December 11, 2014

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

10 CFR 50.90

Ladies and Gentlemen:

DOCKET NUMBER 50-483
CALLAWAY PLANT UNIT 1
UNION ELECTRIC CO.
FACILITY OPERATING LICENSE NPF-30
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION ROUND 2
RE: APPLICATION FOR AMENDMENT TO FACILITY OPERATING LICENSE NPF-30 REVISION TO FINAL SAFETY ANALYSIS REPORT STANDARD PLANT SECTION 3.6 FOR HIGH DENSITY POLYETHYLENE PIPE CRACK EXCLUSION (TAC NO. MF3202, LDCN 13-0016)

References: 1. ULNRC-06043 dated December 6, 2013, “Revision to FSAR Standard Plant Section 3.6 for HDPE Crack Exclusion (LDCN 13-0016)”
2. NRC Request for Additional Information, Carl F. Lyon (NRC) to Fadi Diya (Union Electric Company) dated July 1, 2014
3. ULNRC-06137 dated September 2, 2014, "Response to NRC Request for Additional Information Regarding Application for Amendment to Facility Operating License NPF-30 (TAC NO. MF3202, LDCN 13-0016) Revision to FSAR Standard Plant Section 3.6 for HDPE Crack Exclusion"
4. NRC Request for Additional Information Round 2, Carl F. Lyon (NRC) to Fadi Diya (Union Electric Company) dated October 28, 2014

In Reference 1 above, Ameren Missouri (Union Electric Company) submitted an application for amendment to Facility Operating License Number NPF-30 for the Callaway Plant. The proposed amendment would add a new pipe crack exclusion allowance to FSAR Standard Plant Section 3.6.2.1.2.4, “ASME Section III and Non-Nuclear Piping – Moderate-Energy,” and FSAR Standard Plant Table 3.6-2, “Design Comparison to Regulatory Positions of Regulatory Guide 1.46, Revision 0, dated May 1973, titled ‘Protection Against Pipe Whip Inside Containment,’” for the high density polyethylene (HDPE) piping installed in ASME Class 3 line segments of the essential service water (ESW) system. The amendment was submitted per the requirements of 10 CFR 50.59(c)(2)(viii).
In Reference 2 above, the NRC requested additional information to complete their review, which was provided by Ameren Missouri in Reference 3. In Reference 4 above, the NRC issued a second request for additional information. The attachment to this letter provides the requested information.

No commitments are contained in this letter. If you have any questions on this amendment application, please contact me at (573) 676-8719 or Mr. Jim Kovar at (314) 225-1478.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on: 12/11/2014

Sincerely,

Scott Maglio
Manager, Regulatory Affairs

JPK/nls

Attachment: RAI Response

Enclosure: RAI 9(b)
cc: Mr. Marc L. Dapas  
Regional Administrator  
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Attachment
to ULNRC-06152

ATTACHMENT

RAI RESPONSE
Attachment
to ULNRC-06152

REQUEST FOR ADDITIONAL INFORMATION
LICENSE AMENDMENT REQUEST TO REVISE FSAR-SP 3.6
UNION ELECTRIC COMPANY
CALLAWAY PLANT, UNIT 1
DOCKET NO. 50-483

Reference:


By application dated December 6, 2013 (Reference 1), as supplemented by letter dated September 2, 2014 (Reference 2), to the U.S. Nuclear Regulatory Commission (NRC), Union Electric Company (dba Ameren Missouri, the licensee) submitted a license amendment request (LAR) to revise the Final Safety Analysis Report-Standard Plant (FSAR-SP) Section 3.6.2.1.2.4, "ASME [American Society of Mechanical Engineers] Section III and Non-Nuclear Piping - Moderate-Energy," to include a new pipe crack exclusion allowance at Callaway Plant, Unit 1.

The NRC staff has determined that the additional information requested below is needed to complete its review.

Mechanical and Civil Engineering Branch (EMCB) - RAI-9

The response to RAI-8 of Reference 2 contains Table 1 on page 10 of 10 of Reference 2: The NRC requests the licensee to provide the following additional information.

(a) Please clarify whether the computed stresses and the crack postulation threshold limits in Table 1 are for the ASME Class 3 High Density Polyethylene (HDPE) moderate-energy piping (not the buried portion, that is, the portion between the buried portion and the metallic piping interface) in the Control Building basement, and in the Ultimate Heat Sink (UHS) Penetration Room.

