SSC-N-281
SSC-MAG-113

Test of SSC Collared Coil Axial Properties

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Introduction

This note describes the experimental setup and results of a recent test to determine the room temperature and cold young's modulus and the thermal contraction integral for an SSC type collared coil assembly in the magnet axial direction. The test was performed on a 10 inch long section cut from a "used" D12C 1-M model magnet previously constructed at LBL. The coil had a 3 copper wedge per quadrant cross section and collars were the BNL 15 mm S.S. type.

Test Set Up

The experimental set up is shown in fig. 1. The 10 inch coil sample was housed in a G-10 container which was filled with LN for the cold test. Deflections were measured using a dial indicator arrangement isolated from bowing of the press platens. The indicators and their supports were removable for the cold test. "Coil" shaped spacers were used to contact and load only the coil area of the sample. This was to insure that collar pins or keys could not inadvertently carry axial load.

Experimental Procedure

Both the warm and cold portion of the test were done with one experimental set up. The procedure followed was to cycle the axial pressure between

1000 psi and 10,000 psi at room temperature, maintain 1000 psi during cooling to 80 K, and then to cycle between 1000 psi and 10,000 psi at 80 K. Prior to the first warm load cycle the indicators were zeroed at 1000 psi. The axial coil pressure was determined by dividing the press force applied by the coil cross sectional area (approximately 3.71 in^2). Measurements were made using this same procedure on a 4 inch diameter by 10 inch long aluminum bar. Using the known properties of aluminum, the results of this test provided instrument correction factors for the warm and cold coil test data.

Results

The results are shown in Fig. 2, 3, and 4.

In Fig. 2 the warm coil axial modulus for cycle 2 was:

$$\frac{10{,}000 \text{ psi} - 1000 \text{ psi}}{(0.0119 - 0.0022) \text{ in}/9.94 \text{ in.}} = 9.22 \times 10^6 \text{ psi}$$

In Fig. 3 the cold coil axial modulus for cycle 2 was:

$$\frac{10{,}000 \text{ psi} - 1000 \text{ psi}}{(0.043 - 0.0367) \text{ in.}/9.94 \text{ in.}} = 14.20 \times 10^6 \text{ psi}$$

In Fig. 4, the thermal contraction integral from 300K to 80K was:

$$\frac{0.0342 \text{ in.} - 0.0024 \text{ in.}}{9.94 \text{ in.}} = 0.0032 \text{ in./in.}$$

For purposes of comparison, Table 1 shows modulus and contraction properties of aluminum and copper.

Table I

Young's Modulus and Thermal Contraction for Aluminum and Copper

	Young's Modulus at 300K[1] (psi)	Young's Modulus at 80K[1] (psi)	Thermal Contraction Integral 300K to 80K[2] (in./in.)
Aluminum 2014,6061,7075	10.5×10^6	11.4×10^6	0.0041
Copper	19.0×10^6	20.0×10^6	0.0032
Stainless Steel 304	28.3×10^6	29.8×10^6	0.0029

(1) Ledbetter, H.M., "Temperature Behaviour of Young's Moduli of Forty Engineering Alloys," Cryogenics, December 1982.
(2) Barron, Randall, Cryogenic Systems, McGraw-Hill.

