HEAT RELEASE RATE Updates

Materials Working Forum FAATC, USA

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October, 2023

Federal Aviation Administration

AGENDA

- Updated Appendix L
- HSI and calibration
- Reflector plate aging issue
- TRL 6 update
- OSU Thermopile discussion
- Next

Updated Appendix L

HFG

MEDTHERM CORPORATION	VATELL CORPORATION
Schmidt-Boelter Heat Flux Gauge (water-cooled)	
P/N 64-5SB-20 (smooth body with flange)	N/A
P/N 64-5SB-18 (smooth body no flange)	
Gardon Heat Flux Gauge (water-cooled)	
P/N 64-5GG-20 (smooth body with flange)	P/N TG1000-0 (smooth body with flange)
P/N 64-5GG-18 (smooth body no flange)	P/N TG1000-1 (smooth body no flange)
	P/N TG1000-0S (center: straight cooling water tubes)
	P/N TG1000-1B (corner: bent cooling water tubes)

Updated Appendix L

Sonic Choke

Design Criteria
Reference conditions (STP): 0°C @ 1 atmosphere (760 mmHg)
Setpoint: 20.0 PSIG @ 22.5 °C (72.5 °F)
Inlet diameter: 0.62 inches (15.7 mm)
Throat diameter: 0.208 inches (5.3 mm)
Mass flow rate: 96.84 lbs./hr

Fox Valve, Inc. (Fox Valve Development Corp.)		Flow Systems, Inc.
Hamilton Business Park		220 Bunyan Ave
Franklin Road		Berthoud, CO 80513 USA
Dover, NJ 07801 USA		Phone: (970) 532-0617
Phone: (973) 328-1011		Fax: (970) 532-0748
Fax: 973-328-6972		www.flowsystemsinc.com
P/N: 625442		P/N: Q18498

Updated Appendix L

L.1.1.1.16 Efficiency Estimation of Globar Heating and Unit Insulation.

This data is acquired when the system is at the proper heat flux level, stable, with no flame present. This efficiency value can be monitored over time for system stability purposes.

T_{out} = Average exhaust gas temperature = (*Enter value*) °C

ρ = Air density at STP = 1.2 kg/m^3

Cp = Specific heat of air = 1006 J/kg °C

$\dot{V}$ = Volumetric airflow rate = 0.00944 m^3/s (20 SCFM)

$\dot{Q}$ = Sensible heat = Globar total power = (*Enter value*) W

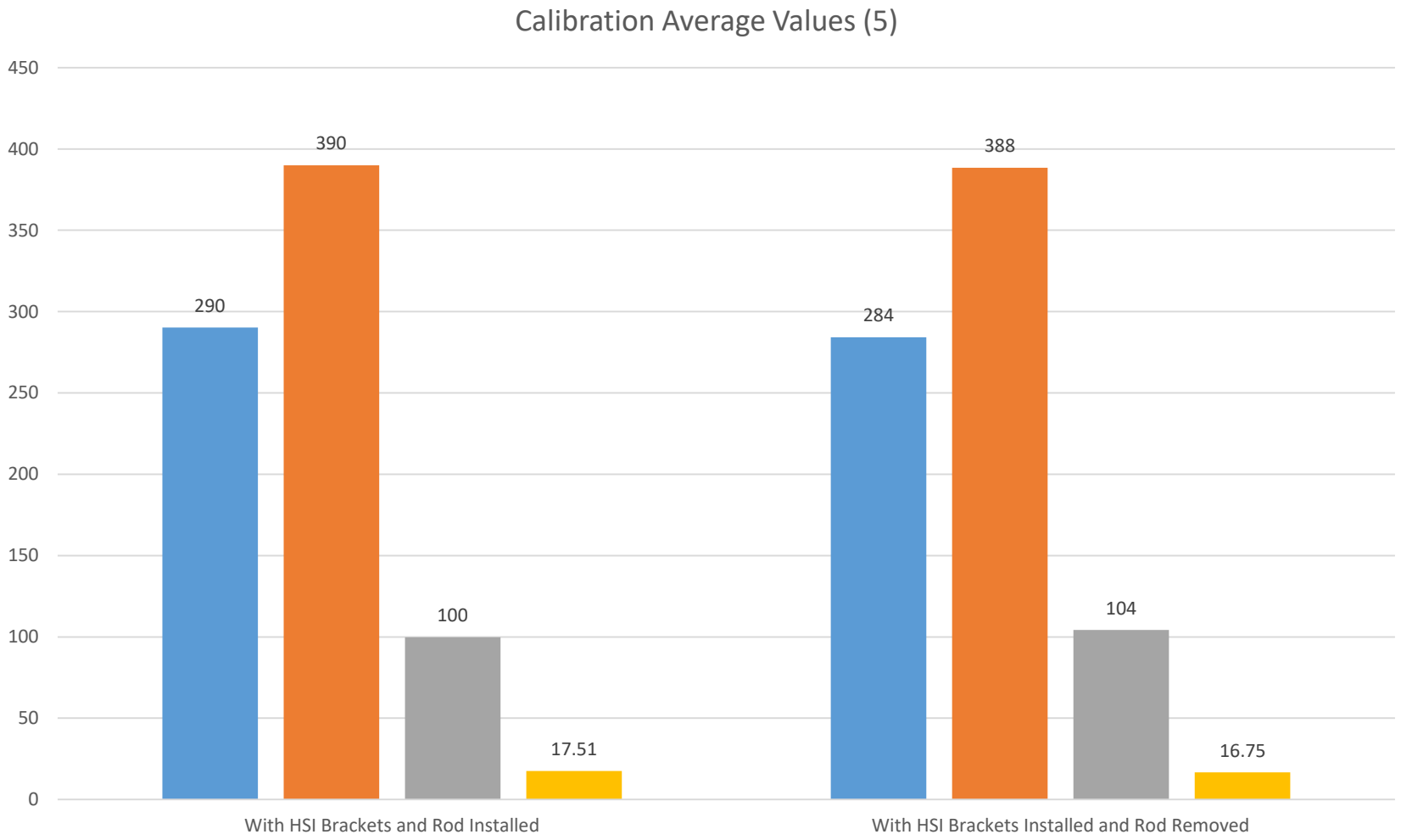
Fraction of effective heat lost to calorimeter (HR2) body = χ_L %

