THERMAL STRESS ANALYSIS OF FIRE DIVERTOR MODULE*

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The FIRE device is designed for high power density and advanced physics operating modes. Due to the short distance of the divertor from the X–point, the connection lengths are short and the SOL thickness is small. A relatively high peak heat flux of 25 MW/m^2 is expected on the divertor.

The FIRE divertor engineering design is based on design approaches developed for ITER. The geometry of the FIRE divertor consists of water cooled copper fingers and a tungsten brush armor as plasma facing material. A swirl tape insert is used in the cooling channels to increase the critical heat flux (CHF). The assembly consists of modular units for remote handling. A 316 stainless steel back plate is used for support and manifolding. The backing plate is joined to the copper fingers by pins which can slide axially in slots. The coolant channel diameter is 8 mm at a pitch of 14 mm. A peak heat flux of 25 MW/m^2 is expected on the surface of the outer divertor.

The total power flow to the outer divertor is 35 MW. With water at an inlet temperature of 30°C, 2 MPa and a flow velocity of 10 m/s and two channels in series, a margin of about 1.5 is obtained on the CHF.

Thermal hydraulic correlations derived for ITER were used to perform the thermal analysis. A three dimensional thermal stress finite element (FE) analysis of this geometry was performed. Design changes were made to reduce the stresses and temperatures to acceptable levels.

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*Work supported by U.S. Department of Energy under Contracts DE-AC03-98ER54411 and DE-AC04-AL85000.

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