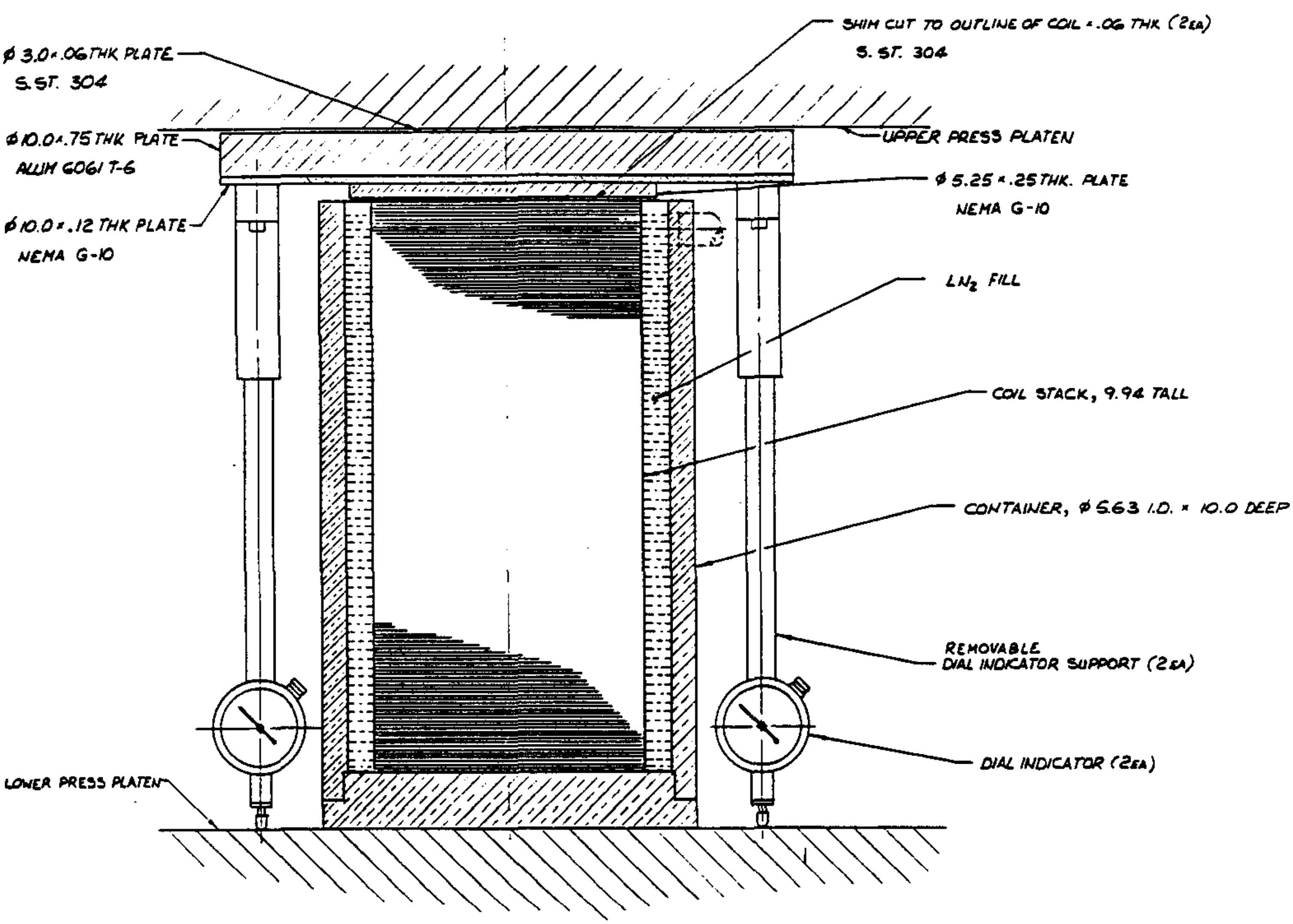

Fig. 1. Collared coil axial properties test set-up.

