

**STRUCTURAL INTEGRITY OF  
QUASI-POLOIDAL STELLARATOR (QPS) MAGNETIC COILS\***

A. Lumsdaine<sup>1</sup>, A. Chaudhri<sup>1</sup>, M. Parang<sup>1</sup>, B. Nelson<sup>2</sup>, S. Sridharan<sup>1</sup>, S. Tang<sup>1</sup>,

<sup>1</sup>University of Tennessee, 414 Dougherty Building, Knoxville, TN 37996, USA

<sup>2</sup>Oak Ridge National Laboratory, PO Box 2009, Oak Ridge, TN 37831, USA

The Quasi-Poloidal Stellarator (QPS) fusion device includes modular coil winding packs, supported by a stainless steel casting, and vacuum-sealed within a stainless steel can. The can is welded to the casting with the winding pack in place in order to achieve a high vacuum seal. In this study a numerical and experimental analysis of welding a thin steel can was carried out to determine the resulting transient thermal effects. Welding causes distortions and thermal stresses to develop in such coils. These distortions may alter magnetic field and degrade the operation of the stellarator. A computer model of the welding process was developed and transient temperature response was computed at predefined locations at the cross-section of the coil. This study predicted that the maximum temperatures reached were within the temperature limits of the insulation. Experiments performed showed no damage to the conductor nearest to the weld zone and provided validation for the computational model. Thermal-structural modeling was also performed in order to determine whether the levels of permanent deformation in the structural stainless steel casting would distort the coil geometry or if the thermal stresses in the casting would jeopardize its structural integrity. Finite element results indicated that the deformation would be within acceptable levels. This analysis was also validated experimentally.

Experiments have also been carried out to determine the property data for the copper-glass-epoxy composite conductor coil, which is used in the computational analysis. Finite element modeling of the magnetic loading and the cooling process is also conducted to determine the effectiveness of cooling tubes, the required thickness of the stainless steel vacuum can, and the required dimensions of stiffeners placed to strengthen the can under the influence of both thermal and magnetic loading.