INTERNATIONAL AIRCRAFT SYSTEMS FIRE PROTECTION WORKING GROUP MEETING

May 10-11, 2017

Hosted by EASA, Cologne, Germany

WEDNESDAY, MAY 10, 2017

Welcome and Meeting/Building Logistics – D. Blake and EASA

Attendee Introductions

Certification of False Alarm Resistant Cargo Smoke Detectors – D. Blake (FAATC)

University of Maryland Detection Work – D. Blake (FAATC)

Break

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

University of Cincinnati Updates– Ryan Hasselback (University of Cincinnati)

Powerplant Fire Testing at DGA Update –

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

Lunch

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

Class C MPS Testing Overview/Status Update – (FAATC)

Commercial Aviation Safety Team Update – D. Blake (FAATC)

Halon Replacement for Airplane Portable Fire Extinguishers Progress Update – M. Madden (Boeing)

Reconsidering Carbon Dioxide as a Nacelle Fire Extinguishing Agent Update – (FAATC)

RTCA Battery Standards Update– S. Summer (FAATC)

Fuel Cell Working Groups (FAA ARC & SAE/EUROCAE) Update– S. Summer (FAATC)

Break

EASA Rulemaking Activities – R. Deletain (EASA)

ICCAIA Cargo Compartment Halon Replacement Working Group (CCHRWG) Update – R. Bennett (Boeing)

Engine/APU Halon Replacement Industry Consortium – Halon Alternatives for Aircraft Propulsion (HAAPS) Update – R. Bennett (Boeing)

History of Cargo Fire Protection – Batteries – R. Hill (FAATC)

THURSDAY, MAY 11, 2017

Status of the G-27 Lithium Battery Packaging Committee – D. Ferguson (Boeing)

G-27 Lithium Battery Packaging Committee Tests Update – (FAATC)

ICCAIA Dangerous Goods –Status & Next Steps – P. Rohrbach (Airbus)

EFB Lithium Battery Test - Cyrille Terrier (Airbus)

FAATC Tablet Tests – S. Summer (FAATC)

Break

Fire Suppression of Batteries in Overhead Bins – (FAATC)

Thermal Runaway Vent Gas Analysis – S. Summer (FAATC)

Draft Standard for an External Fire – R. Hill (FAATC)

Working Group Member Presentations

Aviator UL Smoke Generator – Trevor Dunnington (Concept Engineering)

P3 Group's 2BTP Halon-free Fire Extinguisher Product Development & Market Situation - Joachim Scholz (P3 Group)

Additional Discussion/Closing

Meeting Minutes:

WEDNESDAY, MAY 10, 2017

Certification of False Alarm Resistant Cargo Smoke Detectors – D. Blake (FAATC)

Fog Machine and Smoke Detector Testing (research conducted by Rutgers graduate student). The fog machines used in this study are Aviator UL Concept Oil 135 and Rosco Clear Fog Fluid. Dave described the tests conducted and reviewed the results for the smoke sources used. Future Work: we are going to do some full-scale testing at the FAATC with a full-scale mock up of a cargo compartment to see how the smoke transports in a full-scale mock up in a representative geometry. Chiesa: can you confirm the motivation behind this – to come up with a new smoke generator. Blake: the reason for this work is to come up with a way to certify the new types of smoke detectors. We are open to testing whatever people might come up with. Hariram: did she compare this to the smoldering suitcase that we had as a basis before? Blake: no, she didn't. The output you can get from that is very erratic, because it is an actual fire. It is something we can discuss in the Task Group. Canari: EASA is facing a number of applicants facing these issues with the new smoke detectors. We have this issue with a number of projects. We really look forward to seeing the outcome from this Task Group. Hariram: I have a problem with that – how can you compare it to a real fire? Blake: you

cannot use a real fire in certification testing. Canari: the challenge is to develop a new method of testing to certify the new detectors. We cannot burn something in the cargo compartment during certification testing. Blake: that's why the new FAA TSO was generated to begin with. Freiling: the objective of the Task Group – new smart detectors designed to reduce false alarms. The challenge is with a certification test to find a way that is not with a real fire. Simpson: you quoted some particle size distribution at the start of the presentation. Blake: that information was in the previous presentations on this work. You can find them on the FAA Fire Safety website. Simpson: are they close to where the smoke detectors are? Blake: yes, she tried to get them as close as possible.

