

Commonwealth Edison Company
Zion Generating Station
101 Shiloh Boulevard
Zion, IL 60099-2797
Tel 847-746-2084




November 11, 1996

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555-0001

The enclosed Licensee Event Report number 96-008-00, Docket No. 50-304/DPR-48 from Zion Generating Station is being transmitted to you pursuant to 10 CFR 50.73(a)(2)(i)(B), which requires a 30-day written report when any operation or condition occurs that is prohibited by the plant's Technical Specifications.

Very truly yours,


G. K. Schwartz
Station Manager
Zion Generating Station

GKS/GS/jks

Enclosure: Licensee Event Report

cc: NRC Region III Administrator
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LICENSEE EVENT REPORT (LER)

FACILITY NAME ZION NUCLEAR POWER STATION UNIT 2										DOCKET NUMBER 0 5 0 0 0 3 0 4				PAGE 1 OF 0 5						
TITLE Steam Generator Tube Indications Greater than Technical Specification Requirements, Due To Stress Induced During the Fabrication Process																				
EVENT DATE			LER NUMBER				REPORT DATE			OTHER FACILITIES INVOLVED										
MONTH	DAY	YEAR	YEAR	SEQ.	REV.	MONTH	DAY	YEAR	FACILITY NAMES				DOCKET NUMBER(S)							
1	0	1	9	6	-	0	0	8	-	0	0	1	1	1	9	6				
OPERATING MODE			THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (CHECK ONE OR MORE OF THE FOLLOWING)																	
N			20.402(b)				20.405(e)				50.73(a)(2)(iv)				73.71(b)					
POWER LEVEL			20.405(a)(1)(i)				50.36(c)(1)				50.73(a)(2)(v)				73.71(c)					
0			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																				
NAME										TELEPHONE NUMBER										
R. J. Skowzgard, Maintenance Engineering ext. 2192										8 4 7 7 4 6 - 2 0 8 4										
COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT																				
CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS										
B				Y																
SUPPLEMENTAL REPORT EXPECTED																				
<input type="checkbox"/> YES, (If yes, complete EXPECTED SUBMISSION DATE)										<input checked="" type="checkbox"/> NO		EXPECTED SUBMISSION DATE		MONTH	DAY	YEAR				

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines).

On October 11, 1996, during the Zion Unit 2 Refueling Outage 14 (Z2R14), eddy current inspection results of the steam generators indicated that Zion exceeded the requirements of Technical Specification 4.3.1.B.2. The identified indications are characterized by Technical Specifications as follows: greater than or equal to 10% of the tubes inspected are classified as degraded or greater than or equal to 1% of the tubes inspected are considered defective. An Emergency Notification System (ENS) call was placed to the NRC pursuant to Section 6.6.2.a.B.1 of the Technical Specifications.

The cause of this event is manufacturing. Based on industry experience, eddy current indications of the nature identified are not uncommon in steam generators. Roll transition indications appear as a result of the stresses induced during the fabrication process.

Corrective actions include determining and applying the appropriate repair method, inspecting the entire hot leg/cold leg tubesheet region with Rotating Pancake Coil, performing in situ pressure testing of 32 tubes and pulling 5 tubes for laboratory inspection.

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

A. PLANT CONDITIONS PRIOR TO EVENT

Unit 2 Mode-Refueling Rx Power 0% RCS [AB] Temperature/Pressure ambient°F/atmospheric

B. DESCRIPTION OF EVENT

Zion Unit 2 steam generators [SB](SG) are Westinghouse series 51 design. The generators utilize 7/8 inch inner diameter, Inconel 600 tubes. The tubes are constrained within the tubesheet by a partial depth, mechanical roll expansion. The roll expansion is nominally 2-1/4 inches from the bottom of the tubesheet. The tubesheet is 21 inch thick carbon steel with Inconel cladding. A nominal gap exists between the tube and tubesheet which is 18-3/4 inches long and has a diametrical gap of 13 to 18 mils.