Response:
The computed stresses and crack threshold limits in Table 1 (page 10 of 10 of the Attachment included in Reference 2) are for the short sections of Class 3, safety-related HDPE that are not buried. These sections are located between the buried portions and the metallic interfaces. The computed stresses and crack postulation threshold limits in Table 1 are not for the buried HDPE piping. The portions of HDPE piping that are not buried are located in the Control Building basement, the Ultimate Heat Sink (UHS) Penetration Rooms, and the ESW Yard Vault. These are the same locations where the metallic interfaces occur and a moderate-energy pipe crack is still postulated for the metallic piping for the Internal Flooding Analysis. The scope of this request is limited to the HDPE piping that is not buried and is located in the Control Building basement and the UHS Cooling Tower. The basis for excluding the HDPE piping in the yard vault is contained in the response to Question 3 of the NRC’s July 1, 2014 RAI, as documented in Reference 2.
(b) The computed stresses in Table 1 include stresses based on ASME equations 9b and 10. Please clarify if the equation 9b portion of the stresses includes contributions from axial force and the moment from dead weight (non-buried portion of HDPE piping) in addition to those from pressure, the Operating Basis Earthquake (OBE), and seismic anchor movement (SAM).

Further, pages 4 of 15 through 14 of attachment 4, Section 5 of Reference 1 mention pressure, OBE, and SAM, but do not mention dead weight. If the contribution from dead weight is not included, please explain the rationale.

Response:
The HDPE piping is not designed using the Code Equations from ASME Section III. It is installed in an ASME Section III, Class 3 system. The design was approved by the NRC in Relief Request I3R-10. The approved design principals are contained in Callaway procedure APA-ZZ-00662 Appendix F and follow those contained in Code Case N-755-1. Note that the use of Code Case N-755-1 was not part of the relief request. As stated above, APA-ZZ-00662 Appendix F contains the design principles for the HDPE pipe.

The Service Level B Longitudinal Stress Equation, as defined in APA-ZZ-00662 Appendix F, does not include contribution due to dead weight as defined in ASME Section III Subsection ND-3652.

The impact due to including dead weight, in addition to the APA-ZZ-00662 Appendix F loads, is calculated in an Enclosure to this response. The dead weight loads from calculations EF-119 Rev. 0, EF-120 Rev. 0, 2007-18082 Rev. 2, 2007-18083 Rev. 1, and 2007-16601 Rev. 1 were incorporated into the axial force (F_a) and the moment (M) for the Service Level B Longitudinal Stress equation as defined in calculation 2007-16760 Rev. 2 Add. 2. A summary of the results for the sum of Service Level B Longitudinal Stress (Eq. 9b) and the Alternative Thermal Expansion or Contraction Stress (Eq. 10) is contained below.

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Description</th>
<th>Location</th>
<th>Computed Stress (w/o Dead Weight) (psi)</th>
<th>Computed Stress (with Dead Weight) (psi)</th>
<th>Crack Postulation Threshold limit (psi)</th>
<th>Margin (w/o Dead Weight) (psi)</th>
<th>Margin (with Dead Weight) (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EF-003-AZC-36&quot;</td>
<td>A Train Supply Control Building Basement</td>
<td>673.26</td>
<td>693.83</td>
<td>773.6</td>
<td>100.34</td>
<td>79.77</td>
<td></td>
</tr>
<tr>
<td>EF-007-AZC-36&quot;</td>
<td>B Train Supply Control Building Basement</td>
<td>717.48</td>
<td>730.62</td>
<td>773.6</td>
<td>56.12</td>
<td>42.98</td>
<td></td>
</tr>
<tr>
<td>EF-083-AZC-36&quot;</td>
<td>A Train Return Control Building Basement</td>
<td>300.58</td>
<td>326.15</td>
<td>734.2</td>
<td>433.62</td>
<td>408.05</td>
<td></td>
</tr>
<tr>
<td>EF-140-AZC-36&quot;</td>
<td>B Train Return Control Building Basement</td>
<td>441.04</td>
<td>449.38</td>
<td>734.2</td>
<td>293.16</td>
<td>284.82</td>
<td></td>
</tr>
<tr>
<td>EF-083-AZC-36&quot;</td>
<td>A Train Return UHS Penetration Room</td>
<td>236.06</td>
<td>267.29</td>
<td>734.2</td>
<td>498.14</td>
<td>466.91</td>
<td></td>
</tr>
<tr>
<td>EF-140-AZC-36&quot;</td>
<td>B Train Return UHS Penetration Room</td>
<td>236.06</td>
<td>267.29</td>
<td>734.2</td>
<td>498.14</td>
<td>466.91</td>
<td></td>
</tr>
</tbody>
</table>
The impact of including dead weight increases the Service Level B Longitudinal Stress by 20.57 psi for the A Train Supply line and by 13.14 psi for the B Train Supply line, which are the most limiting locations. The stresses at all locations remain below the crack postulation threshold limit.

