2021 FAA Fire Safety Highlights

Contents

Research and Industry Activities:

FAA Reports:

Forums Meetings:

This document provides summaries of research projects and industry activities, FAA reports published, and information related to International Aircraft Materials Fire Test Forum and International Aircraft Systems Fire Protection Forum meetings chaired by the FAA Fire Safety Branch (ANG-E21) during FAA Fiscal Year 2021 (October 1, 2020-September 30, 2021).

Research and Industry Activities

Review of the Statistical Analysis of Calibration Data Generated from a Next-Generation "HR2" Heat Release Rate Test Apparatus: (October 2020)

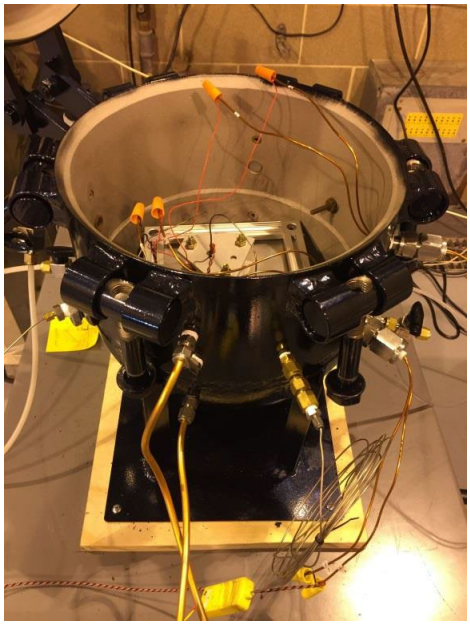
Mike Burns from the Materials Fire Test Section, ANG-E212, collaborated with an industry team comprised of the FAA, Boeing, Airbus, Marlin Engineering Inc. and DEATAK. The main focus of the meeting was to conduct a review of the statistical analysis of calibration data generated from a next-generation "HR2" Heat Release Rate test apparatus used for future certification of aircraft interior materials. The discussion determined that the results of tests conducted in the Small-Scale Materials Flammability Lab showed very good correlation between several prototype apparatuses in terms of repeatability and reproducibility of several key parameters measured during calibration runs. The calibration runs are an essential element of a Technical Readiness Level (TRL) exercise being conducted to ensure the new apparatuses are in agreement before comparative material flammability tests are performed in early 2021. Mike Burns, mike.burns@faa.gov, (609) 485-4985.

"HR2" Heat Release Rate Test Apparatus

United Nations 5th Informational Working Group on Lithium Batteries: (December 2020)

Thomas Maloney and Matthew Karp attended the United Nations 5th Informational Working Group on Lithium Batteries on December 9 and 10, 2020. The goal of the working group is to create test guidelines for the classification of lithium-ion battery hazards for the safe transport and handling of lithium-ion batteries. The purpose of the meeting was to update the group on

completed testing and planned future work. The FAA has unique testing facilities including pressure vessels and a variety of gas analyzers that other test labs in the group do not have. The enhanced capability of the FAA labs increases the value of their results to the committee, as they can evaluate the impact of parameters that other labs are not able to assess. Matthew Karp presented the FAA's research to support the gas analysis section of the UN Working Group. Matthew Karp, matthew.karp@faa.gov, (609) 485-4538.

