ASSESSMENT OF THE ACTIVATION, DECAY HEAT, AND WASTE DISPOSAL OF A DUAL COOLANT LITHIUM LEAD TEST BLANKET MODULE FOR ITER

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The US is proposing a test blanket module (TBM) to be placed in half of the three dedicated test ports of ITER. The TBM is based on the dual coolant lithium lead (DCLL) blanket concept. Conventional ferritic steel (F82H) is used as the structure of the first wall (FW), the two breeder channels, the back plate, the inlet/out piping, and the shield plug. Two separate cooling circuits are employed: helium is used to cool the FW and blanket structure while the Pb-17Li (enriched to 90% Li-6) is used as a coolant and breeder mainly in the two breeder channels. SiC flow channel inserts (FCI) are used to thermally and electrically isolate the flowing Pb-17Li from the relatively low-temperature structure. A 2 mm thick beryllium layer is used as a plasma facing material on the FW area (1.25 m^2) subjected to 0.78 MW/m^2 neutron wall load. The radial thicknesses of the TBM, the piping zone and shield, are 41.3, 30 and 128, cm, respectively. The radial build was arrived at after several iterations and the relevant nuclear performance parameters are reported in a companion paper. In this paper, we present results pertaining to the radioactive inventory and decay heat levels at shutdown and at several post-irradiation times. Pulsed operation mode is assumed. Each pulse is assumed to be 400 s full flat top followed by 1800 s dwell time. The 500 MW pulses are assumed to be generated one after another until a fluence limit of 0.3 MWa/m^2 is reached without replacing the TBM. This gives upper conservative estimates for the radioactive inventory and decay heat.

At shutdown, the total radioactivity inventory and decay heat are as low as ~2 MCi and 0.02 MW, respectively. They are mainly due to the F82H structure present in the shield, back plate, the back breeder channel, and the FW, in that order. Although tritium bred in the Pb-17Li is accounted for, yet, the parameters are 2-3 orders of magnitude lower than the values in the structure while the attainable levels in the SiC insert are even lower by extra 2-3 orders of magnitude. The waste disposal ratings (WDR) of the F82H structure, the Pb-17Li breeder and SiC insert were found to be $1.3x10^{-2}$, $9x10^{-3}$, and $2x10^{-4}$, respectively. These values are far below unity and thus the impact on safety and waste disposal is minimum and well within ITER regulatory guidelines.