CRITERIA FOR SEISMIC ANALYSIS OF NUCLEAR PLANT STRUCTURES AND SUBSTRUCTURES

M. STOYKOVICH

Gibbs & Hill, Inc., New York, N.Y. 10001, U.S.A.

SUMMARY

This paper encompasses criteria for seismic analysis of nuclear power plant structures such as supporting structures founded on ground as well as substructures. Nuclear power plant equipment can be treated as substructures such as pressure vessels, tanks, heat exchangers, piping systems, cable trays, electrical bus ducts, electrical bus runs among other components.

Since instructure response spectra play an important role in the design and analysis of nuclear power plant components, methods for development of instructure response spectra as well as variations of input parameters considered in determining instructure response spectra are described.

When the principal contribution to the equipment response is due to supporting substructures, an analytical approach to the problem for obtaining condensed stiffness and associated mass matrices of supporting substructures with finite element representation for use in the dynamic analysis of equipment and supporting structures is described. Use of instructure or ground response spectra as well as time history analysis is presented. When supporting structures and equipment, that have inherently different damping properties, are included as integral parts of the dynamic models, the approximate evaluation of the modal damping based on the weighted damping according to the modal energy stored in each component is outlined.

The effects of relative displacements between the support points of substructures and systems in each significant mode of the supporting structures as well as the procedures of combining these responses are detailed. This procedure is based on the fact that when the response spectrum concept of analysis is used, only the maximum modal responses are known and the phasing of modes cannot be determined as in time-history analysis. Therefore, the total response at a point in the multi-degree-of-freedom system can only be approximated. Since only the maximum relative displacements resulting from the structure spectrum analysis are known, they cannot always be used in the flexibility analysis of substructures and systems because the maximum relative displacements do not necessarily yield the most severe differential displacements of the supporting points that will impose maximum stresses in the substructures and systems.

The combined effect resulting from the spectrum analysis, differential displacement analysis and other analyses such as analysis due to thermal expansion among others is considered.