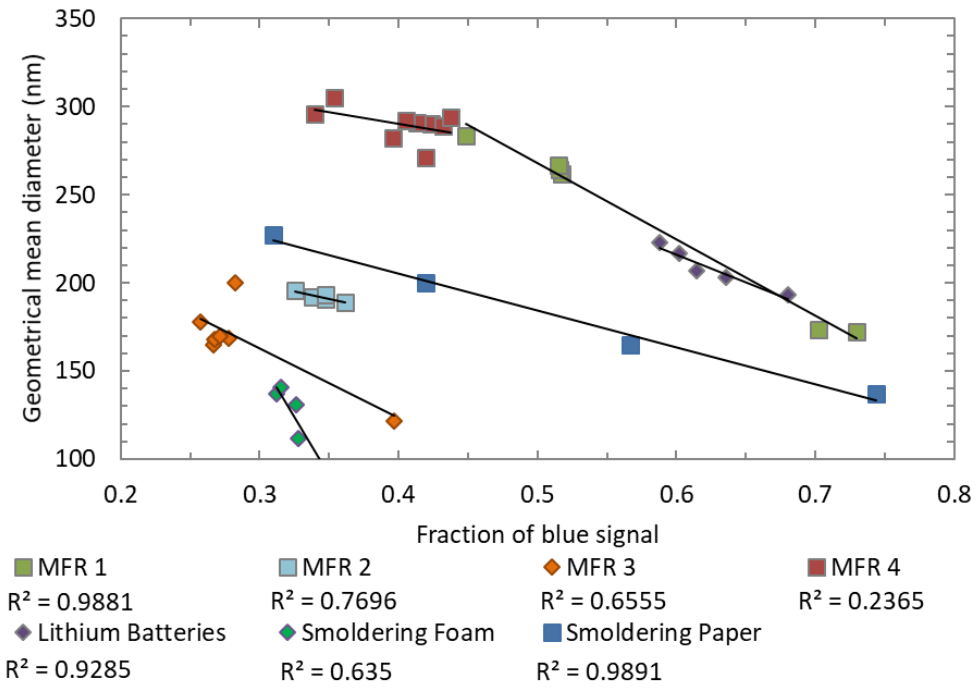


Pressure vessel for lithium-ion vent gas analysis

"Methods for Characterizing Artificial Smoke Generators for Standardizing Inflight Smoke Detection Certification" published in Fire Technology Journal: (December 2020)

Matthew Karp and Robert Ochs had their article "Methods for Characterizing Artificial Smoke Generators for Standardizing Inflight Smoke Detection Certification" published in the Fire Technology journal. False alarm resistant smoke detectors must pass the inflight smoke-detection certification test for implementation in aircraft. This test utilizes artificial smoke generators due to health and safety considerations. However, there are no objective parameters that are currently used to standardize an artificial smoke generator's aerosol production when used for certification testing. The research detailed in this report creates potential guidelines for standardizing an artificial smoke generator's aerosol production. The study found that artificial smoke generators produce an aerosol with similar particle size distributions and light scattering characteristics to smoke created by smoldering foam, smoldering wood, and lithium-ion battery thermal runaway vent-gas. Therefore, it is reasonable to conclude that aerosols from the tested artificial smoke generators are capable of alarming most false alarm resistant smoke detectors. There were however significant differences in the total quantity of aerosol produced and the rate of aerosol production between smoke generators used by four major airframe manufacturers for smoke-detection certification testing. Aircraft Certification Offices have approved similar smoke generators and

settings as acceptable means of compliance for smoke generation methods for certifying cargo smoke-detection systems. Matthew Karp, matthew.karp@faa.gov, (609) 485-4538.



SMPS Diameter vs BIRD Fraction of Blue Signal

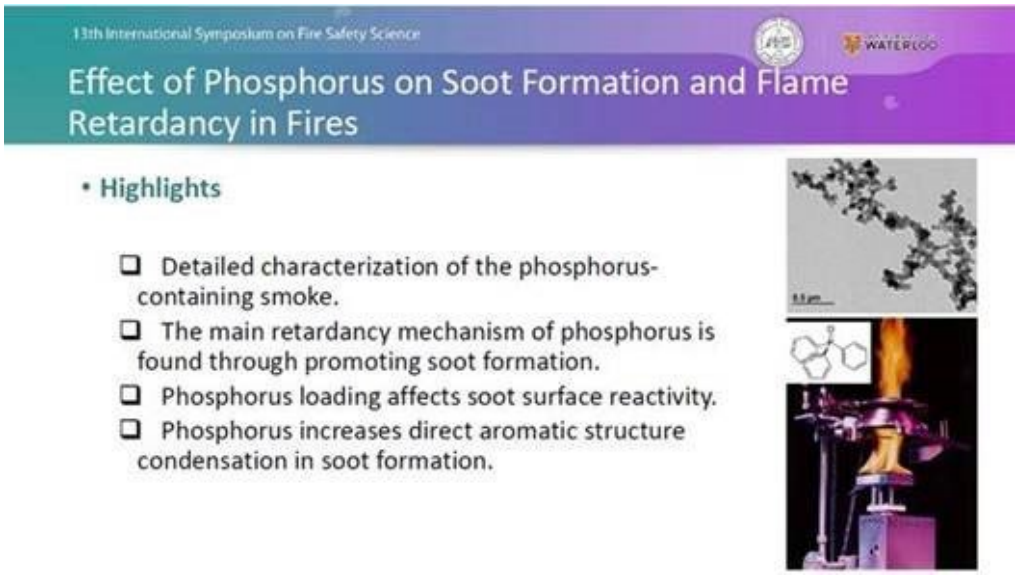
HR2 Next-Generation Heat Release Rate Test Apparatus: (March 2021)

