Assessment of the Activation, Decay Heat, and Waste Disposal of a Dual Coolant Lithium Lead Test Blanket Module for ITER

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**US DCLL TBM model**

All structures are He-cooled @ 8MPa

PbLi self-cooled flows in poloidal direction

**Relative location of the test module in the test-pit, transporter location and module cross-section sketch.**

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**Calculation Procedures**

- The 1-D discrete ordinates code, ANISN, was used to calculate the neutron flux in the 1-D toroidal model with a multigroup cross-section library based on FENDL-2 data.
- The activation code, DRK-PULASAR, to calculate the radioactivity and decay heat levels at shutdown and at 11 post-irradiation times up to 1000 years.
- The activation/deactivation data library of FENDL-2 was used in the calculation.
- The impurities (reps) considered for F82H structures are as follows: Cu(0.3%), Ag(0.15%), Fe(0.09%), Ni(0.01%), Mo(0.06%), Pb(17.6%), Ag(0.156), Co(0.049), Cu(0.049), Dy(0.049), Nb(0.049), Os(0.049), Re(0.049), and Rb(0.049). For Pb-17Li, they are: Na(5%), E(0.122), Ca(0.139), C(0.044), Sb(0.122), Si(0.216), and Nb(0.216). And for SiC, they are: B(0.103), C(0.081), Si(0.618), and F(0.618).

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**Total activity generated in the test blanket module and contributions from each material**

- The total radioactive inventory in the DCLL TBM at shutdown is relatively small due to the decay of the Pb-207m isotope. It stays at that level for ~1 hr and drops slowly thereafter.
- The total activity in the back plate is also large.
- The activation inventories in the 1st and 2nd wall are comparable but they are less than those attributed to the shield, the back breeder channel, and the back plates.
- The total activity is dominated by the activation of the tritium bred while the activation in the SiC insert is ~2-6 orders of magnitude lower. The activation/decay data library of FENDL-2 was used in the calculation.

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**Waste Disposal Rating**

The waste disposal rating (WDR) depends on the level of the long-term safety. For the F82H structure:

- Na: 5.2x10^{-11} (Class A)
- Nb: 5.2x10^{-12} (Class A)  
- Ni: 5.2x10^{-13} (Class A)

For Pb-17Li breeder:
- Pb: 1.0x10^{-13} (Class A)
- SiC insert:
  - C: 1.4x10^{-5} (Class B)
  - B: 1.4x10^{-6} (Class B)

The WDR values are much lower than unity and therefore these materials are qualified for shallow land burial according to the Class C limits.

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**Summary**

- The total radioactivity in the DCLL TBM at shutdown is relatively small due to the decay of the Pb-207m isotope. It stays at that level for ~1 hr and drops slowly thereafter. The inventory is almost entirely due to the activation of the F82H structure.
- The activity in the structure is not dominated by the FW, but rather by the structure in the back breeder channel, the back plate, and the shield.
- The decay heat generated is also the major contributor to the total decay heat in the TBM (blanket in general). The decay heat in the back plate is also large. The decay heat generated in the SiC insert is ~2-6 orders of magnitude lower than the level in the structures of the blanket.

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**Activation**

- The total radioactivity in the DCLL TBM at shutdown is relatively small due to the decay of the Pb-207m isotope. It stays at that level for ~1 hr and drops slowly thereafter. The inventory is almost entirely due to the activation of the F82H structure.
- The activity in the structure is not dominated by the FW, but rather by the structure in the back breeder channel, the back plate, and the shield.
- The decay heat generated in the TBM (blanket in general) is also the major contributor to the total decay heat in the TBM (blanket in general). The decay heat in the back plate is also large.
- The decay heat generated in the SiC insert is ~2-6 orders of magnitude lower than the level in the structures of the blanket.

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**Decay Heat**

- The total decay heat in the FW is ~0.001 MW. After the decay of the Pb-207m isotope, the total decay heat is attributed entirely to the structures in the back breeder channel, the back plate, and the shield.
- The decay heat in the FW is not the major contributor to the total decay heat in the TBM. The decay heat generated in the SiC insert is ~2-6 orders of magnitude lower than the level in the structures of the blanket.

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**Waste Disposal Rating**

- The waste disposal rating (WDR) depends on the level of the long-term safety. For the F82H structure:
  - Na: 5.2x10^{-11} (Class A)
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The WDR values are much lower than unity and therefore these materials are qualified for shallow land burial according to the Class C limits.