

**Crew Exploration Vehicle Thermal Protection System
Advanced Development Project**

**Instrumented Arc Jet Model
Thermocouple Plug Assembly Guide**

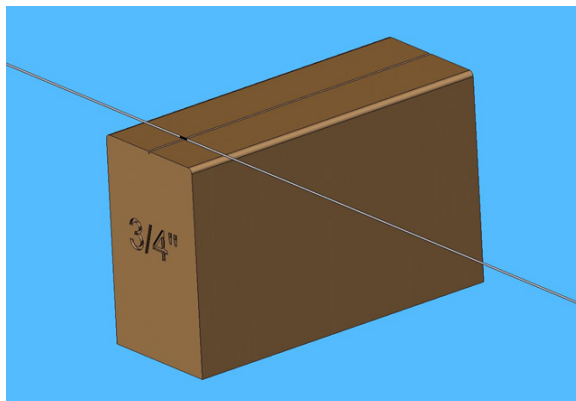
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This guide addresses instrumentation of 3/4" plugs and can be adapted to any diameter plug desired by substituting all 3/4" references in the guide with the new desired diameter.

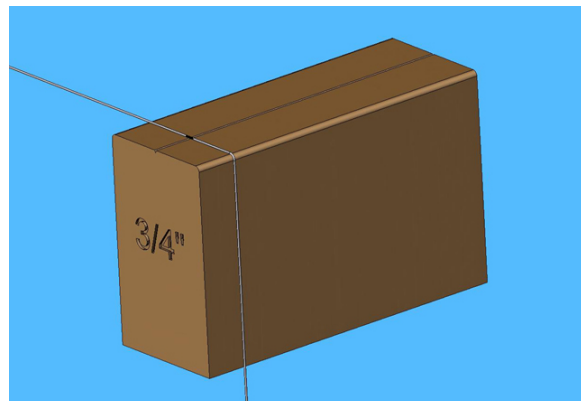
Items required for plug instrumentation and insertion.	
Butt-welded bare wire thermocouples	Tweezers (sharp point)
3/4" mandrel for bending TC land length	Tweezers (blade tips)
Plug insertion tool	Sharpie marker
PanaVise – or other small table top vise.	3M painter's masking tape – blue
Small blade screwdriver ~0.1" blade	Digital Multi Meter (DMM)

Note: at all times, work very carefully with the TC wires to prevent bending or kinking of the wires.

- 1) Determine the location on the back face of the plug where the negative lead will exit for the thermocouple closest to the face of the model, this will be referred to as TC#1 for this guide. Place a dot or some type of mark on the back face of the plug adjacent to this location using a sharpie marker. If there are multiple plugs in process a number on the back of each plug makes a convenient mark.
- 2) If thermocouples have serial numbers then record the TC serial numbers to be used for each plug, their locations in the plug, and the plug number. See sample assembly form at end of assembly guide.
- 3) Mark the negative lead for easy identification by making a small loop, ~0.03" diameter, at the end of the wire for each TC to be installed. Do this only on the negative lead.
- 4) Locate the weld junction for each TC to be installed. Orient the TC wire perpendicular to the scribed centerline of the 3/4" in mandrel and place the junction directly on the centerline. Bend the negative lead 90 degrees while holding the junction securely on the centerline and using the mandrel as a guide. Do this for each TC to be inserted through the plug. Note: if the plug will have a TC across its front face then bend both the negative and positive leads, otherwise only bend the negative lead.