Improvements in Aircraft Fire Detection – D. Blake (for U of MD Dept. of Fire Protection Engineering)

FAA has given University of Maryland Department of Fire Protection Engineering a grant that covers work on the need for timely fire detection in cargo compartments on board aircraft; high proportion of nuisance alarms from smoke detection systems and the issues they lead to. Phase I will close at the end of May 2017, and they will be funded for Phase II. Areas: cargo compartments: smoke detection deficiencies (ULDs), nuisance sources, outstanding recommendations, proposed solutions; and hidden spaces: accidents/incidents, outstanding recommendations, proposed solutions. A table listing the different types of detection technologies was presented and what U of MD has identified as the challenges with these technologies. The strategies they have identified for this work were presented. The five types of cargo compartments and the various environmental conditions (gases, etc. produced by cargo being carried) will be considered as part of this work. FAA requirement has response time set at 1 minute. Expect time delay to detect fire that originates within ULD (until breach of ULD). No detection requirements for fires originating within ULDs under FARs. Nuisance sources are difficult to identify. Nuisances sources that have been confirmed: faulty signal loops, burnout lamp bulbs. NTSB Recommendations must be responded to by FAA. The Recommendations identified in this grant are based on NTSB testing done at the ATF facility after the UPS fire in Dubai. Hidden areas: considering potential ignition sources such as wire bundles, insulation, batteries, ducts. There is currently no detection in hidden areas. They are just in the early Phases of this grant work at this time. Goal of this research: identify detection technologies to reduce nuisance and false alarms.

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

Background: currently specified oil burners are no longer commercially available. Industry is left with the propane burner, however this burner has been shown to be less severe than an engine flammable fluid flame. FAATC Fire Safety Branch has been tasked by Transport Airplane Directorate to develop burner performance standards for the next-generation fire test burner for powerplant fire tests. The NexGen burner has been developed and the specifications to build it are available on the FAA Fire Safety website. It consists of commercially available parts. Current Status – Testing: Steve Rehn at FAATC has been doing the testing. We have been looking for suitable materials to use. Steve reviewed the burner settings used. A series of 17"x17" test samples of various materials were tested. A series of 24"x24" test samples in three different materials were tested. Photos of the 10-ply carbon composite test were shown. Post test photos were shown – there was burnthrough of the two initial layers of the

material. Due to difficulty in finding non-metallic materials that will provide consistent burnthrough results, two proposed options moving forward: Test with pressure on the sample and test varying thicknesses of aluminum. Current Status – Regulatory: we will discuss both testing and regulatory during the Task Group meeting tomorrow. Industry-led group has been meeting regularly. The group has decided on a list of "top 10" items that need to be addressed in the rewrite of AC20-135. These 10 items are included in the slide for this presentation. Several of these go to ensuring consistency. Authorities group held face-to-face meeting March 28-30, 2017: completed initial review of all of the industry comments that had been submitted to us and decided on the best way forward to address these issues. There was some discussion of the flame temperature and differences between AC20-135 and the ISO requirement. Draft policy memo regarding the use of the Propane Burner is in the works. Steve stopped the tests at 15 minutes. The carbon fiber did not appear to be anywhere near failure at the 15-minute mark. Question: has there been any dialogue with ISO on this? Summer: we have been working with EASA and the idea is to harmonize both documents. Deletain: yes, we are following this work closely. We have a goal of being harmonized on this. We have our own shopping list of problems, also, that we would like addressed in the revision of AC20-135. We (EASA) may need to have some supplements to AC20-135. Question: the ISO is an independent organization. Has there been an outreach to ISO? Or, will it be not as prevalent in the revision of AC20-135 or are we going to ask them to change? Deletain: The ISO is separate. The ISO is much more limited than the AC20-135 today. If we (EASA) are satisfied with the revised AC and it can be adopted for use in Europe. We do not control the ISO committee.

