NRC Form 366
(9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES: 8/31/85

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Salem Generating Station	0 5 0 0 0 2 7 2	1 OF 0 4

TITLE (4)
Reactor Trip From 100% Due to Turbine Generator Failure

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES	DOCKET NUMBER(S)
0 2	2 4	8 4	8 4	0 0 5	0 1	0 3	1 9	8 5		0 5 0 0 0
										0 5 0 0 0

OPERATING MODE (9)	1	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
POWER LEVEL (10)	1 0 0	20.402(b)	20.405(c)	X 50.73(a)(2)(iv)	73.71(b)
		20.405(a)(1)(i)	50.36(c)(1)	50.73(a)(2)(v)	73.71(c)
		20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	OTHER (Specify in Abstract below and in Text, NRC Form 366A)
		20.405(a)(1)(iii)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	
		20.405(a)(1)(iv)	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
		20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER
J. L. Rupp	AREA CODE 6 0 9 3 3 9 - 4 3 0 9

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	
X	E B	T G	W 1 2 0	Y							

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 fifteen single-space typewritten lines) (16)

On February 24, 1984, during routine power operation, a reactor trip occurred from one-hundred percent power. The reactor trip was a result of Unit 1 Turbine Generator tripping on generator neutral ground protection. Initial investigation revealed that Coil B31 had failed outside the iron, at the cooling water connection on the exciter end of the generator. A cooling water leak had also developed in this area. Some copper spatter from the failed coil, and degraded insulation was noted in several areas. It has been concluded that the generator was built with an incompletely cured conformable layer of impregnating resin; resulting in resin "runout" during operation. The generator was rewound utilizing an improved conformable layer of resin and incorporating many improved features during the rewind process. The reactor protection system functioned as designed. The turbine trip and the reactor trip occurred as required to prevent additional generator damage, and to minimize the primary plant transient. This occurrence involved no undue risk to the health or safety of the public. Because of the automatic actuation of the Reactor Protection System, the event is reportable in accordance with the Code of Federal Regulations, 10CFR 50.73(a)(2)(iv).

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Y1

PLANT AND SYSTEM IDENTIFICATION:

Westinghouse - Pressurized Water Reactor

Energy Industry Identification System (EIIS) codes are identified in the text as [XX].

IDENTIFICATION OF OCCURRENCE:

Reactor Protection System [JC] - Reactor Trip From 100% - Turbine Generator Failure - (Rx Trip #84-05)

Event Date: 02/24/84

Report Date: 03/19/85

This report was initiated by Incident Report No. **84-038**

CONDITIONS PRIOR TO OCCURRENCE:

Mode 1 - Rx Power 100 % - Unit Load 1129 MWe

DESCRIPTION OF OCCURRENCE:

At 1726 hours, February 24, 1984, during routine power operation, Unit 1 Turbine Generator was tripped by the generator stator ground fault protection relays. These relays are set to actuate when ground current reached two (2) amperes. Control room instrumentation showed no evidence of generator distress prior to the failure. By design, the turbine trip caused a reactor trip.

Inspection of the generator revealed that the electrical fault was at the exciter end of the bottom coil in slot No. 31 (designated B31), at the 2:30 o'clock position as viewed from the exciter end. The electrical insulation at the end of B31 and neighboring coils was blackened. The surface of these coils and of adjacent coil braces was spattered with nodules of copper from coil B31. The arc which produced the copper spatter had blown a hole through the electrical insulation of coil B31. The phase block adjacent to B31 was heavily eroded by electrical tracking. It was subsequently determined that the arc had partially melted the end of the B31 coil and the series connection which electrically connects it to the next coil. The exciter end stator coil end winding basket was found to be extremely loose. There was heavy dusting (wear particles) on many diamond spacers, and five diamond spacers had fallen out of their position in the winding. Core block looseness caused wear through up to sixty percent (60%) of the ground wall insulation; the worst wear being located at phase group boundaries. The stator coil end turns on the turbine end, except for some relatively minor looseness of strain blocks, were tight and in good condition. There was no indication of excessive water temperature or loss of stator coil cooling water flow, or of hydrogen cooling water flow.

DESCRIPTION OF OCCURRENCE: (cont'd)

Loss of coolant flow would have resulted in high hydrogen temperature or high stator coil discharge temperatures, which would have caused control room alarms; no such alarms were recorded. Large deposits of lead carbonate were found on the hydrogen coolers. Traces of this substance were found on the windings themselves. The windings and the entire generator were observed to be dry, and dew point readings were maintained below 45°F during operation.

