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DESIGN AND ANALYSIS OF A FIRST WALL AND SHIELD MODULE FOR ITER*

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The ITER vacuum vessel is protected from neutron loads by thick shield modules that are covered by first wall panels to absorb the plasma thermal loads. Each shield module is about 450 mm thick and is composed of type 316 stainless steel with internal water cooling passages to remove the nuclear heating. The first wall is 81 mm thick and is composed of 10 mm of Be facing the plasma mounted on 22 mm thick CuCrZr alloy plates with internal water cooling channels supported by 49 mm thick 316 stainless steel with an internal water cooling passage. There are 18 different styles of first wall and shield (FWS) modules in the poloidal direction. The US plans to contribute module 18 to the ITER construction project. This module is just above the outer divertor. There are 36 modules of style 18 in a complete toroidal ring. Module 18 is mounted on a special support structure called the lower triangular support that protrudes from the vessel to maintain the FWS separation from the plasma and protect the top of the divertor. Because of this support Module 18 is only 400 mm thick. Module 18 has the greatest variation of major radius of all the FWS modules and has a trapezoidal shape. We have adapted the generic FWS design done for module 4 on the inner wall to the special case of module 18. The internal cooling passages in both the first wall and shield were modified to fit in the tapered shape. Hydraulic analysis has been done to determine pressure drop and heat transfer coefficients. Temperature rise in the shield due to nuclear heating was calculated to determine the thermal stress in the shield. Plasma heat loads were applied to the first wall and thermal deflection of the first wall was calculated. We analyzed the eddy currents induced by disruptions using the code OPERA® and adjusted the location and size of cuts in the shield to control the eddy currents. Two disruption cases were analyzed; 18 ms exponential current decay and 40 ms linear decay. Both cases included plasma motion toward the divertor. The disruption scenarios were provided from the DINA code by the ITER Team. The eddy currents generate forces due to interaction with the toroidal field. The stress in the FWS and loads on the mounting points will be calculated in collaboration with Lawrence Livermore National Laboratory. The results of our analysis and a conceptual design for module 18 will be presented.

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