FAA Microscale Combustion Calorimeter Inter-Laboratory Study Update

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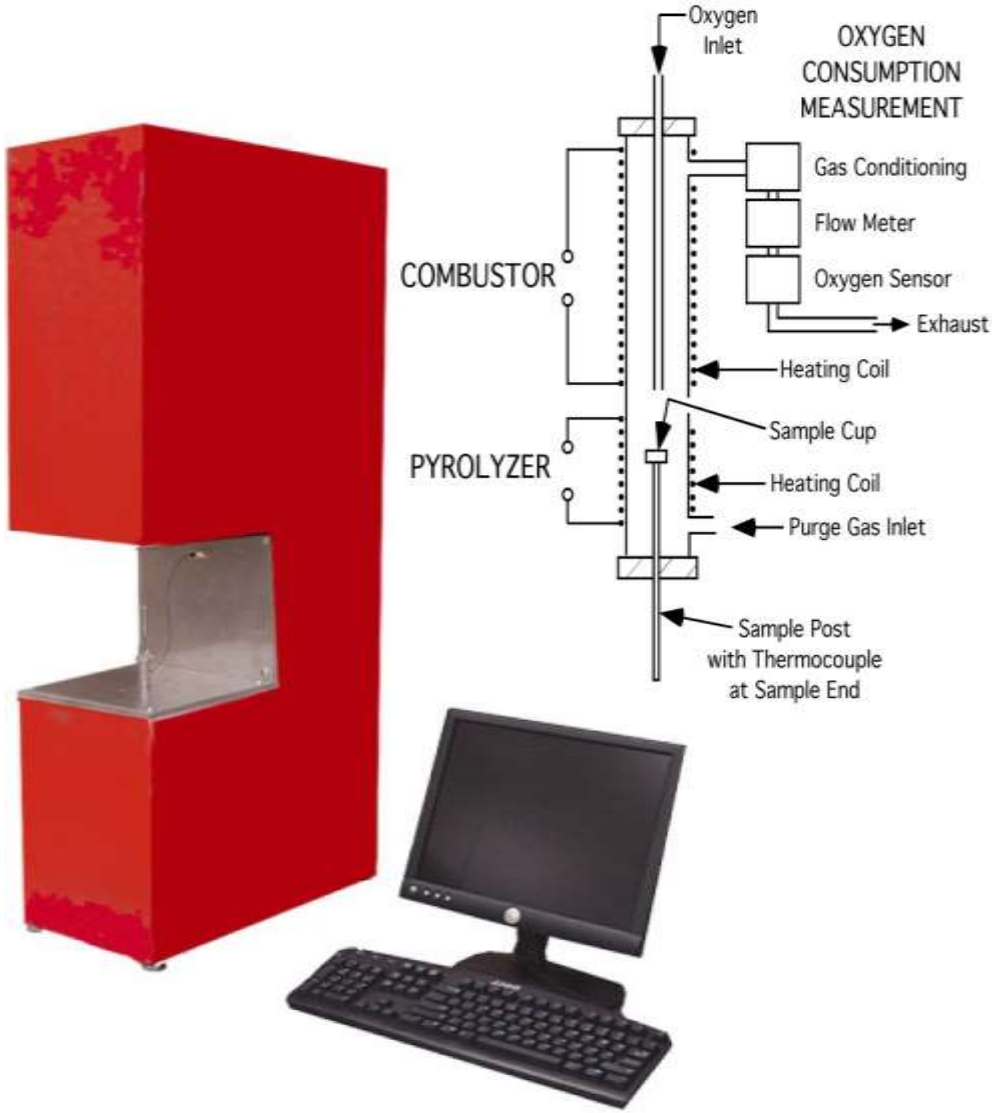
