International Aircraft Systems Fire Protection Working Group Meeting

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Wednesday, April 19, 2006

Handheld Extinguisher Draft Advisory Circular Review – L. Speitel

Purpose of Advisory Circular (AC)
FAR requirements for handheld extinguishers
Minimum performance standard (MPS) for transport category aircraft
Approach
Fire Fighting Guidance
Toxicity
Ventilation selector graphs

AC is a method to show compliance with the applicable airworthiness requirements for each handheld fire extinguisher. This AC is not mandatory.

Louise provided an overview of the FAR for handheld extinguishers. She also reviewed the MPS for handheld extinguishers. The MPS is to show equivalence to 1211.

AC deals with two types of toxicity: the neat agent toxicity and hypoxia issues in a small cabin.

Letter from FAA Administrator: UL listed 5B:C and equivalent EN3 listed hand extinguishers must meet MPS requirements.

Louise provided a list of the applicable sections of the FARs that are related to the AC.

Extinguisher listings for Halons: listed under AC20-42C: (Halons).

Extinguisher listings for halon replacement halocarbons:

Aircraft Cabin: Includes the following recommendations: a minimum 5B:C UL listing; a permanent label is required, indicating a FAA approval for use in transport category aircraft.

Cabin Safety Guidance: Includes: cargo extinguishers should be available to fight cabin fires, select a cargo extinguisher that meets the safe use guidance for the aircraft cabin. If no cargo extinguisher meet the safe use guidance for the aircraft cabin: consider installing a class C fire flooding suppression system in the cargo compartment or alternatives to handheld extinguishers that would provide effective fire protection. Use the required UL listed extinguisher. Select the least toxic agent of the required UL listing. Place a placard on or alongside the bottle stating: "Discharge of the entire contents of this size bottle into the occupied cabin area exceeds safe exposure limits. Use only the amount necessary to extinguish a fire."

Toxicity Considerations: toxicity of halocarbon itself, low oxygen hypoxia (very small aircraft), toxicity of halocarbon decomposition products.

Approach for safe exposures to the agents. Louise reviewed the details of the approach.

Agent toxicity: maximum safe concentrations. Details of this were explained.

Agent Toxicity: Minimum Safe Compartment Weight/Volume (no ventilation) Table was presented and explained.

Agent Toxicity: Number of 5BC Bottles Allowed (no ventilation, 8000 ft. altitude, 70˚F) Table was presented and discussed.

Graph of Kinetic Modeling of Arterial Halon 1211 Blood Concentration (No Ventilation) was presented and discussed.

Ventilation – WARNING: Small increase in concentration above the Maximum Safe 5 Minute Exposure Concentration results in a much shorter time to effect.

Graph of Effect of Air Exchange Time on Normalized Agent. Modeling Arterial Blood Concentrations of halocarbons Using 1st Order Kinetics – formulas for each case described. Graph of Kinetic Modeling of Arterial Halon 1211 Blood Concentration in Ventilated Aircraft.

HFC236fa Selector for Ventilated Compartments. Low Oxygen Hypoxia at Altitude Unpressurized Small Aircraft Graph.

Engine Nacelle Halon Replacement – D. Blake (for D. Ingerson)

Review of equivalence data to date: for HFC-125 and CF3I (Chart presented).

Minimum Performance Standard Testing – NOVEC 1230

Testing of NOVEC 1230 in the FAATC Engine Nacelle Simulator began in April 2006. Doug will have more information on this test program at the next Systems Working Group meeting.

Current Status was provided. Draft MPSe and obtain comments from Task Group. HFC-125 overpressure characterization. Draft report due September 2006.

ECOLOG: An Airbus Research Project – C. Fabre

ECOLOG = Extinguishing Concept Lowering Ozone Depletion and Green House Effect

Project Objective: Halon replacement for A350Engine/APU fire extinguishing applications.

Two partners with Airbus France: Siemens SAS and SNPE in this project. Work on this project started in 2002 studying several different concepts for engine and APU extinguishing systems.

3M NOVEC 1230 Fire Protection Fluid. Christian described the design of the NOVEC 1230 fire extinguishing bottle.

Project Achievements: new environmentally friendly agent identified, system capable of delivering efficiently this agent developed, test benches capable of evaluating the system performance built, and extensive testing campaigns performed, airworthiness authorities contacted (EASA and FAA).

