

Toroidal Coils for TORE SUPRA



MAGNETS
FOR FUSION



MAGNETS FOR HIGH
ENERGY PHYSICS



MAGNETS FOR
MEDICAL
APPLICATIONS



SYSTEMS
FOR ENERGY



SERVICES & REPAIRS

In 1986 ASG (acting as Ansaldo Magnet Division) manufactured all the toroidal field coils (TFC) for the French Tokamak TORE SUPRA, currently in operation at CEA-Cadarache.

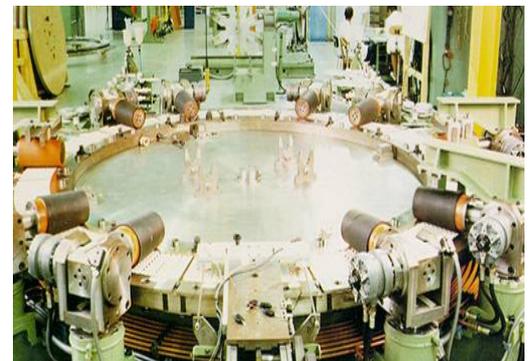
The Tokamak consists of 18 superconducting TFC wound with Nb-Ti conductor double pancakes, copper matrix and Cu-Ni barriers. The coils are cooled in superfluid helium bath at 1 bar. and 1.8 K. Each coil is mounted in a stainless steel 316LN case, sealed with a closure weld under pressure along the whole perimeter, thermal spacers are interposed between coil and chamfer in order to avoid peaks of temperature on the conductor. The case is cooled by forced helium circulation at 4.5 K and 150 kPa. The type of winding is circular double pancakes with $\text{R}_{\text{ei}} = 2,3 \text{ m}$ and $\text{R}_{\text{ee}} = 2,8 \text{ m}$ and the coil weight is 9000 Kg. Besides the general prescriptions of working in a clean area environment, special care had to be taken to prevent contamination of the helium cooling system, as the insulation spacers between turns was very thin. Furthermore, the superconducting cable was wound on its smaller edge, requiring a particular care to prevent any damage to the insulation between turns. Welding of the different parts of the stainless steel cases and especially of the closures of the cases around the coils (with thicknesses from 30mm to 80mm), were performed adopting an automatic welding machine equipped with MIG and TIG welding heads.

Special care needed to be taken for those parts of the cases where the He channels were machined in order to preserve geometrical tolerances and avoid deformations.

Industrialisation of the manufacturing process and its repeatability, which are indispensable to maintain the required quality standard, were achieved by employing special tools and automation processes.



3D Control of 3 assembled coils inside the case



Double pancakes winding

Type of winding circular double pancake	$(\phi_i = 2.3 \text{ m}, \phi_e = 2.8 \text{ m})$
Maximum field in the center	9 T
Stored Energy	600 MJ
Nominal current	1,400 A
Conductor	NbTi + Cu CuNi
Type of cooling	superfluid helium bath (1.8 K)
Coil weight	9,000 Kg