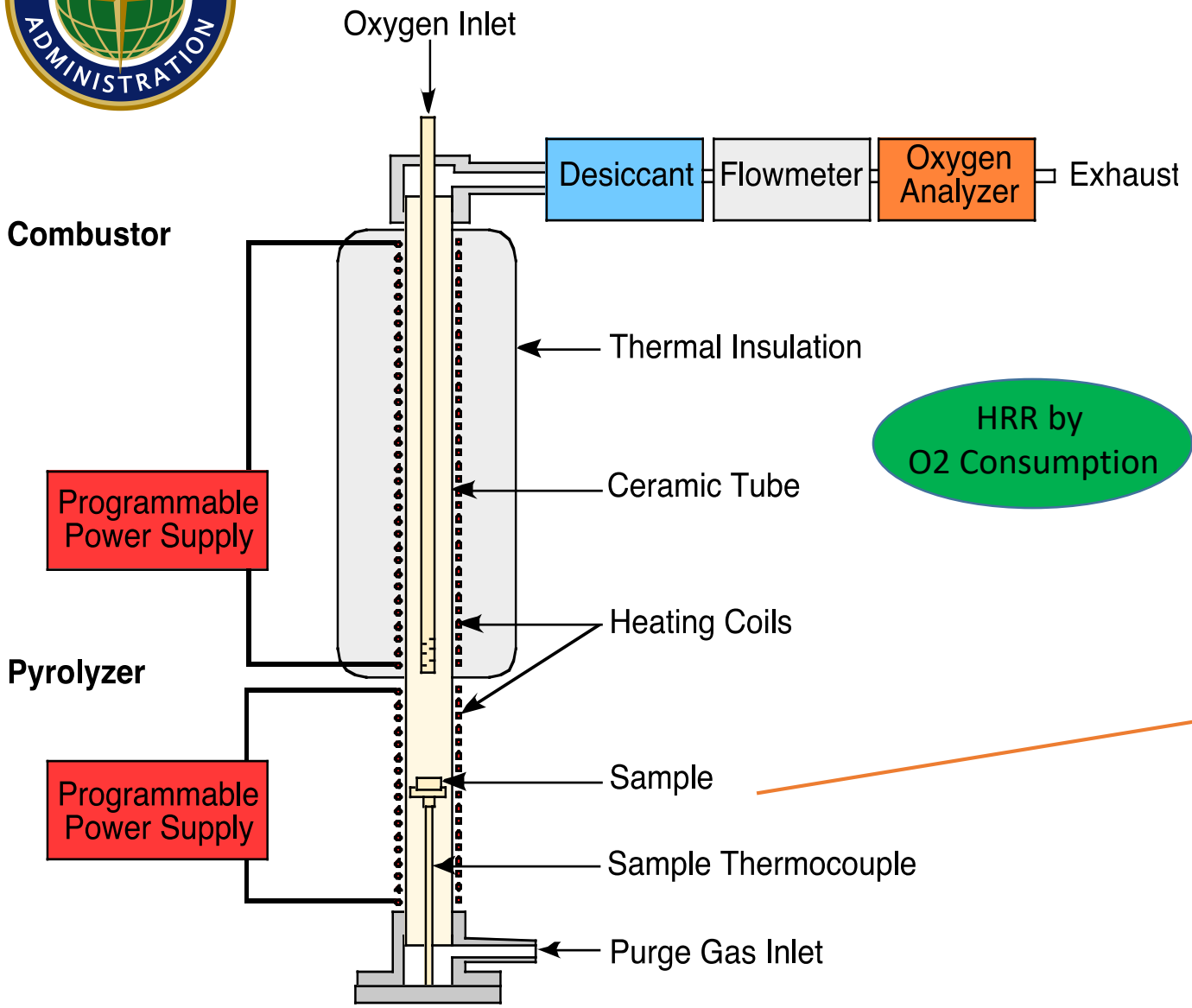
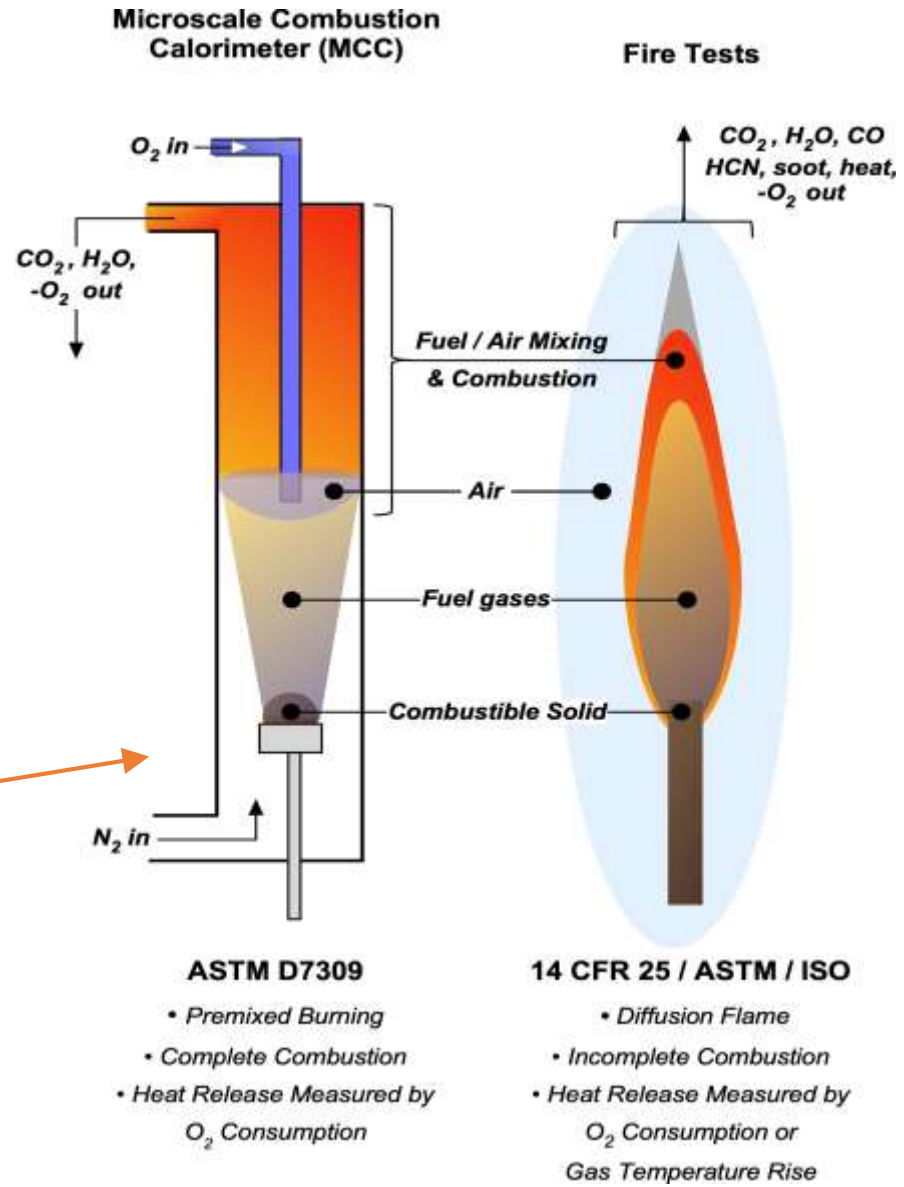
FAA Microscale Combustion Calorimeter (ASTM D7309-21)



