US DCLL TBM Introduction / Overview

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US DCLL TBM Team

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• The US serves as interface coordinator (InCo) and will do its best to fulfill this function
• The US will need support from other parties with expertise and interest in lead-lithium blanket in developing the interface information for integration in ITER
• We continue the DCLL TBM design with focus on the last DT module, address critical issues for DEMO and technology and scientific challenges via R&Ds

For InCo, the most urgent duties are :
• interact with IO technically and on interfaces in a timely manner
• participating to the required integration effort with other ITER systems;
• participation to the reviewing process of all ITER-TBM document
• provide information to IO on the corresponding TBM R&D programs
• for the TL and InCo, interact with the corresponding PM to allow the PM to perform his duties
Presently, Japan plans to deliver two WCCB modules: HH in 2018 and DT in 2023.

US DCLL cannot meet the CDR in Jan 2011 and therefore will not deliver HH in 2018.
First DCLL module to be delivered in 2021 and DT module in 2023?

- Presently, Japan plans to deliver two WCCB modules: HH in 2018 and DT in 2023.
- US DCLL cannot meet the CDR in Jan 2011 and therefore will not deliver HH in 2018.

Options under consideration:

1. HH WCCB also delivered in 2021
2. Japan to have another TBM ready for 2021
3. Independent ½ port module change out (agreed on the delivery of formal request to IO)
DCLL Design - Example: Vertical Section View Thru PbLi Channels
DCLL RAFM steel mass is about half of HCLL

Mass of DCLL TBM RAFM Steel: **618 Kg** < 650 Kg (recommended)

Volume of PbLi:
- 0.098 m³ (TBM)
- 0.038 m³ (Pipes)
- 0.106 m³ (AEU)
Total 0.244 m³ < 0.28 m³
  (2268 kg)

Radial thickness of shield 1.2 m
Flow distribution with performed with ANSYS CFX
Non-uniformity at the first wall is noted.
He Flow Distribution - with CRADLE

Also seeing flow non-uniformity, but how much is acceptable?

By Alice Ying
3-D Neutronics Results: Example

Used DAG-MCNP with direct coupling to CAD

Mid-plane nuclear heating

Steel damage at section X2

DCLL TBM

Cross section He appm/FPY dpa/FPY

Mid-plane T production
Von Mises Stress Contours:

Stress concentration points are identified under the different loading conditions. These plots show the Von Mises stresses (~1.0-1.3 GPa) at one critical location under normal pressure loading at 450 °C. These stresses are due to the deformation caused by the pressure difference between the 8 MPa He and 0.5 MPa PbLi channels. This resultant stress is above the allowable, but occurs over a small, concentrated region. More detailed analysis will be performed at this location. Small design modifications may be made to alleviate these stresses.
MHD analysis has been initiated for IB blanket (DEMO) aiming at estimates for the MHD pressure drop in a strong 10-12 T magnetic field.

- Flows in the blanket
- Flows in entry/exit ducts
- Flows across the gradient magnetic field
Tritium Extraction
Primary Side Pb-17 Li Vacuum Permeator Scheme

Vacuum Permeator:

Concept is based on the Pd-Ag membrane applied to gas stream permeators; untested for use of refractory (Nb) with liquids.

ITER TBM Process overview

Experiment supported by the US/J TITAN program
Impact of TBM ferromagnetic effects on ITER performance

Experimentally assessed in DIII-D in Nov. 2009

ITER $B_{\phi}$

Mockup $B_{\phi}$ in DIII-D
US R&D activities for DCLL

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