Mike Burns from the Materials Fire Test Section, ANG-E212, hosted an industry team comprised of the FAA, Boeing, Airbus, Marlin Engineering Inc. and DEATAK. The main focus of the on-site meeting was to complete live testing on two prototype heat release apparatuses at the Fire Safety Branch's Small Scale Materials Flammability Lab. The next-generation "HR2" Heat Release Rate test apparatus is being developed for future flammability certification of aircraft interior materials. During the week-long visit by industry, over 100 tests were completed for analysis. Prior to hosting the visitors, test materials were secured and sorted for randomization, a daily schedule was generated, and a test plan and procedures were developed. The test series is an essential element of a Technical Readiness Level (TRL) exercise being conducted to ensure the new apparatuses are in agreement before finalizing the test procedure and pass/fail criteria. The joint FAA/industry effort was the first on-site meeting hosted by the Fire Safety Branch since the pandemic. All visitors were sent FAA Technical Center safety protocols for review in advance of the visit, and followed all necessary protocols while on site. Mike Burns, mike.burns@faa.gov, (609) 485-4985.

"HR2" Heat Release Rate Test Apparatus

13th IAFSS (International Association of Fire Safety Science) Symposium: (April 2021)

Dr. Haiqing Guo, an employee of Diakon working under contract for the Fire Safety Branch, attended the 13th IAFSS (International Association of Fire Safety Science) symposium from April 26 – 30, 2021 and chaired a session on Fire Chemistry, in which he presented a paper entitled "Effect of phosphorus on soot formation and flame retardancy in fires". The meeting was held by IAFSS virtually due to the pandemic. The meeting activities directly support the FAA's proposed fire safety rulemaking and standardization of flammability test methods for aircraft materials. The work was conducted by Dr. Haiqing Guo, Dr. Richard Walters, Dr. Richard Lyon and Sean Crowley of the Fire Safety Branch. In the work presented, Dr. Guo and co-authors described how flame retardants affect the fire size and toxic product yields of burning aircraft materials. In the Flammability session of the IAFSS symposium, Dr. Richard Lyon presented a paper co-authored with Sean Crowley entitled, "Fire Properties of Combustible Materials from Unsteady Burning," describing a fire calorimeter methodology to assess the relative flammability of the materials. These research findings are important for the assessment and development of fire safe aircraft cabins. Dr. Richard Lyon, richard.e.lyon@faa.gov, (609) 485-6076.

