ALSTOM Magnet and Superconductivity Applications (MSA Unit)

KOHLER

E-mail :claude.kohler@ind.alstom.com

ALSTOM Magnet and Superconductivity Applications (MSA Unit) in ALSTOM organization, is on one hand, in charge of developing and producing equipments using superconductivity and, on the other hand, one of the world leader in superconducting wires and cables.

ALSTOM experience in superconductors design and manufacture dates back to the nineteen seventies. ALSTOM is one of the leading companies active in the design and manufacturing of metallic superconductors (NbTi and Nb3Sn), as evidenced by the fact that its customers involve some of the largest superconducting projects in the word, including SSC (USA), LHC (Switzerland), NET/ITER (world fusion program). Regarding LHC which will be the largest facility where the acceleration and collision of protons will be possible at previously unattainable energy levels, ALSTOM has been selected by CERN to supply more than 55 % of the European made superconducting cables.

ALSTOM develops superconducting wires and cables with high critical current capacity for various worldwide projects of colliders (LHC) and tokamaks (NET/ITER, TORE SUPRA) and is also manufacturing wire for Magnetic Resonance Imaging magnets as well as for Magnetic Resonance Spectroscopy magnets and for various custom made application.

Furthermore, ALSTOM has a long experience in Cu/CuNi/NbTi wire and has pioneered the development of ultrafine filaments suitable for AC application ("50 Hz wire with sub-micron filaments).

ALSTOM also developed a significant capability for superconducting cable (triplet, 6 + 1.... Rutherford, wire in channel, CICC, aluminium cladded cables for SMES applications or collider/detector magnets).

Main products produced by ALSTOM are:

- NbTi - Nb3Sn wires for MRI - MRS magnets
- NbTi and Nb3Sn cables
- Cu/CuNi/NbTi wires and cables
- Aluminium jacketed conductors
- Composite NbTi superconductors
- Sub-micron wire for 50 Hz applications

Collider conductors:

Cables developed at ALSTOM for colliders (e.g. SSC, LHC) have strands which contain several thousands of NbTi 46.5Wt% filaments of diameters varying between 5 μm to 7 μm, embedded in an oxygen free copper matrix. Filaments are cladded with Nb to avoid intermetallic compounds formation during the extrusion steps and the phase precipitation heat treatments. Several tons of conductors have been manufactured in an industrial process from large billets, giving lengths longer than several tens of kilometers.

To achieve the manufacture of those conductors, single stacking has been used.

Conductors for pulsed magnets:

For magnet systems used in fusion reactors or SMES, low loss conductors have to be designed for operation with important field variations (up to 100T/s). This requirement imposes the use of multiple resistive barriers across the superconducting strand. For that reason, the conductors will be composed of filaments of few microns diameter embedded in a mixed matrix. This matrix is composed with Cu for thermal stability and CuNi alloy judiciously located to limit the coupling currents.

ALSTOM has manufactured large quantities of mixed matrix conductors. The use of CuNi 70-30, chosen for its electrical resistivity, induced some problems in the fabrication because of its relatively low ductility comparing with CuNi 90-10 and the difficulties in getting good adhesion between CuNi constituents of the strand. However, tens of kilometer lengths were obtained by mastering the manufacture conditions. Figure enclosed illustrates the specific design of that kind of strand (for a SMES).