International Aircraft Systems Fire Protection Working Group Meeting Minutes

February 15-16, 2005

Hosted by Transport Canada Civil Aviation, Ottawa, Ontario, Canada

TUESDAY, FEBRUARY 15, 2005

The Development of Guidance for the Use of New Agents in Handheld Extinguishers for Aircraft Cabins – L. Speitel

Outline:

- FAR Requirements for Handheld Extinguishers
- Minimum Performance Standard (MPS)
- Purpose of Advisory Circular
- Related FARs, CFRs, ACs, and Ads
- Approach
    - Handheld Task Group recommends a separate AC for Halon Replacement Extinguishers that will be revised as new agents are introduced.
    - The proposed AC is subject to review and change/rewrite by the FAA Aircraft Certification Office.
    - Agent manufacturers may provide PBPK data and tables for ventilated aircraft at their expense.
    - Advantages/disadvantages of a separate AC presented
- Review of the current AC 20-42C
- Highlights of Proposed Halocarbon Extinguisher AC
    - Handheld Task Group interested in input on this
    - User Preference Survey results
    - Toxicity Considerations (ventilated and non-ventilated aircraft compartments)
    - Safe extinguisher weights for aviation
    - Ventilation Issues/Development of Ventilation Tables
    - AC Language for Halocarbon Fire Extinguishers

Aircraft Cargo Compartment Fire Detection – R. Hill (for Dave Blake)

Sandia CFD Transport Code:

- Dr. Walt Gill of Sandia presented the code at the Fire and Cabin Safety Conference in Lisbon in November 2004
- A version was distributed to those who attended the Workshop held at the conference
    - Dave Blake is awaiting feedback due April 1, 2005, from 10 member users

Intrinsically Safe Current Limits for Fuel Tanks – R. Hill (for Rob Ochs)

Reason for this study: There were questions concerning small fragments of cleaning debris (steel wool, etc.), wiring, etc., acting as ignition sources in fuel tanks.

Definition of Intrinsically Safe: Any instrument, equipment, or wiring that is incapable of releasing sufficient electrical or thermal energy under normal operating or anticipated failure conditions to cause ignition of a specific hazardous atmospheric mixture in the most easily ignited concentration (AC 25.981-1X).

Objective: To determine the minimum electrical current that could cause a flammable fuel/air mixture to ignite using a minimum ignition energy test apparatus with a calibrated hydrogen-oxygen mixture and spark source that can reliably ignite the mixture at a determined spark energy.

The results of the previous work done with steel wool were reviewed.

Difficulties with Open Cup.
Current Test Apparatus.
Photo of Hydrogen Chamber.
Hydrogen-Oxygen Mixture.
Calibrating the mixture.
Overall results and individual results for Test Configuration 1, 2, 3, 4, and 5 were presented.
Conclusions and Recommendations.
A paper presented on Intrinsically Safe Current Limits for Fuel Tanks was presented at the November 2004 Fire and Cabin Safety Conference in Lisbon and will be available in the conference proceedings in about one month.

Conrad Roseburg mentioned that Boeing has used propane in similar tests and asked if the FAA had considered using propane instead of the hydrogen mixture. Dick stated that the nitrogen mixture is what those studying lightning effects on fuel tanks in the FAA have used, and it was what the FAA regulatory side recommended using. The explosion caused by propane would destroy the test fixture being used. The lightning group did a lot of research to ensure the repeatability of the test.

<u>Low Fuel Load Flammability Work</u> – R. Hill (for Steve Summer)

Objective: Reduce flammability in a fuel tank.

Apparatus.
Test procedure,
Conclusion.

<u>Hidden Fire Testing Summary</u> – R. Hill (for Tim Marker)

Testing of Thermal Imaging Device (Argus®3) – 3 Scenarios Tested:

1. Stow Bin Fire (simulated and actual)
2. Overhead Area Fire (simulated and actual)

3. Aircraft System “Live” Check

Photos of some of the thermal images detected during the stow bin tests were presented and discussed.

Fast-Port Testing in Narrowbody Aircraft Inaccessible Areas:

Overhead Bin Area
Photo of agent discharge through port
The test report is available on the FAATC Fire Safety Branch website at www.fire.tc.faa.gov.

Conculsion:

The use of handheld extinguishers and ports to combat overhead fires is more feasible in a narrowbody aircraft than a widebody aircraft.

