspections, and was the focus of a substantive crosscutting issue in the area of problem identification and resolution described in NRC Assessment Letters dated March 3, 2008, and September 2, 2008.

Timeline of Events Identified by Licensee

The licensee maintained that the organization performed well in responding to the degraded battery voltage that was identified on March 25, 2008. This conclusion was supported by the following sequence of the events as documented in the licensee's corrective action program (CAP):

March 25, 2008

~0550 Electricians discovered low voltage at Battery 2D2 during surveillance testing and reported the condition to the responsible supervisor.

~0610 The loose bolting connections were discovered during troubleshooting activities.

~0615 The Manager of Electrical maintenance discussed the loose connection issue with the Director of Operations.

~0630 The responsible electrical supervisor documented the adverse condition in AR 080301117.

0640 Operations Log noted: D2 battery declared inoperable as a result of electricians finding loose connection on battery breaker (battery side) while performing weekly battery checks. Per TS 3.8.4, Condition A, Unit 2 entered a 2 hour action to restore battery to operable or be in Mode 3 in 6 hours and Mode 5 in 36 hours. Notified Operations management.

0715 Electricians commenced troubleshooting and corrective maintenance. As directed by supervision and Step 1 of MO 08031721000 removed protective covers to access breaker bus connections. Discovered loose bolts on the battery side of the breaker bus connection.

0840 Operations Log noted: Initiated MSR Cooldown per SO23-10-2, Attachment 5. GOC notified. Entered 6 hour shutdown to Mode 3 per LCO 3.8.4, Action B.

0850 Operations Log noted: Exited LCO 3.8.4, Action B after tightening the loose cable connection from 2D2 Battery (B008) to the 2D2 Bus battery breaker, and completion of a satisfactory quarterly surveillance. Secured from MSR Cooldown, GOC and Chemistry notified.

Timeline of Events Identified by the Team

The team evaluated the timeline of events for March 25, 2008, through a review of vital area door access logs, control room log entries, MO records, and interviews with personnel involved. The licensee's documentation of the event was not consistent with information that the team identified during their review. There were four periods of time throughout this event that the team evaluated. This evaluation of the time periods was performed to assess the effectiveness of licensee's actions taken in response to the electrical connection deficiencies. Based on this evaluation, the following timeline was developed:

March 25, 2008

INITIAL DISCOVERY OF DEGRADED CONDITON

0408 The electricians entered the battery equipment area on the 50' elevation of the control building.

0410 The electricians began the weekly battery surveillance on Battery 2B008. The electricians identified that the measured voltage was less than the acceptance criteria, constituting an unsatisfactory (UNSAT) condition and failed surveillance. The electricians validated the degraded battery voltage reading.

0415 Electrical maintenance supervisor notified of failed surveillance and the condition. The supervisor instructed the electricians to discontinue the surveillance on Battery 2B008, and continue the surveillance on the remaining batteries.

0439 Electrical maintenance supervisor entered the battery equipment area.

TROUBLESHOOTING DEGRADED CONDITION

0445 The electrical supervisor verified the UNSAT readings on Battery 2B008. The supervisor decided that his immediate supervisor, the dayshift electrical maintenance General Foreman, should be notified prior to additional actions.

0500 The electrical supervisor called the General Foreman, described the condition, and requested that he come to the battery equipment area.

0538 The General Foreman and other electrical maintenance supervisors arrived at the battery equipment area to investigate the cause of the degraded battery voltage.

0540 Electrical maintenance supervision, including the General Foreman, re-validated the degraded voltage readings by performing measurements at various points in the circuit to determine the cause of the degraded battery voltage.

0550 The General Foreman took measurements inside of the cubicle for Breaker 2D201. Movement on a bolt was noted while placing a measuring probe on the battery to breaker connection and the voltage reading returned to normal. Coincident with this event, the 2D2 Trouble Alarm was received in the control room.

0555 The control room operator dispatched to investigate the 2D2 Trouble Alarm entered the battery equipment area and reported that an "Army of Guys" were assembled in the area. The control room supervisor directed the General Foreman to come to the control room.

CONTROL ROOM NOTIFICATION

0603 The General Foreman entered the control room to describe the situation to the control room supervisor.

0615 The control room supervisor contacted the shift manager and informed him that there had been anomalous voltage readings taken on Battery 2B008.

0628 Condition documented on AR 0803001117.

0635 The Electrical Maintenance Manager discussed the situation, including the fact that there were loose bolts on Breaker 2D201, with the shift manager. Actions necessary to repair the degraded connection were discussed.

0640 Battery 2B008 was declared Inoperable as a result of electricians finding loose connection on battery Breaker 2D201 and TS LCO 3.8.4, Condition A, was entered.

CORRECTIVE MAINTENANCE

0700 Electricians were briefed on the emergent battery breaker maintenance and were instructed to begin work to correct the condition. Eight bolts were found loose at the top side of the Breaker 2D201 to Battery 2B008 connections.

0840 TS LCO 3.8.4 action time expired. TS LCO 3.8.4, Condition B, was entered requiring a plant shutdown.

0850 Exited TS LCO 3.8.4, Condition B, after the loose bolts on the Breaker 2D201 to Battery 2B008 connections were tightened, and a quarterly battery surveillance test was satisfactorily completed.

The team's evaluation of the event timeline identified additional observations (Sections 2.1.2 through 2.1.4) that were not identified by the licensee's evaluations. The inadequacies associated with the licensee's evaluations for this event are similar to inadequacies that the NRC has identified in their follow up of other events during past special inspections. The team noted that the licensee's evaluation lacked the rigor necessary to ensure an accurate assessment of their responses to the degraded battery connections.

2.1.2 Discovery of Degraded Battery Condition

On March 25, 2008, electricians were in the progress of performing the weekly surveillance on safety-related Battery 2B008 per Procedure SO123-I-2.2, "125 Vdc Pilot Cell Battery Inspection," Revision 7. This surveillance satisfied the requirements of TS Surveillance Requirement 3.8.4.1. The electricians measured battery bank terminal voltage per Procedure SO123-I-2.2, Step 6.2, and identified that the measured voltage was less than the acceptance criteria of 129 Vdc. The measured voltage was 121.29 Vdc, constituting an UNSAT condition and failed surveillance. The electricians validated the degraded battery voltage reading and immediately notified their supervisor as required by Procedure SO123-I-2.2. Procedure SO123-I-2.2, Step 6.2.1.2, stated

that, “This supervisor **SHALL** report a failed surveillance according to Procedure SO123-I-1.3.” Procedure SO123-I-1.3, “Work Activity Guidelines,” Revision 14, required that, “A **SUPERVISOR SHALL** immediately provide written notification to the shift supervisor for any surveillance found failed.”

The team noted that the electrical maintenance supervisor notified of the UNSAT condition by the electricians did not immediately inform the operations shift supervisor as required by procedural guidance. The supervisor was acting in an upgrade capacity and inappropriately understood that he was expected to notify the electrical maintenance general foreman prior to taking further action. The team determined that the upgrade supervisor’s inaction was, in part, a result of ineffective supervisor training and unclear expectations. Instead of notifying the operations shift supervisor as required, electrical maintenance supervision, which included the nightshift supervisor and dayshift general foreman, performed unauthorized troubleshooting to more fully understand the cause of the degraded terminal voltage. The team observed that the behaviors of the electrical maintenance supervisors were such that an understanding of the cause, or explanation for the UNSAT reading, was desired before reporting the condition outside of the electrical maintenance organization.

As previously discussed operations personnel became aware of the degraded battery condition when an alarm annunciated in the control room as a result of the unauthorized troubleshooting. Following additional discussions between maintenance and operations personnel to reach an understanding of the degraded voltage reading, Battery 2B008 was declared inoperable and TS 3.8.4, Condition A, was entered. This TS entry time was approximately 2.42 hours after the identification of the UNSAT condition.

The failure of the electrical supervisor to immediately provide written notification to the shift supervisor after being informed of the failed surveillance was identified as a violation of procedural requirements. Additionally, the night shift electrical supervisor and dayshift general foreman performing unauthorized troubleshooting activities was identified as a procedural violation of the work control process. Details for these violations of Technical Specification 5.5.1.1, “Procedures,” are discussed in Sections 3.1 and 3.2 of this report.

2.1.3 Correction of the Loose Battery Breaker Connection

On March 25, 2008, electricians identified that the measured terminal voltage on Battery 2B008 was less than the acceptance criterion of 129 Vdc during a weekly surveillance. After verifying that the acceptance criterion was not met, the electricians notified their responsible supervisor of the failed surveillance and the UNSAT condition. The electrical maintenance supervisor told the electricians that he would come to the battery equipment area to assess the situation. The supervisor gathered system drawings, proceeded to the battery equipment area, and performed various measurements to troubleshoot the cause of the failed surveillance. A while later, at the beginning of dayshift, the electrical maintenance general foreman and another electrical supervisor arrived at the battery equipment area. The electrical maintenance supervisors continued troubleshooting activities to more fully understand the cause of the degraded voltage condition.

During the troubleshooting activities, the general foreman opened panels on the

associated breaker, which were labeled as being a “Unit Trip Hazard,” to investigate the cause of the degraded voltage readings. While placing a probe on the energized bus bar, a bolt moved, and the charger was observed to commence battery charging. Battery 2B008 terminal voltage was re-verified and it was observed that the reading had returned to normal. The unauthorized troubleshooting activities identified that loose bolting on the Breaker 2D201 terminal connection was the cause for the degraded battery voltage. Coincident with the movement of the bolt, the 2D2 Trouble Alarm was received in the control room. Operations personnel were dispatched to investigate the cause of the alarm. Upon arrival at the battery equipment area, operations personnel observed numerous electrical maintenance personnel troubleshooting the degraded equipment condition. At the request of the control room supervisor, the general foreman returned with the operator to inform the control room of the situation. This was the first time that operations personnel became aware that there was an issue with Battery 2B008.

The manager of electrical maintenance discussed the emergent equipment condition with the shift manager, including actions necessary to repair the degraded connection on Breaker 2D201. As a result of ineffective communications, work was not appropriately authorized and an MO was not available prior to initiating work. The manager of electrical maintenance believed that the corrective maintenance activities would be performed per the Shift Manager Accelerated Maintenance (SSAM) process. However, the team was unable to identify any evidence that the requirements associated with using the SSAM process, contained in Procedure SO123-XX-5, were followed. For example, the team determined that no shift manager’s log entry was made to document implementation of SSAM, as required by procedural guidance, and an advance copy of the MO was not available prior to initiating work. Further, during an interview the shift manager did not recall authorizing the use of SSAM. The shift manager understood that the paperwork required to perform the corrective maintenance was ready, and that he was providing verbal authorization to the manager of electrical maintenance to commence work. The team was unable to identify any evidence that the requirements for verbal authorization, contained in Procedure SO123-XX-5, were followed since the subject activities were beyond the scope of activities allowed to be performed by verbal authorization.

The team determined that the repair activities associated with the degraded electrical connection was identified as a procedural violation of the work control process. Details associated with this violation of Technical Specification 5.5.1.1, “Procedures,” are discussed in Section 3.3 of this report.

2.1.4 Extent of Condition Inspection

On March 25 and 26, 2008, MOs were implemented to verify that other connections associated with the Units 2 and 3 safety-related battery breakers were properly tightened. The decision was made to perform the work energized based on time constraints and the inability to completely de-energize the breaker in the current mode of operation. Performing the work on energized equipment introduced additional risk since the area in which the work was performed was restrictive, difficult to access, and included terminal connections in close proximity to each other. An error in the confined area could have resulted in a loss of the 125 Vdc bus and a subsequent reactor trip.