$$\chi L = \frac{T_{out} \times \rho \times C_p \times \dot{V}}{\dot{Q}} = \frac{(Enter\ T_{out}\ value)\ °C \times 1.2 \frac{kg}{m^3} \times 1006 \frac{J}{kg\ °C} \times 0.00944 \frac{m^3}{s}}{(Enter\ \dot{Q}\ value)\ W}$$

HSI and Calibration

- Possible error induced during thermopile calibration when hot surface igniter rod is installed
- Heat produced from Methane flame impingement is absorbed into the rod/bracket and upper pilot burner tube
- Recommendation to have the rod removed during calibration (only used when testing)

HSI and Calibration



HSI and Calibration

With HSI Brackets Installed and Rod Removed

	#1	#2	#3	#4	#5	**Average**	**STDEV**	**COV**
Baseline Temperature (°C)	284	284	284	285	284	**284**	**0.4**	**0.2%**
TST (°C)	388	389	388	388	389	**388**	**0.5**	**0.1%**
Differential Temperature (°C)	104	105	104	103	105	**104**	**0.8**	**0.8%**
Calibration Factor (W/°C	16.79	16.68	16.74	16.94	16.6	**16.75**	**0.1**	**0.8%**

With HSI Brackets and Rod Installed

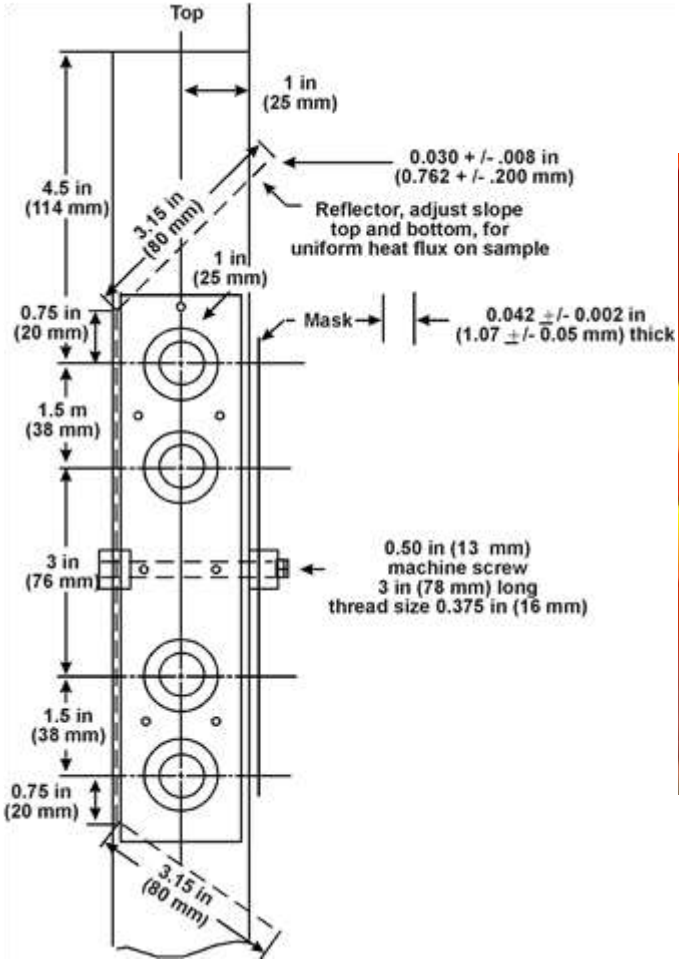
	#1	#2	#3	#4	#5	**Average**	**STDEV**	**COV**
Baseline Temperature (°C)	289	291	293	291	287	**290**	**2.3**	**0.8%**
TST (°C)	389	391	393	390	387	**390**	**2.2**	**0.6%**
Differential Temperature (°C)	100	100	100	99	100	**100**	**0.4**	**0.4%**
Calibration Factor (W/°C	17.55	17.51	17.41	17.62	17.48	**17.51**	**0.1**	**0.4%**

