INTERNATIONAL AIRCRAFT SYSTEMS FIRE PROTECTION FORUM MEETING

Hosted by FAA Technical Center Fire Safety Branch at Resorts, Atlantic City, New Jersey, USA

October 31-November 1, 2018

WEDNESDAY, OCTOBER 31, 2018

International Halon Replacement Update Decision XXIX/8 – Dan Verdonik (Jensen Hughes)

ICAO Informal Working Group was formed in 2018. This group developed a questionnaire related to halon 1301 servicing of civil aviation bottles. 53 questionnaires were received, 33 confirmed servicing halon 1301 bottles. Unfortunately, we did not get a lot of responses. The Working Group recognized that a number of major service companies did not respond – some only provided data from one facility and not companywide. HTOC estimates 37,750 metric tons of halon 1301 available globally at the end of 2018 – Japan maintains 16,250 metric tons and it will not be available outside Japan, so there are about 21,500 metric tons potentially available for civil aviation. The Working Group estimated emissions and run-out date. Dan explained these estimates and how they were calculated. Based on the run-out dates of 2032-2054 and aircraft lifetimes of 40 years, it is now highly likely that civil aviation is producing aircraft that cannot be sustained with the available supplies of halon 1301. Q: you are factoring annual non-aviation emission rates. It looks like you are starting with aviation and then factoring in non-aviation uses. Verdonik: it does include some non-aviation uses.

Proof of Concept Testing – Cargo Halon Replacement – D. Dadia (FAATC)

EASA cutoff date for cargo halon replacement agent in a new design aircraft is 2018. Review of aerosol can simulator was given: Simulator is heated to 240 psi. The contents are then discharged rapidly across the ignitors. The test procedure was described. Dhaval presented videos of the aerosol can simulator tests conducted at FAATC. Test results chart was presented. Summary: minimum inerting concentration established to be 10% (by volume). Cargo MPS tests to be conducted in December.

21L Pressure Vessel – conducting testing in a 21L pressure vessel with said agent to establish an easier proof of concept testing setup and quicker turnaround. Simulated aerosol can with propane. Photo of test article was shown. Results of these tests were shown. Summary: used propane to develop a bench scale proof of concept test. Need to conduct more tests in this vessel in the future. Q: what's the agent? Dadia: I cannot mention what the agent is at this time. We may be able to in the future. Q: how long did you let the agent circulate in the pressure vessel? Dadia: it varied from 2 minutes up to 5 to 10 minutes. It still remained well mixed.

Rebuild of the Cargo MPS Test Article – D. Dadia (FAATC)

Background: cargo MPS test method article developed a lot of natural leaks from repeated fire tests. We opted to reskin the article and add more framework to the structure. Photos of the completed rebuild were shown. Specs of test article were provided.

Cargo MPS Task Group – D. Dadia (FAATC)

Several questions and concerns regarding certain specifications in the MPS materialized during the cargo MPS rebuild. Dhaval reviewed these concerns. Task Group meeting will be held October 31 after conclusion of main Systems Forum meeting. Q: will the task group also deal with more global things like the challenge fire test or will there be a task group to look at that? Dadia: we can discuss that in the task group to determine if we want to include it in the MPS or not.

Engine Nacelle Halon Replacement – Overview and Update – D. Ingerson (FAATC)

Working draft of MPSHRe Rev04 is available on the FAA Fire Safety website (www.fire.tc.faa.gov). Outcomes of candidates for nacelle halon replacement testing were discussed. HFC-125, CF3I, and 2-BTP were reviewed in more detail. FAATC is still intending to complete CO2 testing. FAATC supported US Army preliminary investigation, potential low-GWP halon replacement candidates in August 2018.

EASA Rulemaking Activities – Enzo Canari and Remi Deletain (EASA)

Halon Replacement Issues: DG-CLIMA maintains 2018 as cut off date for cargo compartment. Halon Guide (DG-CLIMA/EASA) is in preparation. The guide will be published on EASA and DG-CLIMA websites. Target release of the guide is Q1 2019.

