December 15, 2000

Mr. Mark Reddemann
Site Vice President
Point Beach Nuclear Plant
Nuclear Management Company, LLC
6610 Nuclear Road
Two Rivers, WI 54241

SUBJECT: POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2 - REVIEW OF LEAK-BEFORE-BREAK EVALUATION FOR THE PRESSURIZER SURGE LINE PIPING AS PROVIDED BY 10 CFR PART 50, APPENDIX A, GDC 4 (TAC NOS. MA7805 AND MA7806)

Dear Mr. Reddemann:

By letters dated December 2, 1999, July 7 and August 16, 2000, the Wisconsin Electric Power Company (WEPCo) submitted a request for the NRC to review and approve the leak-before-break (LBB) evaluation for the Point Beach Nuclear Plant, Units 1 and 2, pressurizer surge line piping. WEPCo was subsequently succeeded by Nuclear Management Company, LLC (NMC), as the licensed operator of Point Beach, Units 1 and 2. By letter dated October 5, 2000, NMC requested the staff to continue to process and disposition licensing actions previously docketed and requested by WEPCo. The submittal was made in accordance with the provisions of Title 10 of the *Code of Federal Regulations*, Part 50, Appendix A, General Design Criteria 4, which permits licensees to exclude the dynamic effects associated with postulated pipe ruptures from the facility's licensing basis if "analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping." LBB evaluations utilizing the guidance of NUREG-1061, Volume 3, have been previously approved by the staff as a method for making such a demonstration.

The staff has completed its evaluation of your submittal. The information provided in the original submittal and supplemented by the July 7 and August 16, 2000, responses to the staff's request for additional information was sufficient to permit the staff to independently evaluate the licensee's conclusions. While the detailed results of the staff's evaluation differ with the licensee's, the staff agrees with your conclusion that LBB behavior has been demonstrated for

the pressurizer surge line piping. Therefore, the staff finds that you may remove consideration of the dynamic effects associated with the postulated rupture of the pressurizer surge line piping from the licensing basis of Point Beach, Units 1 and 2.

The safety evaluation that addresses the technical basis for the staff's finding is enclosed.

Sincerely,

/RA/

Beth A. Wetzel, Senior Project Manager, Section 1
Project Directorate III
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-266 and 50-301

Enclosure: Safety Evaluation

cc w/encl: See next page

the pressurizer surge line piping. Therefore, the staff finds that you may remove consideration of the dynamic effects associated with the postulated rupture of the pressurizer surge line piping from the licensing basis of Point Beach, Units 1 and 2.

The safety evaluation that addresses the technical basis for the staff's finding is enclosed.

Sincerely,

/RA/

Beth A. Wetzel, Senior Project Manager, Section 1
Project Directorate III
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-266 and 50-301

Enclosure: Safety Evaluation

cc w/encl: See next page

DISTRIBUTION:
PUBLIC
PDIII-1 Reading
CCraig
BWetzel
RBouling
OGC
ACRS
MMitchell
RLanksbury, RIII

OFFICE	PDIII-1/PM	PDIII-1/LA	PDIII-1/SC
NAME	BWetzel	RBouling	CCraig
DATE	12/15/00	12/15/00	12/15/00

ACCESSION NO. ML003777863

OFFICIAL RECORD COPY

Point Beach Nuclear Plant, Units 1 and 2

cc:

Mr. John H. O'Neill, Jr.
Shaw, Pittman, Potts & Trowbridge
2300 N Street, NW
Washington, DC 20037-1128

Mr. Richard R. Grigg
President and Chief Operating Officer
Wisconsin Electric Power Company
231 West Michigan Street
Milwaukee, WI 53201

Site Licensing Manager
Point Beach Nuclear Plant
Nuclear Management Company, LLC
6610 Nuclear Road
Two Rivers, WI 54241

Mr. Ken Duveneck
Town Chairman
Town of Two Creeks
13017 State Highway 42
Mishicot, WI 54228

Chairman
Public Service Commission
of Wisconsin
P.O. Box 7854
Madison, WI 53707-7854

Regional Administrator, Region III
U.S. Nuclear Regulatory Commission
801 Warrenville Road
Lisle, IL 60532-4351

Resident Inspector's Office
U.S. Nuclear Regulatory Commission
6612 Nuclear Road
Two Rivers, WI 54241

Ms. Sarah Jenkins
Electric Division
Public Service Commission of Wisconsin
P.O. Box 7854
Madison, WI 53707-7854

Michael D. Wadley
Chief Nuclear Officer
Nuclear Management Company, LLC
700 First Street
Hudson, WI 54016