HSI and Calibration

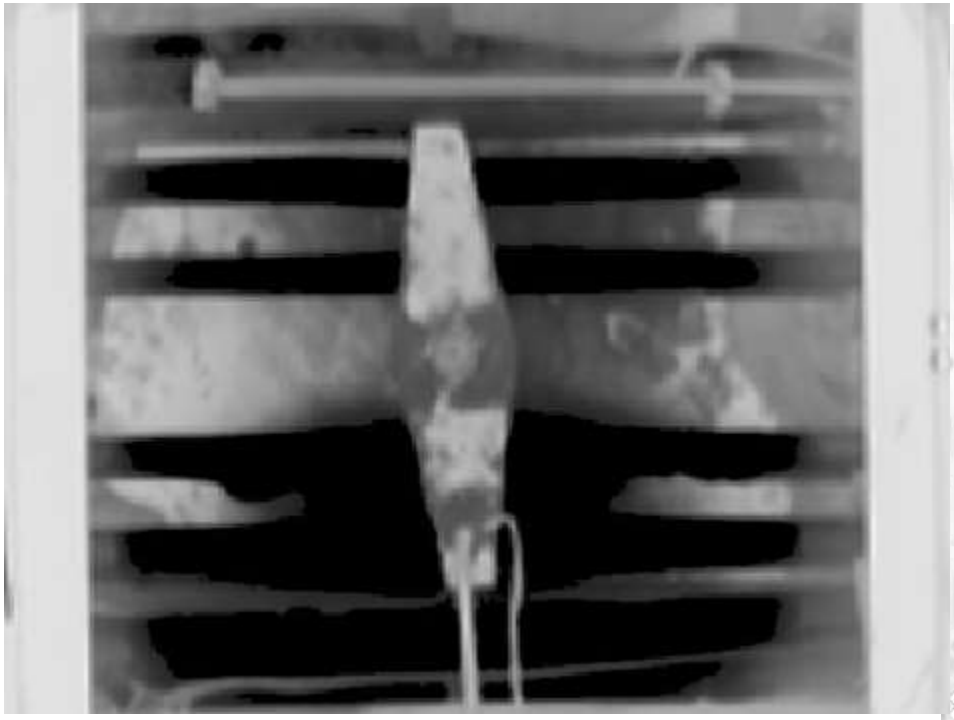
- Induced error could increase HRR test results by approximately 5%
- Minimal impact when HSI rod is installed for testing since baseline values are zeroed out.

CF (W/°C)		HRR (kW/m^2)
Without HSI Rod	16.75	75.0
With HSI Rod	17.51	78.4
% Delta	-----	5%

