

October 12, 2005

Mr. Ronnie L. Gardner, Manager  
Site Operations and Regulatory Affairs  
Framatome ANP/B&W Owners Group  
3315 Old Forest Road  
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SUBJECT: BABCOCK AND WILCOX OWNERS GROUP (B&WOG) - WHITE PAPER ON  
ONCE-THROUGH STEAM GENERATOR (OTSG) DESIGN AND LICENSING  
BASIS (TAC NO. MC6216)

Dear Mr. Gardner:

In February 2005, the B&WOG and the Nuclear Regulatory Commission (NRC) met to discuss the approach being taken by the B&WOG to demonstrate compliance with 10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling Systems (ECCS) for Light Water Nuclear Power Reactors," and 10 CFR Part 100, "Reactor Site Criteria," for a large break loss of coolant accident scenario. This demonstration was intended to support the present design basis for OTSG tube loads.

The B&WOG committed to prepare a "white paper" describing the basis for the approach being taken to establish the design basis for steam generator tube loads and provide the means by which this basis would be preserved for future operation.

By letter dated June 15, 2005, the B&WOG provided the subject "white paper" to the NRC for review. The NRC has completed its review of the "white paper" and enclosed its comments from that review for your consideration. It is hoped that the NRC comments will form a basis for the B&WOG to complete its draft of the related topical report and submit it for NRC review and approval during the first half of 2006.

In the event that any comments or questions arise, please contact me at 301-415-1436.

Sincerely,

/RA/  
Drew G. Holland, Project Manager  
Project Directorate IV, Section-1  
Division of Licensing Project Management  
Office of Nuclear Reactor Regulation

Project No. 693

Enclosure: As stated

cc w/encl: See next page

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B&W Owners Group

Project No. 693

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## NRC STAFF COMMENTS

### BABCOCK AND WILCOX OWNERS GROUP

#### WHITE PAPER ON ONCE-THROUGH

#### STEAM GENERATOR DESIGN AND LICENSING BASIS

By letter dated June 15, 2005, the Babcock and Wilcox (B&W) Owners Group (B&WOG) submitted a "white paper" addressing their proposed approach for establishing once-through steam generator (OTSG) design tube loads for OTSGs. The Nuclear Regulatory Commission (NRC) staff has reviewed this white paper and provides the following comments for your consideration:

1. The topical report (TR), BAW-2374, "Evaluation of OTSG Thermal Loads During Hot Leg LOCA," should provide a clear explanation of what the B&WOG is asking the NRC staff to approve. For example, is the B&WOG asking the staff to review the entire design and licensing basis for the OTSGs? It is the NRC staff's impression that the B&WOG is simply requesting the NRC to review a revision to the design and licensing basis of the steam generator for the loads associated with certain large break, loss of coolant accidents (LBLOCAs). A source of confusion is that in several instances, the "white paper" seems to imply that the TR will be a document summarizing the entire design basis for the OTSGs (refer to executive summary, page A-3, page A-7). In other instances, the "white paper" seems to imply that the TR will focus on a redefinition of one aspect of the licensing basis of the OTSG; namely that OTSG tube failures (and a resultant increase in primary-to-secondary leakage over what was previously evaluated) will be permitted under certain hot-leg LBLOCAs.
2. The TR should consistently refer to those LBLOCAs for which a redefinition of the licensing basis is being requested. In the executive summary, the redefinition seems to apply only to breaks in the hot-leg U-bend region of the reactor coolant system (RCS) piping. On page A-3 (last line of first paragraph on page A-3), it appears that the TR will focus on all hot-leg LBLOCAs. On page A-7, the "white paper" seems to imply that the redefinition will apply to the main RCS piping and to LBLOCAs, in general. On page A-9, the "white paper" implies that the redefinition will apply to a break in the hot leg U-bend (or LBLOCA break above surge line attachment to the hot leg).
3. In addition to tube failures which may occur during the "LBLOCA of concern" (refer to item 2 above), the TR should be clear on how leakage from other sources will be accounted for in the assessments of tube integrity for the "LBLOCA of concern". This information will be needed to ensure that the appropriate regulations (e.g., 10 CFR Part 100, "Reactor Site Criteria" and 10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Nuclear Power Reactors") are being met. That is, primary-to-secondary leakage from sources other than tube failures (ruptures) will also need to be accounted for in the assessments. This includes tube plugs, rerolls, repair products, and through-wall flaws. Data supporting the behavior of the tube plugs, rerolls, repair products, and through-wall flaws under the conditions of the "LBLOCA of concern" should be provided.

