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The Northeast Utilities System

NOV 9 1998

Docket No. 50-336
B17516

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Millstone Nuclear Power Station, Unit No. 2
Request For Permission to Apply Leak Before Break Methodology
To The Pressurizer Surge Piping

The purpose of this letter is to request NRC review and approval of Leak Before Break (LBB) methodology for the Pressurizer Surge Piping. The scope of this LBB application is limited to the Pressurizer Surge Piping extending between the Pressurizer and the RCS hot leg. Pressurizer Surge Piping is designated as high energy, being subject to the normal operating conditions of the RCS hot leg and the Pressurizer. All affected piping considered for this application of LBB is located inside the containment.

A recent evaluation of the walkdown information on the Pressurizer Surge Piping system, completed in May 1998, concluded that the protection of adjacent closed loop piping systems from potential pipe breaks was not provided as part of the original Millstone Unit No. 2 design. This concern was reported via LER 98-005-01.[1] NNECO has evaluated various options to address this concern and concluded that the application of the LBB technology is the most effective and reasonable approach to ensure adequate pipe break protection of the closed loop piping systems. Other available options included plant physical changes, such as, installation of whip restraints and jet shields, relocation of piping or the installation of secondary isolation valves. All of these options were determined to be less effective than the LBB option.

As required by GDC-4, a review and approval by the NRC of the LBB methodology for the Pressurizer Surge Piping will eliminate the requirement to consider the dynamic effects associated with postulated ruptures in this piping system. The LBB methodology utilizes the guidance and criteria provided in NUREG 1061, Volume 3. This request for NRC review and approval will not affect the ECCS design bases,

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(1) Letter from J. A. Price to U. S. Nuclear Regulatory Commission, "Millstone Nuclear Power Station, Unit No. 2, Licensee event Report 98-005-01, High Energy Line Break Deficiencies for Piping Inside Containment (Information Notice 89-55 Review)," dated August 17, 1998.

containment and compartment design bases, or equipment qualification bases for Millstone Unit No. 2.

This request for permission to exclude the dynamic effects associated with postulated pipe ruptures in Pressurizer Surge Piping is organized as follows:

Attachment 1 to this letter provides an executive summary of the NNECO submittal.

Attachment 2 provides the background and introductory remarks and system description related to this request.

Attachment 3 provides a detailed report on the results of the LBB evaluations for the Pressurizer Surge Piping. This attachment also addresses each of the LBB evaluation criteria contained in NUREG 1061, Volume 3.

Attachment 4 provides a discussion of the plant specific information and service experience to date with the Pressurizer Surge piping system. Issues, such as NDE inspection results, water hammer experience, and the impact of any other potential sources of degradation, such as fatigue, vibration, corrosion, and thermal stratification are addressed.

Attachment 5 contains a discussion of the material properties, welding processes and weld procedures that pertain to the Pressurizer Surge piping.

The information provided earlier as Attachments 7 and 8 to the NNECO letter of July 24, 1998,[(2)] concerning the Millstone Unit No. 2 installed leak detection system inside containment and the qualitative value impact assessment are relevant to this evaluation request as well but are not included herein to avoid redundancy.

Some of the benefits that will accrue from application of the LBB technology include the elimination of the need for installing the pipe whip restraints and jet barriers on the Pressurizer Surge piping, elimination of associated occupational personnel exposure during construction and periodic removal and re-installation of these restraints and barriers, less congestion in the containment, and the elimination of potential damage to piping from malfunction of rupture restraints.

There are no regulatory commitments contained within this submittal.

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(2) Letter from Martin L. Bowling, Jr. to U. S. Nuclear Regulatory Commission, "Millstone Nuclear Power Station, Unit No. 2, Request For Permission to Apply Leak Before Break Methodology, To Portions of Safety Injection and the Shutdown Cooling Systems," dated July 24, 1998.

If you have any additional questions concerning this submittal, please contact Mr. Ravi G. Joshi at (860) 440-2080.

