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Development and Validation of Cryostat Finite Element Model with Unique FE Method

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The ITER Cryostat, the largest stainless steel vacuum pressure chamber ever built which provides the vacuum confinement to components operating in ITER ranging from 4.5 k to 80 k. Cryostat Design Model was qualified[1] by ITER. As a Safety Important Class system, Design qualification at every change in its development and installation phases is mandatory. The Cryostat system is currently at manufacturing stage, several Deviation request are being reported e.g. tolerances change, ribs modification etc. These changes affect the behavior of Cryostat which needs re-assessment. The conventional design approach in Finite Element method (FEM) needs significant time and effort, as incorporation of changes calls for redevelopment of full mathematical model.

In this paper a "unique method"of developing FE model for complex systems like Cryostat is presented, which typically addresses above need and the method is qualified with results of Cryostat engineering model (CEM)[1,2]. This unique method involves dividing and meshing of the big components in to sub components, so the full Cryostat is divided into 30 sub components and mathematical models of these individual components are developed. These sub components are integrated using suitable constraint equations to create full FE model[3,4]. Then the integrity of model is assessed using the modes shapes. This unique method enables to incorporate component level changes without affecting the full FE model, thus saving time and efforts of re-development of mathematical model.

For qualification of developed FE model category II loading and selected load combinations are applied. The results obtained are in close approximation with CEM results[1,2]. As the present need was to address the changes of manufacturing model, so further Cryostat manufacturing FE model (CMM) is developed with this unique approach. It is then analyzed for category II loading and selected load combination.

This paper gives detailed insight about the developing and qualification of the Unique Method and details of the analysis results of CMM.

Reference

[1]ITER Cryostat—an overview and design progress, Fusion Engineering and Design 86(2011)1924–1927

[2]The structure analysis of ITER Cryostat based on the FEM, Fusion Engineering and Design 88(2013)42–45

[3]Instructional Material Complementing FEMA 451, Design Example, SI- 15-7-53

[4]ANSYS code help

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