SEISMIC ANALYSIS AND DESIGN OF ELECTRICAL CABLE TRAYS AND SUPPORT SYSTEMS

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SUMMARY

Electrical cables constitute one of the vital systems of power plants, as they are relied upon for the monitoring, control and operation of a great number of safety-related equipment. This consideration imposes certain requirements and restrictions on the design of the trays on which the cables are laid and the supports of these trays.

Typical values of natural frequencies obtained from modal analysis and static deflection tests for commonly used trays indicate that when loaded close to capacity trays would, in many instances, have natural frequencies within the resonant range for most types of power plant structures. Consequently, trays are expected to respond to the earthquake excitations transmitted through the building and supports with relatively high levels of amplification. Because of the difficulties of achieving sufficient rigidity to hold the response outside the resonant range, trays must be selected on the basis of structural strength, and their ability to withstand the amplified seismic accelerations must be verified. A thorough analysis for qualifying a tray must take into consideration the properties of sections and material of which the siderails and rungs are made, the connections between the siderails and the rungs, splices, etc., and various modes of failure such as common flexure, buckling, web crippling, etc., in accordance with the AISC and AISI Design Codes. Testing is considered to be a more reliable means of predicting the load carrying ability of trays, especially when their shapes and form of construction are not simple.

Trays are tested under static loads derived from an analysis of the support and tray system. Uniformly distributed loads in the normal and lateral directions are applied to typical tray specimens, simply supported with spans equal to the intended spacing of the support frames. In addition, axial compression tests are performed. The ultimate capacity of a tray can thus be determined under each of the three principal loadings. The test results provide a basis to which the combined effects of dead load and seismic loads from three directional earthquake excitations can be compared by means of an interaction formula.

The effects of continuity cannot be counted on to induce an appreciable increase in the frequency of the system because in dynamic loading, as opposed to static, a continuous beam deflects in an infinite number of modes, each associated with a certain natural frequency and damping resulting from geometric and material properties, and an amplitude resulting from the imposed forcing function or excitation.

The supporting frames for trays or groups of trays must be designed to have adequate rigidity in order not to cause additional amplification of the seismic accelerations transmitted to them by the building structures. In addition, they must be designed to withstand all seismic loads obtained by the analysis of the system.

The analysis of the dynamic characteristics of typical trays indicates that cable tray systems are subject to high seismic loads. The selection of trays must be based on tests to verify their structural strength. The design of a rigid support system is found essential.