

**INTERNATIONAL AIRCRAFT SYSTEMS FIRE PROTECTION WORKING GROUP
MEETING**

November 1-2, 2017

Held at Resorts Casino-Hotel, Atlantic City, New Jersey, USA

AGENDA:

WEDNESDAY, NOVEMBER 1, 2017

Welcome and Meeting/Logistics – D. Blake

Attendee Introductions

Certification of False Alarm Resistant Cargo Smoke Detectors –R. Ochs, PhD
(FAATC)

FAATC Testing – M. Karp (C-Far)

Smoke Detection Project – T. Emami (FAATC)

University of Maryland Detection Work – Status Update – R. Ochs, PhD (FAATC)

Break

Standardization of Smoke Generation for Certification Testing – André Freiling
(Airbus)

CFD Modeling – H. Guo, PhD (C-Far)

Status of NexGen Burner for Powerplant Testing – S. Summer (FAATC)

University of Cincinnati Updates– San-Mou Jeng (University of Cincinnati)

Lunch

SAE/ISO Standards on Fire Containment Covers and Fire Resistant Containers -
D. Blake (FAATC)

Smoke, Fire, Fume Events Report – Update – R. Hill (FAATC)

MPS Testing of Water/Nitrogen System in a Class C Cargo Compartment – D.
Dadia (FAATC)

Challenge Fire Scenario for a Halon Replacement Agent in a Class C
Compartment – D. Dadia (FAATC)

MPS Nacelle Testing Carbon Dioxide Update – D. Ingerson (FAATC)

Break

RTCA Battery Working Group Updates – S. Summer (FAATC)

Button Cells and Polymers Testing - M. Karp (C-Far)
Hydrogen Fuel Cell Working Group Updates – S. Summer (FAATC)
FAA Aircraft Certification and Regulation Reorganization – Jeff Gardlin (FAA)
ICAO Halon Replacement Dates – David Scorer (ICAO)
EASA Rulemaking Activities – (EASA)
ICCAIA Cargo Compartment Halon Replacement Working Advisory Group
(CCHRwAG) Update – R. Bennett (Boeing)
Engine/APU Halon Replacement Industry Consortium – Halon Alternatives for
Aircraft Propulsion (HAAPS) Update – Alan Macias (Boeing)

MINUTES:

THURSDAY, NOVEMBER 2, 2017

9:00-9:20 AM Status of the G-27 Lithium Battery Packaging Committee –
D. Ferguson (Boeing)

9:20-9:40 AM FAA Support of Packaging Standard – T. Maloney
(FAATC)

9:40-10:10 AM Hazard of PEDs in Checked Luggage – H. Webster (FAATC)

10:10-10:15 AM High-Energy Fire Training Enhancement (HEFTE) Working
Group – DK Deaderick (FAA)

10:15-10:45 AM *Break*

10:45-10:55 AM Solid-State Lithium Battery Tests – T. Maloney (FAATC)

10:55-11:05 AM FAATC Tablet Tests – T. Maloney (FAATC)

11:05-11:20 AM Installed Lithium Batteries Task Group – Al Carlo (Boeing)

11:20-11:45 AM Additional Discussion/Closing

WEDNESDAY, NOVEMBER 1, 2017

Certification of False Alarm Resistant Cargo Smoke Detectors – R. Ochs, PhD (FAATC)
25.858 Cargo Fire Protection, 2/10/1998 – smoke detection requirement. AC25-9A and
TSO-C1e also cover smoke detection. Problem: AS8036 false alarm conditional are
similar to theatrical smoke aerosols. A Task Group was formed to discuss this issue and

work to develop smoke certification procedure that will cause all detectors to alarm even those that are false-alarm resistant.

