INTERNATIONAL AIRCRAFT SYSTEMS FIRE PROTECTION WORKING GROUP MEETING

Hosted by Transport Canada Civil Aviation, Ottawa, Canada

July 8-9, 2003

TUESDAY, JULY 8, 2003

Fuel Tank Inerting Research – R. Hill
(Presentation Title: "Robs inerting")

Jet-A Vaporization at Subatmospheric Pressures – R. Ochs (Rutgers Fellow at FAATC)

Introduction:

Several incidents in recent years linked to explosions in center wing tanks of commercial airplanes

Explosions caused by heating and vaporization of thin layers of nearly empty fuel tanks in these accidents/incidents

Reducing Flammability:

Maintain sufficient amount of fuel in CWT to eliminate fuel temperature rise and vaporization

Reduce the amount of 02 in tank such that the vapors are not flammable

Fuel Tank Inerting:

Reducing the 02 concentration by pumping N2 into the tank

Have developed a system that can be adapted to different planes

Uses engine bleed air to make NEA to inert fuel tanks

Scale model and full-scale tests underway

Jet Fuel Flammability:

23 ASTM D1655 specifications for jet fuel

Exact composition not specified, other parameters such as distillation temp, flash point, etc., are specified

Flammability properties-limits, ignition energy, quenching distance also not specified

Vapor accumulates in closed tank until equilibrium is reached

Constant temperature-number of molecules leaving fuel equals the number of molecules returning to liquid surface

Vapor pressure is the pressure exerted by fuel molecules in the vapor space

Can determine the amount of vapor in ullage with temperature and ullage volume known

Rob Ochs is conducting experiments to look at varied wall temperatures of fuel container and how they relate to temperature of fuel and determining amount of vapors in the fuel with these variations at ground and at altitude

Predicting Flammability:

Can use fuel properties to determine flammability (vapor pressure, flash point)

Use of thermal modeling to determine the heat transfer from external source through tank walls to the fuel

Computer model written by Professor Polymeropoulos (Rutgers University)

Uses properties of fuel and experimental parameters to determine flammability as a function of time

Model Inputs:

Equilibrium temperature
Tank dimensions
Fuel volume
Pressure
Surface and temperature profiles

Model Outputs:

Equilibrium vapor concentration
Hydrocarbon concentration as a function of time
Ullage temperature profile

Experimental Set-up:

Rectangular fuel tank – 36"x36"x24", ¼" aluminum
Sample ports – heated hydrocarbon samples lines
12 thermocouples
Blanket heater for uniform heating
FID hydrocarbon analyzer, calibrate with 2% propane
JP-8 jet fuel (the military version of Jet A)

Schematic of tank was shown here (refer to Presentation Section)

Experimental Procedure:

Fill tank with a specified quantity of fuel
Let sit for 1-2 hours until equilibrium is reached
Take initial hydrocarbon reading to get equilibrium concentration
Set fuel temperature setpoint and begin heating fuel
Experiment concludes when hydrocarbon concentrations level off and decrease

Results of Experiment shown here (refer to Presentation Section)

Computer model was displayed (refer to Presentation Section)

What's Next:

Complete preliminary sea-level tests and iron out the test procedure

Perform tests at constant subatmospheric pressures, verify accuracy of model

Perform flight profile tests, with varying atmospheric conditions simulating climb, cruise, and descent

FAATC Goal: Reduce flammability of center tanks on newly certified aircraft, prediction of what effect some of these variables/parameters are on the flammability of the center tank using a realistic approach

This model will be available if anyone is interested (see Fire Safety Website)

Scale Model Testing: A320 Center Tank – R. Hill
(Presentation Title: "Scale Model Inerting")

Photo of scale model was displayed (see Presentation Section for photograph)

Dick described design and structural differences between B747 and A320 center tanks

Inerting experiments will be conducted using this scale model

This model can be tested in the FAATC altitude chamber to simulate flight altitudes

B737 Center Tank – R. Hill

The FAATC Fire Safety 737 test aircraft is operational (not flightworthy), all systems are operational on the ground (aircraft cannot be flown)

FAATC has recently purchased a 737-200 center tank to use in testing (same type of tank that is on the 737 test aircraft)

This tank will be used in connection with the altitude chamber to simulate flight altitude (inerting system can be put into altitude chamber and this tank will be connected/hooked to the altitude chamber once some structural supports are installed to prevent implosion of tank) various tests will be conducted once this test article is set-up

