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Subcompartment Pressurization Analysis for Auxiliary Building of APR1400DC

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1. Introduction

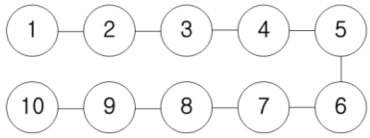
Generally, the subcompartment of PWR means a fully or partially enclosed volume that could house high-energy piping systems or restrict the flow of fluid in the event of a postulated pipe rupture. To meet the requirements of General Design Criteria (GDC) 4 and 50, Standard Review Plan (SRP) 6.2.1.2 states that the subcompartments shall be designed with sufficient margin to prevent the fracture of structure due to pressure differential across the walls of the sub-compartment and specifies the criteria related to the design and functional subcompartment nodalization schemes, vent flow path and vent flow behavior. Therefore the subcompartments structures within the containment and auxiliary building are designed to withstand the transient differential pressures loads, jet impingement forces, and pipe whip forces occurring due to a postulated pipe break.

In this paper, the analyses of pressure transients after a postulated pipe rupture in subcompartments of APR1400DC auxiliary building is performed and the calculated peak differential pressures during the piping break transients for each sub compartment are less than structural design differential pressures.

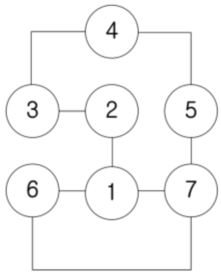
2. Analysis

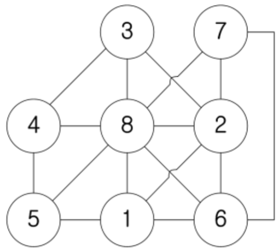
The pressurization analysis in the auxiliary building is performed for turbine driven auxiliary feedwater pump compartment, main steam isolation valve (MSIV) compartment, main steam enclosure compartment and steam generator blowdown tank compartment such as defined high energy line break areas. In this paper, the analysis for boric acid concentrator compartment, gas stripper compartment, HELB HVAC duct shaft, and condensate receiver tank/condensate return pump compartment is not introduced, although those compartments are HELB areas, because of the similar analysis condition with S/G BD flash tank room.

The computer program COMPARE-MOD1A is used to perform the subcompartment pressure transient analysis. Mass and Energy inflow or outflow accounting for each volume, is first accomplished for the particular time increment, assuming vent flows are constant. Thermo- dynamic equilibrium is then assumed and state points determined. The resulting volume thermo-dynamic conditions are assumed to be constant and used to calculate the new vent flows from or into volumes for the next time interval.



(a) T/D Aux. FW pump Compartment





(b) MSIV Compartment (C) MSE

Figure 1 Flow Path Diagram for the pressurization of T/D Aux. Feedwater Pump, MSIV and MSE Compartment

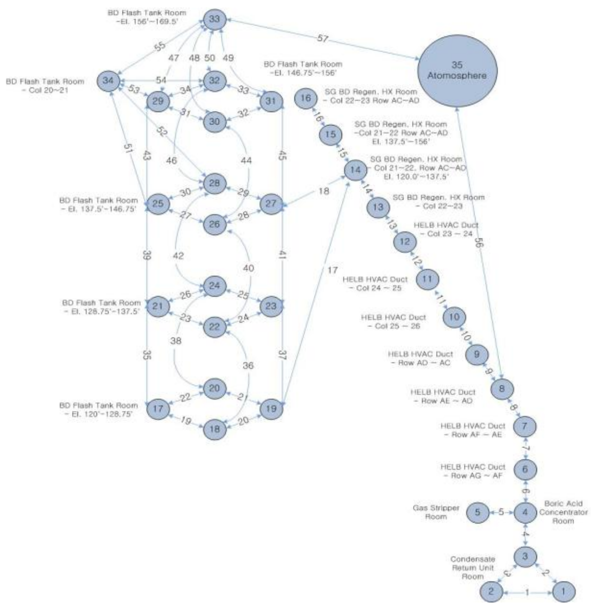


Figure 2 Flow Path Diagram for the pressurization of S/G BD Flash Tank Compartment

The flow path diagrams for the pressurization in each compartment are shown in Figure 1 and 2. Effective volumes of each node were calculated with reflecting the design drawing and walk-down. The 20% margin was given to the volume calculation for room facilities and other structure conservatively.

