DRAFT

Request for Additional Information No. 48 (885,887,888,889,894), Revision 0

8/6/2008

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 03.06.03 - Leak-Before-Break Evaluation Procedures
Application Section: FSAR Ch 3
CIB1 Branch

QUESTIONS

03.06.03-1

Subsection 3.6.3.3 – Potential Piping Failure Mechanisms
Subsection 3.6.3.3.4.1 – Stress Corrosion Cracking in Main Coolant Loop and Surge Line Piping – Tensile Stress:
How does reactor coolant chemistry prevent Stress Corrosion Cracking (SCC), (i.e., how is oxygen concentration monitored and controlled)? Will the EPRI Guidelines for water chemistry be implemented? Are welding procedures (including repairs) that are planned to be utilized, minimize the tensile stresses on the internal diameter (ID)?

03.06.03-2

Subsection 3.6.3.3 – Potential Piping Failure Mechanisms
Subsection 3.6.3.3.6 – Thermal Aging:
Please identify all of the applicable references used to determine whether thermal aging embrittlement is a concern for the Reactor Coolant Pressure Boundary (RCPB) materials and welds. Please provide the J-R curve for these materials.

03.06.03-3

Subsection 3.6.3.3 – Potential Piping Failure Mechanisms
Subsection 3.6.3.3.7.2 – Thermal Stratification – Surge Line Piping:
For the Surge Line (SL) it is stated that thermal stratification is not a concern due to the layout of the SL geometry and the continuous bypass spray flow based on Reference 10 (ANP-10264NP, Revision 0, "U.S. EPR Piping Analysis and Pipe Support Design Topical Report," AREVA NP Inc., September 2006). Slide 52 of the June 26, 2008 AREVA presentation lists the SL stratification results for a French PWR. There are values for ΔT and SL stratification. Will these values be typical of the EPR SL? For the EPR SL, how will such effects be analyzed, (i.e., ASME Section III stress analyses including determination of the fatigue usage factors to meet Code limits)?

03.06.03-4

Subsection 3.6.3.3.7.2 – Thermal Stratification – Surge Line Piping:
During the June 26, 2008 audit between the NRC/AREVA, AREVA described the improved system operation (i.e., continuous spray bypass flow at normal operation to suppress turbulent penetration and how the pressurizer-to-hot-leg change in Temperature is minimized during plant heat-up by initiating in-surges via the CVCS system). Please identify how the pressurizer-to-hot-leg change in temperature is minimized and discuss any other systems' measures taken during start-up or shutdown to minimize the Hot-Leg-to-Cold-Leg temperature change.

03.06.03-5

Subsection 3.6.3.4 – Inputs for Leak-Before Break Analysis
Subsection 3.6.3.4 – General (Tensile Properties):
The tables in this section provide the Ramsberg-Osgood material constants for engineering stress-strain curves used to represent the material behavior. Are the tensile properties for the pertinent piping materials obtained from the ASME Code material specifications or from some other source? Were the lower bound or average tensile properties used for stability/leak-rate analyses? Please clarify.

03.06.03-6

Subsection 3.6.3.4 – General (Toughness Properties):
Although the equation for the toughness (J-R curve) is shown, no material constants are provided. There are many such instances where the toughness of a particular material is referenced, but no details on the actual toughness values are given. For instance, Section 3.6.3.4.3.2, the dissimilar metal Alloy 52 weld J-R curve is from fatigue pre-cracked specimens on the fusion line. Please identify where the material toughness (J-R curves) values are found for each of the materials used in the analyses.

03.06.03-7

Subsection 3.6.3.4.2.2 Main Steam Line (MSL) Piping Materials:
The MSL piping material is SA-106 Grade C carbon steel. This material may be susceptible to Dynamic Strain Aging (DSA) for the loadings and temperature that the MSL is designed for. Among the negative effects of DSA are decreased ductile fracture resistance and unstable crack propagation. How have the effects of DSA been accounted for on the material toughness for this material? How have the negative effects of DSA been accounted for in the MSL design? In addition, how has it been determined that the piping material will not be susceptible to brittle cleavage type failures over the full range of system operating temperatures, (i.e., that the material is on the upper shelf of the Charpy Impact energy versus test temperature curve)? What was the toughness values used? Please specify the welding processes to be used for the MSL welds, (i.e., SMAW, SAW or others). Please specify the aging effects to be considered for these welds.

03.06.03-8

Subsection 3.6.3.4.3.3 – Primary Component Nozzles of the Main Coolant Line (MCL):

Please provide the basis of the CVN – J-R curve relationship used and what was the final J-R curve that was used.

03.06.03-9

Figure 3.6.3-3:

It appears that the dissimilar metal (DM) weld on the SL is a field weld and not a shop weld as is typical. The MCL drawing shows the DM welds as shop welds. Is this correct? This will have an effect on the post-weld heat treatment (PWHT) process and may affect the welding residual stresses in the DM weld. Please correct the drawing to identify the DM weld on the SL as a shop weld if this has been incorrectly identified.