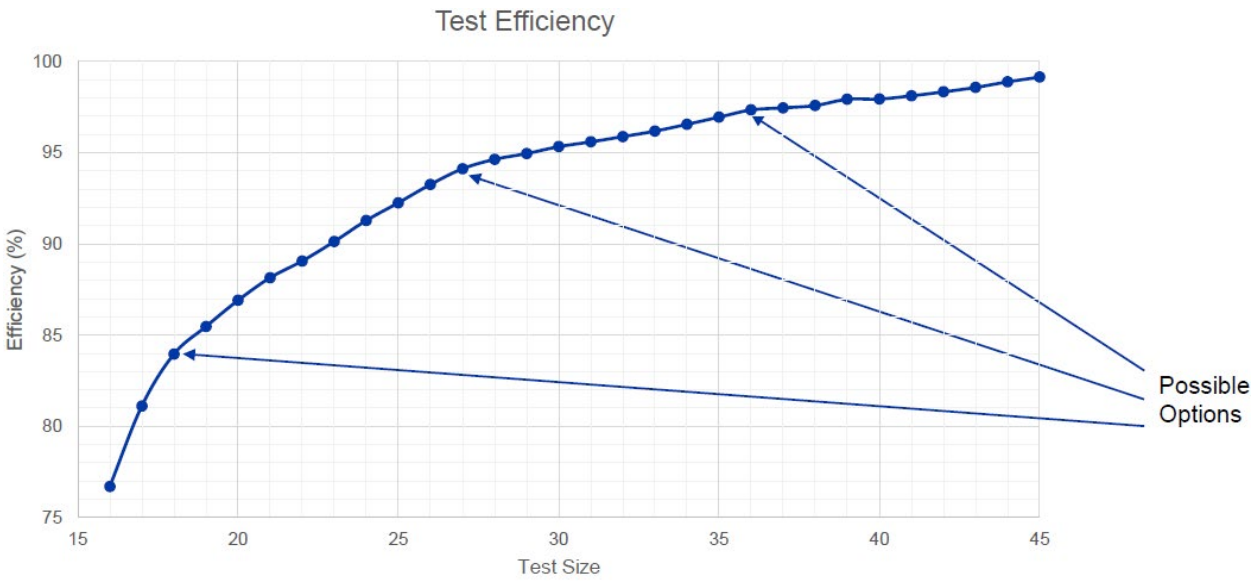


UL-5800 A Standard for Containment Bags for Personal Electronic Devices: (June 2021)

Underwriter Laboratories (UL) announced the adoption of UL-5800 – a standard for containment bags meant to contain personal electronic devices such as laptops, phones and tablets that undergo thermal runaway. Fire safety branch personnel, along with members of UL, lithium battery experts, battery package manufacturers, and others participated in the development of this consensus-based standard that is geared towards aircraft applications and includes various fire tests that a bag must be able to withstand in order to pass. Currently, many airlines utilize containment bags that do not adhere to any specified standards, so information is limited as to the effectiveness of these devices. This standard will provide the airline industry with confidence in knowing that containment bags put into service will meet their needs and promote continued safe operation of their aircraft. The Standard is expected to be released this month.

Design of Experiment Training: (July 2021)

Fire Safety Branch engineers and scientists participated in a Design of Experiment training session given by The Boeing Company's Research and Technology Applied Mathematics team. This arose out of the need for creating an efficient experiment to evaluate the flammability of 3D printed materials in which the same aircraft component can be printed in hundreds of different ways. Boeing was assisting in designing this experiment and offered to train all of the Fire Safety Branch personnel on these mathematical techniques and the computer programs that perform them. This training occurred online for four hours each day on July 27 – 28, 2021, with about twenty FAA employees participating. The techniques taught for designing efficient experiments can be applied to many Fire Safety projects that involve several variables, saving time and money, and producing better results. Steve Rehn, steven.rehn@faa.gov, (609) 485-5587.

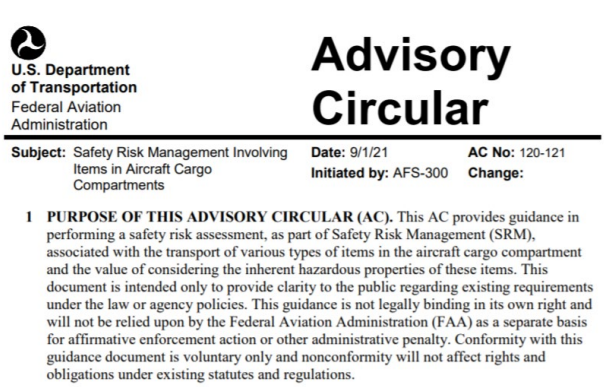


Acquisition of Boeing 757 Test Article: (August 2021)

The Fire Safety Branch has recently taken custody of a Boeing 757 previously owned by the Department of Homeland Security (DHS). This functioning but non-flyable asset will be utilized in a collaboration between the Aviation Research Division and FAA Civil Aerospace Medical Institute (CAMI) for future cabin air quality research as part of work supporting section 326 of the FAA Reauthorization Act of 2018**.** The airplane was originally flown to the Technical Center in September 2016, and was used for several DHS projects including an FAA/DHS joint Cybersecurity research effort and counter-terrorism training by various law enforcement agencies. In order to receive custody of the airplane, the Fire Safety Branch had to interface with various entities, including the Flight Program Operations office, to ensure the asset would remain in a non-flyable state. Fire Safety Branch personnel are currently working to relocate the aircraft near the FAA hangar, where it can be adequately maintained and instrumented for the upcoming air quality research. Tim Marker, tim.marker@faa.gov, (609) 485-6469.

