RS-04-060

April 16, 2004

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

Braidwood Station, Unit 1
Facility Operating License No. NPF-72
NRC Docket No. 50-456

Subject: Response to Request for Additional Information Regarding the Braidwood Station Unit 1 April 2003 Steam Generator Inspection

References: (1) Letter from J. D. von Suskil to U. S. NRC, "Tenth Refuel Outage Steam Generator In-Service Inspection Report," dated May 7, 2003

(2) Letter from M. J. Pacilio to U. S. NRC, "Braidwood Station , Unit1 Tenth Refueling Outage Steam Generator Inservice Inspection Summary Report," dated July 29, 2003

Based on the review of the referenced reports, the NRC determined that additional information was required in order to complete their evaluation of the Braidwood Station Unit 1 April 2003 steam generator inspection reports. During a March 18, 2004 teleconference, the NRC requested responses to four questions. The attachment to this letter documents the Braidwood Station responses that were provided verbally during the teleconference.

Should you have any questions concerning this letter, please contact David J. Chrzanowski at (630) 657-2816.

Respectfully,

Kenneth A. Ainger
Manager, Licensing

Attachment: Additional Information Regarding the Braidwood Station Unit 1 April 2003 Steam Generator Inspection

Attachment
Additional Information Regarding the Braidwood Station Unit 1
April 2003 Steam Generator Inspection

Question 1

Various types of tube wear have occurred in Babcock and Wilcox recirculating steam generators (SG) including typical wear, localized fan bar wear (theorized to be a result of arch-bar distortion which affects specific columns of tubes), and atypical wear (attributed to asperities on the flat surfaces of the fan bar supports). For the indications of tube wear detected at Braidwood 1 at the fan bar and lattice grids, clarify the type of tube wear that is occurring at these locations.

Braidwood Station Response:

All indications of fan bar wear and lattice grid wear were categorized as "typical wear." All these indications received Plus Point inspection during the Braidwood Station Unit 1 April 2003 refueling outage. Of the seven fan bar wear indications, the largest was identified as 10% through-wall (TW). The largest of the five lattice grid wear indications was listed as 12% TW.

Question 2

The February 9, 2001 amendment request [1] to extend the operating interval between inspections indicated that several tubes were in contact with other tubes and this condition is expected to naturally correct itself. Discuss the extent to which this condition (i.e., tube-to-tube contact) was monitored during your 2003 inspections. Discuss whether any tubes in contact were identified during the 2003 outage. If tubes in contact were identified, discuss whether the tubes were also in contact prior to placing the SG inservice. Discuss whether all tubes previously determined to be in contact were inspected in 2003. If all tubes known to be in contact were not inspected, discuss the basis for concluding that the structural and leakage integrity of the SG will be maintained at these locations until the next inspection.

Braidwood Station Response:

All tubes identified as being in contact during the previous outage i.e., the Braidwood Station Unit 1 outage in March 2000, were re-inspected during the Unit 1 outage in April 2003 and none showed any signs of wear. During the preservice examination, 508 tubes were identified as being in contact. This number of tubes in contact dropped to 85 when examined in the March 2000 outage. Reinspection of these 85 tubes during the Unit 1 April 2003 outage showed 67 of the 85 still in contact. Also, during this outage, 65 tubes were newly identified as being in contact.

[1] Letter from R. M. Krich to U. S. NRC, "Request for Technical Specification Change Braidwood Station Unit 1, Steam Generator Inspection Frequency Revision for the Fall 2001 Refueling Outage," dated February 9, 2001

When tube to tube contact was identified during fabrication of the SG, Babcock and Wilcox developed a report to assess the condition: B&W-TR-97-18, "U-Bend Radial Gap Assessment Report," Revision 0, October 1997. This report provides an evaluation of the tube-to-tube contact condition and assessed the potential of fretting, wear damage, and corrosion-induced degradation due to long-term tube-to-tube contact.

Based on conservative estimates of wear coefficients and work-rates at the tube-to-tube contact area, the report concluded that a maximum tube wall loss of 40% would not occur until after 60 years of continuous full power operation. Therefore, it is not expected that tube contact fretting would result in challenging the structural integrity criteria during the life of the SG.

