Contribution ID: **285** Type: **not specified**

Preliminary RAMI assessment for ITER test blanket module ancillary systems

Monday, 17 September 2018 11:00 (2 hours)

A RAMI (Reliability, Availability, Maintainability and Inspectability) assessment performed on the ITER Test Blanket Module ancillary systems is presented. The assessment is aimed at evaluating design criticalities possibly jeopardizing the achievement of the overall 75% availability requirements for the considered ITER plant. The Ancillary systems of the European Test Blanket Systems for ITER here analysed are the helium cooling systems (HCSs) of both the Helium Cooled Lithium Lead (HCLL) and Helium Cooled Pebble Bed (HCPB), lithium-lead loop of the HCLL TBM and the Tritium Extraction System (TES) of the HCPB TBM.
Reliability and availability performance were assessed by means of reliability block diagrams (RBDs) over a foreseen mission of 11 days and 20 years respectively, with operating cycles reflecting ITER schedule. In particular, a set of events leading to unavailability of the systems was initially defined by means of a failure mode and effect analysis. Then RBDs were implemented according to reliability-wise integration of the components included in such systems. Different RBDs were defined depending on the component judged to impact normal operation or start-up operation mode.
Systems analysis was performed exploiting a modular approach in order to elicit the relative contribution of specific components to the system availability so to support possible design improvement by highlighting critical sub-systems. In particular the cooling, tritium extraction and trapping functions were assessed separately for HCLL and HCPB concepts.
Both HCLL and HCPB ancillary systems presented design resulted able to achieve the availability and reliability targets with performance ranging from 83% up to 99% for reliability at 11 days and from 89% up to 99% for mean inherent availability. Finally the integrated impact of all ancillary systems on overall tokamak operational availability was estimated and the assessed systems, also considering the current preliminary level of design development, appear able to match expected performance.

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Session Classification: P1