University of Cincinnati Updated Experimental Investigation of the NexGen and Propane Burner – Ryan Hasselbeck (University of Cincinnati)

Ryan provided an update of the work that has been conducted at University of Cincinnati. Two fuel nozzles were used in these tests. Ryan reviewed the 2.5 and 2.0 gallon nozzle – flow rate variation testing results. A side study was done on burner cone age. Summary: the burner performance is highly dependent on fuel flow rate. NexGen and Propane Burner Comparison: three different panel sizes were tested in this comparison work. Photos of the set-up for each size panel were shown. Vertical NexGen burner vs. propane burner comparison: the results were presented. Question: comparison of propane and NexGen burners: what nozzle? Hasselbeck: 2.5 gallon. Davis: comparing the new and the old cones – did you check the thickness? We found that the thicker cone maintains heat. Hasselbeck: I wasn't aware you could use different thicknesses. We will have to compare different thicknesses.

Powerplant Fire Testing at DGA Update – S. Summer (for Serge LeNeve)

Steve reviewed the scope of Serge's work. The Round Robin showed significant differences in test results from Park and Sonic burners. This work compared flame characteristics of both burners and other comparisons. Results: differences in burnthrough times and profiles. Various devices were used for flame characterization: slug thermocouples, K-type thermocouples, and plate thermocouples. This was in an effort to look at new methods to characterize the flame. Specifications and part numbers for the plate thermocouple Serge used were included in the presentation. Summary: flame characterizations were made under conditions representative to the conditions seen by a plate sample submitted to fire. Under these conditions the sonic burner flame is more homogeneous in temperature than the Park burner.

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

FAA requested that SAE develop these standards as a result of CAST Safety Enhancement SE 127. SAE AS 6453 Fire Containment Covers (ISO 14186) SAE AS 6278 Fire Resistant Containers (ISO 19281).

FCCs: SAE AS 6453 published in August 2013. FAA published TSO 203 (published July 2014) references SAE AS6453 standard with modifications. The use of FCCs is not required by the FAA. There is danger of external flaming that would ignite adjacent unprotected cargo or aircraft structure or systems. Fire Resistant Containers (FRCs): FAA requested SAE to develop a standard. ISO/CD 19281 was published in February 2016. SAE Standard AS6278 is under development. Differences exist between the two standards. Dave discussed these differences. The ISO and SAE Standards are diverging instead of converging. ISO/SAE harmonization is desired. FAA unofficial position is that the cargo liner test method should be included in the standard. Original goal of the FAA was to reference the SAE standard in a TSO. Difficulty now arises if the standard has more than one criteria for FRCs. This is the unofficial position of the FAA. FAA Update – TSO-C90: TSO C90 Revision e: scheduled for release in December 2017. Incorporates TSO-C203 FCC and Pallet/Assembly Test Requirements from SAE6453. This depends on the progress of the SAE standards. TSO-C90 Revision f: will be scheduled for release within a year of SAE AS6278 (FRC). The next SAE meeting is in October 2017.

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

FSF Database info was provided. The FSF Report and Database are available on the FAA Fire Safety website. This covers incidents from 2002 to 2012 (14,533 occurrences). The database is searchable. The FAA report number is DOT/FAA/TC-16/49. It is available in the Reports section of the FAA Fire Safety website (www.fire.tc.faa.gov). The database is downloadable.

Class C MPS Testing of Cargo Compartment Halon Replacement Agent – Boris Phillip (for Dhaval Dadia)

Boris provided the background for this work. A diagram of the test set up was shown. There are four test scenarios that must be demonstrated. AOA tested the water mist nitrogen system at the FAATC. A diagram of the system set up was explained. Test Campaign Status: remaining tests will be conducted in September 2017.

