U.S.NRC

UNITED STATES NUCLEAR REGULATORY COMMISSION

Protecting People and the Environment

Regulations and Methodology for Leak-Before-Break Piping with Overlaid Alloy 82/182 Dissimilar Metal Welds

John Tsao

Office of Nuclear Reactor Regulation

October 28, 2010

Overview

- Review of Regulatory Background
- SRP 3.6.3 Guidance
- RIS 2010-07
- 10 CFR 50.59
- Fundamental Questions
- NRC Response to Public Comments on RIS 2010-07
- NRC Staff Position
- LBB Methodology Consideration for analyzing weld overlay on a LBB pipe

Regulatory Background

- General Design Criterion 4 states that "..dynamic effects associated with postulated pipe ruptures in nuclear units may be excluded from design basis when <u>analyses reviewed and approved by the Commission</u> demonstrated that the probability of fluid system piping rupture is extremely low…".
- Once approved, the LBB application and associated LBB evaluation are incorporated into the UFSAR as part of the plant's design basis.
- Any changes to the design basis in the UFSAR must be evaluated per 10 CFR 50.59 to determine whether a license amendment should be submitted.

Standard Review Plan (SRP) 3.6.3

- SRP 3.6.3 specifies margins of 2 and 10 for crack size and leakage, respectively.
- SRP recommends that the worst locations with the highest stresses and worst material properties be analyzed.
- SRP specifies that LBB is applied to specific pipe segments with specific geometry, configuration, and loadings.
  - However, NRC has approved LBB generic analysis that bounds the plant specific configuration.
- The candidate piping should satisfy screening criteria for the degradation mechanisms e.g., water hammer, creep damage, erosion, corrosion, PWSCC, fatigue, and environmental conditions.

Regulatory Issue Summary (RIS) 2010-07

- Item 7 -- NRC approval of weld overlay design for the LBB piping does not imply approval of design changes affecting LBB.
- Item 8 – Weld overlay changes the geometry of the original Alloy 82/182 dissimilar metal weld; therefore, the original LBB analysis may be invalidated and needs to be updated.
- Item 9 – Licensees should use criteria in 10 CFR 50.59 to determine whether an updated LBB analysis needs to be submitted as a license amendment request. Weld overlay changes crack morphology for the critical crack and leak rate calculations.

Regulatory Issue Summary (RIS) 2010-07

- Item10 –Licensees who have already installed a weld overlay on LBB piping need to perform Operability Determination, update the LBB analyses, and determine if a license amendment request is needed
- per 10 CFR 50.59.
- Item 11 –Licensees, who have not yet but are planning to install a weld overlay, need to update the LBB analyses and determine if a license amendment request is needed per 10 CFR 50.59.

10 CFR 50.59

- 50.59(a)(2) defines “departure from a method of evaluation described in the FSAR..” as
- 50.59(a)(2)(i) - changing of any elements of the method in FSAR unless the results of the analysis are conservative or essentially the same, or
- 50.59(a)(2)(ii) – changes from a method in FSAR to another method unless that method has been approved by the NRC.
- (c)(1)(ii)– license amendment is not needed if the changes do not meet (c)(2).
- (c)(2) – A licensee shall obtain a license amendment pursuant to 50.59 prior to implementing a proposed changes, test, or experiment if the change, test, or experiment would:
  - (c)(2)(i) Result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the final safety analysis report (as updated);

10 CFR 50.59

- (c)(2)(ii) Result in more than a minimal increase in the likelihood of occurrence of a malfunction of a structure, system, or component (SSC) important to safety previously evaluated in the final safety analysis report (as updated);
- (iii) Result in more than a minimal increase in the consequences of an accident previously evaluated in the final safety analysis report (as updated);
- (iv) Result in more than a minimal increase in the consequences of a malfunction of an SSC important to safety previously evaluated in the final safety analysis report (as updated);
- (v) Create a possibility for an accident of a different type than any previously evaluated in the final safety analysis report (as updated);

10 CFR 50.59

- (c)(2)(vi) Create a possibility for a malfunction of an SSC important to safety with a different result than any previously evaluated in the final safety analysis report (as updated);
- (c)(2) (vii) Result in a design basis limit for a fission product barrier as described in the FSAR (as updated) being exceeded or altered; or
- (viii) Result in a departure from a method of evaluation described in the FSAR (as updated) used in establishing the design bases or in the safety analyses.

• (c)(4) – the provisions in this section [50.59] do not apply to changes to the facility or procedures when the applicable regulations establish more specific criteria for accomplishing such changes.

Fundamental Questions

- Why does the original LBB analysis need to be updated after weld overlay installation?
- What are the assumptions and methods of analyzing overlaid LBB piping?
- Why does an updated LBB analysis need to be submitted?
- How does one use 10 CFR 50.59 to determine whether an updated LBB analysis needs to be submitted?
- When should an updated LBB analysis be submitted?

