

Material Change Similarity Task Group

Microscale Combustion Calorimetry

IAMFTF

October 29-30, 2018

Atlantic City, New Jersey

Task Group Co-leader:

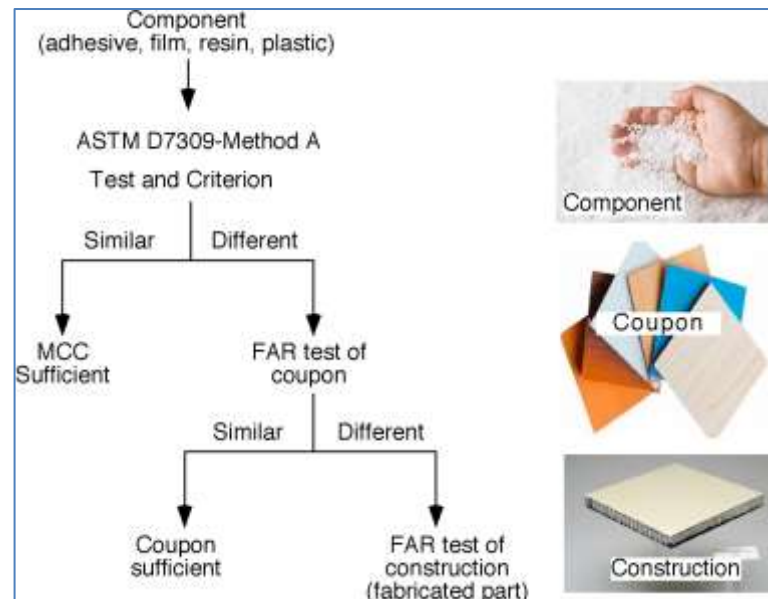
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FAA International Aircraft Materials Fire Test Forum

Material Change Similarity Task Group

Overview - Task Group Goal

- Develop guidance using the Microscale Combustion Calorimeter (MCC) to determine the flammability performance characteristics of a material.
- Utilize the MCC method to compare the flammability properties of a currently certified material with those of the material that has been changed in some way to determine if there is a significant change in the fundamental flammability properties.
- Once determined to have similar flammability properties at the material level, this data supports a similarity determination of the material change, thus eliminating the need to assess the specific flammability properties of all the different part configurations where this material is used.



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Pass / Fail FAA Flammability Tests (≥ 2-Parameters)



OSU Rate of Heat Release
(Large Area Materials)

- Peak HR
- 2-min Total HR



Vertical Bunsen Burner
(All materials)

- Burn length
- After Flame time
- Flame Drip time



Radiant Panel
(Thermal-acoustic Insulation)

- Flame Propagation
- After Flame time

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Updated Guidance Released

Federal Aviation Administration
Fire Safety

Disco Inferno X Submit

Fire & Cabin Safety Materials Systems Fire Research Handbook Reports Meetings Conference

Aircraft Materials Fire Test

Menu

Introduction

The International Aircraft Materials Fire Test Forum meets three times per year. One meeting is held in Atlantic City, New Jersey, area, one meeting is held at a host organization at another location in North America, and one meeting is hosted by an organization. Concerns in the area of aircraft materials fire safety testing are discussed with emphasis on the current state of the industry.

For the upcoming meeting, topics to be discussed will include the OSU/NBS test methods, Bunsen burner tests, and presentations and updates of round robin tests.

Forum attendees are welcome to open a discussion on any new topic in the aircraft materials fire safety testing area with the international community in industry, government, and academia with an interest in aircraft materials fire safety testing. For more information, see the minutes and next meeting details.

Updates & Downloads

- MCC Guidance Updated Rev B
- September 2013 HR2 Task Group Meeting

Updated to include:

- Definition of Fire Growth Capacity (FGC)
- Recommended statistical analysis to determine similarity.

Draft, Rev B – October 2018

POSSIBLE ADVISORY CIRCULAR CONTENT

(Author Note: AC25.856-1a was used as a template.)

Subject: MICROSCALE COMBUSTION CALORIMETRY TEST METHOD TO DETERMINE WHETHER A MATERIAL CHANGE REQUIRES ADDITIONAL CERTIFICATION TESTING FOR FLAMMABILITY

Revision A Summary: This revised guidance has been updated based on two years of refinement to the analysis methodology being developed by the FAA Technical Center and the MCC Similarity Task Group. The changes include the definition of a Fire Growth Capacity (FGC) and a recommended statistical analysis to determine similarity.

1. **PURPOSE.** This advisory circular (AC) provides guidance on using the Microscale Combustion Calorimetry (MCC) test method to determine the relative flammability performance characteristics of a material. This method can be used to compare the flammability properties of a currently certified material with those of the material that has been changed in some way (e.g. chemical/material changes to remove environmental impacts, alternate sources of chemical constituent/material, replacement for out-of-production material, changed material to improve manufacturing & performance

Special Thanks:

- FAATC Fire Safety Branch
- FAA Transport Standards Staff
- Boeing Research & Technology

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Motivation

Code of Federal Regulations 14 (FAA) Part 21 (Certification Procedures)

§21.93 Classification of changes in type design (paraphrased)

(a) Changes in type design (e.g., B737-100, -200, -300, -400, -500 and A340-200, -300, -500, -600) are classified as minor and major. A “minor change” is one that has no appreciable effect on the weight, balance, structural strength, reliability, operational characteristics, or other characteristics affecting the airworthiness of the product. All other changes are “major changes” and require re-certification of the airplane.