Nuclear Asset Manager
Wisconsin Electric Power Company
231 West Michigan Street
Milwaukee, WI 53201

SAFETY EVALUATION OF THE REQUEST TO APPLY LEAK-BEFORE-BREAK

STATUS TO THE PRESSURIZER SURGE LINE PIPING AT

POINT BEACH NUCLEAR POWER PLANT, UNITS 1 AND 2

1.0 INTRODUCTION

By letter dated December 2, 1999, as supplemented July 7 and August 16, 2000, the licensee for Point Beach Nuclear Plant, Units 1 and 2, requested that the NRC review and approve their application to remove consideration of the dynamic effects of postulated ruptures of the pressurizer surge line piping from the licensing basis for Point Beach, Units 1 and 2. The licensee's submittal was based on an application of Title 10 of the *Code of Federal Regulations*, Part 50, Appendix A, General Design Criteria (GDC) 4, which states, in part:

> [h]owever, dynamic effects associated with postulated pipe ruptures in nuclear power units may be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping.

For the purposes of this demonstration, the licensee submitted a leak-before-break (LBB) analysis prepared by Westinghouse for the subject portions of the pressurizer surge line piping. LBB evaluations developed by the NRC using the analysis methodology contained in NUREG-1061, Volume 3 (Reference 1), have been previously approved by the Commission as demonstration of an extremely low probability of piping system rupture.

2.0 REGULATORY REQUIREMENTS AND STAFF POSITIONS

Nuclear power plant licensees have, in general, been required to consider the dynamic effects that could result from the rupture of sections of high energy piping (fluid systems that during normal plant operations are at a maximum operating temperature in excess of 200 °F and/or a maximum operating pressure in excess of 275 psig). This requirement has been formally included in 10 CFR Part 50, Appendix A, GDC 4, which states, "[s]tructures, systems, and components important to safety....shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit."

As noted in Section 1.0 above, the NRC modified GDC 4 to permit the dynamic effects of some high energy piping ruptures to be excluded from facility licensing bases based upon the demonstration of an extremely low probability of piping system rupture. Consistent with this modification to GDC 4, the NRC accepted the LBB analysis methodology as an acceptable means by which this extremely low probability of piping system rupture could be demonstrated. The philosophy of LBB behavior for high energy piping systems was developed by the NRC

ENCLOSURE

in the early 1980s, used in certain evaluations stemming from Unresolved Safety Issue A-2, "Asymmetric Blowdown Loads on PWR Primary Systems," and then subsequently expanded for application toward resolving issues regarding defined dynamic effects from high energy piping system ruptures.

3.0 LICENSEE'S DETERMINATION

The following discussion contains information supplied by the licensee in its December 2, 1999, submittal. Included in the submittal was the report prepared by Westinghouse (WCAP-15065, "Technical Justification for Eliminating Pressurizer Surge Line Rupture as the Structural Design Basis for Point Beach Units 1 and 2 Nuclear Plants"). The following discussion also includes information provided in the licensee's responses, dated July 7 and August 16, 2000, to the NRC staff's request for additional information (RAI), dated June 7, 2000. The figures and tables referred to herein are attached to this safety evaluation.

3.1 Identification of Analyzed Piping and Piping Material Properties

The licensee's submittal identified and analyzed the following sections of piping for LBB behavior verification. The licensee addressed the pressurizer surge line for each unit from its connection to the reactor coolant system hot leg to the pressurizer, as shown in Figures 1 and 2.

The pressurizer surge line piping was manufactured from several materials. The piping and fittings of the Point Beach, Units 1 and 2, pressurizer surge lines were manufactured from wrought American Society of Mechanical Engineers (ASME) specification SA-376 Type 316 stainless steel (SS). The welds in this system were fabricated from SS using gas tungsten arc and shielded metal arc welding (SMAW) processes. The line is manufactured from 10-inch nominal diameter, Schedule 140 (wall thickness = 0.896 inches) pipe.

For the material properties used in the pressurizer surge line LBB evaluations, Westinghouse used minimum and average room temperature tensile properties based on Certified Materials Test Report (CMTR) data. The minimum and average tensile properties at temperatures of interest (i.e., 245 °F, 617 °F, 653 °F) were calculated using the ratio of the ASME Code, Section III, properties at room temperature to the Code properties at the temperatures of interest to scale the CMTR-based data. The modulus of elasticity variation with temperature was established based on ASME Code, Section III, values. The minimum tensile properties were used by Westinghouse in the LBB critical flaw size determination, while the average tensile properties were used in the LBB leakage flaw size determination.

