November 7, 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 ACCUMULATOR LINE PIPING AS PROVIDED BY 10 CFR PART 50, APPENDIX A, GDC 4 (TAC NOS. MA7834 AND MA7835)

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, accumulator 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 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 analyzed portions of the accumulator line piping. Therefore, the staff finds that you may remove consideration of the dynamic effects associated with the postulated rupture of the analyzed portions of the accumulator 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 analyzed portions of the accumulator line piping. Therefore, the staff finds that you may remove consideration of the dynamic effects associated with the postulated rupture of the analyzed portions of the accumulator 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.

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

STATUS TO THE ACCUMULATOR LINE PIPING AT

POINT BEACH NUCLEAR 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 accumulator 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:

> However, 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 accumulator 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, "Structures, 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.

ENCLOSURE

The philosophy of LBB behavior for high energy piping systems was developed by the NRC 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-15107, "Technical Justification for Eliminating Accumulator Lines Rupture as the Structural Design Basis for Point Beach Units 1 and 2 Nuclear Plants") for the licensee. 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 high energy piping for LBB behavior verification. The licensee addressed the accumulator lines for each unit from their connections to the cold leg of the main coolant loop and the accumulator to the point of containment penetration. Figures 1 through 4 show the layout for the piping attached to each of the four accumulator tanks at the two units. The piping shown in these figures is 10-inch nominal diameter piping ranging from Schedule 40 (0.340-inch wall thickness) to Schedule 140 (0.896-inch wall thickness).

The accumulator line piping was manufactured from several materials. The piping and fittings of the Point Beach Units 1 and 2 accumulator lines were manufactured from wrought ASME specification SA-376 Type 316 and wrought ASME specification SA-312 Type 304 stainless steel (SS). The welds in this system were fabricated from SS using gas tungsten arc and shielded metal arc welding (SMAW) processes.

For the material properties used in the accumulator 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., 105 °F, 547 °F) were calculated using the ratio of the American Society for Mechanical Engineers (ASME) Code, Section III, properties at room temperature to the Code properties at the temperature of interest to scale 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. Additional fracture toughness properties were reported and used to demonstrate flaw stability at the limiting location identified by the licensee.

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) 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 Accumulator Line Piping

The analysis of the accumulator 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-15107. 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. The licensee's submittal concluded that pressurized-water reactor accumulator 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, 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. 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-third of the thickness of the pipe wall, little flaw 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 very low and below levels at which it would pose a concern.

Next, the Westinghouse analysis evaluated the accumulator line piping by developing the applied stresses under NOP and NOP plus SSE loading and determining the leakage and critical through-wall flaw size for various locations along the piping. In the determination of the applied stresses, the analysis included the tensile and bending stresses resulting from the internal pressure, deadweight, and thermal expansion, with SSE loads included when determining the loads associated with the critical flaw size evaluation. It should, however, be noted that in the original submittal, load combinations in WCAP-15107 did not account for torsional loads on the accumulator line piping for either NOP or NOP plus SSE loading conditions. 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, pressure, and SSE stresses were summed absolutely for the critical flaw size determination. The deadweight, thermal expansion, and pressure stresses were summed algebraically for the leakage flaw size determination. Table 1a summarizes the significant load combination results provided by the licensee and Westinghouse in the December 2, 1999, submittal. Table 1b shows the load combinations submitted by the licensee in its 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 NOP plus SSE stresses. 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 accumulator 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. An additional J-R-based analysis was performed for the location identified as limiting by the licensee and Westinghouse to ensure that flaw stability concerns were addressed.

The leakage flaw size for an LBB analysis is defined as the flaw size which, 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 5.3.3 of WCAP-15107, 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.

Table 2 summarizes the limit-load analysis results submitted by the licensee for the locations that were identified to be limiting for the purposes of the accumulator line LBB analyses. For all nodes (except node 165) on the Point Beach, Unit 1, Tank A accumulator line, the margin of 2 on length between the leakage and critical flaws sizes recommended by NUREG-1061, Volume 3, was achieved. The margin reported by the licensee for Point Beach, Unit 1, Tank A, node 165, was 1.87. The more detailed, J-R-based stability analysis performed by Westinghouse demonstrated that a 20.40-inch long flaw at node 165 would be stable under

NOP plus SSE loading conditions and therefore, a margin of 2 also existed for that location. Finally, since all critical flaw analyses used the absolute summation on NOP plus SSE loads, stability analysis of the leakage size flaw under 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, accumulator line piping and the loads under NOP and NOP plus SSE 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 accumulator 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 3. 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 3. 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-15107 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 3.6.3 was 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 accumulator piping, the overall impact of including torsional loads in the analysis is small.