Procedure SO123-XX-10, "Maintenance Rule Risk Management Program Implementation," Revision 4, described the licensee's process for implementation of the requirements of 10 CFR 50.64(a)(4). Procedure SO123-O-A2, "Operations Division Personnel Responsibilities," Revision 9, described the shift technical advisors (STA) responsibilities. One responsibility of the STA was to perform the maintenance rule risk management program (MRRMP) once per shift and prior to changing the configuration of equipment important to safety. The team determined that the MRRMP performed by the STA on March 25 and 26, 2008, did not appropriately assess and manage the risk associated with the emergent work activities. The team noted that only industrial safety precautions were implemented which included the use of insulated tools and blankets for performing the work. The team determined that these industrial safety measures resulted in actions that incidentally helped to manage the likelihood of an error that could have caused an initiating event.

The team concluded that the licensee's program lacked specific guidance for appropriately assessing and managing risk for emergent items that are non-routine, such as the scope of work performed on March 25 and 26. Procedure SO123-XX-10, stated that, "The MRRMP assessment method may use quantitative approaches, qualitative approaches, or blended methods." One qualitative item that the assessment should consider is, "The likelihood the maintenance activity will significantly increase the frequency of a risk-significant initiating event." The team observed that the MRRMP performed by the STA each shift, inappropriately focuses on the quantitative approach, and does not incorporate qualitative approaches when conditions warrant.

The failure to assess and manage the risk associated with the increased likelihood of an initiating event while working on energized safety-related reactor trip hazard equipment was identified as a violation of 10 CFR Part 50.65(a)(4). Details associated with this violation are discussed in Section 3.4 of this report.

2.1.5 Cause of the Loose Battery Breaker Connection

On March 25, 2008, while performing a weekly battery surveillance, the terminal voltage of safety-related Battery 2B008 was measured at 121.29 Vdc. The TS minimum terminal voltage for this battery is 129 Vdc. The safety function of the Battery 2B008 is to provide power to the loads on 125 Vdc Bus 2D2 during three types of accident scenarios: Safety Injection Actuation Signal (SIAS) with Loss of Voltage Signal, Degraded Grid Voltage with SIAS Signal, and Station Blackout.

Following discovery of the inadequate terminal voltage, the battery was declared inoperable and TS LCO 3.8.4, Condition A, was entered. Troubleshooting identified eight loose fasteners on the Breaker 2D201 upper stud to bus bar connections. It was determined that around March 21, 2008, a high resistance connection developed due to the loose fasteners, resulting in the failure of the battery to meet the TS minimum terminal voltage requirements.

Action Request 080301117 was initiated to correct the loose connections. The deficient electrical connections were corrected and the battery bus was declared operable shortly after the 2 hour action statement had expired. An ACE was initiated to evaluate the condition. The ACE determined that the most probable cause for the loose connections occurred during installation of a new thermal trip device on the breaker in March 2004

using MO 03100406000, “Change the Short Time Delay Settings per Calc E4C-109 for Breaker 2D201.” Although the high resistance connection developed around March 21, 2008, which resulted in the degraded voltage condition, the team concluded that the safety-related battery was not maintained in a configuration capable of performing its function during all design basis events during the four year period in which the fasteners did not meet the design criteria for electrical connection integrity.

The team reviewed MO 03100406000 to determine the scope of the maintenance action, and whether the MO had sufficient detail, instructions, and acceptance criteria to ensure that activities affecting quality were satisfactorily accomplished. The team identified that the *Work Plan Detail* section of the MO provided limited instructions on accomplishing the task, relying on “skill-of-the-craft” over detail and defense in depth. Section I required craft to obtain a replacement breaker and test in accordance with applicable sections of Procedure SO123-I-4.7 (Molded Case Circuit Breakers). This procedure had no quantitative steps to torque compression-type electrical connections. Additionally, Section II had only two steps: a) Obtain work authorization; and b) Remove Breaker 2D201 and install the successfully tested replacement breaker. The MO did not have steps to torque breaker connections during or after installation.

The failure to develop and implement an adequate procedure for installation of the safety-related 125 Vdc station battery breaker 2D201 in March of 2004 was identified as a violation of 10 CFR Part 50, Appendix B, Criterion V, “Instructions, Procedures, and Drawings.” Details associated with this violation are discussed in Section 3.5 of this report.

2.1.6 Reportability Review

The team reviewed the reportability assignment for AR 080301117. Procedure SO123-XV-52, “Functionality Assessments and Operability Determinations,” Revision 7, provided the requirements for performing reportability assessments. Procedure SO123-XV-52, Attachment 14, described the process overview. Attachment 14 stated that the responsible engineer and compliance engineer shall assess reportability. It also stated that engineering input may be bypassed by regulatory compliance personnel when the issue is obviously reportable. The team observed that the reportability assessment for AR 080301117 bypassed engineering input, even though the issue was not obviously reportable. Regulatory compliance personnel independently concluded that Battery 2B008 was “failed when found” based on their determination that there was no compelling evidence of an earlier failure. In July 2008, the NRC resident inspector performed an initial review of AR 080301117 and questioned the conclusions of regulatory compliance personnel since information in the ACE and field support assignments provided information that contradicted the conclusions of the reportability assessment.

The team observed that the reportability assessment only focused on the aspects of the initiation of a plant shutdown and failed to consider the degraded connection’s potential impact on past operability. After a subsequent review, prompted by the NRC, the licensee determined that Battery 2B008 was inoperable for greater than the TS allowed outage time. Licensee Event Report 05000361/2008-006-00 was submitted to the NRC on September 17, 2008, to report the event.

The team performed a two month sampling of reportability assessments and identified that engineering input was bypassed by regulatory compliance personnel for 95 percent of the assessments that were not obviously reportable. The team also observed that reportability assignment backlogs were inadequately managed, resulting in reportability assessments that were less than adequate. Based on the programmatic issues identified by the team, the licensee initiated an action to perform an extent of condition review to assess the adequacy of reportability reviews performed for the identified electrical connection issues associated with safety-related equipment.

The failure to report that a 125 Vdc battery was inoperable for approximately four years, a condition prohibited by technical specifications, was identified as a violation of 10 CFR Part 50.73, "Licensee Event Report System." Details associated with this violation are discussed in Section 3.6 of this report.

2.2 Failure to Maintain Design Control for Electrical Connections

Following NRC inspectors' initial review of AR 080301117 that discussed the loose electrical connections affecting the 125 Vdc battery breaker the inspectors questioned whether other degraded electrical connection issues had been identified by the licensee. Based on these questions additional examples were identified consisting of: (1) on June 25, 2005, emergency supply Fan 3A276 failed due to a loose wire, which resulted in the inoperability of the emergency diesel generator (EDG) 3G003; (2) on September 17, 2007, loose electrical bolt connections were identified affecting 125 Vdc Bus 2D2; (3) in 2007, a loose electrical connection was identified affecting emergency chiller supply Breaker E336; and (4) on July 9, 2008, a loose electrical connection was found affecting EDG 3G002 cooling fan supply breaker.

Based on these examples having the generic potential to adversely affect the safety function of multiple safety systems used for accident mitigation the NRC concluded that a special inspection was warranted. The special inspection team performed a review of plant corrective action documents, procedures, and work orders, associated with deficient electrical connections to determine whether the existing processes for control of electrical connection integrity were adequate.

From January 2005, to July 2008, the team noted that over 30 loose electrical connection events occurred, with thirteen events occurring in equipment important to safety. Loose electrical connections that were identified and evaluated included the following:

Item	Equipment	Description	Condition
1	3A276	EDG 3G003 Building Supply Fan (3BH11)	Failed to start; Discovered June 2005
2	3A277	EDG 3G002 Building Supply Fan (3BH12)	2 loose connections; Discovered June 2005
3	E549	EDG 3G002 Radiator Fan (3BH07)	Discovered June 2005
4	2BY37	Fuel Handling Building Pump Room Emergency Air Conditioning Unit E441 Feeder Breaker	Failed to run; Discovered March 2007

5	2BJ06	Safety Injection Tank 2T008 to Reactor Coolant Loop 1A Valve 2HV9340	Documented January 2006

6	3BE06	Auxiliary Feedwater to Steam Generator Control Valve 3HV4713	3 loose connections; Discovered August 2005
7	2BY30	Component Cooling Water Building Pump Room Emergency AC Unit E453	Loose grounding wire in MCC bucket; Discovered July 2005
8	2BE11	Safety Injection Tank T009 to Reactor Coolant Loop 2A Valve 2HV9360	3 loose connections; Discovered January 2006
9	BS09	Control Building Control Room Emergency Air Supply Fan A206	Loose connection in indicator circuit; Discovered February 2006
10	2/3ME336	Emergency Chiller Supply Breaker E336	Control panel power failure; Discovered June 2007
11	2B008	125 Vdc Battery 2D2	Loose connection on bus bar; Discovered September 2007
12	3RY7870	Condenser Air Ejector Wide Range Radiation Monitor	Failed Surveillance; Discovered June 2008
13	3BD21	Diesel Radiator Fan 3E550 Feeder Breaker	Degraded connection; Discovered July 2008

The team reviewed several procedures listed in the RCE associated with loose electrical fasteners. Examples of identified weaknesses are discussed below and associated with the following procedures:

- SO123-I-4.7, "Molded Case Circuit Breakers," had no steps with quantitative values for torques associated with electrical connections.

- SO123-I-4.59.6, "600V Power Cable Termination & Repair Guide," Attachment 4, "Maximum Recommended Torque Value for Electrical Terminations," listed values for various bolt sizes and materials. The torque value units were listed as lb/in and lb/ft. Torque values are generally listed in units of distance – force and not force/distance (i.e. foot-pounds, inch-pounds, etc.).

  Attachment 4 listed "SCE Engineering Standards Electrical Construction Station, Fittings – Bolted- Torque Data 31-85-10." This document was the reference document from which torque values were taken. The licensee informed the team that this document was no longer available and could not be located. No further references for these torque values were provided.

- SO123-I-9.11, "480V Load Center and Transformer Inspection and Cleaning," Attachment 4, Maximum Recommended Torque Values, Mechanical Bolting table, showed a fastener size of 5/16" X 28, which differs from the threads-per-inch values listed in reference Procedure SO123-I-4.59.6, which listed a size of 5/16" X 24.

- SO123-I-9.13, “480VAC Linestarter Inspection, Coil and Power Contact Replacement,” Step 6.5.7, required line and load side connectors for molded case circuit breakers to be tightened firmly. The step does not provide quantitative values for torque of compression-type connectors on molded case circuit breakers.

In general, the team observed the following inadequacies for establishing adequate electrical connections: (1) quantitative acceptance values in steps for torquing electrical connectors in procedures were inadequate to ensure that these important activities have been properly completed; (2) maintenance orders involving reestablishing connection integrity were limited in scope and thoroughness; and (3) maintenance orders frequently did not have quantitative steps or values for required torques.

The team reviewed documentation associated with training in the establishment and maintenance of electrical connections. Documents describing the training program for torquing mechanical bolted connections and instrumentation and control connections were provided. While training programs existed for mechanical bolted connections, formal training related to electrical connections was limited to instrumentation and control connections. No training documents related to general electrical connection integrity was provided. The team determined that formal training on torquing electrical connections was not provided, and the reliance on skill of the craft, does not appear adequate to ensure uniform application of proper techniques for making electrical connections.