3.2 General Aspects of the Licensee's LBB Analysis

The analyses provided by the licensee sought to address the following four principal areas that were consistent with the criteria established for LBB analysis acceptability in NUREG-1061, Volume 3: (1) demonstrate that the subject piping is a candidate for LBB analysis by showing that the piping is not particularly susceptible to active degradation mechanisms or atypical loading events; (2) establish the critical through-wall flaw size under which analyzed locations would be expected to fail under normal operation (NOP) plus safe-shutdown earthquake (SSE) or startup/shutdown loading conditions; (3) establish the leakage behavior of smaller through-wall flaws under NOP loads alone for each location; and (4) evaluate the margin between the

critical through-wall flaw size and an appropriate leakage through-wall flaw size and the stability of the through-wall leakage flaw.

3.3 Evaluation of Pressurizer Surge Line Piping

The analysis of the pressurizer surge line piping that was submitted to the staff as an attachment to the licensee's December 2, 1999, letter was prepared for the licensee by Westinghouse as report number WCAP-15065. This section summarizes the Westinghouse results for the four subject areas noted in section 3.2 above.

Initially, the licensee's submittal addressed the issue of potential piping degradation mechanisms and atypical loading conditions. Per the discussion of the limitations of LBB analyses in NUREG-1061, Volume 3, the LBB approach should not be considered when operating experience has indicated particular susceptibility to failure from the effects of corrosion, water hammer, or fatigue. Such mechanisms could cause the development of complex or extensive flaws in piping which significantly degrade its load carrying capacity while not propagating through-wall over a sufficient length to be detectable, or provide loads which are difficult to bound analytically. The licensee's submittal concluded that pressurized-water reactor pressurizer surge line piping like that at Point Beach, Units 1 and 2, has not been shown to be particularly susceptible to the effects of water hammer, intergranular stress corrosion cracking, or erosion-corrosion.

Regarding the potential for fatigue cracking from mechanical and thermal loadings, the licensee and Westinghouse noted that low cycle fatigue considerations were accounted for in the design of this piping system through the fatigue usage factor evaluation to show compliance with the rules of Section III of the ASME Code (also in accordance with analyses in response to NRC Generic Letter 88-11). Additionally, the licensee and Westinghouse provided an analysis of the growth of postulated surface flaws based on design transient loading conditions and the analysis procedure suggested by Section XI, Appendix A, of the ASME Code. Westinghouse showed that for semi-elliptic surface flaws with initial depths of up to one-tenth of the thickness of the pipe wall, little or no growth was expected to occur. High cycle fatigue loads, primarily from pump vibrations, are managed through the monitoring of reactor coolant pump shaft vibration limits and inservice measurements have shown that the magnitude of the stresses associated with these vibrations is low and is not expected to raise a concern through the operating life of the facilities.

Next, the Westinghouse analysis evaluated the pressurizer surge line piping by developing the applied stresses under NOP, NOP plus SSE, startup/shutdown, and the low probability event of startup/shutdown plus SSE loading conditions and determined the leakage and critical through-wall flaw size for various locations along the piping. In the determination of the NOP applied stresses, the analysis included the tensile and bending stresses resulting from the internal pressure, deadweight, and thermal expansion. The licensee also provided another set of NOP loads that also included the contribution of the thermal stratification stresses at NOP conditions. SSE loads were added to the NOP loads (with and without NOP thermal stratification loads) when determining loads to be considered for the critical flaw size evaluation. In addition, startup/shutdown and startup/shutdown plus SSE loading conditions were developed separately and are of interest for evaluating the allowable critical flaw size since large thermal bending stresses due to thermal stratification are developed in this piping as a result of the temperature difference between the hot leg and pressurizer during these

evolutions. It should, however, be noted that in the original submittal, load combinations in WCAP-15105 did not account for torsional loads on the pressurizer surge line piping for any of the loading conditions mentioned above. Loads that were provided in the licensee's August 16, 2000, supplemental letter responding to the NRC staff's RAI did include torsional loads as requested by the NRC staff.

In the load combination, the deadweight, thermal expansion and/or thermal stratification, pressure, and SSE stresses were summed absolutely for the critical flaw size determination. Likewise, when evaluating the loads for the startup/shutdown conditions (with or without the SSE), the deadweight, thermal expansion, thermal stratification, and pressure loads were summed absolutely. The deadweight, thermal expansion and/or thermal stratification, and pressure stresses for NOP conditions were summed algebraically for the leakage flaw size determination. Table 1a summarizes the significant load combination results provided by Westinghouse in the December 2, 1999, submittal. Table 1b shows the load combinations of interest submitted by the licensee in their August 16, 2000, supplemental submittal.