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

EASA Proposed Certification Memorandum on Smoke Propagation Testing: purpose is to provide specific clarification and additional guidance regarding certification testing to be conducted to evaluate the entry of hazardous quantities of smoke into compartments occupied by the crew or passengers as a result of an in-flight fire event in the pressurized areas of the fuselage of a large airplane. Further coordination with the FAA is need in order to purpose a policy that is fully harmonized. Goal is to publish in Q1 2019.

(EACWG)Engine Aircraft Certification Working Group – Remi Deletain (EASA)

EACWG established Feb-March 2016 by EASA and FAA leadership to look at improving engine/aircraft interface certification practices. The final report is available on the EASA website. The group continues to work on a more formal setting and establishment of activities. Fire is one item identified in R4 (Item 4.6). The SAE A-22 group is proposed revision of AC-20-135. Cortina: has anyone requested derogation yet for any of the halon requirements in Europe? Deletain: yes, it is a new applicant. Q: are there draft papers for powerplant? Deletain: there are some topics already in the works. Beginning of 2019 you will see two topics from EASA. Hariram: who is handling emissions on the ground? Deletain: a team at EASA is working on these.

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

Recent CCHRAG Developments: ICAO May 2017 memo – CCHRAG sent questionnaire to all stakholders for interest in participating in Technical Assessment of potential solutions. By June there were 9 interested respondents. 8 participants provided 9 potential halon replacement solutions in their responses. Most of these technologies have not been tested to MPS or approved via US EPA's SNAP. Robin reviewed the Technical Assessment Criteria Categories. A Technical Assessment Draft Executive Summary Report is under development by the CCHRAG. It will keep the respondents anonymous. Next Steps: CCHRAG will continue evaluation and coordination with Technical Assessment Participants. Final report to be provided at the ICAO 40th General Assembly.

Engine/APU Halon Replacement Industry Consortium – Halon Alternatives for Aircraft Propulsion (HAAPS) Update – Daniel Escamilla (Bombardier)

Daniel reviewed the HAAPS Charter and Statement of Work. Phase I completed: Primary working agreements signed June 2018 by Airbus, Boeing, Bombardier, Embraer, Textron, and Ohio Aerospace Institute. Phase II – Development of Technical Statement of Work is in progress. The HAAPS organization was outlined. HAAPS Critical Milestones were reviewed.

SAE/ISO Standards on Fire Containment Covers and Fire Resistant Containers – Jamie Lessard (FAA)

TSO-C90e ULDs release within 6 months after release of AS6278/1. An Advisory Circular will be written in 2019 referencing ARP6905. Commercial Aviation Safety Team (CAST) – CAST granted an extension (December 2019) for the release of TSO-C90e. Safety Enhancement SE127 tracks the progress of AS6278/1.

Smoke Generator Standardization and the Effects of Varying Environments – M. Karp (FAATC)

Matt outlined some of the questions under consideration and described the altitude chamber used at FAATC. The test apparatus was described. Concept Aviator UL and the Siemens Cerberus smoke generators were used for this test series. The results from these two smoke generators were presented. The Scanning Mobility Particle Sizer (SMPS) was used in this test series. Theory Light Scattering – Mie Scattering Theory. We used the Smoke Generator Standardization Apparatus (SGSA) – photo shown. There is a positive correlation between SMPS particle size and SGSA Blue signal after grouping the data points by the test environment and start time of data collection. Answers to pre-testing questions were reviewed including what parameters should be considered while creating a smoke generator standard: smoke density, particle size, smoke plume buoyancy, test compartment volume. Hariram: did you discuss ventilation of the cargo compartment and its effects? Karp: it is an enclosed compartment with no airflow. We are just starting out. Hariram: are you going to come up with a matrix to ensure everyone uses the same standard? Karp: I would like to keep it as simple as possible. We can consider it. Hariram: I'm looking for type of standardization that everyone uses so that if you don't have certain temperature, etc., you don't test. Q: what is this smoke made of. Karp: paraffin smoke. Q: theatrical smoke? Karp: yes. Ferguson: is it the air temperature of the oil temperature that is important? Q: did you turn the generator on and then off and measure the concentration or keep the generator on for the whole test? Karp: one of the smoke generators we used has preset programs for smoke generation. Q: you are producing theatrical smoke? Karp: yes. Q: most fires I have seen are heavy particulate smoke. Karp: you need the smoke movement and obscuration to be similar to real smoke without the toxic hazards.