(c) Table 1 (Page 10 of 10 in Attachment 1 of Reference 2) shows a temperature of 175°F as the thermal mode analyzed for the Essential Service Water (ESW) return trains in the Control Room basement and UHS Penetration Room. The Equation 10 portion of computed stresses for the return trains therefore includes 175°F thermal mode. Please clarify if the Equation 9b allowable stress (Sh) used in the crack postulation threshold limit for HDPE corresponds to the allowable stress at 175°F. In case Sh at 175°F is not used, please explain the rationale.

Response:
The Service Level B Longitudinal Stress Equation for the upset condition (Equation 9b) and the Crack Postulation Threshold Limit do not use a water temperature of 175°F for the ESW return lines in the Control Building basement and the UHS Penetration Rooms.

All the variables in the Service Level B Longitudinal Stress Equation are independent of design temperature. The axial force (Fa) and the resultant bending moment (M) in the Service Level B Longitudinal Stress Equation (Eq. 9b), as defined in APA-ZZ-00662 Appendix F, are due to mechanical loads and do not include forces and moments due to thermal expansion. The Service Level B Longitudinal Stress Equation is not directly compared to an allowable stress. The output of the Service Level B Longitudinal Stress Equation is added to the output of the Alternative Thermal Expansion or Contraction Equation and compared to an allowable stress value defined in both Branch Technical Position (BTP) MEB 3-1 and FSAR Section 3.6.2.1.2.4(c) for piping design to ASME Section III. This is equivalent to the moderate energy crack exclusion described in Branch Technical Position (BTP) MEB 3-1, and contained in FSAR Section 3.6.2.1.2.4(c) that is applicable to Class 2 and 3 piping designed to ASME Section III. The HDPE piping is designed to APA-ZZ-00662 Appendix F and not to ASME Section III, so the moderate energy crack exclusion does not directly apply.

As stated in Calculation 2007-16760 Rev. 2 Add. 2 page 3 and Callaway FSAR Section 3.6.1.1(d), when a leakage crack in moderate-energy fluid system piping is postulated, each crack is considered separately as a single postulated initial event occurring during normal plant conditions.

Thus, the allowable stresses used to calculate the Crack Postulation Threshold Limit for the supply and return lines are based on normal operating conditions, as opposed to those present during a design basis event. The allowable stress used for the return lines is 613 psi based on an operating temperature of 113°F, which is greater than the maximum allowable temperature for water returning to the pond during normal operating conditions. The 175°F return temperature would result from a Loss of Coolant Accident (LOCA) and would not occur during normal operations.

As described in calculation 2007-16760 Rev. 2 Add. 2 page 3, the Alternative Thermal Expansion or Contraction Stress (Eq. 10) in this license amendment request uses the maximum allowed normal operating conditions for A Train return line in the Control Building Basement, as well as, the A and B Train Return Lines in the UHS Cooling Tower Penetration Rooms. The B Train return line in the Control Building basement uses LOCA temperatures as described in
calculation 2007-16760 Rev. 2 Add. 2 page 10-11. Calculations 2007-16760 Rev. 2, 2007-18082 Rev. 2, 2007-18083 Rev. 1, and 2007-16601 Rev. 1 evaluate the higher thermal expansions due to a LOCA as part of the design basis for the piping. However, they were not incorporated into the Crack Postulation Threshold Limit since a moderate energy crack is postulated during normal operating conditions and not coincident with a LOCA. The Thermal Mode Analyzed Column of Table 1 (page 10 of 10 in Attachment 1 of Reference 2) is corrected and contained in the last page of this response. Note that these values do not include dead weight. See the Enclosure to this response for values that include dead weight.