- The *MCC* test measures Materials Properties related to Flammability on a milligram size scale.
- One of the outputs: Fire Growth Capacity. The ***FGC*** is a measure of ignitability and burning rate of a material, i.e., the **total fire hazard**
- *MCC* is proposed method for **alternate means of compliance** when a small change is made to a construction

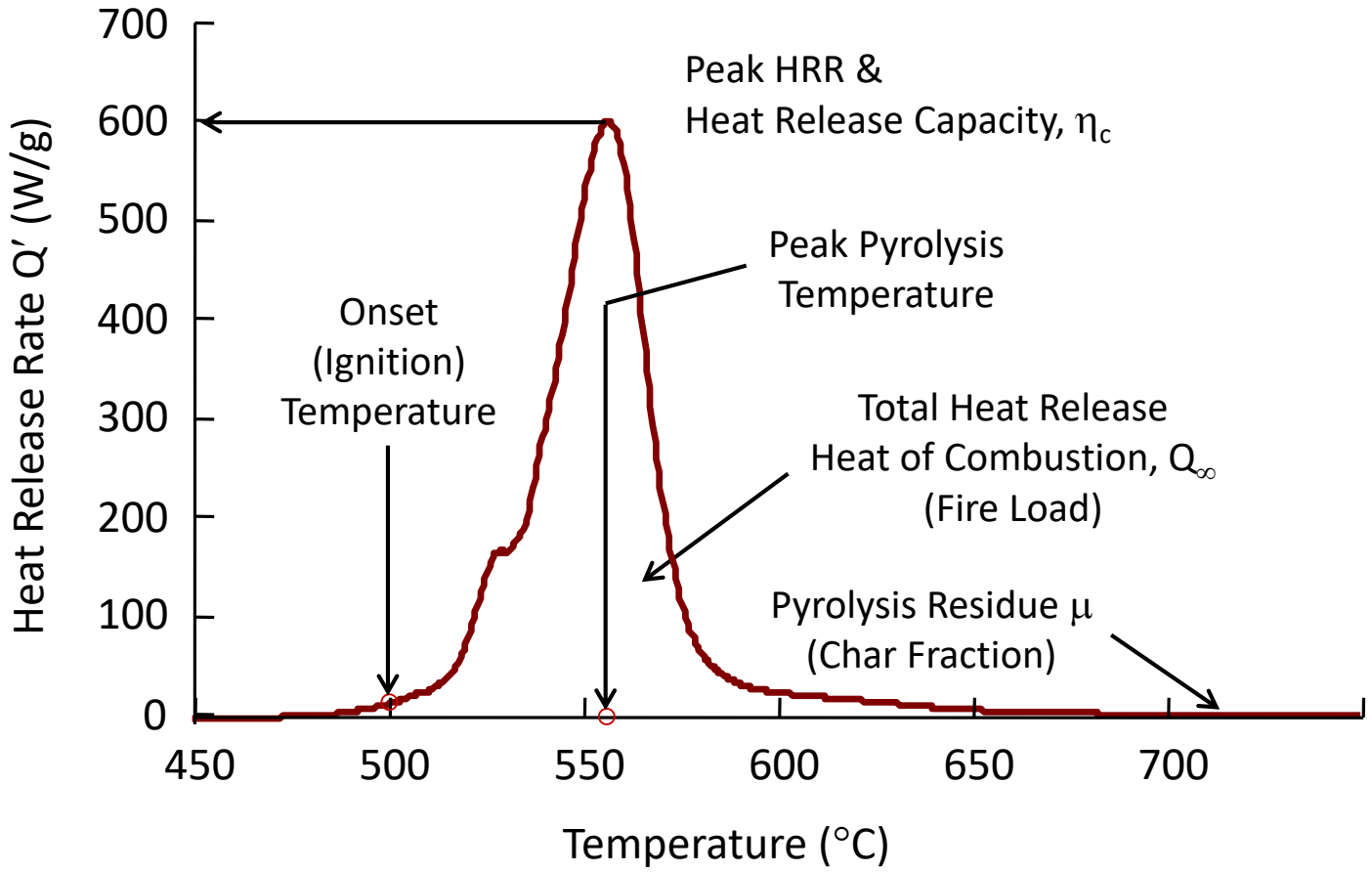
FAA Microscale Combustion Calorimeter





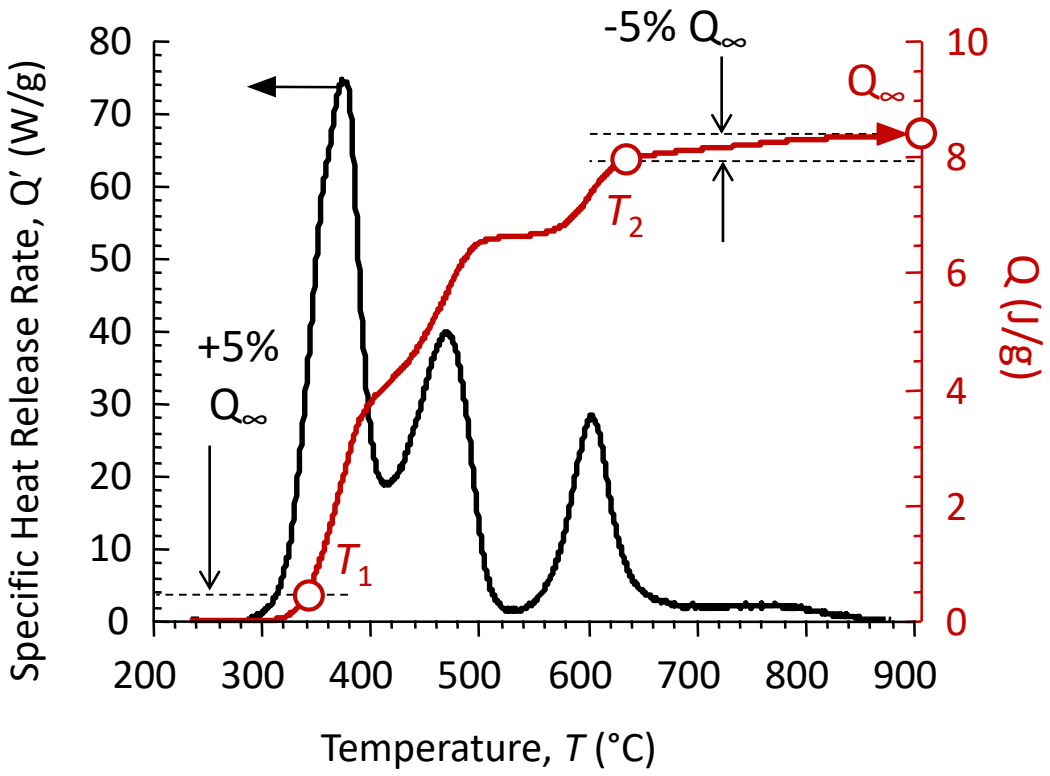
Standard Test ASTM D 7309 (Method A)

Anaerobic pyrolysis at 1 K/s + complete combustion of gases at 900°C, 20% O_2



Microscale Combustion Calorimeter

Fire Growth Capacity - FGC



T_0 = 25°C (298K)

