

Commonwealth Edison Company
Braidwood Generating Station
Route #1, Box 84
Braceville, IL 60407-9619
Tel 815-458-2801



November 19, 1996

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

Subject: ComEd Braidwood Station Unit 1 Cycle 6 Midcycle Outage
Steam Generator Inservice Inspection Report
Docket No. STN 50-456

References: (1) NUREG-1276, Technical Specifications, Braidwood
Station, Unit Nos. 1 and 2

Specification 4.4.5.5.c of reference (1) requires that results of steam generator (SG) tube inspections which fall into Category C-3 shall be reported in a Special Report to the Commission pursuant to Specification 6.9.2 within 30 days, and prior to resumption of plant operation. This report shall provide a description of investigations conducted to determine the cause of tube degradation and corrective measures taken to prevent recurrence.


The initial sample inspection resulted in the following SGs being classified into Category C-3 based on the number of defective tubes found during the Cycle 6 Midcycle outage (A1P02):

1A, 1B, 1D	On October 24, 1996 at 20:45 hours
1C	On October 26, 1996 at 18:30 hours

Notification per Technical Specification Table 4.4-2 pursuant to 10 CFR 50.72 (b) (2) (i) for steam generators being classified in Category C-3 was initiated. The enclosed summarizes the inspection results.

Please direct any questions regarding this submittal to Douglas Huston, Braidwood Licensing Supervisor, (815) 458-2801, extension 2511.

Very truly yours,


Timothy J. Tulon
Station Manager
Braidwood Station

TJT/ft/mc96007.doc

Enclosure: Steam Generator C-3 Report
Attachment

cc: Senior Resident Inspector - Braidwood
Braidwood Project Manager, NRR
Regional Administrator, Region III

AC471

000098

9611290377 961119
PDR ADOCK 05000456
G PDR

A Unicom Company

**Braidwood Station Unit 1
Cycle 6 Midcycle Outage A1P02
Steam Generator C-3 Report**

On October 15, 1996, a Steam Generator (SG) Tube Inservice Inspection was initiated on Braidwood Unit 1 as a result of a commitment to the NRC for a midcycle inspection. Technical Specification Surveillance Requirement (TSSR) 4.4.5.2.e requires that the results of each sample inspection be classified into one of three categories. A SG will be classified in Category C-3 if more than 10% of the total tubes inspected are degraded or more than 1% of the inspected tubes are defective. A SG tube is considered degraded if it has an imperfection of greater than or equal to 20% of the nominal tube wall thickness. A SG tube is considered defective if it has an imperfection of greater than or equal to 40% of the nominal tube wall thickness.

An initial sample size of 100% of all available hot-leg top-of-tubesheet roll transitions was selected. The inspection was conducted using the 3-coil Plus Point probe consisting of a Plus Point coil, a 0.080 inch Pancake coil, and a 0.115 inch Pancake coil. The eddy current data was analyzed using the EddyNet 95 software. The initial sample inspection resulted in the following SGs being classified into Category C-3 based on the following reasons:

- 1A On October 24, 1996 at 20:45 hours, greater than 1% of the 4029 inservice tubes being defective.
- 1B On October 24, 1996 at 20:45 hours, greater than 1% of the 4450 inservice tubes being defective.
- 1C On October 26, 1996 at 18:30 hours, greater than 1% of the 3835 inservice tubes being defective.
- 1D On October 24, 1996 at 20:45 hours, greater than 1% of the 4181 inservice tubes being defective.

Notification per Technical Specification Table 4.4-2 pursuant to 10 CFR 50.72 (b) (2) (i) for steam generators being classified in Category C-3 was initiated within four hours of the affected SGs being evaluated as C-3.

Table 1 provides, by SG, the number of tubes plugged during this outage, the number of tubes sleeved during this outage as well as the number of tubes plugged in previous outages.

Table 1
Braidwood Unit 1 A1P02 Inspection/Repair Overview

Indication	1A SG	1B SG	1C SG	1D SG	Total
Circumferential	221	276	610	293	1400
Axial	1	20	3	8	32
Mixed Mode	2	3	6	3	14
Total Indications	224	299	619	304	1446
Total Repairable Tubes*	224	295	618	299	1436
Total Tubes Sleeved	181	0	445	271	897
Tubes Stabilized and Plugged	43	295	173	28	539
A1P02 Equiv. Plugged Tubes	53.5	296	198.9	43.8	592.2
Tubes Previously Plugged	549	128	743	397	1817
Total Tubes Plugged	602.5	424	941.9	440	2409.2
Total Equivalent Plugging (%)	13.2	9.3	20.6	9.6	13.2

* Ten tubes had more than 1 indication.

