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November 27, 2000
OG-1802

Project No. 693

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

Subject: Additional Information to Topical Report BAW-2374, "Justification for Not Including Postulated Breaks in Large Bore Reactor Coolant System Piping in the Licensing Basis for Existing and Replacement Once-Through-Steam-Generators"

Reference: Letter from David J Firth to Document Control Desk, OG-1792, dated July 7, 2000

Gentlemen:

During several conference calls on the subject topical report, it became clear that the NRC required some additional information. Framatome Technologies, Inc. (FTI) was asked to describe if, and how, the hot leg break is included in the Appendix K spectrum for B&W-designed plants. In addition, FTI was asked to describe how licensees who expect damage to steam generator tubes from large LOCA meet the long-term core cooling requirements of 10 CFR 50.46, since an exemption to 10 CFR 50.46 was not requested. The NRC also required clarification of statements on the operability assessment of re-rolls in the lower tubesheet, since Appendix D of BAW-2374 only discussed re-rolls in the upper tubesheet.

ECCS Response

The FTI 10 CFR 50.46 evaluation models (EMs) consider breaks in any reactor coolant system (RCS) pipe for validating adequate core cooling as defined by the five acceptance criteria of 10 CFR 50.46. Detailed EM analyses are performed up to the time of whole-core quench, which is generally less than 200 seconds for large loss-of-coolant accidents (LOCAs). An analysis of any hot leg break during this initial core period produces a peak clad temperature, local clad oxidation, and whole core hydrogen generation value that are bounded by those that are predicted for the limiting cold leg pump discharge break. The core geometry will also remain amenable to cooling following any hot leg break.

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Long-term cooling, which follows the successful initial core cooling, is provided by continuous pumped emergency core cooling system (ECCS) injection achieved by successful operator realignment of the flow paths from the borated water storage tank (BWST) to the reactor building sump as the BWST inventory decreases. Appendix K calculations are performed until the time of core quench. The long-term cooling criterion in 10 CFR 50.46 is assured primarily through the emergency operating procedures (EOPs). These procedures include provisions for monitoring and adjusting the ECCS flow rates and path alignments as necessary to ensure long-term operation of the ECCS pumps. The plants also have provisions for successfully preventing excessive boron concentration buildup in the core. For a hot leg break, core exit subcooling is regained, such that the active boron dilution alignments are not needed to protect the core against potential boron precipitation.

If a large break in the upper hot leg is postulated, a substantial steam generator tube-to-shell temperature difference can be generated between 10 to 20 minutes after break initiation. This temperature difference can create high SG tube loads that may cause some tubes to exceed elastic strain limits. Unflawed tubes may yield and deform slightly, but their function as a primary-to-secondary isolation boundary will not be compromised. However, if an unplugged tube has a significant flaw, its ability to maintain the integrity of the effective boundary isolation is less assured. The type and location of the flaw as well as its position within the steam generator are all critical to its performance in the long term. Should some primary-to-secondary leakage occur, the amount of this leakage, as well as subsequent leakage to the environment, could be stopped by operator actions that isolate the secondary side. These actions will preserve adequate ECCS and RCS liquid inventory in the sump to support continuous ECCS pump operation during the long-term cooling phase.

The scenario that proves challenging for long-term cooling requires failures of a significant number of tubes (which is not expected), plus a failure (see Section 3.4.5 of BAW-2374) that prevents the operator from effectively isolating the secondary side. If the largest hot leg break (the one that produces the highest tube loads) is postulated, then the leakage will be self-limiting because the pressure difference that drives continuous leakage will be minimized. Smaller break sizes could have a higher pressure difference to support longer-term leakage rates, but these smaller break sizes will result in lower SG tube loads. Therefore, fewer tubes would be potentially compromised with a corresponding reduction in the total leakage rate.

The EOP documents, which are separate and distinct from the Appendix K analyses, set forth required actions necessary to provide for continuous long-term core cooling independent of the accident scenario. While Appendix K applications use only safety-related equipment to demonstrate compliance, the EOPs instruct the operators to use safety as well as non-safety grade equipment that may be available to maintain the ECC function following a LOCA. The EOPs are structured to preserve ECC function as required per GDC 35 and 10 CFR 50.46 (b)(5) for long-term cooling. Examples of options that the plants have to ensure long-term cooling include provisions for ECCS throttling and provisions for initiating the normal decay heat removal system from one of two operating LPI trains. Both of these actions assist in the successful completion of mitigating of the consequences of a LOCA with limited SG tube pressure boundary breaches from undetected tube flaws.

Operability Assessment Response

Section D.3.3 of BAW-2374 provides the operability assessment for tube-to-tubesheet re-roll repairs. This section only addressed re-roll repairs in the upper tubesheet since that is the only place that the re-roll repair is currently installed. This section and the discussion points presented therein are also directly applicable to re-roll repairs that may be installed in the lower tubesheet in the future.

Please call me at 804/832-3635 if you need any other material for your review of BAW-2374.

Sincerely,

David J. Firth
Project Manager
B&W Owners Group Project Management

DJF/kab

Attachment

c: SN Bailey - NRR