NASA Fire Prevention Update – C. Chang/B. McKnight (NASA Glenn)
(Presentation Title: "CTChang July03FAA Meeting")

Update:

1. State of the NASA OBIGGS/OBOGS contract
2. OBOGS development observations

OBIGGS/OBOGS Program Status:

Phase II OBIGGS/OBOGS technology development contract option put into place in June 2003

Valcor and Honeywell contracts option exercised, $600K each over 18-months (they are developing next generation nitrogen membrane systems – these will be high temperature systems)

Request program extension into FY05 (from FY04)

Technology development: higher temperature membranes >140C and system-level performance improvement

Phase II SBIR cryogenic-separation OBIGGS/OBOGS finishing up in FY03

Aviation Security Program funding possible in FY04 to extend OBIGGS to all tanks defending against small arms and MANPADS

OBOGGS Development Observations:

Currently no suitable means for OBOGS to satisfy surge load (surge load requires some form of stored oxygen)

Single-stage ASM waste-stream 0_2 purity marginal for 15kft depressurized flight

Higher-altitude emergency depressurized cruising (20-25kft)

Combined OBIGGS/OBOGS system to spread cost among aircraft systems is not cost effective with membrane-based system. This concept only works for cryogenic-based system or PSA-based system.

For additional info contact: Clarence Chang at 216-433-8561 or Clarence.T.Chang@nasa.gov

Inerting Flight Tests – R. Hill
(Presentation Title: "Inerting flight tests")

Boeing Certification Flight Tests (B747):

The test set-up is scheduled to begin on July 14, 2003. The FAATC inflight instrumentation is being installed on this aircraft and FAATC Fire Safety personnel will be on-board to run the system during the flight tests.

Airbus A320 Flight Tests:

The FAATC system is currently on being installed into an A320 cargo compartment (system has been modified to fit the Airbus cargo compartment design) in preparation for flight tests that will be conducted this month in cooperation with Airbus in Toulouse, France. Photographs of the inerting system being installed in the A320 were displayed (see Presentation Section for photographs). Only one membrane of this system will be used for the A320 flight tests (due to the size of the A320 as compared to number of membranes needed for a B747 cargo compartment).

The A320 flight tests are now set to begin about the week of July 21, 2003. Even if the schedule is pushed back slightly, there should be a considerable amount of information available on these tests to present during the Fall 2003 Working Group meeting.

NASA 747 Flight Tests – R. Hill

The FAATC system will be installed on a NASA B-747 (this installation will be installed on the NASA aircraft exactly as it was on the FAATC 747SP at the Technical Center. These flight tests will be conducted upon completion of the Airbus A320 flight tests. A main reason for conducting these flight tests is that all information obtained will be public information as all the equipment used and the aircraft used will be government owned. The plan is to monitor hydrocarbons, also, during these tests. The aircraft that will be used is one of the two 747 aircrafts that NASA uses to transport the Space Shuttle around the U.S. The center tank is to opened for installation of instrumentation and probes (by a contractor) in early August. The tentative flight test timeframe is October 2003.

Limiting Oxygen Concentration (LOC) Work Update – S. Summer
(Presentation Title: "Fuel Flam Update – SFPWG 7-08-03")

Conducted sea level (SL) testing with a J-57 engine igniter

Conducted SL testing with a short duration arc from oil burner transformer

Measured voltage/current at spark gap and calculated energy for both spark/arc generator

Composed report of all data generated to date with the various ignition sources (Tech Note #AR-02/79) – due out shortly

Description of Facilities Set Up:

Pressure Chamber
LOC Test Article
Locations of Thermocouples
Schematic of how vapor samples were taken

Steve described the Test Program:

JP-8 LOC Tests

Tests conducted initially at all altitudes with long duration oil burner transformer arc

The results of these tests were reviewed

The J-57 Engine Spark Igniter Test Results were presented

The Short Duration Test Results were presented

Hot Surface Vapor Ignition Test Results were presented

Conclusions:

LOC at SL through 10kft is about 12% increasingly linearly through 40kft to about 14.5%
Little effect seen on SL LOC due to ignition source

(See Presentation Section for a complete copy of this Presentation)

Future LOC Work:

Currently working with a very high energy spark (>20 J)
- 120 Vac, 400 cycle hard short to ground
- Will be placing in the tank within the next week

Technote AR-02/79 will be available on the Fire Safety Website once it is released

