

Thermal Analysis of Protection Important Components of ITER XRCS-Survey Diagnostic System

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In the ITER, an important aspect of qualifying the components to the mandatory regulatory requirements, the system developers have a challenge to first design the components fulfilling guidelines of the ITER recommended French nuclear code RCC-MR (2007) and later on demonstrate to the regulator. It is even more involving for systems that are extending primary vacuum to the interspace and port-cell as these zones are accessible by a human. The paper addresses such requirements in the thermal design of the X-Ray Crystal Spectroscopy-Survey (XRCS-Survey) system, which is a first plasma diagnostic.

The XRCS-Survey is a broadband (1 - 100 Å) X-ray crystal spectrometer for real-time monitoring of absolute concentration and in-flux of the plasma impurities. For measurements, the transport of x-ray emission is done using a nearly 10m long sight-tube directly connecting the spectrometer to the closure plate of the port-plug. The sight-tube components, classified as Protection Important Components due to their function in confinement of radioactive tritium and dust, are subjected to various thermal loads while machine operations. These loads are mostly due to baking to achieve ultra-high vacuum inside the ITER vacuum vessel. Furthermore, the components are also subjected to a neutron, gamma radiation of D-T fusion.

For reliable performance and safe operation of XRCS-Survey diagnostic, a preliminary engineering design and ANSYS analysis of the XRCS-Survey sight-tube components have been performed, with and without radiation shielding, in order to analyze the behavior of components under baking heat loads, operational heat loads and also accidental fire heat loads.

The paper presents an optimized design layout for the sight-tube of XRCS Survey and results of the thermal analysis; defining temperature limits to observe compliance with safety criterion defined by ITER regulatory guidelines on PIC (class SIC-1) components as well as providing inputs to the structural integrity analysis of the system.

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