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REQUIREMENTS FOR MANUFACTURING OF SEALING FLANGES OF THE ITER VACUUM VESSEL UPPER PORTS ^{*)}

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The concept of constructing the ITER tokamak reactor, which provides for phased installation and regular scheduled maintenance of the in-vessel elements, requires the equipment of detachable high-vacuum seals for the vacuum vessel ports and diagnostic port plugs. Vacuum sealing of the ports is provided by double Sealing Flanges (SF) integrated with the diagnostic port plugs and Temporary Closure Plates (TCP) used at the initial stage of the ITER project. Vacuum tightness is provided by the leap seals and, at the initial stage of experiments, with elastomer and metallic (Helicoflex) gaskets [1].

Sealing flanges and closure plates are manufactured accordingly with the ITER Quality Assurance Program (Quality class QC-1) and high vacuum requirements (VQC-1A), with leak rate less than 1×10^{-10} Pa m³ s⁻¹. Baking temperature of the Sealing Flanges 200 - 240 °C. Usage of the metallic gaskets requires enhanced tolerances, including maximum deviations +/-0.5mm, flatness 0.4/1000mm and design roughness 0.8µm Ra (ISO 4287) Max/Min = 1.0 / 0.4 µm Ra (APB2&4_01).

Design, manufacturing, and testing of the Sealing Flanges are provided according with the Codes and Standards of RCC-MR 2007 [2]. Double Sealing Flanges with fastenings are components important for the nuclear safety and are classified as PIC/SIC-1. Closure Plates are equipped with the heating water pipes attached at the outer TCP surface and are classified as Nuclear Pressure Equipment (PED Module A Category 1). Two NCP types are used: Type1 with elastomer gaskets used at the initial stage of ITER construction (non-PIC components) and Type2 with metallic gaskets provided sealing at the subsequent stages and considered as nuclear safety PIC/SIC-1 class. Fastenings providing fixation of the port plugs are considered as PIC/SIC-2 components.

Due to enhanced radiation (tritium, dust) and activation of the Sealing Flanges and due to large dimensions and heavy weight of the components, installation of the Sealing Flanges is provided by remote handling equipment (RH Class 3).

Main materials used in the Sealing Flanges Manufacturing are stainless steel 304L and alloy Inconel 718 (AHMGDY v2.1), manufactured according to IO specifications.

Manufacturing of the Sealing Flanges and Closure Plates is provided according to the ITER Vacuum Vessel Upper Ports Procurement arrangements PA1.5.P2B.RF.01 in compliance with Manufacturing and Inspection Plans (MIP). Main operations of the MIPs are supervised by RFDA Project Center ITER and IO ITER to ensure Quality and Nuclear safety requirements. The main supplier is JSC NIIEFA, which provides the entire range of development and research work necessary for manufacturing of Sealing Flanges and Closure Plates for Upper Ports according to the schedule provided by ITER IO.

References

- [1]. Yu.Utin et al., Fusion Engineering and Design, Vol.98–99, 2015, p.1643.
- [2]. RCC-MR 2007 Design and Construction Rules for Mechanical components of nuclear installations edited by AFCEN, <http://afcen.com/en/publications/rcc-mrx/69/rcc-mr-2007>

^{*)} [abstracts of this report in Russian](#)