Actively cooled plasma facing components qualification, commissioning and health monitoring (O3A-F-171)

Frederic ESCOURBIAC(1), Alain Durocher(1), André Grosman(1), Xavier Courtois(1), Jean-Luc Farjon(1), Jacques Schlosser(1), Mario Merola(2), Richard Tivey(2)

1. Association Euratom CEA, CEA/DSM/DRFC Cadarache 13108 St Paul Lez Durance France
2. ITER Garching Joint Work Site, Max-Planck-Institut für Plasmaphysik Boltzmannstrasse 2 D-85748 Garching Germany

In modern steady state magnetic fusion devices, actively cooled plasma facing components (PFC) have to handle heat fluxes in the range of 10-20 MW/m². This generates a number of engineering constraints: the armour materials must be refractory and compatible with plasma wall interaction requirements (low sputtering and/or low atomic number); the heat sink must offer high thermal conductivity, high mechanical resistance and sufficient ductility; the component cooling system -which is generally based on the circulation of pressurized water in the PFC's heat sink -must offer high thermal heat transfer efficiency. Furthermore, the assembling of the refractory armour material onto the metallic heat sink causes generic difficulties strongly depending on thermo-mechanical properties of materials and design requirements. Life time of the PFC during plasma operation are linked to their manufacturing quality, in particular they are reduced by the possible presence of flaw assembling. The fabrication of PFC in an industrial frame including their qualification and their commissioning - which consists in checking the manufacturing quality during and at the end of manufacture - is a real challenge. From experience gained at Tore Supra on carbon fibre composite flat tiles technology components, it was assessed that a set of qualifications activities must be operated during R&D and manufacturing phases. Dedicated Non Destructive Technique (NDT) based on advanced active infrared thermography was developed for this purpose, afterwards, correlations between NDT, high heat flux testing and thermomechanical modelling were performed to analyse damage detection and propagation, and define an acceptance criteria valuable for industrial application. Health monitoring using lock-in technique was also recently operated in-situ of the Tore Supra tokamak for detection of possible defect propagation during operations, presence of acoustic precursor for critical heat flux detection induced by defect propagation is also investigated.

PFC qualification, commissioning and health monitoring will be discussed in this paper and illustrated by experimental data and modelling from the Tore Supra experience and studies on the monoblock geometry for the ITER divertor vertical target.