Development of Superconducting Outserts for the NHMFL Series-Connected-Hybrid Program

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Introduction

Two Series-Connected Hybrid magnets (a combination of resistive and superconducting coils) are planned for construction, one to be located at the NHMFL and one at the Hahn Meitner Institut in Berlin. The most critical development for the magnet systems is the configuration of the cable-in-conduit conductor (cicc) for the superconducting coil. It has been shown that the performance of cicc's can degrade from the transverse pressure produced during electromagnetic cycling.

In defining our project strategy, we have tried to follow the following objectives / principles:

a. To minimize project risks, in particular the risk of failure in the final phase of the project.
b. To develop, in parallel to the main design, alternative back-up solutions to pursue in case of failure of main option.
c. To minimize completion time.
d. To develop an initial experimental plan helping us to find a cable configuration "insensitive" enough to Lorentz force.
e. To develop a theoretical tool capable of extrapolating experimental results obtained on sub-cables on I_C and T_{CS} to the final cable operation.
f. To implement a qualification test on the final conductor to check performance of the CICC.

Based on these objectives/principles we have defined the plan showed in Fig.1.

Progress Status

The status on the different streams is below reported:

TEST PHASE I: Completed. Results seems to indicate that 30% triplet performs better than 40% 6 around 1 when the cable is subject to longitudinal strain. Initially the long twist pitch seemed to perform better than the short twist pitch but we found out that this was due to slippage between jacket and cable.

FEMCAB: The numerical code has been completed and validated against many tests carried out on other projects as well on our PHASE I tests.

STRANDS PROCUREMENT: 2 strand suppliers were selected. One strand is already available and ready to be cabled. The second should arrive in March 2008.

DESIGN FINALIZATION: The cable and magnet design has been finalized.

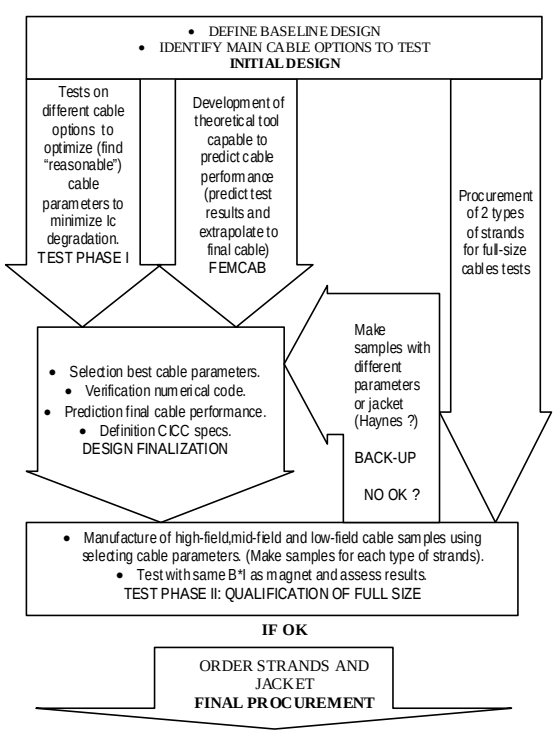

Figure 1. Flowchart of the CICC Development

TEST PHASE II: QUALIFICATION OF FULL SIZE. The contract for manufacturing the samples is being placed. The samples should be ready by April and the test completed by August.

BACK UP SOLUTION: In parallel to the main option with stainless steel jacket, a back up solution is being developed. This consists in using Haynes 242 jacket. Haynes has a thermal contraction very close to the Nb_3Sn, so its utilization should guarantee a lower thermal strain in the cable, therefore a higher J_C compared to the stainless steel jacket. Unfortunately it has never been used on superconducting coils, so it needs some R&D upfront to check its compatibility with the Nb_3Sn coil as well as its operation at low temperature under high magnetic field. Therefore a special R&D program has been launched to check these aspects. This consists in building and testing (partial test with no current) a coil utilizing a Cable-in-Conduit-Conductor with Haynes jacket. Another R&D step will consist in testing a sample as for TEST PHASE I, but utilizing Haynes jacket. If both model coil and CICC test are successful, this Haynes will be considered as a valid back up option. This validation process will be done in parallel to the preparation and test of the full-size samples utilizing stainless steel jacket: if these do not work and the Haynes R&D is successful, new full size samples utilizing Haynes jacket will be built and tested.

Acknowledgements

This work was supported in part by the National Science Foundation under grant DMR0412169, the State of Florida, and the Hahn Meitner Institut.