SEISMIC EVALUATION OF VALVES FOR NUCLEAR POWER PLANT (NPP) APPLICATIONS

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Abstract

Paper describes development of methodology for seismic evaluation of valves used in nuclear power plants towards structural integrity assessment. Paper also discusses case studies how to apply the FEM analysis procedure in conjunction with the ASME B&PV (boiler and pressure vessel) codes. Care to be taken in the design checks, analysis procedures and sources of common mistakes during structural integrity assessment are described.

A Nuclear Power Plant (NPP) has variety of Systems, Structures and Components (SSCs) namely tanks/ vessels, pumps, valves, blowers, etc. These SSCs are classified as Class-1, Class-2 and Class-3 equipment based on their function and safety significance. It is required to qualify these SSCs for various loads that they are subjected to during its life. In this paper, the qualification of valves for different operating loading conditions and seismic loads will be discussed. The normal operating loads include dead weight, pressure, temperature and nozzle loads. Seismic analysis will be carried out for two levels of earthquake namely Operating Basis Earthquake (OBE) and Safe Shutdown Earthquake (SSE). The qualification of valves should meet two requirements namely structural integrity and pressure boundary integrity and intended functional operability. It is required that the valves continue to perform the intended function during and after earthquake. The qualification of valves for various service conditions will be carried out as per ASME B&PV, Sec III.

Finite element analysis will be carried out for the seismic qualification of valves. The valves will be modelled using second order brick elements. The mass of hand wheel or actuating device will be considered as a lumped mass at its COG. The valve will be analysed for static loads like dead weight, design pressure, nozzle loads. The temperature distribution in the valve due to fluid flow will be obtained by steady state analysis. The thermal stress due to the fluid flow will be arrived at from the temperature distribution obtained using steady state analysis. Seismic analysis can be done using either response spectrum method or equivalent static method depending on the first natural frequency of the valve.

Various loads will be combined for different service level and qualification as per ASME B&PV, Sec III. Stress levels determined by FEA will be compared with stress limits as per codes to determine structural integrity.