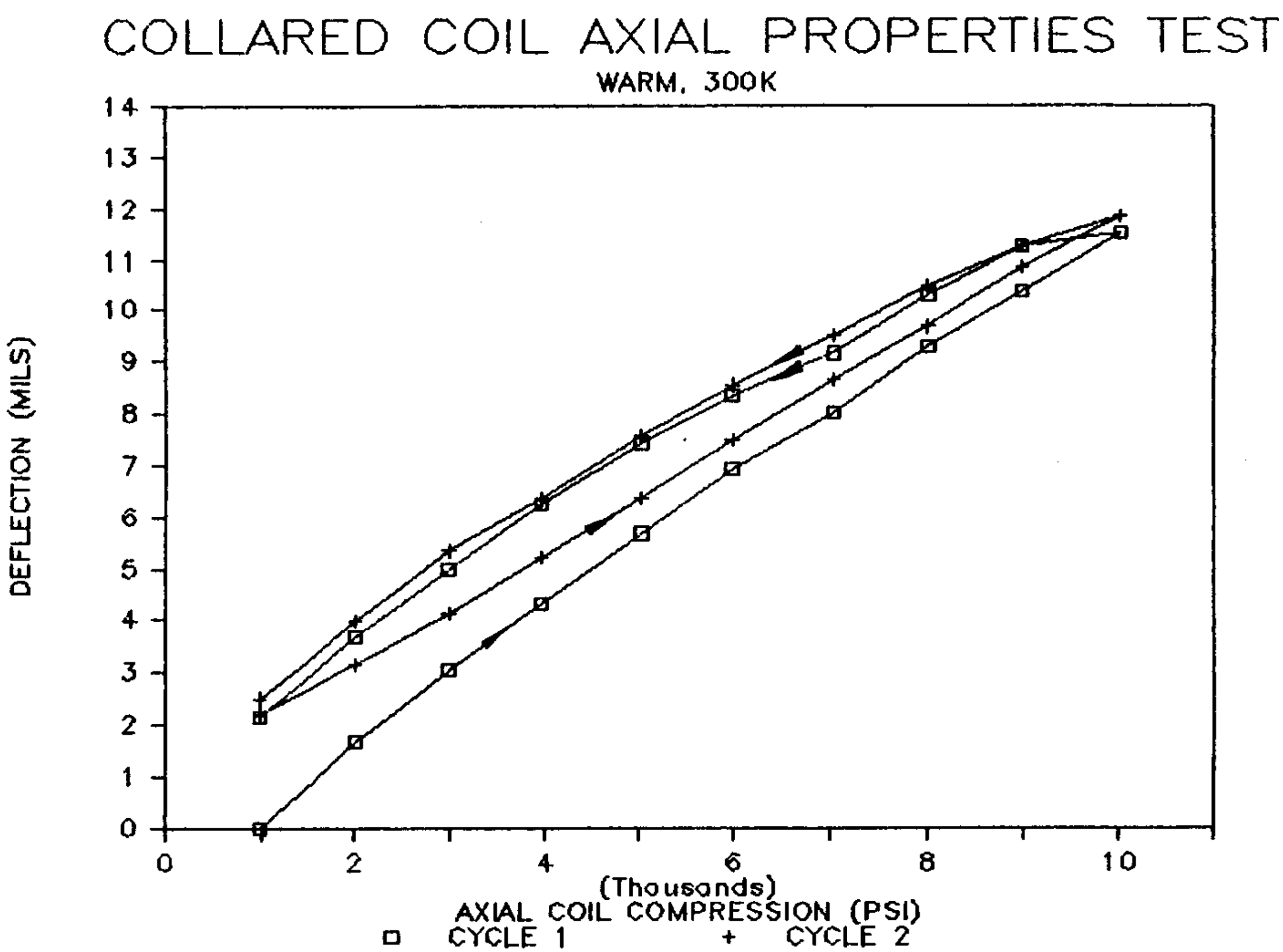

Fig. 2. Axial deflection results for warm collared coil sample.