4. On page A-6 of the "white paper," a characterization of the February 2005 meeting was provided. The NRC staff feedback during the meeting was that, in order to be in compliance with the regulations, full margins of safety would need to be deterministically demonstrated for the most limiting LBLOCA (i.e., failure of the OTSG tubes should not occur during a LBLOCA with the appropriate regulatory margin to failure). During the meeting, industry representatives indicated that meeting these requirements may lead to additional in-situ testing and personnel exposure that was not warranted based on the low risk of a LBLOCA. The industry personnel also indicated that they may not be able to apply the LBLOCA axial loads with the current in-situ pressure testing equipment. Although this may be true, there are other methods for demonstrating tube integrity, including analytical calculations and the destructive examination of pulled/harvested tube segments. As a result, the NRC staff does not agree that limitations of in-situ testing equipment is the basis for revising the design/licensing basis of the OTSG as the paragraph on page A-6 implies.
5. The last sentence of the third paragraph on page A-7 discusses how compliance is to be achieved. Compliance should be based on demonstrating structural and leakage integrity consistent with the plant design and licensing basis, and as embodied in the Nuclear Energy Institute's (NEI) publication, NEI 97-06, "Steam Generator Program Guidelines," structural and leakage integrity performance criteria.
6. In the last sentence on page A-9, the "white paper" seems to imply that long term cooling is the only acceptance criteria for the LBLOCA. The acceptance criteria should include limiting the number of tube severs (or leakage) and demonstrating that this leakage will result in acceptable offsite dose consequences.
7. Future revisions to the technical specifications (TS) to redefine the performance criteria for the "LBLOCA of concern" should not only address tube failures (ruptures or severs), but also any other leakage source.
8. It would be beneficial to have a generic proposal for revising the TS in the TR.
9. On page A-5, a discussion of Framatome ANP's preliminary safety concern (PSC 2-98, "Report of Preliminary Safety Concern Related to Design Steam Generator Tube Tensile Loads," October 19, 1998) is provided. The actions taken as a result of this PSC should be included in the TR.
10. The industry "white paper" makes frequent use of the expression, "best estimate." The use/meaning of this term should be clarified in the TR, since there is a big difference between a "best estimate" and a "realistic" analysis. If a best estimate analysis shows that a safety criterion is just met, one might reasonably conclude that there is a 50% chance that the safety criterion is not met. Thus, a best estimate analysis provides little assurance that the safety criterion will be met. A realistic analysis, on the other hand, is intended to identify a likely outcome relative to the safety criterion.
11. As we understand it, the TR will identify the acceptable number of tube severs that can be tolerated while maintaining reasonable assurance that the limits of 10 CFR 50.46 and 10 CFR Part 100 (and 10 CFR 50.67, "Accident Source Term") are met, or the TR will

identify the methods for determining the acceptable number of tube severers (or equivalent primary-to-secondary leakage). From a 10 CFR Part 100 perspective, the acceptable number of tube severers will be determined on a realistic basis through consideration of realistic operator actions. The acceptable number of tube severers (or equivalent primary-to-secondary leakage) will then become the success criterion against which future operability assessments will be performed by licensees. The NRC staff would view such a criterion as a supplemental performance criterion (to those in the forthcoming NEI 97-06, Revision 2 and Technical Specification Task Force (TSTF) item TSTF 449, Revision 4) uniquely applicable to LBLOCA. However, the "white paper" states (2nd paragraph of page A-9, last sentence) that these operability assessments will be performed on a best estimate basis. As noted in comment 10 above, the staff believes that "best estimate" operability assessments are inappropriate. Assuming that the "white paper" really meant "realistic" operability assessments, use of realistic assessments needs to be defined quantitatively and justified. In general, staff expectations regarding the treatment of uncertainties in OTSG tube integrity operability assessments are as defined in NEI 97-06, Revision 1. NEI 97-06, Revision 1 states that "These assessments shall account for all significant uncertainties so as to provide a conservative assessment of the condition of the tubing relative to the performance criteria...." The staff believes that this philosophy is applicable to operability assessments relating to LBLOCA, since compliance with 10 CFR 50.46 in accordance with 10 CFR Part 50, Appendix K, "ECCS [Emergency Core Cooling System] Evaluation Models" is based on conservative analysis. The staff notes that the operability assessments may be performed probabilistically or deterministically. If probabilistic operability assessments are performed, the TR needs to specify an appropriate probabilistic criterion with accompanying justification for demonstrating that the success criterion (supplemental performance criterion) on the tolerable number of tube severers (or equivalent primary-to-secondary leakage) is not exceeded (e.g., the operability assessment shall demonstrate that the success criterion is not exceeded with a probability of 0.95). If deterministic assessments are used, then the TR needs to provide guidance on the level of conservatism to be incorporated into deterministic operability assessments.

12. The B&WOG should provide in its final version of the TR the following information:
  - a. the major parameters, assumptions, and methodologies used in determining the fuel cladding integrity,
  - b. evaluation of the potential number of tubes that might fail under LBLOCA loading and resulting primary-to-secondary leakage rate associated with those failures, and
  - c. the radiological consequences (dose calculations) using the radioactive source terms resulting from cladding failure, if any, and the primary-to-secondary leakage rate estimated.
13. The white paper should be clarified with respect to analysis methodology. The 10 CFR 50.46 response, including fuel cladding response, is to be calculated in accordance with Appendix K to 10 CFR Part 50. Operator actions and long-term response can be

addressed via realistic methodologies that reasonably bound expected behavior as long as Appendix K requirements are met.

14. The NRC staff understands that the dose assessment is predicated on the 10 CFR 50, Appendix K short term response analysis having established that fuel cladding does not rupture. If this is incorrect, we should be informed immediately.