Dick mentioned that the FAATC will develop the standards for new agents if we have some assurance that there is an end-user who intends to use this new agent on a new platform. We are not in the business of testing every new agent that comes along. In this case, we have an agent supplier who is manufacturing this agent and an airframe who intends to use this on an aircraft. This is the reason this testing was done at the FAATC.

OBIGGS Utilization in Inaccessible Areas – R. Hill (for S. Summer)

Background: The FAA recently has released an NPRM requiring the reduction of flammability within heated fuel tanks (affecting over 3,200 in service aircraft). The most likely method of conformance is the utilization of an On Board Inert Gas Generating Systems (OBIGGS). Photo of system as installed in FAATC test aircraft was presented. With inerting systems now/soon to be on board, an integrated fire protection system to provide protection for these hidden areas may be feasible. Such a system would provide enhanced fire protection while utilizing a system already installed, thus saving on cost, weight and space on board the aircraft.

Objectives:

Design and install an NEA distribution system for fire protection of overhead area of the FAAs 747SP test article.
Examine the effect of various conditions on the ability of the OBIGGS to successfully protect the overhead area:

- Bleed air pressure
- OBIGGS feed pressure
- OBIGGS back pressure
- Permeate pressure (altitude)
- Ventilation
- Etc.

Future work will include examining the use of OBIGGS in 737 hidden areas

Future work may include expanding the OBIGGS system to other hidden areas aboard the aircraft (E/E bys, wheel wells, etc.).

Diagram of test configuration presented. Photo of current test section presented – located at approximately STA 1241, approximately 20 ft. wide, and 5 ft. tall at center, cross sectional area of approximately 42 ft^2.

Extinguishing Oxygen Concentration: previous tests have shown 12% O_2 to be sufficient in preventing ignition events, but what is the needed concentration to extinguish a fire? FAATC will be performing a series of insulation burn experiments in the Pressure Fire Modeling Facility, Insulation being used is a metalized polyester Type L film cover, Tests to be performed at sea level and 8000 feet. Current Status:

Preliminary testing with a single NEA deposit location has confirmed the need for a vacuum source (or other method) to control the spread of NEA, vacuum pump has been installed in forward cargo bay and is plumbed to test section (we are awaiting electric hookup for the pump before we can begin testing, should be ready to begin extinguishing oxygen concentration (EOC) tests in altitude chamber within 1-2 weeks (waiting for oxygen sensor to arrive).

Hidden Fire Testing – D. Blake

Current 727 Instrumentation diagram displayed and described. Photos of the 727 test article set-up for this test program were presented and described.

UPS DC-8 In-flight Cargo Fire on February 7, 2006, in Philadelphia, PA. This aircraft was on scheduled approach into Philadelphia when the fire started. Dave presented photos he took of the fire damage in the interior and exterior of the aircraft. The fire investigation is ongoing at this time.

Cargo Bay Fire Suppression ASM Data – R. Hill (for B. Cavage)

FAA developed a proof of concept inerting system to inert the CWT of classic style Boeing model 747. FAA intends to make a rule requiring flammability control of some or all CWTs with an emphasis on inerting system technologies. Potential for using these systems to expand fire protection needs to be explored. Need to develop good ASM performance data to perform trade studies, analyze requirements, etc.

Test Article & Methods: Use existing fire safety environmental chamber. Test articles will be installed (MEDAL D640 HFM ASM). Measuring temperature, pressure, flow, and oxygen concentration. Examine performance changes with several key parameters.

A block diagram of the ASM performance experiment was presented and explained.

Results – ASM Performance Effects:

ASM productivity very sensitive to feed pressure at the low pressures associated with commercial airplane OBIGGS. Higher feed temperatures give better performance, but ASM operates the same across 150-180 degree F range (and lower). Significant performance benefit from operating ASM at increased altitude (decrease permeate pressure). New ASM data very similar to one with 200 hours flight testing.

Continuing Research:

Developed a matrix of performance points with Cherry & Associates to allow for modeling of the ASM performance in support of trade study.

Dick explained that this work will be ongoing over the next year or two.

An Integrated Fire Protection System – An Overview – Y.Asmayawati (RGW Cherry & Associates)

Background: concept of this system has been proposed by the FAA, Transport Canada has commissioned a research study to: Identify the feasibility, practicality, and issues that are likely to result from implementation of such a system prior to the concept being considered.

Yani gave an explanation of the aspects of the integrated fire protection system that will be researched.

