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A toroidal confinement facility study and eventual experimental device to investigate a range of liquid metal divertor and first-wall concepts

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A toroidal confinement facility study and development of a characteristic experimental device was undertaken to investigate a range of liquid metal divertor and first-wall concepts build on past and expected results from liquid metal experiments: the Lithium Tokamak Experiment (LTX), the National Spherical Torus Experiment Upgrade (NSTX-U), and the Experimental Advanced Superconducting Tokamak (EAST). The device configuration is driven by the need to adequately provide the concept details that depicts component features, space allocations, plumbing arrangements, thermal insulation, etc. of liquid metal systems. Of equal importance is to validate that the developed designs are upward compatible to exist within a blanket system of a DEMO or an eventual fusion power plant design. The proposed studies also builds upon recent low-A High Temperature Superconductor (HTS) tokamak pilot plant studies that incorporated a liquid metal divertor for high-heat-flux mitigation as a means of reducing poloidal field coil current and simplifying the magnet layout and maintenance schemes. Tokamak aspect ratios in the range of A = 1.8 to 2.5 would be considered based upon recent pilot plant studies indicating this range would be optimal for fusion power production if high-current-density HTS magnets were utilized. This aspect ratio range is subject to change pending the results of the first 1 to 1.5 years of the study. A current snapshot of a 1-m, 2.4m aspect ratio device configuration is illustrated in the included figure incorporating HTS magnets and a fast flowing liquid metal divertor/FW system.
This paper will provide the design details of the Toroidal confinement facility –defining the general arrangement of the device configuration, details of the HTS magnet system and all LM system details investigated along with any engineering defined limitations or issues that may be expected when attempting to migrate the designs into the environment of a DEMO operated blanket defined system.

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