Very truly yours,
NORTHEAST NUCLEAR ENERGY COMPANY

Martin L. Bowling, Jr.
Recovery Officer - Technical Services

Attachments

cc: H. J. Miller, Region 1 Administrator
E. V. Imbro, Director, Millstone ICAVP Inspections
W. M. Dean, Director, Millstone Project Directorate
W. D. Lanning, Director, Millstone Inspections
J. P. Durr, Chief, Inspections Branch
D. G. McDonald, Jr., NRC Senior Project Manager, Millstone Unit No. 2
S. Dembeck, NRC Project Manager, Millstone Unit No. 1
D. P. Beaulieu, Senior Resident Inspector, Millstone Unit No. 2

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Attachment 1

Millstone Nuclear Power Station, Unit No. 2

Request For Permission to Apply Leak Before Break Methodology
To The Pressurizer Surge Piping

Executive Summary

November 1998

EXECUTIVE SUMMARY

This Millstone Unit No. 2 request to the NRC for application of the Leak Before Break (LBB) to the Pressurizer Surge Piping system in accordance with the provisions of General Design Criterion (GDC) 4 of Appendix A to 10CFR Part 50 is based on the methodology described in NUREG 1061, volume 3. The subsequent attachments two through five provide the technical justification and relevant supporting information for this LBB submittal.

The scope of requested exemption is limited to the Pressurizer Surge piping extending from the RCS hot leg to the Pressurizer. The entire piping system is designated ASME Class 1 high energy, being subject to the normal operating conditions of the RCS hot leg and the Pressurizer. All affected piping considered for this application of LBB is located inside the containment.

The subject Pressurizer Surge Piping is 12 inch Schedule 160 seamless piping fabricated from A 351 Gr CF8M stainless steel. The Pressurizer surge nozzle is fabricated of SA 508 Cl 2 forged alloy steel with type 304 stainless steel cladding and is fitted with a SA-351 Gr CF8M stainless steel safe end. The hot leg surge nozzle is fabricated from A105 Grade II forged carbon steel and is also fitted with a SA-351 Gr CF8M stainless steel safe end. The dissimilar metal welds (i.e. carbon to stainless steel components) were made with inconel 182 filler material using the SMAW weld process.

Deterministic Elastic-Plastic Fracture Mechanics (EPFM) J-Integral - Tearing Modulus (J/T) evaluations were performed for all weld locations identified in the Pressurizer surge piping system. In order to demonstrate the required safety margins of $\sqrt{2}$ on the accident load combination, factor of two on the critical crack length, and a margin of 10 on the leakage detection, several fracture mechanics evaluations were performed.

The fracture mechanics evaluations for the Pressurizer Surge Piping determined critical flaw sizes at each weld location using generic lower bound base and weld material properties for (a) pressure plus dead weight plus thermal plus safe shutdown earthquake (P + DW + TH + SSE) with a factor of safety of two on flaw size and for (b) $\sqrt{2}$ (P + DW + TH + SSE) with no margin on flaw size. These evaluations show that for all material types, the loading condition (P + DW + TH + SSE) with margin of safety of two on flaw size controlled the allowable critical crack size. The critical crack sizes ranged from 9.76 inches to 14.28 inches in length for aged cast stainless steel. For the SMAW weld material properties, the critical sizes ranged from 12.56 to 17.66 inches. The fracture mechanics calculations showed that the critical crack sizes based on a factor of $\sqrt{2}$ times (P + DW + TH + SSE) were all smaller. The leakage rate calculations performed using PICEP computer program showed that in all cases, the 10 gpm leakage size flaw was smaller than the above critical flaw sizes. Material and fluid properties at normal operating condition were utilized in the leakage assessments.

An installed leak detection capability of at least 1 gpm is required to demonstrate the required safety margin of 10 on leakage detection as stipulated in NUREG 1061, volume 3. Millstone Unit No. 2 has an installed leak detection capability of 1 gpm unidentified leakage inside containment which meets the LBB leakage detection requirements calculated above for the Pressurizer Surge Piping. This capability is in compliance with Regulatory Guide 1.45 requirements.

The ASME XI fatigue crack growth analyses of shallow flaws considered all normal and upset transient thermal and mechanical loadings including a full spectrum of thermal loadings associated with thermal stratification. Both global and local stress contributions from thermal stratification were considered. Thermal stratification loading spectrum specified in Combustion Engineering Owners Group submittal Report CEN-387-P, Revisions 0 and 1 were utilized. This CEN-387 report developed in response to I & E Bulletin 88-11 has been previously reviewed by Staff via SER dated July 6, 1993. It may be noted that where applicable, weld residual stresses and bi-metallic stress effects were also included in the ASME XI fatigue crack growth evaluations.

The results of fatigue crack growth analyses of shallow flaws at the critical locations comprising the nozzle to safe end welds at the hot leg and Pressurizer show that flaw growth propensity is greater in the radial direction. Thus, potential crack growth as a result of service loads would exhibit leak-before-break behavior. At the most limiting location, a crack with initial depth of 11.1% of the wall thickness and aspect ratio of 6:1 (similar to that used in ASME XI Appendix G) is predicted to grow to 80% depth in 350 heat-up and cooldown cycles. To date Millstone Unit No. 2 has experienced approximately 56 heatup and cooldown cycles.

