

## SOIL-STRUCTURE INTERACTION FOR TRANSIENT LOADS DUE TO SAFETY RELIEF VALVE DISCHARGES

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### SUMMARY

A BWR containment structure can experience severe vibrations when subjected to the transient loads due to the reactor safety relief valve (SRV) discharge into the suppression pool. The dynamic response of the structure has a significant effect on the design of equipment in the containment. This paper presents the results of an analytical investigation on the dynamic response of a BWR Mark II containment subjected to the extreme case SRV discharge loadings, including soil-structure interaction effects.

The Mark II containment is an axisymmetric concrete shell structure supported on a circular base mat. For dynamic response analysis, the entire containment including the reactor pressure vessel, was modelled by an assemblage of axisymmetric finite elements. The foundation soil of the structure was modelled by two distinct foundation models: (a) an axisymmetric finite element model; and (b) a simplified lumped parameter model. Viscous boundary elements were used on the boundary of the finite element foundation model for simulating the energy loss into the farfield. The lumped parameter foundation model was derived from the elastic half-space theory.

The SRV discharge loadings considered were axisymmetric dynamic pressures acting over the wetted surface of the suppression pool derived from the simulation of the extreme case where all SRV discharges were simultaneously activated. The resulting pressure time histories were periodic, having a constant pulse period between 0.1 to 0.2 second. The total duration was 0.75 second and the amplitude varies from pulse to pulse.

A series of dynamic analyses using the direct integration method were performed considering pressure loadings of different frequencies and foundation soil properties varying from very soft to hard rock conditions. The results indicated a consistent significant high-frequency-mode response contribution to the total response of the structure. The soil-structure interaction effect reduced the overall dynamic response substantially. The variation of foundation soil properties showed significant influence on the low frequency response but relatively less effect on the high frequency response. This is because high frequency responses are due to localized shell vibration modes which are insensitive to the variation of foundation conditions.

The dynamic analyses performed using the finite element and the lumped parameter foundation models yield results in very close agreement with each other. The comparison justified the use of the lumped parameter foundation model, thus reducing the analysis effort and cost significantly.

The dynamic response of the structure results in high in-structure response spectral peaks in the high frequency range (40 to 80 cps). These peaks create a severe problem for the equipment design when the usual response spectrum analysis technique, as in the seismic analysis, is used. However, recognizing that the high frequency peaks are caused by localized structure mode responses, the effects of multiple-support motion and equipment-structure coupling, which may be insignificant for the seismic design, can be very significant in this case. Hence, realistic equipment design for SRV discharge loadings should properly consider the equipment-structure coupling effect.