During the Zion Unit 2, Refueling Outage 14 (Z2R14), the following inspection scope was implemented:

- 100% Full Length Bobbin Exam
- 100% MRPC Hot Leg Tubesheet +8
- 100% MRPC Cold Leg Tubesheet +1
- 100% +Point Exam of all Sleeves
- 100% +Point of Row 1 & 2 U-bend
- 100% MRPC of all Hot Leg Dents > 5.0 Volts

Based on the results of the eddy current inspection, Zion determined that the requirements of Technical Specification 4.3.1.B.2 would be exceeded. Under Technical Specification 4.3.1.B.2 the steam generators are classified into one of three categories based upon the results of the eddy current inspection. Category C-3 is characterized as follows: greater than 10% of the tubes inspected are classified as degraded or greater than 1% of the tubes inspected are considered defective.

The eddy current indications that lead to the category C-3 determination were found within the tubesheet region of the steam generators. The indications in this region were primarily of two distinct forms. First, Primary Water Stress Corrosion Cracking (PWSCC) was found predominantly at the roll transition. The roll transition is the section of tube between the mechanical expansion and the point at which tube resumes its normal diameter. Second, Outside Diameter Stress Corrosion Cracking (ODSCC) was identified at various locations within the tubesheet.

On October 11, 1996, inspection results identified that Zion steam generators had greater than 1% of the tubes inspected categorized as defective on October 11, 1996. An Emergency Notification System (ENS) call was made to the NRC pursuant to Technical Specification 6.6.2.a.B.1.

Defective tubes are tubes with through wall defects greater than 40%. Although none of these tubes have been characterized in sufficient detail to determine the actual through wall percentage of the defect, the indications have been confirmed with Rotating Pancake Coil (RPC), which is recognized by the industry as having a high probability of a defect exceeding 40% through wall.

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C. CAUSE OF EVENT

The cause of this event is manufacturing. Based on industry experience, eddy current indications of this nature are not uncommon due to the steam generator manufacturing process. Roll transition indications (PWSCC) appear as a result of the stresses induced during the fabrication process. In a non-stress relieved condition the roll transition region is prone to axially oriented indications which are very short in length, typically less than 0.70 inches. ODSCC in the tubesheet crevice region of the tubesheet crevice appears to be induced by a combination of stresses induced during fabrication as well as secondary side caustics that form in the crevice region of the tubesheet.

D. SAFETY ANALYSIS

This event is reportable pursuant to 10 CFR 50.73(a)(2)(i)(B), which requires a 30-day written report when any operation or condition occurs that is prohibited by the plant's Technical Specifications.

In an effort to address the safety analysis of this issue, the potential of rupture, industry information and Zion experience will be discussed.

Indications contained within the tubesheet do not pose a significant safety risk, regardless of whether the indication appears to be ODSCC or PWSCC. The diametrical gap between the tube and tubesheet is very small (13 to 18 mils). Due to this small gap, tube rupture is high unlikely in the region due to the structural reinforcement provided by the tubesheet. During this outage (Z2R14) a number of these indications were in-situ pressure tested to determine leakage at Main Steam Line Break (MSLB) pressures. All tubes pressure tested within the tubesheet region exhibited zero leakage at MSLB pressures. Therefore, since no leakage was identified at MSLB conditions, the 10 CFR 100 site boundary dose limits are not approached.

In addition, the eddy current inspection performed during Z2R14 is considered state of the art and conforms with the current Electric Power Research Institute (EPRI) Steam Generator Eddy Current Inspection Guidelines. All defective tubes will be repaired during Z2R14 by one of three methods: plugging, sleeving or re-rolling the tube.

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

D. SAFETY ANALYSIS (Continued)

As identified in the two EPRI references listed below, PWSCC is well documented as a roll transition concern. Although Zion is not licensed to leave axial cracks in service, these two EPRI documents highlight the relatively low safety significance associated with PWSCC cracks in the roll transition (RT).

