USE OF A THERMAL ANALOGY TO FIND ELECTRICAL RESISTANCES OF THE ELECTRICAL BREAKS IN THE TPX PASSIVE STABILIZATION SYSTEMS*

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The inner and outer passive stabilization systems for the Tokamak Physics Experiment (TPX) are similar in design in that they both utilize copper passive plates that form large toroidal rings. The rings are electrically continuous except at one toroidal location where a high resistance break must exist. Vertical conductors connect the rings together on either side of the electrical break forming a saddle coil. In order to prevent all the current during initial plasma start-up from flowing through the rings instead of the plasma, the resistances of the breaks for the inner and outer stabilizers must be greater than 70 and 300 micro-ohms respectively. A thermal-electrical analogy has been developed so that 2-D heat transfer finite element codes can be used to find the electrical resistances in the proposed designs of the high resistance breaks. This analogy is based on classical heat transfer theory using an electrical analogy for finding the equivalent conductances of materials that are in series or parallel. In these cases the conductivities of the materials are converted into conduction resistances. The conduction resistances are associated with actual electrical resistances, the heat transfer rate with current, and the temperature difference with potential drop. Therefore the basic heat transfer equation, $q = K\Delta T$, can be used to express the electrical equivalent equation, $V = IR$ as $\Delta T=q(1/K)$. By imposing a temperature drop across the 2-D finite element thermal models of a break and having the code determine the total heat flow through the model, the resistance of the break, $R = 1/K$, can then be calculated.

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