False Alarm Smoke Detection and Smoke Generators – M. Karp (C-Far)

Matt discussed tests conducted at the FAATC and presented the results: can smoke detector, talc powder, incense, Rosco smoke generator, Aviator UL smoke generator. Photos of the test set-up were shown. The test procedure was described. The obscuration, blue & IR signal and % blue recorded during these tests were discussed. Conclusions: blue and IR signal can be used to characterize smoke detector nuisances, actual and generator smoke. The smoke generator particle size, smoke density and/or refractive index varies with: gas propellant, precision micrometer valve adjustments, gas propellant regulator adjustments (varies the flow rate). Question: where do you go from here? Karp: we have to characterize the smoke generators, particle size with various propellants.

Characterization of Smoke Machines in Testing Aircraft Smoke Detectors – T. Emami (FAATC)

Whittaker Smoke Detector and Kidde Smoke Detector were used in this project. Tina discussed the characteristics measured during the test series. The test set-ups were described. Tina presented the results of all of the tests that she conducted.

University of Maryland Detection Work – R. Ochs, PhD (FAATC)

This work was done under a grant with the FAATC Fire Safety Branch. Analysis of nuisance alarms was done by the University of Maryland researchers. The ULD smoke detection challenges were discussed. Their proposed solutions for ULDs and for detection in ULDs were reviewed. Quintiere: there was a similar study at University of Maryland in the 1990s. Try to push the technology. Slaton: schedule for this project? Ochs: the grant was about 18 months. We just received the Phase I report. Hopefully, we will have a final report within a year.

Standardization of Smoke Generation for Certification Testing – Dr. André Freiling (Airbus)

Motivation for this project: What smoke to use to certify the latest smoke detectors? As determined by results of tests conducted at FAATC, the Rosco smoke machine is not suitable for the smoke detection testing. André discussed the particle size measurement challenges in this project. Smoke, fog, dust particle sizes were discussed. André stressed the importance of standardization. What parameters would be used to standardize? André reviewed what Airbus sees as items the standard should cover, what not to cover, academic approach on requirements for smoke generator; how to reflect in a standard the dependency of smoke detection performance on particle size; agreement on particle size measurement principle; define certification test validity criteria (amount of smoke generator fuel consumed); what standard should it be (FAA AC update, SAE)? Hill: what is your opinion – is the idea to standardize the condition that would be with cargo compartment or standardize on the size of the fire you are going to detect independent of the size of the cargo compartment? Blake: from an airplane safety point of view, what's your opinion of what's more important to detect – a flaming fire or smoldering fire? Freiling: a smoldering fire.

Modeling of Hidden Fire in Aircraft Overhead Area – H. Guo (C-Far)

Haiqing reviewed the motivations and objectives of this modeling work done at the FAATC. The test article was the FAATC Fire Safety 747-SP a region 6.7m long x 5.4 m wide x 2m tall. An 11kW propane gas burner was used. The experiment design was described. Results of the tests and CFD modeling were presented. Quintiere: the top and bottom temps are good agreements but the ones in the middle are not, could you show me where those middle thermocouples are located? Carlo: all the materials have to meet requirements for self extinguishing now.

Next Generation Fire Test Burner for Powerplant Fire Testing Applications – S. Summer (FAATC)

A quick background was provided explaining reasoning behind introducing use of the new technology sonic burner which is already in use in some of the materials fire test methods. The materials that have been tested: carbon fiber, fiberglass cargo liner, Garolite, 10-ply carbon material and burner settings used in this study were shown. 0.060" FR4 Glass Epoxy was recently tested at the FAATC. It did not burnthrough after 15 minutes, so it was considered not suitable for the Round Robin tests. Resonate Testing conducted some tests on composite panels supplied by Bombardier/Shorts. Steve discussed these tests and presented their results. Next Steps: additional materials to be explored? Felt materials? Varying thickness of aluminum. Is burnthrough the proper measure of failure for this type of material? How else can we measure pass/fail? We plan to discuss this in our Task Group meeting on November 2, 2017. Questions arose within our TG discussions: standards refer to aluminum as being fire-resistant (i.e.: burnthrough >5 minutes). Steve Rehn tested the few aluminum panels we had in the lab. Not repeatable with 50 psi air pressure, however, very repeatable with 40 psi air pressure.