For the purposes of LBB analyses, the critical flaw size can be defined as the longest preexisting through-wall flaw that could exist without growing unstably to double-ended pipe rupture under faulted or off-normal loading conditions. As explained above, for the pressurizer surge line piping, this includes considering the NOP plus SSE and startup/shutdown loading conditions. The analysis performed by Westinghouse to establish the critical flaw size at a nodal location was based on the use of a limit-load analysis approach. This approach effectively predicts piping failure based on net section collapse of the cross-section that has been reduced by the through-wall cracked section. In the Westinghouse analysis of the pressurizer surge lines, the SS welds were identified as the limiting material (i.e., the material for which the smallest margin between the critical and leakage flaw size exists). When analyzing SS welds using a limit-load-based approach, an additional factor, the Z-factor, is incorporated to account for the generally lower toughness and lower load carrying capacity of SMAW welds. The Westinghouse analysis applied the Z-factor to increase the applied loads and thus reduce the through-wall flaw size that could be withstood without piping failure.

The leakage flaw size for an LBB analysis is defined as the flaw size that, under NOP conditions, would leak 10 times the amount of fluid detectable by the facility's leakage detection system. The factor of 10 is established in the LBB guidance of NUREG-1061, Volume 3, as the safety factor on leakage to account for uncertainties in calculating leakage from a through-wall crack. As noted in section 5.2.3 of WCAP-15065, the performance of the Point Beach pressure boundary leakage detection system is consistent with the guidelines of Regulatory Guide 1.45, "Reactor Coolant Pressure Boundary Leakage Detection Systems," and is therefore capable of detecting a one-gallon-per-minute (gpm) leak in 1 hour. Therefore, the leakage flaw calculated by Westinghouse at each nodal location was based on a leak rate of 10 gpm under NOP conditions. The leakage analysis performed by Westinghouse was based on the use of a Westinghouse proprietary methodology for calculating single or two-phase flow through cracks in light-water reactor piping.

Westinghouse identified the limiting location to be node 1030 in the Point Beach, Unit 2, surge line piping. For node 1030, Westinghouse determined that the leakage flaw size that would provide 10 gpm of leakage at NOP conditions would be 5.25 inches if NOP thermal stratification loads were not considered and 4.35 inches if NOP thermal stratification loads were included in the analysis. For the startup/shutdown and NOP plus SSE loading conditions, the critical flaw

sizes ranged from 11.93 to 13.89 inches, respectively. Hence, for any combination of leakage flaw size and critical flaw size, the licensee and Westinghouse concluded that the margin on flaw size would be at least 11.93/5.25 = 2.3. For the low probability event of an SSE during startup/shutdown, the critical flaw size was likewise determined to be 11.22 inches. Therefore, the NUREG-1061, Volume 3, recommended margin of 2 on length between the leakage and critical flaws sizes was achieved. In addition, since the load summation for the critical flaw size analysis was done on an absolute basis, the stability of the leakage size flaw under startup/shutdown or NOP plus SSE conditions with a safety factor on the loads of unity was also demonstrated.

4.0 STAFF EVALUATION

Based on the information provided by the licensee regarding the materials comprising the Point Beach, Units 1 and 2, pressurizer surge line piping and the loads under NOP, NOP plus SSE, and startup/shutdown conditions, the staff independently assessed the compliance of these systems with the LBB criteria established in NUREG-1061, Volume 3. The staff has concluded that the analysis submitted by the licensee, including the additional information supplied in response to the staff's RAI, was sufficient to demonstrate that LBB behavior would be expected from the subject piping. The following sections will focus on the differences between the details of the staff's analysis, conducted per NUREG-1061, Volume 3, and the licensee's analysis.

4.1 Identification of Analyzed Piping and Piping Material Properties

The staff examined the list of materials identified for the pressurizer surge line piping and concluded that the materials of primary interest for the LBB analysis would be the SS welds because of their susceptibility to thermal aging. However, in evaluating the fracture behavior of the SS welds, the stress-strain properties of the surrounding wrought SS piping would also be used, as addressed below. NUREG-1061, Volume 3, specifies particular aspects that should be considered when developing materials property data for LBB analyses. First, data from the testing of the plant-specific piping materials is preferred. However, in the absence of such data, more generic data from the testing of samples having the same material specification may be used. More specifically, it was noted in Appendix A of the NUREG that "[m]aterial resistance to ductile crack extension should be based on a reasonable lower-bound estimate of the material's J-resistance curve," while section 5.2 of the NUREG stated that the materials data should include "appropriate toughness and tensile data, long-term effects such as thermal aging and other limitations."

