MATERIAL CHANGE SIMILARITY OVERVIEW

ASTM D7309 (MCC)

? ?

14 CFR 25 (OSU HRR)

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What does “Similar” mean?

- Similar: Equivalent with respect to flammability

- Flammability:

  14 CFR 25 Fire Tests (**VBB, OSU**, etc.) for *constructions*

- Equivalent:

  MCC Fire Properties **IGC** *and* **HRC** of certified component and substitute component are the same at the *95% Confidence Level*.

Background / History of Material Change Similarity Task Group

1998: IAMFTWG Task Group attempts to determine similarity of seat upholstery fabrics using VBB to correlate oil burner test. Not surprisingly, results were inconclusive. Recommended single test method to interpret (establish) similarity.

2007: ASTM D7309 Standard Test Method for Determining Flammability Characteristics of Plastics and Other Solid Materials Using Microscale Combustion Calorimetry (MCC) established.

- ✓ Instrument currently licensed to 3 manufacturers by FAA.
- ✓ Standard updated every 4 years by ASTM D20 committee

2010: • EPA initiates phase out of PBDE flame retardants (FR) widely used in AC

• Flammability Standardization Task Group (industry) meets in Clearwater, Fl. Petitions FAA to simplify testing.

- ✓ Recommends considering MCC as a means to demonstrate similarity
- ✓ Samples solicited from industry for MCC testing by FAA

2012: FAA issues Policy Statement (PS-ANM-25.853-01) on acceptable methods of compliance with 14 CFR Part 25 to reduce industry test burden.

- ✓ Establishes basis for evaluating component variations and substitutions using 14 CFR 25 test methods of worst case scenario (substantiation).
- ✓ Classifications vague. No method for quantitative comparison.

History of Material Change Similarity Task Group (continued)

2013: Industry submits potting compounds, sealants and adhesives with pass/fail VBB data to FAATC for MCC testing

- ✓ MCC gives qualitative predictions of 12-s and 60-s VBB results.
- ✓ HRC and HR (Q_∞) are best predictors of VBB data
- ✓ Sale of decabromodiphenylether (decaBDE) ceases.

2014: Flame Retardants/Material Change Similarity Task Group created within IAMFTWG.

- ✓ Dan Slaton (Boeing), Chair
- ✓ Rich Lyon (FAATC), FAA Liaison

2015: Industry petitions FAA to consider using MCC to define "Small Change." Provides a few samples for Case Studies.

- ✓ MCC testing shows that absolute prediction of pass/fail is not possible due to variability in 14 CFR 25 test methods and sample preparation.
- ✓ FAA begins evaluating MCC for relative determination of flammability (i.e., similarity) of certified and substitute components.

2016: FAA issues draft guidance on using MCC to determine relative flammability performance of materials.

Subject: MICROSCALE COMBUSTION CALORIMETRY TEST METHOD FOR DETERMINING WHETHER A MATERIAL CHANGE AFFECTS FLAMMABILITY

PURPOSE. This document 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 properties, etc…) 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 determination that the material change would not negatively impact existing certification results, thus eliminating the need to assess the specific flammability properties of all the different part configurations where this material is used. Further development of this guidance could lead to an advisory circular.

This guidance applies to airplanes required to comply with § 25.853, and part TBD of appendix F to Title 14 Code of Federal Regulations (14 CFR) part 25.

1. APPLICABILITY.

   a. The guidance provided in this document is directed to airplane manufacturers, modifiers, foreign regulatory authorities, and Federal Aviation Administration (FAA) transport airplane type certification engineers and their designees.

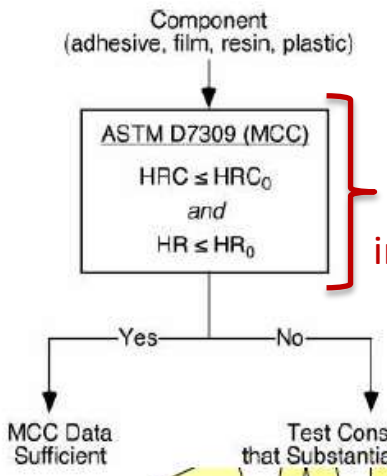
   b. This guidance is neither mandatory nor regulatory in nature and does not constitute a regulation. It describes acceptable means, but not the only means, for demonstrating compliance with the applicable regulations. The FAA will consider other methods of demonstrating compliance that an applicant may elect to present. While these guidelines are not mandatory, they are derived from extensive FAA and industry experience in determining compliance with the relevant regulations. On the other hand, if we become aware of circumstances that convince us that following this guidance would not result in compliance with the applicable regulations, we will not be bound by the terms of this guidance, and we may require additional substantiation or design changes as a basis for finding compliance.

   c. This guidance does not change, create, authorize, or permit deviations from regulatory requirements.