The team determined that these electrical deficiencies resulted in configurations where structures, systems, or components, may not have been able to perform their design function during a seismic event. The integrity of electrical connections is a key element in the reasonable assurance of operability. The failure to ensure that appropriate measures were maintained to assure that systems specified in the design basis were maintained in a configuration which provided a reasonable assurance of operability during design basis events is being considered an unresolved item pending further NRC review: URI 05000361; 05000362/2008013-07, “Degraded Electrical Connections.”

2.2.1 Actions to Identify and Correct Deficient Electrical Connections

The team reviewed the adequacy of licensee’s ability to identify, evaluate, and establish corrective actions related to identified loose electrical connections. The team noted that in June of 2005, EDG 3G003 Building Supply Fan 3BH11 failed to start during a surveillance test. The failure was attributed to a loose electrical connection at the thermal overload for the fan. Further investigation by the licensee revealed that similar loose connections existed at the EDG 3G003 building supply fan and radiator fan. The licensee performed RCE 050601315 to further understand the failure of these safety-related components. The corrective actions identified by the RCE included the development of a fastener trending program to more accurately capture data on the looseness of electrical connection fasteners found during maintenance and inspections. Trending of loose fasteners was implemented by the revision of several procedures to incorporate acceptance criterion for fastener tightness, and a requirement to submit a corrective action document when this criterion was not met. The intent of the corrective action was to describe the loose fastener and its relative tightness.

The ability to identify and correct degraded electrical connections must be a priority in maintenance programs dealing with electrical equipment. The effectiveness of maintenance programs depend, in part, upon establishing adequate criteria for identification, trending, and repair of degraded conditions. The team noted that the licensee's acceptance criterion for trending and repair of loose electrical connections was based on a condition identified as "less than 1-turn loose criterion."

The team requested information that described the basis for the acceptance criterion used to determine input to the fastener trending program. An email message from a member of the licensee staff was provided to the team to document the origin of the 1-turn loose criterion. The email message stated that bench testing was performed to evaluate the impact to electrical connections with fasteners being less than fully tightened. The devices used in the testing were identified as 49-auxiliary device (thermal overload) and 42-auxiliary device (contact) assemblies. The testing consisted of wiring the auxiliary contact assemblies with ring-tongue lugs commonly used in the plant and fastened with screw type connectors. The connector was gradually loosened, ¼-turn at a time and circuit continuity measured. The position of the fastener was noted when continuity was lost. This test validated the connection geometry integrity for only the 49 and 42-auxiliary devices, with ring tongue style terminal lugs. No other testing was conducted to validate the 1-turn loose criterion for different types of electrical connections.

The team noted several procedures listed in the RCE associated with loose electrical fasteners that referenced use of the 1-turn loose criterion:

- SO123-I-4.7, "Molded Case Circuit Breakers," had no steps with quantitative values for torques associated with electrical connections, and several steps listed the 1-turn loose criterion as the acceptance basis.

- SO23-I-2.27, "Line Starter Thermal Overload Bypass Inspection," Step 6.2.1.2.10, required craft to generate an AR to correct suspect [loose] connections and to verify other connections were NOT loose. One bullet item stated that the AR include the 1-turn loose criterion as the required acceptance criterion.

- SO123-I-4.59.6, "600V Power Cable Termination & Repair Guide," Step 6.6.2, stated the following, "Where it is NOT physically possible to use ring tongue connections use the same connection method supplied by the vendor. The 1-turn loose criterion has only been validated using ring tongue connections."

The team concluded that the application of the 1-turn loose criterion to broad classes of electrical connections, without analysis supporting the applicability, is a programmatic weakness. Not all electrical fastener geometries will remain operable when the fastener is not securely tightened. Further, the team observed that no guidance documents were created to establish trending program guidelines, and no specific process existed for disposition of fastener issues that met the 1-turn loose criterion. In fact, RCE 050601315, Assignment 98, to evaluate results of the trending program was inappropriately closed approximately one year after the trending program was implemented. Application of the "less than 1-turn loose" criterion in procedures for inspecting or performing electrical connections for different types of connections was

non-conservative in application, and inadequate to prevent loose electrical connections in different fastener geometries.

The team determined the following event also illustrates the ineffectiveness of corrective actions taken for the significant conditions evaluated in RCE 050601315. On July 9, 2008, safety-related Breaker 3BD21, "Diesel Radiator Fan 3E550 Feeder Breaker," was declared inoperable by an immediate operability assessment performed as part of Nuclear Notification (NN) 200047962. The notification was generated following the discovery of a stripped compression connector for the breaker B-phase conductor, with visible signs of melting, and insulation degradation due to overheating.

Breaker 3BD21 was previously inspected, under AR 050601324 and MO 05062182000, as part of the extent of condition review for RCE 050601315. MO 05062182000 was written to check for loose connections in motor control center Panel 3BD. The MO required the licensee to test the wires and connectors for loose connections by performing a wiggle test, and tighten any loose connections found. The inspection of Breaker 3BD21 was listed as completed on June 26, 2005, with no degraded conditions identified. Additionally, on August 7, 2007, maintenance was performed on the line starter for radiator Fan 3E550 per MO 05080446000 using Procedure SO123-I-9.13, "480 VAC Linestarter Inspection, Coil and Power Contact Replacement." Step 6.3.2 of the procedure required inspection of internal wiring, including both line-side and load-side breaker connections. The procedure step was marked as being satisfactory in the MO, with no degraded conditions identified.

On April 14, 2008, a thermographic image was taken of Breaker 3BD21 while under load. The team requested a copy of the thermal image, but was told no image was available. Procedure SO23-V-2.14, "Thermal Inspection of Plant Components," Section 6.3, Note 1, stated, in part, that thermal images should be taken of each inspection, as this allows for trending and review of each thermographic inspection point. Procedure SO23-V-2.14, Attachment 5, "Unit 3 motor control center and Electrical Equipment Inspection," Section 1.C(3), stated that, if an anomaly is found during an inspection, obtain sufficient data to document a complete description of the thermal state of the component. Section 1.D required generation of an AR for any identified equipment problems, such as fasteners that need repair. Based on discussions with the licensee, thermographic images are only stored when anomalies meeting licensee-established severity criteria are exceeded and confirmed by the thermographer. Procedure SO23-V-2.14, Section 7.0, stated, in part, that the thermal inspection program is not required for licensing or regulatory compliance, therefore results of thermal inspections are not required as part of permanent plant records.

In conclusion, the team noted that Breaker 3BD21 had been inspected as part of the extent of condition review for RCE 050601315, and had been subsequently subjected to thermography and a preventive maintenance inspection using the post RCE 050601315 maintenance programs and procedures. Evidence of a long standing degraded connection was not identified for correction during three inspection opportunities. The deficient electrical connection was only discovered by the licensee on July 9, 2008, while performing work on adjacent equipment.

The team determined the licensee failed to establish measures to assure that deficient electrical connections were promptly identified and corrected. This performance

deficiency was also identified as a violation of 10 CFR Part 50, Appendix B, Criterion XVI, “Corrective Actions.” Details associated with this violation are discussed in Section 3.8 of this report.

2.2.2 Directed Assessment Report Evaluation

In July 2008, the licensee prepared a DAR titled, “Loose Electrical Fastener Assessment.” The DAR was performed in response to NN 200066209 and Corrective Action Order 800126624. The purpose of the DAR, as stated in the executive summary, was to assess the extent and significance of loose electrical connections at the facility. To accomplish this, the DAR defined seven objectives including data searches, an assessment of corrective actions, and assessment of practices and experience relative to industry peers. The time period examined was post-RCE 050601315 (late 2005 to the present).

The team reviewed the DAR to determine whether it demonstrated that the licensee understood the nature and extent of the issues associated with deficient electrical connections. Since the DAR was not a formal corrective action document, the team also reviewed the DAR to determine whether it identified any items that needed to be documented in the corrective action program.

The team concluded that the seven objectives, as stated in the DAR, were not sufficiently focused and complete to enable a thorough determination of the extent and significance of loose electrical connections at the facility. In particular, the DAR was not well focused on identifying whether corrective actions were actually effective in identifying and correcting deficient electrical connections.

As part of Objective 1, the DAR provided a tabulation and graph of loose connections found since the implementation of the trending program. The data showed an increasing trend in the number of loose connections discovered in both safety-related and non-safety-related equipment. The DAR remarked favorably on the effectiveness of station practices to identify loose connections but did not address the apparent failure of the trending program to reduce the number of loose connections being discovered. The team noted that the increase in discovery would be expected immediately following the implementation of new procedures in 2005, but the increasing trend has persisted to the present. This trend was not noted or evaluated in the DAR. In addition, the team noted that the threshold for documenting loose fasteners in the CAP was an as-found acceptance criterion of one or more turns loose. The team concluded that this criteria potentially excluded a large number of deficient connections since less than 1-turn loose is typically enough to completely remove pressure from a wire or lug. Consequently, the data documented in the DAR may have been considerably more optimistic than actual field conditions.

A survey of other nuclear plants was also conducted as part of the data search under Objective 1. The survey included two questions, the first regarding the incidence of loose connections and the second regarding practices for discovery and correction. The DAR concluded that the data showed that the practices at SONGS were comparable to the industry peers. However, the team noted that, based on survey results, the incidence of loose connections was much greater at SONGS than at most other plants. Nonetheless, the DAR ignored this result and only discussed conclusions relative to practices.

Objective 2 determined how many preventive maintenance activities had been performed since the implementation of corrective actions for RCE 050601315 in order to

assess the effectiveness of the actions. However, the DAR did not evaluate the effectiveness of the preventive maintenance activities by identifying how many items with loose connections discovered since 2005 had previously been inspected following the implementation of the actions associated with RCE 050601315. As previously discussed, the team identified examples where preventive maintenance inspection activities were not effective in identifying electrical connection deficiencies.

Objective 3 was intended to perform an effectiveness review for corrective actions from RCE 050601315. A key measure to determine effectiveness of corrective actions is whether or not it prevents recurrence of the problem. This measure was not assessed under Objective 3. Instead, the assessment of this topic was focused on process issues rather than the fundamental problem of deficient electrical connections. The assessment concluded that Assignment 98 from RCE 050601315 to perform a data review had been inappropriately closed. It also identified that assignments had been closed with no actions, and that there was no actual trending of loose connections being performed. All of these items had been previously identified by the NRC. By contrast, there was no discussion of the apparent continued occurrence of loose fastener problems.

Although the DAR was of questionable effectiveness in accomplishing its stated objectives, it did document several problems and recommendations for improvement. However, the licensee did not enter these DAR findings and recommendations into the CAP until prompted by the team during the special inspection. The licensee then initiated NN 200089167 for the slow corrective action response, and NN 200066209 to document the actual DAR issues.

2.2.3 Operating Experience Reviews

Personnel from the Operating Experience Branch of Nuclear Reactor Regulation supported the team by performing searches of OE databases and other sources. The intent was to identify OE reports of similar problems and other relevant information. The team also performed searches of internal events at SONGS and reviewed the searches performed by licensee personnel in support of their cause evaluations.

The licensee documented their review of OE for the March 25, 2008, events in ACE 080301117, and later in an RCE 800121216. Due to the narrow scope for the search criteria used in both the ACE and RCE, the licensee missed relevant OE. Internal OE existed, that documented significant failures of safety-related components due to loose connections. For example, in 2003, a loose connection caused the failure of a high pressure safety injection header isolation valve during a simulated safety injection actuation signal. A noncited violation (NCV) was identified, NCV 05000361/2003002-06, for the licensee's failure to establish adequate maintenance procedures to assess the condition of electrical terminations. This NCV is similar to the team's conclusion that procedures were inadequate to properly install the Breaker 2D201 and terminate electrical connections to Bus 2D2 (Section 3.5).

