MANUFACTURING AND TESTING OF A DIVERTOR BAFFLE MOCK-UP WITH BERYLLIUM ARMOUR

M. Merola¹, A. Erskine², K. Cheyne², P. Sherlock², M. Rödig³, W. Kühnlein³

¹EFDA Close Support Unit, Boltzmannstr. 2, D-85748 Garching, Germany
²NNC Ltd, Warrington Rd, Risley, Cheshire, WA3 6BZ, UK
³Forschungszentrum Jülich, D-52425 Jülich

This paper describes the manufacturing, the high heat flux testing and the destructive examination of a beryllium armoured mock-up manufactured by NNC Ltd under EFDA contract and tested at JUDITH facility in FZJ. The mock-up had a straight geometry, and an overall length and width of 146 and 24 mm, respectively.

The cooling tube (10/12 mm ID/OD) was made of dispersion strengthened copper (DS-Cu), type GlidCop, and had a 0.2-mm thick stainless steel liner joined by Hot Isostatic Pressing (HIP) at 940 °C, 2 hrs, 140 MPa.

The heat sink consisted of two half-plates, made of GlidCop, with two grooves obtained by machining where the cooling tube was inserted. During this HIP cycle, at 940 °C, 2 hrs, 140 MPa, a stainless steel back plate was also joined on the rear side of the heat sink.

The final step consisted in the HIP of the armour onto the heat sink at 580 °C, 2 hrs, 100 MPa. The armour was made of beryllium tiles with a width, axial length and thickness of 24, 20 and 4 mm, respectively. Each tile had a 2-mm deep castellation of approximately 6 x 6 mm obtained by EDM.

Ultrasonic examinations were performed after each joining process as well as pressure and leak test on the final component.

During the high heat flux testing, the mock-up endured 100 cycles at 1 MW/m², 100 cycles at 2 MW/m², 1000 cycles at 3 MW/m² and 1000 cycles at 5 MW/m² before overheating was observed after 90 cycles at 7 MW/m². It is worth mentioning that the divertor baffle has a design heat flux of 3 MW/m², which is well below the achieved experimental values.

Final destructive examinations revealed that the failure occurred not in the armour to heat sink joint but in the joint of the two half plates forming the heat sink.