T_1 = Ignition temperature

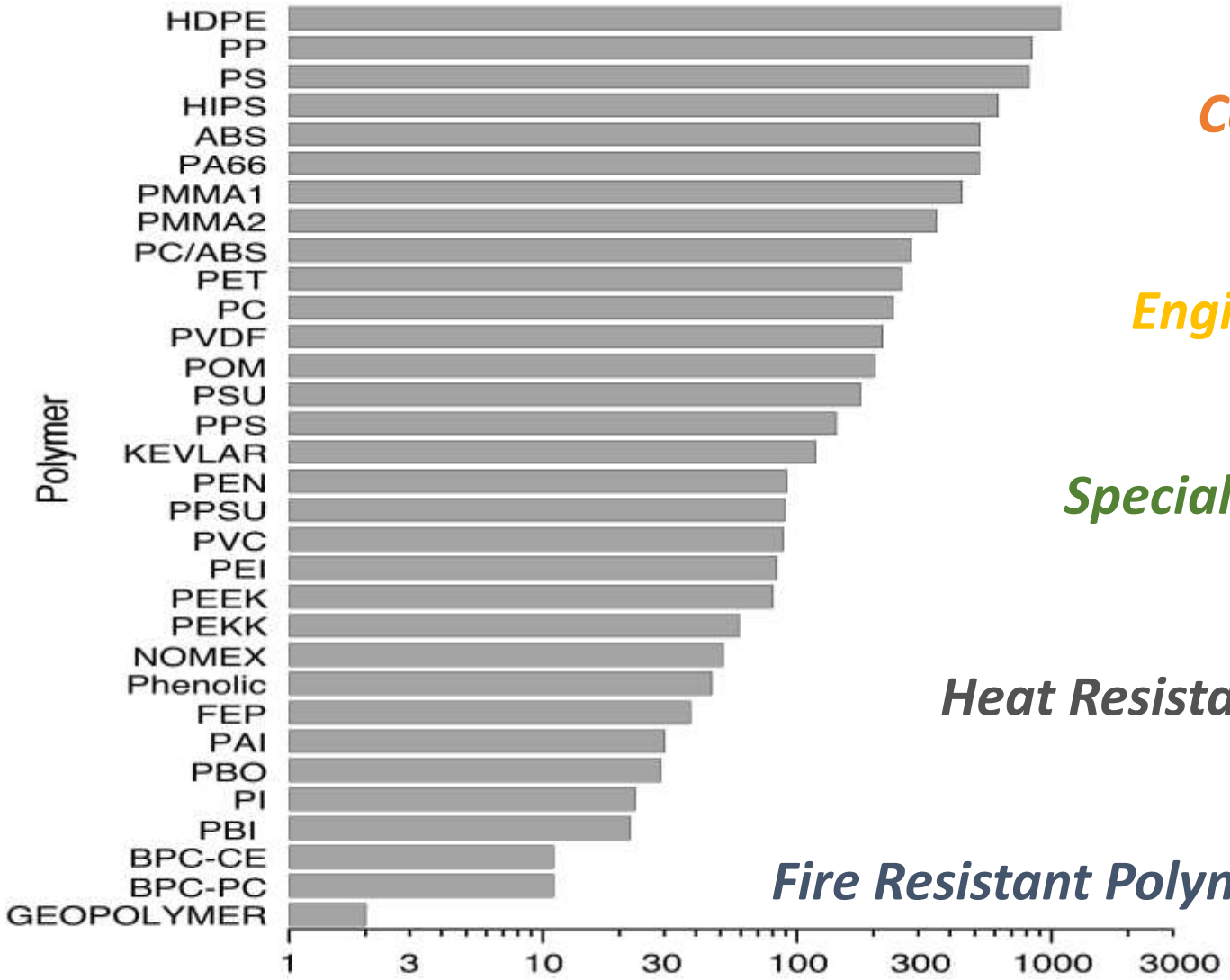
T_2 = Burning temperature

$$FGC = \left(\frac{Q_\infty}{T_2 - T_1}\right)\left(\frac{T_2 - T_0}{T_1 - T_0}\right)$$

MCC procedure for FGC

1. Measure specific heat release rate Q′ versus temperature *T* as per ASTM D7309 (5 replicates)
2. Integrate Q′/β versus *T* to obtain Q versus *T*, i.e., Q(*T*)
3. Obtain total heat release $Q(T_\infty) = Q_\infty = h_c$(J/g)
4. Obtain T_1 at 5% deflection from Q(T) baseline, i.e., at $0.05Q_\infty$
5. Obtain T_2 at Q_∞ i.e., $0.95Q_\infty$.
6. Calculate Fire Growth capacity (FGC)

