

Development of PFD simulation tools for transient tritium transfers and system inventories modeling of HCLL TBMs and DEMO auxiliaries

R. Tona^{a*}, C. Moreno^b, L. Mesquida^a, E. Serra^a, R. Nomen^a, Julià Sempere^{a*}, L. Sedano^b

^a *IQS Universitat Ramon Llull. Via Augusta, 390, 08017, Barcelona, Spain.*

^b *EURATOM-CIEMAT Fusion Association, Av. Complutense 22, 28040 Madrid, Spain.*

e-mail: rodolfo.tona@iqs.url.edu

The demonstration of tritium self-sufficiency of future DEMO reactors is a major milestone for fusion technology to be tested in ITER Test Blanket Module (TBM) programmes. TBM tritium testing exploitation in ITER needs of validated Process Flow Diagrams (PFD) numerical simulation tools. PFD simulation tools should be as far as possible developed and validated as “predictive”. “Predictive” goal represents a very ambitious goal of tritium fusion technology. A blind testing of the PFD modelling tools prediction capabilities in ITER represents a major test of prediction qualities and of the reliable understanding of tritium transport phenomena under a realistic blanket environment. Furthermore it means the certitude of extrapolation capabilities to DEMO breeding blanket design. The development of similar tools at both, TBM and DEMO operational ranges appear as a reasonable R&D strategy.

PFDs balancing dynamically transferred T atoms below 0.1% at both, TBM and DEMO scale levels have been developed in CIEMAT and IQS based on TMAP7 (as the unique tritium transport modelling tool having ITER QA pedigree) and commercial Aspen+® software largely used in chemical engineering, respectively. Current PFDs models includes refined coupling of primary coolant chemistry control and EUROFER permeation properties through the surface state of oxidation based on Ellingham’s diagrams.

Aspen+® library of modules are generated as a new set of operating blocks. The modular nature of PFD tool with both TMAP7 and Aspen+® solutions permits system scale sizing analyses of reference operational ranges. TMAP7 and Aspen+® solutions are compared for PFD modelling tool bases at both, ITER-TBM and DEMO scales for HCLL, designs and reference runs.

The scope of the results and the projection of the model capabilities for the design of systems are discussed.