The team observed that the OE review for RCE 800121216 was not completed in accordance with the requirements of Procedure SO123-XV-50.39, "Cause Evaluation Standards, Methods, and Instructions," Revision 8. The OE review for RCE 800121216 only referenced an OE review that was completed as part of the July 2008 DAR,

performed to assess loose electrical fasteners. The OE review in the DAR only looked at the two years prior to the March 25, 2008, event, which was contrary to guidance in Procedure SO123-XV-50.39. Root cause evaluations require that the OE review covers, at a minimum, the four year period leading up to the event.

3.0 SPECIAL INSPECTION FINDINGS

3.1 Untimely Entry Into Technical Specification Action Statement

The team identified a Green NCV of TS 5.5.1.1 for the failure of an electrical maintenance supervisor to follow procedures after notification that Battery 2B008 terminal voltage was less than the TS required value of 129 Vdc. Specifically, the supervisor failed to notify the control room shift supervisor after being informed of a failed battery surveillance activity. The failure to follow procedures resulted in over a 2 hour delay in entering the required 2 hour TS action statement. Details associated with this finding are described in Section 2.1.2.

The failure to follow procedural requirements for notification of the operations shift supervisor after being informed of a failed battery surveillance was a performance deficiency. The finding is greater than minor because it is associated with the equipment performance attribute of the mitigating systems cornerstone and affects the associated cornerstone objective to ensure the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. In accordance with NRC Inspection Manual Chapter 0609, Attachment 4, “Phase 1 – Initial Screening and Characterization of Findings,” a Phase 2 estimation was required because the finding resulted in the loss of safety function for the Unit 2 safety-related Battery 2B008 for greater than the TS allowed outage time.

The team performed a Phase 2 estimation in accordance with NRC Inspection Manual Chapter 0609, Appendix A, "Determining the Significance of Reactor Inspection Findings for At-Power Situations." The team assumed that the performance deficiency affected the risk of operating the plant for 2.42 hours because the failure to follow plant procedures resulted in delaying corrective action for this period of time. As a result, in accordance with Appendix A, Attachment 1, Step 2.1.2 “Determine the Appropriate Exposure Time,” the team selected an exposure period (EXP) of less than 3 days. Using the Risk-Informed Inspection Notebook for SONGS Units 2 and 3, Revision 2.1a, the team selected “Battery of One Panel (bus) Fails,” as the appropriate target for the subject finding in the presolved table. The team utilized the presolved table to determine that the finding was Green and that core damage frequency was the dominant contributor. Therefore, no large-early release frequency analysis was required.

Because the result from the presolved table indicated that the result was greater than or equal to 1×10^{-7}, the team requested the senior reactor analyst to evaluate the potential contribution to risk from external events. As documented in Attachment 3 to this inspection report, the analyst determined that seismic events were the only external initiators that significantly contributed to risk for this finding. The analyst calculated the change in seismic-related core damage frequency ($\Delta CDF_{Seismic}$) resulting from the

improperly terminated Battery 2B008 to be 1.45 x 10^{-6}/year. Therefore, the analyst calculated the change over a 2.42-hour period ($\Delta CDF_{2.42}$) as follows:

$\Delta CDF_{2.42}$ = $\Delta CDF_{Seismic}$ ÷ 8769 hours/year * EXP

= 1.45 x 10^{-6}/year ÷ 8769 hours/year * 2.42 hours

= 4.0 x 10^{-10}

Based on the results of the Phase 2 estimation and the analysis of external events, the finding is determined to have very low safety significance.

The team determined that this finding has a crosscutting aspect in the area of human performance associated with decision making because maintenance personnel did not make safety significant decisions using a systematic process when faced with uncertain and unexpected plant conditions to ensure safety was maintained. This included the failure to formally define the authority and roles of the electrical maintenance supervisors for decisions affecting nuclear safety [H.1(a)].

Technical Specification 5.5.1.1 requires, in part, that written procedures be established, implemented, and maintained covering the activities specified in Appendix A, "Typical Procedures for Pressurized Water Reactors and Boiling Water Reactors," of Regulatory Guide 1.33, "Quality Assurance Program Requirements (Operations)," Dated February 1978. Appendix A, Section 8.b, requires procedures for the performance of surveillance tests, inspections, and calibrations. Procedure SO123-I-2.2, "125 Vdc Pilot Cell Battery Inspection," Revision 7, implemented the requirements of TS Surveillance Requirement 3.8.4.1. Contrary to the above, on March 25, 2008, following notification of a failed surveillance identified by electricians, electrical maintenance supervisors failed to make a timely notification as required by Procedure SO123-I-2.2. Specifically, electrical maintenance supervisors failed to follow Procedure SO123-I-2.2, Step 6.2.1.2, which required that, "This supervisor **SHALL** report a failed surveillance according to Procedure SO123-I-1.3." Procedure SO123-I-1.3, "Work Activity Guidelines," Revision 14, required that, "A **SUPERVISOR SHALL** immediately provide written notification to the shift supervisor for any surveillance found failed." As a result of the untimely notification, operations personnel only became fully aware of the degraded battery condition 2.42 hours after the degraded condition was discovered, and entered the requirements of TS 3.8.4, Condition A, to perform actions within 2 hours to restore Battery 2B008 to operable status. Because this finding is of very low safety significance and has been entered into the licensee's CAP as NN 200196248, this violation is being treated as an NCV, consistent with Section VI.A of the NRC Enforcement Policy: NCV 05000361/2008013-01, "Failure to Follow Procedure Delays Entry Into Technical Specification Condition."

3.2 Unauthorized Troubleshooting on Safety-Related Equipment

The team identified a Green NCV of TS 5.5.1.1, for the failure of electrical maintenance personnel to follow Procedure SO123-XX-1, "Action Request/Maintenance Order Initiation and Processing," Revision 20. Specifically, electrical maintenance personnel performed troubleshooting on safety-related equipment without an MO and control room authorization. Details associated with this finding are described in Section 2.1.2.

The failure of electrical maintenance personnel to follow work control procedures during the events of March 25, 2008, was a performance deficiency. The finding is greater than minor because it would become a more significant safety concern if left uncorrected in that more significant consequences would occur if work control procedures are not followed when performing maintenance on safety-related structures, systems, and components. The finding affected the mitigating systems cornerstone. In accordance with Manual Chapter 0609, Attachment 4, a Phase 2 estimation was required because the finding resulted in the loss of safety function for the Unit 2 safety-related Battery 2B008 for greater than the TS allowed outage time.

The team performed a Phase 2 estimation in accordance with Manual Chapter 0609, Appendix A. The team assumed that the performance deficiency affected the risk of operating the plant for 2.42 hours because maintenance personnel continued to work outside the controls of plant procedures throughout this period of time. This performance deficiency resulted in an equivalent risk impact to that evaluated for NCV 05000361/2008013-01 documented in Section 3.1 of this inspection report. Therefore, the finding is determined to have very low safety significance.

The team determined that the finding has a crosscutting aspect in the area of human performance associated with decision making because electrical maintenance personnel did not make safety significant decisions using a systematic process, especially when faced with uncertain or unexpected plant conditions [H.1.(a)].

Technical Specification 5.5.1.1 requires, in part, that written procedures be established, implemented, and maintained covering the activities specified in Appendix A, "Typical Procedures for Pressurized Water Reactors and Boiling Water Reactors," of Regulatory Guide 1.33, "Quality Assurance Program Requirements (Operations)," Dated February 1978. Appendix A, Section 9.c, requires procedures for the repair or replacement of equipment to be prepared prior to beginning work. Procedure SO123-XX-1, "Action Request/Maintenance Order Initiation and Processing," Revision 20, Attachment 2, contains a listing of maintenance activities that may be completed without an MO. Troubleshooting safety-related Class 1E electrical systems was not included within the scope of activities outlined in this procedure. Contrary to the above, on March 25, 2008, electrical maintenance personnel failed to obtain an MO and control room authorization to perform troubleshooting to identify the cause of the degraded voltage on Battery 2B008. Because this finding is of very low safety significance and has been entered into the licensee's CAP as NN 200196248, this violation is being treated as an NCV, consistent with Section VI.A of the NRC Enforcement Policy: NCV 05000361/2008013-02, "Failure to Follow the Work Control Process to Perform Troubleshooting."

3.3 Failure to Follow the Work Control Process

The team identified a Green NCV of TS 5.5.1.1, for the failure of electrical maintenance personnel to follow Procedure SO123-XX-5, "Work Authorizations," Revision 17. Specifically, work to correct the degraded battery condition was initiated prior to having an appropriately authorized MO. Details associated with this finding are described in Section 2.1.3.

The failure of electrical maintenance and operations personnel to follow work control procedures during the events of March 25, 2008, was a performance deficiency. The finding is greater than minor because it would become a more significant safety concern if left uncorrected in that more significant consequences would occur if work control procedures are not followed when performing maintenance on safety-related structures, systems, and components. The finding affected the mitigating systems cornerstone. Using the Manual Chapter 0609, "Significance Determination Process," Phase 1 Worksheets, the finding is determined to have very low safety significance because it was not a design or qualification deficiency, did not result in a loss of safety function, and did not screen as potentially risk significant due to external events.

The team determined that the finding has a crosscutting aspect in the area of human performance associated with work practices because the licensee did not perform adequate pre-job briefings and did not properly document the maintenance activities [H.4(a)].

Technical Specification 5.5.1.1 requires, in part, that written procedures be established, implemented, and maintained covering the activities specified in Appendix A, “Typical Procedures for Pressurized Water Reactors and Boiling Water Reactors,” of Regulatory Guide 1.33, “Quality Assurance Program Requirements (Operations),” Dated February 1978. Appendix A, Section 9.c, requires procedures for the repair or replacement of equipment to be prepared prior to beginning work. Procedure SO123-XX-5, “Work Authorizations,” Revision 17, requires for SSAM, that an entry be made into the shift manager’s log and that there be an advance copy of the MO prior to initiating work. Procedure SO123-XX-5, allows verbal authorization for work that does not require a TS surveillance to return the equipment to operable status. Contrary to the above, on March 25, 2008, electrical maintenance and operations personnel failed to follow the appropriate work authorization process to obtain an MO to initiate work to correct the loose bolt condition on Breaker 2D201. Specifically, the requirements for the use of SSAM were not followed and verbal authorizations were not allowed for the scope of work performed on Breaker 2D201. Therefore, an MO should have been present and authorized prior to beginning work. Because this finding is of very low safety significance and has been entered into the licensee’s CAP as NN 200196248, this violation is being treated as an NCV, consistent with Section VI.A of the NRC Enforcement Policy: NCV 05000361/2008013-03, “Failure to Follow the Work Control Process.”

3.4 Failure to Properly Manage Risk for Tightening Battery Breaker Bolts on Live Equipment

The team identified a Green NCV of 10 CFR Part 50.65(a)(4) involving the failure to adequately assess the increase in risk and effectively implement risk mitigation actions for emergent maintenance activities on safety-related 125 Vdc battery breakers. Details associated with this finding are described in Section 2.1.4.

The failure to adequately assess and manage the increase in risk associated with emergent work activities was a performance deficiency. This finding is greater than minor because the licensee’s risk assessment failed to consider that the maintenance activities on the 125 Vdc breakers could increase the likelihood of initiating events. In accordance with Inspection Manual Chapter 0609, Appendix K, “Maintenance Risk Assessment and Risk Management Significance Determination Process,” Step 4.1.2, the

team requested that the senior reactor analyst independently evaluate the risk because there were notable limitations with the licensee's configuration risk assessment tool for work on vital dc components.