Given the above, the staff did not concur with the Westinghouse methodology for evaluating the SS weld materials. Westinghouse's use of a Z-factor modified-limit load approach is consistent with guidance in draft Standard Review Plan, Section 3.6.3 (Reference 2) (published for comment in 1987), on LBB and the technical bases on which some of the flaw evaluation criteria in ASME Code, Section XI, were developed. However, since the mid-to-late 1980s time frame, additional evidence regarding the effects of thermal aging on SMAW SS pipe welds has been collected. When comparing the J-R data cited as the basis for the flaw evaluation criteria of ASME Code, Section XI, and the Z-factor approach (References 3 and 4), it appears that the thermal aging of SS weld materials may not be adequately accounted for. It is the staff's position that an LBB analysis is significantly different from a flaw evaluation and that the thermal aging of SS weld materials must be explicitly addressed. An additional study from Argonne

National Laboratory (Reference 3) was the staff's reference for this information and the staff's characterization of the J-R curve is given in Table 2. The mean minus one standard deviation lower bound J-R curve used by the staff was actually developed by Wilkowski and Ghadiali at Battelle Columbus Laboratory as a fit to unaged SS weld data, but the conclusions of Reference 3 noted that there was little observed change in the fracture toughness behavior with thermal aging for those welds that began with inferior fracture toughness properties. The stress-strain properties of aged SS weld material for this evaluation are also given in Table 2. For the wrought austenitic SS piping, the NRC staff accepted the tensile properties provided by the licensee for use in the NRC staff's analysis.

In addition, the NRC staff did not concur with the original licensee and Westinghouse position in WCAP-15065 to not include torsional moments in the load summations for determining both the critical and leakage flaw sizes. In discussions with the licensee and Westinghouse regarding this matter, the staff noted that the guidance provided in NUREG-1061, Volume 3, and draft Standard Review Plan, Section 3.6.3, were clear on this subject. In an LBB evaluation, torsional loads shall be included in a square-root-sum-of-the-squares (SRSS) summation with the other bending moments. While assessment in this manner may be conservative, excluding torsional moments from the analysis outright would certainly be non-conservative. Hence, unless an alternate methodology were provided to "more accurately" assess the impact of torsional loads (and assess the fracture toughness of the subject materials under combined Mode I and Mode II loadings), the SRSS summation is necessary to ensure all loads are adequately accounted for. A comparison of the load values given in Table 1a and Table 1b demonstrates that for the pressurizer surge line piping, the impact of including torsional loads for some loading conditions is significant.

4.2 General Aspects of the Staff's LBB Analysis

The staff's analysis was performed in accordance with the guidance provided in NUREG-1061, Volume 3. Based on the information submitted by the licensee, the staff determined the critical flaw size at potential bounding locations for each piping system using the codes compiled in the NRC's Pipe Fracture Encyclopedia (Reference 5). For the purposes of the staff's evaluation, the list of potential bounding locations was defined by those locations at which materials with low postulated fracture toughness existed in combination with high ratios of SSE-to-NOP or startup/shutdown-to-NOP stresses. This was because high SSE or startup/shutdown stresses tend to reduce the allowable critical flaw size, while low NOP stresses increase the size of the leakage flaw. When evaluating pipe welds, the staff used the LBB.ENG3 code developed by Battelle (Reference 6) for that express purpose. The LBB.ENG3 methodology is significantly different from the other codes in Reference 5 and from the licensee's analysis in that LBB.ENG3 explicitly incorporates a J-R-based approach and accounts for the differences in the stress-strain properties of the weld and an adjoining base material when determining the effective energy release from the structure with crack extension. Criteria regarding the applied J exceeding the material J_{IC} and the applied dJ/da exceeding the material's d(J-R)/da were used to identify the critical crack size.

The staff then compared the critical flaw at the bounding location to the leakage flaw which provided 10 gpm of leakage under NOP conditions to determine whether the margin of 2 defined in NUREG-1061, Volume 3, was achieved. The leakage flaw size calculation was carried out using the PICEP (Pipe Crack Evaluation Program), Revision 1, analytic code (Reference 7). The 10 gpm value was defined by noting that the compliance of the

Point Beach, Units 1 and 2, containment leakage detection system with the position in Regulatory Guide 1.45 indicates that this system would be able to detect a 1 gpm leak in the course of 1 hour and a factor of 10 is applied to this 1 gpm detection capability to account for thermohydraulic uncertainties in calculating the leakage through small cracks. The stability of the leakage flaw under NOP plus SSE loads was subsequently evaluated to check the final acceptance criteria of NUREG-1061, Volume 3.