FAA Cargo Fire Safety Website: (September 2021)

Fire Safety Branch personnel published a website in support of AC 120-121, Safety Risk Management Involving Items in Aircraft Cargo Compartments. This AC provides guidance to operators when performing a safety risk assessment, as part of Safety Risk Management (SRM), associated with the transport of various types of items in the cargo compartment. The website, developed in conjunction with, and referenced to in the AC, provides information about the hazards, operational risks, and mitigation strategies an operator could use in the development of their assessment to transport various hazardous goods. The effort to generate the layout and content for the website started in April 2020, in collaboration with personnel from AXH and AIR to ensure the website contained useful content laid out in an easy to use manner. The content for the website was generated from the research that the Fire Safety Branch has conducted over many years in an effort to better comprehend the hazards and risks posed while in transit, and to develop standards that can be used to mitigate this potential danger. The website will be maintained by Fire Safety Branch personnel to ensure the most current information is available. Dhaval Dadia, dhaval.dadia@faa.gov, (609) 485-8828.

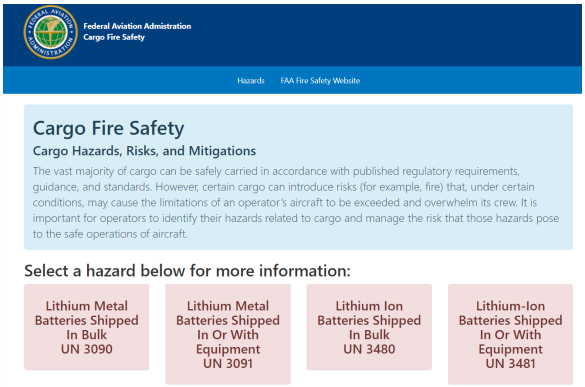


U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Safety Risk Management Involving Items in Aircraft Cargo Compartments
Date: 9/1/21 **AC No:** 120-121
Initiated by: AFS-300 **Change:**

1 **PURPOSE OF THIS ADVISORY CIRCULAR (AC).** This AC provides guidance in performing a safety risk assessment, as part of Safety Risk Management (SRM), associated with the transport of various types of items in the aircraft cargo compartment and the value of considering the inherent hazardous properties of these items. This document is intended only to provide clarity to the public regarding existing requirements under the law or agency policies. This guidance is not legally binding in its own right and will not be relied upon by the Federal Aviation Administration (FAA) as a separate basis for affirmative enforcement action or other administrative penalty. Conformity with this guidance document is voluntary only and nonconformity will not affect rights and obligations under existing statutes and regulations.



Federal Aviation Admistration
Cargo Fire Safety

Hazards FAA Fire Safety Website

Cargo Fire Safety

Cargo Hazards, Risks, and Mitigations

The vast majority of cargo can be safely carried in accordance with published regulatory requirements, guidance, and standards. However, certain cargo can introduce risks (for example, fire) that, under certain conditions, may cause the limitations of an operator's aircraft to be exceeded and overwhelm its crew. It is important for operators to identify their hazards related to cargo and manage the risk that those hazards pose to the safe operations of aircraft.

Select a hazard below for more information:

Lithium Metal Batteries Shipped In Bulk UN 3090

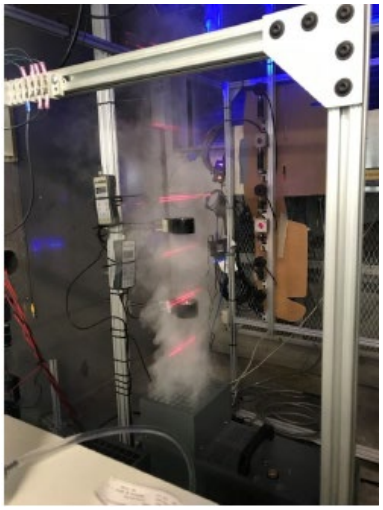
Lithium Metal Batteries Shipped In Or With Equipment UN 3091

