INTERNTAIONAL AIRCRAFT SYSTEMS FIRE PROTECTION WORKING GROUP MEETING

Hosted by the FAA Technical Center at Trump Taj Mahal, Atlantic City, New Jersey

November 19-20, 2008

WEDNESDAY, NOVEMBER 19, 2008

Fuel Cell Flammability – H. Webster

Harry is investigating flammability assessment of fuel cell cartridges. We are currently looking into the potential hazards of the various types of fuels and fuel cells. FAA concerns are in-flight use, carry on luggage, checked baggage, and bulk shipment. Fuels FAATC will be investigating: methanol, formic acid, borohydride, butane, hydrogen stored in metal hydrides. First test article was supplied by Metis 24/7 Power Pack (fuel: sodium/potassium borohydride and potassium hydroxide, and water enclosed in a plastic case. Next unit provided by Ultracell – it is a fuel cartridge that contains 2/3 methanol and 1/3 water enclosed in metal with plastic hardware. Test results were presented. Next unit provided by Protonex C720 fuel cell cartridge, fuel type sodium hydroxide, sodium borohydride, enclosed in a plastic case. Next unit: Jadoo Power Systems Type C5 fuel cell cartridge, fuel type: hydrogen in a metal hydride in a metal enclosure. Keep in mind that some of these fuel cells are prototypes and not available commercially at the present time. Next unit from Tekion, small unit approximately the size of an ink cartridge, fuel: formic acid, enclosed in plastic. Next unit by Angstrom: very small unit designed to directly power cell phones, fuel cartridge, hydrogen in a metal matrix, metal enclosure with plastic coating. Next unit: Lilliputian Systems: fuel cartridge filled with butane, plastic enclosure at 45 seconds into test the contents container released and ignited. Fuel that Millenium cell will be using to power their fuel cells was tested next. Additional work planned: flammability tests will be conducted on different technologies as production units become available.

Aircraft Lithium-Ion Battery Testing – S. Summer

Report #DOT/FAA/AR-04/26 and D"OT/FAA/AR-06/38 (FAATC Background – previous test program reports).

The potential hazards of lithium-ion batteries will be examined. Initial testing is designed to examine performance of individual battery cells. Further testing will be conducted to look into the full battery systems. Batteries from three different battery manufacturers were tested: 2 different cylindrical lithium-ion batteries and a lithium-polymer battery. 64 cubic foot chamber was used for testing. A description of test set-up was provided. Video of the tests conducted was shown. Steve explained the results of these tests. Next test looked into external short circuit of batteries. Test results: no ignition or venting event occurred. Next test: Pressure Pulse Tests were conducted. Results were reviewed. Next test: auto ignition test. Results of these tests were reviewed. Halon 1211 Handheld suppression tests were conducted for the three types of batteries. Steve reviewed the results of these tests. Question regarding stratification of the Halon or concentration of Halon in test chamber. Harry described observations from previous tests where some Halon stratification was observed.. Next phase of testing will include full system cell packaging, etc.

Dave gave a brief description of the previous work Harry Webster did with laptop battery testing and the video availability on the FAA Fire Safety website.

In-flight Fire Fighting Video – D. Blake

Dave provided the background for the production of this video including several incidents of in-flight fires where very little actions were taken by the cabin crew. The second version of the video was shown. This version incorporated comments from some other aviation authorities. This video was shown to attendees. Dave indicated that this video should be available for download on the FAA Fire Safety website in approximately 3-4 weeks.

Engine Nacelle Halon Replacement – D. Ingerson

MPS for Nacelle and APU revision 03, recent task group activity, and recent test activity were discussed. The Task Group met November 2, 2007, and November 18, 2008. Principal outcomes (2007 TG meeting): remove halon 1301 use from MPSe, replace halon 1301 with a surrogate gas, HFC-125, consider other means to quantify fire extinguishing agents. Outcomes TG meeting 2008: Updated verbally (information not available at time of Systems meeting). Revision 04 is next. Doug explained the items that will remain from MPSe rev03 and the planned changes/adjustments/edits/additions for MPSe rev04.

International Environmental Update – T. Cortina (Alcalde-Fay)

Tom briefly reviewed related areas of Kyoto Protocol including major issues long-term and mid-term targets, sectoral approaches, developing country participation/funding, deforestation, and binding commitments. Agreement on post-2012 treaty more likely in 2010 than 2009 – new US President. "Bali roadmap" calls for negotiating new post-2012 climate treaty (second budget period) by COP 15 in December 2009.

Kyoto Protocol – Aviation: GHG emissions from aviation are about 3.5% of global GHG emissions and have grown about 65% from 1990-2005. GHG emissions from aviation are not currently covered by the Kyoto Protocol, but are handled by ICAO. Proposals by EU, Argentina, Norway to include aviation in Kyoto Protocol. Proposal to add new compounds to Kyoto Protocol or its successor.

