May 22, 2001

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SUBJECT: FOREIGN TRIP REPORT - VISIT TO BABCOCK AND WILCOX CANADA, APRIL 25, 2001

On April 25, 2001, Bart Fu and Andrea Lee of the Materials and Chemical Engineering Branch visited the Babcock and Wilcox Canada (BWC) facility in Cambridge, Ontario, Canada. We discussed and observed fabrication processes for constructing replacement steam generators destined for Calvert Cliffs Units 1 and 2, and Oconee's Units 1, 2 and 3. Representatives from Baltimore Gas and Electric Company (licensee for Calvert Cliffs), Duke Power, and the Steam Generator Team (SGT) (A Morrison Knudsen /Duke Engineering and Services Company), were present for the discussions and the tour of the BWC facility.

Discussions on Steam Generator Design and Fabrication

The first day began with an afternoon session that included introductions between participants, presentations from Calvert Cliffs and Duke Power, and discussions on replacement steam generators.

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BWC, BGE and the Steam Generating Team representatives discussed the general engineering design aspects of the replacement SGs. This included an overview of the materials for the major internal components, specific design considerations and improvements to minimize the potential for problems encountered in older vintage SGs, and a comparison of the overall characteristics relative to the original design presently in operation at Calvert Cliffs Nuclear Power Plant and at Oconee Nuclear Plant.

BGE and Duke Power decided to replace its SGs due to degradation of the tubes caused by service-induced corrosion of the mill annealed alloy 600 tubing. Several design enhancements in the replacement SGs should improve the corrosion resistance of the SG tubes. The primary enhancement is the use of tubing fabricated from thermally treated alloy 690. Since 1989 (beginning with Cook Unit 2), 20 US nuclear plants have replaced SGs using alloy 690 tubing. Industry experience from world-wide operating plants with replacement SGs has not identified any service-induced corrosion of the alloy 690 tubing to date. The use of alloy 690 tubing should significantly improve the operating performance of the two units at Calvert Cliffs Nuclear Power Plant as well as Duke Power's three Oconee units. BWC has incorporated many other enhancements which resulted from industry operating experience. The specific improvements include the following:

1. Calvert Cliffs only) Full depth hydraulic expansion of the tubes in the tube sheet and stainless steel lattice grid tube supports. The replacement SGs have a high circulation ratio which should also help to prevent corrosion by avoiding dry-out, minimizing sludge deposits and maintaining contaminants in suspension. This assembly reduces pressure drop, increases the area of heat exchange interface, and increases erosion/corrosion resistance.

2. Self draining channel head. This unique design will reduce significant outage inspection related dosage because primary coolant can be drained out completely after shut down.

3. Redesign of feed water inlet. The new "goose neck" design will eliminate water hammer and minimize thermal stratification of the feed nozzle.

4. (Calvert Cliffs only) Floating Fan Bar (FFB). This design will replace the old Anti- Vibration Bar (AVB) design. Operating experience at units with FFB configuration shows that it significantly minimized wear and wear related degradation.

5. 18" mans. The change from 16" to 18" is said to accommodate bigger American mechanics and technicians.

6. Alloy 690 TT tubes with over 15:1 signal to noise (S/N) ratio. The increase in S/N ratio allows for more reliable ECT inspection.

7. (Oconee only) Stainless steel (SS) broached support plates. The SS broached support plates increase erosion/corrosion resistance and reduce wear.

8. (Oconee only) Tube sheet depth has been changed from 24" to 22". This increases exposed tube length and thus the heat exchange interface area.

9. The overall design incorporated erosion/corrosion resistant materials in many components.

10. (Oconee only) A shortened distance from tube expansion to the first support plate increases fatigue resistance.

11. Full depth hydraulic expansion of the tubes in tubesheet. This design minimizes sludge deposits and maintains contaminants in suspension.

12. (Calvert Cliffs only) Larger minimum U-bends to minimize residual stress and thus reduce SCC susceptibility.

13. (Calvert Cliffs only) Lattice grid assembly instead of support plate. This type of assembly is more open to water flow, more flexible, less prone to crudding, and it reduces pressure drop.

14. (Calvert Cliffs only) All-welded separator assembly to eliminate loose parts risk.

Following the discussions on the design features of the replacement SGs, the attendee's discussed the current status of the overall SG fabrication process.

BWC Facility Tour

In the morning of the following day, representatives from BWC, BGE, the SGT and the NRC toured the BWC facility to view the work in progress of the replacement SGs. During the tour the attendees observed activities such as welding of the SG shell, shroud, and tube sheets, assembling of lattice grid support, the tube support broaching process, and the tube sheet drilling process.

After the tour was completed, the NRC staff expressed their gratitude to the BWC, BGE, and SGT representatives and departed the facility. Attachment 1 is a list of the attendees. Attachment 2 contains the material that the licensee's presented to the NRC attendees.

Attachments: As stated

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