§21.95 Approval of minor changes in type design.

(a) Minor changes in a type design may be approved under a method acceptable to the FAA before submitting to the FAA any substantiating or descriptive data.

§21.97 Approval of major changes in type design.

(a) An applicant for approval of a major change in type design must—

(1) Provide substantiating data and necessary descriptive data for inclusion in the type design;...

Excerpt from draft guidance: Change Classification

2.c. An applicant may propose to incorporate this methodology into their overall compliance plan, including establishing how changes are identified as either major or minor under § 21.93.

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Excerpts form draft guidance: FGC Calculation

6.a. If the MCC result for the fire growth capacity (FGC) of a new or changed component is statistically indistinguishable from FGC of the original (certified) component in accordance with Section 8 of this document, the new material/component is considered to be similar with respect to flammability

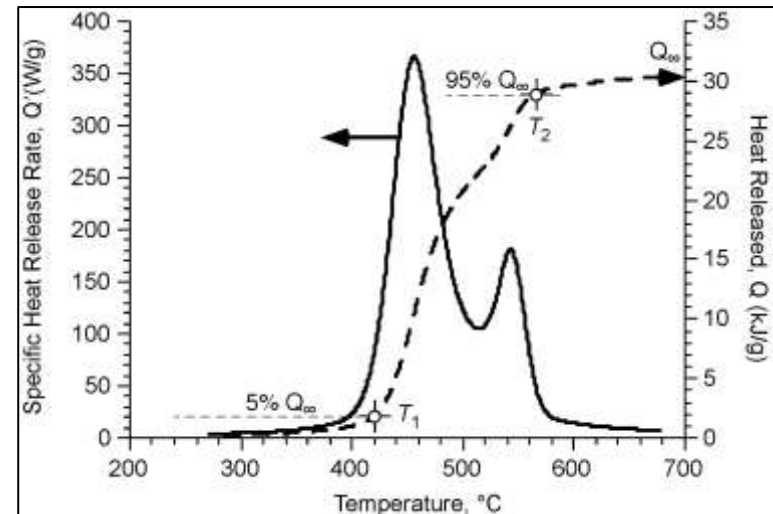


Figure 1. MCC Test of a Plastic Showing the Three Properties Q_{∞} , T_1 and T_2 Used to Compute FGC of Components.

7.e. A sample calculation of FGC using Figure 1 as the flammability diagram for a 5 mg sample of a changed component is as follows. The maximum/total/ integrated heat release in Figure 1 is the intersection of the time integral of Q' , shown as a dashed line in Figure 1, with the right hand ordinate at T_{∞} . For Figure 1 this value is, $Q_{\infty} = 30.2$ kJ/g. The ignition temperature is the abscissa value (temperature) of the dashed line at which 5% of the total heat has been released. In Figure 1, $T_1 = 420^{\circ}\text{C}$ at $0.05Q_{\infty} = 1.5$ kJ/g. The temperature at which 95% of the heat has been released is the abscissa value of the dashed line at $0.95Q_{\infty} = 28.7$ kJ/g. In Figure 1, $T_2 = 564^{\circ}\text{C}$. From these 3 properties compute, FGC of the sample of the changed component using Equation 1,

$$FGC = \frac{30.2 \text{ kJ/g}}{564^{\circ}\text{C} - 420^{\circ}\text{C}} \times \frac{564^{\circ}\text{C} - 25^{\circ}\text{C}}{420^{\circ}\text{C} - 25^{\circ}\text{C}} = 286 \frac{\text{J}}{\text{g} - ^{\circ}\text{C}} = 286 \frac{\text{J}}{\text{g} - \text{K}}$$

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Excerpt from draft guidance: Statistical Analysis Calculation

8.f. A sample calculation comparing two grades of the same high temperature plastic using the similarity criterion is as follows. Five samples of plastic component 1 were tested ($n_1 = 5$) in the MCC with mean and standard deviation, $\langle \text{FGC} \rangle_1 = 43 \pm 2 \text{ J/g-K}$. Five samples of plastic component 2 were also tested ($n_2 = 5$) in the MCC, with $\langle \text{FGC} \rangle_2 = 59 \pm 2 \text{ J/g-K}$. From Equation 2, $s_p = 2 \text{ J/g-K}$ and, $|t| = 12.65$ by Equation 3. In Table 1, $t_{0.05} = 2.306$ for $n_1 = n_2 = 5$, so $|t| > t_{0.05}$, and the null hypothesis is rejected. That means that random error cannot account for the difference in FGC between plastic component 1 and plastic component 2, so they are considered to be different with respect to flammability in the MCC. The MCC results are therefore insufficient to demonstrate similarity.

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Task Group Approach

-  1) Parameterize MCC data to obtain relevant micro-scale fire properties of materials for comparison.
-  2) Develop simple, reliable method to compute flammability parameters from MCC data
-  3) Define guidance document.
- 4) Compare materials in MCC and in FAA fire tests to demonstrate acceptable “similar” method to validate the guidance document.