Ranking of Materials



Commodity Plastics

Engineering Plastics

Specialty Plastics

Heat Resistant Plastics

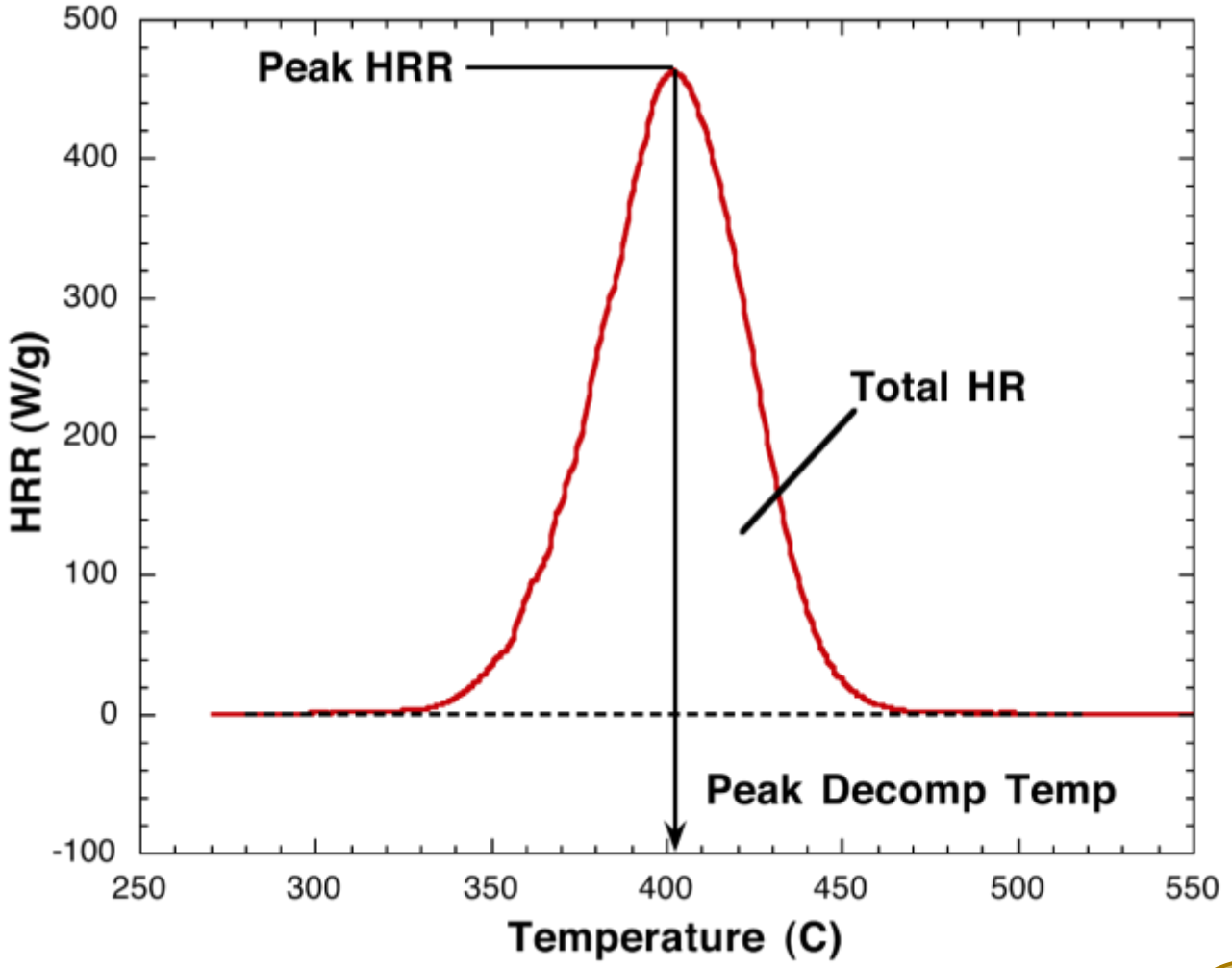
Fire Resistant Polymers

ASTM E691

Conducting an Inter-Laboratory Study to Determine the Precision of a Method

- **Repeatability**
  - **An action, event, or other thing that is done again**
- **Reproducibility**
  - **Create something very similar to (something else) in a different medium or context**

Measured Values



Sample Weight (mg)

Char Yield (%)

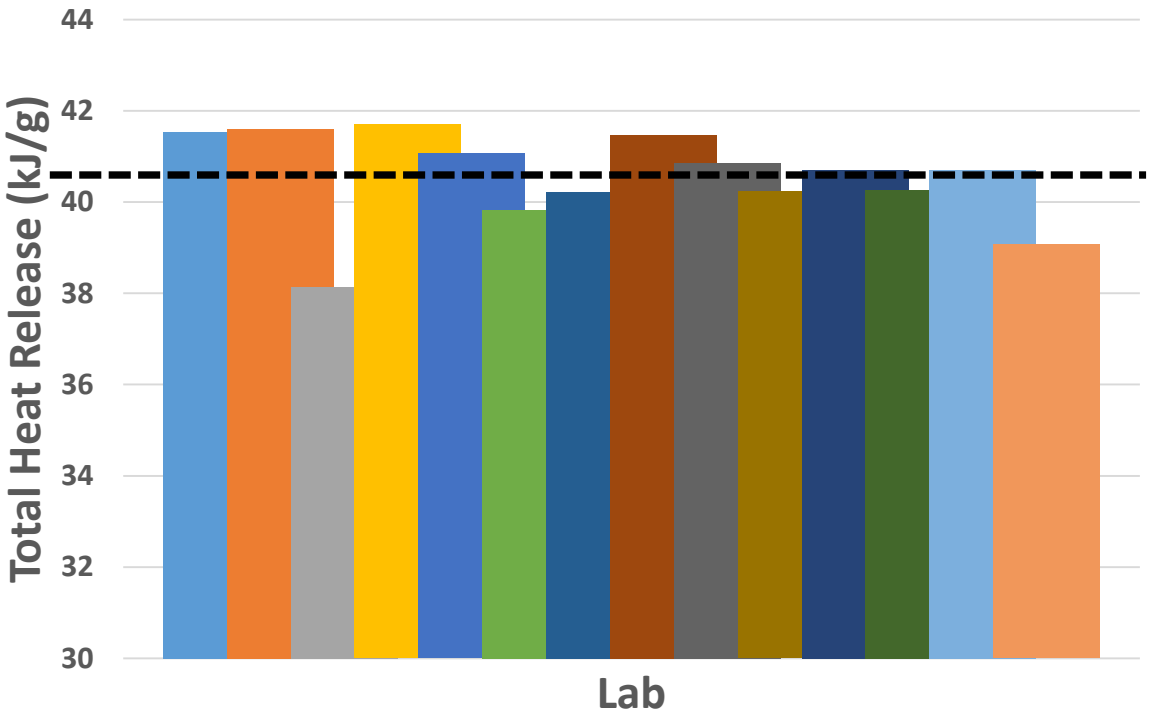
Peak Heat Release Rate (W/g)

Total Heat Released (kJ/g)

Peak Heat Release Temperature (C)

Fire Growth Capacity (J/g-K)

