DESIGN OPTIMIZATION OF THE 100 KV HV BUSHING FOR ITER-DNB

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The 100 kV HV Bushing (HVB) of the Diagnostic Neutral Beam (DNB) injector provides all necessary services - like gas feed, water cooling pipes, electrical busbars and RF transmittance lines - to the beam source. It is a cylindrical feedthrough which forms the interface between the gas insulated transmission line and the torus primary vacuum as shown in Fig. 1. As it is part of the vacuum envelope of the DNB vacuum vessel, which is directly connected to the tokamak, it is part of the first containment barrier and hence it is classified as a Safety Important Component (SIC). All protocols of safety have been taken into account in its design and the choice of materials as well as considering the voltage holding requirement, vacuum compatibility and the ionizing radiation from the tokamak plasma.



Figure 1 DNB High Voltage Bushing

Finite Element Analyses (FEAs) for the electrostatic and the structural configuration were carried out to validate the design of the HVB and several iterations and optimizations of the stress shields were carried out to meet electrostatic criteria, especially at the Triple point (the ceramic, metal and vacuum connection point), which is critical for good voltage holding. The calculated electrostatic stress for the present configuration is well within the safe limit (3 kV/cm).

Structural analyses were carried out to assess the stress distribution in the fiber reinforced plastic insulator, the alumina insulator and the integrated structure in its operation orientation (horizontal), during commissioning, operation and under seismic conditions. For the worst case, the maximum stress obtained was 117.6 MPa at a deflection of 2.7 mm which is acceptable. SL2 seismic analysis for this SIC component indicated that the maximum stress (8.42 MPa) and deflection (0.04 mm), obtained in the vertical direction, were within acceptable limit.

Engineering and manufacturing feasibility studies are presently underway of this relatively complex component. This paper shall present the design of HV bushing and highlights the optimization carried out.