2. RELATED REGULATIONS AND DOCUMENTS.

   a. Title 14 Code of Regulations 25.853 and Appendix F to 14 CFR part 25
   b. Title 14 Code of Regulations 21.93
   c. ASTM D-7309-13, Standard Test Method for Determining Flammability Characteristics of Plastics and Other Solid Materials Using Microscale Combustion Calorimetry, American Society for Testing and Materials, West Conshohocken, PA (2013)

Draft – June 28, 2016



FAA similarity Criteria now includes ignitability

7. TEST METHOD

   a. ASTM D7309 defines the test method, calibration procedures and analysis methods. The MCC apparatus must be accurate to within the specifications in ASTM D 7309 as demonstrated by calibration with polystyrene.
   b. The Reproducibility Limit of ASTM D 7309 is the basis for comparing HRC, HR of the new component with HRC_0, HR_0 of the original component of the certified part.

8. APPLICABILITY TO CERTAIN MATERIALS

   Before adopting this methodology, a systematic assessment of the different materials and constructions potentially affected is needed. This would involve testing with both the MCC and the OSU heat release apparatus' (as well as the Bunsen burner if OSU tests are not required for the part), to determine whether there are conditions or material constructions for which the MCC results are not a good predictor of certification results. The FAA has limited data, which is linked in paragraph a. below. Additional data that encompass the spectrum of parts to which this method would be applied, are needed from industry in order to formalize this document.

   a. Case Study #1: FAATC example of change - Similar MCC results
      FAA example from:
      https://www.fire.tc.faa.gov/pdf/materials/Oct15Meeting/Lyon-1015-Similarity.pdf
   b. Case Study #2: FAATC example of change – Equivalent MCC results. .
   c. Case Study #3: Industry example
   d. Case Study #4: Industry example

Industry: Conduct Case Studies

History of Material Change Similarity Task Group (continued)

2017: FAATC revises MCC criteria for similarity to include both ignitability (IGC) and heat release rate (HRC)

- ✓ HRC and IGC are physically-based, HRR (OSU) $\propto$ HRC*IGC.
- ✓ Analogous to PHRR and 2-min HR in OSU
- ✓ Dissimilar determination requires high degree of confidence (95%).
- ✓ Applied to several case studies of relative flammability (A versus B) using MCC (HRC & IGC) and 14 CFR 25 data.
- ✓ MCC is more discriminating than 14 CFR 25 at 95% confidence (2σ).

2018: Additional case studies planned in cooperation with industry.

- ✓ Include flame time, drip flame time and burn length results from VBB for component and replacement to compare with MCC at 2σ.
- ✓ Additional comparison of constructions (OSU) and components (MCC) at 2σ.

Material Change Similarity Task Group

2017 Process Proposal

Component Change

Test the Currently Certified Component and New Formulation (ASTM D 7309)

Apply MCC Similarity Criteria to MCC test results

Fail

Test Construction as per 14 CFR 25

Pass

New formulation is Similar (MCC is sufficient)

Minor Change

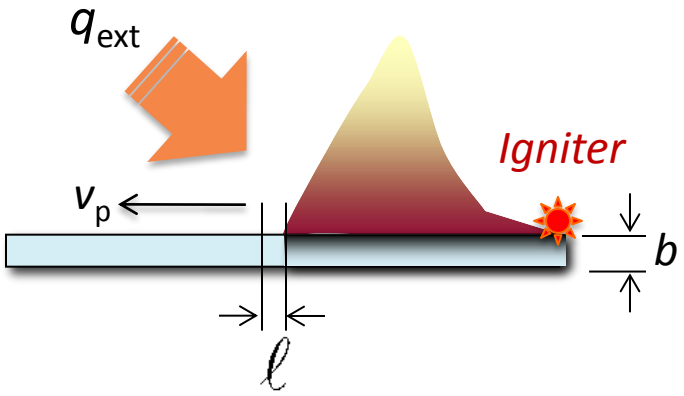
Designation: D7309 – 13

Standard Test Method for
Determining Flammability Characteristics of Plastics and Other Solid Materials Using Microscale Combustion Calorimetry[1]