Working Progress:

1. Initial Benefit Assessment
2. Initial feasibility assessment of cargo compartment water mist/nitrogen system
3. Preliminary weight assessment
4. Preliminary Cost Assessment

Cabin Water Mist System: Literature review conducted, identification of issues, Safety reliability levels, activation system architecture, and consideration for fuselage breaks.

Initial feasibility assessment of hidden area inerting system: calculation of percentage of overhead area volume that can be inerted within 8 minutes with available NEA.

E/E Bay inerting initial feasibility assessment: need data (size and airflow) and tests.

Wheel well inerting system: currently there is no fire suppression system for the wheel wells. Yani reviewed the current applicable regulations for this area. There is currently no regulation regarding built in fire extinguishing system in the wheel wells.

Related Accidents: There are three known fatal accidents related to wheel well fire events are:

Boeing 727-264 XA-MEM Mexicana (March 31 1986, 167 fatalities)
DC-8-61 C-GMXQ Nationair (July 11, 1991, 261 fatalities).

Fairchild/Swearingen Metroliner II C-GQAL Propair Inc. (June 18, 1998, 11 fatalities).

Question: Would wheel well inerting prevent or mitigate these types of fires?

How would the flight crew or the sensors distinguish a brake overheat event from a wheel well fire event?

Feasibility of inerting the wheel wells: What is the airflow condition in the wheel wells?

Future Considerations:

Test Results: ASM tests, cargo bay inerting, overhead area inerting, water mist, air separation technology. Changes in regulation: Proposed new Class F cargo compartment, possibility of fuel tank inerting requirement for security reasons, advances in technology: fuel cell APUs.

Halon Use in Civil Aviation – J. O'Sullivan

Key data inputs and data sources
Key assumptions
Results: halon installed and emitted
Halon use in Russia

HTOC Progress:

Future supplies of Halon 1211 – 5 year supply remaining
US Navy/Army 2 year program to replace flight line Halon 1211
Halon 1301 future supplies/feed stocks – feed stocks not covered under Montreal Protocol
Update and decision XV/11 – coordinated effort with ICAO
Alterations/training – considerable amount of training for operators will be required
Banks/Recycle – ensure that airlines need to bank and properly recycle Halon
Challenges in Article 5 (1) countries – ensure they properly manage Halon
Halon 2402 Phase-out – India has a large problem with 2402 systems they cannot support
Destruction challenges – important to recycle when possible
IASFPWG Research/MPS – recognition to groups who have worked on this for over 20 years

Smoke Generation for Certification Ground and Flight Tests – K. Behle

The following efforts were made for standardization of test scenarios for smoke detection certification tests since 2004:

Theoretical approach presented during Fire Protection Workshop in Renton September 2004
Validation method
Influence of ventilation rate – the influence of ventilation will be verified in an A380 mock-up test campaign beginning of 2006
Photos of A380 full scale mock-up were presented
Mock-up test campaign with smoke generator AX1000 performed for AFT-LDCC configuration –several ventilation configurations were tested. A diagram of standard configuration was presented and described. Results: all but one test passed. Smoke generator program #5 produced too little smoke and is not representative of a real fire. Smoke generator program #6 was designed (redesign after #5). Results: all tests passed.

Conclusion:

In general the smoke amount to be used for certification ground and flight testing is to be adapted to: compartment size, compartment geometry, and ventilation rate.

Future Programs: the same approach as on A380 will be applied (simulation, lab tests, and ground and flight tests).

In-Flight Fire Fighting Training Video – D. Blake

This video is to provide a visual guidance for illustrating the key points discussed in AC 120-80 dealing with in-flight fires.

Concepts to be included:

Proper use of handheld extinguishers (results of vertical vs. horizontal use)
Don't let fire burn to out-of-control stage while looking for the correct fire extinguisher to put out that type of fire (examples will be demonstrated)
Previous work with flight attendants in extinguishing cargo fires (lack of visibility due to smoke)
737 and 747 available at FAATC for filming these scenarios with theatrical smoke
Mock up of galley, coat closet at FAATC full-scale fire test facility (real fires can be used in this)
Graham Greene of the CAA has written the first draft of video script. Draft is currently under review by regulatory authorities.
Spirit Airlines has tentatively agreed to provide flight attendants for filming.
Airbus has offered the use of their cabin simulator in Toulouse for additional filming; Airbus has also produced a very comprehensive brochure entitled Getting to Grips with Cabin Safety that highlights many of the same issues.
NTSB and ALPA have requested the opportunity to review video before finalization.
The final video will also be available on the Internet to be downloaded.