All repairable indications identified during this inspection have been repaired using the Westinghouse Laser Welded Sleeve or have been removed from service by plugging. Stabilizers were installed in the tubes that were plugged so that further degradation of the tubes can not result in a double ended break at the top of the tubesheet. With the additional 539 tubes plugged during this inspection and accounting for the 17.2:1 sleeves to plug ratio, Braidwood Unit 1 has 13.2% of the total SG tubes plugged with a single loop maximum of 20.6% plugged in the 1C SG loop. These plugging levels are within the acceptable range to ensure the RCS total flowrate in Technical Specification 3.2.3 is achieved.

The Westinghouse Laser Welded Sleeving process and the mechanical SG tube plugging process used at Braidwood are approved methods of SG tube repair per the Braidwood Technical Specifications.

Twenty-three tubes, with the largest indications, were insitu pressure and leak tested. None of the tubes burst at three times normal operating differential pressure demonstrating the structural integrity of the SGs prior to this inspection. Some of the tubes leaked under insitu pressure testing at Main Steam Line Break differential pressure. The total leakage in the limiting SG was 2.15 gpm. Adding this to the predicted leakage from the Tube Support Plate Interim Plugging Criteria (6.99 gpm) and potential leakage from the unfaulted SGs (0.3 gpm), the resultant leakage from the limiting SG is 9.44 gpm. This is less than the site allowable leakage of 26.8 gpm. Therefore, the accident dose rate is below a small fraction of the 10CFR100 limits.

This report is being provided in accordance with Specification 4.4.5.5.c of NUREG 1276, Technical Specifications, Braidwood Station, Units Nos. 1 and 2.

INVESTIGATION CONDUCTED TO DETERMINE THE CAUSE OF THE TUBE DEGRADATION

During the Braidwood Unit 1 midcycle SG Tube inservice inspection, axial and circumferential indications were identified at the SG top-of-tubesheet roll transition region. These top-of-tubesheet indications resulted in 539 tubes being removed from service by plugging and 897 tubes being sleeved using the Westinghouse Laser Welded Sleeve. The top-of-tubesheet indications are a result of Outside Diameter Stress Corrosion Cracking (ODSCC). The cause of the indications is related to the manufacturing process of hard-rolling the SG tubes into the tubesheet. This process caused residual stresses in the SG tubes, thereby creating an environment for stress corrosion cracking. A majority of the indications are located in the "T" slot of the tube bundle. Sludge accumulates in the area of the "T" slot. This suggests a possible link between sludge and the formation of indications at the top-of-tubesheet roll transition region. The "T" slot is susceptible to dry-out which could also contribute to the number of indications in this area.

Twenty-three tubes with circumferential indications were insitu pressure and leak tested. The insitu test program was discussed with NRR. All of the tests were conducted per the agreements with NRR. All of the tubes were insitu tested to 3100 psi (above Main Steam Line Break conditions when corrected for temperature and pressure). Ten of these tubes were tested to 5000 psi (greater than three times normal operating differential pressure - Regulatory Guide 1.121). None of the tubes burst, therefore, the tests proved the structural integrity of the tubes. Some of the tubes leaked under accident conditions. The total leakage in the limiting SG was 2.15 gpm. Adding this to the predicted leakage from the Tube Support Plate Interim Plugging Criteria (6.99 gpm) and potential leakage from the unfaulted SGs (0.3 gpm), the resultant leakage from the limiting SG is 9.44 gpm. This is less than the site allowable leakage of 26.8 gpm.

Four of the ten tubes tested to 5000 psi were removed from the 1B SG to determine the morphology of the indications, assess the percent degraded area and 100% throughwall area, and to assess the eddy current voltage sizing techniques.

CORRECTIVE MEASURES TO PREVENT RECURRENCE

All of the defective tubes were repaired by sleeving or were removed from service by plugging. The Braidwood Unit 1 Steam Generators will be replaced during the A1R07 refueling outage (Fall of 1998). The new Steam Generators will include a different tube material (Inconel 690) and the tubes will be hydraulically expanded into the tubesheet instead of hard-rolling. The Inconel 690, along with the hydraulic expansion of the tubes, will reduce the potential for stress corrosion cracking at the roll transition region.

The dominant form of corrosion identified during the A1P02 outage is circumferential ODSCC at the top-of-tubesheet roll transition regions. Braidwood Station implemented the following programs to mitigate the corrosive environment in the SGs which lead to ODSCC:

- Use of advanced amines, such as methoxypropylamine (MPA), for secondary pH control to reduce the amount of corrosion products which enter the SG.
- Compliance with the EPRI Secondary Chemistry Guidelines.
- Maintain hotwell dissolved oxygen concentrations <3 ppb.
- Continue use of high hydrazine concentrations for maintaining reducing conditions in the SGs and passivation of piping systems and components.

Analysis of samples of sludge from previous outages determined that Braidwood Unit 1 does not have significant levels of lead or copper in the sludge. Lead and copper have been identified as contributors to the formation of ODSCC.