Lithium Ion Batteries Shipped In Bulk UN 3480

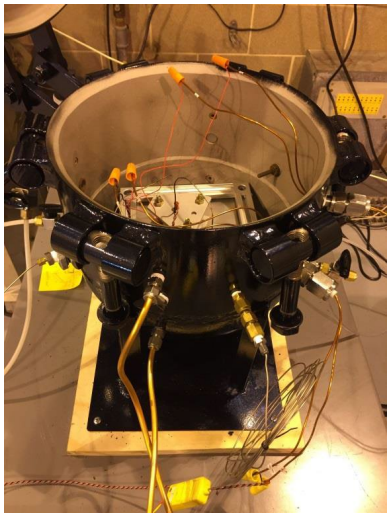
Lithium-Ion Batteries Shipped In Or With Equipment UN 3481

17th International Conference on Automatic Fire Detection (AUBE '21): (September 2021)

Matthew Karp presented two topics and published corresponding conference papers at the 17th International Conference on Automatic Fire Detection' (AUBE '21) from September 21-23. One presentation and conference paper was titled "Thermal Runaway Vent Gas Analysis for Lithium Ion Batteries at Various Heating Rates". This topic highlights the FAA's unique testing facilities including pressure vessels and a variety of gas analyzers and discusses the combustion hazard associated with shipping lithium ion batteries. The second presentation and conference paper, a collaboration with Andre Freiling from Airbus, was titled "Methods for Characterizing Theatrical Smoke Transport for Aircraft Cargo Smoke Detection Certification". This topic discussed FAA's research and ongoing discussions regarding the creation of a standard for smoke generator aerosol production for in flight cargo smoke detection system certification. AUBE '21 is jointly organized with the 2021 Suppression, Detection, and Signaling Research and Applications Conference (SUPDET 2021). The conference was hosted at the University of Duisburg-Essen, Germany and was a hybrid format (in person and virtual). The conference addressed the latest developments in research, technology, and applications for the fire protection community. Matt Karp, matthew.karp@faa.gov, (609) 485-4538.



Smoke Generator Standardization

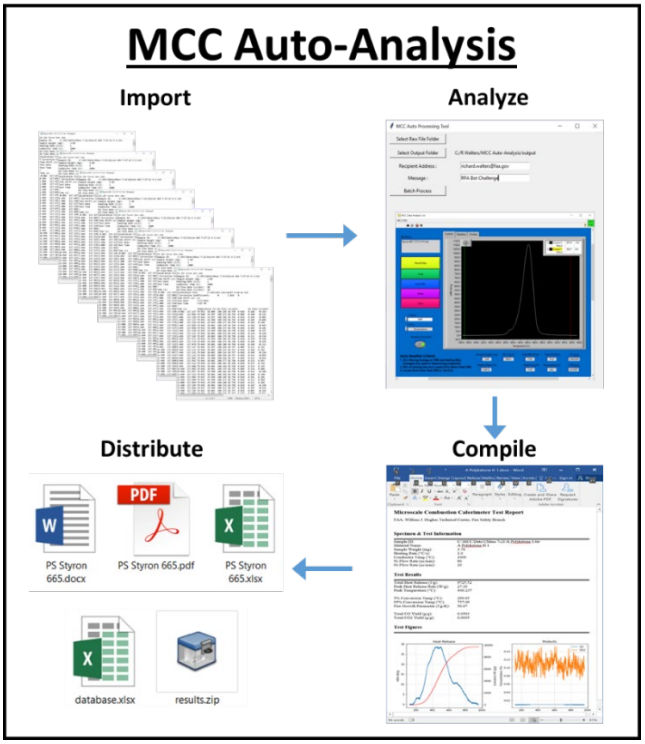


Thermal Runaway Vent Gas Analysis

RPA Bot Challenge 1st Annual Battle of the Bots: (September 2021)

