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November 13, 1995  
BW/95-0110

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

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

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

Gentlemen:

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 this outage:

- 1A On October 27, 1995 at 22:00 hours
- 1B On October 24, 1995 at 16:55 hours
- 1C On October 29, 1995 at 21:00 hours
- 1D On October 29, 1995 at 21:45 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. Notification was made based on the only approved Technical Specification SG tube plugging criteria being 40% through-wall degradation. The 1.0 Volt Interim Plugging Criteria that was in effect for Braidwood Unit 1 Cycle 5 had expired. At the time of the inspection, the Technical Specification amendment for a 3.0 Volt Interim Plugging Criteria had not been approved by the NRC. The 3.0 Volt Interim Plugging Criteria was approved by the NRC on November 9, 1995, in a letter from M. D. Lynch to D. L. Farrar, "ISSUANCE OF AMENDMENTS (TAC NOS. M91671, M91672, M91673, and M91674)." None of the SGs meet the criteria for Category C-3 based on the 3.0 Volt Interim Plugging Criteria.

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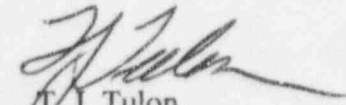
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The enclosed summarizes the inspection results. Included is a description of the investigations being performed to determine the cause of degradation and corrective actions to prevent recurrence.

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

Very truly yours,



L. J. Tulon  
Station Manager  
Braidwood Nuclear Station

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Enclosure: Steam Generator C-3 Report

Attachment

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

**Braidwood Station Unit 1  
Fifth Refuel Outage  
Steam Generator C-3 Report**

On October 7, 1995, a Steam Generator (SG) Tube Inservice Inspection was initiated on Braidwood Unit 1 in accordance with Technical Specification Surveillance requirement (TSSR) 4.4.5.0.

An initial sample size of 100% of all available tubes was selected.

TSSR 4.4.5.2.c 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% nominal tube wall thickness. A SG tube is considered defective if it has an imperfection of greater than or equal to 40% nominal tube wall thickness.

The initial sample inspection resulted in the following SGs being classified into Category C-3 based on the following reasons:

- 1A On October 27, 1995 at 22:00 hours, greater than 1% of the 4073 inservice tubes being defective.
- 1B On October 24, 1995 at 16:55 hours, greater than 1% of the 4476 inservice tubes being defective.
- 1C On October 29, 1995 at 21:00 hours, greater than 1% of the 3872 inservice tubes being defective.
- 1D On October 29, 1995 at 21:45 hours, greater than 1% of the 4213 inservice tubes being defective.

The exact number of tubes exceeding the 40% through wall limit is not known since the eddy current examination was performed assuming approval of a 3.0 Volt Interim Plugging Criteria Technical Specification amendment. Enough eddy current examinations were performed to verify the results met Category C-3. At the time of the examination, the only approved Technical Specification SG tube plugging limit was the 40% through wall limit. The 1.0 Volt Interim Plugging Criteria that was in effect for Braidwood Unit 1 Cycle 5 had expired. At the time of the SG eddy current examination, the 3.0 Volt Interim Plugging Criteria had not been approved by the NRC. The 3.0 Volt Interim Plugging Criteria was approved by the NRC on November 9, 1995 in a letter from M. D. Lynch to D. L. Farrar, "ISSUANCE OF AMENDMENTS (TAC NOS. M91671, M91672, M91673 AND M91674)." None of the SGs meet the criteria for Category C-3 based on the 3.0 Volt Interim Plugging Criteria. Most of the defective tubes based on the 40% through wall criteria are due to indications at the hot leg tube support plate regions.

Attachment A provides, by SG, the number of tubes plugged this outage per the 3.0 Volt Interim Plugging Criteria as well as the number of tubes plugged in previous outages. This attachment also includes the reason why each tube was plugged during this outage.

Technical Specification 4.4.5.5.c requires results of SG tube inspections which fall into Category C-3 to 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 the tube degradation and corrective measures to prevent recurrence.

### **INVESTIGATION CONDUCTED TO DETERMINE THE CAUSE OF THE TUBE DEGRADATION**

The SG tube eddy current inspection performed during the Unit 1 fifth refuel outage met the requirements for the implementation of the 3.0 Volt Interim Plugging Criteria. The requirements for the 3.0 Volt Interim Plugging Criteria calls for 100% bobbin coil probe examination of all hot leg tubes down to the lowest cold leg indication. The lowest cold leg indication is determined by a minimum examination of 20% of the SG tubes full length. Rotating Pancake Coil (RPC) inspections were performed on all hot leg support plate indications greater than 3.0 volts and all cold leg support plate indications greater than 1.0 volt. In addition, a minimum of 20% of the hot leg indications between 1.0 and 3.0 volts were inspected by RPC. The bobbin coil inspection resulted in 4136 indications being identified at the support plate regions. The RPC inspection verified that the support plate indications are primarily axially oriented outside diameter stress corrosion cracking (ODSCC) and that the indications are confined within the thickness of the SG tube support plates. In addition to the ODSCC at the support plate regions, axial and circumferential cracks were identified at the top-of-tubesheet roll transition region. These top-of-tubesheet indications resulted in 30 tubes being removed from service. The top-of-tubesheet indications are also a result of ODSCC. Two tubes were removed from service due to wear greater than 40% through wall at the Anti-Vibration Bars.

