Part 21 Discussion

Issue

Feedwater Line Break (FWLB) transfers a large quantity of liquid into the Suppression Pool, increasing the pool water level. A higher Suppression Pool water level expands the wetted regions of the Suppression Pool walls, the access tunnel, and submerged structure segments. This affects the LOCA containment hydrodynamic loads including condensation oscillation (CO), chugging (CH), and Safety Relief Valve (SRV) actuation loads. Pool swell is unaffected since swell occurs very quickly at the beginning of the transient.

Suppression Pool Water Level

The suppression pool water level transient was evaluated using GOTHIC code. The model is identical to that described in the report WCAP-17058 "Implementation of ABWR DCD Methodology using GOTHIC for STP 3 and 4 Containment Design Analyses." The in-flow and out-flow to the containment (blowdown, feedwater and ECCS suction flows) are provided as input to the code to calculate the time dependent pool water level.

The assumptions for boundary conditions are the same as those for STP-3/4 COL.

- Event : FWLB (limiting case for S/P water level increase)
- RPV blowdown and ECCS suction flow : GOBLIN code
- BOP flow : COL Figs. 6.2-3 and 6.2-4
- Initial suppression pool water level : LWL = 7.0 meter

The S/P water level peaks at around 2~3 minutes following break, and the water level starts to decrease because of ECCS suction flow and water retention in the drywell. The maximum suppression pool water level increment (Δh from initial level) during CO/CH period is about 1 meter.

After about 10 minutes, the vent steam flow has diminished below that required for CO or CH to occur, since the RPV depressurizes and cold ECCS water spills over from broken pipe.

Increased Pressure Loads

A LOCA and SRV actuation result in dynamic loads on the suppression pool boundaries. These hydrodynamic loads are formulated by applying a time function to the attenuated pressures in the suppression pool. The attenuated pressures are calculated based on the methodology presented in Appendix 3B. Once the pressure time histories are formulated, they are represented in terms of an equivalent static load and then used as input for the finite element analysis with a dynamic load factor.

For this assessment, these pressure loads are applied over a larger area of the suppression pool walls and access tunnels due to the increased suppression pool level. The changes in the load distribution and pressure loads are shown superimposed on the DCD figures.

Load increments in CO, CH and SRV due to increase in suppression pool water level are estimated based on the changes in load distribution.

The percentage increases in loads due to the change in level are about 10% (wall) and 60% (access tunnel) for CO, 12% (wall) and 63% (access tunnel) for CH, and 15% (wall) and 80% (access tunnel) for SRV.

Load Combinations

Because the STP 3&4 design has not progressed to the detailed stress analysis and structural evaluation for the Reactor Building, a plant specific detailed analysis cannot be performed at this time. Instead, a conservative, bounding estimation of the increased loads has been performed utilizing data available in the DCD. When the detailed STP 3&4 design is resumed, analyses will be performed as required to complete the design and satisfy the appropriate ITAAC, i.e., 2.14.1.

Load combination 15 from DCD Table 3H.1-5a was evaluated as most limiting for this time period. Based on the load combination evaluated in DCD 3H.1, loads on the pool walls can be accommodated with available margin. The CO contribution in Load Combination 15 is about 7%. Therefore, a 10% increase in the CO load results in less than a 1% increase in the calculated load. Since the margin to the allowable is greater than 30% of the calculated load, this small change is not significant. The final results from the detailed design and analysis will be even smaller without the simplifying conservative assumptions.

The access tunnel is not specifically evaluated in the DCD. Based on the access tunnel stress analysis for the Japanese plants, however, the increased CO, CH, and SRV loads result in a relatively small increase in the total load, since the governing load for the access tunnel is the thermal load.