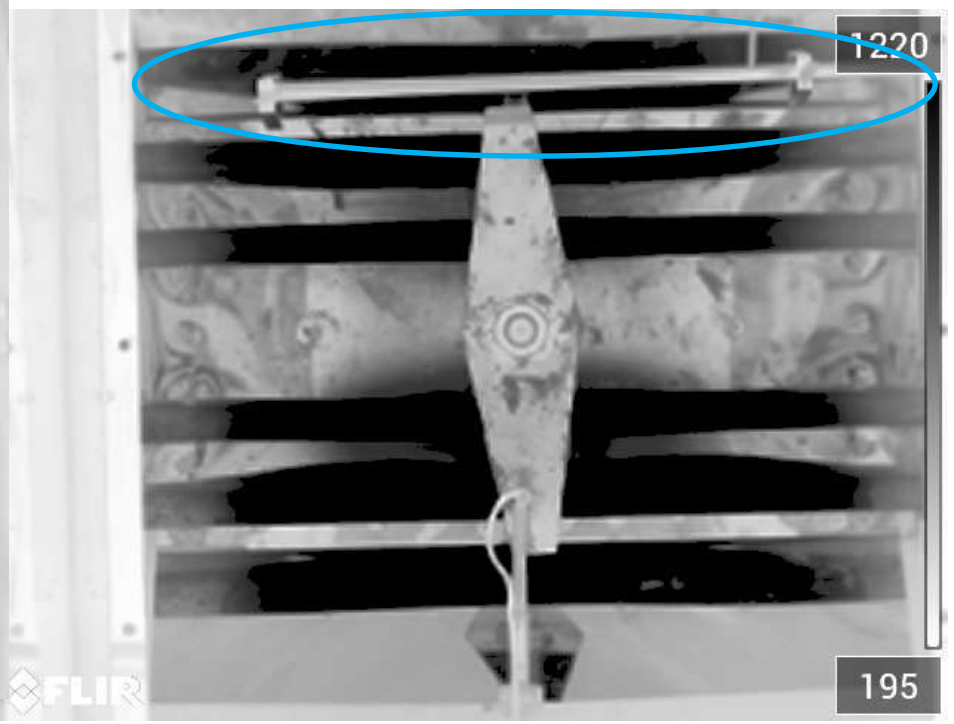
HR2 Reflector plate aging issue



FLIR: Globar Area (Black is hot)



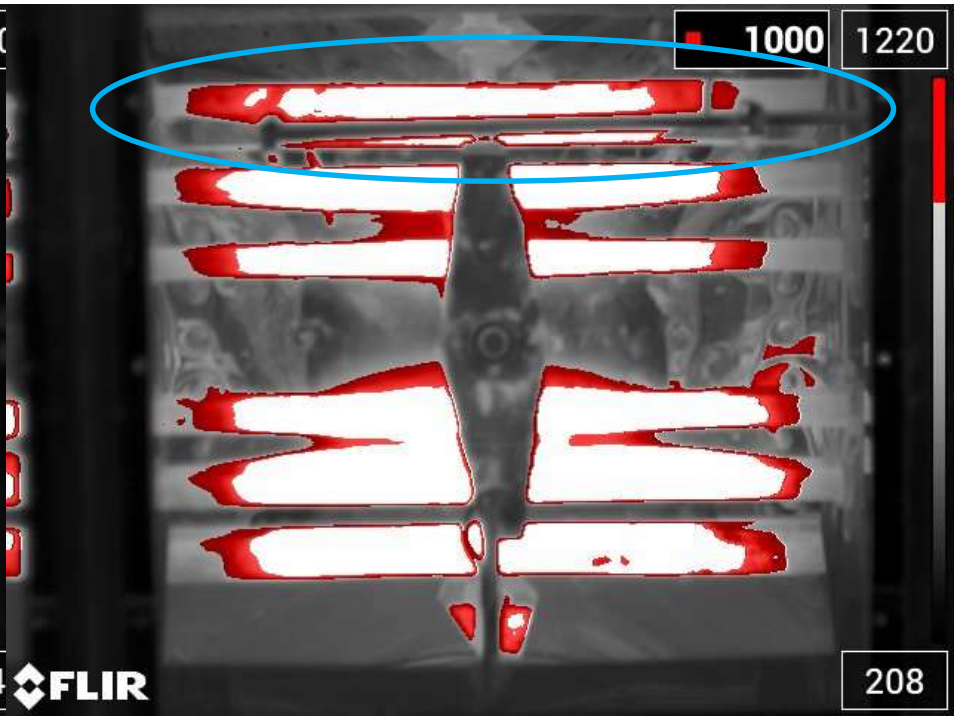
DEATAK



M.E.

FLIR: Globar Area (White is hot)

DEATAK



M.E.

TRL 6 update

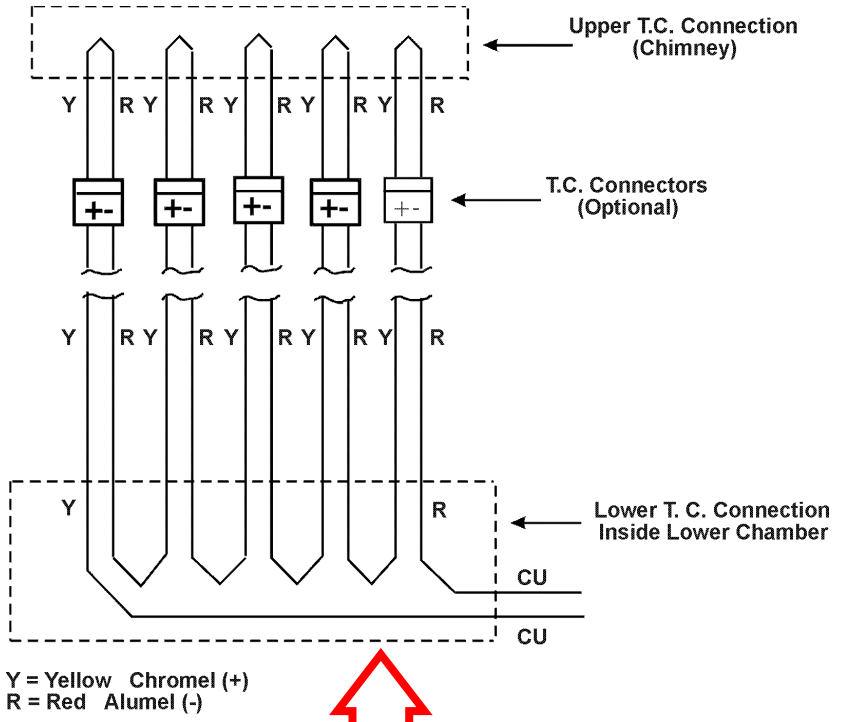
Boeing HR2:

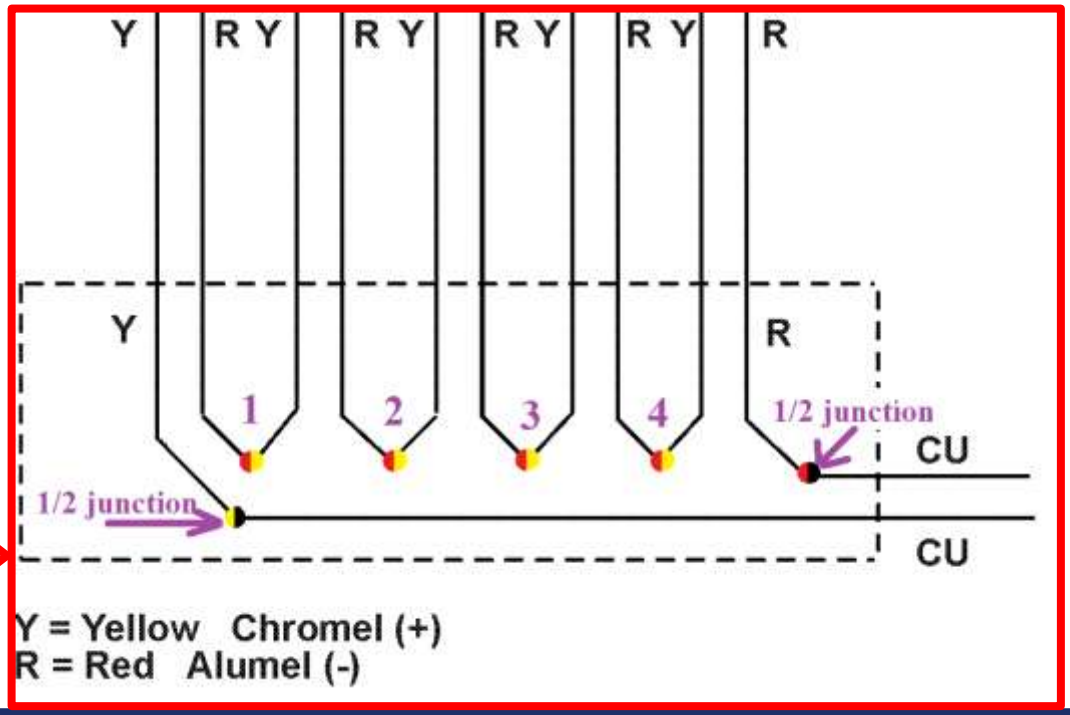
- Boeing HR2: Heater activation turning off MFC airflow
- Manufacturer visit to Seattle lab to fix this and install a new pressure monitoring port (lower plenum)
- Fix will allow calibration operating parameter progress to continue (TRL 6)

Chemitox HR2:

- Comparative system parameters were recorded and found similar to the Boeing machine.
- Unable to proceed with 100 calibration cycles due to heavy workload of the lab.
- Due to an excessively hot climate in summer in Japan, difficulty stabilizing inlet air temperature to below 23C. Internal discussions on how to improve air distribution system (making an atmosphere surrounding the chiller cooler, adding thermal insulation to the hose between the chiller and test machine…)
- Ability to participate in TRL 6 under internal discussion.
- Under comparison work between the data of HR2 and OSU to see the correlation.