The analyst utilized the Standardized Plant Analysis Risk (SPAR) Model for SONGS Units 2 and 3, Revision 3.45 to identify the highest risk direct current component at SONGS. The component identified was the vital 125 Vdc Bus 2D. To bound the risk related to these work configurations the analyst made the following assumptions:

- All the work completed on energized vital components presented the same risk profile as if it had all been done in vital 125 Vdc Bus 2D.

- Throughout the time that work was being accomplished, it was 10 times more likely that an inadvertent reactor trip would occur.

- Any human error, estimated at 2×10^{-2} probability, would result in a failure of the bus. This assumption would tend to overestimate the risk of the configuration because such a failure would likely be identified and corrected prior to an initiator occurring.

- These configurations were in effect for the entire 24-hour period that terminations and fasteners were being verified and/or tightened.

The analyst quantified the risk related to this plant configuration using the SPAR model. The resulting incremental CDF was 2.6×10^{-5} /year. Given the 24-hour exposure period, the incremental CDP was 7.1×10^{-8}. Because the licensee had not performed a risk assessment, the risk deficit is equal to the incremental CDP.

Based on the magnitude of the calculated incremental CDP deficit being less than 1×10^{-6}, this finding is determined to have very low safety significance (Green).

The finding has a crosscutting aspect in the area of human performance associated with resources for the failure to provide appropriate risk management tools by maintaining complete, accurate, and up-to-date procedures [H.2(c)].

10 CFR Part 50.65(a)(4), states in part, that before performing maintenance activities (including but not limited to surveillance, post-maintenance testing, and corrective and preventive maintenance), the licensee shall assess and manage the increase in risk that may result from the proposed maintenance activities. Contrary to this, on March 25 and March 26, 2008, the licensee failed to adequately assess and manage the increase in risk associated with emergent work activities. Specifically, the STA failed to perform an adequate MRRMP for the work on safety-related 125 Vdc battery breakers and consider the risk associated with the increased likelihood of an initiating event. Because this finding is of very low safety significance and has been entered into the licensee's CAP as NN 200196248, this violation is being treated as an NCV, consistent with Section VI.A of the NRC Enforcement Policy: NCV 05000361, 05000362/2008013-04, "Inadequate Implementation of Risk Assessment and Risk Management Actions for Emergent Work Activities."

3.5 Inadequate Procedures and Instructions to Ensure Electrical Connection Integrity for Safety-Related 125Vdc Battery Bank Supply Breaker 2D201

The team identified a violation of 10 CFR Part 50, Appendix B, Criterion V, "Instructions, Procedures, and Drawings," for the failure of maintenance and work control personnel to establish appropriate instructions for performing maintenance activities on safety-related 125 Vdc station battery Breaker 2D201. As a result, electrical connection integrity was not adequate to ensure that the equipment would be able to perform its safety function. This condition existed for approximately 4 years. Details associated with this finding are described in Section 2.1.5.

The failure to provide adequate MO's and procedures related to the replacement of safety-related Breaker 2D201 was a performance deficiency. The finding is greater than minor because it is associated with the equipment performance attribute of the mitigating systems cornerstone and affects the associated cornerstone objective to ensure the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. The final significance determination performed by the senior reactor analyst and approved by the Significance and Enforcement Review Panel is documented in Attachment 3 to this inspection report. As documented in the final significance determination, this finding has been determined to be of low to moderate safety significance (White).

This finding has a crosscutting aspect in the area of human performance associated with resources because the licensee failed to establish adequate procedures and programs related to electrical connection integrity [H.2(c)].

10 CFR Part 50, Appendix B, Criterion V, "Instructions, Procedures, and Drawings," states, in part, that activities affecting quality shall be prescribed by documented instructions, procedures, or drawings of a type appropriate to the circumstances and shall be accomplished in accordance with these instructions, procedures, or drawings. Instructions and procedures shall include appropriate quantitative or qualitative acceptance criteria for determining that important activities have been satisfactorily accomplished. Contrary to this, in March 2004, maintenance and work control personnel failed to develop appropriate instructions or procedures, and failed to include quantitative or qualitative steps to ensure the maintenance activities on safety-related 125 Vdc station battery Breaker 2D201 had been satisfactorily completed. Specifically, the work plan described in MO 03100406000 was incomplete and lacked the checks necessary to ensure that fasteners on the Breaker 2D201 upper stud to bus bar connections were properly installed. This failure resulted in the Unit 2 safety-related Battery 2B008 being inoperable between March 2004 and March 25, 2008. This item has been entered into the licensee's CAP as RCE 800121216. This finding is identified as VIO 05000361/2008013-05, "Failure to Establish Appropriate Instructions."

3.6 Failure to Report Conditions Prohibited by Technical Specifications

The team identified a Severity Level IV NCV of 10 CFR Part 50.73 for the failure of the licensee's regulatory compliance organization to submit a required LER within 60 days after discovering an event requiring a report. Specifically, compliance personnel failed to

properly assess the past operability of the safety-related 125 Vdc Battery 2B008, which had been inoperable for greater than the TS allowed outage time. Details associated with this finding are described in Section 2.1.6.

The failure of licensee's regulatory compliance organization to submit a required LER within 60 days after discovering that a safety-related structure, system, or component had been inoperable for greater than TS allowed outage time was a performance deficiency. The finding was determined to be applicable to traditional enforcement because the NRC's ability to perform its regulatory function was potentially impacted by the licensee's failure to report the events. The finding was determined to be a Severity Level IV violation in accordance with Section D.4 of Supplement I of the NRC Enforcement Policy.

The finding has a crosscutting aspect in the area of problem identification and resolution associated with CAP because the licensee failed to thoroughly evaluate problems such that the resolutions address causes and extent of conditions. This included properly classifying, prioritizing, and evaluating for operability and reportability conditions adverse to quality [P.1(c)].

10 CFR Part 50.73(a) requires, in part, that licensee shall submit an LER for any operation or condition prohibited by TS within 60 days after the discovery of the event. Contrary to this requirement, on May 22, 2008, licensee's regulatory compliance organization failed to submit a required LER within 60 days after discovering a condition prohibited by TS. Specifically, on April 24, 2008, licensee's regulatory compliance organization incorrectly characterized the loose connection on the Breaker 2D201 "failed when found" and closed the reportability assignment. Subsequent investigations demonstrated that the Class 1E 125 Vdc Battery 2B008 was inoperable for greater than the allowed TS outage time. Because this finding is of very low safety significance and has been entered in the licensee's CAP as NN 200059017, this violation is being treated as an NCV, consistent with Section VI.A of the NRC Enforcement Policy: NCV 05000361/2008013-06, "Failure to Submit LER for Condition Prohibited by Technical Specifications."

3.7 Failure to Promptly Identify and Correct a Condition Adverse to Quality

The team identified a Green NCV of 10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Actions," for the licensee's failure to establish measures to assure that deficient electrical connections were promptly identified and corrected, and that corrective actions taken for a significant condition evaluated in RCE 050601315 were adequate to preclude repetition. Details associated with this finding are described in Section 2.2.1.

The failure to identify deficient electrical connections and to correct the conditions during inspection opportunities was a performance deficiency. The finding is greater than minor because it is associated with the equipment performance attribute of the mitigating systems cornerstone and affects the associated cornerstone objective to ensure the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. Using the Manual Chapter 0609, "Significance Determination Process," Phase 1 Worksheets, the finding is determined to have very low safety significance because the condition did not represent an actual loss of safety

function of a single train for greater than its TS allowed outage time, and did not represent an actual loss of one or more risk-significant non-TS trains of equipment for greater than 24 hours.

This finding has a crosscutting aspect in the area of problem identification and resolution associated with CAP because the licensee failed to thoroughly evaluate problems such that the resolutions address causes and extent of conditions. This includes properly classifying, prioritizing, and evaluating for operability and reportability conditions adverse to quality. This also includes, for significant problems, conducting effectiveness reviews of corrective actions to ensure that the problems are resolved [P.1(c)].

10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Actions," states, in part, that measures shall be established to assure that conditions adverse to quality are promptly identified and corrected, and in the case of significant conditions adverse to quality, the measures shall assure that the cause of the condition is determined and corrective action taken to preclude repetition. Contrary to the above, between June 2005 and August 2008, the licensee failed to ensure that a significant condition adverse to quality was promptly identified and corrected. Specifically, the licensee failed to establish measures to assure that deficient electrical connections were promptly identified and corrected. These ineffective measures resulted in a long standing degraded electrical connection that was not identified for correction during three inspection opportunities associated with safety-related Breaker 3BD21, "Diesel Radiator Fan 3E550 Feeder Breaker," that occurred between June 2005 and April 2008. Because this finding is of very low safety significance and has been entered in the licensee's CAP as NN 200047962, this violation is being treated as an NCV, consistent with Section VI.A of the NRC Enforcement Policy: NCV 05000362/2008013-08, "Failure to Promptly Identify and Correct Condition Adverse to Quality."

3.8 Lack of Procedures to Respond to a Loss of a 125 Vdc Bus

The team identified a Green NCV of TS 5.5.1.1 for the failure to establish written procedures for a loss or degradation of a safety-related electrical power source. Specifically, no procedural guidance was provided to operations personnel to combat and recover from a loss or degradation of a Class 1E 125 Vdc bus.

The Class 1E 125 Vdc Buses D1, D2, D3, and D4, are normally powered from Class 1E 480 VAC through battery chargers. The Class 1E buses provide 125 Vdc power for all safety-related systems, including EDG control systems, switchgear control and tripping functions for Trains A and B, and are the primary source of power for the vital bus power supply system, which provides power for the plant protection system and the engineered safety features actuation system. The 125 Vdc electrical power subsystems each consists of a battery, a battery charger, and the corresponding control equipment and interconnecting cabling within the train. The subsystems are required to be operable to ensure the availability of the required power to shut down the reactor and maintain it in a safe condition after an anticipated operational occurrence or a postulated design basis accident.

Loss of a 125 Vdc bus was part of the NRC scenario development efforts in support of the Component Design Basis Inspection pertaining to operator actions documented in NRC Inspection Report 05000361; 05000362/2008010. The inspectors observed that

operators demonstrated a lack of understanding of proper actions following a loss of a 125 Vdc bus. The inspectors observed that the lack of understanding was, in part, due to the lack of formalized procedures to combat and recover from a loss of the safety-related power source. This identified inadequacy was evaluated by the team due to its relevance to the loose battery breaker bolting event discovered on March 25, 2008.

The failure to provide procedures for a loss or degradation of a safety-related electrical power source was a performance deficiency. The finding is greater than minor because it is associated with the procedure quality attribute of the mitigating systems cornerstone and affects the associated cornerstone objective to ensure the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. Using the Manual Chapter 0609, "Significance Determination Process," Phase 1 Worksheets, the finding is determined to have very low safety significance because it was not a design or qualification deficiency, did not result in a loss of safety function, and did not screen as potentially risk significant due to external events. This finding was reviewed for crosscutting aspects and none were identified.

Technical Specifications 5.5.1.1, requires that written procedures be established, implemented, and maintained for activities specified in Appendix A, “Typical Procedures for Pressurized Water Reactors and Boiling Water Reactors,” of Regulatory Guide 1.33, “Quality Assurance Program Requirements (Operations),” Dated February 1978. Regulatory Guide 1.33, Appendix A, Section 6.c, recommends procedures for combating emergencies and other significant events, including a loss of electrical power and/or degraded power sources. Contrary to the above, between 1982 and October 2008, the licensee failed to establish written procedures for a loss or degradation of a safety-related electrical power source. Specifically, no procedural guidance was provided to operations personnel to combat and recover from a loss or degradation of a Class 1E 125 Vdc bus. Because this finding is of very low safety significance and has been entered into the licensee’s CAP as NNs 200060584 and 200196248, this violation is being treated as an NCV, consistent with Section VI.A of the NRC Enforcement Policy: NCV 05000361, 05000362/2008013-09, "Lack of Written Procedures for a Loss of 125 Vdc Bus."

