CHALLENGES IN DESIGNING THE MODULAR COILS FOR THE NATIONAL COMPACT STELLARATOR EXPERIMENT (NCSX)*

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The National Compact Stellarator Experiment (NCSX) is a quasi-axisymmetric facility that combines the high beta and good confinement features of an advanced tokamak with the low current, disruption-free characteristics of a stellarator. The experiment is based on a three field-period plasma configuration with an average major radius of 1.4 m, a minor radius of 0.3 m, and a toroidal magnetic field on axis of up to 2 T. The modular coils are one set in a complex assembly of four coil systems that surround the highly shaped plasma. There are six each of three coil types in the assembly for a total of 18 modular coils. The coils are constructed by winding copper cable onto a cast stainless steel winding form that has been machined to high accuracy, so that the current center of the winding pack is within ±1.5 mm of its theoretical position. The modular coils operate at a temperature of 80 K and are subjected to rapid heating and stress during a pulse. Modular coil fabrication is currently underway at the Princeton Plasma Physics Laboratory (PPPL). This paper will describe some of the design and manufacturing challenges, as well as the limitation of design capture solutions, such as parametric solid modeling, which were overcome during the design of the modular coils. Advanced techniques for shape optimization, CAD model development, analysis, and assembly simulation are described.

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