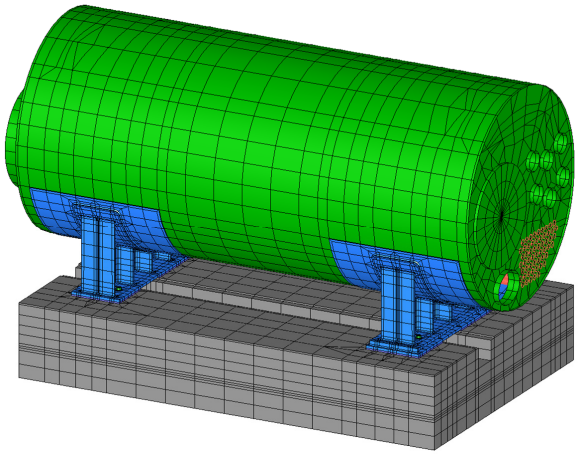
SEISMIC QUALIFICATION OF STEAM BOILER PACKAGES

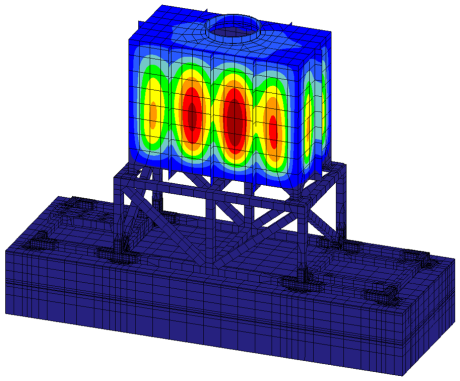
Besides the obvious requirement to safely contain defined internal and/or external pressure loading, pressure vessels must also be able to withstand the effects of all other potential load sources. At sites deemed to be located in seismically active regions, seismic ground accelerations may generate significant stress levels and can often limit certain aspects of the vessel design such as supports and anchorage arrangements. FCL's staff have many years of experience in the seismic qualification of pressurised equipment and are thus highly qualified to advise on projects of this nature.

A recent example of such work involved the seismic qualification of a set of three-pass steam boilers and associated hotwell tanks, feedwater pump skids and blowdown vessels, which were to be installed within new steam boiler houses being built at the Hinkley Point B and Hunterston B AGR nuclear power stations. The aim of the work was to establish whether the boiler packages were able to safely withstand a Design Basis Earthquake (DBE) for 'bottom line plant' – equipment essential for the continued safe operation of the power station – and the assessment therefore represented a key part of the safety case for the new plant.



In order to obtain an accurate prediction of stress levels arising in the boilers and associated items under the combined influence of internal pressure, self weight, contents weight, piping loads and seismic accelerations, the work was based on the results of a series of three-dimensional linear elastic finite element stress analyses carried out using Pro/MECHANICA (now CREO/Simulate) finite element software. In each case these analyses included detailed consideration of the interaction between the equipment supports, the anchor bolts and the foundation via contact methods, with solid elements used in all areas of principal interest to ensure the accuracy of calculated stresses. Elsewhere, shell and beam elements were used to represent those areas of the structures where seismic loading was not expected to limit to reduce modelling effort and to make more efficient use of computational resources.

Modal analyses were used to identify the fundamental natural frequency of each item, with seismic loading then idealised using the equivalent static force method with peak spectral accelerations obtained from the bottom line response spectra established for the site. Predicted stresses were assessed primarily using rules in PD5500 Annex A, although allowable stresses for the boiler were established in accordance with the appropriate code of construction, BS EN 12953. Initial work identified a need for a number of design modifications to the boiler supports and to the hotwell tanks, but after the incorporation of recommended changes the formal documentation produced by FCL permitted our client to successfully demonstrate the adequacy of the boiler packages to the relevant authorities.



FINGLOW CONSULTANTS LTD
Beane Bridge House, 34 Chambers Street, Hertford, SG14 1PL, UK
Telephone: +44 (0)1992 585450
Facsimile: +44 (0)1992 585460
e-mail: fcl@finglowconsultants.co.uk
website: www.finglowconsultants.co.uk