NRC FORM 366 (4-95) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104
EXPIRES 04/30/98

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS MANDATORY INFORMATION COLLECTION REQUEST: 50.0 HRS. REPORTED LESSONS LEARNED ARE INCORPORATED INTO THE LICENSING PROCESS AND FED BACK TO INDUSTRY. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (T-6 F33), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

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SALEM GENERATING STATION UNIT 1	05000272	1 of 8

TITLE (4)
INOPERABLE 230 VOLT MOTOR CONTROL CENTERS DUE TO FAILED BUS BAR BOLTING

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
09	14	95	95	-- 020 --	00	10	13	95	Salem Generating Station, Unit 2	05000311
									FACILITY NAME	DOCKET NUMBER

OPERATING MODE (9)	N	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)			
POWER LEVEL (10)	000	20.2201(b)	20.2203(a)(2)(v)	50.73(a)(2)(i)	50.73(a)(2)(viii)
		20.2203(a)(1)	20.2203(a)(3)(i)	X 50.73(a)(2)(ii)	50.73(a)(2)(x)
		20.2203(a)(2)(i)	20.2203(a)(3)(ii)	50.73(a)(2)(iii)	73.71
		20.2203(a)(2)(ii)	20.2203(a)(4)	50.73(a)(2)(iv)	OTHER
		20.2203(a)(2)(iii)	50.36(c)(1)	50.73(a)(2)(v)	Specify in Abstract below or in NRC Form 366A
		20.2203(a)(2)(iv)	50.36(c)(2)	50.73(a)(2)(vii)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
Mr. M. Mortarulo, Controls and Electrical Supervisor, Salem Station	609-339-2741

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS
B	ED	BU	G080	NO						

SUPPLEMENTAL REPORT EXPECTED (14)			EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE).	X	NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

On 9/14/95 all Salem Unit #1 and Unit #2 Vital 230 Volt motor control centers (MCC) were declared inoperable due to a lack of assurance that the MCCs could withstand a seismic event. During an inspection of 230 Volt 1B West Vital MCC, 5 of 48 5/16 inch diameter silicon bronze carriage bolts connecting the vertical cubicle bus bars to the horizontal main bus failed when attempts were made to torque the bolts. Following the discovery of the failed bolts, an operability assessment resulted in all related MCCs being declared inoperable. A design change was implemented to replace all of the silicon bronze bolts with carbon steel bolts. The safety significance for this event was determined to be low. The apparent root cause for the bolting failure was stress corrosion cracking.

This was reported in accordance with 10CFR50.72(b)(2)(i) within four hours of discovery and also within thirty days per 10CFR50.73(a)(2)(ii)(B), any operation or condition that resulted in the nuclear power plant being in a condition that was outside the design basis of the plant.

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TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

PLANT AND SYSTEM IDENTIFICATION

Westinghouse - Pressurized Water Reactor

230 Volt Motor Control Center {ED/BU}*

* Energy Industry Identification System (EIIS) codes and component function identifier codes appear in the text as {SS/CCC}.

IDENTIFICATION OF OCCURRENCE

On September 14, 1995, following an engineering review of failed bolts found in the 1B West vital 230 Volt bus, the affected MCC and all related MCCs were declared inoperable as there was no assurance that the MCCs could continue to perform their function following a seismic event. Technical Specifications section 3.8.2.2 requires that when in modes 5 and 6 that a minimum of two AC electrical bus trains shall be operable with each train consisting of at least one 230 Volt vital bus and associated MCCs operable (applicable only to Unit #2 at the time since Unit #1 was defueled).

Event Date: September 14, 1995

Discovery Date: September 14, 1995

Report Date: October 13, 1995

CONDITIONS PRIOR TO OCCURRENCE

Defueled, Reactor Power 0% for Unit #1
Mode 5, Reactor Power 0% for Unit #2

The 230 Volt Vital MCCs were energized.

