NUCLEAR POWER BUSINESS UNIT
CALCULATION REVIEW AND APPROVAL

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|---|---|
| Calculation # 96-0182 | |
| Number of Pages 11 | |

Title of Calculation: Determination of PBNP LTOP Setpoint Through an Inside Surface Fluence of 2.05x10^19 n/cm^2 (appx. Jan 2001)

☐ Original Calculation    ☒ QA-Scope

☒ Revised Calculation. Revision # 1

☐ Superseding Calculation. Supersedes Calculation # ________

| Modification # | Description: |
|---|---|
| n/a | n/a |

Other References:
Technical Specifications 15.3.15
Additional References listed on Page 1 of calculation.

| Prepared By: | Date: |
|---|---|
| [signature] | 9/16/96 |

This Calculation has been reviewed in accordance with NP 7.2.4. The review was accomplished by one or a combination of the following (as checked):

____ A review of a representative sample of repetitive calculations.

____ A detailed review of the original calculation.

✓ A review of the calculation against a similar calculation previously performed.

____ A review by an alternate, simplified, or approximate method of calculation.

Comments: Reviewed against Calculation 96-0182 Rev. 0. Noted changes were checked for Validity & Accuracy. Methodology used for this calculation is same as used for Rev. 0. Changes were only editorial in nature for Rev. 1.

| Reviewed By: | Date: | Approved By: | Date: |
|---|---|---|---|
| G. P. Barta | 9/19/96 | [signature] Walther | 9/19/96 |

CALCULATION SHEET

CALC. NO. 96-0182, Rev. 1

SUBJECT Determination of PBNP LTOP Setpoint Through an Inside Surface Fluence of $2.05 \times 10^{19}$ n/cm$^2$ (appx. Jan. 2001)

MADE BY J. R. Pfefferle DATE 9/16/96
REV'D. BY G. P. Bareta DATE 9/19/96

Purpose:

This calculation will formally assess the acceptability of the present Low Temperature Overpressure Protection System setpoint and determine whether the present restrictions on reactor coolant pump operation at low temperatures may be relaxed. The period through the expiration of the current Technical Specification pressure-temperature limit curves is evaluated in this calculation. Revision 1 is being issued to correct a minor typographical error that was present throughout Revision 0.

References:

1. BAW-2166, "B&W Owners Group Response to Generic Letter 92-01," June 1992.
2. ASME Boiler and Pressure Vessel Code, Sections III & XI.
3. NPM 93-0193, "Low Temperature Overpressure Protection (LTOP)," March 24, 1993.
4. Instruction Manual 132-Inch I.D. Reactor Pressure Vessel, Babcock & Wilcox, September 1969.
5. Calculation N-94-05, Rev. 2, "Reactor Coolant System Heatup and Cooldown Curve Calculations - Effective Through January 2001," January 23, 1996.
6. WCAP-12794, Rev. 3, "Reactor Cavity Neutron Measurement Program for Wisconsin Electric Power Company Point Beach Unit 1," December 1995.
7. NRC Regulatory Guide 1.99, Revision 2, "Radiation Embrittlement of Reactor Vessel Materials," May 1988.
8. NRC Branch Technical Position - MTEB 5-2, Rev. 1, "Fracture Toughness Requirements," July 1981.
9. Westinghouse Report, "Pressure Mitigating Systems Transient Analysis Results," July 1977.
10. Westinghouse Report, "Supplement to the July 1977 Report, Pressure Mitigating Systems Transient Analysis Results," September, 1977.
11. ASME Code Case N-514, "Low Temperature Overpressure Protection," 1993.
12. Vectra letter to Wisconsin Electric, "Low Temperature Overpressure Protection (LTOP) Preliminary Instrument Loop Uncertainty," March 5, 1996.
13. ISI 94-40, "Proposed Revision to Appendix G Stress Intensity Factors," April 30, 1996.
14. DBD-09, Rev. 0, "Reactor Coolant System," December 12, 1995.
15. NRC Branch Technical Position - RSB 5-2, draft Rev. 3, "Overpressurization Protection of Pressurized Water Reactors While Operating at Low Temperatures," April 1996.