Fire Detection in Aircraft Applications – Selena Chin (University of Maryland)

Selena provided the background of her research. Questions she addressed in her research: Does smoke density scale across different volumes? Experimental test setup was described and tests conducted were described. Results of these tests were presented. Conclusions; small scale smoke density testing is strongly correlated with large scale testing. Future work: nuisance source testing would be helpful with the new technology. Also, hidden spaces and wireless detectors.

Smoke Detector Response Time Comparison to Artificial Smoke Sources – André Freiling (Airbus)

André reviewed background for this work and brief review of work prior to this test series. One possible way to the reference was presented. The transition point from smoldering to flaming should be used – with an agreed and justified scenario and margin – to estimate the smoke density reference. Summary: multisensory smoke detectors respond differently to artificial smoke. This might represent a challenge for certification testing. The Siemens smoke generator is generally useable to certify multisensory smoke detectors. Next steps: validation of calibration methodology, comparative data gathering for aviator smoke generator, agreement on reference smoke amount and properties, and eventual flight tests. Hariram: you have a very good point on open flame detection. You can convert that into smoke and find out equivalency.

Next Generation Fire Test Burner for Powerplant Fire Testing Applications - T. Salter (FAATC)

Background: currently specified oil burners are no longer commercially available. Current Status/Plan was reviewed. Thermocouple Round Robin details were outlined. Composite Material Evaluation (Spirit Aero) details of this testing will be provided by Spirit Aero during the SAE A22 meeting on November 1, 2018.

SAE A-22 and AC20-135 Revision – Overview – Phil Dang (Honeywell), John Ostic (Boeing), Scott Johnson (FAA), Mike Dostert (FAA)

The group reviewed the top 10 industry team issues, current FAA/EASA/TCCA/industry group efforts and new focus since May 2018 kick-off meeting. AC20-135 sections and SAE-A22 Fire Test Specification Proposal. Schedule of deliverables. The objectives of this committee were highlighted. Document(s) for final SAE balloting approval June to December 2019. FAA revision to AC20-135 to reflect SAE document(s) May 2020-December 2020. Next Generation burner post December 2020.

Carlin Burner/Sonic Burner Comparison – Simon Hind (NRC Canada) and Mary Kelly (Resonate Labs)

Mary described the test set-up and thermocouples used in this test program. Carlin 200 CRD burner used in testing. Sonic burner FAA (existing) used in comparative tests. Plots from the test temperature meter were shown. They are representative plots of some of the data. Calibration data for Carlin and sonic burner was presented. Summary of the burnthrough data was reviewed. We see the variability in the Carlin burner data – factors: air P, density, temperature. Hariram: do you think the temperature difference at two different times is the density of fuel? Hind: I think that is a good point but it may only tell part of the story. Hariram: pre-test heat flux and post-test heat flux – sonic burner takes a longer time than the Carlin, will it be fixed by having a stabilization time. Hill: the problem with the standard oil burners is the mass flow of air changes. It is a fan that is giving you your air, if the electric current changes, it changes, if the barometric pressure changes, it changes. The sonic burner has a sonic choke. You could have a sonic burner that is similar to the Carlin burner and replace your fan with a sonic choke. The whole idea of the sonic burner is to get a constant mass flow of air. Hind: I think the configuration of the sonic burner that Steve Summer has used most recently is similar to the configuration of the sonic burner in Chapter 7 of the Aircraft Materials Fire Test Handbook.

High-Energy Fire Training Enhancement Workgroup (HEFTE WG) – Candace Kolander, H.G. Bombardi (Airline Pilots Assoc. International - ALPA)

Background that led to establishment of this Workgroup. HEFTE scope of work: recommend updates/improvements to current training and guidance around response to high energy fires that can occur in occupied areas of the aircraft. Candace reviewed the recommendations from this group's work. Containment Products – several items to be addressed here.