Engine Nacelle Halon Replacement Test Update – R. Hill (For D. Ingerson)
(Presentation Title: "pres0378")

Overview of Work, March 2003-June 2003:

Finished certification work for high/low ventilation

Evaluated the impact of agent storage pressure on reignition time delay

Completed equivalence of HFC-125 at high ventilation

Began quantifying CF_3I equivalence at high ventilation

Near Term Plans:

Complete equivalence testing for HFC-125 and CF_3I

Perform proof-of-concept tests

Certification Work (Test Conditions/Results):

Purpose: To find certification with Halon 1301 in the test fixture for two ventilation configurations that will be used in future equivalence tests

High and Low Ventilation with Test Fixture information presented

The Agent Concentration Profiles were presented (see Presentation Section)

Comments:

The certification at the low ventilation was difficult to achieve

Variation observed during repeated test conditions

Agent distribution sized to guarantee certification

Distribution plumbing was not symmetric

Agent concentration profile was symmetric

HFC-125 simulation used for system design

Agent Storage Impact on Reignition Time Delay:

Purpose: Determine the varying agent storage pressure will impact the behavior of the reignition time delay

High/Low Ventilation within Test Fixture

Results:

Agent storage pressure has negligible impact on reigntion time delay for these tests

HFC-125 Equivalence:

Purpose: Find the quantities of HFC-125 equivalent to the extinguishments performance of Halon 1301 at high ventilation in the test fixture

The results were presented

Comments:

Related HFC-125 concentration profiles captured

HFC-125 concentration profiles not yet analyzed

HFC-125 concentration profiles not balanced across the cross section of the test fixture

Gas concentration, not mass equivalence, will be the final reported result

Near Term Plans:

Began equivalence work with CF3I late June 2003

Plan to complete equivalence work with HFC-125 and CF3I by September 2003

Proof-of-Concept Tests

- Run tests to demonstrate cold agent extinguishes fire in the test fixture
- Slated for Fall 2003

Cargo Smoke Detection Work – R. Hill (For D. Blake)

Jill Suo-Anttila will provide a review the work currently underway at Sandia National Labs at the next Working Group meeting (Fall 2003)

Fire Suppression System Scaling – R. Hill (For J. Reinhardt)
(Presentation Title: "SystemScaling")

Objectives: To determine the critical parameters required to scale a water mist system combined with nitrogen, used as an aircraft cargo compartment fire suppression system that have met the MPS.

Consideration: The scaling consideration of the water mist/N2 fire extinguishing system is for cargo compartments of volume sizes 719 ft3 (298 in x 125 in x 42 in) and 6252 ft3 (590 in x 164 in x 80 in).

Adopt NFPA 750 – Standard on Water Mist Fire Protection Systems – literature review/research conducted.

Scaling Approach:

Characterize the WMS/N2 system that passed the MPS tests using the NFPA 750 standard and other techniques

Characterization of Water Mist:

NFPA 750 Section A-5-2 (Appendix A): list of design parameters to be considered

Nitrogen Measurement: The measurement of nitrogen volumetric concentration, in the scaled cargo compartment, will be achieved by determining the oxygen volumetric concentration in the hypoxic condition (using gas analyzers).

Computer Modeling: Task Group members recommended usage of computer modeling techniques to facilitate scaling analysis using critical characterized parameters. It may be used if provided by Task Group member.

Status:

The characterization of the FAA's WMS/N2 has been initiated using the NFPA 750 standard

Test fixtures to determine water mass in the fire zone is under construction

Searching for a Phase Doppler Particle Analyzer or similar equipment to measure particle size distribution and velocity of the mist on the fire zone. Anyone who owns one and is willing to share the equipment please contact John Reinhardt at 609-485-5034 or email him at john.reinhardt@faa.gov.

November 2004 Fire and Cabin Safety Conference Call for Papers
(Presentation Title: "call for papers")

The Fourth Triennial Aircraft Fire and Cabin Safety Research Conference will be held in Lisbon, Portugal, November 15-18, 2004. Call For Papers: Abstracts for Papers are now requested for review by the CSRTG organizing committee. These should be no longer than one page and be submitted by January 23, 2004.