Methods and Assumptions:

The methodology of this calculation follows the steps listed below:

I. Determine the projected fluence at the limiting material at the reactor vessel inner radius on January 1, 2001.

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CALC. NO. 96-0182, Rev. 1

SUBJECT Determination of PBNP LTOP Setpoint Through an Inside Surface Fluence of $2.05 \times 10^{19}$ n/cm$^2$ (appx. Jan. 2001)

MADE BY J. R. Pfefferle DATE 9/16/96
REV'D. BY G. P. Baretta DATE 9/19/96

II. Determine the corresponding fluence at the 1/4T reactor vessel location.
III. Determine the chemistry factor, initial properties, and margin term for the limiting PBNP reactor vessel material.
IV. Determine the projected adjusted reference temperature at the 1/4T location for the limiting reactor vessel material on January 1, 2001.
V. Determine the reference stress intensity factor corresponding to the metal temperature of interest and adjusted reference temperature of the limiting material.
VI. Determine the permissible stress intensity caused by membrane stress for an isothermal event at the temperature of interest.
VII. Determine the allowable pressure corresponding to the permissible membrane tension.
VIII. Correct for pressure instrument location bias in relation to the reactor vessel beltline.
IX. Correct for pressure overshoot due to PORV accumulation during the design basis mass input or heat input LTOP transient for the conditions of interest to determine the acceptable LTOP pressure setpoint.
X. Determine LTOP enable temperature per NRC Branch Technical Position RSB 5-2.

Other methods and assumptions are listed below:

1. One setpoint applicable to Point Beach Units 1 and 2 will be determined based on the most limiting material fracture toughness. The limiting material is the intermediate-to-lower shell circumferential weld for Unit 1, SA-1101 (Ref. 1).
2. The reactor vessel is assumed to be in an isothermal condition for evaluation of LTOP setpoints.
3. Instrument errors will not be applied in the calculation of the LTOP setpoint. This is consistent with the PBNP pressure-temperature curve methodology (Ref. 5). It will be demonstrated that the instrument errors for Point Beach are less than the additional margin that can be gained through application of ASME Section XI Code Case N-514.

**Inputs:**

Pressure Instrument Location Bias: - 25 psig w/one RCP in operation (Ref. 3)
- 63 psig w/two RCPs in operation

These instrument location bias values associated with the elevation difference of the wide range pressure transmitter and the mid-plane of the reactor vessel were provided by Westinghouse and represent bounding values for Westinghouse 2-loop plants.

Min. Yield Strength of SA302, Grade B Steel: 50 ksi @ 100°F (Ref. 2, Table I-2.1)
47.5 ksi @ 200°F

Reactor Vessel Thickness: 6.5 inches (Ref. 4)
One-Quarter Thickness: 1.625 inches
Reactor Vessel I.D.: 132.312 inches

Accumulated Reactor Vessel Fluence:

IS = $2.05 \times 10^{19}$ n/cm$^2$ through January 2001 (Ref. 5)
T/4 = $0.647 * 2.05 = 1.33 \times 10^{19}$ n/cm$^2$ (Ref. 6, Table 4.1-7)

Plant specific fluence attenuation is used in lieu of Reg. Guide 1.99, Rev. 2, because a more accurate estimate is obtained from the PBNP plant specific program which uses both in-vessel and ex-vessel measurement data (see Draft Regulatory Guide DG-1053).

Limiting Material Properties:

Pertinent material properties for SA-1101 weld material are (Ref. 1):

Cu = .26 wt. %
Ni = .60 wt. %
CF = 180°F

Ir tial $RT_{NDT}$ = 10°F (measured)
Margin $= 2(\sigma_I^2 + \sigma_\Delta^2)^{1/2} = 2(0^2 + 28^2) = 56°F$

**Calculations:**

**I. Calculation of Adjusted Reference Temperature:**

$ART = \text{Initial } RT_{NDT} + \Delta RT_{NDT} + \text{Margin}$ (Ref. 7, Section C.1.1):

$\Delta RT_{NDT} = (CF)(\text{Fluence Factor})$

Fluence Factor $= f^{(0.28 - .10 \log f)}$
Where f = fluence at one-quarter thickness ($10^{19}$ n/cm$^2$)

$ART = 10°F + (180 * (1.33^{(0.28 - .10\log(1.33))})) + 56°F$
$= 260.1°F$

**II. Determination of Allowable Pressure for One Reactor Coolant Pump Operation**

**A. Calculation of Reference Critical Stress Intensity Factor ($K_{IR}$):**

$K_{IR} = 26.78 + 1.223\exp[0.0145(T_{min} - ART_{NDT} + 160)]$ (Ref. 2, Art. G-2110)