It was observed that, at some time in history, resin had run out of the slots and finally hardened on the stator teeth and wedges. The windblown appearance of the resin led to the conclusion that this had occurred when the generator was in service. This resin had come from the epoxy-impregnated dacron felt, which is placed in the bottom of the slot and between the top and bottom coils to aid in assuring uniform support of the coils against magnetic forces. It was observed, during coil removal, that many top and bottom coils were bonded into the slots by the resin which had run out from the conformable layers and finally hardened in the space between the coils and the stator teeth.

Each generator coil is connected electrically to its neighbor by a group of copper strands which are soldered into the box-like header cap ferrule. This group of strands is called a "series connection". Investigation revealed that several of these series connections contained cracks in the solder bond. The stainless steel nipple, which feeds water from the inlet water manifold to the teflon hose which connects to coil B31, was partly missing. It had the appearance of having been eroded or corroded away. The identical nipple on the coil end of the B31 hose had disappeared entirely. No other nipples showed any distress.

APPARENT CAUSE OF OCCURRENCE:

It has been concluded that the generator was built with an incompletely cured conformable layer of impregnating resin. In service, this material re-liquified and ran out into the space between the coils and the stator teeth. It then re-solidified and bonded the coils into the slots. This happened first on the hotter turbine end. The resultant thermal expansion loosened the end turn bracing on the exciter end. This led to high thermal and vibratory stress at the B31 coil end. The series connection strand to header cap solder joint failed in fatigue. This was followed by a fatigue failure of the header cap ferrule. This last failure resulted in an arc which melted the coil end. When the header cap melted or vaporized from the heat of the arc, steam pressure blew the hot gases back through the teflon water hose and into the water manifold, eroding the stainless steel nipples in the process; this was verified by chemical analysis of the deposits found in the water manifold. Ground current, through the partially ionized hot gas blast and inside the teflon hose, actuated the ground relay which tripped the generator.

ANALYSIS OF OCCURRENCE:

The primary function of the reactor trip (on turbine trip) is to prevent steam generator safety valve actuation, due to the steam generator pressure increase, in the event that the turbine should trip during power operation. A turbine trip is sensed by two (2) out of three (3) signals from low autostop oil pressure or all turbine steam stop valves closed signals. A turbine trip causes a direct reactor trip above approximately ten percent (10%) reactor power (P-7 interlock circuitry), and results in a controlled short term release of steam to the turbine condenser. This steam release removes sensible heat from the RCS, and thereby avoids steam generator safety valve actuation.

This reactor trip is anticipatory, and included as part of good engineering practice and prudent design. No credit is taken in any of the safety analyses for this trip. Reactor protection during power operation is provided by the Power Range Detectors, for rapid transients, and by the Overtemperature and Overpower Delta Temperature, for slower developing transients. The Reactor Protection System [JC] functioned as designed. The turbine trip and the reactor trip occurred as required to prevent additional generator damage, and to minimize the primary plant transient. This occurrence involved no undue risk to the health or safety of the public. Because of the automatic actuation of the Reactor Protection System, the event is reportable in accordance with the Code of Federal Regulations, 10CFR 50.73(a)(2)(iv).

CORRECTIVE ACTION:

The generator was rewound, utilizing an improved conformable layer of impregnated resin to minimize the possibility of resin runout. During the rewind, many improved end turn bracing features were incorporated to prevent end turn bracing looseness, a new process control was utilized to reduce series connection stiffness and ferrule stress concentration was reduced by incorporating a new radii at the ferrule to header cap interface.

General Manager -
Salem Operations

JLR:tns

SORC Mtg 85-037

PSE&G

Public Service Electric and Gas Company P.O. Box E Hancocks Bridge, New Jersey 08038

Salem Generating Station

March 19, 1985

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

Dear Sir:

SALEM GENERATING STATION
LICENSE NO. DPR-70
DOCKET NO. 50-272
UNIT NO. 1
LICENSEE EVENT REPORT 84-005-01
SUPPLEMENTAL REPORT

Pursuant to the requirements of 10CFR 50.73(a)(2)(iv), we are submitting supplemental Licensee Event Report for Reportable Occurrence 84-005-01.

Sincerely yours,

J. M. Zupko, Jr.
General Manager -
Salem Operations

JR:tcs

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