Task Group: Sub-Group A: Calibration Method/Burner flame temp/TCs (size, type): Draft Policy Memo on use of the Propane Burner (mentioned at May 2017 Systems WG meeting) will now address this issue through a change to AC20-135. Steve reviewed the history of FAA propulsion fire test flame – document release dates. The FAA has not changed our definition of the test flame. We have always intended the definition of fireproof to be 2000°F. Marker: how did Resonate go about increasing the heat flux? Mallon: We cranked it up. We typically do not want to run it at that, but we were looking for the panel to fail.

Experimental Investigation of the Park Burner, Comparisons to NexGen – San-Mou Jeng (University of Cincinnati)

Demonstrate that the 2000F minimum average temperature requirement drives heat flux to upper bound and draw comparison between the calibration and burnthrough of Park vs NexGen burner. Settings of both burners were checked prior to start of test program. The test set-up was described. Results of each burner were discussed. The University of Cincinnati lab has used the NexGen burner for the last six (6) years. The Park burner appeared to be more severe from a BTU perspective. Observations: Park flame less uniform than NexGen flame. Comparison of burners: Park has high center temperature, BTU patterns are different. Question: how many coupons did you run? Jeng: only one coupon for Park, two coupons for NexGen. Mallon: what was calibration and age of

thermocouples used? Jeng: 1/16" thermocouple was used one time in our lab. Consistent temperature measurements are important.

SAE/ISO Standards on Fire Containment Covers and Fire Resistant Containers – D. Blake (FAATC)

A new project was approved to revise SAE Ass6453 Fire Containment Covers in October 2015. A revised draft version of the standard was added to the SAE committee member website on October 17, 2017. The revised standard contains wording that attempts to address the external fire concerns. A working group meeting to discuss the proposed revision to the standard was not held during the October 2017 meeting.

SAE standard AS6278 Fire Resistant Containers is under development. During the October 2017 SAE meeting, the working group's general consensus was the standard would now include two types of FRCs. Additional ISO/SAE harmonization is desired. The FAA is seeking industry input on status of FCC/FRC use to provide data to the Commercial Aviation Safety Team (CAST) on hazmat fire risk reduction. Input will also be used to address NTSB recommendations to FAA on improvements to cargo fire safety. The industry Survey is: available at: www.fire.tc.faa.gov/temp/FCC_FRC...

FAA Update – TSO-C90 ULDs – anticipated release date is now mid-2018. TSO-C90 Revision f will be scheduled for release within a year of SAE AS6278 release.

Fire, Smoke or Fumes Occurrences on Transport Airplanes – R. Hill (FAATC)

This work has been completed. FSF events from 2002-2014 have been compiled into an FSF Database (Excel). Dick described some of the data that can be accessed via the database. The report is available on the FAA Fire Safety website: DOT/FAA TC-16/49. Chiesa: will more events be added over time? Hill: Ray Cherry has retired and closed his business. Would TCCA fund some of that work in the future? If there is a time in the future when the authorities decide additional events should be added, a new research company would need to be indentified to complete the work. Cortina: does this tell you if the fire protection system was discharged, also? Hill: yes, from a standpoint of in-flight. It is just U.S. registered airplanes. Carlo: did it have date of manufacture of the aircraft? Hill: it has tail number you can use to find that. Slaton: are you aware of any activities within the FAA or the community of groups that are discussing doing a deeper analysis of this data and what it means to them? Hill: a group in the FAA was considering looking into this further, but it may not be in the way you are referring to.

