Journal of Nuclear Materials 406 (2010) 1

Contents lists available at ScienceDirect

Journal of Nuclear Materials

journal homepage: www.elsevier.com/locate/jnucmat

Editorial

Development of numerical simulation tools in the Euratom Framework Programmes

Several research projects aiming at the development of numerical simulation tools have been funded in nuclear fission and radiation protection in the 6th Euratom Framework Programme (FP6) (2002–2006). This trend continues under the 7th Euratom Framework Programme (FP7) (2007–2011). These simulation tools need to be validated against an adequate set of experimental data. Numerical simulation is used in several areas such as irradiation damage of reactor components, basic understanding of fuel behaviour, nuclear reactor operation, severe accident management and decision support systems for nuclear and radiological emergency management.

The integrated project PERFECT in FP6 was aiming at developing multi-scale numerical tools able to simulate the effects of irradiation on the material (low alloy steel and austenitic steels) microstructure and also on their mechanical and corrosion properties. These tools will be used to solve issues related to Light Water Reactor pressure vessels and internal structures. Four tools were delivered: (i) a module providing the irradiation-induced damage and the strain–stress curve of the irradiated steel, (ii) a module providing different approaches to the evaluation of the fracture toughness of irradiated reactor pressure vessel (RPV) steel; (iii) a module simulating irradiation effects in stainless steels of internal structures; (iv) a module aimed at simulating the Irradiation Assisted Stress Corrosion Cracking (IASCC) behaviour of these steels. These 'computational tools' and models were integrated in a standalone computational platform, consistent with many open source standards. This approach enabled the overall community to exchange more easily their developments and perform benchmarking. In FP7, a collaborative project, PERFORM 60, will further develop these multi-scale modelling tools to predict the combined effects of irradiation and corrosion on internal structures and improve those for RPV.

Multi-scale modelling is also performed for structural materials for reactor core and primary coolant components in Generation IV and transmutation systems to ensure their safe and reliable operation in the collaborative project GETMAT in FP7. As well, in the F-BRIDGE collaborative project in FP7, a new approach to fuel design for Gen IV systems relying on the basic understanding of fuel behaviour from atomic to macroscopic scale is developed through multi-scale modelling and characterization tools. The NURESIM integrated project in FP6 had the objective to integrate advanced physical models in a shared and open software platform for nuclear reactor simulation based on the SALOME open source tool. The latest developments of Monte Carlo and deterministic codes for reactor and core physics have been incorporated into the platform, as well as those for thermal-hydraulics and coupled multi-physics modelling (e.g. coupling of core physics and thermal-hydraulics codes). Progress has been made in assessing deterministic and statistical sensitivity and uncertainty analyses. Continuation of this work will be performed in the NURISP collaborative project in FP7 with the development of a new interface with a fuel behaviour code. In the EC-SARNET network of excellence in FP6, the knowledge generated in severe accident has been incorporated in the integral severe accident analysis code, ASTEC, which can be used for most water-cooled reactor types in Europe. This work will be continued in the SARNET2 network of excellence in FP7 focusing on the six high research priorities identified in EC-SARNET. In the EURANOS integrated project in FP6, the decision support system RODOS for nuclear and radiological emergency management has been completely re-engineered and is now fully operational on a lap top. Models and data bases for estimating and managing the radiological situation and countermeasures in inhabited and agricultural areas have been developed and integrated into RODOS.

Roadmaps on modelling and numerical simulation are included in the Strategic Research Agenda of the Sustainable Nuclear Energy Technology Platform (SNE-TP). Advanced simulation tools, and in particular those for multi-scale modelling, will require access to high performance computing facilities in the future.

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0022-3115/$ - see front matter
doi:10.1016/j.jnucmat.2009.04.006