For minimum RCS bolt-up temperature of 70°F. Substituting:

Minimum temperature ($T_{min}$) = 70°F

$K_{IR} = 27.57$ ksi-in$^{1/2}$

**B. Calculation of Maximum Allowable Pressure (Ref. 2, G-2215):**

Maximum Allowable Membrane Tension ($K_{Im}$):

$2K_{Im} < K_{IR}$

$K_{Im} = K_{IR}/2 = 27.57/2 = 13.79$ ksi-in$^{1/2}$

Maximum Allowable Pressure:

$K_{Im} = M_m$ * membrane stress (Ref. 2, Article G-2214.1)

membrane stress = P*R/t = P*D/(2*t) (Ref. 8, Section 2.2.2)

where: P = maximum pressure, psig
D = inside diameter, inch
t = vessel thickness, inch

D = 132.312 inch, t = 6.5 inch (Ref. 4, Section 1.1.3)

Initially assume:

$M_m = 2.4$ (Ref. 2, Fig. G-2214-1, assuming $\sigma/\sigma_y = .1$)

$$P_{max} = \frac{K_{Im} * (2*t)}{M_m * D} = \frac{13.79 \text{ ksi-in}^{1/2} * 2 * 6.5 \text{ inch}}{2.4 * 132.312 \text{ inch}}$$

= 564.3 psig

Verifying selection of $M_m = 2.4$:

Membrane stress = (P*D) / (2*t) = (.564 ksi * 132 inch) / 2 * 6.5 inch
= 5.73 ksi

$\sigma/\sigma_y$ = 5.73/50 = 0.11

From Fig. G-2214-1: $M_m = 2.4$ verifies assumption.

Maximum Allowable Indicated Pressure:

$P_{max\text{-}ind} = P_{max}$ - Location Bias

= 564.3 psig - 25 psig = 539.3 psig

**III. Determination of Allowable Pressure for Two Reactor Coolant Pump Operation**

**A. Calculation of Reference Critical Stress Intensity Factor ($K_{IR}$):**

By trial and error, 120°F was determined to be the minimum acceptable temperature for a setpoint of 425 psig. Minimum temperature ($T_{min}$) = 120°F ✓

$$K_{IR} = 26.78 + 1.223\exp[0.0145(T_{min} - ART_{NDT} + 160)] = 28.41 \text{ ksi-in}^{1/2}$$

**B. Calculation of Maximum Allowable Pressure:**

Maximum Allowable Membrane Tension ($K_{Im}$):

$2K_{Im} < K_{IR}$

$K_{Im} = K_{IR}/2 = 28.41/2 = 14.21$ ksi-in$^{1/2}$

Maximum Allowable Pressure:

$K_{Im} = M_m$ * membrane stress (Ref. 2, Article G-2214.1)

membrane stress = [P*D/(2*t)] (Ref. 8, Section 2.2.2)

Initially assume:

$M_m = 2.4$ (Ref. 2, Fig. G-2214-1, assuming $\sigma/\sigma_y = .1$)

$$P_{max} = \frac{K_{Im} * (2*t)}{M_m * D} = \frac{14.21 \text{ ksi-in}^{1/2} * 2 * 6.5 \text{ inch}}{2.4 * 132.312 \text{ inch}}$$

= 581.6 psig

Verifying selection of $M_m = 2.4$:

Membrane stress = (P*D) / (2*t) = (.581 ksi * 132 inch) / 2 * 6.5 inch
= 5.90 ksi

$\sigma/\sigma_y = 5.90/50 = 0.12$

From Fig. G-2214-1: $M_m = 2.4$ verifies assumption.

Maximum Allowable Indicated Pressure:

$P_{max\text{-}ind} = P_{max}$ - Location Bias

= 581.6 psig - 63 psig = 518.6 psig

**IV. Determine Acceptable LTOP Setpoint for Mass Input Transient**

By trial and error, an LTOP setpoint of 425 psig was determined to be the maximum acceptable setpoint for two reactor coolant pump operation with a minimum RCS temperature of 120°F. This setpoint was also determined to be conservative with respect to single reactor coolant pump operation at 70°F. Details of the determination of the acceptability of this setpoint are provided below for the mass input transient.