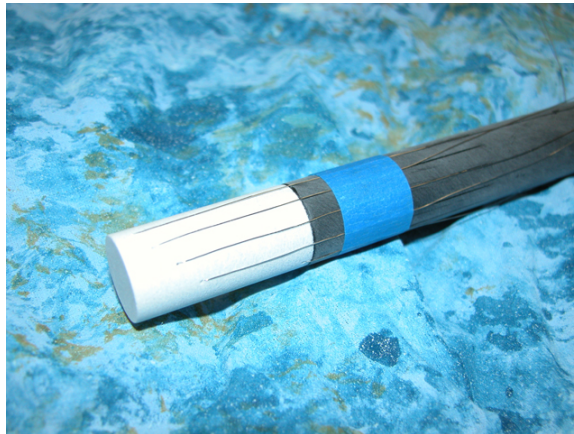


TC orientation before bending



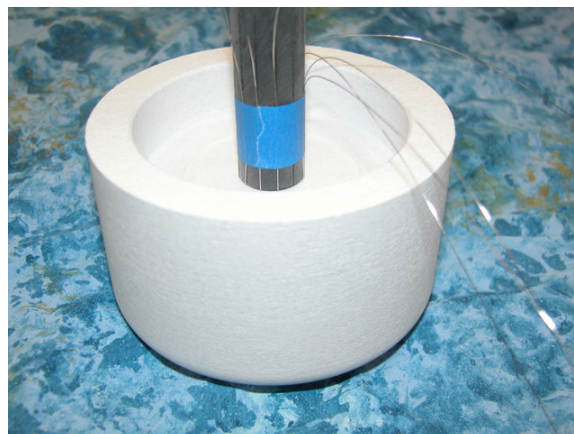
TC orientation after bending

- 5) For each thermocouple, feed the positive lead through the plug until the 90° bend in the negative lead comes into contact with side of the plug. Orient the negative lead so it follows the straightest possible path down the side of the plug to its exit location. Hold the negative lead in place and then bend the positive lead in the straightest possible path down the side of the plug to its exit location. Do this for each TC to be inserted through the plug.
- 6) Securely mount the plug insertion tool in the panavise in a vertical orientation. Place a plug on the end of the tool, located concentrically with the tool, and with the TC wires aligned with scribe marks in the tool. Starting with the negative lead of the TC#1; straighten the wire, lay it into the scribed groove and secure it with blue 3M painter's masking tape. Do the same with the negative lead for TC #2, 3, etc., working your way completely around the plug until all wires are straight and taped in their corresponding grooves in the insertion tool. Note: work very carefully with the TC wires to prevent bending or kinking of the wires.



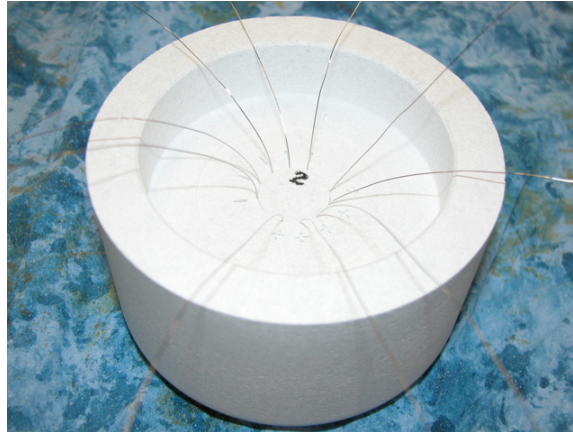
Instrumented plug on insertion tool
with all wires taped in their
corresponding grooves

- 7) Insert the plug into the model.



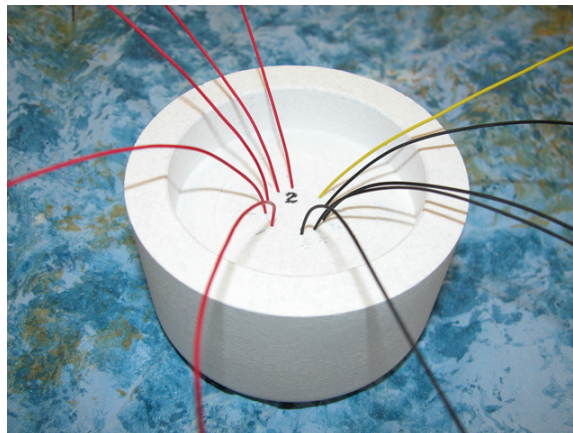
Plug inserted into model

- 8) Remove the blue 3M painter's masking tape, proceeding carefully so as not to bend or kink any wires, and then remove the insertion tool.



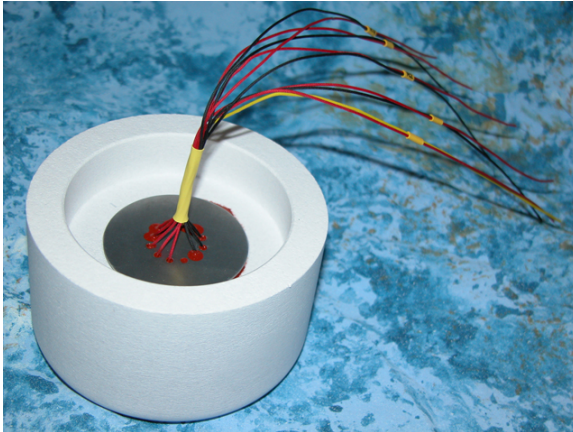
Bare wires at back of model after removal of insertion tool. Note the smooth, un-kinked wires.

- 9) Mark the back of the model with a “-“ or “+” adjacent to the exit location for each wire using the small bladed screwdriver. Make an additional mark on the model to identify TC#1.
- 10) Gather all TC wires together and orient them as straight as possible and perpendicular to the back of the model. Cut all wires to equal length, trimming as little as possible. As a guide, locate the shortest negative lead and trim just enough from its end to remove the small loop that was made in step 3, then trim the length of all other wires to match.
- 11) Measure the length of the wires protruding from the back of the model and subtract $\sim 1/2$ ". Cut all sleeving to this length.
- 12) Install the sleeving. Red (-) for both K and R. Yellow (+) for K and Black (+) for R.