Preliminary Lab Comparison – Polystyrene

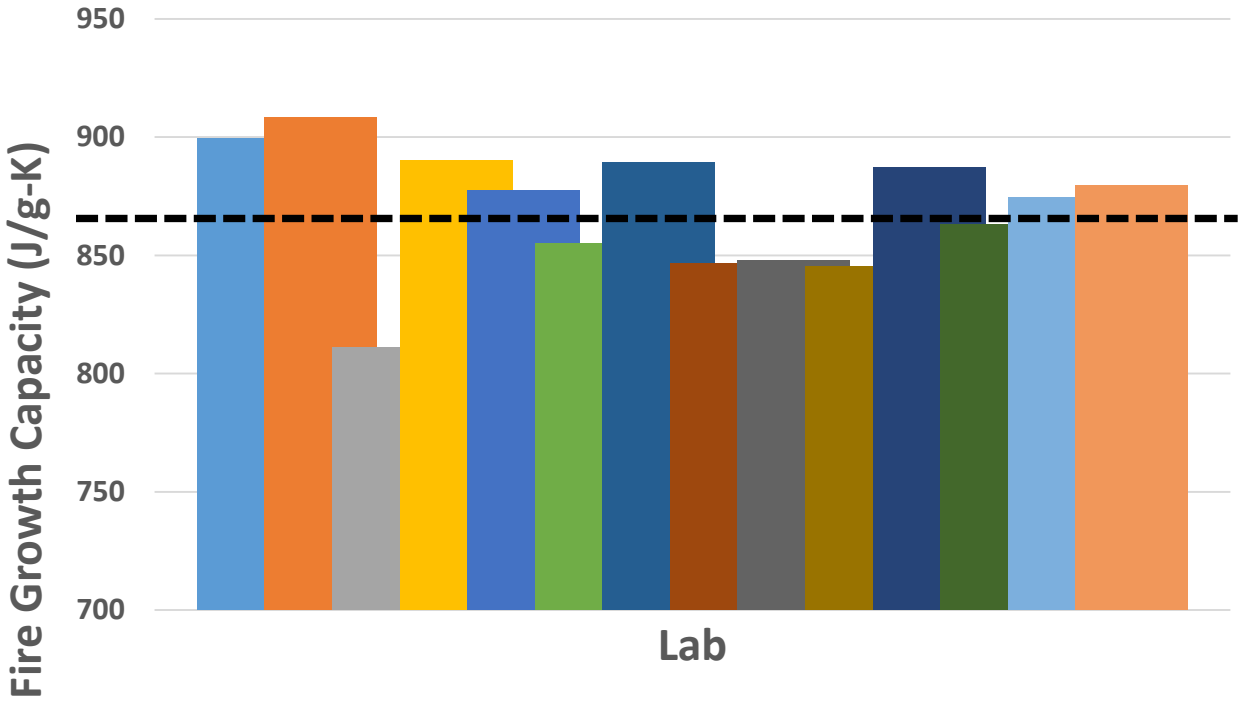


Total Heat Release

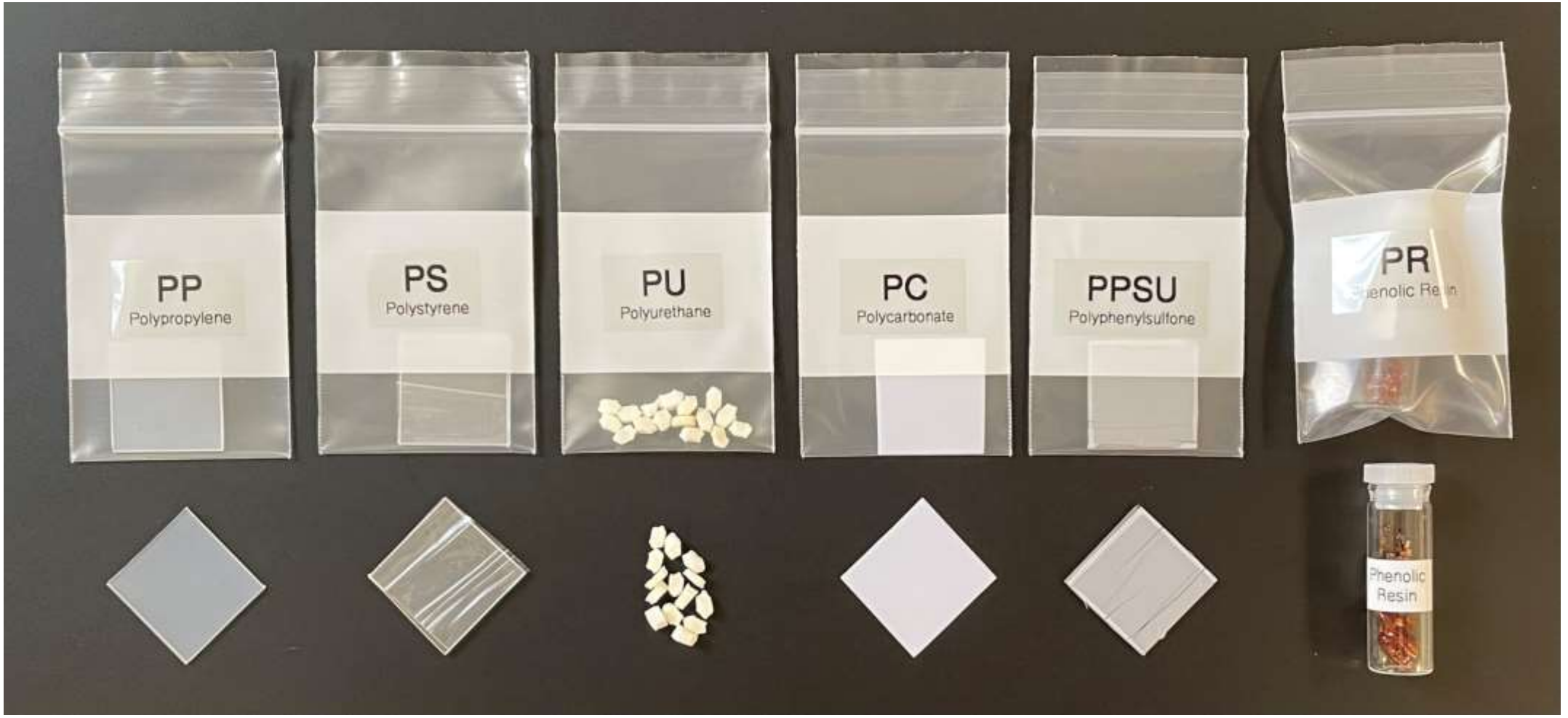
40.6 +/- 1.1 J/g-K
2.8%

Fire Growth Capacity

868 +/- 35 J/g-K
4.1%

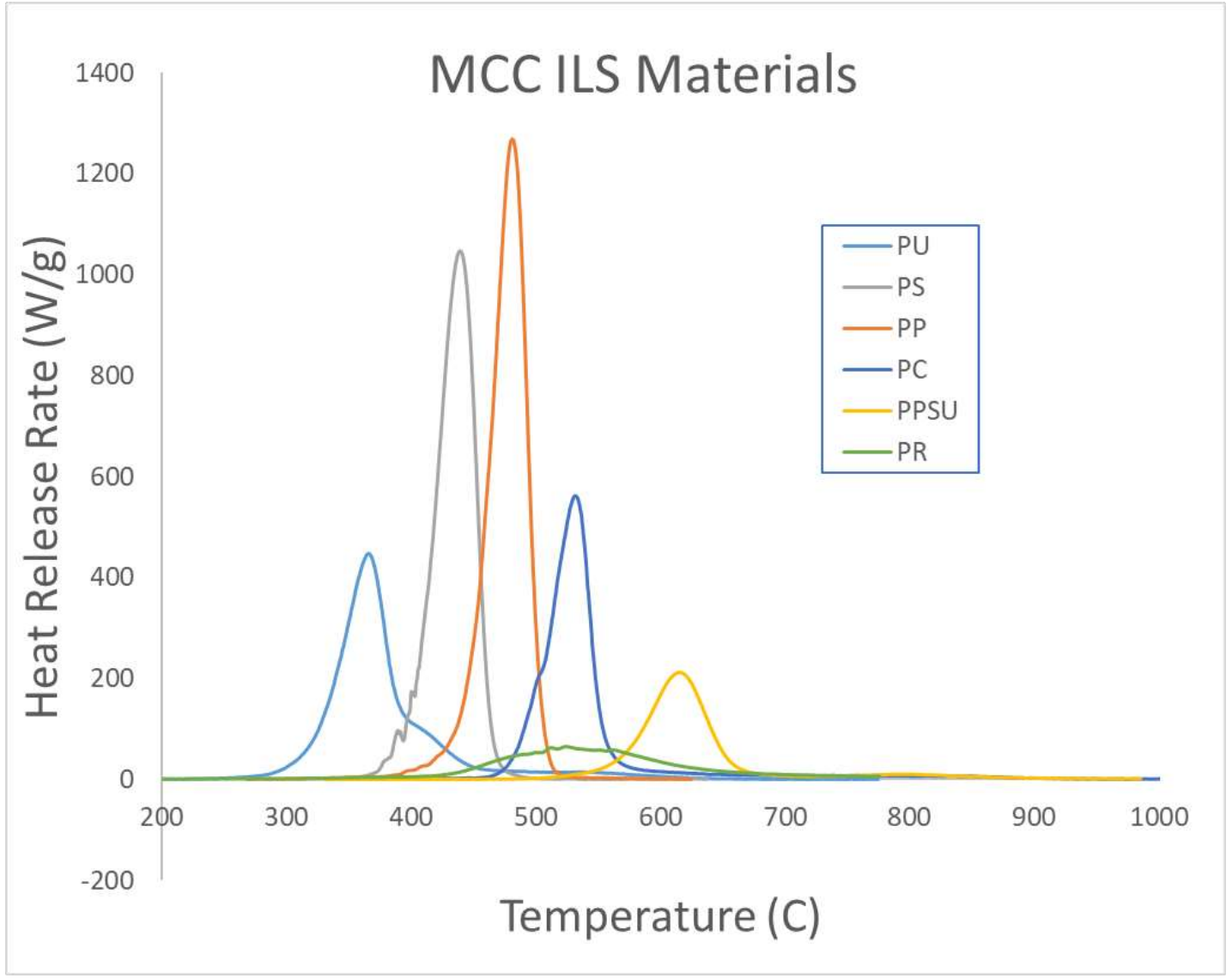


Samples for ASTM FAA MCC ILS



Aircraft Material - Boeing Phenolic Resin

MCC Heat Release Rate – ILS Materials

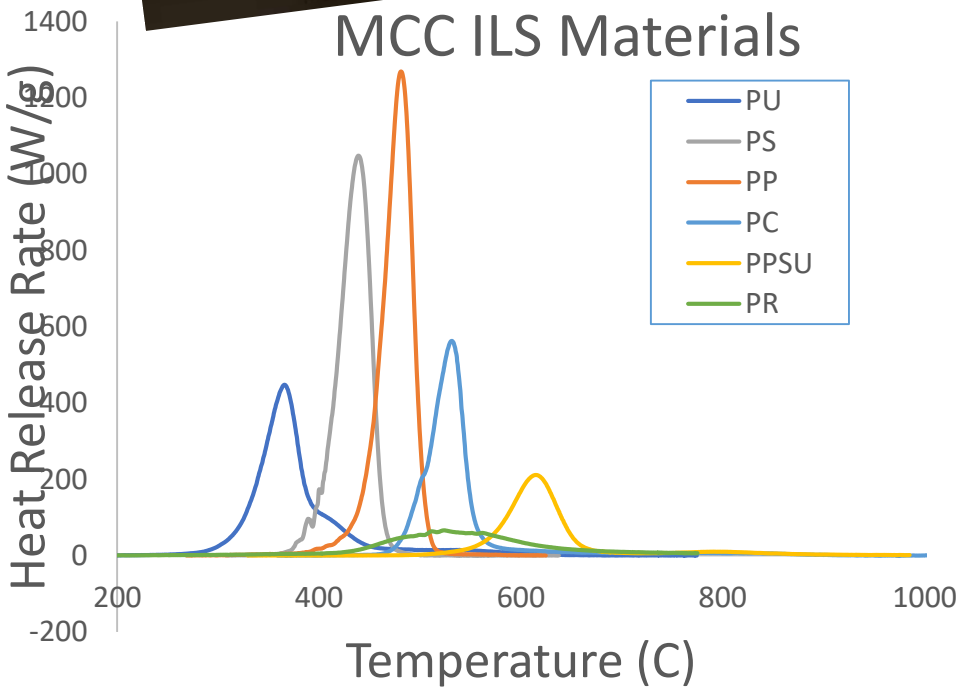