Europe: EU emissions trading scheme (ETS) is now in second phase (2008-2012), covers 10,500 facilities in 27 EU countries, covered facilities have a cap on CO2 emissions and can sell or purchase additional allowances, National Allocations Plan (NAP) are mostly complete for second phase, allowance price is currently about 17 euros a ton, down from 29 euros on July 1.

Europe – Aviation: an agreement was reached in October on inclusion of aviation in EU ETS starting 2012, covers all airlines flying in and out of EU airports, likely to affect at least 87 major airlines, 35 of which are headquartered outside the EU, 2012 emissions cap = 97% of average 2004-06 EU emissions, proposed cap of 95% for 2013 and beyond still under discussion.
United States: legislation to create Federal GHG regulation likely to pass Congress in 2009 or 2010, most of the current proposals have targets in the range of 5-20% below 2005 levels in 2020 and 60-80% below 2005 levels in 2050, all of the current proposals create an economy-wide cap-and-trade program covering about 85% of US GHG emissions, most are hybrid of upstream and downstream approaches. Trend in newer bills is to auction the majority of allowances, current bills do not cover aviation emissions directly but instead regulate transportation fuels at point of production, if Congress does not act in a timely fashion, possibility that new administration may move to regulate specific sectors like utilities under the existing Clean Air Act.
United States – HFCs: Current proposals cover HFCs at the point of production, which means that users would not need allowances for HFC emissions, some of the bills create a separate HFC cap-and-trade program and include an excise tax, HFC reduction schedules based on new low-GWP

refrigerants and are intended to provide an adequate supply of HFCs, House discussion draft includes exemption for HFCs in aviation safety.

Impact on Halons: Ozone-depleting substances like CFCs and halons have high GWPs, similar or higher than the HFCs that have replaced them (Halon 1301 = 7,140, Halon 1211 = 1,890, HFC-125 = 3,500). Providing GHG credits for destruction of ODS is already allowed on the Chicago Climate Exchange (CCX) and could be included in a future US regulation or international climate treaty. The cost of recycled halon is the US is currently in the range of $15 per pound which is = approximately $33,000 per metric ton (this is an approximation only). IF GHG credits are priced at $20 a ton of CO2 equivalent, a ton of Halon 1301 would be worth $142,800 to destroy (again, an approximation).

EU ODS Regulations: No change to halon critical use list but EC chaired regulatory committee given authority to change the list and/or set time limits, DG Environmental proposal contains the following end dates for aviation critical uses: Cargo compartment fixed systems – cannot be installed on new aircraft after 2015, end of critical use exemption is 2030, cabin/crew compartment portables – 2010, 2015, engine nacelles and APU – 2010, 2030, lavatory (potty bottles) – 2008, 2015, dry bays 2010, 2030, inert fuel tanks 2008, 2030. These are proposed regulations only at this time. Exports of products containing or relying on halons would be allowed as long as the halons are intended for one of the critical use listed in the regulation, exports of recovered, recycled, or reclaimed halon stored in transportation or storage containers is allowed beyond 2009.

Update on Ozone and Climate Protection Activities – B. Maranion (U.S. EPA)

Why is recovery of the ozone layer important? It is a critical shield from overexposure to UVB, skin damage, eye damage (cataracts), suppressed immune system, crop damage, stress on marine ecosystems. Accomplishments of Montreal Protocol to date: 191 countries have national regulations to reduce emissions to the ozone layer, ozone layer is on track to heal (over many years), Protocol is an important framework for addressing global environmental problem: measurable goals/actions for achieving success, sound scientific basis, technical expertise, support for developing countries. 2007 – 19th Meeting of Parties accelerated Class II, HCFC phasedown: global benefits: 47% cut in HCFC production/consumption; for ozone layer: about 1 million ODP tons averted, UNEP Ozone Awards, US EPA Best-of-the-Best award program.

EPA Stratospheric Ozone Protection Report of 2007 – EPA-430-R-07-001 published April 2007.

A summary of the US Halon Activities from the 1994 ban on production and import: SNAP through emerging issues: bank management, imports and carbon credits for destruction was discussed.

2006 UNEP HTOC Assessment - Report: Halon Inventory – Halon production for fire protection (only China and South Korea – 1301). Adequate global stocks of 1211/1301 to meet existing critical use fire equipment until end of useful lives, uncertainty in future market availability. Report: Civil Aviation: alternative methods used on ground-based situations, existing civil aircraft and new designs continue to depend on halons.