OSU Thermopile Discussion





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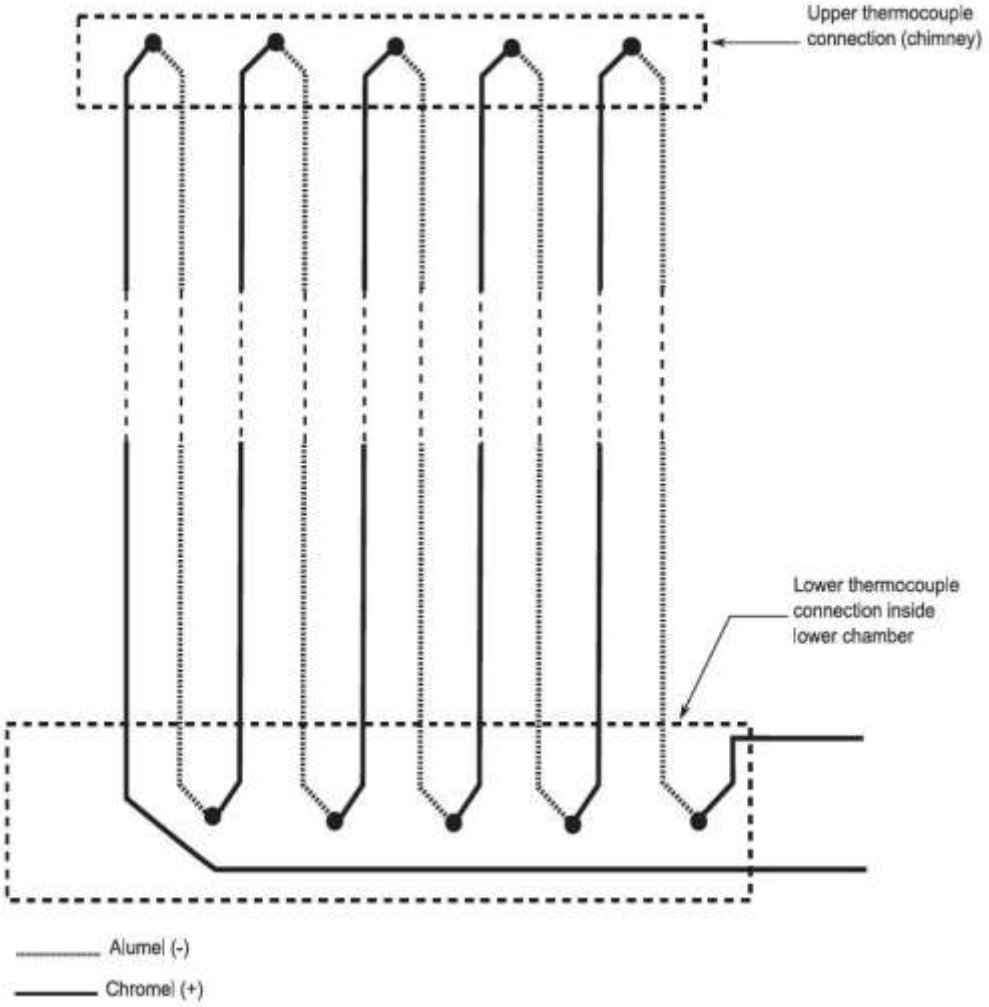

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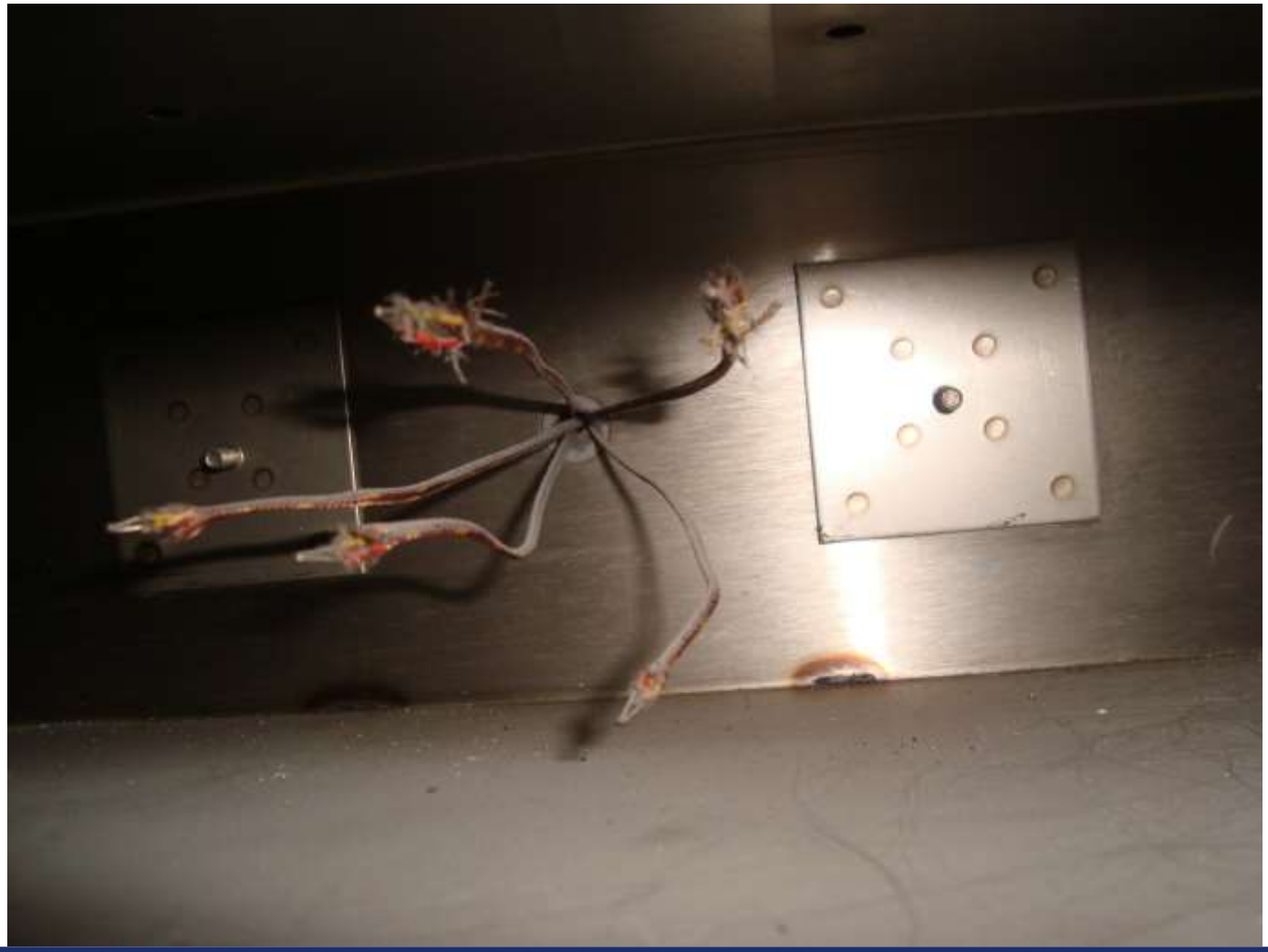