4.0 MEETINGS, INCLUDING EXIT

On August 21, 2008, the results of this inspection were presented to Mr. Ross T. Ridenoure, Senior Vice President and Chief Nuclear Officer, and other members of the licensee’s management staff who acknowledged the findings. On November 5, 2008, the results of this inspection were presented to Mr. Ridenoure, and other members of the licensee’s management staff who acknowledged the findings. Additionally, on December 11, 2008, the final results of the inspection were presented to Mr. Al Hochevar, and other members of the licensee’s management staff who acknowledged the findings. The team confirmed that no proprietary material was examined during the inspection.

ATTACHMENT 1: SUPPLEMENTAL INFORMATION
ATTACHMENT 2: SPECIAL INSPECTION CHARTER
ATTACHMENT 3: SIGNIFICANCE DETERMINATION EVALUATION

SUPPLEMENTAL INFORMATION

KEY POINTS OF CONTACT

Licensee

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Nuclear Regulatory Commission

D. Loveless, Senior Reactor Analyst
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LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

Opened

05000361/2008013-05	VIO	Failure to Establish Appropriate Instructions
05000361, 05000362/2008013-07	URI	Degraded Electrical Connections

Opened and Closed

05000361/2008013-01	NCV	Failure to Follow Procedure Delays Entry Into Technical Specification Condition
05000361/2008013-02	NCV	Failure to Follow the Work Control Process to Perform Troubleshooting
05000362/2008013-03	NCV	Failure to Follow the Work Control Process
05000361, 05000362/2008013-04	NCV	Inadequate Implementation of Risk Assessment and Risk Management Actions for Emergent Work Activities
05000361/2008013-06	NCV	Failure to Submit LER for Condition Prohibited by Technical Specification
05000362/2008013-08	NCV	Failure to Promptly Identify and Correct a Condition Adverse to Quality
05000361, 05000362/2008013-09	NCV	Lack of Written Procedures for a Loss of 125 Vdc Bus

LIST OF DOCUMENTS REVIEWED

Procedures

Number	Title	Revision
SO123-I-1.3	Work Activity Guidelines	14
SO123-I-2.2	125 Vdc Pilot Cell Battery Inspection	9
SO123-XX-1	Work Process Procedure	20
SO123-XX-5	Work Clearance Application/Work Clearance Document/*Work Authorization Record (WCA/WCD/WAR)	18
SO123-I-4.59.6	Maximum Recommended Torque Value for Electrical Terminations	0
TS 3.8.4	DC Sources – Operating	
SO123-I-1.3	Notification of a Failed on Operable Equipment or Past Due Surveillance	14
SO123-I-1.7	Work Order Preparation and Processing	20
SO123-I-1.45	Torque Manual	12
SO123-I-2.2	Perform Weekly 125V Battery Bank and Charger Operability Verification Checks	7
SO123-I-2.3	Perform Quarterly 125V Battery Bank and Charger Operability Verification Checks	7
SO123-I-2.5	Battery Service Test and Rapid Recharge	10
SO123-XII-2.7	Reporting of Quality Trends	3
SO23-V-2.14	Thermal Inspection of Plant Components	8
SO23-I-2.27	Line Starter Thermal Overload Bypass Inspection	10
SO23-I-2.47	Containment Penetration Molded Case Circuit Breaker Inspection	7
SO23-I-2.52	Containment Penetration Circuit Breaker Overcurrent Test	15
SO123-I-4.7	Molded Case Circuit Breaker	7
SO123-I-4.59	Wire/Cable Inspection	4
SO123-I-4.59.1	Control and Instrument Cable Termination & Repair Guide	0
SO123-I-4.59.4	4kV/6.9kV Power Cable Termination & Repair Guide	0
SO123-I-4.59.6	600V Power Cable Termination & Repair Guide	0
SO123-I-9.11	480V Load Center and Transformer Inspection and Cleaning	7
SO123-I-9.12	Motor Control Center Cleaning, Inspection and Megger Testing	9
SO123-I-9.13	480 VAC Linestarter Inspection, Coil and Power Contact Replacement	9
SO123-I-9.26	Miscellaneous Low Voltage Bus Panel Inspection, Cleaning and Testing	2
SO23-XV-2	Troubleshooting Plant Equipment and Systems	2
SO123-XX-1	Action Request/Maintenance Order Initiation and Processing	21
SO123-I-1.7	Maintenance Order Preparation and Processing	19
SO123-I-1.3	Work Activity Guidelines	14
SO123-XX-5	Work Authorization	71
SO123-XX-3	"Fix It Now" Program	11

Number	Title	Revision
SO123-XX-4	SONGS Work Control	10
SO123-XV-50.39	Cause Evaluations Standards, Methods, and Instructions	8
SO123-XV-52	Functionality Assessments and Operability Determinations	7
SO123-XXX-3.4	Determination to Report Abnormal Occurrences and Events or Adverse-To-Quality Conditions and Follow-Up Licensee Event Reports (LER)	7
SO123-XXX-3.6	Accessing Events and Conditions for Reporting to the NRC	0

Notifications

200053004	800121216	200059017	200066209	200059004
200047962				

Action Requests

080301117	050601324	080600666	070300033	050801627
080600579	021201414	080400575	080500248	080301404
080400541	070600347	050601315	070300033	050500051
080500060	080500549	080500551	080500642	080500932
080501003	080501287	080501290	080501340	080501345
080600023	080600105	080600206	080600214	080600219
080600275	080600313	080600350	080600351	080600479
080600509				

Work Orders/Maintenance Work Orders

08031771000	08031772000	08031773000	08031775000	08031776000
08031777000	08031473000	08031721000	08001177000	05062182000
08031738000	03100406000	08031721000	05080446000	07060546000
08031721000	08031473000	06060103000	05050497000	08031729000

Drawings

Number	Title	Revision
30136	One Line Diagram 480V MCC 2BD (ESF)	18
30166	One Line Diagram 480V MCC 208/120VAC Heater Panels - ESF	45
31650	Wiring Diagram Control Building Panels 2/3L176, 177, 225 & 230, Sheet 1	10
32136	One Line Diagram 480V MCC 3BD (ESF)	19
32141	One Line Diagram 480V MCC 3BH (ESF)	19
31650	Wiring Diagram Control Building FNLS 2/3L176,177, 229 & 230	1

Miscellaneous Information

Door Logs
Organizational Charts
Licensee Event Report 2005-001
OSM-107
Maintenance Qualification Standard Signoff
Vital Area Door Logs for Individuals Responding to Battery 2B008 Event on March 25, 2008
Unit 2 Control Room Logs for March 25, 2008
Guidance for evaluating Operating Experience dated April 3, 2008
Generic Letter 82-04
Directed Assessment Report, Loose Electrical Fastener Assessment, 7/2008

LIST OF ACRONYMS USED

ACE	apparent cause evaluation
AR	action request
CAP	corrective action program
DAR	directed assessment report
EDG	emergency diesel generator
LCO	limiting condition for operation
LER	licensee event report
MO	maintenance order
MRRMP	maintenance rule risk management program
OE	operating experience
NCV	noncited violation
NN	nuclear notification
NRC	U.S. Nuclear Regulatory Commission
RCE	root cause evaluation
SSAM	shift manager accelerated maintenance
STA	shift technical advisor
TS	technical specification
UNSAT	unsatisfactory

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
612 EAST LAMAR BLVD, SUITE 400
ARLINGTON, TEXAS 76011-4125

July 21, 2008

MEMORANDUM TO: Greg Warnick, Senior Resident Inspector
San Onofre Nuclear Generating Station
Project Branch D, Division of Reactor Projects

Sam Graves, Reactor Inspector
Engineering Branch 1, Division of Reactor Safety

Mica Baquera, Reactor Inspector
Plant Support Branch 2, Division of Reactor Safety

FROM: Dwight Chamberlain, Director, Division of Reactor Projects ***/RA/***

SUBJECT: SPECIAL INSPECTION CHARTER TO EVALUATE DEFICIENT ELECTRICAL CONNECTIONS

A Special Inspection Team is being chartered in response to identification of deficient electrical connections at the San Onofre Nuclear Generating Station with the potential to adversely affect the safety function of multiple safety systems used for accident mitigation. You are hereby designated as the Special Inspection Team members. Mr. Warnick is designated as the team leader. The assigned senior reactor analyst (SRA) to support the team is David Loveless.

A. Basis

On March 25, 2008, maintenance personnel found the Unit 2, Train B, terminal voltage of the battery at 121V dc; below the TS limit (129.17V dc). The operators declared the battery inoperable and entered the 2-hour action, TS 3.8.4 condition A. Maintenance discovered loose battery breaker bus bolts as the cause of the degraded battery voltage.

During followup inspection related to the extent of condition for loose electrical terminations the following additional examples were identified.

1. On June 25, 2005, during a monthly surveillance of Unit 3 Train B EDG its associated cooling fan failed due to a loose wire.

2. On September 17, 2007, loose electrical bolt connections were identified affecting the 2D2 electrical DC bus. Specifically, loose bolts on a battery feeder cable and loose intercell connectors were identified. This is the same DC bus that was identified as degraded due to loose electrical connections in March of 2008.

3. In 2007 a loose electrical connection was identified affecting emergency chiller supply Breaker E336.

4. On July 9, 2008, a loose electrical connection was found affecting Unit 3, Train A, EDG cooling fan supply breaker.

This Special Inspection Team is chartered to review the circumstances related to historical and present deficient electrical connection problems and assess the effectiveness of the licensee's actions for resolving these problems. The team will also assess the effectiveness of the immediate actions taken by the licensee following identification of these deficiencies.

B. Scope

The team is expected to address the following:

1. Develop an understanding of the electrical connection deficiencies and the impact these deficiencies have related to the safety functions of affected systems.

2. Assess licensee effectiveness in identifying deficient electrical connection problems, evaluating the cause of these problems, and implementation of corrective actions to resolve identified problems.

3. Assess adequacy of licensee processes (procedures, maintenance instructions, training, etc.) for maintaining proper electrical connections.

4. Assess the licensee's RCE, the extent of condition, and the licensee's common mode evaluation for identified electrical connection deficiencies.

5. Evaluate pertinent industry OE and the effectiveness of licensee actions taken in response to the OE.

6. Determine if there are any potential generic issues related to the electrical connection deficiencies identified. Promptly communicate any potential generic issues to Region IV management.

7. Determine if the Technical Specifications were met when the licensee identified the associated electrical connection deficiencies.

8. Collect data as necessary to support a risk analysis.

C. Guidance

Inspection Procedure 93812, "Special Inspection," provides additional guidance to be used by the Special Inspection Team. Your duties will be as described in Inspection Procedure 93812. The inspection should emphasize fact-finding in its review of the circumstances surrounding the event. It is not the responsibility of the team to examine the regulatory process. Safety concerns identified that are not directly related to the event should be reported to the Region IV office for appropriate action.

The Team will report to the site, conduct an entrance, and begin inspection no later than August 4, 2008. While on site, you will provide daily status briefings to Region IV

management, who will coordinate with the Office of Nuclear Reactor Regulation, to ensure that all other parties are kept informed. A report documenting the results of the inspection should be issued within 30 days of the completion of the inspection.