(d) Provide a brief discussion related to the fire hazard of the non-buried sections of the HDPE piping in the Control Building Basement, in the Ultimate Heat Sink (UHS) Penetration Room, and in the yard vault on any safety related commodities in the vicinity. Please also address fire resistance characteristics of the insulation, and any wrapping used on the HDPE piping.

Response:

**HDPE Pipe Fire Hazard**
The HDPE pipe which is composed of high density polyethylene is considered a combustible material; however; its ignition temperature is >300 degrees C and auto-ignition temperature is 349 degrees C. If ignited, HDPE pipe will create dense smoke. The exposed HDPE pipe fire hazard could be considered comparable to electrical cable trays filled with IEEE rated electrical cables which are used throughout the plant in terms of its susceptibility to ignition and its smoke generation should it be ignited. The HDPE pipe is not an ignition source, and its addition does not affect the probability of a fire occurring in any fire area.

**Control Building Basement**
In the Control Building 1974 elevation room 3101, ESW Pipe Space, both trains of ESW piping have approximately 2′ of HDPE material terminating inside the room for both the ESW supply and return lines, so there are 4 terminations that are 2′ in length. The four HDPE pipe terminations are located such that they are not subject to fire damage from any fixed ignition sources or the postulated transient ignition sources. Additionally, based on fire modeling, a hot gas layer is not postulated in room 3101. In this fire area the HDPE pipe has been evaluated and it does not present a fire hazard to the two trains of ESW equipment in the fire area.

**UHS Penetration Room**
The ESW HDPE piping at the UHS Cooling Tower is separated into two separate fire areas that are train-related, UNCT, "Ultimate Heat Sink Cooling Tower A", and USCT, "Ultimate Heat Sink Cooling Tower B," which are separated by rated fire barriers. Fire damage is evaluated in these two fire areas as whole room burn-up; therefore, the inclusion of the HDPE pipe has no impact on the fire damage assumed for the safety related equipment.

**Yard Vault**
The ESW HDPE piping in the yard vaults is ESW train specific and separated by rated fire barriers. There are no fixed ignition sources in the vaults, and fire damage is evaluated as whole room burn-up; therefore, the inclusion of the HDPE pipe has no impact on the fire damage assumed for the safety related equipment.

**Resistance Characteristics**
No insulation or fire barrier materials are used on the exposed HDPE ESW pipe sections.
<table>
<thead>
<tr>
<th>Description</th>
<th>Location</th>
<th>Design Pressure (psig)</th>
<th>Maximum Pressure (psig)</th>
<th>Design Temperature (°F)</th>
<th>Thermal Mode Analyzed (°F)</th>
<th>Computed Stress (psi)</th>
<th>Crack Postulation Threshold limit (psi)</th>
<th>Margin (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Train Supply</td>
<td>Control Building Basement</td>
<td>190</td>
<td>190</td>
<td>95</td>
<td>95</td>
<td>673.26</td>
<td>773.6</td>
<td>100.34</td>
</tr>
<tr>
<td>B Train Supply</td>
<td>Control Building Basement</td>
<td>190</td>
<td>190</td>
<td>95</td>
<td>95</td>
<td>717.48</td>
<td>773.6</td>
<td>56.12</td>
</tr>
<tr>
<td>A Train Return</td>
<td>Control Building Basement</td>
<td>45</td>
<td>45</td>
<td>175</td>
<td>113</td>
<td>300.58</td>
<td>734.2</td>
<td>433.62</td>
</tr>
<tr>
<td>B Train Return</td>
<td>Control Building Basement</td>
<td>45</td>
<td>45</td>
<td>175</td>
<td>175</td>
<td>441.04</td>
<td>734.2</td>
<td>293.16</td>
</tr>
<tr>
<td>A Train Return</td>
<td>UHS Penetration Room</td>
<td>45</td>
<td>45</td>
<td>175</td>
<td>113</td>
<td>236.06</td>
<td>734.2</td>
<td>498.14</td>
</tr>
<tr>
<td>B Train Return</td>
<td>UHS Penetration Room</td>
<td>45</td>
<td>45</td>
<td>175</td>
<td>113</td>
<td>236.06</td>
<td>734.2</td>
<td>498.14</td>
</tr>
</tbody>
</table>