The mass input transient setpoint determination follows the methods described in Section 4 of Reference 9. The criteria for demonstrating that the 425 psig setpoint is acceptable is to determine the setpoint overshoot (ΔP) and add it to the setpoint. If this sum is less than

the maximum allowable indicated pressure for two RCPs of 518.6 psig (539.3 psig for one RCP), the setpoint is considered to be acceptable.

The equation to use in the determination of setpoint overshoot for the mass input transient is as follows:

$$\Delta P\ (V, S, Z, X) = \Delta P_{REF}\ (X) * F_Y * F_S * F_Z * \text{Exp. Ratio}$$

where: $\Delta P\ (V, S, Z, X)$ = setpoint overshoot, psig
- V = total RCS & RHR volume, ft$^3$
- S = relief valve setpoint, psig
- Z = relief valve opening time, sec.
- X = mass input rate, lb/sec
- $\Delta P_{REF}(x)$ = reference overshoot at mass input rate X, psi
- $F_Y$ = RCS volume factor
- $F_S$ = relief valve setpoint factor
- $F_Z$ = relief valve opening time factor
- Exp. Ratio = ratio of maximum overshoot with metal expansion considered versus without its consideration

The method described in Reference 9 was developed from a reference set of parameters which are as follows:

X = mass input rate from the reference safety injection pump
V = 6000 cubic foot primary system volume
S = relief valve setpoint at 600 psig
Z = reference 3 second opening valve

From the reference parameters and results of the various transient analyses, the factors $F_Y$, $F_S$, and $F_Z$ were developed as described in Section 4.3 of Reference 9. The report states that the development of these factors is conservative and plant specific analyses would result in peak values less than the peak values calculated using the algorithm outlined in the report. The Point Beach plant specific parameters are the same for both units and have the following values:

X = mass input rate for Point Beach is identical to the reference SI pump used in the analyses (curve C of Figure 2.3.2). Therefore, the results of the analyses can be used directly for the Point Beach SI pump characteristic.
V = 7200 cubic feet for total RCS and RHR volume (per PBNP FSAR) ✓
S = 425 psig, relief valve setpoint
Z = 2 seconds for relief valve open time (Ref. 14) ✓

The factors $\Delta P_{REF}(x)$ and $F_S$ can be considered to determine the overshoot at a specific setpoint for the characteristics of a given mass input transient. Because the Point Beach pump characteristic was the one used in the analyses, the results of the analyses can be used directly.

Therefore, the appropriate values for setpoint overshoot are:

| Setpoint (psig) | Overshoot (psi) | Reference |
|---|---|---|
| 600 | 155 | Line 1, page A-2 of Ref. 9 |
| 400 | 192 | Line 1, page A-3 of Ref. 9 |

Linear interpolation for a 425 psig setpoint results in:

$$\text{Overshoot} = \Delta P_{REF}(x) * F_S = 187 \text{ psig.}$$

From Figure 4.2.3 the $F_Z$ for a 2 second valve is:

$$F_Z = 0.733 \text{ at 2 seconds.}$$

From Figure 4.2.2 the $F_V$ for a 7200 cubic foot volume is:

$$F_V = 0.92 \text{ at } 7200 \text{ ft}^3$$

The effect of metal expansion is evaluated using the method of Section 5.2 of Ref. 9. The effect on overshoot is related to the ratio of the value in peak pressure when metal expansion is assumed in the analysis to the value without metal expansion. Using the maximum values from Figure 5.2, the ratio is:

$$\text{Exp. Ratio} = \frac{\text{Maximum overshoot with metal expansion}}{\text{Maximum overshoot without metal expansion}} = \frac{115}{155} = 0.74$$

The resulting overshoot is:

$$\Delta P = 187 * 0.733 * 0.92 * 0.74 = 93.5 \text{ psi}$$

Adding this to the setpoint results in:

$$P_{MAX} = 425 + 93.5 = 518.5 \text{ psig}$$

This value is less than the maximum indicated allowable pressure for two RCPs at 120°F of 518.6 psig (and for one RCP at 70°F of 539.3 psig) for the mass input transient. Therefore, the proposed setpoint of 425 psig is acceptable.

## V. Determination of Overshoot for Heat Input Transient

The design basis heat input transient assumes the starting of a reactor coolant pump during water solid conditions with a temperature difference between the reactor coolant system and the steam generator of 50°F. Pressure is relieved by a single power operated relief valve.

The information provided in the Supplement to the July 1977 Report (Ref. 10, "the supplement") is used to determine the setpoint overshoot for the heat input transient.

