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

PROGRESS REPORT FOR THE QUARTER ENDING SEPTEMBER 30, 1980

by

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INTRODUCTION

This report covers progress by Team One of the DOE/OFE/D&T 12 Tesla Coil Development Program during the fourth quarter period of fiscal 1980. General Atomic Company is the Team One leader, with Magnetic Corporation of America (MCA) as industrial subcontractor.

The basic mission of this effort is to demonstrate the feasibility of, and establish an engineering data base for utilizing bath cooled NbTi alloy to generate a peak toroidal field of 12 tesla in a tokamak reactor.

The FY-1980 effort has been concentrated upon four major tasks:

- Completion of the conceptual design of an ETF reactor compatible TF-coil employing helium bath cooled NbTi alloy conductor.
- Procurement of conductor for the coil to be tested at the LLNL HFTF during FY-1982.
- Design of the test coil.
- A series of relevant tests using the GA High Field Test Facility.

TF–COIL REPORT

Although completed during the third fiscal period, General Atomic Report GA–A15974, "12 Tesla ETF Toroidal Field Coil, Helium Bath Cooled NbTi Alloy Concept," was distributed in October 1980.

TEST COIL CONDUCTOR

Though initially scheduled for delivery in July 1980, Teledyne Wah-Chang did not complete delivery of the NbTiTa rod stock to MCA until October. Billet extrusion is now scheduled for December, and conductor cabling for January 1981. Delivery to GA is still anticipated by March.

TEST COIL DESIGN

The test coil design was completed in September, except for finalizing cryogenic details of the neck region; but, see Postscript.

FY 1980 STATUS REPORT

The FY-1980 effort of the Team One effort is summarized in General Atomic Report GA-A16070, "The Team One (GA/MCA) Effort of the DOE 12 Tesla Coil Development Program," September 1980. This is a preprint of the poster session paper presented by John Alcorn at the Fourth ANS Topical Meeting on the Technology of Controlled Nuclear Fusion, October 14–17, 1980, King of Prussia, Pennsylvania.

The four-year program/schedule is presented therein, as are details of the FY-1980 (He I) configuration of the Test Coil.

PAPERS PRESENTED AT THE APPLIED SUPERCONDUCTIVITY CONFERENCE SEPTEMBER 1980, SANTA FE, NEW MEXICO

The following papers presented at this conference describe aspects of the FY-1980 Team One effort:

- "Status of the GA/MCA 12 Tesla Coil Development Program," J.S. Alcorn, et al., (Paper HA-6).
- "Stability Analysis of NbTiTa Based High Field Conductor Cooled by Pool Boiling Below 4 K," W.Y. Chen, et al., (Paper BB-3).
- "The Use of NbTiTa as a High Field Superconducting Alloy," H.R. Segal, et. al, of MCA (Paper BB-2).
- "Measurement of Stability of Cabled Conductors Cooled by He I at Reduced Temperature, or He II," Y-H. Hsu, et al., (Paper IB-6).

POSTSCRIPT

During October the decision was made to redesign the conductor and coil for optimal performance in the superfluid (He II) regime. This was the result of a growing conviction among the 12 Tesla Advisory Committee, at DOE, and at GA that on balance, the superfluid option appears preferable to subatmospheric, sub-cooled He I operation in the 2.5 – 3 K range. Despite this change of emphasis, the intent is to operate the Test Coil in both modes at LLNL.

The conductor is now sized for 10 kA operation at 1.8 K. The superconductor current density of 50 kA/cm^2 is about 80% of short sample performance for NbTiTa (32/43/25 wt%) at 2.17 K. Stability performance is based upon a He II surface heat flux of 0.75 W/cm^2, and an effective cooled perimeter equal to one-half of that for the "flowered" perimeter of one 1 kA second level cable. The resulting wire diameter is 0.055 cm (22 mils), four active wires being employed in the seven wire first level cable.

The revised coil design consists of six pancake wound layers, 20 turns per layer. Thus the ampere-turns at 1.8 K are 1.20 x 10^6. Stainless steel strip is interwound with the conductor for hoop load support.