NRC Response to Public Comments on RIS

- NRC staff response to public comments on RIS can be found in ADAMS ML101380009.
- *Comment # 8: Why does a licensee need to update the existing LBB analysis if the margins in the existing analysis bound the margins in the overlaid LBB pipe?*
- ANS: The licensee needs to demonstrate by analysis that the overlaid weld location satisfies SRP 3.6.3.
- *Comment #9: What constitutes a change in the LBB methodology?*
- ANS: LBB Methodology includes equations, crack modeling assumptions, and certain input parameters. Any change to these items is considered as a change in LBB methodology.

NRC Response to Public Comments on RIS

- *Comment # 14: Why does the updated LBB analysis need to be submitted as a license amendment for NRC review and approval?*
- ANS: When the original LBB application was approved, the LBB analysis was incorporated in the UFSAR as part of design basis.
- When the LBB analysis is changed as a result of weld overlay, the design basis in UFSAR is changed.
- When the design basis in the UFSAR is changed, a licensee needs to disposition the UFSAR change per 10 CFR 50.59.

NRC Response to Public Comments on RIS

- *Comment # 13: Industry could provide a topical report justifying weld overlays on LBB piping.*
- ANS: The NRC agrees with the topic report proposal. The topical report should provide guidance on how to update the original LBB analysis and how to submit the updated LBB analysis per 10 CFR 50.59.
  - The staff would review and approve the topical report.
  - Licensees would follow the NRC-approved topical report to disposition the updated LBB analysis.

NRC Response to Public Comments on RIS

- *Comment #9: Would a change in the RCS leakage detection capability consider a change in methodology?*
- ANS: The licensee needs to assess the change per 10 CFR 50.59. Staff has concerns on the adequacy of the RCS leakage detection systems based on the review of recent LBB submittals.

NRC Staff Position

- Case A: A licensee requests LBB application for a Class 1 Pipe that has not been approved previously for LBB and the Alloy 82/182 pipe weld is not mitigated.
  - Install the weld overlay (the NRC has not approved any LBB applications for piping that contains unmitigated Alloy 82/182 welds since 2000.)
  - Perform LBB analysis considering weld overlay.
  - Submit the weld overlay relief request and LBB license amendment request (LAR).
  - Submit the LAR early so that the staff can approve it before LBB implementation. A licensee could install the weld overlay and start up, but it cannot remove pipe restraints or barriers until LAR is approved.

NRC Staff Position

- Case B: Class 1 Piping that has been approved previously for LBB and the weld overlay has already been installed
  - Perform Operability Determination and have it available at the plant for NRC inspection
  - Update the original LBB analysis, considering the weld overlay.
  - Perform 50.59 evaluation to determine if a license amendment request (LAR) is needed.
  - If an LAR is needed, submit the LAR with the updated LBB analysis within 6 to 9 months from the date of RIS 2010-07 issuance (June 8, 2010).
  - If an LAR is not needed, prepare justification and have it available at the plant for NRC inspection.

NRC Staff Position

- Case C: Class 1 Piping that has been approved previously for LBB and the weld overlay has been planned for installation, but not yet installed.
  - Install weld overlay.
  - Update the original LBB analysis, considering the weld overlay.
  - Perform 50.59 evaluation to determine if an LAR is needed.
  - If an LAR is required, submit the LAR well in advance because the LAR needs to be approved before the plant can restart. For exigency situation, if LRA cannot be submitted well in advance, perform Operability Determination.
  - If an LAR is not needed, prepare justification and have it available at the plant for NRC inspection.

LBB Methodology

- NRC has approved an LAR with updated LBB analyses for the full and optimized structural weld overlay at Davis Besse (ADAMS Accession ML100640506).
- Reassess the pipe loading considering the weld overlay geometry and weight and use the updated pipe loading in the LBB analysis.
- The overlaid Alloy 82/182 weld location needs to be analyzed even if it was not analyzed in the original LBB analysis because it was not the worst location.

LBB Methodology

- Idealized crack model is permissible, i.e., the circumference crack length can be assumed to be the same for the Alloy 82/182 weld and Alloy 52 weld overlay.
- Following parameters should be addressed
  - The material properties of Alloy 82/182 and Alloy 52 (use either the conservative property of the two or an equivalent material property).
  - The reduction in the fracture toughness of shield metal arc and submerged arc welds and ferritic material.
  - Pressure on the surface of the crack in the DMW and overlay.

LBB Methodology

- Include the weld overlay and Alloy 82/182 dissimilar metal weld (DMW) configuration in the leakage crack model.
- Assume PWSCC morphology for the portion of the crack in Alloy 82/182 weld (even if no flaws are detected in DMW) and fatigue crack morphology for the portion of the crack in the weld overlay.
- Consider surface roughness (local and global), flow path length, and number of turns to calculate leak rate.

Acknowledgments

- Would like to thank the following individuals for their contributions to the presentation slides:
- Aladar Csontos, Office of Regulatory Research (RES)
- Robert Tregoning, RES
- David Rudland, RES
- Raj Iyengar, RES
- Darrell Dunn, RES
- Timothy Lupold, Office of Nuclear Regulation (NRR)
- Robert Hardies, NRR