ICAO Resolution A36-12: agrees with the urgency of the need to develop and implement halon replacements for civil aviation. Requests that the Council consider a mandate to be effective in the 2014 timeframe for the replacement of halon in handheld extinguishers for new production aircraft; encourages ICAO to continue collaboration with the International Aircraft Systems Fire Protection Working Group and the United Nations Environmental Programme's (UNEP) Ozone Secretariat through its Technology and Economic Assessment Panel's Halons Technical Options Committee on the topic of halon replacement for civil aviation, and resolves that the Council shall report to the next Ordinary Session of the Assembly on progress made with halon replacements in civil aviation.

ICAO State Letter on Halons: On March 28, 2008, issued a letter to all member States. On May 19, 2008: "Civil Aviation Halon Transition Team" received EPA award.

Handheld Advisory Circular Update – L. Speitel

NOTE: This AC is under rulemaking, so it cannot be discussed under exparte communications or release a draft version of the AC at this time, but Louise will discuss recent data and work.

Updated Data was explained.

Cargo Fire Suppression by Depressurization Tests – R. Hill (work by Mike Burns/Frank Hahn)

FAATC conducted tests to look at the effect of depressurization in controlling a fire in an aircraft. Dick described the pressure vessel test chamber and the test set-up (schematic presented). Chart of PMMA burn rate cm/sec starting at sea level to 26,000 ft altitude. Chart: Jet A Mass Loss vs. Altitude. Lithium-ion batteries were also tested in this program. Cargo fires were also conducted in altitude chamber test apparatus.

Integrated Fire Protection Systems – Update – R. Cherry (RGW Cherry & Associates)

Overview of Concept of Integrated Fire Protection System. Ray reviewed the results of Cargo Compartment Water Mist/NEA System analysis. Cabin Water Mist Systems Concept overview. Hidden Areas Fire Suppression Systems concept overview. Equipment Bay Fire Suppression System is still in process. IFP Task Group & Compendium: The Task Group has composed a compendium for Transport Canada summarizes: Relevant Airworthiness Requirements, Proposed Reliability Targets, Proposed Standard Requirements, Other Issues: MPS, Crashworthiness, Fireworthiness, Health and Safety, etc.

Cabin Crew Fire Training Needs Analysis – R. Cherry (RGW Cherry & Associates)

Objectives: to evaluate current and possible future issues and identify potential improvements in existing fire training and ensure that training programs match current and future fire threats. The project structure was explained. Review of Current Fire Training Programs: 8 UK and 2 European operators and training organizations were observed/evaluated. Over 2,500 questionnaires were completed of which 2,164 were analyzed. Of the UK respondents, 9% had experienced an in-flight fire. Summary of questionnaire responses was presented. Fire Protection Training in Non-Civil Aviation Environments was also evaluated: Royal Air Force, Royal Navy and Eurostar. Identification of Cain Fire Threats: 316 fire-related UK Mandatory Occurrence Reports were analyzed (similar to US Service Difficulty Reports). Future in-flight threats were identified by brainstorming with Airworthiness Authority Fire and Cabin Safety Specialists supported by literature searches. It was agreed that an EASA Regulatory Impact Assessment approach would be used since a cost-benefit analysis was not feasible. Identification of Potential Improvements: fire extinguishers used in training, PBE used in training not representative of what is on the actual aircraft, fires more representative of actual fires, smoke more representative of actual smoke in-flight, standards for fire and smoke training facilities, standards for fire training instructors, evaluation criteria in practical fire and smoke training, fire prevention measures (theoretical), communication/coordination with flight crew (theoretical and practical), communication/coordination among cabin crew members (practical), detecting and locating source of smoke and fire (theoretical and practical), dealing with hidden fires (theoretical and practical), removing firefighting equipment from storage (difficulty of removing this equipment), removing PBE from packaging. Recommendations were made to generate regulatory material addressing: fire scenarios, firefighting using protective equipment, theoretical training in conversion & differences training and

recurrent training, regulation of training provided by third-party training organizations. The UK CAA will be publishing the Training Needs Paper in the near future. The UK CAA will arrange a Fire Training Instructors Workshop/Forum. The UK CAA will consider the need for regulatory or advisory changes.

Class E Cargo Compartment Smoke Detection and Active ULD Testing – D. Blake

Mainly detection times in empty compartments vs. loaded compartments. UPS DC-8 Feb. 7, 2006, fire Philadelphia, PA, USA, led to NTSB recommendations. This test program supports these recommendations. Dave showed photos of remains of this freighter aircraft. These tests relate NTSB Recommendation A-07-98. Overhead view (schematic) of palette positions and smoke detection system intake ports. The test article was the TC-727 test aircraft at the FAATC. Dave presented a chart showing results of these tests. The next phase of this project will look at the Lower Deck container empty and fully loaded. We have been asked to look at "active" LD-3 containers and how they affect smoke detection times.