Smoke in the flightdeck – H.G. Bombardi (ALPA)

Electronic Flight Bag (EFB) use is more prevalent now. We have concerns about the cabin and the flightdeck. HEF (high energy fires) have potential for dense smoke and release of toxic vapors need to be addressed. AC 25-9A limits entry of SFG to reflect current concerns of volume and toxicity. Are there other pieces of equipment besides PBEs that can be used when there is a HEF. More realistic tested requested.

Conclusion – Candace Kolander (ALPA)

Work together to address this current and emerging threats: updating the guidance and training material; developing performance standards for products; ensuring adequate equipment onboard to fight the threat; updating design standards to mitigate smoke, fumes, and noxious gases out of the flightdeck. Q; did you have medical personal on the committee? Kolander: we did not allow any vendors, we did not have medical representatives. We had SMEs from the FAA. Kolander: the document does talk about lithium battery fire smoke and toxic hazards.

THURSDAY, NOVEMBER 1, 2018

Smoke Transport Modeling for Cargo Bays – Parametric Study - Vaidya Sankaran (Kidde/UTRC)

Objective: develop a model-base too to augment and streamline certification process. Design – Simulation Tool: Fire Dynamics Simulator: 3-D unsteady, solver, Large Eddy Simulation (LES): low Mach with Direct Poisson equation solver for pressure. Vaidya presented results from Baseline Case 1: Smoke Gen A, Baseline Case 2: Smoke Gen A Temp and Smoke Gen B Velocity, Baseline Case 3: Smoke Generator B. Baseline vs. Higher T Smoke Gen: Case 1: Baseline Smoke Gen A and Case 3: Smoke Gen B. Case 4: inflight condition:

Smoke Generator A at inflight ambient conditions, Case 5: smoke generator A at STP with ventilation. Summary and Next Steps: smoke transport simulation capture the effect of different smoke generators, modeling capability to simulate real-scale cargo bay with varied input conditions: approximately 20-30 cases/conditions/designs can be simulated in a week. Next Step: we are acquiring data to validate transport/detector models for the cargo bay. Hariram: is the model proprietary to Kidde? Sankaran: yes, it is. Hill: can you put cargo in the cargo compartment and run the model? Sankaran: yes, we can do that. If needed, we can simulate a fire as well.

Development of Flexible Meshing Capability in Fire Dynamics Simulator (FDS) to Better Model Smoke and Heat Movement Around Curved Surfaces in Aircraft Cabins – Haiqing Guo (C-Far)

FDS was used to simulate the heat transport in the aircraft cabin overhead area with very complex curved surfaces. Reasonable agreements were found between the measured and simulated ceiling temperature. FDS uses rectangular cell mesh size for fast calculation. For more complicated geometry, small cell size is preferred, which requires much longer computations. Haiqing reviewed the tests conducted last year for the cabin overhead. Results of this year's modeling test with the flexible meshing were presented. Summary: a seleted section of the cabin overhead area in the Boeing 747-SP is investigated. CFD simulation with flexible geometry is performed and the simulation results are compared with tests. Future smoke density measurement could be performed to validate.

If we want to model the smoke transport in the whole area or aircraft, that is totally doable.

Hydrogen Fire Testing – S. Summer (FAATC)

