

ANALYSIS AND TESTING OF THE DIII-D OHMIC HEATING COIL LEAD REPAIR CLAMP*

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DIII-D has been operating for the last year with limited volt-second capabilities due to structural failure of a conductor lead to one of the ohmic heating (OH) solenoids. The conductor failure was due to poor epoxy impregnation of the overwrap of the lead pack, resulting in copper fatigue and a water leak. A number of structural analyses were performed to assist in determining the failure scenario and to evaluate various repair options. A fatigue stress analysis of the leads with a failed epoxy overwrap over a length of twenty inches indicated crack initiation after 1000 cycles at the maximum operating conditions. It is probable that the crack was initiated at a skip weld used to facilitate fabrication of the lead pack. The failure occurred in a very inaccessible area which restricted design repair options to concepts which could be implemented remotely. Several design options were considered for repairing the lead so that it can sustain the loads for 7.5 Vs conditions at full toroidal field. Using a clamp, along with preloaded banding straps and shim bags, provide a system that guarantees that the stress at the crack location is always compressive. Structural analyses were performed to determine the preload required to prevent further crack growth in the conductor and possible failure the adjacent conductor. Due to the limited space available for the repair, it was necessary to design the clamp system to the material yield stress values. The results of the detailed stress analyses supporting the final design of the clamp system are summarized. The main components of the clamp system were verified by load tests prior to installation. The main body of the clamp contains a load cell and potentiometer for monitoring the load-deflection characteristics of the clamp and conductors during plasma operation. Strain gages were installed on the load plate to provide redundant instrumentation. If required, the preload on the conductors can be increased remotely by a special wrench attached to the clamp assembly.

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