The potential for corrosion induced degradation (as a result of excessive fouling or deposit bridging) compounded by tube contact is bounded by the top of tubesheet expansion region. This condition at the top of tubesheet has been previously qualified by extensive testing. The Babcock and Wilcox report recommends that the tube contact be monitored over time through the plant's normal inspection program. Exelon Generation Company, LLC will continue to monitor the condition and perform inspection of the affected tubes during each scheduled steam generator inspection.

Question 3

The February 9, 2001 amendment request to extend the operating interval between inspections indicated that no foreign objects were known to be present in the SG. For the loose parts that were identified during the 2003 outage, were these locations (i.e., the locations where the loose parts were detected in 2003) inspected (visually) during the inspections in 2000? The inspection results indicate wear on one tube proceeding to 48% through-wall in the course of two operating cycles (or possibly less), therefore, the staff requests a discussion on when these loose parts were introduced into the SG.

Braidwood Station Response

All areas where foreign objects were identified during the April 2003 outage were inspected by both visual and 100% eddy current during the March 2000 outage. During the March 2000 examination three objects were identified. These objects were removed and no tube wear was identified.

The majority of the objects identified in the secondary side of the SG during the April 2003 examination are believed to have been the result of a collapsed feedwater pump suction strainer. The collapsed suction strainer was identified during the outage and repaired prior to returning the associated feedwater pump to service. The remaining feedwater suction strainers were inspected during the outage and were intact.

A review of online feedwater iron transport data over the last two cycles of operation indicates a spike in iron concentrations in August of 2001; this is most likely when the suction strainer collapsed. The spike in August 2001 was late in Cycle 9 (i.e., March 5, 2000 thru September 22, 2001) of Unit 1 operation.

As part of the assessment of foreign objects identified during the April 2003 Braidwood Station Unit 1 refueling outage, Babcock and Wilcox performed an evaluation of the identified conditions. The evaluation assumed all foreign object wear had occurred in one cycle of operation and used the bounding wear identified during the 2003 inspection. The evaluation used the maximum flow velocity region of the top of tubesheet region as a bounding condition.

The evaluation concluded that for objects at the top of tubesheet region, the outermost five tubes on the bundle periphery were most susceptible to foreign object wear. Inboard of the first five tubes, the flow velocity substantially reduces and accordingly so does the potential for significant tube wear. The evaluation concluded that for an object similar to the bounding object identified in the 2003 examination and assuming that the object was located in the limiting high flow region of the periphery of the tube bundle, the expected wear morphology would not be projected to exceed the SG tube structural limit for two cycles of operation.

During the upcoming Braidwood Station Unit 1 outage, scheduled for October 2004, eddy current inspection of one SG is planned. If foreign object wear is identified that does not support two cycles of operation, scope expansion to assess the condition of the other SG will be required.

Question 4

The SG at Braidwood 1 were replaced in 1998. Provide the following general design information: the manufacturer of the tubes, the thickness (axial extent) of the tube supports (fan bars and lattice grid), and the pitch and pattern (e.g., triangular) of the tubes. Also, clarify the rows of tubes that were stress relieved after bending (i.e., what rows have bend radii less than or equal to 12-inches).

Braidwood Station Response

Steam Generator Manufacturer	Babcock and Wilcox International (BWI)
Tubing Manufacturer	Sumitomo Japan
Tube Outside Diameter	0.6875"
Tube Wall Thickness	0.040"
Tube Material	Inconel 690 Thermally Treated (SB-163)
Tube Support System	410 stainless steel lattice grids
	9 elevations
	high lattice ~ 3" tall every sixth pitch
	low lattice ~ 1" tall all other locations
	lowermost lattice grid uses a ~ 2" tall low lattice in place of the 1"
	low lattice near the periphery tubes ends are captured by a ring around the periphery

Attachment
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U-bend Support System	410 stainless steel fan bars
	10 bars (5 each half of bundle)
	fan bars are ~ 1.25" tall
	nominal tube to bar clearance is 0.006"
Tube Pitch	tubes are triangular pitch
	0.93" pitch
	gap between tubes is < ¼"
U-Bend Stress Relief	all U-Bends up to a 12" centerline radius are stress relieved
	rows 1 to 21 have bend radii less than or equal to 12"