1. EPRI Draft Report, PWR Steam Generator Repair Limits: Technical Support Document For Expansion Zion PWSCC in Roll Transition Rev. 2, June 1993.
2. EPRI Report, Steam Generator Progress Report, Rev. 9, October, 1993

These documents identify that PWSCC has appeared in both foreign and domestic units with Mill Annealed Inconel 600 tubing. Eleven (11) domestic units with partial depth expansion have experienced RT PWSCC. Sixteen (16) domestic units with full depth expansion have experienced RT PWSCC. Thirteen (13) foreign units with full depth expansion have experienced RT PWSCC.

Current domestic practice is to repair RPC indications by rerolling, plugging or sleeving. However the EPRI report (Ref. 1) was written with the intention of allowing certain RT PWSCC indications less than 40% to remain in-service. The methodology was first developed in Europe and is fully implemented in France, Sweden, Belgium and Spain.

The repair limit, reflected in EPRI Report (Ref. 1), has been defined by using a conservative correlation between burst pressure and crack length, an experimental determination adjustment for tubesheet constraint (an adjustment for Non-Destructive Examination measurement uncertainty level determined from destructive examination of pulled tubes) and a mean crack growth rate.

Industry experience for plants with RT PWSCC indicates very low levels of cumulative leakage during normal operation, ranging from 5 to 35 gpd. Additionally, industry experience indicates that RT PWSCC is subject to a leak-before-break scenario, i.e., sudden tube rupture of axial PWSCC is highly unlikely. Tube rupture in partial depth expansion units, such as Zion, is prohibited by the presence of the tubesheet in the RT area.

Zion Unit 2 has experienced PWSCC and ODS CC, resulting in plugging and sleeving of tubes since 1983. Eddy current test methods utilized in the past have proven to be effective at identifying tube degradation prior to the occurrence of significant leakage. Zion Unit 2 has experienced only one forced outage due to steam generator tube leakage. In 1994, an indication located approximately one inch below the top of the tubesheet, in the "D" SG, caused a delay in the start-up of Unit 2. An additional forced outage, in 1989, occurred due to seven indications found in the tubesheet region of the "A" SG.

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D. SAFETY ANALYSIS (Continued)

Extensive Eddy current inspections are performed during each refueling outage at Zion Station. The purpose of these inspections is to identify indications that could represent a risk to safety. This was the first inspection in which Zion Unit 2 performed extensive Rotating Pancake Coil (RPC) inspections in the tubesheet region. This inspection was partially as a result of the commitment made by Zion in the response to Generic Letter 95-03, "Circumferential Cracking of Steam Generator Tubes." This Unit 2 inspection expanded to the cold leg tubesheet region after the large number of indications were evident on the hot leg. Zion Maintenance Engineering expected that a larger than normal number of indications would be found during the initial 100% inspection of the roll transition area with RPC. Inspection transients occur throughout the industry when improved eddy current techniques are utilized or new regions are inspected in detail for the first time. The Zion indications observed are not different than industry experience.

Therefore, based on the above, the safety significance of this event is minimal.

E. CORRECTIVE ACTIONS

1. All tubes identified in Z2R14 with ODSCC or PWSCC degradation will be reviewed by corporate and station Steam Generator engineers to determine and implement the appropriate repair method: sleeving, rerolling or plugging. (304-180-96-3273-01)
2. Five tubes will be pulled to help identify and characterize the indications and provide more insight into what is occurring with each mode of degradation. (304-180-96-3273-02)

F. PREVIOUS EVENTS SEARCH AND ANALYSIS

LER 95-020 (Unit 1) reports the same event on Unit 1. Although the corrective actions in LER 95-020 would not have precluded occurrence of the subject LER, the previous event served as lessons learned for the steam generator inspection activities for the Z2R14 refueling outage.

G. COMPONENT FAILURE DATA

<u>Manufacturer</u>	<u>Nomenclature</u>	<u>Model</u>
Westinghouse Electric Co.	Steam Generator	Series 51