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FTP/P1-30: Fusion Technology Facility –Key Attributes and Interfaces to Technology and Materials

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On the way to a Demonstration Fusion Power Plant (DEMO), a number of fusion technology issues will need to be resolved including the long burn or steady state DT operation, net tritium breeding ratio of >1 and the application of the Fusion Technology Facility (FTF) as a material and component testing vehicle. This paper focuses on four interface areas between physics and technology that will have significant impacts on the design of FTF. For the interface area of divertor peak heat flux, both water and helium-cooled divertor designs are projected to be able to handle a maximum heat flux of 10 MW/m^2. When extended to the FTF, both mantle and divertor radiation will be needed including an innovative snowflake or super-X divertor concept. For a robust divertor design, based on results from edge localized mode (ELM) and disruption simulation experiments, both high power ELMs and disruptions will have to be avoided; otherwise the surface material will suffer significant damage. For the interface area of uniform chamber wall surface heat flux, 1-D estimates were performed and, due to the minimum and maximum temperature limits of >350℃ and <550℃ for the selected RAFM steel structural material, the maximum heat flux that the design can handle is <1 MW/m^2. For the area of robust chamber wall surface material, presently W is the favored surface material for the chamber wall and divertor. Recent vertical displacement event exposures to Si-W samples in DIII-D indicated the formation of the lower melting point eutectic tungsten silicide, which forms when the surface temperature reached 1400℃. The intent was for silicon to protect the tungsten by the vapor shielding effect. For the area of low activation structural material, recent boron-doped RAFM steel results indicate the possible increase of the minimum operating temperature of RAFM steel to higher than 350℃. This could significantly narrow the operating temperature window of the RAFM steel at higher neutron fluence, leading to the need for development of ODS and nano-ferritic-alloys. These areas of plasma edge physics, chamber surface and divertor materials and advanced structural material interactions and the associated necessary research directions for both tokamak and stellerator approaches are discussed in this paper. This work was supported by the US Department of Energy under DE-FG02-09ER54513.

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