**Conclusion:** The sum of the *Service Level B Longitudinal Stress* and the *Alternative Thermal Expansion or Contraction Stress* (Computed Stress column) is less than the Crack Postulation Threshold for all locations. The Crack Postulation Threshold is equivalent to the moderate-energy pipe-break stress limit for ASME Section III design equations listed in NRC MEB 3-1 Section B.2.b and Callaway FSAR Section 3.6.2.1.2.4.
Enclosure
to ULNRC-06152

ENCLOSURE

RAI 9(b)
RAI 9(b) Enclosure

Evaluation:
This enclosure will incorporate the dead weight loads from calculations EF-119 Rev. 0, EF-120 Rev. 0, 2007-18082 Rev. 2, 2007-18083 Rev. 1, and 2007-16601 Rev. 1 into the Service Level B Longitudinal Stress calculation. The Service Level B Longitudinal Stress equation is defined in APA-ZZ-00662 Appendix F, which was approved by Relief Request I3R-10, and does not include a component for dead weight stress. This enclosure will incorporate dead weight stresses into the short sections of HDPE piping located in the Control Building Basement and the UHS Cooling Tower.

ESW Supply Line Analysis-Control Building Basement:
The crack threshold limit is 773.6 psi for the ESW Supply lines located in the Control Building Basement per calculation 2007-16760 Rev. 2 Add. 2.

For the seismic load case the term Fa is the absolute sum of the dead weight axial stress value, the OBE axial stress value, and the square-root-sum-of-the-square (SRSS) of the X, Y, and Z SAM values (in that order), which can be found in EF-119 Rev. 0 for node 120 (A Train) and EF-120 Rev. 0 for node 40 (B Train). The stresses for both trains were calculated and reviewed against moderate energy crack criteria.

\[
F_{aATrain} = 1393 + 1466 + \sqrt{245^2 + 28^2 + 1091^2} = 3978\text{lb}
\]
\[
F_{aBTrain} = 1979 + 1204 + \sqrt{66^2 + 29^2 + 1243^2} = 4428\text{lb}
\]

The moment, M, is found by first calculating the individual moments, which are the absolute sums of the dead weight case values, the OBE case values, and the SRSS of the X, Y, and Z SAM case values. The resultant moment is the SRSS of the individual moment values.

**Individual Moment Values**

\[
M_{XATrain} = 2281 + 8090 + 2367 = 12738\text{ft} \cdot \text{lb}
\]
\[
M_{YATrain} = 3229 + 15360 + 1354 = 19943\text{ft} \cdot \text{lb}
\]
\[
M_{ZATrain} = 228 + 552 + 53 = 833\text{ft} \cdot \text{lb}
\]
\[
M_{XBTtrain} = 619 + 3087 + 3128 = 6834\text{ft} \cdot \text{lb}
\]
\[
M_{YBTtrain} = 1756 + 17714 + 841 = 20311\text{ft} \cdot \text{lb}
\]
\[
M_{ZBTtrain} = 17 + 629 + 49 = 695\text{ft} \cdot \text{lb}
\]

**Resultant Moment Values**

\[
M_{ATrain} = \sqrt{12738^2 + 19943^2 + 833^2} = 23678.6\text{ft} \cdot \text{lb} = 284142.6\text{in} \cdot \text{lb}
\]
\[
M_{BTrain} = \sqrt{6834^2 + 20311^2 + 695^2} = 21441.2\text{ft} \cdot \text{lb} = 257293.9\text{in} \cdot \text{lb}
\]
Next, the *Service Level B Longitudinal Stress* can be calculated for each train.

\[
A \text{ Train Supply} \\
0.5 \times \frac{190 \times 36}{2 \times 3.789} + 2 \times 0.5 \times \frac{3978}{383.42} + 1.0 \times \frac{284142.6}{2800.87} = 563.13 \text{ psi}
\]

\[
B \text{ Train Supply} \\
0.5 \times \frac{190 \times 36}{2 \times 3.789} + 2 \times 0.5 \times \frac{4428}{383.42} + 1.0 \times \frac{257293.9}{2800.87} = 554.72 \text{ psi}
\]

Note the minimum wall thickness is used as opposed to the nominal wall thickness to calculate the cross-sectional area and section modulus, which adds conservatism to the results.

