THERMAL ANALYSIS AND EXTENDED OPERATION SIMULATION OF THE DIII–D TOROIDAL FIELD COIL BELT BUS SYSTEM*

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The DIII–D toroidal field (TF-coil) belt bus system provides an electrical connection between adjacent TF-coil bundles to form a continuous current path for the TF-coil system. There is also a return path which is electrically isolated from the belt bus. The function of the system is to carry TF-coil current while minimizing the TF-coil error field in accordance with physics requirements. The system is currently capable of handling 5 s of operation with a peak current of 127 kA in the TF-coil. Future requirements for the system are the capability to support 10 s operation with 10 min cooldown periods in between shots. Experiments have been carried which describe the physical parameters of the system, such as the contact resistance across the bus bar joints. Additionally, using an optical fiber-based temperature monitoring unit, the temperature response of the system to operations was determined. Based on these characterizations of the system, a 3-D thermal model was built to predict the behavior of the system for 10 s operations. The limitation of the system is the maximum allowable temperature of 90° centigrade for the G10 insulators. The model was constructed full scale per engineering drawings using Solidworks, meshed, and then exported to Cosmos for analysis. Once good correlation was achieved with the observed responses to 5 s pulses, the behavior of the system for 10 s pulses was predicted. Various design modifications, such as water cooled bolts, were simulated in order to estimate their impact on creating a system that meets the 10 s criteria.

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