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 stresses. This was because high SSE 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, Residual Heat Removal System Piping

Based on the loadings supplied by the licensee in their August 16, 2000, RAI response and preliminary scoping calculations, the staff concluded that the locations which would be expected to be limiting for the accumulator line piping evaluation would be node 165 in the Unit 1 accumulator Tank 1A line. Since the weld at node 165 existed between two sections of wrought 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 105 °F, the aged SS weld properties cited in Table 3, and the J-R curve based on the information from Wilkowski and Ghaliadi, the staff calculated that the critical flaw size at Point Beach, Unit 1, Tank A, node 165, would be 18.30 inches under NOP plus SSE loading conditions.

The staff then used the PICEP code to evaluate the leakage flaw size for node 165. 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 10.4-inch through-wall flaw. Therefore, the factor of safety between the length of critical and leakage size flaws using this approach would be (18.3/10.4) = 1.76. 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 1.76 provides adequate assurance that the Point Beach, Units 1 and 2, accumulator line piping will exhibit LBB behavior. Finally, the 10.4-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, accumulator 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 is 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, 2, and 3
2. Figures 1 through 4

Principal Contributor: M. Mitchell

Date: November 7, 2000

TABLE 1a:
Point Beach Unit 1 and 2 Accumulator Line Loads for
Licensee-Identified Critical Locations (Not Including Torsional Loads)

Unit / Tank	Node	Pipe Schedule	Normal Operation (NOP) Loads: Deadweight + Thermal + Pressure		NOP + Safe Shutdown Earthquake Loads	
			Axial (lbs)	Moment (in-lbs)	Axial (lbs)	Moment (in-lbs)
Unit 1 Tank A	165	140	47377	22401	49187	204867
Unit 1 Tank A	225	80S	57063	11269	58447	134206
Unit 1 Tank B	5	40	38126	139233	38916	290456
Unit 1 Tank B	310	140	90929	486598	134417	554062
Unit 1 Tank B	340	140	89113	555885	132777	630280
Unit 1 Tank B	380	140	104875	663421	153189	735195

TABLE 1b:
NRC Staff-Selected Point Beach Units 1 and 2 Accumulator Line
Piping Loads (Including Torsional Loads)

Unit / Tank	Node	Pipe Schedule	Normal Operation (NOP) Loads: Deadweight + Thermal + Pressure		NOP + Safe Shutdown Earthquake Loads	
			Axial (lbs)	Moment (in-lbs)	Axial (lbs)	Moment (in-lbs)
Unit 1 Tank A	165	140	47377	23166	49187	217415
Unit 1 Tank A	225	80S	57069	23112	58418	137426
Unit 1 Tank B	340	140	89113	564670	132777	640210
Unit 1 Tank B	380	140	104875	678603	153189	763369

TABLE 2:
Licensee's Results Regarding the Comparison of the Leakage and Critical Flaw Sizes (by Limit Load Analysis) for Limiting Nodes in the Analyzed Portion of the Point Beach Units 1 and 2 Accumulator Lines

Unit / Tank	Node	Critical Flaw Size Based on NOP + SSE Loads	Leakage Flaw Size based on NOP Loads	Margin
Unit 1 Tank A	165	19.05 inches*	10.20 inches	1.87
Unit 1 Tank A	225	17.50 inches	7.40 inches	2.36
Unit 1 Tank B	5	15.12 inches	5.60 inches	2.70
Unit 1 Tank B	310	14.23 inches	4.50 inches	3.16
Unit 1 Tank B	340	12.92 inches	4.35 inches	2.97
Unit 1 Tank B	380	11.94 inches	3.80 inches	3.14

* For node 165, the licensee performed a more detailed, J-R analysis and demonstrated that a flaw of length 20.40 inches would be stable under NOP plus SSE conditions, hence demonstrating a margin of 2 for this node as well.

TABLE 3:
Parameters used in Staff Evaluation of Accumulator Line Node 165, Point Beach Unit 1, Tank A

Parameter	Value
Young's Modulus	28265 ksi
Yield Strength	64.0 ksi
Ultimate Tensile Strength	87.0 ksi
Sigma-zero	64.0 ksi
Epsilon-zero	0.00226
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.