Lithium Battery Fire Tests – R. Hill (for H. Webster)

Transport of lithium and lithium ion batteries. There have been several incidents involving both lithium primary (non-rechargeable) and lithium-ion batteries (rechargeable) batteries.

Report published: DOT/FAA/AR-04/26 can be found at http://www.fire.tc.faa.gov.
RSPA Interim Final Rule Issued: "Prohibition on the Transportation of Primary Lithium Batteries and Cells Aboard Passenger Aircraft"

Lithium-Ion Battery Flammability Tests:

Initial testing will be done with 18650 types cells routinely used to power laptop computers.
Additional tests may be done with flat prismatic cells used in cell phones.

Tests will be conducted at 100% and 50% charge.

Test Conditions for Lithium-Ion Batteries were described.
Lithium-Ion Battery Test Results:

Typical 50% charge cell response to alcohol fire:

Initial pressure relief through positive terminal blow out vent ports, small amount of liquid released. Fire would ignite adjacent cells. Explosion: occasionally, a cell did not vent, and instead exploded forcefully, expelling the entire contents of the cell from the casing

Typical 100% charge cell response to alcohol fire:

Probability of explosion was higher and explosions were more violent.

Photo of remains of exploded cell was shown.

Other tests conducted:

Pressure pulse test
Oven Test

Conclusions:

Heated cells vented flammable gas
Halon extinguishes the electrolyte fire even at 3%
Lithium-ion cells pose no undue threat to cargo liner material
Draft report has been completed

FAATC has been asked to start investigating fuel cells and the transport of fuel cells that are the next generation of power for laptops and cell phones. These contain various types of fuel including corrosive materials, flammable gases, and flammable liquids. Use of refill canisters and transport of these canisters.

Cargo MPS Testing of NOVEC 1230 – D. Blake (for J. Reinhardt)

FAATC will initiate testing program to evaluate NOVEC 1230 as a possible candidate to replace Halon 1301 in the cargo compartment area. A COTS system will be used. The latest version of the MPS (2nd update, June 2005) will be used during this program. John Reinhardt will be conducting these tests. A diagram of the cargo compartment set-up was presented.

THURSDAY, APRIL 20, 2006

Handheld Extinguisher AC Task Group – L. Speitel

Questions:

How do we deal with new agents, mixed agents, and how do we handle Halon 1211?
New agents: Obtain information from an FAA report.
Mixed agents: It would be the agent manufacturers' responsibility to provide information on their agent.
Include a Table of Minimum Safe Volumes for different altitudes for each agent that can be directly calculated for a specific size of aircraft. This information would be in the appendix. The main body of the report would have the weight-to-volume table.
How do we handle Halon 1211? Current AC references Halon 1211 – it is very important using the new toxicity guidelines to show where Halon 1211 fits in.
Dick: Does everyone in the Task Group understand that there is a possibility that the Halon 1211 numbers would be taken out of the AC, because it is conflicting to the information on Halon 1211 in the existing AC? Sham: I see the current AC going away through attrition. Dick: You need a explanation/justification, because the regulatory side is going to have to answer comments on the new AC. You will need a story as to why there is a discrepancy between this new AC and the existing one on Halon 1211. We will need to give this story to the regulatory person in Washington who will be answering the comments.

Fires in Inaccessible Areas – D. Blake

Airbus, Boeing, Kidde, and Embraer have agreed to be part of this Task Group. FAATC is going to re-evaluate which engineer will be working on which part of the project. Use CFD for scoping numbers. We can do on the ground airflow measurements in the FAATC 727, 737, and 747 test articles. What is the capability of the inerting system on board an aircraft for fuel tank inerting in protecting hidden areas? How do you deal with smoke from a fire? These will also be discussed during our engineering meeting at the FAATC.

Additional Discussion – R. Hill

Any additional information on NOVEC 1230? Dick: Go to the 3M website. Jean-Louis Salinas: Some work in compatibility has been done. Let me know if you are interested in receiving this information.

Dick: NASA's program on aircraft safety was eliminated. This is why NASA is now represented at this meeting.

Next Meeting

The next meeting will probably be held in the Atlantic City, New Jersey, area in fall 2006. The meeting dates and location will be posted to the FAA Fire Safety website (http://www.fire.tc.faa.gov) when it is available.