

European Test strategy for Test blanket modules to be tested in ITER

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There are two European Test Blanket Modules (TBM) a Helium Cooled Pebble Bed (HCPB) and a Helium Cooled Liquid Lead (HCLL). During 2003 both concepts were redesigned with the goal to use as much as possible similar design options and fabrication techniques for both types in order to reduce the European effort for TBM development. The result is a robust TBM box being able to withstand 8 MPa internal pressure in case of in-box LOCA, filled with typically 18 and 24 breeding units (BU), for HCPB and HCLL respectively. A breeding unit has about 200 mm in poloidal and toroidal direction and about 400 mm in radial direction. The TBM box consists of First wall (FW), caps, stiffening grid and manifolds. The BU's have a back plate and different types of cooling plates in the radial toroidal plane.

The test strategy starts with the qualification of the fabrication processes for the important subcomponents. These are Hot Isostatic Pressing (HIP) to make the caps, stiffening grid and FW, for the latter also the bending of the plate has to be tested. Another important item is the qualification of TIG welding process with additive wire. This is new for the EUROFER steel to be used for the TBM's. Clarification of this question has an important feedback on the weld design and preparation. Finally a small demonstrator is to be produced where FW, stiffening grid and caps are welded together to see the quality of the welds produced under more realistic conditions.

In the next step special problems were investigated like a) flow distribution in the TBM manifolds and the mass flow distribution in all the channels; b) thermal stresses of pebble beds in a BU interacting with the adjacent cooling structure c) losses for the HCLL flow in a magnet field under typical conditions.

The third type of tests are integral tests of testing in large Helium facilities simulating the boundary conditions in ITER. These steps are mandatory to qualify such a component which should be inserted in ITER without jeopardising availability or safety of this machine.

For the tests in ITER of the HCPB concept four different types are foreseen. The first, the so called Electro Magnetic (EM) module is used in the initial phase of ITER, without neutron flux. This allows checking the computer codes, used for predicting the electromagnetic forces. At the same time typical characteristics of the Helium coolant system can be tested.

The second module, used from the D-D plasma phase of ITER is to test the codes for the neutron transport and interaction with the module and the Tritium generation rate.

The third module is to check the knowledge of pebble bed behaviour and its interaction with the steel cooling plates. Thermal properties and mechanical questions have to be answered, for the latter especially the interplay of swelling and creep under the constraints of temperature field and mechanical enclosure.

The fourth module finally is thought to be kind of a demonstrator. It should show the possibility of breeding sufficient Tritium for continuous power process, the high grade of heat being extracted and the stable operation under different loading conditions.