Richard Walters, Haiqing Guo and Richard Lyon of the Fire Research & Safety Branch, ANG-E21, participated in the FAA-wide Robotic Process Automation (RPA) Bot Challenge competition on September 14. Their bot, entitled **"**Microscale Combustion Calorimeter (MCC) Auto-Analysis**"**, won the Trailblazer Award, which was given to the team with highest overall score out of the 15 automations submitted. The automation was developed using Python and facilitates the analysis and distribution of bulk test data. It does this by performing calculations on columns of logged measurements of gas flow rates, concentrations and temperatures to obtain a heat release rate. The automation then applies a set of conditions to determine the test endpoints, applies baseline corrections, performs calculations to derive fire test results, compiles and saves those results in multiple formats (Word, Excel, pdf), updates

a database file, zips the report files, and distributes them through email to defined recipients. This automation saves an analyst about one hour per day of testing. This technology was developed for internal purposes, but has much broader applications and can be used by others and applied to other systems. It has the capability to bring historical test data up to date with the latest standard methodologies and store that test data and summarized results in a format that can be made available to the public in alliance with the FAA's Data Management Plan (DMP). Link to recorded event: https://www.youtube.com/watch?v=FhcTrYft2qA. Richard Walters, richard.walters@faa.gov, (609) 485-4328.



Expansion of FAA Fire Chemistry Research Laboratory Capabilities: (September 2021)

The FAA Fire Safety Branch continues to expand its capabilities to assure fire-safe flights for the flying public. The fire research group chemists evaluate not only the fire resistance of materials exposed to fire but also the toxicity of the gases produced from those materials. Aircraft fires may emit combustion gases which can affect the health and survival of passengers. The combustion products of aircraft materials, Lithium batteries and fire extinguishing agents contribute to the toxic hazard.

Louise Speitel and Natallia Safronava of the Fire Safety Branch ANG-E21 and integral Fire Chemistry Research Laboratory acquired and installed instrumentation to expand the gas analysis capability of the lab to measure acid gases. This instrumentation includes a high pressure Ion Chromatography (IC) system as well as a system to generate ultrapure water required for the IC. The installations were completed in August 2021. The acid combustion

gases HF, HCl, HBr, NO, NO2, H3PO4, SO2, SO3 can be quantified with this IC in complex combustion gas mixtures.

This IC will be used to support various bench scale and full-scale fire tests performed in the diverse laboratories of the Fire Safety Branch. Louise Speitel, louise.speitel@faa.gov, (609) 485-4528, Natallia Safronava, natallia.i.safronava@faa.gov, (609) 485-4529.

Ultrapure Water System

Ion Chromatography System

FAA Reports

The following FAA reports were published during FAA Fiscal Year 2021.

Fuel Tank Flammability Assessment Method User's Manual – Updated for Version 11

Author: Steven M. Summer

FAA Report Number: DOT/FAA/TC-21/3

https://www.fire.tc.faa.gov/Reports/listresults.asp?searchList=DOT%2FFAA%2FTC-21%2F3&listSubmit=

The Fuel Tank Flammability Assessment Method (FTFAM) is a Federal Aviation Administration-developed computer model designed as a comparative analysis tool to determine airplane fuel tank flammability as a requirement of Title 14 Code of Federal Regulations Section 25.981. The model uses Monte Carlo statistical methods to determine the average fuel tank flammability of a fleet of airplanes based upon randomly selecting certain unknown variables over defined distributions for a large number of flights. The FTFAM iterates through each flight, calculating the flammability exposure time of each flight given the data input provided by the user. Calculating this flammability exposure time for a sufficiently large number of flights results in statistically reliable flammability exposure data. These calculations can be performed for fuel tank types utilized in transport airplanes, including body tanks located in the fuselage, wing tanks, and center wing tanks. The program can also be modified by the user to determine fuel tank flammability when a flammability reduction means is employed.

This report serves as a user's manual for this computer model to assist the user in its operation and to discuss the permissible changes that may be made to this model specific to a particular fleet of aircraft. It is updated through version 11 of the FTFAM. The user should reference Advisory Circular 25.981-2A for additional guidance on when to use this model and for a discussion of interpretation of results.