### **CORRECTIVE MEASURES TO PREVENT RECURRENCE**

The dominate form of corrosion in the Braidwood Unit 1 SGs is ODSCC at the support plate regions. Braidwood Station implemented the following programs to mitigate the corrosive environment in the tube support plate region which leads to ODSCC:

#### **Industry Guidelines**

- Compliance with the EPRI Secondary Chemistry Guidelines, Revision 3.

#### **SG Tube Crevice Fouling**

- Maintain hotwell dissolved oxygen concentrations <3 ppb

- Use of advanced amines, such as ethanolamine (ETA), for secondary pH control

#### SG Crevice pH

- Evaluation of SG hideout return data during shutdown to assess the impact of operating chemistry on SG crevice chemistry, and potential formation of caustic crevices which can cause Tube Support Plate ODSCC.
- The molar ratio control program begun at the start of Cycle 4 will be maintained. This program adjusts the sodium to chloride ratio in the SG by adding ammonium chloride to the condensate system.

#### SG Sodium Reduction

- Installed a reverse osmosis unit in the makeup water system to reduce sodium input to the secondary side.
- Performed 100% eddy current inspection on the four condenser water boxes over the last three refuel outages.

#### SG Electrochemical Potential (ECP) Reduction

- Continue use of high hydrazine concentrations for maintaining reducing conditions in the SGs and passivation of piping systems and components.
- Braidwood does not have any copper components in its feedwater or condensate systems.

Currently, Braidwood Station, in conjunction with our Corporate Chemistry Support Organization, is pursuing additional methods to further enhance our SG corrosion control program. They are as follows:

- The addition of other amines either with ETA or in place of ETA will be evaluated to optimize the pH control and minimize iron transport.
- Chemistries are being evaluated to improve iron transport out of the SG. The goal is to increase the efficiency of iron removal via the SG blowdown system.

During Cycle 5, Braidwood Unit 1 implemented a Secondary Side Boric Acid program as a measure to reduce the corrosive environment in the SG tube support plate region which leads to ODSCC, thereby lengthening the life of the SGs. Since this time, ComEd has decided to replace the SGs in Braidwood Unit 1. The SG replacement is scheduled for the seventh refuel outage in the Fall of 1998. The overall Unit 1 Cycle 5 voltage growth rate of the support plate indications was greater than the voltage growth rate from Unit 1 Cycle 4. The Secondary Side Boric Acid program was not in effect during Unit 1 Cycle 4.

Since the Secondary Side Boric Acid program was expensive to perform and did not stop the formation of ODSCC or reduce the voltage growth rate, and since the SGs will be replaced in the near future, the Secondary Side Boric Acid program will not be continued for Braidwood Unit 1 Cycle 6.

## Attachment A

### Braidwood Unit 1 Fifth Refuel Outage (A1R05) SG Tube Plugging Results

	1A SG	1B SG	1C SG	1D SG	TOTALS
Total Tubes	4578	4578	4578	4578	18312
Previously Plugged Tubes	505	102	706	365	1678
Total Tubes Inspected This Outage	4073	4476	3872	4213	16634
A1R05 Tube Support Plate Pluggable	1	0	0	0	1
Anti-Vibration Bar Wear Pluggable	0	1	1	0	2
Confirmed Wedge Location Pluggable Indications	10	0	1	3	14
Top-of-Tubesheet Pluggable Indications (Circ/Axial/Mixed Mode)	8/1/0	2/0/1	8/1/1	5/3/0	23/5/2
Tubes Plugged due to Administrative Reasons	1 AVB 2 Loose Parts	1 AVB	1 TSP VOL 2 Dents	0	7
Tubes Plugged due to TSP Locking to Support the 3.0 Volt IPC	21	21	22	21	85
A1R05 Total Tubes Plugged	44	26	37	32	139
Restart Total Tubes Available	4029	4450	3835	4181	16495
Total Tubes Plugged	549	128	743	397	1817
Percentage of Tubes Plugged	12.0	2.8	16.2	8.7	9.9

SG Tube Plugging Limits are a maximum of 30% in any one SG with a maximum of 24% total.