It is noteworthy that the above fatigue crack growth analyses account for the reactor water environment. A factor of 2 is applied to the in-air ASME XI Crack growth law for austenitic steels to account for the reactor water environment. For carbon steel, the ASME XI fatigue crack growth curve for ferritic steel in water environment was utilized.

The ASME XI Inservice Inspection experience for Pressurizer Surge piping has been very favorable. A majority of the controlling weld locations identified in the fatigue crack growth analyses discussed above have been inspected recently (years 1989 through 1994) and found to be acceptable per ASME XI, IWB-3500 requirements. The bi-metallic welds between the Pressurizer surge nozzle and piping and the hot leg surge nozzle and piping were inspected in 1989 and 1994 respectively and found acceptable per ASME XI, IWB- 3500 requirements.

As part of this submittal, NNECO intends to inspect the fatigue critical weld locations once per ISI interval of 10 years. This will provide added assurance that potential flaws in fatigue sensitive locations will not grow to structurally unacceptable dimensions prior to the end of life of Millstone Unit No. 2.

The susceptibility to other potential degradation mechanisms, such as intergranular stress corrosion cracking (IGSCC) and flow accelerated corrosion (FAC) were considered and determined not to be a concern for the surge line piping system. Similarly, the probability of occurrence of water hammer or significant vibrations were considered low. The Pressurizer surge nozzle is protected from thermal fatigue by a thermal sleeve.

Material properties at appropriate operating temperature, utilized in the LBB evaluation for the SMAW weld metal and all base metal, were either lower bound properties or Millstone Unit No. 2 unique properties. No additional material testing was conducted for the purpose of this LBB evaluation. The applicable lower bound material properties were further adjusted to account for the impact of thermal aging on the material properties of cast stainless steel and SMAW weld metal.

In summary, NNECO believes that Millstone Unit No. 2 satisfies all requirements relative to the leak-before-break analysis, stipulated in NUREG 1061, Volume 3, for the Pressurizer Surge Piping. Accordingly, NNECO requests NRC review and approval of the attached LBB evaluation so that the dynamic effects associated with postulated ruptures in the Pressurizer Surge Piping can be excluded from the design basis as allowed by GDC-4.

Attachment 2

Millstone Nuclear Power Station, Unit No. 2

Request For Permission to Apply Leak Before Break Methodology To The Pressurizer Surge Piping

Introduction And Background

November 1998

INTRODUCTION AND BACKGROUND

In the original assessment of high energy line breaks (HELB) inside containment, the protection of closed systems was not addressed and is, therefore, not considered a part of the Millstone Unit No. 2 licensing or design bases (LB/DB). The generic industry oversight of closed loop systems was recognized in the Information Notice 89-55, with full evaluation with supporting walkdowns completed for Millstone Unit No. 2 in May, 1998. In reviewing the inside containment HELB program for its adequacy in protecting closed loop piping systems from a postulated impact due to the rupture of an adjacent High Energy Line, several deficiencies were identified (Ref. 1). The Safety Injection, Shutdown Cooling and Pressurizer Surge Lines were all identified as initiating sources of unacceptable interaction with closed loop systems. The possible corrective actions for the identified interactions considered options for both targets (moving lines or adding secondary isolation valves) and sources (restraint of ruptured line or elimination of the postulated break).

The best target-related option is the use of a second isolation valve at the containment penetrations to ensure containment integrity under the postulated breaks. While this approach could provide successful resolution of this issue, it introduces a considerable amount of additional maintenance and reliability concerns which would negatively impact plant operation. In total, eight new motor or air operated isolation valves, with associated controls to close on a Containment Isolation Actuation Signal (CIAS), would be required to address all identified interactions. The target lines under consideration include four RBCCW lines (two 6" and two 8" penetrations), two Steam Generator Blowdown (SGBD) lines (two 2" penetrations) and two SGBD Sampling lines (two 1/2" penetrations). The addition of more motor or air operated valves to these systems increases their complexity and decreases their overall efficiency and reliability. The impact on personnel exposure associated with the installation and maintenance of these valves is significant. Thus, benefits of this approach are judged to be greatly exceeded by the overall negative impact on plant operation.

