

Dreaming Collaborating Innovating Exploring Trailblazing

# Determination of HR 2 Key Operating Parameters

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#### HR 2 Key Operating Parameters

- Preparing machines for best performance
- Air and Water thermopile cleaning comparison
- Applied Calibration Factor (K<sub>H</sub>)
  - How to limit calibration factor variations on heat release properties

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PARAMETER	DESCRIPTION	MIN	NOMINAL	MAX
Inlet Airflow Rate	SCFM	19.6	20	20.4
Inlet Air Temperature	°C	21.1	22.5	23.9
Inlet Air Relative Humidity	% RH	-	-	≤65
Heat Flux (W/cm <sup>2</sup> )	Center	3.60	3.65	3.70
	Each Corner (4)	3.55	3.65	3.75
Average Baseline Exhaust Gas Temperature	No Flame (°C)	270	280	290
	Slope (L/°C)	0.0255	0.0289	0.0323
Calibration Factor Range	W/°C	15.00	17.00	19.00
	kW/m <sup>2</sup> /°C	0.646	0.732	0.818
	3 SLPM ΔT (°C)	92.8	103.7	117.6
Interspace Pressure	inH2O	0.40	0.55	0.70
Lower Plenum Pressure	inH2O	11.0	12.5	14.0
Methane Gas Supply Pressure	PSIG	18	20	22
Main Air Supply Pressure	PSIG	18	20	22
Mixing Air Supply Pressure	PSIG	18	20	22
Thermal Stability Temperature (TST)	20 sec average (°C)	365	380	395
Specimen Conditioning	Temperature (°C)	18	21	24
	Relative Humidity (%)	45	55	65
Upper Pilot Gas Flow	Air (SLPM)	0.98	1.00	1.02
	Methane (SLPM)	1.47	1.50	1.53
Lower Pilot Gas Flow	Air (mL/min)	0.65	0.70	0.75
	Methane (mL/min)	115	120	125

270 – 290 °C
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15 – 19 W / °C

365 – 395 °C
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#### Conditions

- Baseline Temperature
  - Heat Flux Density: 3.65 W/cm<sup>2</sup>
  - Unit: Stabilized
  - Pilot lights: OFF
- Thermal Stability Temperature
  - Heat Flux Density: 3.65 W/cm<sup>2</sup>
  - Unit: Stabilized
  - Pilot lights: upper pilots ON only, 3 SLPM methane gas flow rate
- Calibration Factor
  - Proportionality constant, determined by performing the calibration procedures
  - Correlates heat released by specimen when burned to the known heat content of methane

#### Setting the Specification Limits

- Establish operating response specification limits using TRL 6 unit assessment data
  - Set range using 99-95% tolerance interval statistic
    - 95% confidence that 99% of the population will fall within range
    - Capture a practical range, but not too wide
  - Sample: 100 data points from each unit



#### Baseline, Thermal Stability Temperature (FAA-DT, FAA-ME)



Baseline = 271.0 - 286.7 Deg C

Range = 15.7 (5.6% of mean)

TST = 376.3 - 389.2 Deg C

Range = 12.9 (3.4% of mean)

#### Calibration Factor (FAA-DT, FAA-ME)



Calibration Factor = 16.42 - 17.33 W/C Range = 0.91 (5.4% of mean)

Compressed Air and Water Mist thermopile cleaning method comparison (FAA-DT)



Method	AVG	STDEV	CoV	Range
Water Mist	16.78	0.22	1.3%	1.01
<b>Compressed Air</b>	16.84	0.33	2.0%	1.54

Water mist cleaning method seems to result in more consistent calibration factor



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# **Determination of Applied Calibration Factor**

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## **Applied Calibration Factor**

What is the calibration factor?

- Calibration Factor (K<sub>h</sub>)
  - Proportionality constant, determined by performing the calibration procedure
  - Correlates the heat released by a specimen when burned to the known heat content of methane
  - Calibration procedure conducted weekly and after each repair or maintenance of the apparatus that may affect the unit's response
  - May vary significantly, variations impact heat release properties



## **Applied Calibration Factor**

**Calibration Factor Correction** 

- Mike Burn's Proposal
  - Use simple moving average to compute Applied Calibration Factor (K<sub>H</sub>)
    - Offers stable calibration factor value over time
    - Calibration factor less prone to whipsawing up and down
    - More representative of instrument's performance over time



Data from FAA-DT unit response assessment experiment, 104 calibrations conducted by Mike Burns at FAA Tech Center

## **Applied Calibration Factor**

Selecting Moving Average Interval

- Moving Average Sensitivity Analysis
  - Determine most practical moving average interval
  - Sets the interval for moving average calculation
  - 56% range reduction using interval of 5 best option, most practical



Data from FAA-DT unit response assessment experiment, 104 calibrations conducted by Mike Burns at FAA Tech Center

### Summary

#### HR Key Operating Parameters

- Specification limits determined with 99-95% tolerance interval statistic using TRL 6 unit assessment data
  - Baseline temperature (°C)
  - Thermal stability temperature (°C)
  - Calibration constant (W/(°C)
- Water mist cleaning method results in more consistent response
- Adopting simple moving average (interval of 5) to compute applied calibration factor
  - Offers stable calibration factor value over time
  - Reduces calibration factor variations impact on heat release properties