PrairieIslandNPEm Resource

From: Eckholt, Gene F. [Gene.Eckholt@xenuclear.com]
Sent: Monday, May 04, 2009 1:44 PM
To: Plasse, Richard
Subject: Additional Information for Call
Attachments: Draft Response to NRC Question E related to L-PI-09-060_PML (090504).doc

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Follow-up questions regarding the supplemental information submitted by NSPM

Reviewing the NSPM letter L-PI-09-060, dated 4/28/2009, titled “Supplemental Information Closing License Renewal Commitment Number 36 Regarding Application for Renewed Operating Licenses”, the staff found several areas need clarification, as described below:

(A) On Page 1 of Enclosure 1, 3rd paragraph states “… The results of those analyses are being incorporated into the LRA …”. Does this mean that NSPM will issue a new version of LRA? If not, please explain.

(B) On Page 2 of Enclosure 1, paragraphs under the subsection titled “Determination of Fatigue Usage Unadjusted for Environmental Effects” contained in the NSPM letter L-PI-09-060, under Section 4.3.3, describes the transients used for the Safety injection accumulator nozzle, charging nozzle, and PZR surge line hot leg nozzle. Some of the transients used in fatigue evaluations for these components are not included in LRA Table 4.3-1. These undefined transients are listed below.

> *inadvertent RCS depressurization, inadvertent auxiliary spray actuation, control rod drop, excessive feedwater flow, RCS refueling, OBE, inadvertent accumulator blowdown, RHR operation during plant cooldown, high head safety injection*

Request:

(1) Specify the number of design cycles for the transients listed above as well as the cycles most recently accrued and the cycles projected for 60 years.

(2) Confirm that **all** transients (including those listed above) used for the fatigue analysis have been tracked and monitored since the plant startup and tracking for all transients that may contribute fatigue usage will be continued during the period of extended operation.

(C) On Page 3, the top paragraph states “… charging/letdown system flow shutoff and flow change transients were defined based on a standard set of Westinghouse design transients for auxiliary systems, as modified for the expected number of occurrences at 60 years…”.

Request:

(1) Provide basis for making the cycle modification on the flow shutoff and the flow change transients and specify the actual cycles used for the analysis.

(D) LRA Table 4.3-8 shows the results of environmentally assisted cumulative fatigue usage (CUF_{en}) for the NUREG/CR-6260 components. For the nozzle components, it is unclear exactly for what spot/location of the nozzles the CUF values are representing. Example: nozzle safe end; nozzle knuckle (nose); etc.

Request:
Please specify for spots/locations where the CUF shown in Table 4.3-8 is representing. Consider the following nozzles.

(1) Surge line hot leg nozzle: __________________

(2) Safety injection accumulator nozzle: __________________

(3) Charging system nozzle: __________________

(E) Pages 5 & 6 of Enclosure 1 discuss the Fen calculations.

Request:

(1) Please describe how you handled the strain rate and temperature going into calculation for F_{en} of each load set pair.

(2) What was the "conservatively-assumed" DO-level used for the calculations described in (1)?

Response:

(E)(1) – The following is an excerpt from the EAF calculation packages:

The F_{en} relationships described in NUREG/CR-5704 [2] were used in this analysis. MRP-47 Rev. 1 [3] was also used for guidance in the calculations.

For Types 304 and 316 Stainless Steel [2]: $F_{en} = \exp(0.935 - T^* \varepsilon^* O^*)$
where: F_{en} = fatigue life correction factor
T = fluid service temperature of transient, °C
$T^* = 0$ for $T < 200°C$
$= 1$ for $T \geq 200°C$
$\varepsilon^* = 0$ for strain rate, $\varepsilon > 0.4\%/sec$
$= \ln(\varepsilon/0.4)$ for $0.0004 \leq \varepsilon \leq 0.4\%/sec$
$= \ln(0.0004/0.4)$ for $\varepsilon < 0.0004\%/sec$
$O^* = 0.260$ for dissolved oxygen, $DO < 0.05$ parts per million (ppm)
$= 0.172$ for $DO \geq 0.05$ ppm

