BWROG Regulatory Basis Determination for Finite Break Opening Time

NRC Webinar

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BWR OWNERS' GROUP

BWR Expertise – Proven Solutions

Agenda

Purpose
Background
Current Pipe Break Methods
Regulatory Basis Determination Process
NEI 96-07 Guidance
10 CFR 50.59 Screening
10 CFR 50.59 Evaluation
NRC Staff Review Comments / BWROG Responses
Conclusions

Purpose

To inform the NRC Staff regarding the BWROG conclusion that application of Finite Break Opening Time (FBOT) for evaluation of Acoustic Loads (AC) and Annulus Pressurization (AP) loads by Licensees for Design Basis Accident Loads can be addressed under 10 CFR 50.59.

Background

Over the course of the BWR fleet's operation, GEH has performed 10 CFR Part 21 evaluations when questions have been raised concerning the magnitude of AC Loads and the combination and timing of AC Loads with other design basis accident loads on plant components. The results of these evaluations have been provided to applicable BWR plant owners with no related Part 21 reports resulting.

Current Pipe Break Evaluation Methods

- In the current design analyses, the AC load determination assumes an instantaneous severance of the pipe with a concurrent instantaneous displacement of the broken pipe from the safe-end. This assumption maximizes the AC load being applied to the RPV internal structures; however, the instantaneous displacement of the broken pipe from the safe-end is physically impossible.
- NUREG-0609, Asymmetric Blowdown Loads on PWR Primary Systems, Section 3.1, provides the NRC's procedures for evaluating methods for calculating internal subcooled blowdown loads (i.e., AC loads). Section 3.1.2 describes the plant-specific considerations reviewed for the development of the assumed break opening time and area characteristics.

Current Pipe Break Evaluation Methods

- NUREG-0609, Appendix C, summarized studies conducted by EG&G on four nuclear plants to study break opening areas and times for postulated LOCA pipe ruptures. The study concluded that the times for break-opening areas to develop are significantly greater than the 1- and 10-msec times presently assumed, and, in the cases of limited breaks, the break areas developed were significantly less than those to which the plants were designed.

FBOT Part 1 Regulatory Basis Determination Report Process

Regulatory and Design Basis

- 10 CFR 50 GDC-4 does not specify that the dynamic effects analyses must assume that the pipe separation be instantaneous.
- The finite break opening time is used for the pipe whip restraint load calculations and, in some BWRs, for the mass/energy release input to the AP load calculations.
- BWR licensing basis (LB Review and survey results) found that there is no indication that the instantaneous separation assumption was a key conservatism used to offset potential non-conservatisms in any plant AC load calculations.
- Instantaneous separation is considered as an “input” to the accepted methodology, not an “element of the methodology” in the 10 CFR 50.59 evaluation.

FBOT Part 1 Regulatory Basis Determination Report 10 CFR 50.59 Guidance

NEI 96-07, Rev 1, Section 3.8 defines

- *"Input parameters " as those values derived directly from the physical characteristics of SSC or processes in the plant, including flow rates, temperatures, pressures, dimensions or measurements (e.g., volume, weight, size, etc.), and system response times.*

Therefore, the pipe break opening time meets the definition of an input parameter per NEI 96-07, Rev. 1, Section 3.8, as it is a value derived directly from the physical characteristics of SSCs in the plant, including flow rates, temperatures, pressures, dimensions or measurements, and system response times.

FBOT Part 1 Regulatory Basis Determination
Report 10 CFR 50.59 Screening Results

NEI 96-07 Screening Question 1: *Does the proposed activity involve a modification, addition to, or removal of a structure, system, or component (SSC) such that a design function as described in the UFSAR is adversely affected?*

- "Yes". The modification of the assumed LOCA Reactor Recirculation piping displacement, from a physically impossible value, used to maximize AC load, to a more realistic FBOT displacement with realistic AC loads fundamentally alters the existing analysis inputs. Therefore, the resulting analysis stresses on reactor vessel internals and associated equipment are affected and, for the purpose of the 50.59 evaluation, are conservatively treated as adverse.
- Remaining Screening Questions resulted in "No" answers.

FBOT Part 1 Regulatory Basis Determination Report 10 CFR 50.59 Evaluation Results

Evaluation Questions 1- 7 resulted in "No" answers.

Question 8: *Does the proposed change result in a departure from a method of evaluation described in the UFSAR that is used in establishing the design bases or in the safety analyses?*

- "No". Piping displacement meets the definition of an input parameter per NEI 96-07, Rev. 1, Section 3.8.
- "No". This change is not a change to a methodology used in establishing design bases or in the safety analysis.
- "No". Justification is valid regardless whether or not AC loading methodology is described in the UFSAR
- Piping displacement meets the definition of an input parameter per NEI 96-07, Rev. 1, Section 3.8. ." Piping displacement meets the definition of an input parameter per NEI 96-07, Rev. 1, Section 3.8.