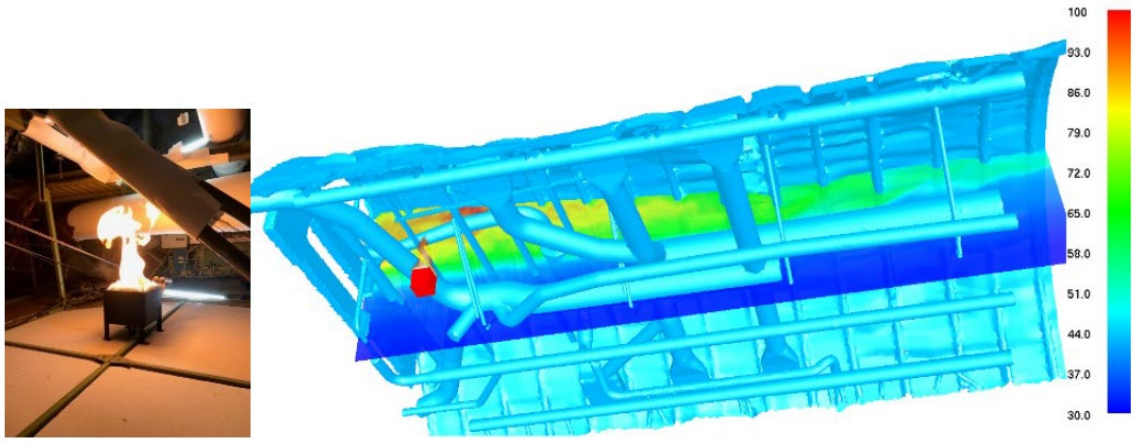
A Study on Experimental Tests and Numerical Simulations of Boeing 747 Overhead Inaccessible-Area Fires

Authors: Richard E. Lyon, Sean Crowley, Haiqing Guo, Marcos Vanella, Randall McDermott, Paul Scrofani

FAA Report Number: DOT/FAA/TC-21/8

https://www.fire.tc.faa.gov/Reports/listresults.asp?searchList=DOT%2FFAA%2FTC-21%2F8&listSubmit=

Hidden fire in an aircraft overhead inaccessible-area is hazardous to in-flight safety and could lead to catastrophic disaster. In this case, fire detection at the earliest stage requires an improved understanding of the heat and mass transfer in overhead areas with curved fuselage sections. In this effort, an experimental campaign was conducted at the FAA William J. Hughes Technical Center on different fire scenarios for the Boeing747-SP overhead inaccessible-area to advance knowledge on this phenomenon and provide validation data for the Fire Dynamics Simulator (FDS). Extensive work has been done recently to enable computer simulation of fire on complex geometries within this tool. Therefore, we use the experimental data obtained to perform validation of said capability. Model validation results are defined in terms of thermocouple readings measured and computed with satisfactory overall agreement.



(a) Photo of fire (b) Steady temperature slice at y = 3 m

Forums Meetings

The Fire Safety Branch, ANG-E21, hosted the International Aircraft Materials Fire Test and the Systems Fire Protection Forums on April 19-22, 2021. These forum meetings allow for an open exchange of information between the FAA researchers and industry. Both meetings were held virtually, with a combined total of over 330 participants logging in for over 30 different technical presentations.

International Aircraft Materials Fire Test Forum Meeting

Dates: April 19-20, 2021

Location: Virtual

Host: FAA Fire Safety Branch

The Materials Fire Test forum included discussions concerning the release of a Final Rule on the updating of all flammability tests in Appendix F to Part 25. Additional updates were provided on: the development of a Vertical Flame Propagation test for materials located in inaccessible cabin areas; the development of a new heat release apparatus for cabin materials, including a rigorous Technical Readiness Level exercise to ensure the proposed apparatus is suitable for industry use; the development of a new flammability test for electronic enclosures; an investigation of 3-D printed materials, and how the various printing parameters can influence flammability; the development of parameters used to evaluate the similarity of materials tested in the microscale combustion calorimeter (MCC); the impact that cabin disinfection agents may have on material flammability.

Meeting presentations and minutes are available at https://www.fire.tc.faa.gov/materials.asp.

International Aircraft Systems Fire Protection Forum Meeting

Dates: April 21-22, 2021

Location: Virtual

Host: FAA Fire Safety Branch

The Systems Fire Protection Forum meeting, April 21-22, 2021, covered topics such as cargo compartment fire detection and suppression, powerplant component fire testing, and continued lithium battery fire research.

Meeting presentations and minutes are available at https://www.fire.tc.faa.gov/systems.asp.