The following parameters are applicable to Point Beach:

| | | |
|---|---|---|
| Steam generator heat transfer area | = | 44,000 ft$^2$ (Ref. 14) |
| RCS volume | = | 6,259 ft$^3$ (per PBNP FSAR) |
| RCS/SG $\Delta T$ | = | 50 °F |
| Initial RCS pressure | = | 300 psig |
| Relief valve setpoint | = | 425 psig |
| Relief valve opening time | = | 2 seconds (Ref. 14) |

However, after making a correction for steam generator heat transfer area, a bounding assessment based on the overshoot with a 6000 ft$^3$ RCS, 500 psig setpoint, and 3 second relief valve opening time for the Point Beach LTOP setpoint will be made. This assessment is bounding because:

1. A smaller system volume results in a larger overshoot pressure;
2. A higher relief valve setting results in a larger overshoot pressure; and
3. A longer relief valve opening time results in a larger pressure accumulation.

Therefore, the actual pressure overshoot will be smaller than that estimated in this bounding assessment.

Calculations of the bounding cases of pressure overshoot for initial RCS temperatures of 100°F and 250°F with two reactor coolant pumps operating are provided below. These are the minimum and maximum temperatures evaluated in Ref. 10. ✓

**A. Pressure Overshoot for Heat Input Transient at 100°F**

**1. Calculation of Reference Critical Stress Intensity Factor ($K_{IR}$):**

Minimum temperature ($T_{min}$) = 100°F

$K_{IR} = 26.78 + 1.223\exp[0.0145(T_{min} - ART_{NDT} + 160)] = 28.00$ ksi-in$^{1/2}$

**2. Calculation of Maximum Allowable Pressure (Ref. 2, G-2215):**

Maximum Allowable Membrane Tension ($K_{Im}$):

$2K_{Im} < K_{IR}$
$K_{Im} = K_{IR}/2 = 28.00/2 = 14.00$ ksi-in$^{1/2}$

Maximum Allowable Pressure:

$K_{Im} = M_m$ * membrane stress (Ref. 2, Article G-2214.1)

membrane stress = $[P*D/(2*t)]$ (Ref. 8, Section 2.2.2)

Initially assume:

$M_m = 2.4$ (Ref. 2, Fig. G-2214-1, assuming $\sigma/\sigma_y = .1$)

$$P_{max} = \frac{K_{Im} * (2*t)}{M_m * D} = \frac{14.00 \text{ ksi-in}^{1/2} * 2 * 6.5 \text{ inch}}{2.4 * 132.312 \text{ inch}}$$

$$= 573.1 \text{ psig}$$

Verifying selection of $M_m = 2.4$:

Membrane stress = $(P*D) / (2*t) = (.5734 \text{ ksi} * 132 \text{ inch}) / 2 * 6.5 \text{ inch}$
$= 5.82$ ksi

$\sigma/\sigma_y = 5.82/50 = 0.12$

From Fig. G-2214-1: $M_m = 2.4$ verifies assumption.

Maximum Allowable Indicated Pressure:

$P_{max\text{-}ind} = P_{max}$ - Location Bias

$= 573.1$ psig - 63 psig = 510.1 psig

**3. Calculation of Overshoot Pressure**

From Figure 16 of the supplement, the Reference UA for an RCS volume of 6000 at 100°F is read as 0.083. This reference value is normalized to Point Beach by applying the ratio of steam generator heat transfer areas:

Normalized UA @ 6000 ft$^3$ = 0.083 * 44,000/58,000 = 0.063

Entering Figure 16 with UA = 0.063 we find:

$P_{MAX} - P_{SETPOINT} = \Delta P_{6K} = 23$ psi.

The maximum pressure that can be reached with this bounding overshoot value is:

$P_{MAX} = P_{SETPOINT} + \Delta P_{6K} = 425 \text{ psig} + 23 \text{ psi} = 448$ psig.

This value is less than the maximum indicated allowable pressure of 510.1 psig at a RCS cold leg temperature of 100°F. Therefore, a setpoint of 425 psig is acceptable for the heat input transient at 100°F.

