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FTP/P7-35: A Fast-Track Path to DEMO Enabled by ITER and FNSF-AT

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A Fusion Nuclear Science Facility based on the Advanced Tokamak concept (FNSF-AT) [1] is a key element of a fast track plan to a commercially attractive fusion DEMO. The next step forward on the path towards fusion commercialization must be a device that complements ITER in addressing the community identified science and technology gaps to DEMO, and that enables a DEMO construction decision triggered by the achievement of Q=10 in ITER, presently scheduled for the year 2030. This paper elucidates the logic flow leading to the FNSF-AT approach for such a next step forward, and presents the results of recent analysis resolving key physics and engineering issues.

A FNSF-AT will show fusion can make its own fuel, provide a materials irradiation facility, show fusion can produce high-grade process heat and electricity. In order to accomplish these goals, the FNSF has to operate steady-state with significant duty cycle and significant neutron fluence. In FNSF-AT, advanced tokamak physics enables steady-state burning plasmas with the high fluence required for FNSF's nuclear science development objective, in the compact size required to demonstrate Tritium fuel self-sufficiency using only a moderate quantity of the limited supply of Tritium.

Physics based integrated modeling has found a steady-state baseline equilibrium with good stability and controllability properties. 2-D analysis assuming ITER heat and particle diffusion coefficients in the SOL predicts peak heat flux <10 MW/m^2 at the outer divertor targets. High fidelity and high-resolution 3-D neutronics calculations have also been carried out, showing acceptable cumulative end-of-life organic insulator dose levels in all the device coils, and TBR>1 for two blanket concepts considered. This FNSF-AT baseline plasma scenario has significant margin to meet the FNSF nuclear science mission. Moreover, the facility allows the development of more advanced scenarios to close the physics gaps to DEMO. Because its design can already start now, FNSF-AT can enable a DEMO construction decision triggered by the achievement of Q=10 in ITER.

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[1] V.S. Chan, R.D. Stambaugh, A.M. Garofalo, et al., Fusion Sci. Technol. 57, 66 (2010).

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