4.3 Evaluation of the Point Beach, Units 1 and 2, Pressurizer Surge Line Piping

Based on the loadings supplied by the licensee in their August 16, 2000, supplemental submittal and preliminary scoping calculations, the staff confirmed that the location which would be expected to be limiting for the pressurizer surge line evaluation would be node 1030 for Point Beach, Unit 2. It should be noted that the NRC staff's analysis did not include a consideration of the loads from the event in which an SSE is postulated to occur during startup or shutdown of the unit. For the purpose of the LBB evaluation, the staff has consistently considered this to be a sufficiently low probability event that using this load combination to establish the critical flaw size would be overly conservative given the other margins explicitly included in the analysis. Since the weld at node 1030 existed between two sections of wrought 316 SS piping, the LBB.ENG3 code was used to evaluate the impact of the base material stress-strain properties on each side of the weld.

Using base material properties as submitted by the licensee for appropriate temperature (617 °F when analyzing the NOP plus SSE condition, 245 °F when evaluating the startup/shutdown event), the aged SS weld properties cited in Table 2, the J-R curve based on the information from Wilkowski and Ghaliadi, and the loads from Table 1b, the staff calculated the limiting critical flaw size at Unit 2 to be node 1030. The critical flaw size at node 1030 for the NOP plus SSE condition (including NOP thermal stratification stresses) was determined to be 9.25 inches. In comparison, the critical flaw size at node 1030 for the startup/shutdown condition was determined to be 9.87 inches. This result may, from the loads shown in Table 1b, appear to be contradictory. If the overall stresses from the startup/shutdown condition loads are calculated versus the overall stresses for the NOP plus SSE condition, the startup/shutdown stresses will be shown to be higher. However, the increase in material strength at 245 °F (the temperature at node 1030 when the largest stresses occur in the startup/shutdown transient) increases the pipe's load carrying capacity during this transient relative to the capacity at NOP conditions. This increase in load carrying capacity makes the flaw size that can be withstood without failure longer and is sufficient to mitigate the effects of the increased loads and cause the NOP plus SSE evaluation (when node 1030 is at 617 °F) to be limiting.

The staff then used the PICEP code to evaluate the leakage flaw size for node 1030 under NOP plus thermal stratification conditions. Using the surface roughness value that the staff has used in previous LBB evaluations of $\varepsilon = 0.003$ inch, the staff determined that 10 gpm of leakage would be expected from a 4.89-inch through-wall flaw. Therefore, the factor of safety between the length of critical and leakage size flaws using this approach would be (9.25/4.89) = 1.89. In previous LBB evaluations, the staff has concluded that margins of slightly less than 2 on the critical-to-leakage flaw size are acceptable, provided that a full margin of 10 is maintained on the leakage uncertainty. The NRC staff concluded that for this evaluation, a margin of 1.89 provides adequate assurance that the Point Beach, Units 1 and 2, pressurizer surge line piping will exhibit LBB behavior. Finally, the 4.89-inch leakage flaw was shown to be stable under a

combination of NOP plus SSE loads. Therefore, both LBB criteria were demonstrated for the bounding location.

5.0 CONCLUSION

Based on the information and analysis supplied by the licensee, the staff was able to independently assess the LBB status of the analyzed portions of the Point Beach, Units 1 and 2, pressurizer surge line piping. The staff has concluded that because acceptable margins on leakage and crack size have been demonstrated, these sections of piping will exhibit LBB behavior. Furthermore, the licensee should be permitted to credit this conclusion for eliminating the dynamic effects associated with the postulated rupture of these sections of piping from the Point Beach, Units 1 and 2, facility licensing basis, consistent with the provisions of 10 CFR Part 50, Appendix A, GDC 4.

6.0 REFERENCES

[1] NUREG-1061, Volume 3, “Report of the U.S. Nuclear Regulatory Commission Piping Review Committee, Evaluation of Potential for Pipe Breaks,” November 1984.

[2] Draft Standard Review Plan, Section 3.6.3, “Leak-Before-Break Evaluation Procedures,” Volume 52 of the Federal Register 32626, August 28, 1987.

[3] Gavenda, D.J., et al., “Effects of Thermal Aging on Fracture Toughness and Charpy-Impact Strength of Stainless Steel Pipe Welds,” NUREG/CR-6428, ANL-95/47.

[4] EPRI Report NP-4768, “Toughness of Austenitic Stainless Steel Pipe Welds,” October 1986.