DESCRIPTION OF OCCURRENCE

On April 7, 1988, the US NRC issued NRC Information Notice 88-11 discussing potential loss of motor control center and/or switchboard function due to faulty bus tie bolts in GE 7700 series MCCs. This Information Notice as well as INPO Significant Event Report 12-88 (SER), were subsequently reviewed by PSE&G for applicability to Salem Generating Station, Units #1 and #2. The review concluded that a limited inspection was appropriate to determine the significance of the bus bar bolting connection concerns identified in both documents.

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DESCRIPTION OF OCCURRENCE (cont'd)

On July 8, 1988, a 230 Volt non-vital MCC (GE 7700 series) in the Fuel Handling Building was removed from service and visually examined by removing all bolted fasteners. No cracking or material degradation was documented from the July 8, 1988 visual inspection. Based on the determination that silicon bronze bolts were confirmed to be in 230 Volt MCCs, it was decided to pursue inspections of a sample of other 230 Volt MCCs.

This follow-up examination was planned to sample four vital MCCs in each unit. MCCs were designated to be inspected from three different environments by targeting MCCs in the Service Water Intake Structure, Turbine Building and Auxiliary Building. Since no previous bolting failures had been identified, it was planned to inspect only a sample of bolts in the targeted MCCs. However because of the potential that a visual inspection might not be adequate for assessing Stress Corrosion Cracking (SCC), a microscopic examination by a laboratory was deemed appropriate. Thus, replacement silicon bronze bolting materials were identified as being required to provide for replacement bolts before the examination work could be authorized.

The examination requirement was tracked in the Salem Generating Station Action Tracking System (ATS). The action item provided direction to remove and conduct a laboratory examination of bolts in four MCCs during Unit #1 outage 1R10 (planned for 4/4/92 to 6/15/92) and Unit #2 outage 2R7(planned for 3/27/93 to 5/20/93). The task required removal, replacement, and examination of one dozen silicon bronze bolts of every type and size for each of the selected MCCs.

In preparation for the planned bolt sampling plan, the System Engineer for the 230 Volt buses requested that replacement silicon bronze bolts be procured. Procurement activities were never completed, and as a result, the bolt removal and examination was deferred since replacement bolts had not been received. Thus the task was not performed in the outages identified in the initial plans described above. Prior to the initiation of the Salem System Readiness reviews, the task had been rescheduled to be performed in the 1996 refueling outages.

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DESCRIPTION OF OCCURRENCE (cont'd)

Salem System Readiness Reviews, conducted in July and August of 1995, which were being performed to establish the readiness of Salem Units 1 and 2 for restart, identified that the 230 Volt vital MCCs had not been inspected for the bus bar bolting concerns identified in NRC Information Notice 88-11. It was also identified that the Maintenance Procedure (SC.MD-PM.ZZ-0010(Q)- GE Series 7700 Line Motor Control Center) did not specify a torque value for the silicon bronze carriage bolts. The procedure previously only required that the connections be verified hand tight and was last used on the 1B West vital bus on March 6, 1991. This procedure was then revised to add a torque value of 9 ft-lbs. This inspection and torquing was listed as a requirement for completion prior to Salem Units 1 and 2 restart.

The revised procedure was used for the first time when the 1B West vital bus maintenance began on September 5, 1995. The first MCC to be inspected was the 230 Volt 1B West vital MCC. Five of a total of 48 bolts in this MCC failed when a torque of less than 20 inch-lbs was applied. The remaining bolts were successfully torqued to 9 ft-lbs. In each instance of encountering a failed bolt, the second bolt at the connection was intact. A Service Water MCC being examined in parallel with the 1B West vital MCC indicated a similar failure rate. Two of 18 bolts torqued failed in this MCC. Based upon the high rate of failure (10%) of the bus bar bolts, the preventive maintenance on the vital MCCs was halted to initiate an investigation.