FBOT Part 1 Regulatory Basis Determination Report Conclusion

Although instantaneous displacement causes the most conservative AC load results, no current reliance is placed on this conservatism by the NRC in their acceptance of this methodology.

Therefore, it is concluded, using a generic 10 CFR 50.59 evaluation process, that prior NRC review and approval is not required for the implementation of Finite Break Opening Time (FBOT) in the disposition of the aforementioned SCs.

BWROG Responses to NRC Informal Comments on BWROG document 002N4971*

1) NRC Reviewer Comment: *The change to facility involves changing BWR plant's LOCA thermal hydraulic analysis from an assumed instantaneous break-opening time to instead use calculated values for break-opening times and areas.*

BWROG Response: The BWROG disagrees with this conclusion. Just to be clear, FBOT is only being applied to Annulus Pressurization (AP) and Acoustic (AC) loads on the components (e.g., RPV, RPV internals) as described in NUREG 0609. This change does not affect other LOCA analyses that assume instantaneous break and instantaneous pipe separation/displacement, such as ECCS evaluation models and radiological release. FBOT has been applied to the BWR original design calculation of AP loads analyses based on the guidance of NEDO-24548 ("Technical Description Annulus Pressurization Load Adequacy Evaluation", January 1979) and is documented in the applicable plant FSARs (a list of plants using FBOT is provided in the next slide). The method in NEDO-24548 was provided to the NRC via letter "Generic Annulus Pressurization Mass Energy Release Methodology," MFN 178-78 dated May 2, 1978. AC and AP loads are derived from the same initiating pipe break (i.e., recirculation suction line break). The basis for the BWROG conclusion that the application of FBOT to disposition AC related GEH issued Safety Communications does not impact licensing bases as documented in Section 3 of BWROG document 002N4971.

* Provided by email from Jason Drake to Garold Carlisle and Michael Iannantuono dated September 9, 2016

BWROG Responses to NRC Informal Comments on BWROG document 002N4971 (Cont.)

Plants using FBOT:

1) Hope Creek – BWR/4 FSAR Appendix 6B
2) Limerick – BWR/4 FSAR Appendix 6A
3) Susquehanna- BWR/4 FSAR Appendix 6A
4) Columbia – BWR/5 FSAR Section 6.2.1.2
5) LaSalle – BWR/5 UFSAR Section 6.A

From a typical reference above, where "finite break opening time" wording is specifically used:

"Table 6A-1(a) presents the mass and energy release data estimated by applying the NEDO-24548 method of combining blowdown data calculated from finite and instantaneous break opening time approaches."

The NEDO-24548 method first calculates the break flow time history based on instantaneous opening, then overlays the break flow based on the finite break opening area time history. The minimum of the two flows is used.

BWROG Responses to NRC Informal Comments on BWROG document 002N4971 (Cont.)

2) NRC Reviewer Comment: *The FBOT Committee's 50.59 has incorrectly determined that the calculated values for break-opening times and areas met the definition of "input parameters", and has failed to evaluate the new method for calculating the break-opening times and areas against 50.59 criterion viii as a change in method of evaluation.*

BWROG Response: The BWROG disagrees with this conclusion. NRC endorsed* NEI 96-07 identifies two exceptions when an input parameter is considered to be an element of the methodology:

> *The method of evaluation includes a methodology describing how to select the value of an input parameter to yield adequately conservative results. However, if a licensee opts to use a value more conservative than that required by the selection method, reduction in that conservatism should be evaluated as an input parameter change, not a change in methodology.*

NUREG 0609, Section 3.1.2, provides relevant considerations needed for determining the pipe displacement time. Although instantaneous displacement causes the most conservative AC load results, no current reliance is placed on this conservatism by the NRC in their acceptance of this methodology.

* From Regulatory Guide 1.187: Revision 1 of NEI 96-07, "Guidelines for 10 CFR 50.59 Evaluations,"2 dated November 2000, provides methods that are acceptable to the NRC staff for complying with the provisions of 10 CFR 50.59.

BWROG Responses to NRC Informal Comments on BWROG document 002N4971 (Cont.)

The break opening time determination is not a "new method".

