

Updating the Design of the Poloidal Field Coils for the ITER Magnet System

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The ITER superconducting coil system consists of 18 Toroidal Field coils, six Poloidal Field (PF) coils, six Central Solenoid (CS) modules, 18 Correction Coils and their feeders. The six PF coils are attached to the TF coil cases through flexible plates or sliding supports allowing radial displacements. The PF coils and CS modules provide suitable magnetic fields for plasma shaping and position control.

The PF coils use NbTi superconductor, cooled by supercritical helium. This gives a substantial cost saving compared to Nb₃Sn and the elimination of a reaction heat treatment greatly simplifies the insulation of such large diameter coils. The cable configuration is 6 sub-cables arranged around a central cooling space. The conductors have a heavy square walled stainless steel jacket. The latest parameters of conductor design are evaluated by analysis of the minimum quench energy and hotspot temperature.

The PF coils are self supporting as regards the radial magnetic loads. The vertical loads on each PF coil are transmitted to the TF coil cases. Load transmission is through flexible plates for the PF2 to PF5 coils or sliding supports for the PF1 and PF6 coils with fibresplice bearing surfaces. The supports for the PF winding consist of a set of clamping plates and stud bolts. The shape of the clamping plates has been designed to minimize stresses in the winding pack insulation. Bolts are pre-tensioned to keep pressure between the winding pack and clamping plate.

Because of the difficulties in replacing the PF coils, the most unreliable component (the coil insulation) is designed with extra redundancy. There are two insulation layers with a thin metal screen in between. By monitoring the voltage of the intermediate screen, it is possible to detect an incipient short, defined as a short in only one of the two insulation layers. Adjustment of the screen voltage level may allow the shot growth to be stopped once it is detected. Alternately the faulty double pancake must be disconnected and by-passed. This implies that the remaining pancakes are operated at a higher current as the backup mode. Since all PF coils include 8 double pancakes the backup mode involves operation at a current which is 8/7 of the nominal current. Jumpers are pre-installed on the coil surface to allow this reconnection with a minimum of works in the cryostat and the conductor is designed with an extra margin.