Inter-Laboratory Study

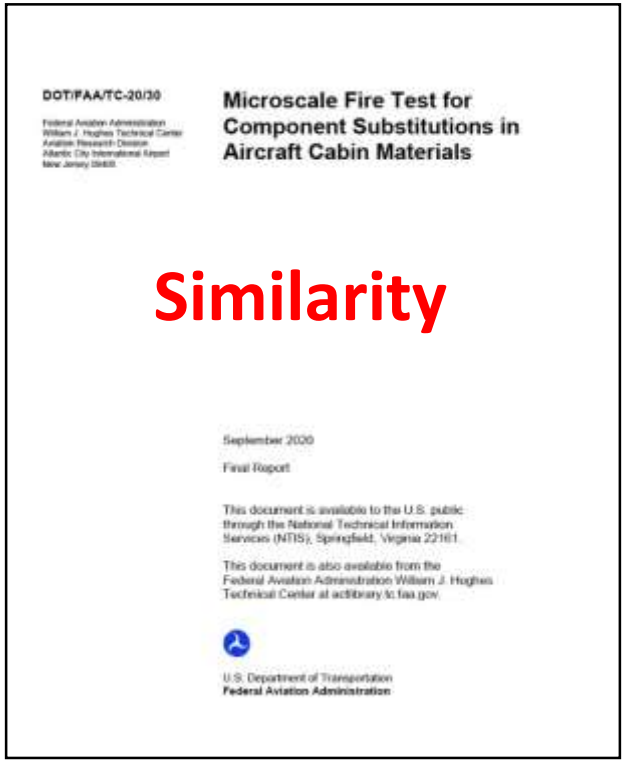
- 4 manufacturers/licensees of the MCCs out there
  - Deatak
  - Fire Testing Technologies
  - Concept Equipment Ltd
  - Me
- Samples shipped to labs
  - 18 labs claimed they are able to participate
  - Several labs have more than one unit
- Data to be sent directly to ASTM
  - Statistical analysis
  - Update ASTM D7309 precision & bias statement