This Charter may be modified should the team develop significant new information that warrants review. Should you have any questions concerning this Charter, contact me at (817) 860-8173.

ATTACHMENT 3
FINAL SIGNIFICANCE DETERMINATION EVALUATION

San Onofre Nuclear Generating Station
Improper Vital dc Bus Bar Electrical Integrity
Significance Determination Basis

A. Statement of Performance Deficiency

Maintenance and work control personnel failed to establish appropriate instructions for performing maintenance on safety-related 125 Vdc station battery Breaker 2D201. As a result, electrical connection integrity was not adequate to ensure that the equipment would be able to perform its safety function. This condition existed for approximately 4 years.

B. Significance Determination Basis

1. Phase 1 Screening Logic, Results and Assumptions

In accordance with NRC Inspection Manual Chapter 0612, Appendix B, "Issue Screening," the analyst determined that the failure to properly tighten the bus bar extension mounting bolts was a licensee performance deficiency. The issue was more than minor because it was similar to Example 5.b in Manual Chapter 0612, Appendix E, and it met the “not minor if” requirement because the system was returned to service in the degraded configuration.

The analyst evaluated the issue using the Significance Determination Process (SDP) Phase 1 Screening Worksheet for the Initiating Events, Mitigating Systems, and Barriers Cornerstones provided in Manual Chapter 0609, Attachment 4, "Phase 1 – Initial Screening and Characterization of Findings.” Although this finding affected multiple cornerstones, the analyst determined that the Mitigating Systems Cornerstone best reflected the dominant risk of the finding. The analyst determined that the finding represented an actual loss of safety function of Battery 2B008 for longer than the technical specification allowed outage time. Therefore, a Phase 2 estimation was conducted in accordance with Manual Chapter 0609, Appendix A, “Determining the Significance of Reactor Inspection Findings for At-Power Situations.”

2. Phase 2 Risk Estimation

In accordance with Manual Chapter 0609, Appendix A, Attachment 1, "User Guidance for Phase 2 and Phase 3 Reactor Inspection Findings for At-Power Situations," the Senior Reactor Analyst evaluated the subject finding using the Risk-Informed Inspection Notebook for San Onofre Nuclear Generating Stations, Units 2 and 3, Revision 2.1a. The following assumptions were made:

a. The identified performance deficiency occurred on March 17, 2004 when Battery 2B008 was returned to service following the replacement of Circuit Breaker 2D201 and continued to affect the plant until its discovery

on March 25, 2008.

b. In accordance with Manual Chapter 0609, Appendix A, Attachment 2, "Site Specific Risk-Informed Inspection Notebook Usage Rules," Rule 1.1, "Exposure Time," the analyst evaluated the time frame over which the finding impacted the risk of plant operations. Because the performance deficiency continued to affect plant risk for more than one assessment period, the analyst determined that the appropriate exposure time was one year. Therefore, the exposure time used to represent the time that the performance deficiency affected plant risk in the Phase 2 estimation was greater than 30 days.

c. In accordance with Appendix A, Attachment 1, Step 2.1.3, "Find the Appropriate Target for the Inspection Finding in the Pre-solved Table," the analyst determined that the appropriate target for evaluating this performance deficiency was "Battery of One Panel (Bus) Fails." Therefore, the analyst utilized the pre-solved table associated with the SDP notebook to perform the estimation.

d. The analyst gave no operator action credit as discussed in Manual Chapter 0609, Appendix A, Attachment 1, Table 4, "Remaining Mitigation Capability Credit." The requirements to have procedures in place and to have trained the operators in recovery under similar conditions for such credit were not met.

The dominant sequences from the notebook were documented in Table 3-1 below:

TABLE A3-1
Failure of Vital Battery 2B008
Phase 2 Sequences

Initiating Event	Sequence	Mitigating Functions	Results
Loss of Offsite Power	1	LOOP-AFW/RC	6
	2	LOOP-REC-AFW	6
	3	LOOP-EAC-HGEN-REC	6
	4	LOOP-EAC-TDAFW-REC	6
	6	LOOP-EAC-SEAL-HPR	9
	7	LOOP-EAC-SEAL-EIHP	9
	9	LOOP-EAC-SEAL-REC	8

Using the pre-solved worksheet, the result from this estimation indicated that the finding was of moderate safety significance (YELLOW). However, the analyst determined that this estimate did not include a full coverage of the risk related to the failure identified, particularly because of the changing condition of the

connection over time and the affect that seismic events would have on the specific condition. Therefore, a Phase 3 evaluation was conducted to better assess the risk of the finding related to internal initiators and fully assess the risk related to external initiators.

3. Phase 3 Risk Analysis

In accordance with Manual Chapter 0609, Appendix A, the analyst performed a Phase 3 analysis using the Standardized Plant Analysis Risk (SPAR) Model for San Onofre 2 & 3, Revision 3.45, dated September 2008, to simulate the failure of Battery 2B008 and associated 125 Vdc Bus 2D2. Additionally, the analyst conducted an assessment of the risk contributions from external initiators using insights and/or values provided by the licensee's Individual Plant Evaluation for External Events (IPEEE).

Assumptions:

To evaluate the change in risk caused by this performance deficiency, the analyst made the following assumptions:

a. The San Onofre SPAR model, Revision 3.45 represents an appropriate tool for evaluation of the subject finding.

b. The bus bar extension mounting bolts for the Battery 2B008 feeder breaker to Bus 2D2 were insufficiently tightened from March 17, 2004, when Battery 2B008 was returned to service following the replacement of station battery Breaker 2D201, until discovery on March 25, 2008.

c. There was sufficient continuity through the degraded connection to conduct charging current (usually < 1 amp) at a very low differential voltage across the connection from March 17, 2004 until commencement of spare charger operation on March 17, 2008.

d. There was not sufficient continuity to conduct charging current commencing sometime after March 17, 2008.

e. Once the open circuit developed, it exhibited sufficient resistance to prevent the re-establishment of continuity for a gradual increase in voltage up to 10 Vdc.

f. Given Assumptions d and e, the battery would have failed to energize the diesel generator starting circuitry from some time after March 17, 2008 through March 25, 2008. Additionally, the failure mode of the bus connections, should a large load have been demanded of the battery during this time, would likely have resulted in failure of Bus 2D2.

g. Given Assumption c, Battery 2B008 would have been capable of starting Diesel Generator 2DG003 from March 17, 2004 until March 17, 2008. However, the battery and/or connection to the bus would have failed prior to

completion of its station blackout mission time because of the high resistance connection.

h. Given Assumption g, only accident sequences that demanded a major load on the vital battery would have resulted in Battery 2B008 failure while the connection was in the subject configuration.

i. The exposure time used for evaluating this finding should be determined in accordance with Manual Chapter 0609, Appendix A, Attachment 2, “Site Specific Risk-Informed Inspection Notebook Usage Rules.”

j. The appropriate exposure times (EXP), for use in this evaluation are as documented below:

   Case 1: Given Assumptions b, c and g, Battery 2B008 would have been incapable of providing its station blackout function from March 17, 2004 though March 25, 2008. Therefore, an exposure period of one year, representing the most recent assessment period was used for exposure to this failure.

   Case 2: The exact time at which Battery 2B008 became uncoupled from the battery charger is unknown. However, we know that the battery was appropriately charged on March 17, 2008 and that there was insufficient charging current to the battery on March 25, 2008. Therefore, in accordance with Assumptions f and i, Battery 2B008 would not have started Diesel Generator 2DG003 upon demand for one half the period or 4 days.

k. Given the specific conditions of the buswork, the actual time required to diagnose the problem upon identification of degraded battery voltage, and the potential failure modes considered, operators would not have been able to recover Battery 2B008 prior to core damage.

Internal Initiating Events:

The senior reactor analyst used the SPAR model for San Onofre Units 2 & 3 to estimate the change in risk associated with internal initiators that was caused by the finding. Average test and maintenance of modeled equipment was assumed, and a cutset truncation of 1.0×10^{-13} was used. Two cases were evaluated based on the indications observed.

Case 1: Failure of Battery and Bus for a 4-day period

Consistent with guidance in the Risk Assessment of Operational Events Handbook, including NRC document, "Common-Cause Failure Analysis in Event Assessment, (June 2007)," and Assumptions a, f, g, j and k, the senior reactor analyst modeled the condition by adjusting the following basic events in the SPAR model:

TABLE A3-2 Failure of Vital Battery 2B008 Case 1 SPAR Change Set		
Basic Event	Original Value	Conditional Value
DCP-BAT-LP-B008	4.8×10^{-5}	TRUE
DCP- BDC-LP-BUSD2	9.6×10^{-6}	TRUE

In accordance with Assumption f, the analyst determined that the predominant demands on Battery 2B008 are following a loss of offsite power (LOOP). The analyst evaluated the potential losses of ac power that were not caused by a LOOP. The potential for equipment losses that would put a demand on Battery 2B008 within 24 hours of an initiating event were determined to be at least two orders of magnitude lower than the risks related to a LOOP. Therefore, the analyst quantified only the LOOP sequences.

The SPAR baseline core damage frequency for LOOP sequences (CDF_{BASE}) was 2.28×10^{-6}/year. The evaluation case for the above change set resulted in a conditional core damage frequency for the same sequences ($CCDF_{SPAR}$) of 1.12×10^{-5}/year.

The dominant core damage sequences were documented in Table A3-3:

TABLE A3-3 Failure of Vital Battery 2B008 Phase 3 Dominant Sequences			
Initiating Event	Sequence	Preponderant Failures	Frequency
Loss of Offsite Power	16-30	Station blackout with failure of the turbine-driven auxiliary feedwater system and failure to recover offsite power or the other diesel generator.	4.21×10^{-6}/year
	15	Failure of the auxiliary feedwater system and failure to recover offsite power.	4.34×10^{-6}/year
	16-21	Station blackout with failure to control reactor subcooling combined with failure to recover offsite power or the other diesel generator.	2.13×10^{-6}/year

TABLE A3-3 Failure of Vital Battery 2B008 Phase 3 Dominant Sequences			
Initiating Event	Sequence	Preponderant Failures	Frequency
	16-28-4	Station blackout with failure of the turbine-driven auxiliary feedwater system, followed by recovery of offsite power, but failure of high head injection.	2.45×10^{-7}/year

The change in incremental conditional core damage frequency (ICCDF) was calculated as follows:

$$ICCDF = CCDF_{SPAR} - CDF_{BASE}$$

$$= 1.12 \times 10^{-5}/year - 2.28 \times 10^{-6}/year$$

$$= 8.92 \times 10^{-6}/year$$

Given Assumption i, the exposure time, representing the time that the performance deficiency impacted both the battery and the bus, for this analysis was 4 days. Therefore, the change in core damage frequency for this case (ΔCDF_1) caused by this finding, without applying any recovery to the subject condition, and related to internal initiators was calculated as follows:

$$\Delta CDF_1 = ICCDF * EXP$$

$$= 8.92 \times 10^{-6}/year * (4 \text{ days} \div 365 \text{ days/year})$$

$$= 9.78 \times 10^{-8}$$

Case 2: Failure of Battery Following Start of Diesel Generator

In accordance with Assumptions a, b, g, j and k, the analyst evaluated the affect of Battery 2B008 failing to perform it's intended function while remaining capable of starting Diesel Generator 2DG003. The analyst noted that this condition only affected a station blackout and that it was unlikely to fail Bus 2D2. In accordance with the SPAR, the LOOP initiation frequency for San Onofre is 3.59×10^{-2}/year. The analyst quantified the failure rate of both Unit 2 diesel generators using the associated fault trees. The resulting probability was 3.00×10^{-3}. Therefore, the station blackout frequency (λ_{SBO}) was calculated to be 1.08×10^{-4}/year.

