STRUCTURAL ANALYSIS FOR
SAFETY RELIEF VALVE DISCHARGE LOADS

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SUMMARY

For light water reactors of the BWR type, during certain operating transient, safety relief valves (SRV’s) in the steam supply piping system may actuate to relieve excess pressure build-up. Since, the safety relief lines terminate below the suppression pool of the primary containment, a SRV actuation causes a volume of compressed air to discharge into the pool. This results in a situation where high pressure air bubbles expand and contract periodically within the suppression chamber, thus transmitting pressure waves to act on structural boundaries in the meridional and circumferential directions.

This paper describes a methodology for structural analysis of a Mark II containment for a prescribed magnitude of SRV discharge loads. Though the magnitude of these loads and sequence of SRV firing is uncertain, the purpose of this paper is to present a method of structural analysis having determined the magnitude and spatial distribution of these loads due to a probabilistic sequence of SRV firing. For the purpose of analysis these loads are discretized into both symmetric and asymmetric components. Although these loads are localized within the suppression pool area their effect on the entire containment structure is determined using a 3-dimensional finite element representation of the axisymmetric Containment and Reactor building. Interaction effects between the soil and the structural system are also considered. This is accomplished by idealizing the soil below the plant site and up to the level of bed-rock as 3-dimensional axisymmetric solid shells of revolution. An iterative procedure is adopted to obtain strain dependent soil properties, using a technique similar to the seismic soil structure interaction analysis performed for the plant site.

The structural model consists of a 3-dimensional finite element thin shell of revolution representation of the containment, pedestal, drywell, base-slab and reactor building, with the additional floors and equipment weights located at appropriate elevations. A direct integration solution procedure is used to solve the dynamic equations of motion in the time domain. The analysis is performed for two operating modes and one upset mode of SRV discharge.

In addition to obtaining the force, moment and deformation plots in the containment structure our task is to obtain frequency-acceleration (response spectra) plots at critical locations in the system. Furthermore, comparisons are made between these responses and the overall seismic responses at the same location, for a similar system, subjected to a prescribed site acceleration. It is noteworthy that though the response due to the latter effect is predominantly in the frequency range 5 to 33 cps, that due to the SRV phenomenon covers a broader range. The consequences of this for the design of secondary systems is also discussed.