Summary & Future Work

- **Inter-laboratory study – Round 1 (FAA)**
  - **Preliminary results received**
  - **Offered suggestions to operators to reduce errors**
- **Inter-laboratory study – Round 2 (ASTM)**
  - **Sample set selected (6 Samples)**
  - **Participants verified (20+ MCCs)**
  - **FGC software created**
  - **Input values into ASTM ILS website**
  - **Finalize with ASTM**
  - **Send samples to labs**
  - **Submit results directly to ASTM**
  - **ASTM handling the statistics**
  - **Update precision & bias statement**
  - **FAA report**



FAA Reports - https://www.fire.tc.faa.gov/


DOT/FAA/TC-20/30

Microscale Fire Test for Component Substitutions in Aircraft Cabin Materials

Similarity

September 2020

Final Report

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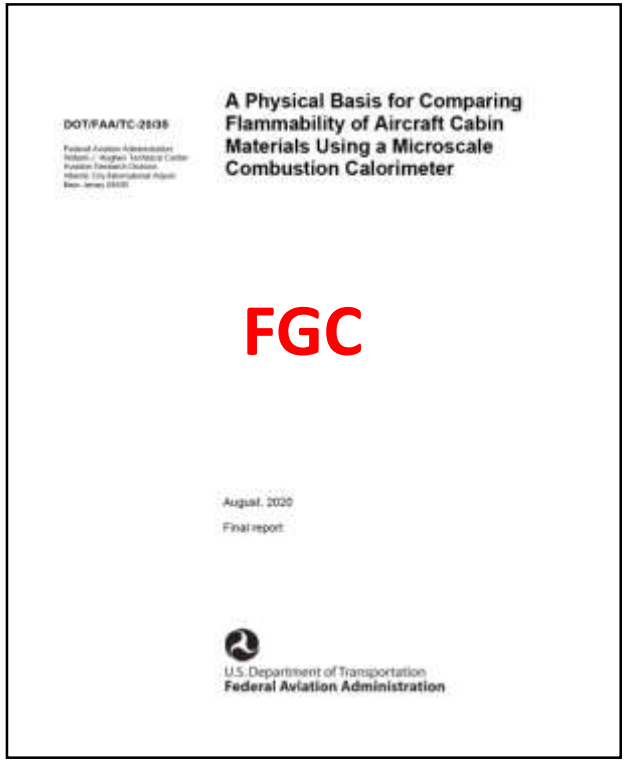
DOT/FAA/TC-20/35

A Physical Basis for Comparing Flammability of Aircraft Cabin Materials Using a Microscale Combustion Calorimeter

FGC

August, 2020

Final report

U.S. Department of Transportation
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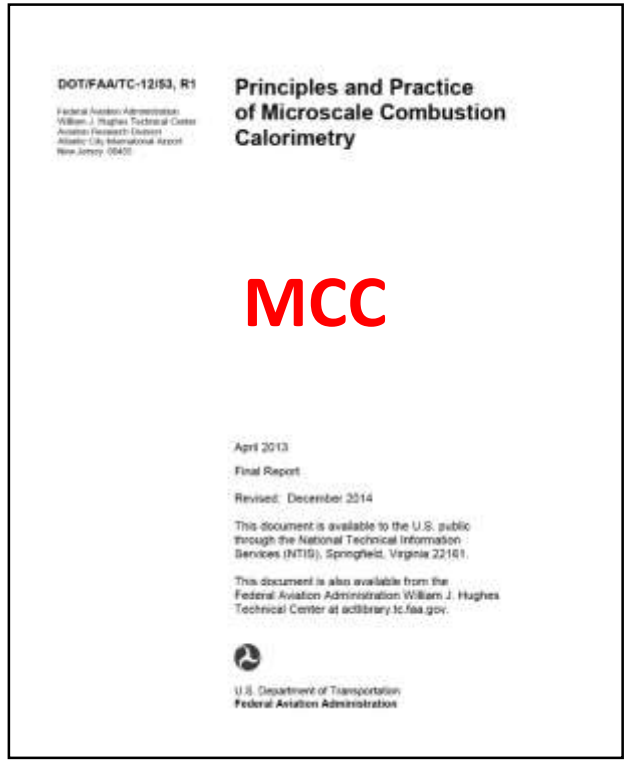
DOT/FAA/TC-12/53, R1

Principles and Practice of Microscale Combustion Calorimetry

MCC

April 2013

Final Report

Revised: December 2014

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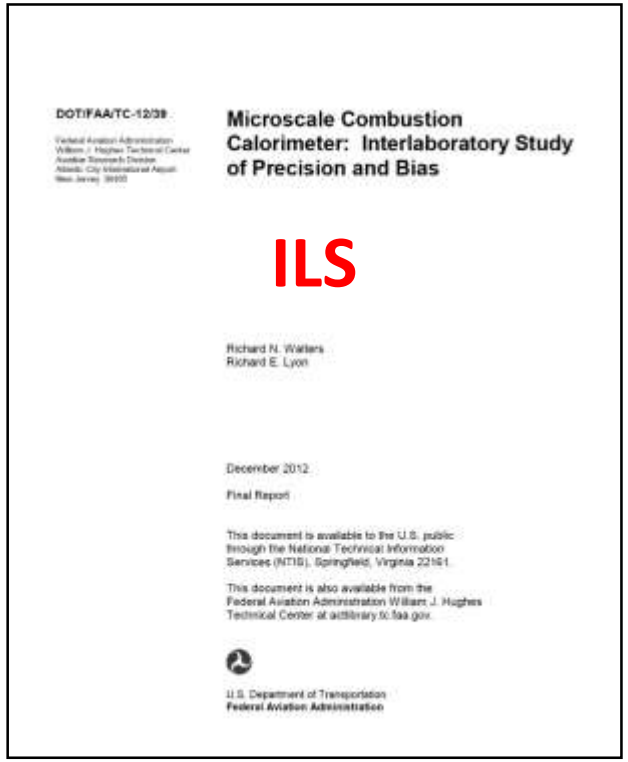
DOT/FAA/TC-12/39

Microscale Combustion Calorimeter: Interlaboratory Study of Precision and Bias

ILS

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December 2012

Final Report

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