Based on the size of the Pressurizer Surge Piping line (12" diameter) and its location within the loop area, where structural attachment locations are minimal, the extension of Leak-Before-Break (LBB) criteria to this piping provides the most effective resolution. Given that the protection of closed loop systems is considered a prudent enhancement to the existing LB/DB of Millstone Unit No. 2, and given the previous industry precedent for application of Leak Before Break methodology for large lines attached to the primary loop, this approach is considered the most effective and reasonable implementation approach. Note that in a previous submittal dated July 24, 1998[(1)] , NNECO requested review and approval of Leak Before Break approach for the Safety Injection and the Shutdown Cooling piping systems.

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(1) Letter from Martin L. Bowling, Jr., to U.S. Nuclear Regulatory Commission, "Millstone Nuclear Power Station, Unit No. 2, Request For Permission to Apply Leak Before Break Methodology,To Portions of Safety Injection and the Shutdown Cooling Systems," dated July 24, 1998.

2.1 PRESSURIZER SURGE PIPING SYSTEM DESCRIPTION

Pressurizer Surge Piping is part of the Reactor Coolant System pressure boundary located between the Pressurizer bottom and the hot leg. The surge line provides a passive response to the operational expansions and contractions in the coolant volume within the RCS pressure boundary. Small pressure and coolant volume variations are accommodated by the Pressurizer steam volume which absorbs flow into the Pressurizer (in-surge) and by the Pressurizer water volume which allows flow out of the Pressurizer (out-surge). Large variations in pressure and coolant volume are mitigated by the Pressurizer pressure control logic which is based on the water level in the Pressurizer and the average coolant temperature. For example, when steam demand is decreased, the average reactor coolant temperature rises. The expanding reactor coolant from the reactor coolant hot leg enters from the bottom of the Pressurizer via the Surge Piping (in-surge), compressing the steam thereby raising the system pressure. The increase in pressure is moderated by the condensation of steam during the compression and also by a decrease in the bulk temperature in the liquid phase. Any large pressure increases occurring as a result of a significant in-surge are controlled by sprays of cold leg water from the spray nozzles located at the top of the Pressurizer. Power operated relief valves (PORV's) are also available to provide over-pressure relief, if needed.

The entire Surge Piping is classified as high energy. The physical layout of the Surge Piping and associated supports is shown in Figures 2-1 and 5.2.

2.2 STRESS ANALYSIS & ASME CODE COMPLIANCE

The stress and fatigue design compliance of the Pressurizer Surge Piping in accordance with the Combustion Engineering Design Specification Number 18767-31-5 [Ref. 3] and the Class 1 requirements of ASME III, 1968 through Summer 1969 Addenda was performed by Combustion Engineering. The surge line piping analyzed by CE in CE Report CENC-1192 [Ref. 2] extends between the bottom of the Pressurizer and the Reactor Coolant hot leg. The Pressurizer Surge Piping is computer analyzed for pressure, dead weight, thermal expansion, OBE and SSE loads. ASME Code compliance is demonstrated for normal, upset, emergency, faulted and test conditions. Additionally, cumulative fatigue usage factor for 40 year service life is shown to be less than the ASME Code acceptable limit of 1.0. All pressure boundary attachments to Class 1 piping were designed to ASME Section III, NB requirements. Structural Steel supports were qualified in accordance with the AISC requirements.

The requirements of I&E Bulletin 79-14 involving as-built verification were subsequently implemented for the Pressurizer Surge Piping.

The details of re-evaluation of the Surge Piping for thermal stratification concerns as discussed in I&E Bulletin 88-11 was performed by ABB/CE as part of the CE Owners Group (CEOG) activity. CEOG Report CEN-387-P, Revisions 0 and 1[Reference 4] were provided for Staff review. Staff acceptance of this report was provided via SER dated July 6, 1993 [Reference 6]. Millstone Unit No. 2 response to the request for additional plant specific information was provided to Staff via letter dated September 30, 1993 [Reference 7]. This letter also confirmed that all actions required by Bulletin 88-11 were complete for Millstone Unit No. 2.

2.3 REFERENCES

1. 25203-EV-98-0063, "Technical Evaluation for NRC Information Notice No. 89-55: Degradation of Containment Isolation Capability By a High-Energy Line Break," issued May 15, 1998.

2. CE-1192, Analytical Report for Northeast Utilities Service Company Millstone Point Station Unit No. 2 Piping, C-E , September 1973.

3. 18767-31-5, Rev. 13, Pressurizer Specification, Combustion Engineering

4. CEOG Report CEN-387-P, Revisions 0 and 1

5. NU Calculation MP2-LOE-380-EM, Rev. 0, Pressurizer Surge Line Analysis Considering Thermal Stratification.

6. USNRC Letter to J. F. Opeka, "Safety Evaluation for Combustion Engineering Owners Group Report CEN-387-P, Rev 1, Pressurizer Surge Line Thermal Stratification Evaluation," Dated July 6, 1993.

