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Radionuclide Inventory Calculations for ESS Target Station

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Abstract

The material activation in ESS facility is an important aspect that has to be taken into account since the early design phase. In particular the design of the target has to consider the following radiation protection issues: i) radiation level received by personnel during maintenance, ii) accident scenarios, iii) the production, handling and disposal of the radioactive wastes. Additionally the evaluation of the environmental problem ESS will cope with the accurate estimation of the emissions from the system is mandatory.
This work was intended to support the management of emissions and wastes arising during operation and after the decommissioning of the ESS facility. In this respect the following quantities were estimated and analyzed for ESS baseline concept:

- total activity in the target and other components;
- decay heat generated in the target and other components;
- the production of inert-acting gases in the target during operation;
- ^{3}H production from all components;
- activation in the cooling systems (H_2O and He);

Special attention was given afterwards to the evaluation of the potential release footprint through the calculation of the hazard index by weighting the inventory nuclide vector with release fractions and effective dose commitment factors.
Assessment of the current degree of confidence with which the most hazardous isotopes are predicted by the codes used in simulations is further reported. A radionuclide vector of major interests was established based on the nuclide relevance during normal operation, accident situations and disposal conditions.
In this respect calculations of the radioactive isotopes produced in the target station were performed by means MCNPX computer code using different available reaction models. Additionally nuclear yields evaluated up to 3 GeV via STN method are used for calculation of the reaction rates based on the proton/neutron spectra calculated with MCNPX. Conservative values from conservative margins for the production of the most problematic isotopes are further derived based on comparisons of the models to available elementary experimental data (essentially excitation functions for spallation produced isotopes).