A Cost-Benefit Analysis for the Installation of Fire Suppression Systems in Cargo Compartments in Freighter Aircraft – R. Cherry (RGW Cherry & Associates)

Based on the NTSB Recommendation A-07-88. Analysis carried out for aircraft types grouped into weight categories: B, C, D, and E. The final results of this cost-benefit analysis cannot be presented at this time, but the report is currently undergoing FAA review for possible future publication. Cost per accident based on: crew injuries (fatal and serious) and damage incurred to the aircraft and cargo, ground collateral damage (property and ground personnel). Average cargo value per flight for US Cargo Fleet in 2007 was estimated for each weight category (B, C, D, and E). The accidents were categorized into controlled and uncontrolled freighter fires for this analysis. Ray explained what the cost assessments were based on.

THURSDAY, NOVEMBER 20, 2008

Composite and Aluminum Wing Tank Flammability Comparison Testing – S. Summer

Wing Tank Flammability Parameters: flammability drivers on ground and flammability drivers in flight. These concepts were observed during previous testing and reported on recently (see Report #DOT/FAA/AR-08/8). The objective is to now compare flammability progression a wing fuel tank test article with both aluminum and composite wing tank. Steve described the test apparatus and test article design and set-up. Results – scale tank in altitude chamber were reviewed. The tests conducted in the airflow induction test facility were described and results were shown. Planned work includes some cold weather tests with aluminum tank will be conducted during fall/winter months and composite panels will be painted a white/grey color to examine change in heat rejection (first examine effects in lab comparing temperature effects of painted to unpainted panel). Other planned work includes: A6 composite wing obtained from China Lake in FY 07 will be utilized in further testing during summer 2009. Preliminary plans are to place it on the ramp next to 737 and monitor tank temperatures and THC progression under varying conditions.

Fuel Tank Rule Status – D. Hill

http://www.fire.tc.faa.gov has the information from the Fuel Tank Flammability Reduction Rule Workshops given in Europe and the United States after the rule was issued. Dick reviewed the Overview of the Fuel Tank Flammability Reduction Rule (a United States regulation FAR) that affects new planes manufactured to Part 25 and any N registered aircraft. EASA is considering coming up with a very similar rule for newly manufactured airplanes. The Overview explains what to calculate and provides a Chart: Timeline for DAH and Operators for this rule that went into

effect in September 2008. Once the system is installed on an aircraft it cannot be removed and it must work. The rule calls for 50% Retrofit completed by September 2014, and 100% Retrofit completed by September 2017. SFAR 88 deals with ignition sources in fuel tanks. This rule takes flammability of the fuel tank into consideration.

Variable Pressure Isothermal Flammability Comparison Tests – B. Cavage

Bill described the test apparatus (scale aluminum fuel tank). The test methods were also described. Planned work: re-baseline with new batch of fuel and do test with increased amounts of fuel with same baseline fuel surface area, examine other tank geometries. We are looking for thoughts/suggestions from Working Group.

FAATC is having the environmental chamber used in this work upgraded. This test work will resume upon the completion of this upgrade.

Modeling Wing Tank Flammability – D. Dadia

Motivation: current flammability models are for center wing tanks. Dhaval has been working on building a model for wing tanks at the FAA's request. He explained his single thermocouple method. STM Correlation works best when: liquid fuel temperature is larger than the ullage temperature (fuel temperature is the driving force). The base model is the current CWT Model developed by Dr. Polymeropoulos of Rutgers University in 2004. The principal assumptions, computational method, and CWT heat and mass transfer correlations of the base model were explained. The differences in model correlations between the CWT model and the wing tank model were explained. The experiments conducted were described including test design, set-up, and test apparatus. The test results from these experiments were presented. Summary: laminar forced convection during ascent, turbulent forced convection the rest of the flight, shows ullage gases are well mixed. Experiments will be conducted to confirm the state of the ullage and to compare computed data to experimental data.

In-Flight Burnthrough Tests – Aluminum vs. Composite – H. Webster

Objective: develop a test that replicates the burnthrough characteristics of a typical alum skinned aircraft in in-flight conditions. Photos of test apparatus were shown and test set-up was described. Harry described some of the issues with the fire sources attempted: pool fire, oxygen/acetylene torch, and propane burner. Aluminum test results were presented. Composite heat conduction test results were presented. Live Fire burnthrough tests: both static (no airflow) and in-flight tests were conducted. The results of these tests were presented.

Working Group Member Presentations

Withdrawal of UL 1093 Impact – A. Carlo (Boeing)

Next Meeting

If anyone is interested in hosting the meeting in Europe in spring 2009, please contact April Horner. A meeting host form is available at www.fire.tc.faa.gov.