In accordance with Assumptions b and j, this condition existed for approximately 4 years. However, as documented in Manual Chapter 0609, Appendix A, Attachment 1, Step 2.1.2, "Determine the Appropriate Exposure Time," the

maximum exposure time used in the significance determination process is limited to 1 year.

The analyst made the following adjustments in the SPAR model to determine the baseline conditional core damage probability for a station blackout:

TABLE A3-4
Failure of Vital Battery 2B008
Case 2 SPAR Change Set

Basic Event	Original Value	Conditional Value
IE-LOOP	3.59×10^{-2}	1.0
EPS-DGN-FS-2DG2	5.0×10^{-3}	TRUE
EPS-DGN-FS-2DG3	5.0×10^{-3}	TRUE

The resulting core damage probability for a baseline station blackout was 3.34×10^{-2}. The analyst then set Basic Event DCP-BAT-LP-B008 to the house event TRUE, indicating that the battery would fail to perform its intended function under these conditions. The resulting conditional core damage probability for the evaluated case was 3.48×10^{-2}, making the change in core damage probability ($\Delta CCDP_{SBO}$) to be 1.40×10^{-3}. The analyst calculated the change in core damage frequency (ΔCDF_2) as follows:

$$\Delta CDF_2 = \lambda_{SBO} * \Delta CCDP_{SBO} * EXP$$

$$= 1.08 \times 10^{-4}/year * 1.40 \times 10^{-3} * 1\ year$$

$$= 1.51 \times 10^{-7}$$

External Initiating Events:

Seismic

The analyst determined that, for the subject performance deficiency to affect the core damage frequency, a seismic event must result in both a LOOP and the failure of the Battery 2B008 connections.

As such, the analyst evaluated the subject performance deficiency by determining each of the following parameters for any seismic event producing a given range of median average spectral acceleration "a" [SE(a)]:

- The frequency of the seismic event SE(a) ($\lambda_{SE(a)}$);
- The probability that a LOOP occurs during the event ($P_{LOOP\text{-}SE(a)}$);
- The probability that Bus 2D2 fails during the event ($P_{BUS\text{-}SE(a)}$); and
- The conditional change in core damage probability ($\Delta CCDP_{SE(a)}$).

The ΔCDF for the acceleration range in question ($\Delta CDF_{SE(a)}$) can then be quantified as follows:

$$\Delta CDF_{SE(a)} = \lambda_{SE(a)} * P_{LOOP\text{-}SE(a)} * P_{BUS\text{-}SE(a)} * \Delta CCDP_{SE(a)}$$

Given that each range "a" was selected by the analyst specifically to be independent of all other ranges, the total increase in risk, ΔCDF, can be quantified by summing the $\Delta CDF_{SE(a)}$ for each range evaluated as follows:

$$\Delta CDF = \sum_{a=.03}^{6} \Delta CDF_{SE(a)}$$

over the range of SE(a).

Frequency of the Seismic Event

NRC research data indicated that seismic events of 0.05g or less have little to no impact on internal plant equipment. As such, to ensure that the risk was bounded, the analyst evaluated the risk of seismic events greater than 0.03g. The analyst also assumed that seismic events greater than 6.0g lead to core damage. The analyst, therefore, examined seismic events in the range of 0.03g to 6.0g.

The analyst divided that range of seismic events into segments (called "bins" hereafter); specifically, seismic events from 0.03g to 0.1g were binned by hundredths, seismic events from 0.1g to 1.0g were binned by tenths, and seismic events from 1.0g to 6.0g were binned by ones.

In order to determine the frequency of a seismic event for a specific range of ground motion (g values), the analyst used the licensee's IPEEE and obtained values for the frequency of the postulated seismic event that generates a level of ground motion that exceeds the lower value in each of the bins. These values were estimated in average spectral acceleration as used by the licensee as opposed to peak ground acceleration used in the risk standardization handbook. The analyst then calculated the difference in these "frequency of exceedance" values to obtain the frequency of seismic events for each of the binned seismic event ranges.

For example, according to the San Onofre IPEEE, the frequency of exceedance for a 0.6g seismic event is estimated at 3×10^{-3}/yr and a 0.7g seismic event at 2×10^{-3}/yr. The frequency of seismic events with median acceleration in the range of 0.6g to 0.7g [SE(0.6-0.7)] equals the difference, or 1×10^{-3}/yr.

Probability of a LOOP

The analyst assumed that a seismic event severe enough to break the ceramic insulators on the transmission lines would cause an unrecoverable LOOP.

The analyst obtained data on switchyard components from the staff's evaluation of the licensee's IPEEE, dated September 29, 1999. Table 5.2 of this document provided the major seismic fragilities for equipment at San Onofre. Additional references utilized for generic fragility values were:

> NUREG/CR-6544, "Methodology for Analyzing Precursors to Earthquake-Initiated and Fire-Initiated Accident Sequences," April 1998; and
>
> NUREG/CR-4550, Volumes 3 and 4, Part 3, "Analysis of Core Damage Frequency: Surry / Peach Bottom," 1986.

The references describe the mean failure probability for various equipment using the following equation:

$$P_{fail}(a) = \Phi [\ln(a/a_m) / (\beta_r^2 + \beta_u^2)^{1/2}]$$

Where Φ is the standard normal cumulative distribution function and

a	=	median acceleration level of the seismic event;
a_m	=	median of the component fragility;
β_r	=	logarithmic standard deviation representing random uncertainty;
β_u	=	logarithmic standard deviation representing systematic or modeling uncertainty.

In order to calculate the LOOP probability given a seismic event, the analyst used the seismic fragility values listed for the San Onofre switchyard components:

a_m	=	0.74g
β_r	=	0.20
β_u	=	0.34

Using the above normal cumulative distribution function equation, the analyst determined the conditional probability of a LOOP given a seismic event. For each of the bins, the calculation was performed substituting for the variable "a" the median average spectral acceleration level for that bin. The following table shows the results of the calculation for various acceleration levels.

TABLE A3-5 Failure of Vital Battery 2B008 Seismic LOOP Probability							
Spectral Acceleration Level/Probability of LOOP							
0.03g	5.2×10^{-15}		0.3g	2.9×10^{-2}		2.0g	1.0
0.07g	3.3×10^{-9}		0.7g	5.1×10^{-1}			

Probability That Bus 2D2 Fails

In order to calculate the probability that the bus bar extension vibrates enough that it results in failure of Bus 2D2 through excessive variation in the supply of direct current to bus relaying, the analyst used the used the seismic fragility values listed for the San Onofre reserve auxiliary transformers. This assumed that any movement large enough to fail an electrical component would be large enough to fail the improperly terminated bus bar. The following values were used:

a_m = 0.52g
β_r = 0.30
β_u = 0.45

Using the above standard normal cumulative distribution function equation, the analyst determined the conditional probability that Bus 2D2 fails given a seismic event for each of the bins. The calculation was performed substituting for the variable "a" the median average spectral acceleration levels for that bin. The following table shows the results of the calculation for various acceleration levels.

TABLE A3-6 Failure of Vital Battery 2B008 Seismic Bus Failure Probability							
Spectral Acceleration Level/Probability of Bus Failure							
0.03g	3.0×10^{-7}		0.3g	2.3×10^{-1}		2.0g	1.0
0.07g	1.7×10^{-4}		0.7g	7.5×10^{-1}			

Conditional Change in Core Damage Probability

The analyst evaluated the spectrum of seismic initiators to determine the resultant impact on the reliability and availability of mitigating systems affecting the subject performance deficiency.

The analyst used the San Onofre 2 & 3 SPAR Model, Revision 3.45, to perform the Phase 3 evaluation. The analyst first created a baseline case by setting the initiating event probability for a LOOP to 1.0 and all other initiating event frequencies in the SPAR model to the house event "FALSE," indicating that these events could not occur at the same time as a LOOP. Offsite power was assumed to be non-recoverable following seismic events that break the ceramic insulators (low fragility components) on the transmission lines. Therefore, the analyst set the non-recovery probabilities for offsite power to 1.0. The SPAR model showed the resultant core damage probability as 2.03×10^{-4}, which represented the baseline case that was used in the above equation.

The SPAR Model showed that loss of Battery 2B008 and Bus 2D2 during an unrecoverable LOOP leads to a conditional core damage probability of 9.88×10^{-4}. Therefore, the change in core damage probability was:

$$\Delta CCDP_{SE(a)} = 9.88 \times 10^{-4} - 2.03 \times 10^{-4} = 7.85 \times 10^{-4}$$

Phase 3 Seismic Results

Considering the factors described above:

- The frequency of the seismic event;
- The probability that a LOOP occurs during the event;
- The probability that Bus 2D2 fails during the event; and
- The conditional change in core damage probability

The total increase in risk, ΔCDF, can be quantified by summing the $\Delta CDF_{SE(a)}$ for each bin as follows:

$$\Delta CDF = \sum_{a=.03}^{6} \Delta CDF_{SE(a)}$$

over the range of SE(a). This result was 1.45×10^{-6}/year.

High Winds, Floods, and Other External Events

The analyst reviewed the IPEEE and determined that no other credible scenarios initiated by high winds, floods, fire, and other external events could initiate a LOOP and directly cause the perturbation of the bus bar extension connection with the breaker stabs. Therefore, the analyst concluded that external events other than seismic events were not significant contributors to risk for this finding.

Total Change in Core Damage Frequency

Given that each of the initiators in this analysis were treated to ensure that the final probabilities were independent of each other, the analyst determined that the total change in core damage frequency (ΔCDF) could be calculated by taking the

sum of each independent change. Therefore, the final Phase 3 result was calculated as follows:

$$\Delta CDF = \Delta CDF_{Internal} + \Delta CDF_{External}$$

$$= \Delta CDF_1 + \Delta CDF_2 + \Delta CDF_{SEISMIC}$$

$$= 9.87 \times 10^{-8} + 1.51 \times 10^{-7} + 1.45 \times 10^{-6}$$

$$= 1.70 \times 10^{-6}$$

This result indicated that the finding was of low to moderate significance to the risk based on core damage frequency.

Risk Contribution from Large Early Release Frequency (LERF)

Using Manual Chapter 0609 Appendix H, "Containment Integrity Significance Determination Process," the analyst determined that this was a Type A finding (i.e., LERF contributor) for a large dry containment. For pressurized water reactor plants with large dry containments (like San Onofre), only findings related to accident categories of intersystem loss of coolant accidents and steam generator tube ruptures have the potential to impact LERF. In addition, an important insight from the individual plant evaluation program and other probabilistic risk assessment studies is that the conditional probability of early containment failure is less than 0.1 for core damage scenarios that leave the reactor coolant system at high pressure (>250 psi) at the time of reactor vessel breach. The analyst noted that none of the cutsets were from steam generator tube rupture or intersystem loss of coolant accident sequences. Therefore, the analyst determined that the change in risk related to the subject performance deficiency was insignificant with respect to LERF.

C. Final Significance Determination

As previously documented in this analysis, the Phase 3 result for total ΔCDF was 1.70×10^{-6} indicating that the finding was of low to moderate safety significance. Additionally, the analyst determined that the change in risk related to the subject performance deficiency was insignificant with respect to LERF. Therefore, in accordance with Manual Chapter 0609, Appendix A, the finding is characterized as being of low to moderate safety significance (White).