The *Alternative Thermal Expansion or Contraction Stress* for the ESW supply lines in the Control Building Basement is taken from calculation 2007-16760 Rev. 2 Add. 2 and is shown below.

\[
A \text{ Train Supply} \\
1.0 \times \frac{291939}{2800.87} + \frac{10158}{383.42} = 130.7 \text{ psi}
\]

\[
B \text{ Train Supply} \\
1.0 \times \frac{398571}{2800.87} + \frac{12888}{383.42} = 175.9 \text{ psi}
\]

The *Service Level B Longitudinal Stress* must be added to the *Alternative Thermal Expansion or Contraction Stress*.

\[
A \text{ Train Supply} \\
563.13 + 130.7 = 693.83 \text{ psi}
\]

\[
B \text{ Train Supply} \\
554.72 + 175.9 = 730.62 \text{ psi}
\]

The sum of the *Service Level B Longitudinal Stress* and *Alternative Thermal Expansion or Contraction Stress* is 693.83 psi for the A Train ESW Supply piping and 730.62 psi for the B Train ESW Supply piping. This is less than the equivalent moderate energy pipe break stress limit for the HDPE piping in the ESW supply lines, which is 773.6 psi. Therefore, a moderate energy crack is not required to be postulated on the ESW HDPE Supply piping in Room 3101.

**ESW Return Line Analysis-Control Building Basement:**

The crack threshold limit is 734.2 psi for the ESW Return lines located in the Control Building Basement per calculation 2007-16760 Rev. 2 Add. 2.
Enclosure
to ULNRC-06152

For the seismic load case the term $F_a$ is the absolute sum of the dead weight axial stress value, the OBE axial stress value, and the square-root-sum-of-the-square (SRSS) of the X, Y, and Z SAM values (in that order), which can be found in 2007-18082 Rev. 2 for node 3 (A Train) and 2007-18083 Rev. 1 for node 5 (B Train). The stresses for both trains were calculated and reviewed against moderate energy crack criteria.

$$F_{aATrain} = 1858 + 6729 + \sqrt{48^2 + 65^2 + 338^2} = 8935lb$$
$$F_{aBTrain} = 2488 + 2418 + \sqrt{0^2 + 78^2 + 416^2} = 5329lb$$

The moment, $M$, is found by first calculating the individual moments, which are the absolute sums of the dead weight case values, the OBE case values, and the SRSS of the X, Y, and Z SAM case values. The resultant moment is the SRSS of the individual moment values.

**Individual Moment Values**

$$M_{XATrain} = 3524 + 7474 + \sqrt{79^2 + 211^2 + 587^2} = 11627ft \cdot lb$$
$$M_{YATrain} = 3423 + 11755 + \sqrt{218^2 + 60^2 + 277^2} = 15536ft \cdot lb$$
$$M_{ZATrain} = 259 + 655 + \sqrt{10^2 + 5^2 + 1^2} = 925ft \cdot lb$$

$$M_{XBTrain} = 200 + 3497 + \sqrt{0^2 + 296^2 + 883^2} = 4628ft \cdot lb$$
$$M_{YBTrain} = 389 + 13781 + \sqrt{242^2 + 5^2 + 2^2} = 14412ft \cdot lb$$
$$M_{ZBTrain} = 18 + 673 + \sqrt{11^2 + 0^2 + 0^2} = 702ft \cdot lb$$

**Resultant Moment Values**

$$M_{ATrain} = \sqrt{11627^2 + 15536^2 + 925^2} = 19427.0ft \cdot lb = 233124.5in \cdot lb$$
$$M_{BTrain} = \sqrt{4628^2 + 14412^2 + 702^2} = 15153.1ft \cdot lb = 181837.4in \cdot lb$$

Next, the *Service Level B Longitudinal Stress* can be calculated for each train.

**A Train CB Return**

$$0.5 \times \frac{45 \times 36}{2 \times 3.789} + 2 \times 0.5 \times \frac{8935}{383.42} + 1.0 \times \frac{233124.5}{2800.87} = 213.42psi$$

**B Train CB Return**

$$0.5 \times \frac{45 \times 36}{2 \times 3.789} + 2 \times 0.5 \times \frac{5329}{383.42} + 1.0 \times \frac{181837.4}{2800.87} = 185.71psi$$

Note the minimum wall thickness is used as opposed to the nominal wall thickness to calculate the cross-sectional area and section modulus, which adds conservatism to the results.
The Alternative Thermal Expansion or Contraction Stress for the ESW return lines in the Control Building Basement is taken from calculation 2007-16760 Rev. 2 Add. 2 and is shown below.