The above equation was evaluated for several sets of parameter values, as shown below:
$F_{en} = 2.55$ ($T < 200°C$, any ε, any DO)
$F_{en} = 2.55$ ($T \geq 200°C$, $\varepsilon \geq 0.4\%/sec$, any DO)
$F_{en} = 3.78$ ($T \geq 200°C$, $\varepsilon = 0.04\%/sec$, $DO \geq 0.05$ ppm)
$F_{en} = 4.64$ ($T \geq 200°C$, $\varepsilon = 0.04\%/sec$, $DO < 0.05$ ppm)
$F_{en} = 5.62$ ($T \geq 200°C$, $\varepsilon = 0.004\%/sec$, $DO \geq 0.05$ ppm)
$F_{en} = 8.43$ ($T \geq 200°C$, $\varepsilon = 0.004\%/sec$, $DO < 0.05$ ppm)

$F_{en} = 8.36$ ($T \geq 200°C$, $\varepsilon \leq 0.0004\%/sec$, $DO \geq 0.05$ ppm)
$F_{en} = 15.35$ ($T \geq 200°C$, $\varepsilon \leq 0.0004\%/sec$, $DO < 0.05$ ppm)

F_{en} values were determined for each load pair in a detailed fatigue calculation, using the integrated strain rate approach outlined in MRP-47 [3]. The environmentally assisted fatigue (EAF) cumulative usage factor (CUF) was then determined as $U_{env} = (U)(F_{en})$, where U is the original fatigue CUF and F_{en} is the EAF multiplier.

The EAF evaluation was performed using the Integrated Strain Rate method described in MRP-47, Rev. 1 [3 p. 4-14]. The F_{en} values for the individual load sets were calculated. The combined stress components for these transients from the fatigue analysis [4] were used as the input for the EAF calculations. Strain rate (ε) is calculated based on the stress time histories from the fatigue analysis [3]. The stress intensity for the total stress from the combined stress results was calculated for each time step, using the 6 stress components. Strain values in terms of percent strain were computed from the signed stress intensity values based on:

$$\varepsilon = (100 * \sigma_{SI}) / E$$

The value of Young's Modulus, E, was taken as the E of the stainless steel fatigue curve [3, p. 4-15]. An environmentally-assisted fatigue factor (F_{en}) was calculated for each time step for steps of tensile strain change (e.g., $\varepsilon_t - \varepsilon_{t-1} \geq 0$), according to the methodology described above. In this process, the strain rates and strain contributions of each time step were also calculated. To determine the overall F_{en} for each transient, the summation of all tensile strain contributions for each time step was performed. Then the F_{en} for each time step was multiplied by the difference in strain amplitude between the current and previous time steps. The results of this product were summed. F_{en} is calculated for all time steps in which strain is increasing (becoming more tensile). The F_{en} for the entire transient was calculated as follows:

$$F_{en(total)} = \Sigma(F_{en(individual)} \text{ x } \Delta\varepsilon) / \Sigma\Delta\varepsilon$$

Where:
$F_{en(individual)}$ = the calculated F_{en} for each time step.
$\Delta\varepsilon$ = the difference between the strain amplitude (%) of the current time step and that for the preceding time step, calculated for each time step.
$\Sigma\Delta\varepsilon$ = the sum of the strain amplitude (%) contributions for each time step.

Using the results for the load sets for the load pairs in the fatigue table, the F_{en} for each transient was calculated. F_{en} values were only calculated for the load pairs with a reasonably significant normal fatigue contribution (i.e.; fatigue usage values ≥ 0.001 for charging nozzle, ≥ 0.0015 for hot leg nozzle). For all other load pairs, the F_{en} was taken to be 15.35, which is the maximum value for a stainless steel material. The fatigue table from the fatigue calculation [4] was appended to include the F_{en} results to determine the EAF results for each load pair. The summation of the EAF results for the individual load pairs represents the cumulative EAF for the nozzle through 60 years of operation. The total EAF was divided by the total CUF (cumulative fatigue usage without environmental effects), resulting in the overall effective F_{en} for the nozzle.

(E)(2) – The following is an excerpt from the EAF calculation packages:

The level of dissolved oxygen in the environment is assumed to be less than 0.05 ppm, which corresponds to a low oxygen environment. The O* value of 0.260 is applicable; this is conservative since this value yields higher F_{en} values. This is the conservative choice – as shown in the equation for the F_{en} above, the value for ε* will always be negative or zero, which means that a larger value for O* will result in a higher F_{en}.