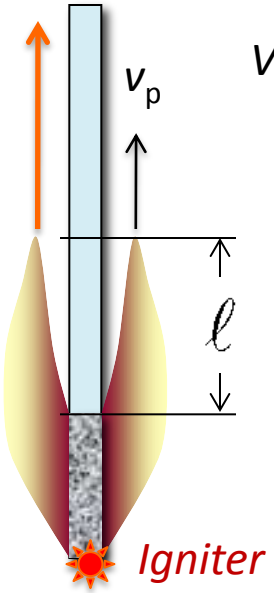
FAA Fire Tests Measure Flame Spread

RADIANT PANEL/HBB

Horizontal spread

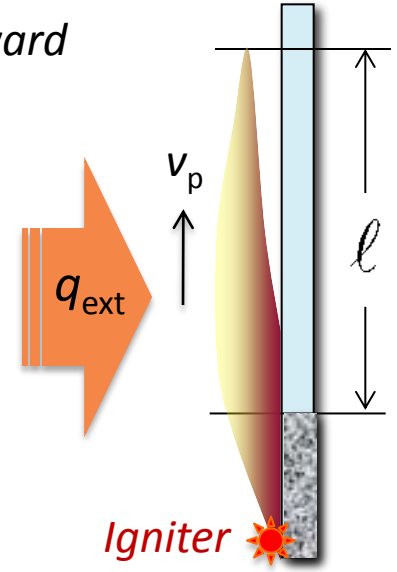


VBB



OSU, VFP

Vertical Upward Spread

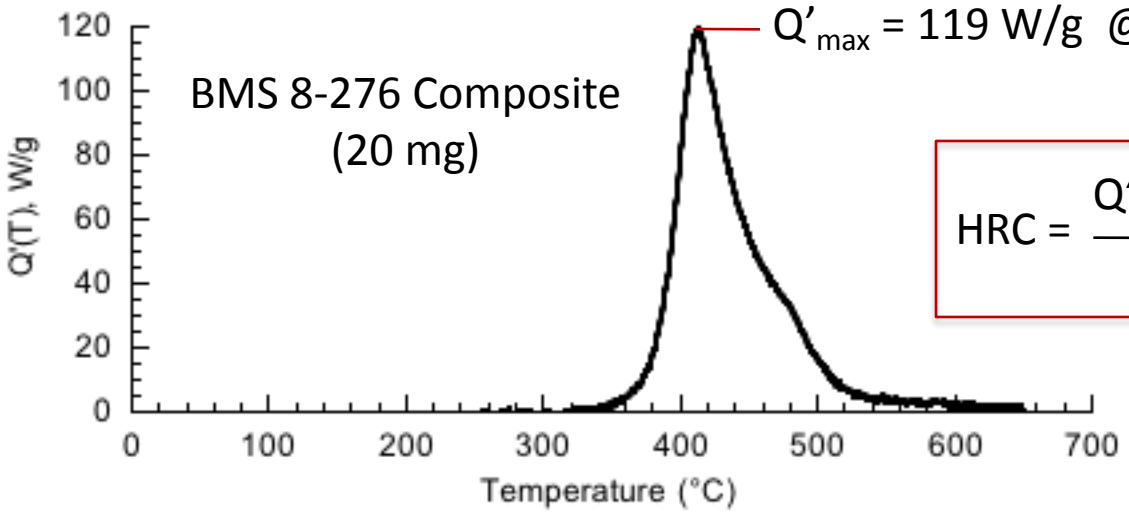


Flame Spread Velocity $= v_p = \dfrac{\text{Heated Length}}{\text{Time to Ignition}} = \dfrac{\ell}{t_{ign}} \propto \dfrac{HRR}{\Delta T_{ign}}$

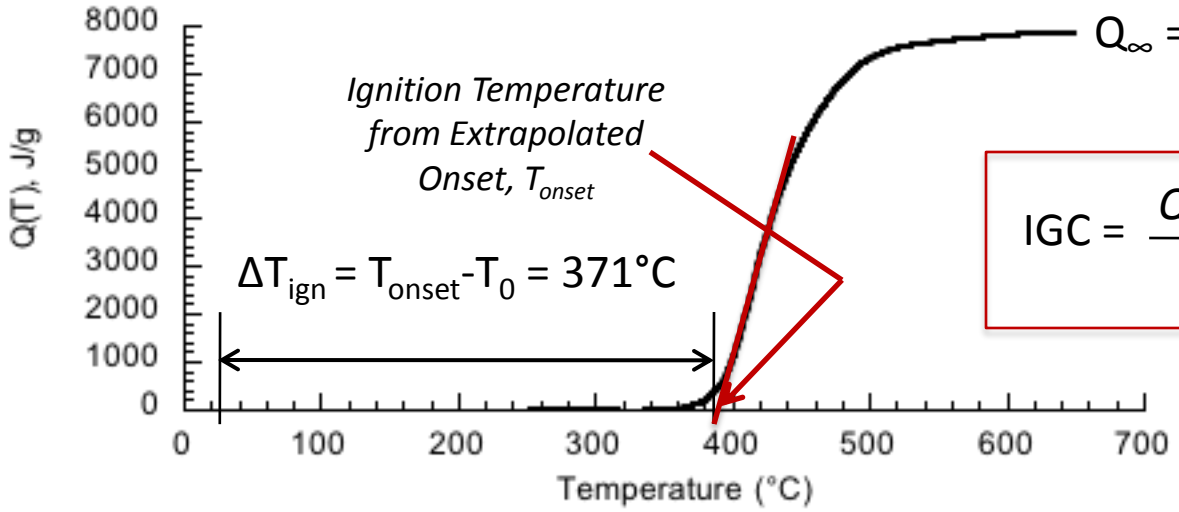
MCC Parameters

$$Heat\,Release\,Rate\,(HRR) = \rho v_p H_c \propto \left(\frac{HRR}{b}\right)\left(\frac{H_c}{\Delta T_{ign}}\right) q''_{ext} \propto (HRC)(IGC)q''_{ext}$$

MCC Parameters for Heat Release Rate (HRC) and Ignitability (IGC)



$$HRC = \frac{Q'_{max}}{\beta} = \frac{119\ W/g}{1\ K/s} = 119\ J/g\text{-}K$$



$$IGC = \frac{Q_\infty}{T_{ign}} = \frac{7856\ J/g}{371K} = 21\ J/g\text{-}K$$

MCC Criteria for Similarity