\[
\text{A Train CB Return} \\
\frac{1.0 \times 241462}{2800.87} + \frac{10170}{383.42} = 112.73 \text{ psi}
\]

\[
\text{B Train CB Return} \\
\frac{1.0 \times 577956}{2800.87} + \frac{21980}{383.42} = 263.67 \text{ psi}
\]

The Service Level B Longitudinal Stress must be added to the Alternative Thermal Expansion or Contraction Stress.

\[
\text{A Train CB Return} \\
213.42 + 112.73 = 326.15 \text{ psi}
\]

\[
\text{B Train CB Return} \\
185.71 + 263.67 = 449.38 \text{ psi}
\]

The sum of the Service Level B Longitudinal Stress and Alternative Thermal Expansion or Contraction Stress is 326.15 psi for the A Train ESW Return piping and 449.38 psi for the B Train ESW Return piping. This is less than the equivalent moderate energy pipe break stress limit for the HDPE piping in the ESW return lines, which is 734.2 psi. Therefore, a moderate energy crack is not required to be postulated on the ESW HDPE Return piping in Room 3101.

**ESW Return Line Analysis-Ultimate Heat Sink Cooling Tower**

The crack threshold limit is 734.2 psi for the ESW Return lines located in the Ultimate Heat Sink Cooling Tower per calculation 2007-16760 Rev. 2 Add. 2.

For the seismic load case the term \( F_a \) is the absolute sum of the dead weight axial stress value and the OBE axial stress value, which can be found in calculation 2007-16601 Rev. 1 for node 105. Note that seismic anchor movements are considered negligible and are not included in the model per Section 3.1 of 2007-16601. Per 2007-16601 the A and B Train piping is symmetric and only the A Train piping is analyzed. The stresses calculated below will bound both trains and will be reviewed against moderate energy crack criteria.

\[
F_a = 537 + 3133 = 3670 \text{ lb}
\]

The moment, \( M \), is found by first calculating the individual moments, which are the absolute sum of the dead weight and OBE case values since SAM is negligible. The resultant moment is the SRSS of the individual moment values.
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*Individual Moment Values*

\[ M_x = 64 + 561 = 625 \text{ ft} \cdot \text{lb} \]
\[ M_y = 587 + 2235 = 2822 \text{ ft} \cdot \text{lb} \]
\[ M_z = 7152 + 4617 = 11769 \text{ ft} \cdot \text{lb} \]

*Resultant Moment Values*

\[ M = \sqrt{625^2 + 2822^2 + 11769^2} = 12118.7 \text{ ft} \cdot \text{lb} = 145424.8 \text{ in} \cdot \text{lb} \]

Next, the *Service Level B Longitudinal Stress* can be calculated using the same philosophy as that used for the return lines in Room 3101 of the Control Building.

*A and B Train UHS Return*

\[
0.5 \times \frac{45 \times 36}{2 \times 3.789} + 2 \times 0.5 \times \frac{3670}{383.42} + 1.0 \times \frac{145424.8}{2800.87} = 168.4 \text{ psi}
\]

Note the minimum wall thickness is used as the nominal wall thickness to calculate the cross-sectional area and section modulus, which adds conservatism to the results.

The *Alternative Thermal Expansion or Contraction Stress* for the ESW return lines in the Control Building Basement is taken from calculation 2007-16760 Rev. 2 Add. 2 and is shown below.

*A and B Train UHS Return*

\[
\frac{1.0 \times 170658}{2800.87} + \frac{14555}{383.42} = 98.89 \text{ psi}
\]

The *Service Level B Longitudinal Stress* must be added to the *Alternative Thermal Expansion or Contraction Stress*.

*A and B Train UHS Return*

\[ 168.4 + 98.89 = 267.29 \text{ psi} \]

The sum of the *Service Level B Longitudinal Stress* and *Alternative Thermal Expansion or Contraction Stress* is 267.29 psi for the ESW Return piping in the UHS Cooling Tower. This is less than the equivalent moderate energy pipe break stress limit for the HDPE piping in the ESW return lines, which is 734.2 psi. Therefore, a moderate energy crack is not required to be postulated on the ESW HDPE Return piping in the UHS Cooling Tower.