NEA System Installation in 727 Test Aircraft is currently undergoing set-up in front of the FAATC Full-scale fire test facility. The aircraft systems are operational (except systems contained in the wings– wings have been removed). Diagrams of NEA system test set-up were presented. FAATC Fire Safety staff hopes to start running tests in this test article during spring 2005. Flow rate calculations have been done. The future work planned was outlined. If you are interested in becoming involved in this test program, contact Tim Marker at 609-485-6469, or Tim.Marker@faa.gov.

Development of an In-Flight Fire Training Video (Handheld Extinguishers) – R. Hill

- NTSB recommendations A-01-83 through A-01-87.
- AC 120-80 was released on 1/8/04.
- Cabin Safety Research Technical Group provides guidance.

The video will be designed to complement the AC.

Dick described a fire incident investigation in Atlanta that he participated in a few years ago. He also highlighted a couple other fire incidents.

Three Topics will be addressed in the video:

1. Major differences of various types of passenger aircraft.
2. Proper use of firefighting and protective equipment.
3. Discussion of actual accidents and incidents.
   Include stories from flight attendants who were involved in the accidents/incidents.

Engine Nacelle Halon Replacement – D. Ingerson

Equivalence Methodology – Overview, Mass

Equivalence Methodology, Part II – Concentration
Equivalence Methodology:
- Example - Mass
- Example – Concentration

Results to Date:

HFC-125 High Ventilation EquivalenceH
CF3I High Ventilation Equivalence
Resolve Disparate Results Based on Fuel Type
HFC-125 Low Ventilation Equivalence
CF3I Low Ventilation Equivalence
Table of Results to Date
Results to Date – Comparing Results
2-BTP Testing, Purpose & End Point
2-BTP Testing, Main Points
2-BTP Test Video
HFC-125 Tier 2 Testing

Summary/Conclusions:

- Follow-on “check” tests with HFC-125 completed, data reduction on-going.
- Remaining CF3I equivalence iterations will follow.
- Upon completing CF3I iterations, project concludes.

<u>Jet Fuel Vaporization and Condensation: Modeling and Validation</u> – R. Hill (for Rob Ochs)

Part I: Physical Considerations and Modeling
- Motivation
- Principal Assumptions
- Heat and Mass Transport
- Liquid Composition of Jet A

Part II: Experimentation
- Requirements for Experimental Setup
- Measuring Input Parameters for the Model
- Experimental Setup
- Thermocouple Locations
- Experimental Procedure
- Test Matrix
- Dry Tank Ullage Temperature
- Fuel Vaporization: Constant Ambient Conditions at Atmospheric Pressure
- Sea Level Vaporization
  - Flammability Assessment
- Calculated vs. Measured Ullage Vapor Concentration
  - Graph

Varying T & P: Modeled Transport Processes
Varying T & P: Flammability Assessment
Summary of Results

<u>Flight Testing of the FAA OBIGGS</u> – R. Hill (for Bill Cavage)

Goals and Objectives

- Study the FAA dual flow methodology as well as a variable flow system methodology and expand upon existing system performance data
- Develop/validate system sizing data

System Architecture

- Uses air separation modules based on HFM technology
- Accepts hot air from aircraft bleed system
- Cools, filters, and conditions air using heat exchanger air from external scoop
- Air is separated by ASMs and NEA is plumbed to output valves to control flow
- OFM is dumped overboard with H/X cooling through dedicated scoop under aircraft on pack bay panel
- System configured to operate in a dual flow methodology for some tests and a variable flow methodology for others
- Prototype OBIGGS components wired to a system control box by a single cable

OBIGGS Installation

- FAA OBIGGS Installation Drawing in 747 Pack Bay
    - System operation described to meeting attendees
    - Photos of FAA OBIGGS Installation on 747 SCA

Instrumentation and Summary of Testing

- Instrumentation and DAS
    Eight sample locations within the CWT in six different bays (diagram presented)
        - FAA (OBOAS) utilized
    Aircraft Altitude measured by pressure transducer
    Measured flammability of CWT and #2 wing tank
    Laboratory DAS utilized (simple out-of-the-box solution)
    Instrumentation Racks mounted in NASA 747 SCA
        - built at FAATC by Fire Safety personnel
    Flight Test Plan