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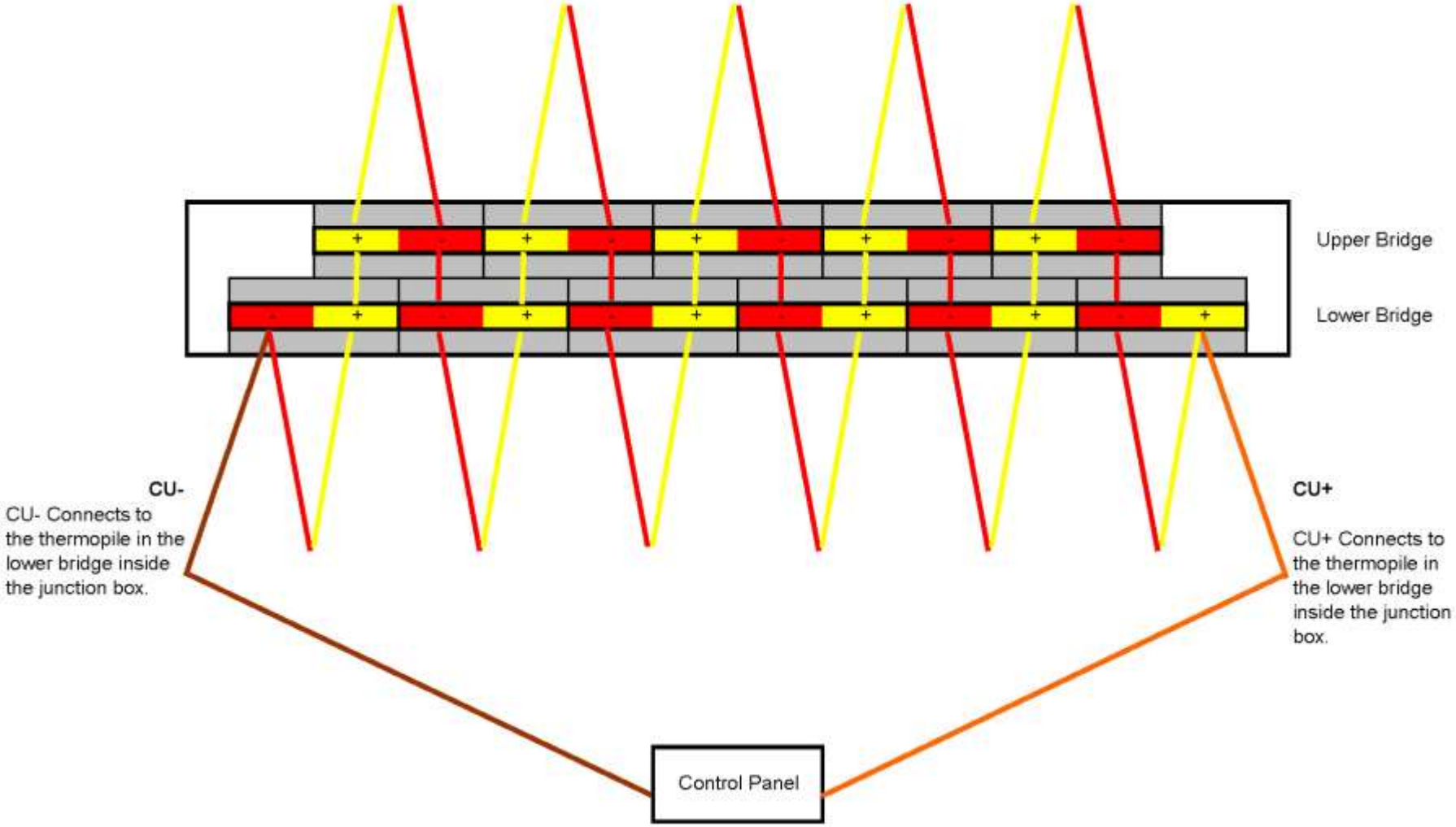
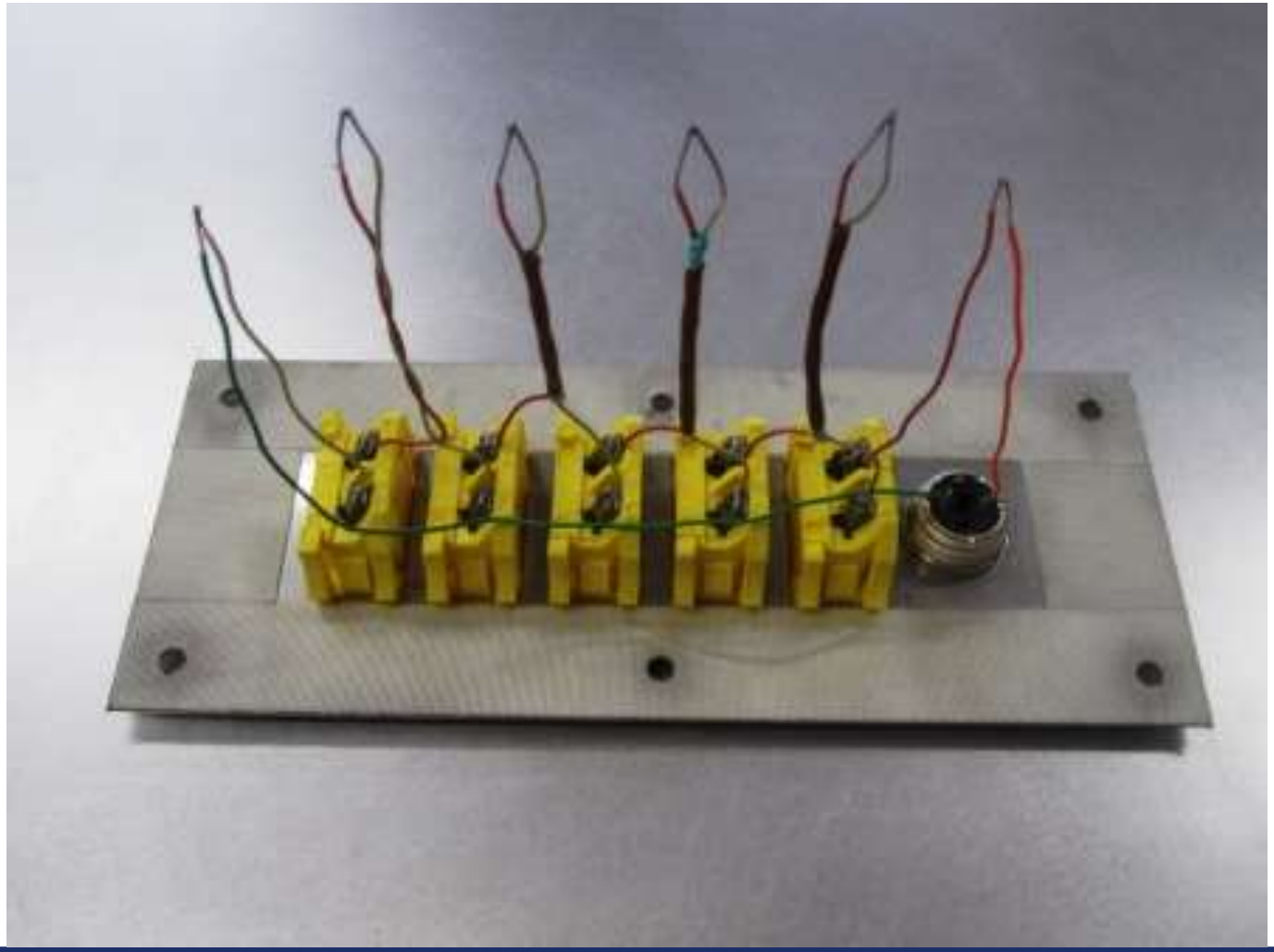


OSU Thermopile Discussion



NEXT

- Continue TRL6 testing
  - Response Parameters - Complete 100 calibration cycles per unit as needed
  - Define Nominal Operating Parameters Range (BL, TST, CF)
  - Additional unit buildups for comparative testing (TRL 6)
- TRL7 planning and acquisition of materials
- Formalize endgame for TRL test series (define activities, goals etc.)
- R&D Globar replacement heater
- Update Rev3 placeholder document

QUESTIONS?