7. Letter from J. Opeka to USNRC, "Response to NRC Staff for Additional Information on Pressurizer Surge Line Thermal Stratification Evaluation," Dated September 30, 1993.

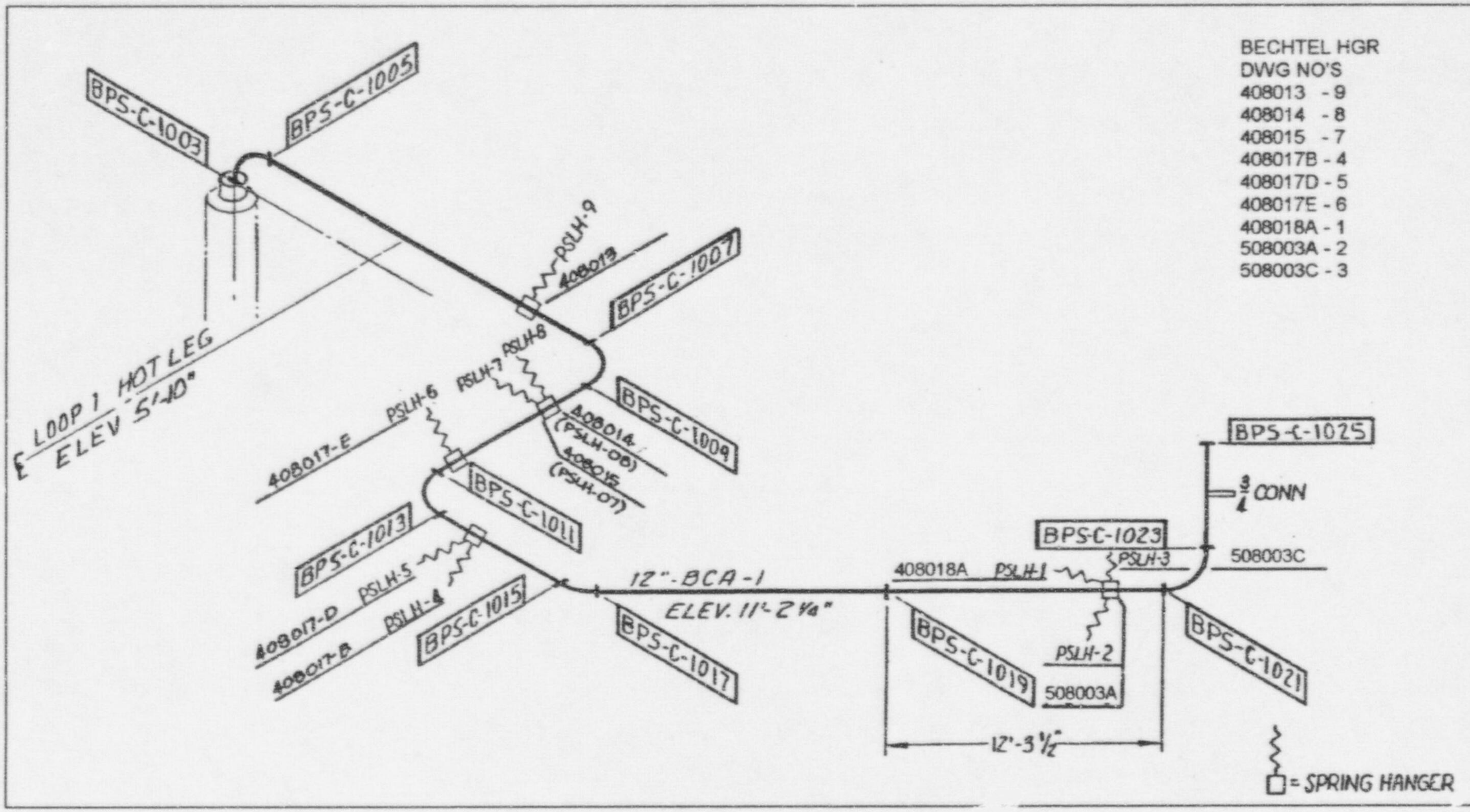

Figure 2-1 Surge Line Hanger and Weld Identifications

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Attachment 3

Millstone Nuclear Power Station, Unit No. 2

Request For Permission to Apply Leak Before Break Methodology
To The Pressurizer Surge Piping

Report Number SIR-98-096, Rev. 0.

Prepared By: Structural Integrity Associates

November 1998