3. Results

In the T/D-AFW pump compartment, as shown Fig. 3, the calculated peak pressure is 20.36 psia. The break was assumed to occur in the node 6. The maximum pressure in the main steam isolation valve compartment is 16.55 psia at the break node 2. The break was assumed to occur in the node 1. The resultant pressure responses in each node are shown in Figure 4. In the MSE, the break was assumed to occur in the node 1 through 5. The calculated peak pressure is 30.40 psia at break node 1. The resultant pressure responses in each node are shown in Figure 5.

In steam generator blowdown tank compartment, the steam generator blowdown lines with 6", 8" and 12" diameter exist. The 6" line break is assumed to occur inside the containment, 8" line break in the node 34 and 12" line break in the node 30 or node 32. The break was assumed to occur in the node 30, 32, 34. The calculated peak pressure is 16.10 psia at node 30, 16.31 psia at node 32 and 18.97 psia at node 34 in each different break case. When nozzle breaks at node 34, the resultant pressure responses in each node are shown in Figure 6.

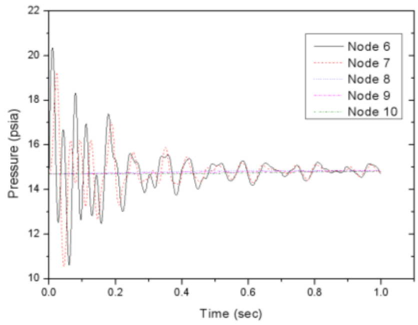


Figure 3 Pressure Transient for T/D AFW Pump Compartment

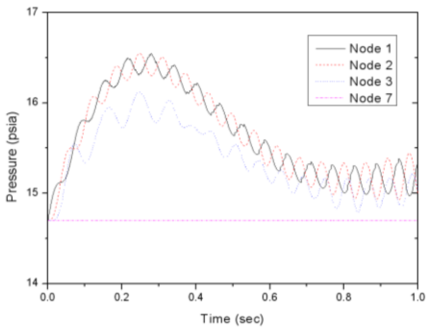


Figure 4 Pressure Transient for MSIV Compartment

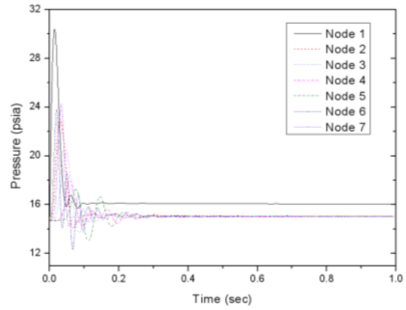


Figure 5 Pressure Transient for MSE

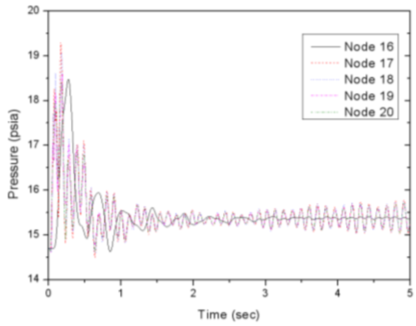


Figure 6 Pressure Transient for S/G BD Flash Tank Compartment

4. Conclusion

According to the criteria of selection of High Energy Ling described FSAR 3.6.1, HELB areas from each auxiliary building were selected and the calculated peak differential pressures during the pipe break transients for each subcompartment were calculated. A design margin of 40 % would be added to the calculated pressure in the design of compartment structure. This comparison demonstrates that the subcompartment walls withstand the peak differential pressures during postulated breaks of any high-pressure line within any subcompartment.

REFERENCES

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