

HEAT RELEASE RATE Updates

2016 June Materials Meeting
Kansas City, MO

Materials Working Group

Michael Burns, FAA Tech Center

June, 2016



Federal Aviation
Administration



AGENDA

- OSU Round Robin
- HR2 Updates
- Chapter HR (Placeholder) Updates
- Miscellaneous Topics
- Next



2016 HRR Round Robin **Completed**

- Thank you to all participants!
- 30 Labs (31 OSU's) / 7 Countries
 - Austria
 - France
 - Germany
 - South Africa
 - Spain
 - Switzerland
 - USA



2016 HRR Round Robin **Completed**

Aearo Technologies, LLC (IN)

Airbus (Germany)

Aviation Cabin Consulting Materials GmbH (Germany)

B/E Aerospace (NC)

B/E Aerospace, Inc. (AZ)

Boeing (Everett) (WA)

CSIR, MSM, Polymers & Composites (South Africa)

CTA (Spain)

Custom Scientific Instruments, Inc. (PA)

DGA (France)

FAA

FAA (Chem Lab)

General Plastics (WA)

Govmark, LLC. (NY)

Heath Tecna (WA)

Herb Curry, Inc. (IN)

Isovolta (OR)

ISOVOLTA AG (Austria)

Jamco-America (WA)

Krueger Consulting LLC (WA)

Lantal (Switzerland)

Lufthansa Technik AG (Germany)

Rescoll (France)

Schneller (OH)

Skandia (IL)

Testcorp (CA)

TTF Aerospace (WA)

Zodiac Aerospace (SELL) (Germany)

Zodiac, La Palma (CA)

Zodiac, Marysville (WA)



2016 HRR Round Robin **Completed**

- Compiled test data will be posted to FAA web site soon.
- Thank you to the Boeing team for assisting in analysis and presentation of data.
- NBS Smoke Density Round Robin to begin.



HR2: Calibration

- Based on DOE data it was desired by task group members to research options to improve the current calibration method.
- Goal: Improve repeatability from calibration to calibration (<5%).
- Two pronged approach:
 1. Slight change to current “Step” method.
 2. Investigate new “Ramp Down” method.



HR2: Calibration

- Current Calibration Method (Step)
 - Unit is preheated at 4 SLPM for 3 minutes.
 - Flow is set to a baseline flow of 1 SLPM.
 - Flow step changes from 1-2, 1-3, 1-4 SLPM after stabilizing for 3 minutes at each flow.
 - A 10 second mV average of the thermopile is recorded during the final 3 minute period.

$$K_h = \frac{(210.8 - 22)}{(22.41 * 0.01433 * 1000)} \text{ (or } 0.588) * (F_1 - F_0 / V_1 - V_0)$$



HR2: Calibration

- Proposed Step Method
 - Incorporate a new 20 second moving average of the thermopile signal (Replacing the average mV value of the final 10 seconds of data during each of the 3-minute step changes).
 - Replace 3-minute preheat with a mV threshold limit which starts the calibration process.
 - Remainder of calibration process unchanged.



HR2: Calibration

- Proposed Ramp Down Method
 - Start of calibration same as Step change method (20 s moving avg. / mV Threshold).
 - Replace step change in flow (1-2, 1-3, 1-4 SLPM) with subtle changes in flow (ramp) over a certain time frame.
 - Instantaneous thermopile mV and gas flow are recorded during the ramping process to calculate slope needed to determine K_h .



HR2: Calibration

- R&D Software Program (Marlin Engineering)
 - Flexibility is being built into the program to adjust parameters:
 - ✓ Selectable: Step or Ramp Method
 - ✓ Adjustable mV Threshold value
 - ✓ Threshold: Auto / Manual
 - ✓ Adjustable Start / Stop Flow Rate and Time (Ramp Method)



HR2: Calibration

- R&D Software Program (Marlin Engineering)

EXAMPLE	Flow			Minutes		
	Start	Stop	Delta	5	10	15
	4	3	1	0.0033	0.0017	0.0011
	4	2	2	0.0067	0.0033	0.0022
4	1	3	0.0100	0.0050	0.0033	
						Rate Change (L/sec)

