STRUCTURAL ANALYSIS OF THE JT60-SA CRYOSTAT BASE

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JT-60SA is a superconducting tokamak to be assembled and operated at the JAEA laboratories in Naka (Japan). The tokamak is designed, manufactured and operated under the funding of the Broader Approach Agreement (between the government of Japan and the European Commission) and of the Japan Fusion National Programme; JT-60SA aims to prepare, support and complement the ITER experimental programme. The European contribution to the JT-60SA is, for a large fraction, procured by France, Germany, Italy, Spain and Belgium. Within this framework, Ciemat is in charge of the design and manufacturing of the JT-60SA cryostat.

The JT-60SA cryostat is the stainless steel metallic vacuum vessel (14 m diameter, 16 m height) which encloses the tokamak provide a vacuum environment (10^{-3} Pa) necessary to limit the transmission of thermal loads to the components at cryogenic temperature and it has to support the external pressure load during normal operation, and accidental overpressure. For transport and assembly reasons the JT-60SA cryostat consists of two main parts, namely the cryostat base and the cryostat vessel body.

The cryostat base, which acts as the foundation of the tokamak, has the most demanding structural requirements since it supports the mechanical loads (gravity, seismic actions, and electrodynamic forces) applied by the vacuum vessel and the superconducting magnets through their supports.

The paper summarizes the finite elements structural analyses performed by Ciemat to evaluate and validate the mechanical behavior of the JT-60SA cryostat base final design.

The overall structural integrity of the cryostat base has been verified and confirmed utilizing the 'limit analysis' approach, according to ASME VIII rules and procedures. The method is based on the application of all design loads, with specified combinations and safety factors, and the performance of non-linear analyses with elastic-perfectly plastic material properties, allowing a more realistic structural assessment in presence of localized stress concentrations. The analyses have been complemented by finite element analyses modeling the material in elastic regime and detailing the fasteners nonlinear behavior, evaluating, mainly, the performance of bolted connections, as well as the deformation of the overall structure.