[5] Pipe Fracture Encyclopedia, produced on CD-ROM by Battelle-Columbus Laboratory for the U.S. Nuclear Regulatory Commission, 1997.

[6] Brust, F.W., et al., “Assessment of Short Through-Wall Circumferential Cracks in Pipes,” NUREG/CR-6235, BMI-2179.

[7] ERPI Report NP-3596-SR, Revision 1, “PICEP: Pipe Crack Evaluation Program (Revision 1),” December 1987.

Attachments: 1. Tables 1a, 1b, and 2
2. Figures 1 through 2

Principal Contributor: M. Mitchell

Date: December 15, 2000

TABLE 1a:
Point Beach Units 1 and 2 Pressurizer Surge Line Loads Used in the Licensee's Analysis (Not Including Torsional Loads)

Unit	Node	Loading Condition	Loads	
			Axial Force (lb)	Moment (in-lb)
2	1030	NOP (Deadweight + Thermal Expansion + Pressure)	143318	211420
2	1030	NOP + Thermal Stratification	143167	378750
2	1030	NOP + SSE	144496	416090
2	1030	NOP + Thermal Stratification + SSE	144345	596150
2	1030	Startup/Shutdown	28765	1272830
2	1030	Startup/Shutdown + SSE	29943	1404250

TABLE 1b:
Point Beach Units 1 and 2 Pressurizer Surge Line Loads Used in the NRC staff's Analysis (Including Torsional Loads)

Unit	Node	Loading Condition	Loads	
			Axial Force (lb)	Moment (in-lb)
2	1030	NOP (Deadweight + Thermal Expansion + Pressure)	143318	651350
2	1030	NOP + Thermal Stratification	143167	709490
2	1030	NOP + SSE	144496	778290
2	1030	NOP + Thermal Stratification + SSE	144345	875800
2	1030	Startup/Shutdown	28765	1325560
2	1030	Startup/Shutdown + SSE	29943	1462660

TABLE 2:
Parameters Used in Staff Evaluation of Point Beach Units 1 And 2 Aged Ss Pipe Welds

Parameter	Value
Young's Modulus (245 °F/617 °F)	27300 ksi / 25200 ksi
Yield Strength (245 °F/617 °F)	58 ksi / 47 ksi
Ultimate Tensile Strength (245 °F/617 °F)	75 ksi / 60 ksi
Sigma-zero (245 °F/617 °F)	58 ksi / 47 ksi
Epsilon-zero (245 °F/617 °F)	0.00212 / 0.00187
Ramberg-Osgood Alpha	9.0
Ramberg-Osgood n	9.8
J_{IC}	73.4 KJ / m^2
C	83.5 KJ / m^2 mm
n	0.643

Note: $J = J_{IC} + C(\Delta a)^n$ and a point-by-point representation was converted to English System units after the calculation was completed in metric units.

PIPE 10" Schedule 140
Minimum wall thickness = 0.696"

