Contribution ID: **226** Type: **Poster Presentation of 1h45m**

Lessons learnt by manufacturing 100 km of varied type of Cable-in-Conduit-Conductors

Tuesday, August 29, 2017 1:15 PM (1h 45m)

ENEA, in collaboration with CRIOTEC Impianti S.r.l. and TRATOS Cavi S.p.A. (the three associated members of the Italian Consortium for Applied Superconductivity, ICAS) has manufactured approximately 100 km of Cable-in-Conduit-Conductors (CICCs) in the last decade, mainly for fusion tokamak, but also for different applications such as magnets for testing facilities. This production includes a wide range of CICCs, in terms of type of superconducting material (not only LTS strands but also some samples of HTS-CICC), size (from the large TF DEMO samples to the small EDIPO conductor), shape (rectangular with different aspect ratios, round, round in square, etc.), jacket thickness, cabling pattern (long-short twist pitch), cooling channel, unit length scale (from a few to hundreds of meters), level of current density and other features. In dealing with these different aspects of production on a case-by-case basis, the researchers and engineers had to address technical issues in the manufacturing of CICCs. In the aftermath of finding solutions to given problems, the team have learnt how to manage unpredictable obstacles arising in the conversion of a conductor design to a production sample, thus widening its expertise and improving its manufacturing flexibility. Furthermore, the successful accomplishment of quality assurance/quality control programs demanded by ITER Organization (IO) to ensure conductor production uniformity and full traceability of intermediate assemblies across numerous suppliers, represented a useful acquired workout. The aim of this paper is to share the lessons learnt from this practice. For example, the relation between the starting tube size/shape and the final CICC desired geometry, reached through a compaction process, CICC deformation with spooling, modification of the cabling final stage with insertion, how to handle the design requirement for cabling pattern with the cabling machine limits, safety of strand performances with cabling stresses, best NDT inspection of jacket and welds.

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Session Classification: Tue-Af-Po2.08

Track Classification: F5 - Cable-in-Conduit and Other Internally-Cooled Conductors