03.06.03-10

Subsection 3.6.3.5 – General Methodology:

It appears that air-fatigue morphology was assumed for the leak-rate calculations. This is the least conservative assumption that can be made because for the same amount of flow, it results in smaller leakage crack sizes (and larger critical crack size margins) than other crack morphology assumptions like PWSCC or IGSCC. While SRP 3.6.3 states that Alloy 690/52/152 (which will be used in the EPR) is not currently considered susceptible to PWSCC for the purposes of LBB applications, these materials are NOT *immune* to PWSCC. There are references that show the effect of assuming PWSCC or IGSCC leakage crack morphologies. If an SCC or corrosion morphology is assumed in the calculations (as a lower bound conservative case) each and every one of the ALL diagrams will change. Please provide the justification for the use of air versus corrosion fatigue crack morphology.

03.06.03-11

Subsection 3.6.3.5 – General Methodology
Subsection 3.6.3.5.2 – Leak Rate Determination for MCL and SL:

The following questions relate to the leak-rate determination:

a. Was the effect of crack-face pressure assumed in the analyses?
b. How was COD calculated? Was the GE/EPRI approach used? What was the stress-strain curve that was used (i.e., minimum, average, or just elastic analysis)? In SQUIRT, there are several options for the J-estimation scheme and this will have an effect on the result.

03.06.03-12

Subsection 3.6.3.5.4 – Flaw Stability Analysis Method:

The following questions concern the stability analyses:

a. It is claimed that the pressure and bend solution is valid only for R/t=10 and R/t=20, and use the R/t=10 solution conservatively. Most of the systems analyzed are R/t≤6. In the next section on the surge line, it is claimed that the pressure and bend solutions cannot be used since the R/t=5, so only a bending solution is used. This is in conflict with the previous paragraph where it is stated that the R/t=10 can be used. Please clarify the assumption in these analyses.

b. For the SL, a bending only solution is used to calculate an “effective” moment for the axial load by equating the stress intensities. However, the collapse moment used is not modified and the axial load will lower the collapse moment. Please demonstrate how the use of the “effective” bending moment correction can correctly capture the driving force for the pressure and bending case.

c. Curve fits of the GE/EPRI F and h functions were used for extrapolating to the lower R/t values. Please clarify the extrapolation of curve fits and the method used (i.e., 4^{th} order polynomials are not good for extrapolation but work well for interpolation).

d. How were secondary loads considered in these analyses? Were 100% of the displacement-controlled stresses used in calculating the TWC subcritical growth and the TWC critical flaw size?

03.06.03-13

Subsection 3.6.3.5 – General Methodology:
As stated previously, Alloy 690/52/152 is not immune to PWSCC. Contributing factors which could increase susceptibility to PWSCC include welding processes, control of welding parameters (i.e., heat input), dilution effects on dissimilar metal welds (DMW), chromium content on DMW. Please provide a discussion identifying the controls that will be considered to minimize the susceptibility to PWSCC. **These controls may include minimizing dilution effects but maximizing chromium content of nickel-based welds, reducing welding residual stress by weld sequence optimization, and other adjustments to primary water chemistry.**

03.06.03-14

Subsection 3.6.3.6 – Results
Subsection 3.6.3.6.1 – Results – MSL Piping:
Using a safety factor of 1.7 instead of 2.0 on critical crack size in the design phase is not consistent with the safety factor provided in NUREG-1061, Volume 3. Discuss your rationale explaining why a factor of 2 on critical crack size is not appropriate or attainable? Please provide the technical justification for this proposed reduction in the safety factor.

03.06.03-15

Section 5.2.5 – RCPB Leakage Detection
Since Section 5.2.5 RCPB Leak Detection is closely related to LBB Evaluation Procedures covered in Section 3.6.3, the following RAIs are provided.

For the localized humidity and temperature monitoring system, provide a description of the instrumentation to be used and identify the exact location of such instrumentation relative to the main steam line piping.

03.06.03-16

Section 5.2.5 – RCPB Leakage Detection
Since Section 5.2.5 RCPB Leak Detection is closely related to LBB Evaluation Procedures covered in Section 3.6.3, the following RAIs are provided.

The RCPB leakage detection system(s) that are capable of detecting 0.5 gpm for the MCL and SL is identified as the NIDVS in Section 5.2.5 of the FSAR. Will this system remain functional under the SSE? Will this system remain functional under seismic events not requiring shutdown? Please identify which systems described in Section 5.2.5 will be included in the plant technical specifications and the limiting conditions for operation for identified, unidentified, RCPB and intersystem leakage and the availability of the various types of instruments to ensure adequate coverage during all phases of plant operation.

03.06.03-17

Section 5.2.5 – RCPB Leakage Detection
Since Section 5.2.5 RCPB Leak Detection is closely related to LBB Evaluation Procedures covered in Section 3.6.3, the following RAIs are provided.

The sensitivity of the containment atmosphere radiation monitors for detection of the limiting leakage is dependent on reactor coolant activity. Under circumstances of low reactor coolant activity (i.e., during initial reactor startup and operation and/or better than expected fuel integrity), what adjustments will be made to compensate for this situation?