Minimum Performance Standard Aircraft Cargo Compartment Halon Replacement Fire Suppression Systems Testing – D. Dadia (FAATC)/Karsten Kirbach (AOA)

This test program was conducted at the FAATC. Dhaval described the test set-up, test scenarios, AOA Water Mist/Nitrogen Fire Suppression System – Karsten reviewed the system design. We did water mist/nitrogen characterization. Summary of Test Results: on average the water mist system used about 66.6 lbs of nitrogen and 2.7 gal water for initial knockdown. Videos of highlights of the tests, test results, and gas analysis were shown: pan fire scenario, containerized test, bulk load fire (no video available yet), and the aerosol can simulation test. Question: what was the pressure of nitrogen? Kirbach: where? Cylinder pressure: 2400 psi, but it varied a lot. We have pressure regulators in between so we get a stable pressure. Question: why do you wait 2 minutes, is that

standard procedure? Dadia: it is to accommodate the time it would take the pilots to receive the signal. Hill: where would you propose to get the nitrogen from in flight? Kirbach: we are currently working on that – cylinders, but we realize there could be a weight issue. Also, looking into nitrogen-enriched air using systems that are already on board the aircraft.

Minimum Performance Standard Aircraft Cargo Compartment Halon Replacement Fire Suppression Systems Testing - Challenge Fire Test – D. Dadia (FAATC)

TAD requested one additional test with a more realistic fire threat consisting of: palletized load of boxes with shredded paper, some boxes with lithium ion batteries, some boxes with flammable fluids, etc. Dhaval described how these fire threats were packed for the Challenge test. The fire load set-up was described and photos of its location in the cargo container were shown. Test sequence was explained. Highlight video was shown. Post test photos were shown. Summary: we used 110 lbs of nitrogen and 2.7 gal of water during this test. Question: why is the error so large on the consumption of nitrogen. Kirbach: we had quite a bit of trouble measuring the nitrogen. It was caused by the type of cylinders available in the U.S.

Engine Nacelle Halon Replacement – D. Ingerson (FAATC)

Doug reviewed the test article, design, set-up, and calibration for CO2 testing in FAATC engine nacelle test article. At this time there has been one test each: CO2 inferior and CO2 superior. 3 tests each are needed. Near-term plans: complete the concentration measurement tests, work with CO2 vs. 'high' vent/pool fire, and review information and determine if further testing will occur.

RTCA Battery Working Group Updated – S. Summer (FAATC)

RTCA SC-225 (Rechargeable): Steve gave overview of items being worked on by this group and status of document.

RTCA SC-235 (Non-rechargeable): document was completed and approved by PMC and was published on September 21, 2017. There are similarities with the SC-225 test procedures, but there are some significant differences as well. Steve reviewed SC-235 thermal runaway definition recently finalized.

Lithium Ion Thermal Runaway – Less than 2 Wh Lithium Ion Batteries – M. Karp (C-Far)

RTCA SC-225 committee working to develop document DO-311A. The scope of the testing, test procedure, and results were presented. Pouch cells and button cells were tested. There are cells at or near 2 Wh that could pose a significant fire threat, so based on this, the committee writing DO-311A decided to maintain the 2Wh limit and not to extend the exemption level. Carlo: what made you draw that final conclusion? Summer: the committee based that decision from this data and the test video.

Hydrogen Fuel Cell Industry Working Group Updates – S. Summer (FAATC)

EUROCAE/SAE WG80/AE-7AFC: This committee was formed in December 2008 to provide design, integration guidance. The group is working on three separate

documents with the objective of getting one document out per year over the next three years. Steve described what each document is planned to cover.

Energy Supply ARC: formed by FAA to provide a forum for the aviation community to provide recommendations to the FAA. ARC was chartered in April 2015. The group is focusing on PEM and SOFC fuel cells. The document is nearing completion with the report to be submitted to the FAA in December 2017.

Fuel Cells – Areas of Research: some areas of hydrogen research, pertinent to fire safety identified through the ARC and SAE committees have been investigated by the FAA. Two reports are available on the FAA Fire Safety website. Steve explained the test proposal, test set-up (currently underway at FAATC), and discussed flame visualization.

FAA Aircraft Certification Service (AIR) Transformation – Jeff Gardlin (FAA)

There are a number of organizations within the FAA that are currently going through transformation. Reasons for this transformation within the FAA: industry growth; globalization of aviation; heightened expectations; and velocity of change. Go to: www.faa.gov/go/AIRTransformation for information. Question: is there a way to involve the FAA in something that is prior to any official project? Gardlin: yes, to a degree. We have a process called an Integration Center under the Policy & Innovation Division (AIR-600), but all the details have not been finalized on how some of these things are going to work. Ferguson: do you have an idea of when the final transformation will occur? Gardlin: most of what I've shown is sort of what the final will look like. It is the things that are going on behind the scenes that will take some time - possibly two years.