Commercial Aviation Safety Team (CAST) – D. Blake (FAATC)

Screen shots from CAST webpage were displayed. CAST members are high-level FAA and industry representatives. Dave explained the organization and procedures. CAST participants have agreed to implement the outcomes of the CST process on a voluntary basis. The objective is to improve safety without the need for the traditional rule making processes. Regulatory guidance material will be needed in some cases. Safety Enhancement 126.3: Cargo - Mitigations for Hazardous Material Fires. Safety Enhancement 223: Cargo – Hazardous Material Fires- Prevention and Mitigation. Safety Enhancement 224 (R&D): Cargo – Hazardous Material Fires –Enhanced Fire Detection

Systems. Safety Enhancement 225 (R&D): Cargo – Hazardous Material Fires – Containment and Suppression. Safety Enhancement 226: Cargo – Hazardous Material Fires – Enhanced Protection of Occupants and Aircraft. Safety Enhancement 127R3.2: Remaining Risk – Cargo – Fire Management (this is what led the FAA to ask SAE to develop the FCC and FRC Standards). CAST recently reported that the efforts to meet risk reduction goals for the cargo area were projected to meet only 50% of the target. FAA has urged SAE to focus on the completion of the standard for the FRC using a Class A fire.

Halon Replacement for Airplane Portable Fire Extinguishers- Progress Report – Mike Madden (Boeing)

Implementation of 2 BTP is officially called Halotron BrX now and available from American Pacific. Mike reviewed the steps to implementation. ICAO Halon handheld replacement date moved from 2016 to 2018. This aligns with EASA CS26 rule. UL approval has been received. Boeing is evaluating each country's chemical registration requirements. Awaiting FAA certification/approval: Boeing proposed compliance to AC20-42D based on UL approval, meeting SAE AS6271. The FAA required an issue paper (IP) to document approval of new fire extinguisher and compliance with toxicity requirements at airplane level. Requires FAA review of FAA MPS seat fire data, UL/MPS data, and EPA data. Chiesa: do you think the 2018 date will be achieved? Madden: yes, our goal is to start putting them on airplanes this year, but it is all up to the FAA now. Future: Boeing and the FAA are working together on Halon replacement lessons learned. Boeing BTP fire extinguisher airplane implementation pending FAA certification. Greiner: Is there any intention in the US to publish something in parallel to the EASA TSO? Madden: I had asked that question to the FAA, and at this time no. There was some discussion regarding toxicity issues. Question: will you continue to offer Halon once 2 BTP received FAA certification? Madden: that will most likely be a customer-driven decision. Chiesa: what is the content of the issue paper you submitted to the FAA? Madden: it touches on everything that is required by the AC. They want to see the data.

Reconsidering Carbon Dioxide as a Nacelle Fire Extinguisher Agent Update – D. Blake (for Doug Ingerson) (FAATC)

Why revisit carbon dioxide? It is an existing fire extinguishing agent with history; past and current use in ground-based systems, and aviation. Doug plans to run the Rev 4 of the MPS and see what data is generated for CO2.

Aircraft Installed Battery Industry Working Group Updates – S. Summer (FAATC)

RTCA SC-225 Rechargeable Lithium Batteries and Battery Systems – committee formed in March 2011. The goal is to merge into a DO-311A document. The first submission was rejected and has now been reworked and resubmitted to the PMC. However, several dissenting opinions were received by members with regards to a full battery thermal runaway test that is included in the document. Work is ongoing to reach an agreement which will address the dissenting opinions, and the group hopes to submit the revised final document to PMC in June 2017.
RTCA SC-235 Non-rechargeable Lithium Batteries and Battery Systems: committee formed in June 2015 to revise RTCA DO-227. This document is in the process of going through the final reviewed with the final meeting scheduled for May 2017.

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

EUROCAE/SAE WG80/AE-7AFC: committee formed in 2008. Short term goal and medium term goal met. Long-Term: Development of detailed specifications for safety assessment and certification of fuel cells on board aircraft. SAE AIR-6464 Aircraft Fuel Cell Safety Guidelines published in June 2013. SAE AS6858 Installation of Fuel Cell Systems in Large Civil Aircraft was published in March 2017.

