INTERNATIONAL AIRCRAFT SYSTEMS FIRE PROTECTION WORKING GROUP MINUTES

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Hidden Fire Testing – R. Hill (for D. Blake)

FAATC modified 727 Test Article to be able to put Nitrogen Enriched Air into the air at certain locations and draw it out at certain locations. A photo of some of the interior modifications was shown and the modifications were explained. The diagram of the 727 instrumentation in area of cabin ceiling mockup was presented. Testing has not begun yet.

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

The FAA recently released an NPRM requiring the reduction of flammability with heated fuel tanks affecting over 3,200 in-service aircraft. The most likely method of conformance is the utilization of the On Board Inert Gas Generating System (OBIGGS) With inerting systems now/soon to be on board an integrated fire protection system to provide protection for these hidden areas may be feasible.

Objectives:

Design and install an NEA distribution system for the protection of the overhead area of the FAA's 747SP and the 737 test articles. Examine the effect of various conditions of the ability of the OBIGGS to successfully protect the overhead area:

Bleed air pressure
OBIGGS test pressure
Etc

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

Test Articles:

747SP equipped with OBIGGS installed in the empty pack bay utilizing up to 6 ASMs.
737 aircraft in process of being equipped with a single ASM OBIGGS

747SP Diagram of test configuration was shown and explained.

737 Diagram of test configuration was shown and explained.

Current Status: Preliminary testing in the 747SP with a single NEA deposit location has confirmed the need for a vacuum source (or other system).

Russell Stark: are you looking at any other ways to detect fires? D. Hill: At the time we started this program, NASA had a program on detection and we were jointly working with them, so initially the FAA did not include detection in their program plan because of this. Now that NASA's

program has been dissolved, we will be starting to look into detection systems. Russell offered to work with Dave Blake regarding detection systems for the test program.

Aircraft Cargo Compartment Testing Update – R. Hill (for J. Reinhardt)

MPS Bulk Load Test:

European cardboard boxes have a fire retardant added into the cardboard that changes the heat spread on the box that can give a slightly different result. The total heat released from both U.S. and European boxes was identical. The heat release rate was different. There is a slower flame buildup on a European box than a U.S. box. Graphs of test results shown and explained. Video of the European cardboard box test was presented.

MPS Aerosol Can Simulation Explosion - Arc Delay vs. Explosion Overpressure:

We have recently conducted tests using Novec 1230 which only caused a slight elevation in pressure unlike the BTP and the HFC-125. John did some experiments to try to explain why this is, since Novec 1230 does not contain hydrogen. A diagram of the chamber was shown and explained. Graphs of the test results were presented and explained. A video of Arcing Delay vs. Explosion Overpressure tests was shown. Change of Fuel Mass Test Matrix and Results were explained.

Test Conclusion:

The ignition timing did not make the difference. It was not determined what caused this. We have not seen any example of this in any of the full scale tests we have conducted nor did we see this when we conducted the engine nacelle tests using this agent.

Halon 1301/N2 Siynergism:

John is now working on testing minimizing the amount of halon by 75% or more if the nitrogen can be used for the long-term. The procedure was described.

Fuel Cells and Lithium Batteries – R. Hill

Rule-Making Lithium Cells:

FAA and PHMSA are working with the ICAO Dangerous Goods Panel on new rules for international transport of batteries including specific rules involving transport of Lithium cells

Discussion Items include:

Banning shipment of lithium primary cells of cargo aircraft (already banned on passenger aircraft)
Elimination of special conditions provisions allowing shipment of certain lithium cells as undeclared cargo, requiring labeling as class 3 hazards
Amendment of the ICAO hazmat response procedures to give crews more specific instruction in fighting a lithium battery fire.

Future Tests – Lithium Cells

Evaluation fire hazards of Lithium Cells installed on aircraft as part of airframe systems. Batteries used to operate aircraft systems.

Assess the safety impact of presence of Lithium cells on aircraft including an evaluation of the various chemistries, potential threat from explosion, fragments, gases released and toxicity. Evaluate Lithium Cells that have already been approved for use including charging and monitoring systems when exposed to expected environmental extremes on board the aircraft. Evaluate threat of worst case state of charge conditions when exposed to expected extremes.

