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Dose Rate Experiment at JET for Benchmarking the Calculation Direct One Step Method (P3-J-306)

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Neutrons produced by D-D and D-T plasmas induce the activation of tokamak materials and of components. The development of reliable methods to assess dose rates is a key issue for maintenance and operating nuclear machines, in normal and off-normal conditions.

In the frame of the EFDA Fusion Technology workprogramme, a computational tool based upon MCNP Monte Carlo code has been developed to predict the dose rate after shutdown: it is called Direct One Step Method (D1S). The D1S is an innovative approach in which the decay gammas are coupled to the neutrons as in the prompt case and they are transported in one single step in the same run. Benchmarking of this new tool with experimental data taken in a complex geometry like that of a tokamak is a fundamental step to test the reliability of the D1S method.

A dedicated benchmark experiment was proposed for the 2005-2006 experimental campaign of JET. Two irradiation positions have been selected for the benchmark: one inner position inside the vessel, not far from the plasma, called the 2 upper irradiation end (IE2), where neutron fluence is relatively high. The second position is just outside a vertical port in an external position (EX). Here the neutron flux is lower and the dose rate to be measured is not very far from the residual background. Passive detectors are used for in-vessel measurements: the high sensitivity Thermo Luminescent Dosimeters (TLDs) GR-200A (natural LiF), which ensure measurements down to environmental dose level. An active detector of Geiger-Muller (GM) type is used for out of vessel dose rate measurement. Before their use the detectors were calibrated in a secondary gamma-ray standard (Cs-137 and Co-60) facility in term of air-kerma.

The background measurement was carried-out in the period July -September 2005 in the outside position EX using the GM tube and in September 2005 inside the vacuum vessel using TLD detectors located in the 2 Upper irradiation end IE2.

In the present work, experimental background data and dose rate, the latter collected during some operation free days in the early phase of the 2006 JET campaign, are compared with the same quantities calculated using the D1S approach.

The impact of key parameters (geometrical model, materials impurities, different sets of cross sections) to the calculated dose rates is discussed as well.