Energy Supply ARC: formed by FAA to determine appropriate airworthiness standards and guidance, identify hazards and determine design and operational principals to safety against the hazards. ARC was chartered in April 2015. There are five task efforts within this group. Document is nearing completion with the final report to be submitted to the FAA in July 2017. FAATC is looking to do some testing related to Hydrogen within a DFZ.

EASA – Halon Replacement Status – Remi Deletain (EASA)

RMT.0560: Halon: Update of Part 26 to comply with ICAO Standards
RMT.0206: ETSO-2C515 For Halon-free portable fire extinguishers Published August 2016
EASA/DG-CLIMA Discussion – clarification of EC Regulation No. 1005/2009. Remi provided the EASA contacts.

ICCAIA Cargo Compartment Halon Replacement Working Group (CCHRWG) Update – R. Bennett (Boeing)

ICAO working papers provided status on lavex, handheld, propulsion, and cargo halon replacements. Robin provided updates on additional areas of work within this group. The CCHRWG will meet on May 11, 2017.

Engine/APU Halon Replacement Industry Consortium – Halon Alternatives for Aircraft Propulsion (HAAPS) Update – R. Bennett (Boeing) (for Alan Macius – Boeing)

A brief review of mission of this Working Group was given. The Plan is a 3-Phase plan. Phase I is nearing completion. Robin also provided the Overview of Phase II.

History of Cargo Compartment Fire Protection In Transport Aircraft – Batteries – R. Hill (FAATC)

This presentation was originally created for members of the SAE G-27 committee that do not have an aviation background. Dick described cargo compartment fire protection starting in 1965 and going forward including types of cargo compartments, fire protection and detection. Dick described accidents/incidents with cargo compartment fires that led to changes to regulations and categories of cargo compartments.

THURSDAY, MAY 11, 2017

Status of SAE G-27 Lithium Battery Packaging Performance Committee – Doug Ferguson (Co-Chair SAE G-27)

Objective of this Committee: Develop a standard for minimum performance to safely ship lithium batteries as cargo on aircraft. The standard may include packaging design, qualification, test procedures and any other related tasks. Doug outlined the Standards Development Process. The committee is currently working on Step 4: document development and document review and doing development testing. Doug reviewed the work related to 'external fire'. Enzo expressed concern regarding large package of large batteries (too large to allow for the respect of the 0.3 m3 of gas inside the chamber. His concern is how it can be ensured that proper testing is performed. He believes it is a big challenge. Ferguson: we are having some of those same discussions within the G-27.

G-27 Lithium Battery Packaging Committee Tests Update – S. Summer (for Tom Maloney) FAATC

This test program is in support of the SAE G-27 committee work. Test video was shown. Steve described the test set up – Non-Hazardous Flame. This was set up in a horizontal and a vertical configuration. The C0 test set up was also reviewed. Video of this test was shown. The test results were presented. Future work: experiment with #60 cheesecloth to see how closely it matches the ignition time to shrink wrap. Evaluate some additional cell chemistries and alternative configurations as needed. Hill: the C0 test where one set passed and one set failed-they are the same cells just in different states of charge. They were not different cells that were tested. This complicates it.

ICCAIA – Dangerous Goods Achievements and Further Intents – Paul Rohrbach

Paul reviewed what has been addressed. Cargo compartment fire protection: prevention, protection, controlling the fire. Currently, there is no guidance material for the specific air mode limitations. Current Status of the Proposal: ICAO established an annex 6 sub group to develop a safety risk assessment for cargo operations.

EFB Lithium Battery Test – Cyrille Terrier (Airbus)

Objective: to assess global risk acceptability, verify fire-fighting procedure efficiency, to define recommendations for risk prevention. 3 Axes for Risk Prevention were identified. Cyrille outlined the test objectives and procedure. The equipment tested and its location in the aircraft was reviewed (laptops, tablets). Test results were reviewed. Question: what alternative agents did you try? Terrier: Fireban. The same results. Question: did you try a water extinguisher? Terrier: No. Summer: did you do other tests with the EFB in the mounted configuration as it is mounted in flight set up for use? Terrier: this is the docking station where Airbus tests it for certification. Question: do you plan to conduct tests with 2 BTP? Terrier: maybe in the future. I was not aware of this agent until this meeting.