Results

747 SCA Results – System Performance
747 SCA Results – Fuel Tank Inerting
Graphs of Results Presented

Summary

FAA dual flow OBIGGS concept validated and variable flow methodology studiedf

Future of Fuel Tank Inerting in General:

Boeing has stated publicly that intend on inerting wing tanks on the 787 composite aircraft

FAA will issue a Notice of Proposed Rulemaking (NPRM) for flammability reduction for the commercial aircraft fleet that will require reduction of flammability of the center tanks

<u>In-Flight Fuel Tank Flammability</u> – R. Hill (for Steve Summer)

Background
FAS System Overview
FAS Safety Features
FAS Block Diagram
THC Sample Point Locations
General Flammability Trends seen in flight
Comparison of Data with Models
- Fuel Air Ratio Calculator
- Vapor Generation Model

Model Comparisons – Equilibrium Values
Vapor Generation Model Comparison – Ground Test
Vapor Generation Model Comparison – Flight Test
Summary

<u>Airbus Inerting Modeling</u> – R. Hill (for Bill Cavage)

Modeling of Fuel Tank Inerting
Previous Work – Ullage (0_2) Calculations
Previous Work – Scale 747SP CWT
- Scale model inerting data comparison graph

Previous Work – Average (0_2) Predictions
Modeling Method – Scale A320 CWT
- Block Diagram of Scale A320 CWT Experiment

Results – Scale A320 CWT Model
- Results indicate duplication of flight cycle with the system performance in the altitude chamber was accomplished with coordination of test personnel
- Measured scale tank oxygen concentration data illustrated good agreement with flight test results considering the large differences in measurement systems sample lag

Full-scale model compared with scale model (0_2) results

OBIGGS Sizing Data for Transport Canada Trade Study – R. Hill (for Bill Cavage)

Objective of Work:
Develop data on OBIGGS system performance to be used for a fire fighting trade study
Use OBIGGS size data to develop fire fighting capability of the system
Analysis
Results of Analysis – Low Descent Rate
Summary

Measurement of Leakage of Nitrogen in Confined Areas – R. Hill

The FAATC will be starting this research in the near future. If anyone is interested in providing information for this study, please contact Dick Hill or Bill Cavage as soon as possible. Boeing has provided a list already.

Auxiliary Tank Testing and In-Flight Facility Development – R. Hill (for Mike Burns)

Center Wing Tank Inerting Facility
- Schmatics of Facility

Brief description of facility design and capabilities overview
Explanation of initial work planned at facility
Facility Equipment – 737 CWT
- Diagram

Facility Equipment – Auxiliary Fuel Tank
- Diagram

Instrumentation for each tank
Facility will be a key tool for continued fuel tank inerting and flammability research
- Study the affect varying surface temperatures have on flammability
- Potential industry tool to validate new inerting systems and methodologies

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

Primary Battery Major Findings
- 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 flames making it much easier to spread the fire from one battery to another

Report Published: "Flammability Assessment of Bulk…"
RSPA Interim Final Rule Issued: "Prohibition on the Transportation of Primary Lithium Batteries and Cells Aboard Passenger Aircraft", 49 CFR Parts 171, 172, 173 and 175 [Docket No. RSPA A-04-19886 (HM-224E)] RIN 2137-AE05
Proposed Lithium-Ion Battery Flammability Tests
- Laptop and cell phone batteries
- FAATC will be beginning a test program in conjunction with RSPA on cell phone and laptop lithium-ion batteries (bulk testing for cargo shipments)

TV Dinner Test Results – R. Hill

The Fire Hazard? Of Flameless Cooking in Aircraft: self-cooking meals

Packets contain magnesium and iron filings activate heating when mixed with salt water packet contained in box. Food comes in a packet with a shelf life of 2-3 years.

Situation: Passengers are bringing these meals on board aircraft to eat.

Varies tests were conducted. Problem: 20 liters of hydrogen is produced by each meal under normal use. Five meal heating setups were tested in the 3'x3'x18" fuel tank apparatus and there was a significant reaction to cause a pressure build up by the hydrogen produced the five meals together.

Conclusion: The production of hydrogen from normal use of the meal is a FIRE/EXPLOSION hazard onboard an aircraft.

FAA has given Transportation Security Administration (TSA) the data from these tests for evaluation and determination on whether passengers will be allowed to carry these on board aircraft (with no intention to use them on board).

Next Meeting

June 23-24, 2005, CAA Aviation House, Holborn, London