- Generate least squares fit of flow rate vs. mV data points (SLPM/mV)

$$K_h = \frac{(210.8 - 22)}{(22.41 * .01433 * 1000)} \text{ (or } 0.588) * \text{ (SLOPE) kW/mV}$$

- Calibration Factor Range: 0.085 +/- 0.01

Chapter HR Tolerance Changes

- Chamber Airflow:

From: $20.0 \pm 5\%$ (19.0 – 21.0 SCFM)

To: $20.0 \pm 2\%$ (19.6 – 20.4 SCFM)

- Upper Pilot Methane Flow:

From: $1.50 \pm 13.3\%$ (1.30 – 1.70 SLPM)

To: $1.50 \pm 2\%$ (1.47 – 1.53 SLPM)

- Upper Pilot Air Flow:

From: $1.0 \pm 20\%$ (0.80 – 1.20 SLPM)

To: $1.0 \pm 5\%$ (0.95 – 1.05 SLPM)



Chapter HR Updates

- Hardware Changes
 - Replace the main air supply Mass Flow Meter (MFM) with a Mass Flow Controller (MFC).
 - Replace the panel mounted flowmeter for the upper pilot airflow with a MFC.
- Calibration method now requires sample holder (with millboard & drip pan) be in place during the calibration process.



Chapter HR Updates

System Airflow (MFC Requirements):

- Airflow is measured in standard cubic feet per minute (SCFM) referenced to STP 0°C at 760 mmHg.
- The flow rate through the environmental chamber will be set to 20 ± 0.4 SCFM at 70 to 75°F.
- Calibrated for air annually with NIST traceability.
- Minimum accuracy of $\pm 2\%$ of F.S.
- Located within 24 inches of the inlet port to the system.



Chapter HR Updates

Mass Flow Controller P/N C100H1-NR-16-OV1-SV1-PV2-V1-S1-C3 or product of similar specification or function has been found suitable.

Standard Accuracy: $\pm 2\%$ of F.S.

Range: 800 SLPM Air

Fittings: 0.75 inch Female NPT

Seals: Viton

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Monterey, CA 93940 USA

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URL: <http://www.sierrainstruments.com>



Chapter HR Updates

Upper Pilot Methane / Airflow (MFC Requirements)

- Thermal-based MFC having nominal 0.25 inch inlet / outlet fittings.
- Calibrated annually with NIST traceability.
- Calibrated for Methane / Air respectively.
- Minimum accuracy of $\pm 1\%$ of F.S.
- Referenced to STP 0°C at 760 mmHg (1013 mbar).



Chapter HR Updates

Mass Flow Controller P/N C100L-NR-2-OV1-SV1-PV2-V1-S1-C3 or product of similar specification or function has been found suitable.

Standard Accuracy: $\pm 0.2\%$ of F.S. / $\pm 1\%$ of Setpoint

Range: 5,000 sccm (CH₄ or Air)

Fittings: 0.25 inch compression

Seals: Viton

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Chapter HR Updates

- Millboard Specification
 - Nominal Thickness: 0.5 inch (12.7 mm)
 - Density: 50 ± 10 lb/ft³ (0.8 ± 0.16 g/cm³)
 - Standard Size: $5.94 + 0, - 0.06$ by $5.94 + 0, - 0.06$ inch in lateral dimensions to fit inside the specimen holder.

Note: Marinite I Board meets this criteria



Miscellaneous

- Awaiting arrival of MFC's / Software for HR2
- The DEATAK HR2 unit has been received and inspected at the Tech Center (Testing soon to follow).
- New NBS smoke density Photomultiplier (PM) tube part number soon (Jan 2017)
 - Current: RCA 1P21
 - New: R11558



Next

- HR2:
 - Install new equipment (MFC's)
 - Conduct calibration testing (Step / Ramp)
 - Continue DOE Test Plan as needed
 - Update Chapter HR as needed
- NBS Round Robin testing to begin



Questions?