NRC Information Notice 88-11 was reviewed during the preliminary investigation. This Information Notice indicated that at Brunswick Units 1&2, GE Series 7700 Motor Control Centers experienced numerous 5/16 inch silicon bronze bolt connecting bus bar failures. PSE&G contacted Brunswick to obtain additional information on their analysis and received a copy of their metallurgical evaluation, which indicated Stress Corrosion Cracking as the failure mechanism.

Based upon a review by the Engineering Analysis staff including the newly obtained Brunswick failure information, a follow-up assessment of operability concluded on September 14, 1995 that the MCCs could not be considered operable due to concerns regarding the MCC bus bar connections' ability to retain their integrity during a seismic event.

DESCRIPTION OF OCCURRENCE (cont'd)

The 230 Volt Vital MCCs were declared inoperable at 2105 on September 14, 1995 for both Salem Generating Station Units #1 and #2. Technical Specification 3.8.2.2 for Salem Unit #2 was applicable as well as multiple other Technical Specifications based on equipment supplied by the affected MCCs for both units. The Salem Senior Nuclear Shift Supervisor (SNSS) placed a four hour report call to the US NRC Operations Center at 2302 hours on 9/14/95 informing them of this condition per 10CFR50.72(b)(2)(i). Containment integrity was established for Salem Unit #2 at 0345 on September 15, 1995, thus satisfying Technical Specification 3.8.2.2 action requirements.

APPARENT CAUSE OF OCCURRENCE

The root cause for the bolt failure is Stress Corrosion Cracking. Specifically, the presence of apparent corrodents (chlorine, sulfur, and sodium) at the fracture area, the morphology of the cracking (predominantly intergranular), and the presence of stress (strain lines in the grains) at the bolt head suggests that the "short" silicon bronze bolts failed by stress corrosion cracking. The ductile type fracture observed in the "long" failed bolt apparently occurred due to applied stress (load) at the bolt head. The presence of corrodents (chlorine and sulfur) and some intergranular cracking observed at the fracture suggests that the failure may have been initiated by stress corrosion cracking.

The root cause for the delay in completing the MCC examinations was ineffective system engineer action to complete tasks in a timely manner, i.e. a personnel error.

Contributing to the event was inadequate management oversight into the extension of task due dates.

PRIOR SIMILAR OCCURRENCES

There are no prior similar occurrences for bolting failures of this type at Salem Station.

PRIOR SIMILAR OCCURRENCES (cont'd)

The failure to complete tasks coupled with ineffective management oversight is related to other recent events that have been the subject of a Notice of Violation regarding failures in meeting 10CFR50 Appendix B requirements. This event represents a condition which occurred as a result of the programmatic breakdowns cited in the Notice of Violation.

SAFETY SIGNIFICANCE

The purpose of the 230 Volt distribution system is to provide a reliable source of power to the 230 Volt plant auxiliaries necessary for the generation of power by the main turbine-generator unit and as required for plant safety during normal, shutdown, and emergency modes of plant operation.

Section 8.3 of the Salem UFSAR describes Onsite Power Systems and the requirements of the Electrical Power System. Section 8.3.1.3 states that the 230 Volt system feeds smaller loads and for convenience of operation, a few motors larger than 15 hp. The 4160 Volt system feeds the 230 Volt system via step down transformers. Each vital instrument bus Uninterruptible Power Supply (UPS) receives as its normal source, vital 230 Volt AC (VAC) power. The 230 VAC power is then rectified to DC and then reconverted to AC power. In the event of a 230 VAC power loss or a UPS malfunction, 125 VDC vital station battery power will automatically supply power to the UPS inverters via an auctioneering circuit to maintain the uninterruptible power.

Other 460 Volt and 230 VAC switchgear loads in Elevation 84' Switchgear Room are not affected by this bolting failure mode since the switchgear is ITE K-Line with carbon steel bolts.

For the original 5/16"-18 silicon bronze bolt (ASTM F-468 No.651, having 70 ksi minimum tensile strength and 53 ksi minimum yield stress, 0.0524 square inches tensile stress area and 0.0454 square inches area of minor diameter) the calculated pre-tension is 1728 lbs. due to 9 ft.-lbs. torque, and allowable shear is 540 lbs.