Send the abstract to:

Ms. Emma Tombleson
Research Management Department
Civil Aviation Authority

General Conference Topics:

Research progress and future directions
Accident studies, databases,

Crash Dynamics

Evacuation

Operational Issues

Materials Fire Safety

Systems Fire Safety

Engine Strut Testing – R. Hill (For J. Reinhardt)
(Presentation Title: "Engine Strut Tests")

John has been doing some work on the installation materials used for engine mounts. Purpose: An ARAC subcommittee islooking at revising AC25-135 (Powerplant and Propulsion System)…

Current Proposed Procedure:

Calibration of Thermocouples
Calibration of Calorimeters
Burner Test

Status:

Three out of five materials selected have been tested according to the prescribed procedure (4130 Steel, 15-5 PH Steel, and Titanium 6A1-4V).

Available test data is currently being analyzed (reference material).

Procedure: ARAC subgroup is currently looking at the data to determine if a test protocol change is required.

Lithium Battery Fire Tests – R. Hill (For H. Webster)
(Presentation Title: "Lithium bat 070203")

Status:

Testing is complete
Final Report is in process
Additional testing at RSPA's discretion pending review of final report
ICAO has issued new regulations restricting battery shipment on transport aircraft

Summary of Conclusions:

A relatively small fire source is sufficient to start a lithium battery fire.
Cargo liner is vulnerable to penetration by molten lithium
Batteries fuse together when exposed to flame, promoting propagation between batteries

The temperatures found in smoldering cargo were sufficient to ignite a primary lithium battery

FAATC Hidden Fire Test Program – R. Hill (For T. Marker)
(Presentation Title: "inaccessible areas3")

Some research has been conducted in the FAATC Fire Safety Section B747-SP test article.

A diagram of the modified overhead area test configuration was presented.

Future Work:

Use of 5lb. Halon 1211 extinguishers

Use of Halon 1301 to extinguish fire in overhead

Feasibility of large bottle w/distribution system

Effectiveness of discharge ports in smaller narrowbody overhead

Effectiveness of thermal imaging device to locate hidden fires

Fires in other areas (cheek, behind sidewall, etc.)

Status of Handheld Extinguisher User Preference Survey – R. Hill (For R. Mazzone)

Overview
Objective
Survey Contents
Survey Results to Date
The survey will be available for viewing on the Fire Safety Section website

Summary of European Air Carrier Responses (G. Weyland):

35 airlines responded. Gilles presented the responses of these airlines. A bar chart indicating the priority level of each issue was presented.

TUESDAY, JULY 9, 2003

Task Group Reports:

Engine
Cargo
Handheld
Hidden Fire Task Group
Fuel Tank Inerting Task Group

These Task Groups will meet at the FAA Technical Center either before or after the next Working Group meeting in November 2003.

Cargo

Engine Task Group: Some slight differences in opinion on how to conduct the cold temperature tests. Doug will set up a conference call with TG members after the 100F testing has been completed prior to conducting the cold temperature tests involving a teleconference/interactive Powerpoint teleconference set up. This will take place in approximately September 2003.

Handheld Task Group: This TG has almost completed its mission. Future TG Work: Discussed the possibility of looking into preparing info on new agents and how they should or should not be used in aircraft in the future. This would be advisory material. Agent manufacturers were asked to put together any advisory materials they have on their agents so that TG can discuss/determine if there is a need to compile all this information into one advisory document, or if the information provided individually for each agent is sufficient. Toxicity issue was discussed as well.

Hidden Fire Task Group: Possible Survey: which areas pose the most risk?, etc. No conclusion on this. Manufacturers should supply advisory information on guidance for installing equipment in hidden areas after aircraft is manufactured (ie: electronic information, etc.). Manufacturers asked to supply this information. The TG discussed the development of an Advisory Circular that is ongoing on crew training and fire fighting onboard the aircraft. Half day TG session will be held in conjunction with November 2003 meeting where Tim Marker will review the work that has been done related to research in hidden areas. TG requested a write up on the scope of the Hidden Fire work from Tim Marker. Dick suggested they review the presentation material Tim provided for the meeting (see Presentation Section of website). K. Schmoetzer: The A380 has numerous design requirements written in conjunction with the JAA (Document April 18, 2003) out of the VLTA conference that are specific to this aircraft. Klaus will send an email copy of this document to Dick Hill/Tim Marker.

Fuel Tank Task Group: There was a general discussion of FAATC and NASA research program discussion and how these two programs tie together. Hot surface ignition tests clarification.

Next Meeting:

The next Working Group meeting is tentatively scheduled to be held at the Trump Taj Mahal Casino-Hotel in Atlantic City, New Jersey, USA, on November 19-20, 2003. See Systems Group “Meeting Details” section for hotel rates/information, etc.