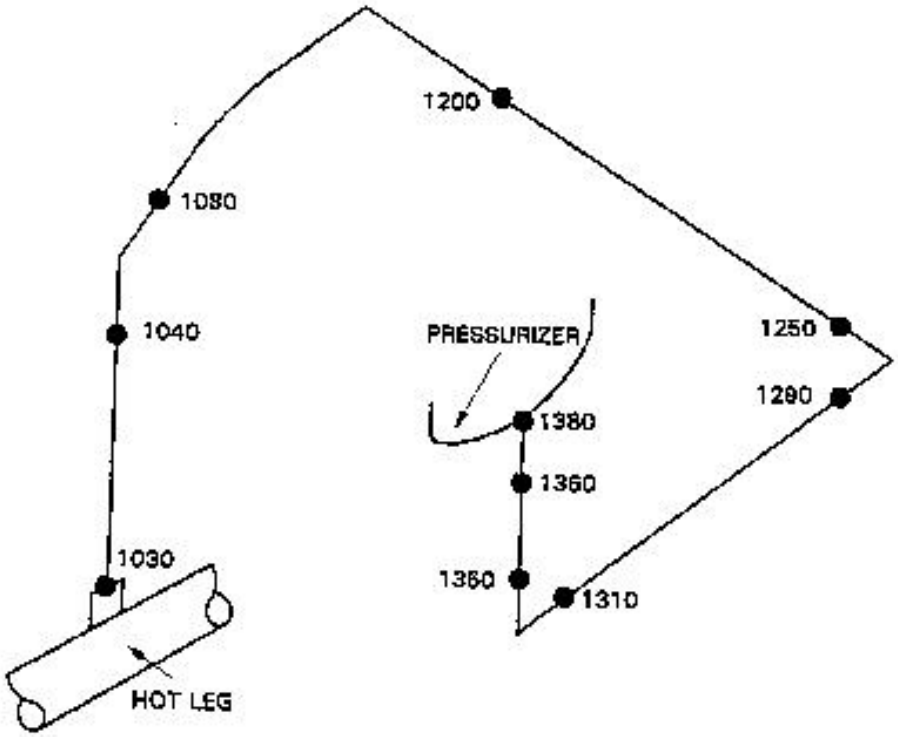

Figure 1 Point Beach Unit 1 Surge Line Layout

ATTACHMENT 2

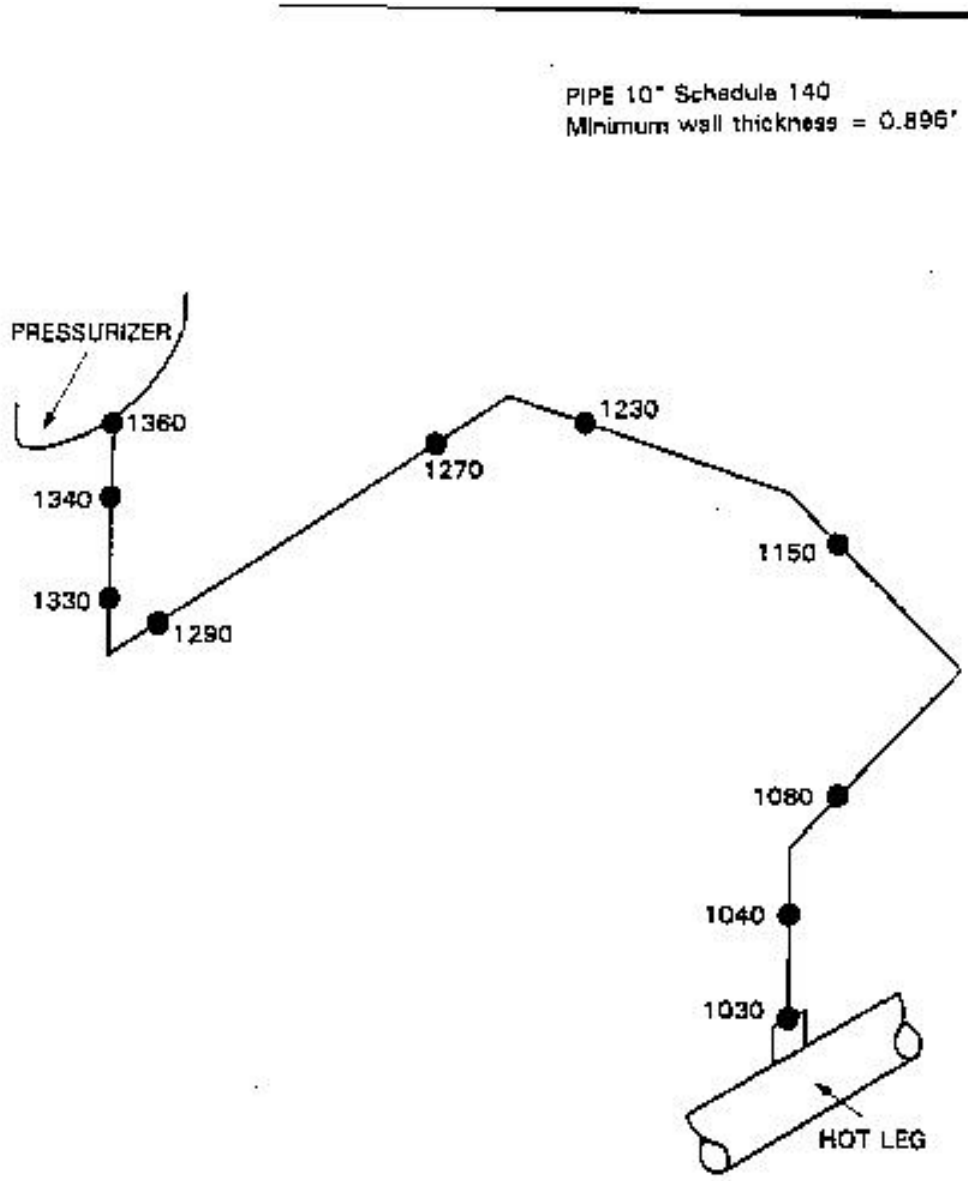

Figure 2 Point Beach Unit 2 Surge Line Layout