Critical Technology Issues and Development Requirements for a Fusion Development Facility

J. C. Wesley and R. D. Stambaugh

General Atomics, P.O. Box 85608, San Diego, CA 92186

The Fusion Development Facility, a 13-MA spherical torus "next-step" DT-burning fusion experiment [R.D. Stambaugh, V.S. Chan, R.L. Miller, M.J. Schaffer, "The Spherical Tokamak Path to Fusion Power," can give the world fusion program a first-of-kind capability for "reactor-relevant" fusion materials and prototype component testing. This testing capability will complement the physics study and plasma optimization capabilities of lower-fluence DT-burning next-step experiments such as the International Thermonuclear Experimental Reactor (ITER). The FDF can also provide fusion with a means to conserve and even modestly increase the "tritium patrimony" that fusion can inherit from the Canadian CANDU fission reactors. Final, FDF can also provide a high-flux, high-fluence, high-duty-factor neutron source for a fusion-based fission waste transmutation demonstration. But all of this promise is contingent on having "near-term" fusion technologies and materials that will allow FDF to operate in a 2015 time period at its anticipated plasma performance levels. The neutron fluxes and fluence capabilities required are '"reactor-like", that is, 5 MW/meters squared and 5 MW/meters squared per calendar year of operation, so technologies with reactor-like performance and service lifetimes will be needed. Also, in contrast to less-ambitious "next-step" fusion device proposals such as ITER, FDF will have to be designed with full remote handling capability, wherein any or all parts of the device can be maintained or replaced in a timely manner. These requirements collectively pose great fusion material and enabling technology challenges. This paper identifies these challenges and suggests how they can begin to be met within the near-term capabilities of the world fusion program. The feasibility of using a "bootstrap" operational approach, wherein an initial cycle of materials testing in FDF itself yields results and experience that can then be incorporated in subsequent testing cycles and/or upgrades of the FDF device components or the whole device. This type of incremental bootstrap approach may provide the most credible scenario for the world fusion community to address the challenging problems of developing fusion reactor materials and technologies in a time and cost effective manner.