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Manufacturing experience and commissioning of Large Size UHV Class Vacuum Vessel for Indian Test Facility (INTF) for Neutral Beams

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Indian Test Facility (INTF) is designed for “Full characterization of the Diagnostic Neutral Beam (DNB)” for ITER, to unveil the possible challenges in production, neutralization and transportation of neutral beam over the path length of ~20.67m. This facility consist of a vacuum vessel (with volume >180m³) which has been designed and manufactured as per the rules of ASME Sec.VIII Div. 1, to house and provide an ultra-high vacuum (UHV) environment for DNB operational components i.e Beam Source, Beam Line Components, High Voltage Bushing.

As per functional requirements, INTF vessel is fabricated from AISI 304L, in cylindrical shape (4.5mD,9mL), with the unique attribute of ‘detachable top lid’ to allow access for internal components during installation and maintenance. As per the best of authors’ knowledge, it is the biggest UHV vessel with this configuration realized ever, it was therefore essential to establish a systematic approach when moving from the ‘non-conventional design’ to ‘non-conventional manufacturing’. During this manufacturing, top lid is cut from the shell itself, which demands controlling the deflection, arising due to stress relaxation caused by welding and shell rolling. This deflection has been controlled by installing the specially designed fixture. Further, distortion monitoring during the welding of large flanges was carried out and following to that machining parameters was controlled to achieve the flatness ~1.2mm over the vacuum sealing periphery of 9mx5m for achieving leak rate 10⁻⁹ mbarl/sec.

Following fabrication, vacuum level of 8E-06 was demonstrated with local and global leak rates of 1E-09mbarl/sec and 1E-07mbarl/sec respectively. This paper presents the experience and methodologies generated in the establishing the manufacturing protocols to achieve the distortion control, deflection requirements and vacuum demonstration for large size UHV vessel with detachable top lid configuration. The learnings during this manufacturing are expected to be useful for ongoing and upcoming equipment with similar challenges.

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