Fusion Nuclear Technology Development and the Roles of ITER TBM and CTF (VNS)

(Includes parts of answers to Questions 1,3,6,7,8)

A strong US Program on Fusion Nuclear Technology is essential for a credible US fusion energy program strategy

Mohamed Abdou
for the US ITER TBM and FNT Team

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Stages of FNT Testing in Fusion Facilities

Fusion "Break-in" & Scientific Exploration	Engineering Feasibility & Performance Verification	Component Engineering Development & Reliability Growth	**DEMO**
Stage I	**Stage II**	**Stage III**	
0.1 – 0.3 MW-y/m^2	1 - 3 MW-y/m^2	> 4 - 6 *MW-y/m^2*	
$\geq$ 0.5 MW/m^2, burn > 200 s	1-2 MW/m^2, steady state or long pulse COT ~ 1-2 weeks	1-2 MW/m^2, steady state or long burn COT ~ 1-2 weeks	
Sub-Modules/Modules	Modules	Modules/Sectors	

Stage I	Stage II	Stage III
• Initial exploration of **coupled phenomena** in a fusion environment • Uncover unexpected synergistic effects, Calibrate non-fusion tests • Impact of rapid property changes in early life • Integrated environmental data for model improvement and simulation benchmarking • Develop experimental techniques and test instrumentation • Screen and narrow the many material combinations, design choices, and blanket design concepts	• Uncover unexpected synergistic effects coupled to radiation interactions in materials, interfaces, and configurations • Verify performance beyond beginning of life and until changes in properties become small (changes are substantial up to ~ 1-2 MW · y/m^2) • Initial data on failure modes & effects • Establish **engineering feasibility** of blankets (satisfy basic functions & performance, up to 10 to 20 % of lifetime) • Select 2 or 3 concepts for further development	• Identify lifetime limiting failure modes and effects based on full environment coupled interactions • Failure rate data: Develop a data base sufficient to predict mean-time-between-failure with confidence • Iterative design / test / fail / analyze / improve programs aimed at **reliability growth** and safety • Obtain data to predict mean-time-to-replace (MTTR) for both planned outage and random failure • Develop a database to predict overall availability of FNT components in DEMO

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