**INTRODUCTION & OBJECTIVES**

**ABSTRACT:**
- The Test Blanket Module (TBM) design based on the dual coolant lithium lead (DCLL) blanket concept has been developed by the US in support of the ITER Test Blanket Module program. The ferritic steel structure is cooled by flowing helium within the structural panels. A lithium lead (PbLi) breeder is circulated through the TBM in the poloidal direction for tritium breeding and power extraction.
- The current design involves a complex flow path for the helium coolant. Sections of the flow are in series while others are in parallel. This causes flow irregularities that are illustrated here.
- Design improvements are presented for the areas listed below, which will resolve each problem.

**PROBLEM AREAS:**
- PbLi Hot-Spot due to Neutron & Gamma Heating
- Helium Flow Asymmetry in the Entry Region
- Uneven Flow in the First Wall and Headers
- Uneven Flow in Grid Plates & Dividers

**THE ANALYSIS:**
- Fluid dynamics software was used to analyze the current geometry and the flow steering geometry to determine the flow evenness.
- Neutronics analysis of the TBM has shown that a hot spot exists between the poloidal PbLi channels where a geometrical feature has been added to allow for draining of the PbLi from the TBM.
- This hot spot could cause undue thermal expansion and stress in that region.

**THE SOLUTION:**

**THE RESULTS:**
- The proposed solution here eliminates much of the parallel flow, reducing the number of parallel channels from 68 to 6. The number of turns within the channels, and therefore the pressure drop, will also be reduced.
- Flow enters the grid plates, flows vertically up the top of the dividers and down the side of the TBM. Flow then enters the divider plates, where it spreads and flows down. It then re-enters the grid plates in the front, flows down and around the dividers at the bottom. Finally, flow goes up the grid plate and exits.

**CONCLUSIONS & FUTURE WORK**
- This poster presents design improvements that will alleviate the following problems with the current TBM design:
  - PbLi Hot-Spot due to Neutron & Gamma Heating
  -まHelium Flow Asymmetry in the Entry Region
  - Uneven Flow in the First Wall and Headers
  - Uneven Flow in Grid Plates & Dividers

**THE SOLUTION:**
- Fluid dynamics software was used to analyze the current flow scheme and the improved flow scheme to determine the evenness of flow and to determine if the improved geometry is advantageous over the current geometry.

**THE RESULTS:**
- The results from the analysis of the current geometry illustrate that there is very uneven flow received by the grid plate sections. The figure below illustrates this discrepancy. If flow went evenly to each section, then each section should have 0.11 kg/s mass flow rate. This is unacceptable for flow uniformity.
- The results from the improved geometry show that flow is very even between the three channels. These values are shown in the table below right.

**FUTURE WORK:**
- A full redesign of the helium flow within the TBM can be completed by implementing and optimizing the improvements presented in this poster.

Edward Marriott, M. Dagher, M. Sawan, C. Wong
University of Wisconsin-Madison – Fusion Technology Institute, 1Consultant, 2General Atomics