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)

d. FAATC Reports – (*Key reports from Rich Lyon such as the following)*:
   I. https://www.fire.tc.faa.gov/pdf/TC-12-53.pdf
   II. https://www.fire.tc.faa.gov/pdf/TC-12-13.pdf
   III. https://www.fire.tc.faa.gov/pdf/tc12-39.pdf
   IV. https://www.fire.tc.faa.gov/pdf/TN12-12.pdf

e. TBD

f. Underwriters Laboratory Documentation, Quality Control Procedure, TBD. (https://www.fire.tc.faa.gov/pdf/materials/Oct15Meeting/Fabian-1015-MCC.pdf)

h. R.E. Lyon, N. Safronava, J.G. Quintiere, S.I. Stoliarov, R.N. Walters and S. Crowley, Material Properties and Fire Test Results, *Fire and Materials*, 38, 264-278 (2014).

1. R.N. Walters, N. Safronava and R.E. Lyon, A Microscale Combustion Calorimeter Study of Gas Phase Combustion of Polymers, *Combustion and Flame*, 162, 855-863 (2015).

4. BACKGROUND.

a. The flammability properties of materials are one factor that determines how the airplane designs will resist ignition and flame propagation when exposed to an ignition source during flight and in a post-crash fire. The flammability regulations define prescriptive test methods to assess the ignition, propagation, combustion, and burn-through performance of airplane designs. These regulations form the basis for certification of the airplane type design. If changes to the design and materials are made, additional certification effort is required which starts with making a determination of whether the change is minor or major in accordance with § 21.93. A minor change is one where it is evident that there is no appreciable effect on the existing certification. While some material changes could fall into this category, that determination is beyond the scope of this document.

b. New and changing global environmental regulations to eliminate hazardous chemicals have a direct impact on the components of many existing material formulations used in the design of aircraft. As industry works to remove these chemical compounds, significant effort is required to evaluate the design change utilizing the modified material and determine if the end use products will continue to meet all the engineering and certification requirements. Another area where this guidance document is viable for a determination of small change is when materials are obsolete or cease to be manufactured for any reason. Flammability performance is a key property that is evaluated when a change in the material is required. This test method provides a method to assess the impact of a small change on material flammability performance to simplify testing and implement changes efficiently.

c. Components of aircraft interior materials that can be considered for assessment by MCC testing are those whose properties can be adequately represented by a 5-10 milligram sample, and have been validated as discussed in paragraph 8, below. Examples of these include adhesives, potting compounds, coatings, films, plastics, resins, rubber, textile fibers used in different design configurations. At the present time it is common practice to fabricate flammability test samples of all the

different design configurations using the new/modified material or new component and perform a full complement of FAA flammability tests (Bunsen burner, OSU heat release, Smoke Optical density, Flame Propagation, etc…) for the different configurations using the material. This approach of fabricating and testing large numbers of test configurations is very expensive. The MCC offers a standard method and procedure to compare the fire properties of a new component with those of an existing component in a certified configuration. If the fire properties of the new component are similar to the original component, and the fabricated part containing this new component is otherwise unchanged, it is expected that the flammability properties of the changed part will be equivalent to the certified part, and that the substitution of the new component for the original component is a small change - eliminating the need to perform extensive configuration tests.

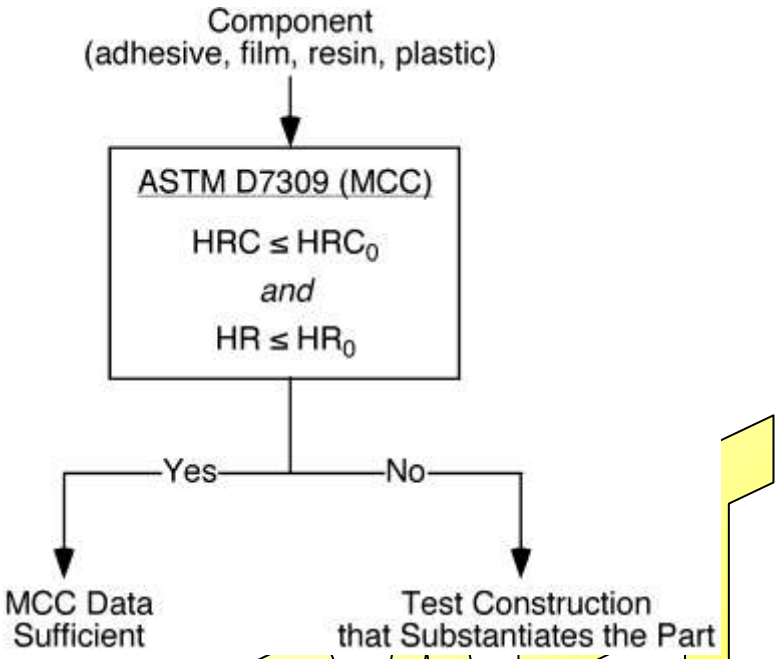
d. The FAA Technical Center in partnership with industry and academia have developed and standardized a microscale combustion calorimeter (MCC) and test method over the last 10 years. The MCC provides a reliable "finger print" or "flammability spectrum" of a component that is sensitive to the chemical composition of the material, and is therefore useful for quality control and product surveillance as well as comparing the flammability properties of a new material with the existing certified material. A parametric representation of the flammability fingerprint using a few fire properties is a convenient and accepted way to characterize flammability performance. This method of using a few MCC fire properties to demonstrate the similarity or equivalence of a changed component in a certified part with regard to its flammability, is the basis for a simplified method of compliance.

5. DEFINITIONS.

a. A component is any substance used in the construction of an aircraft cabin material whose fire properties are adequately represented by the 5-10 mg sample used in ASTM D7309. Examples of suitable components are adhesives, potting compounds, coatings, films, paints, plastics, resins, elastomers, rubber, fibers, wire jackets, etc..
b. Similar is understood to mean that the MCC fire properties that scale with flammability, heat release capacity (HRC) and total heat release (HR) of a new component are less than or equal to the original component to within the reproducibility limits set forth in ASTM D 7309.

6. PROCESS DECISION FLOW

a. MCC results for the fire properties- heat release capacity (HRC), total heat release (HR) of a new component that are all as good or better than HRC_0, HR_0 of the original component are considered to be similar and the new material/component does not require further certification testing.
b. The following schematic outlines the process and decision flow for using the MCC to determine if a component change is a minor change with regard to the overall flammability of the part.



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