Update on ICAO Activities for the Replacement of Halon in Aircraft Fire Suppression Systems – David Scorer (ICAO)

Status Implementation – Portable; status of implementation – engine nacelle/APU.

Implementation in progress: feedback from ICAO Assembly 39 – October 2016: directs council to mandate the replacement of halon in cargo compartment fire suppression systems used in aircraft –for which a new Type Certificate is submitted to the State of Design on or after 28 November 2024 timeframe. Next steps were reviewed.

EASA – Halon Replacement Status – Enzo Canari (EASA)

RMT.0560, Opinion 08/2016 issued – Halon: Update of Part 26 to comply with ICAO Standards.

RMT.0206, CS-ETSO Amendment 11 issued.

EASA/DG-CLIMA Discussion: we have tried to discuss a new cut off date for cargo compartments. There has been a clarification to EC Reg. No. 1005/2009. Hill: if you have a new Type Certificate after 2018, you have to use a halon alternative or propose a halon alternative (i.e.: building an SST). Canari: your understanding is correct.

ICCAIA Cargo Compartment Halon Replacement Working Advisory Group (CCHRWG) Update – Robin Bennett (Boeing)

Terms of Reference are in support of the 2024 deadline.

New name for group (CCHRAG) - Cargo Compartment Halon Replacement Advisory Group.

May 11, 2017, meeting overview was provided. The CCHRAG 2017-2019 Work Plan was presented.

Engine APU Halon Replacement Industry Consortium – Halon Alternatives for Aircraft Propulsion (HAAPS) Update /– Alan Macias (Boeing)

Alan provided a short review of this group. Phase I: HAAPS Joint Collaboration Agreement (JCA) in Approval Signature Cycle at founding OEM airframers: OAI, Boeing, and Bombardier have signed. Phase II: IASFPWG, CCHWRG, NIST, and FAA ARC are already working, and we are working where we can until the JCA is signed by all members.

THURSDAY, NOVEMBER 2, 2017

State of SAE G-27 Lithium Battery Packaging Performance Committee – Doug Ferguson (Boeing)

There is an SAE G-27 Lithium Battery Carriage Packaging Standard Committee that has been meeting for a few months. There are monthly WebEx teleconferences. Doug explained several aspects of the Draft Packaging Standards. An 'external fire' meeting was held in September 2017. Draft Packaging Standards – External Fire Considerations: there was an agreement from the members to create an output document to present to the G27. The output document will be discussed during the upcoming G27 face to face meeting in Renton, WA, in November 2017. Expecting a standard to go through SAE balloting process in 2018. Hariram: how is this implemented? Who determines hazardous quantities of flame & how is it determined? What is hazardous? Ferguson there are some FARs that govern operators, but primarily it is by individual countries as part of safe carriage of hazardous goods by air. The question what is hazardous is the reason it is taking us a long time to come to agreement on this. Blake: besides the external fire what others is the Air Navigation Panel interested in? Ferguson: there's another working group within ICAO that is trying to determine what else should be considered.

SAE G27 Packaging Tests – T. Maloney (FAATC)

