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THE TEAM ONE (GA/MCA) EFFORT OF THE DOE 12-TESLA COIL-DEVELOPMENT PROGRAM

PROGRESS REPORT FOR THE QUARTER ENDING JUNE 30, 1980

by

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1. SUMMARY

This report covers progress by Team One of the DOE/OFE/D&T 12 Tesla Coil Development Program during the third quarter fiscal period of 1980.

The basic mission of this effort is to demonstrate the feasibility of, and to establish an engineering data base for employment of bath cooled NbTi alloy to generate a peak field of 12 tesla in a tokamak reactor. General Atomic Company is the leader of Team One, with the Magnetic Corporation of America as industrial subcontractor.

Phase I, development of a NbTi alloy, compositionally and process optimized for 12 tesla operation at temperatures below 4 K, was completed during FY 1979.

Phase II, conceptual design of an ETF reactor compatible TF-coil system, employing the NbTi alloy selected by Phase I and an appropriate bath cooling regime, was completed during this reporting period.

Progress was also made during this period on Phase III of this effort: Design construction and testing of a solenoid coil utilizing the selected reactor prototypical conductor and bath conditions. Teledyne Wah-Chang has completed the melt of 160 pounds of NbTiTa material for the test coil conductor, and delivery of rod stock to MCA is now anticipated by the end of July. This should allow MCA to complete preparation of superconducting composite (NbTiTa/Cu) and copper wire by the end of FY'80.

During this reporting period, two Phase IV tests were made at the General Atomic High Field Test Facility. Recovery tests were performed upon cabled conductor samples at 3 K and under superfluid (He II) conditions. Results therefrom will be reported in the Fourth Quarter Progress Report of this effort.

Finally, three papers covering this effort are in preparation for the 1980 Applied Superconductivity Conference, to be held in Santa Fe, New Mexico in September.

2. COMPLETION OF PHASE II: CONCEPTUAL DESIGN OF AN ETF COMPATIBLE TF–COIL

This phase was completed during this reporting period, and will be published as General Atomic Report GA–A15974 (July 1980).

General Atomic regards this study as the focal point of the 12 Tesla Team One effort, since it demonstrates the ultimate application of the evolved conductor.

Basically the concept employs helium bath cooled NbTi alloy conductor to generate a peak field of 11.5 tesla in an ETF reactor compatible toroidal field coil. Although the study has been in progress since FY'79, the design was recently modified to reflect the number (ten), size, and peak field of the TF-coils for reference Design 1 of the ETF Design Center (per ETF Parameters, No. 4, 6-25-80). This was done in order to permit quantitative assessment of the Team One TF-coil parameters relative to ETF requirements.

3. PROGRESS ON PHASE III: DESIGN, CONSTRUCTION AND TESTING OF A SOLENOID COIL UTILIZING THE SELECTED REACTOR PROTOTYPICAL CONDUCTOR AND BATH CONDITIONS

NbTiTa SUPERCONDUCTOR FOR THE TEST COIL

During the week of June 23, Teledyne Wah-Chang performed the melting of NbTiTa material for this job. The net yield was 160–165 lb, which is adequate for the final wire requirement. Wah-Chang began extrusion of this material by July 1, and now anticipates delivery of the rod stock to MCA by the end of July.

In this event, MCA can probably complete preparation of the composite superconducting wire by the end of FY'80. In parallel, they will also draw the copper wire.

Although originally scheduled for FY'80, cabling of the wire into 10 kA conductor by an outside vendor will not be possible until early FY'81.

TEST COIL DESIGN

The 10 kA, cabled NbTiTa/Cu conductor for the test coil has been designed. It is similar to that specified for the high field region of the ETF TF-coil concept, except that the number of subcables has been changed from 10 to 12 (for coil space reasons), and its copper area has been reduced in proportion to its lack of neutron radiation degradation.

Since it is not required for hoop support, no stainless steel support strip is included in the test coil. Its coolant flow restriction however will be duplicated by interturn and interlayer insulation.

The coil itself consists of four pancake (spiral) wound layers, each with 21 turns, to generate 84×10^4 amp-turns.

The 16 cm high stainless steel helium vessel is installed with a 17-1/2 cm high vacuum vessel. The 0.3 cm gap between the two is maintained by high grade insulation. Thus the coil can be operated at bath temperatures down to 1.8 K, within the 4.2 K LLNL Test Coil bath.

Final design of the Team One Test Coil will be completed during FY'80, and the structural material ordered.

4. PROGRESS ON PHASE IV: TESTS PERFORMED AT THE GA HIGH FIELD TEST FACILITY

With this apparatus, heat pulse/recovery data is being obtained on various cable samples which will augment, and greatly assist interpretation of the FY'82 LLNL HFTF results. Also, a series of saturated superfluid helium tests are being performed to better understand the parameters of this bath cooling option.

During this period two series of heat pulse/recovery tests were performed on cabled conductor samples installed within the "coldfinger" insert of our test apparatus. Data was obtained for sample environments of 10 tesla and temperatures between 1.8 and 3 K.

Further tests will be performed during the final quarter of FY'80, and reported upon at the Applied Superconductivity Conference in September.