Contribution ID: **730** Type: **not specified**

P2.159 Electromagnetic Analyses and One-Dimensional Modeling of Piping Applied to Optimization of ITER Blanket Manifold Design

Tuesday, 18 September 2018 11:00 (2 hours)

A significant analysis effort was undertaken to address the challenging ITER Blanket Manifold design requirements resulting from electromagnetic (EM) major disruptions and vertical displacements events in a very demanding neutronic environment.
The effort was focused on maintaining the structural integrity of the component itself and minimizing the loads transferred to the Vacuum Vessel to meet the requirements for the categorization of the welding between the Blanket Manifold supports rails and the Vacuum Vessel.
The complexity of the component, consisting of 360 cooling circuits (and their supports) attached to the rear side of 440 Blanket Modules and hydraulically connected to the Blanket Modules through a Coaxial Connector, required a detailed study of the current paths involving the pipes, the supports and the Vacuum Vessel, to determine the layout of electrical connections and enable the minimization of electromagnetic loads.
To this aim, a dedicated EM "wire element" was developed and validated for piping modelling. The "wire element" assimilates the pipe to a 1-d structure with equivalent electromagnetic properties, being able to represent accurately all the electromagnetic phenomena taking place in the pipe itself (i.e. both its inductive and its resistive behaviour). The use of 1d-wire elements was necessary in view of the large number of EM load cases to be run and of the complexity of the toroidal and poloidal paths of the pipes, which would have made a full 3D modelling unmanageable.
The EM analysis campaign performed led to the conception of an optimized layout of the electrical connections within the Blanket Manifold and between Blanket Manifold and Vacuum Vessel, which provided a simpler and much faster means to analyse different scenarios in order to minimize the loads transferred to the Vacuum Vessel and maintain the structural integrity of the Manifold.

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Session Classification: P2