Proposed US Participation in Fabrication of the First Wall and Shield for ITER*

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As a result of international negotiations on the division of responsibility for providing components to the International Thermonuclear Experimental Reactor (ITER), the US has tentatively agreed to provide one toroidal ring of the first wall and shield (FWS) modules. The US portion is the ring just above the outer divertor (module 18 in ITER notation). There are 36 modules in the ring and 4 spare modules are to be provided. Each module is approximately 1.2 by 1.3 m by 0.4 m (thick) and weighs about 3.6 Tonnes. The plasma facing surface is about 10% of the first wall area. Each first wall module consists of 10 mm of Be joined to 11 mm of CuCrZr alloy bonded to 59 mm 316LN stainless steel with two rows of 12 mm diameter water cooling channels. The first wall is mechanically attached to the shield module. Even though there are not any detailed manufacturing drawings of module 18, we have estimated the cost of the modules and the research and development (R&D) needed to successfully fabricate the modules to meet ITER requirements. We will discuss the cost estimation basis. We will work with the ITER Team at Garching, Germany to develop the final manufacturing drawings and specifications.

The R&D identified falls into four general categories. Based on results from the Engineering Design Activity (EDA), we are considering the use of plasma spray to place the Be on the copper alloy but we need to optimize the process for the FWS geometry and requirements. The copper alloy is a precipitation hardened alloy and techniques for joining the copper to stainless steel must be done at a temperature less than about 500C to prevent reduction of the copper alloy strength or else a complex solutionizing, quenching, and precipitation process must be performed to regain the copper properties. Another complication is to avoid formation of brittle Be/Cu intermetallics that are formed at high temperature. We plan to conduct R&D on this issue. Our success with using casting as a cost effective means for fabricating large 316LN structures during the EDA leads us to consider such a fabrication technique for the shield module. Casting offers the possibility of casting the module with the internal cooling channels in place rather than forming the channels by machining. We will investigate the possibility of using casting to fabricate the shield module. Finally, techniques must be found for assuring the thermal bonds in the structure are adequate to remove the plasma heat load on the first wall at a sufficiently early stage in the manufacturing to assure rejection of non-conforming parts before completion of all steps to avoid excessive costs due to non-conforming parts. We will conduct studies to determine the best methods for quality control and quality assurance during the R&D process to ensure that we have suitable processes for the final manufacturing.

* Sandia is a multi-program laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.