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SAFETY SIGNIFICANCE (cont'd)

The forces applied at a single bolt connection due to the anticipated design basis earthquake are 50 lbs. tension and 82 lbs. shear. These applied forces are significantly less than the allowable forces at the connection. This assures that the bus bars would have remained clamped together during and after a design basis earthquake event, assuming a single bolt with complete integrity in place per bus bar connection. Thus, with at least one bolt per phase, the degraded bus bar connections would have survived a design basis earthquake event without jeopardizing the safety of the plant.

In each of the two buses with failed bolts, each connection had at least one bolt that held the correct torque. A visual examination of 284 bolts (entire population of bolts inspected to date, not including nine bolts sent to the PSE&G Testing Laboratory for examination) revealed that 16 bolts had exhibited cracking. Varying degrees of corrosive attack were evident on all bolts examined.

Of the 16 cracked bolts, seven bolts were in configurations that could have rendered the associated equipment inoperable if the bolts had failed during a design basis seismic event. The affected electrical loads are: 1) motor operated valve 1RH1, isolation of RHR suction from the Reactor Coolant System (RCS), 2) motor operated valve 21RH29, a minimum flow valve for one of the two Residual Heat Removal (RHR) pumps for Unit #2, and 3) the 2A Emergency Diesel Generator Vital Motor Control Center. During power operations, 1RH1 is closed and the breaker tagged out, thus loss of the breaker is not safety significant. If 1RH1 was open during a reactor cooldown and rendered inoperable, 1RH2 serves as a backup isolation. Loss of the power supply to 21RH29 could allow the 21 RHR pump to overheat if the pump is deadheaded for an extended period of time. This would result in the loss of one of two RHR pumps which is within the design basis for Salem ECCS requirements. The loss of the 2A Emergency Diesel Generator Vital MCC would cause the loss of the 2A diesel. In the event of a sustained loss of off site power, loads fed from the 2A Emergency Diesel Generator would not be powered. However, the design basis for Salem Station is that any two of the diesel generators and their associated vital buses can supply sufficient power for operation of the required safeguards equipment for a design basis LOCA coincident with a loss of offsite power.

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SAFETY SIGNIFICANCE (cont'd)

Therefore, based upon the evidence available, the safety significance is believed to be low since each bus (except as noted previously) would have maintained its integrity during a seismic event. However, it is recognized that the programmatic failure in management oversight coupled with the hardware deficiencies had the potential for significant common mode failures had the deficiencies gone undetected.

CORRECTIVE ACTIONS

1. Design Change Package DCP-1ER-0098 was implemented and completed on Unit #2 Vital 230 Volt MCCs to replace all bus bolts with carbon steel bolts. This action was completed on September 25, 1995.

2. Design change package (DCP-1ER-0098) for Unit #1 Vital 230 Volt MCCs to replace all bus bolts with carbon steel bolts will be completed by December 31, 1995.

3. Non Vital bus bolt replacement for Unit #1 will be completed by December 31, 1995.

4. Non Vital Bus bolt replacement for Unit #2 will be completed by March 31, 1996.

5. Improve the Operating Experience Program (OEP) by March 31, 1996 to ensure that action items coming from industry events are addressed and closed in a timely manner. As specific tasks are developed from an operating experience issue, these tasks will be monitored until closure by the OEP. Thus the program will be equipped with an effective feedback link which will assure that the scheduling and execution of specific tasks are accomplished without undue delay.

6. The following corrective actions have been implemented as part of PSE&G's response to address the basic issue of timely corrective actions in meeting the requirements of 10CFR50 Appendix B, Criterion XVI. These initiatives are relevant to this LER in addition to their broader role in improving operations at Salem Station.

a. Reducing the backlog of open issues by examining those issues and taking effective action prior to Salem units restart.

b. Improved Salem Station management oversight, expectations, and standards with new Station and Nuclear Business Unit management.