Tablet Fire Extinguishment Testing – S. Summer (FAATC)

Background was given. New materials such as magnesium alloy present concerns in both laptops and tablets: potential for mag-alloy case to ignite. Videos showing differences in thermal runaway in 18650 cylindrical cell vs. polymer cell (both LiCoO2) chemistry) was shown. Battery configuration of each battery type was discussed. There is concern as magnesium-alloy casings have become more and more popular. These can burn at temps up to 5600 degrees F and are extremely difficult to extinguish. The

FAATC Tablet Test Program was described. The extinguishment methods used in the test program were described. General Results were reviewed. We found that the overall philosophy of SAFO 09013 still holds: extinguish the flames and cool the device to prevent propagation. However, based on current testing, some additional guidance could be provided: the most effective cooling is achieved by ensuring the liquid gets inside the device. This may require discharging liquids into any opening formed by the separation of the screen from the unit. Chiesa: will the SAFO be revised? Summer: we are currently working on the best steps forward to get the information out there. There is a group with FAATC and FAA Flight Standards to determine how to handle this, what information to provide, etc. Davis: was there any look at the conductivity of the fluids you were using to cool the tablets? Summer: We were just using straight water. We didn't look at other liquids. Davis: I was wondering if other liquids had been looked at such as tomato juice which might short out the other cells.

Overhead Bin Tests – S. Summer (FAATC)

This is work that Tom Maloney has done. A hazard was identified for potential thermal runaway of lithium batteries in overhead bins. Tests were conducted to qualify the risk of an overhead bin fire with 100Wh batteries. The test set up was described. Results: propagation was difficult to stop with cells that were fully enclosed: the cells burnt a hole in the plastic in one of the tests making access with water easier. In some cases, opening the overhead bin door may be hazardous due to the potential of a cell venting or exploding in someone's face. Future work: conduct tests in FAATC Fire Safety 737 aircraft: multiple 100Wh packs in series. Hill: airlines have been recently installing portable wi-fi, etc., and using the allowance for passengers (what passengers are allowed to bring on board).

Overheat and Overcharge: Thermal Runaway Vent Gas Analysis of Lithium Manganese Oxide Cells – R. Hill (for Matt Karp)

Dick reviewed the scope of testing, test set up, test equipment, and results. Photos of tests conducted with battery in holder, no holder, and in holder but not restricting the venting.

Heat Rate and Vent Gas: Thermal Runaway Vent Gas Analysis of 18650 Cells at Various Heat Rates – R. Hill (for Matt Karp)

Dick reviewed the scope of the tests, test set up, test equipment, and results. These tests were also conducted in a pressure vessel. Theory: the slower heating rate allows more time for the electrolyte inside the cell to boil to vent.

Heat Rate and Vent Gas: Thermal Runaway Vent Gas Analysis of 18650 Cells at Various Heat Rates – R. Hill (for Matt Karp)

Dick reviewed the scope of the tests, test set up, test equipment, and results. These tests were conducted in a pressure vessel.

All of these indicate it is difficult to create a standard to cover a range of types of cells.

Draft External Fire Packaging Test for the Transport of Lithium Batteries as Cargo on Aircraft– R. Hill (FAATC)

For this standard, we are focusing on the Class C cargo compartment for this standard and what the hazards could be.

Working Group Member Presentations:

Aviator UL Smoke Generator – Trevor Dunnington (Concept Engineering)

P3 Group's 2BTP Halon-free Fire Extinguisher Product Development & Market Situation – Joachim Scholz (P3 Group)

The Working Group member presentations are included with the Meeting Presentations on the FAA Fire Safety website at www.fire.tc.faa.gov on the Systems Page.