STANDARDIZED SEISMIC DESIGN SPECTRA FOR NUCLEAR PLANT EQUIPMENT

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SUMMARY

Seismic qualification of the equipment and components in a nuclear plant is based on the floor response spectra computed at the equipment support locations. The floor response spectra can be sufficiently characterized by four parameters: (a) the floor spectrum value at low frequencies; (b) the floor acceleration, which represents the floor spectrum value at high frequencies; (c) the frequency location of the major spectrum peaks; and (d) the magnitude of the major spectrum peaks. These parameters are consistently predictable due in part to the fact that nowadays the seismic ground input motion for nuclear plant design is typically specified in terms of broadband, smooth design spectra. This makes it feasible to establish standardized equipment design spectra for engineering use, which not only saves the need for computing every individual floor spectra, but also expedites the equipment purchase for every nuclear job. More importantly, standard, off-the-shelf items such as electrical cable trays, conduits, etc., need to be qualified only once for the standardized design spectra and can then be used by every nuclear plant located in the same seismic zone. This is most desirous in view of the current tendency of standardizing the design of nuclear power plants.

The magnitudes of the floor spectrum peak and the floor acceleration are a function of the ground motion properties, the soil-structure interaction effect, the structure damping, the damping of the floor spectrum, and the height of the equipment support location above the structure base. Although an analytical derivation is impossible, a probable upper bound of these parameters can be deduced both by comparing the actual floor spectra generated for the typical nuclear plant structures and by analytical judgment. The outcome is a set of idealized spectrum peak envelopes established for the different types of structure materials and different spectrum damping values. Presented here are the spectrum peak envelopes for reinforced concrete structures, prestressed concrete structures, and bolted steel structures, for both the Safe Shutdown Earthquake (SSE) and the Operating Basis Earthquake (OBE) conditions. For each combination of the structure material and the design earthquake condition, the spectrum peak envelopes are given for the top, the mid-height and the base.

In actual applications, the applicable spectrum peak envelope is first decomposed into a family of idealized design spectra. Two procedures of decomposition are recommended here, and the choice depends on whether the equipment is to be qualified by dynamic analysis or by dynamic testing.