D-ZERO END CAP CALORIMETER
INNER VESSEL HEATER DOCUMENTATION

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JUNE 15, 1990

D-ZERO ENGINEERING NOTE NUMBER 3740.220-EN-257

Checked *Kent Rucinski*

INTRODUCTION

There will be 48 finned strip heaters installed in each end cap calorimeter vessel. The strip heaters were specified and the lowest bid vendor submitted a sample heater which was tested. This engineering note will document specifications of the heater, test procedure used, and results of the test.

SUMMARY

The finned strip heaters were of stainless steel construction. The lowest bid was \$45.00 per heater from TEMPCO Electric Heater Corporation. A sample heater from TEMPCO was inspected, cold shocked tested to -320 F, and found to be acceptable.

HEATER SPECIFICATION

Finned strip heater. Stainless steel construction including a stainless steel seamless sheath, stainless steel fin material, Both terminals at one end, 240 volt, 42 1/2" overall length, Nickel-Chromium heating wire embedded in a magnesium oxide insulation inside the sheath. Terminals to be corrosion resistant, all sharp edges free from metal burrs. Fast heat cat. no. RL020179 with above spec. or equal.

One hundred strip heaters were ordered. TEMPCO Electric Heater Corporation of Wood Dale, IL came in with a low bid of \$45.00. The next lowest was Fast Heat Element Mfg. Co. of Elmhurst, IL with a bid of \$87.85. A sample heater from TEMPCO was inspected and tested before a purchase order for the heaters was released.

The TEMPCO quoted heater was Finned Strip Heater Part No. FCX0200-4208T3, 2" wide x 42 1/2" sheath length with stainless steel fins, 5/16" x 3/8" mounting slots, rated at 4150 watts, 240 volts. Distance center to center of mounting slots = 41 1/2"

TEST PROCEDURE

1. Check heater construction for non-stainless steel construction that would make the heater unsuitable for cryogenic temperatures.
2. Check overall construction for possible burrs or contamination problems.
3. Measure resistance across terminals. Record.
4. Measure resistance from terminal to sheath by Hi-Potting. Record.
5. Connect wire of suitable length with 110 volt plug on end to terminals. Wire insulation should be suitable for liquid nitrogen temperature.
6. Submerge heater in a liquid nitrogen bath. Allow it to reach thermal equilibrium. Thermal equilibrium is reached when liquid nitrogen boiling from heater surface becomes negligible.
7. Remove heater from liquid nitrogen bath using cryogenic leather work gloves and repeat steps 3 and 4 within five minutes of removal from bath.
8. Plug heater into properly fused 110 volt outlet to bring the heater to approximately room temperature. Unplug heater.
9. Repeat steps 3 and 4.
10. Repeat steps 6 thru 9 until heater has been cycled to liquid nitrogen temperature five times.

RESULTS

The sample heater purchased from TEMPCO was a finned strip heater of approximately 10 1/2" length.

TEMPCO A89, Part No. FC0200-1008T3, 725 watt, 240 volt.

The heater was checked for construction materials. The sheath was stainless steel, the fins and terminals were not stainless steel. In order to get a sample quickly I didn't require the fins or terminals to be stainless. A sales engineer at TEMPCO, Mike Mallon, said that the quoted heaters would have stainless steel fins and terminal studs unlike the sample which was just off the shelf. The heater looked clean and free of burrs. There was some silicone in the end of the sheath which TEMPCO said was for moisture proofing that particular sample but would not be on the quoted heaters.

The rest of the test procedure was carried out by Mike Hentges AD/CRYO. I will copy his raw data below;

Warm resistance measurement: 75.9 ohms

DC Hi pot terminal 1 to Grnd: 3.0 KV at <.1 micro amp, > 100 Megohm

DC Hi pot terminal 2 to Grnd: 2.9 KV at <.1 micro amp, > 100 Megohm

COLD SHOCK 1

Heater resistance: 74.7 ohms

DC Hi pot terminal 1 to Grnd: 3.0 KV at <.1 micro amp, > 100 Megohm

DC Hi pot terminal 2 to Grnd: 3.0 KV at <.1 micro amp, > 100 Megohm

Heater resistance after warm up: 78.45 ohms

DC Hi pot terminal 1 to Grnd: 2.5 KV at <.1 micro amp, > 100 Megohm

DC Hi pot terminal 2 to Grnd: 2.5 KV at <.1 micro amp, > 100 Megohm

COLD SHOCK 2

Heater resistance: 74.45 ohms

DC Hi pot terminal 1 to Grnd: 3.0 KV at <.1 micro amp, > 100 Megohm

DC Hi pot terminal 2 to Grnd: 3.0 KV at <.1 micro amp, > 100 Megohm

Heater resistance after warm up: 76.33 ohms

DC Hi pot terminal 1 to Grnd: 2.5 KV at <.1 micro amp, > 100 Megohm

DC Hi pot terminal 2 to Grnd: 2.5 KV at <.1 micro amp, > 100 Megohm

COLD SHOCK 3

Heater resistance: 73.73 ohms

DC Hi pot terminal 1 to Grnd: 3.0 KV at <.1 micro amp, > 100 Megohm

DC Hi pot terminal 2 to Grnd: 3.0 KV at <.1 micro amp, > 100 Megohm

Heater resistance after warm up: 76.03 ohms

DC Hi pot terminal 1 to Grnd: 2.5 KV at <.1 micro amp, > 100 Megohm

DC Hi pot terminal 2 to Grnd: 2.5 KV at <.1 micro amp, > 100 Megohm

COLD SHOCK 4

Heater resistance: 73.72 ohms

DC Hi pot terminal 1 to Grnd: 3.0 KV at <.1 micro amp, > 100 Megohm

DC Hi pot terminal 2 to Grnd: 3.0 KV at <.1 micro amp, > 100 Megohm

Heater resistance after warm up: 76.37 ohms

DC Hi pot terminal 1 to Grnd: 2.5 KV at <.1 micro amp, > 100 Megohm

DC Hi pot terminal 2 to Grnd: 2.5 KV at <.1 micro amp, > 100 Megohm

COLD SHOCK 5

Heater resistance: 73.45 ohms

DC Hi pot terminal 1 to Grnd: 3.0 KV at <.1 micro amp, > 100 Megohm

DC Hi pot terminal 2 to Grnd: 3.0 KV at <.1 micro amp, > 100 Megohm

Heater resistance after warm up: 76.54 ohms

DC Hi pot terminal 1 to Grnd: 2.5 KV at <.1 micro amp, > 100 Megohm

DC Hi pot terminal 2 to Grnd: 2.5 KV at <.1 micro amp, > 100 Megohm