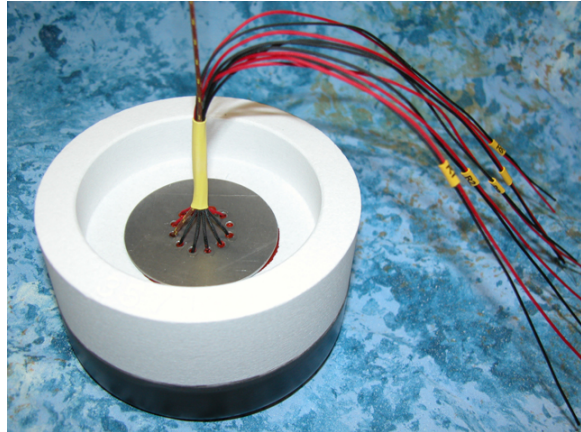


Model with TC sleeves installed

13) Identify each TC pair and number them appropriately with either marked heat-shrink tubing or numbered wiring tags.



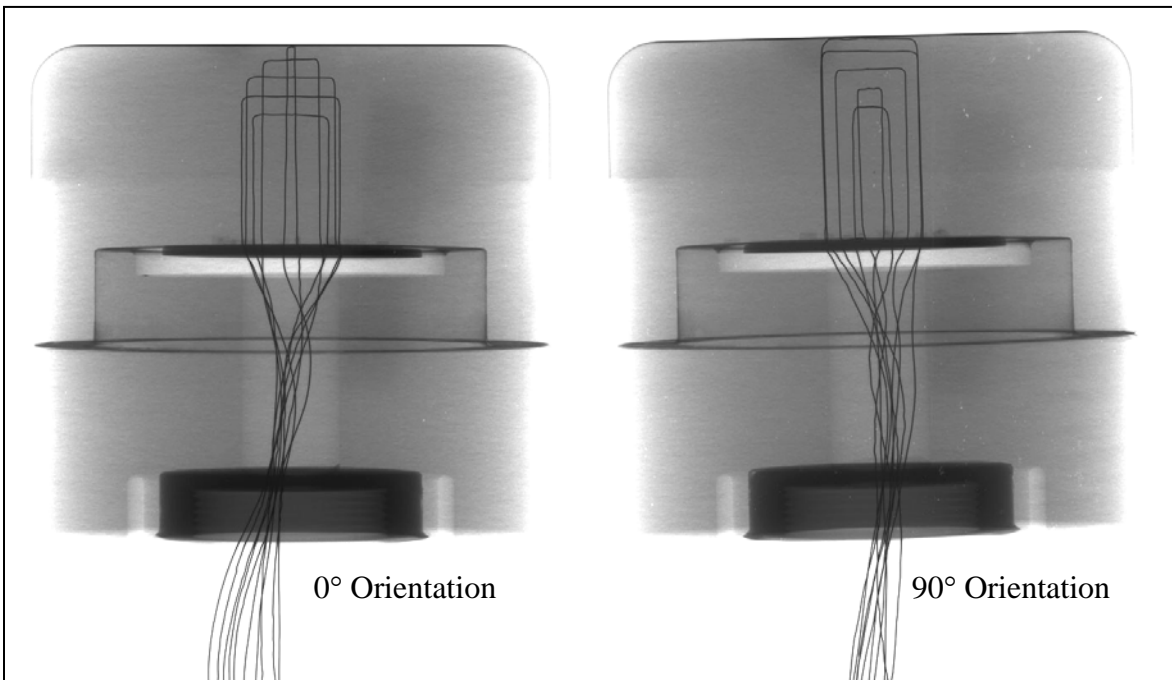
LI-2200 model assembly with TC sleeves installed and identified. Note clean assembly with minimal RTV outside aluminum disk bonding area.



LI-2200/RCG model assembly with TC sleeves installed and identified. Note clean assembly with minimal RTV outside aluminum disk bonding area.

14) Measure the resistance of each TC pair with the DMM and record the values.

15) X-ray models to verify TC locations.



X-Ray image of LI-2200 model assembly with TC plugs installed. Note uniform corners on bends in TC wire, straight isotherm and uniform separation of TC leads within the stack.

Sample **Instrumented Plug Assembly Form**

Date: ##/##/####

Operator: #####

Room Temp: 68°

DMM S/N: CM-1

DMM calibration expiration date: ##/##/####

Model S/N: CRV-LI-707.DC8

Plug ID#: 4

TC location	TC S/N	Measured Resistance
R5	A-7654-4-348	1.7 Ω
R4	A-7654-4-347	1.7 Ω
R3	A-7654-4-346	1.8 Ω
R2	A-7654-4-345	1.7 Ω
R1	A-7654-4-344	1.6 Ω
K1	A-7654-1-404	5.2 Ω