- The break opening times are taken from the results of the pipe whip dynamic response analyses for the recirculation system described in Section 3.6.2.2 of the FSARs.
- The blowdown forcing function methodology used for the pipe whip analyses is described in Section 3.6.2.2.1 of the FSARs.
- The pipe whip analyses use the Pipe Dynamic Analysis Code (PDA). PDA is described in detail in Sections 3.6.2.2 and 3.9.1.2 of the FSARs.
- Section 3.6.2.2 demonstrates compliance with the guidance in NUREG-0609, Section 3.1.2.
- NEDO-24548, Section 2.5 provides the method for calculating the finite break opening flow rate using the pipe displacement time history from the PDA code. Table 3 of NEDO-24548 provides a sample PDA output table showing the pipe displacement time history.

BWROG Responses to NRC Informal Comments on BWROG document 002N4971 (Cont.)

3) NRC Reviewer Comment: *The FBOT Committee would need to find any example where the NRC has approved the method, and it must be either a license amendment for one plant or generic approval of a topical report. The FBOT Committee must demonstrate in their 50.59 that they applied the method within the bounds and limitations of the NRC approved method.*

BWROG Response: Section 3.9.2.4 of NUREG-0979 ("Safety Evaluation Report Related to the Final Design Approval of the GESSAR II BWR/6 Nuclear Island Design, April 1983") states that "Using the guidance of NUREG-0609, GE has provided the methodology of the asymmetric LOCA loads analysis for the reactor system and the affected components...The staff will require individual applicants referencing GESSAR II to provide the results of the annulus pressurization analysis". This methodology has been used for the plants' original design AP load calculations documented in FSARs, including BWR/6 and other BWR types. ML051530350 (MELLLA RAI for one BWR/4) requested a copy of NEDO-24548, which has been used for original plants' AP load analyses in their FSARs and contains the mass energy release using FBOT. Section 3.7.4 of ML060620470 (MELLLA SER for one BWR/4) accepts use of FBOT for mass energy release. (See Slide 13 list of example plants where FBOT has been used in the original design and licensing of the plants.)

BWROG Responses to NRC Informal Comments on BWROG document 002N4971 (Cont.)

4) NRC Reviewer Comment: *NUREG 0609 alone is not a valid example because it is not an NRC approval of a plant specific LAR or generic topical. It is a valid example only if the FBOT Committee finds a plant specific LAR that was based on NUREG 0609.*

BWROG Response: The BWROG understands that NUREG 0609 identifies technical approaches to calculating LOCA break flows that were considered by the NRC. The use of FBOT for some existing plants AP calculations based upon NUREG 0609 is well documented. NUREG 0609 also identifies that from a technical basis the NRC was agreeable to the use of FBOT to AC also. Section 3.9.2.4 of NUREG-0979 ("Safety Evaluation Report Related to the Final Design Approval of the GESSAR II BWR/6 Nuclear Island Design, April 1983") states that "Using the guidance of NUREG-0609, GE has provided the methodology of the asymmetric LOCA loads analysis for the reactor system and the affected components...The staff will require individual applicants referencing GESSAR II to provide the results of the annulus pressurization analysis". This methodology has been used for the plants' original design AP load calculations such as FSARs, including BWR/6 and other BWR types.ML051530350 (MELLLA RAI for one BWR/4) requested a copy of NEDO-24548, which has been used for original plants' AP load analyses in their FSARs and contains the mass energy release using FBOT. Section 3.7.4 of ML060620470 (MELLLA SER for one BWR/4) accepts use of FBOT for mass energy release. The break opening time history is taken from the recirculation system pipe whip analyses documented in Section 3.6 of the FSARs. These analyses conform to the guidance provided in Section 3.1.2 of NUREG-0609 for break opening time and area characteristics. The NMP-2 UFSAR does reference NUREG-0609 in Section 6.2.1.2.4 as providing guidance for the overall AP Loads evaluation.

BWROG Responses to NRC Informal Comments on BWROG document 002N4971 (Cont.)

Background

NEI 96-07R1

5) NRC Reviewer Comment: *The below excerpts from NUREG 0609 (ADAMS Accession No. ML13255A427) which are included in the FBOT Committee's 50.59 show that the break-opening times and areas are plant specific* ***calculated values*** *that in turn are used in the LOCA thermal hydraulic analysis. The values for break-opening times and areas do not meet the definition of an "input parameter" because they are calculated values and therefore are not "values derived directly from the physical characteristics of SSC or processes.*

BWROG Response: The BWROG disagrees with this conclusion. In the case of selecting piping displacement for AC loading, there is no methodology that establishes how this value is derived. Piping displacement meets the definition of an input parameter per NEI 96-07, Rev. 1, Section 3.8, as it is a value derived directly from the physical characteristics of SSCs in the plant, including flow rates, temperatures, pressures, dimensions or measurements, and system response times.

Although instantaneous displacement causes the most conservative AC load results, no current reliance is placed on this conservatism by the NRC in their acceptance of this methodology.

Summary / Action Items

Capture Action Items