Motivation for this work: Aviation industry is pursuing efforts to install hydrogen fuel cells on aircraft for a number of potential operations, such as the main battery, ram air turbine, APU, galley power, etc. FAA has been involved in FAA Energy Supply ARC and EUROCAE/SAE WG80/AE-7AFC committee. Several areas of hydrogen research have been identified by these committees. Current testing: look into kerosene based burner to replicate the fire threat. Tests conducted using 8 mm nozzle and .3 mm nozzle. Intent is to demonstrate a components capability under a fire condition that is likely to occur. Steve described the test proposal submitted to FAATC. FAATC test setup photos were shown. Flame temperature measurements were taken – graphs of these were shown. Heat fluxes were calculated from copper slug calorimeters. 2024 aluminum panel burnthrough times and average heat flux from copper slugs results were shown. Images of the burnthrough aluminum test specimen. Discussion/summary: H2 fires show dramatically increase heat flux compared to oil burner flame, though lower flame temps. In some conditions we were unable to achieve burnthrough up to 15-minute cut-off. Nozzle size affects burnthrough times, size and intensity. Effect of reduced ambient pressure is unknown. Maloney: is there any concern about the build-up of hydrogen? Summer: primary mitigation methods are leak detection and ventilation. Gardlin: this is all with ambient air, right? Are you going to look at oxygen enriched air? Summer: we have not tested with oxygen rich environment yet, but we could. Although a lot of the systems being proposed are with ambient air. Q: are you considering any tests with a horizontal plate and vertical flame? Summer: we could look into that. Q: what is emissivity of hydrogen flame? Summer: I will have to go back and take a look at that.

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

Doug gave background on formation of this committee. AS6413 performance based package standard for lithium batteries. He highlighted some key parts of the AS 6413 standard and its development process. G-27 currently has about 280 members. Future action: There is a requirement for some type of validation testing of standard in multiple facilities. G-27 open issues were reviewed. Background on why we were looking at a specific quantity of vapor: We were trying to figure out what would be a hazardous quantity at the aircraft level. The flammable vapor if ignited would create an overpressure. In the cargo compartment there are decompression panels, so the hazard of gas getting out and reigniting the flammable vapor, the hazard is that it may open the decompression panel and you no longer have a controlled situation. Q: assumption that it is a

single cell event, during transportation impact and vibration is a big issue to make cells unstable and may create a multiple cell reaction (run into pallet with forklift truck, etc.). Ferguson: the issue of vibration while batteries are being transported is not being addressed by this committee. Q: there are types of cells that are different explosive events. You have to make sure you address those. Ferguson: there has been a lot of discussion on types of cells, structure of cells, types of construction of cells, etc. The initial philosophy is to create a performance based standard. Rooney: the issue of impact vibration are taken into account in the original UN test. It is quite possible that the UN are going to have to include a test for thermal runaway.

Ducting of Battery Gasses and Particles – T. Maloney (FAATC)

Photo of test setup was shown and test was described. Tom outlined some observations made while conducting this series of tests. Q: did you consider something like a torturous path for the particles instead of different ducts lengths/diameters? Maloney: no, we haven't looked into that. We wanted to focus on one setup to find out if there are any problems before we came up with other setups. Q: did you clean the duct between tests? Maloney: no, we did not. We did change the cheesecloth. Q: what type of cells? Maloney: lithium cobalt at an equal charge. Chattaway: is the intention to make a duct that makes no change?

UL STP5800 Standard for Battery Fire Containment Products – H. Webster (FAATC)

UL has been tasked with developing a standard for battery containment products. They will be used on board when a PED goes into thermal runaway. Until now, there has been no set standard for the performance of these products. The charter for this panel was reviewed. This panel will develop a standard for testing PED fire containment bags and devices. This is a joint U.S. and Canadian venture. To date, there has been one meeting of this panel. The standard will not cover deployment of the device or the human interface with the device. The next meeting will be held in March-April 2019. Ferguson: how does the thought on having a standard that does not incorporate how to use it? Webster: that's the interesting part of picking UL to do this. UL does not get involved with how the device is put into service. Q: all these bags that I have seen do not allow for venting. To vent, you are obviously allowing smoke into the cabin environment. Webster: ultimately, the airlines would like something that keeps them from having to divert the flight. There is a lot that needs to be done in this standard to make it useful and safe. I encourage anyone who is interested to join the panel. It is open to anyone who is interested. UL contact person available in PPT presentation. Q: how will standard effect those bags that are already installed? Webster: that's really up to the airline to decide what they are going to do with those bags. Blake: do you know how the decision was made to go to UL for this? Webster: the airlines went to UL.

Next Meeting:

May 14-15, 2019
EASA Headquarters
Konrad-Adenauer-Ufer 3
D-50668 Cologne, Germany