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DESIGN AND SEISMIC EVALUATION OF A HIGH TEMPERATURE PRESSURE VESSEL (NUCLEAR RESEARCH) AT SODIUM TECHNOLOGY COMPLEX (FAST BREEDER TEST REACTOR)

A test vessel for sodium technology cell has been designed to work at operating temperature of 600C and an internal pressure as per functional requirement. Shell, nozzles, flanges, welds, bolts, support plates were designed as per provisions in ASME B&PV Code. Vessel was made out of SS 316 LN material.

For seismic evaluation of the design, a finite element analysis (FEA) model of the pressure vessel was created. Initial and boundary conditions as per operating requirements were imposed on the finite element model. These included dead weight, live load, pressure, temperature, earth quake loads, etc. Floor Response Spectra (FRS) as specified by the customer (IGCAR) was considered for the specific mounting elevation of the vessel in the building.

Finite element analysis was carried out as per ASME B&PV Code Section-III provisions, for various load cases and combinations (different service levels). Subsection ND and NF of section-III of ASME code were used for qualification of vessel components and supports respectively.

Eigen value analysis was performed, to obtain eigen values and mass participation for free standing (without sodium in the tank). For the case with liquid sodium filled in the tank sloshing effect was modelled using Housner's Model. Natural frequencies / modes were determined in all three directions.

Dynamic analysis is carried out using response spectrum method with missing mass correction. A pre-determined cut-off frequency was used. For modal analysis responses were combined using Complete Quadratic Combination (CQC). For directional combination, Square Root of Sum of Squares (SRSS) method was used. A critical damping of a specific percentage (%) was considered as per standard industry practices. Stress linearization was done to separate the membrane, and membrane + bending stresses. Stresses were compared with the allowable stresses as per various subsections of ASME Section-III Division-I NF. Shear, Tensile and compressive stresses computed by finite element analysis are compared with the allowable stress as per code to verify the seismic qualification of the test pressure vessel.

Evaluation of all the components of the test pressure vessel, bolts, supports, welds were carried out and found to be qualified under prescribed seismic excitations.