These tests were conducted in support of the SAE G27 Committee. Tom described the main test and sub-tests that were conducted at the FAATC facilities. Tests conducted: External Fire-Oven Tests - Results: thermal runaway occurred in each test when thermocouple in center of box reach 190C or greater – size of box (with 1 cell) had little effect on time to runaway. FAATC looked at: battery packs, external fire (horizontal), cheese cloth, corner initiation, edge initiation, and center initiation. Other tests: metal cells, safer li-ion chemistries, and alternative configurations. Summary: with adequate packaging, external fire battery test could be 'dropped-in' to the oxygen cylinder test method. Testing is ongoing. If anyone has any ideas for future tests or what might be a good thing to look at, let me know. Slaton: why aren't you testing the battery packaging material in the positions you are using the Kaowool? Maloney: it is experimentation to find good testing methods. We are trying to refine the test for the packaging. Hill: the

idea is that you could do a number of different types of tests (oven, external fire). Carlo: Did you go back and ask what is the threat? Ferguson: part of the discussions we had from the external fire committee meetings are what are the threats, there would some elevated temp for some time, and what have been past test characteristics (one set inside the criteria for looking at different aspects of hazardous fires). This is what we are looking at right now - what sort of materials tests could one do as a basis.

Personal Electronic Device Hazard in Checked Luggage – H. Webster (FAATC)

Background: security concerns led the Department of Homeland Security to ban laptops and other large PEDs from the cabin in flights from certain countries in 2016. The FAATC Fire Safety Branch conducted a test program to assess various aspects of the fire hazards of PEDs in checked baggage. Two methods of mitigation were tested in this test series. Photos of how the laptops were prepared for tests were shown. FAATC simulated class C cargo compartment set-up (packaged as airlines were packing passenger PEDs for flights from countries where PEDs were banned from cabins in 2016). Tests: 36 laptops were put in a cargo container, one with a heater.

Laptop luggage test overview was also run simultaneously at FAATC. Luggage provided by Transportation Security Lab. We moved from there to luggage with allowable hazmat – items that are allowable: nail polish remover, aerosol can of dry shampoo.

Luggage fire tests with Halon were also conducted.

Harry discussed the observations from the laptop tests and luggage tests.

Luggage provides some limited containment of a PED in thermal runaway if there is no aerosol hazmat in the same bag.

High Energy Fire and Cabin Safety Risk Management – DK Deaderick (FAA)

We are tracking high energy devices to provide high energy fire training to cabin crew members. Air Carrier Training Aviation Rulemaking Committee (ACTARC) – charter established January 2014. High Energy Fire Training Enhancement was formed by ACTARC – this HEFTE met in August 2017.

Solid-State Lithium Battery Tests – T. Maloney (FAATC)

All of the tests were done in a nitrogen environment. Chiesa: can you explain how you did the tests? Maloney: cell on insulated surface attached flat DC strip heater, heat at specific heating rate, it is a nitrogen environment, we let the cells vent and then we bring the entire chamber up to a pressure.

FAATC Tablet Tests – T. Maloney (FAATC)

E-tablets are being used for the electronic flight bag in the cockpit. What would happen if thermal runaway occurred in the cockpit? We also tested tablets in a galley compartment. What would happen if thermal runaway occurred in galley compartment? Videos of tests conducted at FAATC in galley compartment and cockpit were shown. Summary: we noticed early warning signs of a tablet overheating. Smoke accumulation

could impair pilot's vision in cockpit. Fire may erupt from tablet. Hariram: did you have the necessary flight deck ventilation? Maloney: yes, it was on the whole time. Question: did you ever get ignition with being ignited? In both? Maloney: it definitely happened in the flight deck.

Installed Lithium Batteries Task Group – Al Carlo (Boeing)

Al proposed including the related Task Group as part of the IASFPWG meeting as the International Aircraft Materials Fire Test Working Group does (see Oct 30-31, 2017 Materials agenda). He is proposing a Task Group on installed lithium batteries to be incorporated into IASFPWG to work to standardize numerous items related to installed lithium batteries. Al listed some thoughts of what these would be. Summer: discussed RTCA DO-311A and what it will cover when published. There are efforts already underway to move away from the Special Conditions. Given that we have the work from TRTC completed already to standardize, I wonder if this Task Group will be duplicating efforts that are already being worked on by other groups. Carlo: I'm not proposing going back to re-do what has been done.

Meeting Closing – R. Ochs, PhD (FAATC)

Rob mentioned that a short IASFPWG Survey would be sent to those in attendance and on the Systems WG Email Distribution List.