**B. Pressure Overshoot for Heat Input Transient at 250°F**

**1. Calculation of Reference Critical Stress Intensity Factor ($K_{IR}$):**

Minimum temperature ($T_{min}$) = 250°F

$K_{IR} = 26.78 + 1.223\exp[0.0145 (T_{min} - ART_{NDT} + 160)] = 37.52 \text{ ksi-in}^{1/2}$

**2. Calculation of Maximum Allowable Pressure (Ref. 2, G-2215):**

Maximum Allowable Membrane Tension ($K_{i,n}$):

$2K_{Im} < K_{IR}$

$K_{Im} = K_{IR}/2 = 37.52/2 = 18.76$ ksi-in$^{1/2}$

Maximum Allowable Pressure:

$K_{Im} = M_m$ * membrane stress (Ref. 2, Article G-2214.1)

membrane stress = [P*D/(2*t)] (Ref. 8, Section 2.2.2)

Initially assume:

$M_m = 2.4$ (Ref. 2, Fig. G-2214-1, assuming $\sigma/\sigma_y = .1$)

$$P_{max} = \frac{K_{Im} * (2*t)}{M_m * D} = \frac{18.76 \text{ ksi-in}^{1/2} * 2 * 6.5 \text{ inch}}{2.4 * 132.312 \text{ inch}}$$

= 768.1 psig

Verifying selection of $M_m = 2.4$:

Membrane stress = (P*D) / (2*t) = (.7681 ksi * 132 inch) / 2 * 6.5 inch
= 7.82 ksi

$\sigma/\sigma_y = 5.82/47.5 = 0.16$

From Fig. G-2214-1: $M_m = 2.4$ verifies assumption.

Maximum Allowable Indicated Pressure:

$P_{max\text{-}ind} = P_{max}$ - Location Bias

= 768.1 psig - 63 psig = 705.1 psig

**3. Calculation of Overshoot Pressure**

From Figure 16 of the supplement, the Reference UA for an RCS volume of 6000 at 250°F is read as 0.138. This reference value is normalized to Point Beach by applying the ratio of steam generator heat transfer areas:

Normalized UA @ 6000 ft$^3$ = 0.138 * 44,000/58,000 = 0.105

Entering Figure 16 with UA = 0.105 we find:

$P_{MAX} - P_{SETPOINT} = \Delta P_{6K} = 118$ psi.

The maximum pressure that can be reached with this bounding overshoot value is:

$$P_{MAX} = P_{SETPOINT} + \Delta P_{6K} = 425 \text{ psig} + 118 \text{ psi} = 543 \text{ psig.}$$

This value is less than the maximum indicated allowable pressure of 705.1 psig at a RCS cold leg temperature of 250°F. Therefore, a setpoint of 425 psig is acceptable for the heat input transient at 250°F.

## VI. Determination of LTOP Enable Temperature

In accordance with the guidance of NRC Branch Technical Position RSB 5-2 (Ref. 15), the LTOP enable temperature may be determined as $RT_{NDT}$ + 90°F.

Hence: $T_{enable}$ = 260.1°F + 90°F

= 350.1°F

## Conclusions:

This calculation demonstrates that the present LTOP setpoint of 425 psig provides acceptable protection of the reactor vessel from overpressure events at low temperatures through the expiration of the Technical Specification pressure-temperature limit curves in January 2001. The calculation further demonstrates that the previous assessment of LTOP performed in 1977 was overly conservative in the calculation of the stress intensity factor at the postulated flaw in the reactor vessel. Using the relationship allowed by NRC Branch Technical Position 5.3.2 to determine the stress intensity factor, it was determined that the current administrative restriction (T ≥ 160°F) can be changed to allow operation of two reactor coolant pumps at temperatures greater than 120°F.

ASME Code Case N-514 (Ref. 11) requires LTOP to limit the maximum pressure in the vessel to 110% of the Appendix G limit. At 70°F, the Appendix G maximum allowable pressure is 564.5 psig. Therefore, if N-514 is implemented, an additional 56.5 psig margin is available. The total instrument error for the pressure transmitters is 12 psi (Ref. 12) and is within the additional acceptable margin allowed by the ASME Code.

Calculation of $M_m$ using the revised Appendix G stress intensity factor of ISI 94-40 (Ref. 13) demonstrates that $M_m$ = 2.4 in this calculation provides a conservative margin of safety:

For: $t^{1/2} = 6.5^{1/2} = 2.55$

Use: $M_m = 0.926 * t^{1/2} = 0.926 * 2.55 = 2.36$ (Ref. 13)

Therefore, use of $M_m$ = 2.4 provides an additional conservatism in the evaluation of the LTOP setpoint for PBNP.