Fuel Cells:

Definition: an electrochemical cell in which the energy of a reaction between a fuel such as liquid hydrogen, and an oxidant such as liquid oxygen, is converted directly and continuously into electrical energy.

FAA Concerns:

In-flight use of operation
Carry-on luggage
Checked baggage
Bulk shipment

Micro Fuel Cell Fuels:

Methanol
Formic Acid
Butane
Hydrogen Stored in Metal Hydrites
Borohydride

Future Fuel Cell Tests:

FAA Fire Safety engineers are currently supporting FAA HAZMAT and PHMSA in developing rule making regarding fuel cells.

There is more and more of a push to start using exotic materials on aircraft in order to get weights of aircraft components down. One of these materials is magnesium. For example, if magnesium is used in seat frames, will it be necessary to have extinguishers on board the aircraft that can extinguish a magnesium fire and what about the fire fighters that come on board to extinguish those fires with water hoses in the confined space of the aircraft.

<u>Engine Nacelle Halon Replacement</u> – R. Hill (for D. Ingerson)

Equivalent Concentrations of HFC-125, CF3I, and Novec 1230: a plot of the percent y volume concentrations for these replacement agents was presented.

Alterations to the MPSe: Move the MPSe off a Halon 1301 Benchmark

Why?: Halon 1301 supplies are diminishing, continued discharge to atmosphere SPECIFIED for testing purposes, and need to move forward.

Specify another fire extinguishing agent as the benchmark:

Pro's and con's of using HFC-125 and Novec 1230

CF3I: no forecasted use by working group members currently not considered a possibility for this issue

Other suggestions?

Specify the combustion threats:

During early developmental history of the MPSe task group opted NOT to do this. Complex test environment, ie: aerodynamically dependent flame holding electrical arcs, hot surfaces, ignitor behaviors, fuel/air diffusion behavior, etc.

Other possibilities to remove the Halon 1301 Benchmark?

MPSe is written with sections reserved to allow for atypical replacement candidates. These sections are currently unspecified. Potential examples: agents delivered as liquid or solid, etc. The current state of the art for civil aviation is clean, gaseous agents. The entire certification process is dependent upon the current state of the art. Atypical candidates will require alternate means of measurement to demonstrate acceptable behavior.

How should atypical agent quantification be handled in the MPSe?

Integrated Fire Protection – R. Cherry

Transport Canada has commissioned a research study on an integrated fire protection system for aircraft.

Cargo Compartment Water Mist/NEA System

This involves the development of a comprehensive cargo compartment inerting model.

Possible Future Activities:
Reassessment of system weight based on FAA testing of cargo bay target inerting level.
Development of a specification for a water mist/nitrogen enriched air system.
Investigation of fuel cell technology
Investigation of other compressors
New water mist technology? (water vapor systems, etc.)

Cabin Water Mist System

Determination of the number of fuselage breaks that should be taken into consideration in a cabin water mist system – based on analysis of past accidents

Development of a specification for a Cabin Water Mist System

Handheld Extinguisher Draft Advisory Circular Update – L. Speitel

This Advisory Circular was originally going to be an Amendment to the existing handheld extinguisher A/C. However, FAA Headquarters decided they wanted this to incorporate the previously issued A/C and this new draft A/C into an A/C that will replace the previous A/C. Therefore, Halon 1211 is addressed in this new A/C. The latest toxicity numbers for Halon 1211 are included in this new A/C.

An FAA Policy Letter will be issued.

Extinguisher Listings for Halon Replacement Agents

Cabin Safety Guidance was reviewed and explained.

Throw Range:

The MPS requires a minimum throw range of 6-8 feet
A longer throw range at 10 feet or greater provides significant advantages in fighting fires in large aircraft cabins
A shorter throw range with a lower velocity discharge is less likely to cause splashing and/or splattering of the burning material. Consider a shorter throw range for very small aircraft.
Select a range that would allow the firefighter to effectively fight fires likely to occur.

Agent Toxicity: Maximum Safe Concentrations

The same science is used for all of the toxicity calculations throughout the new A/C.

Ventilation Tables

Louise reviewed the changes since the last update (these are subject to comment by the Working Group/Task Group).