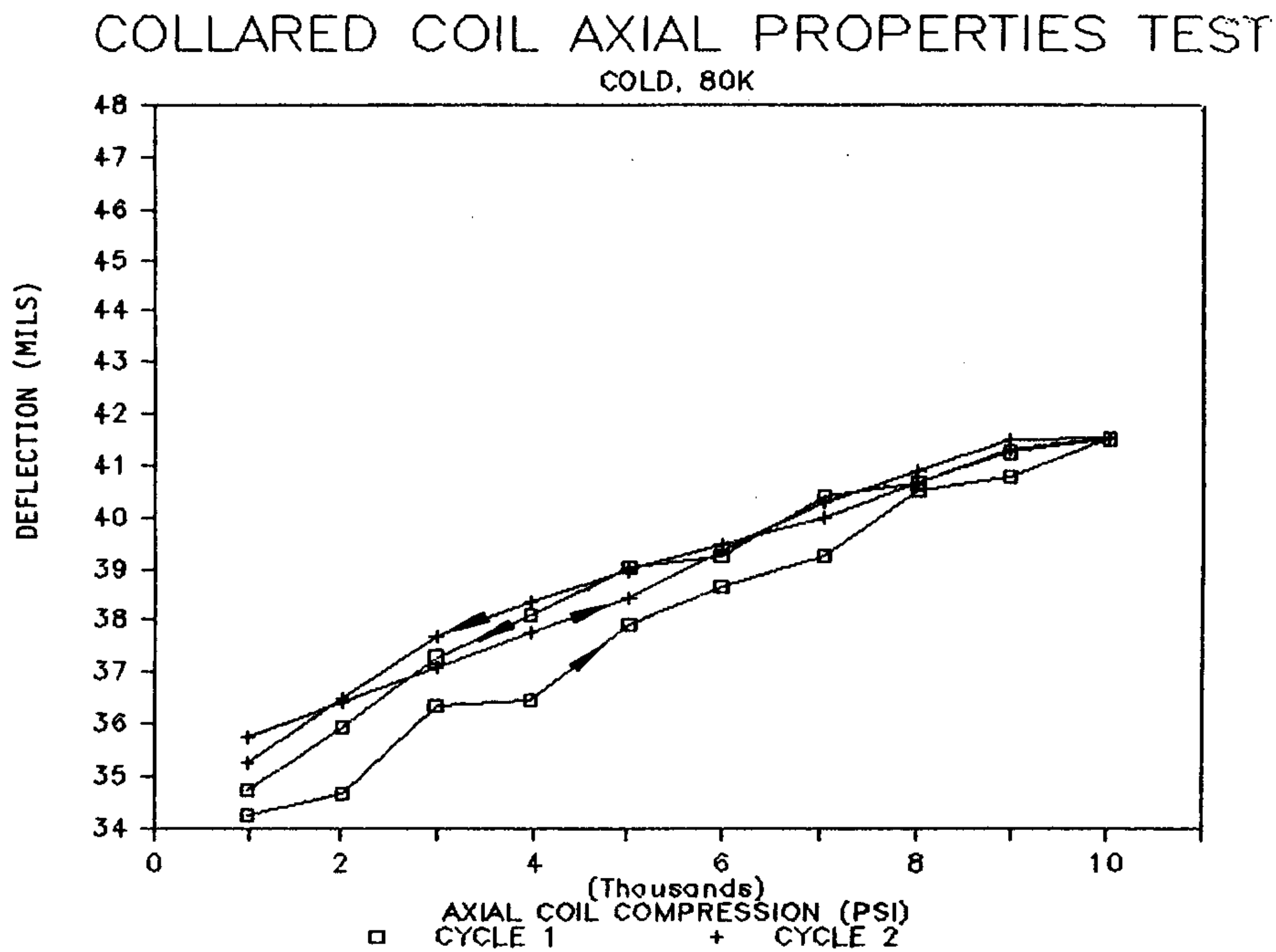

Fig. 3. Axial deflection results for cold (80K) collared coil sample.

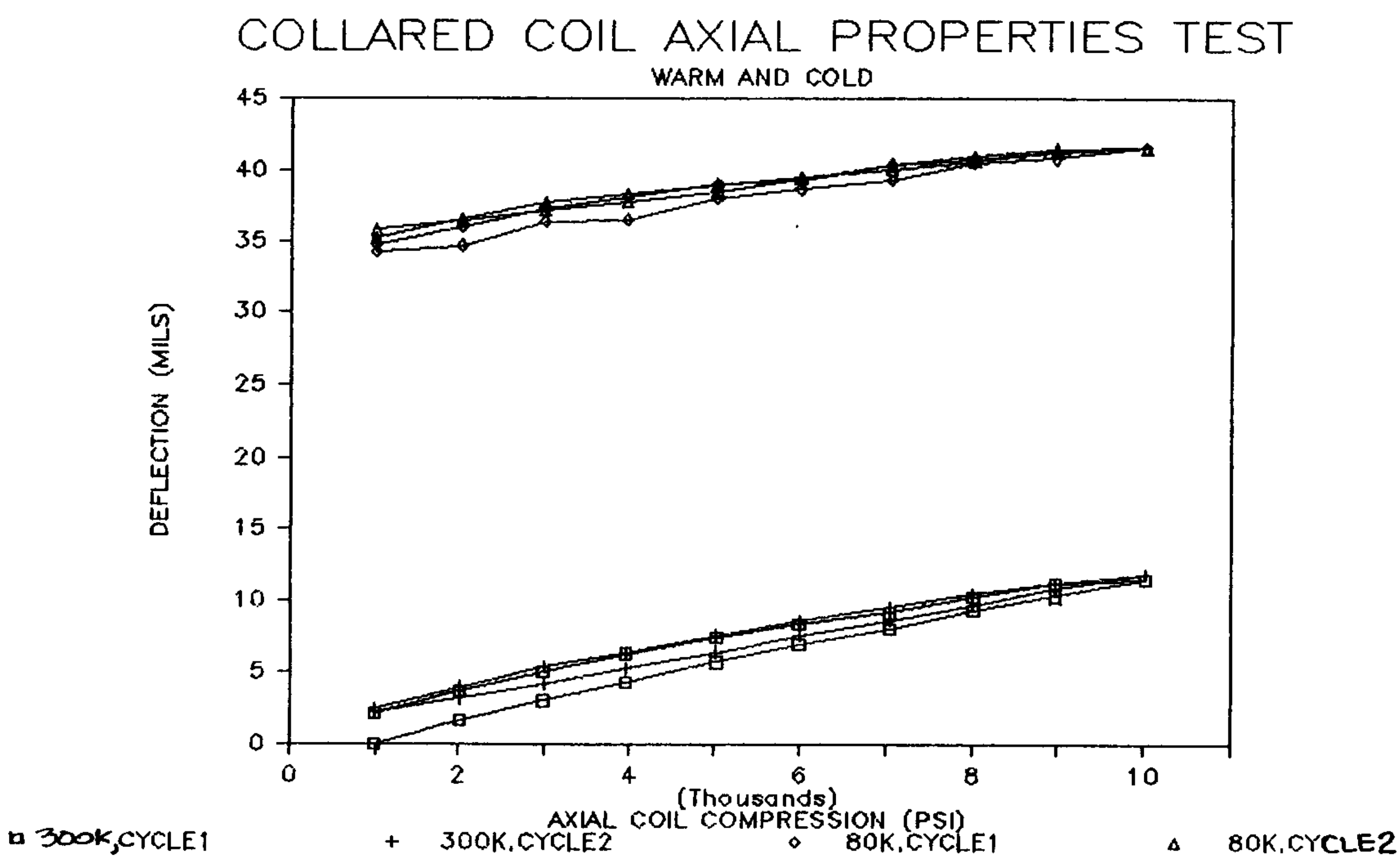

Fig. 4. Thermal contraction results for collared coil sample.