ITER Cryostat - An Overview and Design progress

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The ITER Cryostat is one of the most important & critical systems in the ITER project because it envelops the entire basic systems of the tokamak and is a vacuum tight container. Cryostat provides vacuum environment for the thermal insulation to magnet system operating at 4.5k and thermal shield system operating at 80k. It is evacuated to a pressure of 10^{-4} Pa prior to cool down of the magnets and thermal shields in order to limit heat transfer by gas conduction and convection to a level tolerable to the cryogenically cooled components. The cryostat is also designed to transfer all the loads like gravity, seismic etc. that derive from the tokamak basic machine, and from the cryostat itself, to the floor of the tokamak pit through its support structures during the normal and off-normal operational regimes, and at specified accidental conditions.

ITER Cryostat is a fully welded cylindrical vacuum chamber with top dome shape lid and bottom flat head. It has many penetrations to allow the passage of all the components and systems that are required to operate and maintain the tokamak and the cryostat.

Cryostat is assembled with its axis vertical and has overall dimensions, ~28 meter Diameter and ~29 meter height with a shell thickness ~50 mm. The ASME Section VIII Division-2 shall be used as a reference code for design, construction and testing of the cryostat. The material of construction of cryostat is stainless steel 304L grade.

The ITER Design Review has been carried out in 2007 to update the baseline. The Cryostat design is also reviewed to validate structural and performance requirement for vacuum containment vessel, In-Cryostat maintenance and integration of interfacing systems penetrations. The Cryostat design was updated to a dome shape vessel and additional structural analysis has been performed including buckling and seismic analysis. Recent off-normal event analysis shows that the maximum design pressure is less than 0.15 MPa (Maximum absolute pressure in Cat- I, II and III events) and it is concluded that PED (Pressure Equipment Directive) is not applied to the ITER cryostat.

Detailed design and analysis of the Cryostat is being done. The Cryostat structure is analyzed and checked for structural integrity under different loading conditions like external pressure, gravity, seismic load, electro-magnetic, thermal and its combinations. The global FE analysis of full 360^0 model is performed and deformation and stresses are found to be within limit. Buckling margin and collapse load factor is also obtained under various load conditions. The structural soundness of Cryostat support structure such as skirt support, shear lug and pedestal column is evaluated for horizontal seismic loads. The toroidal force experienced by shear lug is ~5MN, and vertical force and moment experienced by the pedestal column during vertical and horizontal seismic excitation has been obtained.

This paper discusses the up-dated Cryostat design and analysis with integration of the different penetrations required for the communication within the In Cryostat system and its maintenance.

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