Do not recommend the use of dry chemicals or CO2 extinguishers.
Maximum safe weight/volume for blends of Halon 1211, and Halon 1301 can be found by assuming the total weight of the blend is Halon 1211.
Label “For aircraft use as an Approved Halon Equivalent Extinguisher”.
Other comments were also made.

Wing Tank Flammability Modeling Studies – R. Hill (for S. Summer)

Steve has been doing some fuel tank flammability work. The Fuel Air Ratio Calculator is a tool developed by Ivor Thomas. Using the FAA/NASA test data (previous work) the approach gives feasible results for a wing tank while on the ground. In flight, however, where condensation plays such a large roll, we see that the aircraft does not match existing data.

Steve then input ullage temperature from thermocouple readings from inside the wing tank in place of fuel temperature.

If we assume the following:

On the ground the fuel temperature drives evaporation of the fluid fuel and there are no condensation effects.

From limited data, it seems that the approach has some merit. More work needs to be done in order to determine exactly what is happening and how the effect of ullage temperature and the effect of changing altitudes counter each other.

Wing Tank Flammability Testing – B. Cavage

Wing Tank Flammability Parameters

Flammability drivers on the ground:

- top side and ullage are hot from sun
- hot ullage heats up layer of fuel causing evaporation

Current Testing – Scale Tank in Altitude Chamber:

Used existing 17ft. aluminum fuel tank in altitude chamber
This has an extensive array of thermocouples

727 Wing Tank Testing in Wind Tunnel:

The temperatures and flows are not in line with what you would see in a commercial aircraft takeoff, but were usable for these tests. It appears that it is very difficult to keep flammability in a wing tank when the outside air is cold.

Ongoing/Future Testing – Scale All Composite Tank Wind Tunnel Tests:

Steve is in the process of working on the test article for these tests. FAATC acquired an old A6 composite wing that may be used for the test article for this project. Bill described what these tests will be investigating.

Center Wing Fuel Tank Flammability Control – B. Cavage

Background: 17 cubic foot test article, can obtain discreet hydrocarbon samples,
Testing Performed
Results – Preliminary

- reducing the liquid fuel volume in the tank can have a detrimental effect on flammability
- the fuel flashpoint has a significant effect on the resulting flammability exposure
- increasing the ullage pressure by 3psi reduced the ullage flammability

Summary:

We are now beginning to see all the factors that go into flammability. A lot more work is still needed.

State of the Art of Fuel Tank Ullage Oxygen Concentration Measurement – B. Cavage

Background: the measurement of ullage oxygen concentration is important in the fuel tank inerting flammability when researching methods, validating models, and certifying systems.

Emerging products have the potential ability.

Technologies Examined:

FAA Method OBOS
Gas sampling
In situ galvanic cell
In situ time constants

Review of Testing Performed and description of how Bill sets up the sensors and the fuel tank in the altitude chamber.

Preliminary Results:

Graph: SOA of Ullage O_2 Measurement of each technology used – results of each one presented on one graph

Graph: Alenia Ground Testing Results – SOA of Ullage O_2 Measurement

Summary:

State of the art of ullage oxygen concentration measurement has improved considerably in the past 2½ years.

The FAA published special conditions for the flammability of composite fuel tanks in the Federal Register recently.

<u>In-Flight Fire Fighting Training Video</u> – R. Hill (for D. Blake)

AC120-80 gives guidance to cabin crew members on action to take in fighting on board fires. This video is to reinforce some of the fire fighting techniques described in the AC. Filming will be done at the FAA Fire Test Facility and at Cranfield University (simulator), UK. The goal is to have the video completed and present it during the International Aircraft Cabin and Fire Safety Research Conference in late October 2007 in Atlantic City.

Proposed Task Group: Integrated Fire Protection Schemes

Is there any interest in being involved in this Task Group: "Yes"

We can arrange for this Task Group to meet for a few hours sometime during the week of the conference.

No fall 2007 meeting – the Fifth Triennial International Aircraft Fire and Cabin Safety Research Conference will be held in Atlantic City, New Jersey, October 29-November 1, 2007. Please go to http://www.fire.tc.faa.gov and click on the "Conference" tab at the top of the homepage for details on this conference.