INTERNATIONAL AIRCRAFT MATERIALS FIRE TEST WORKING GROUP MEETING

JUNE 17-18, 2008

Hosted by Unifrax, Accufleet, Evonik, and Mankiewicz

TUESDAY, JUNE 17, 2008

Unifrax Welcome by Dave Brooks, President, Unifrax

FAA NexGen Burner Update – R. Ochs (FAATC)

Motivation to develop NexGen Burner – Park Oil Burner no longer available for purchase

Review of diagram/schematic of Park DPL 3400 Oil Burner and description of operation of Park burner.

Park Oil Burner Issues: burner housing differences, fuel nozzle differences, Park Oil Burner ceased production (burner housings are no longer produced), and difficulties in calibration procedure. Rulemaking has been delayed due to these issues. Three phases of development of new burner: Proof of Concept, Delivery of several NexGen burners, fundamental analysis of a fully independent burner.

NexGen Components:

Air Delivery -

Critical Flow Venturi (Sonic Choke)

Fuel Delivery –

Draft Tube, Coupling, Back Section, Fuel Tube, Assembly, Stator, Fuel Nozzle,
Igniters, igniter wires, turbulator, Assembled NexGen Burner Housing, Regulator (air pressure regulator) and Muffler (details and diagrams are available in this presentation on the Fire Safety website at www.fire.tc.faa.gov).

Heat Exchange System was explained via a diagram.
Ice Bath design was described.
Burner Operational Parameters (fuel, air)
Flame Temperature Measurement (same as specified in the rule)

Picture Frame Blanket Holder
Frame Alignment
Testing on Picture Frame: Tex Tech Polyacrylonitrile material

NexGen Burner Test Results:

5 burners tested at FAATC with PAN material on picture frame blanket holder with very good agreement found between burners.

Comparative Results:

NexGen burners were shipped out to participating laboratories. Recently, comparative tests were conducted using NexGen burners shipped to European laboratories.

Analysis of all data: data shows that regardless of which roll of material is tested, average burnthrough times can be found within a very good standard deviation.

Recent Work with NexGen Burners:

A graph of the Backside Heat Flux Results was presented and described. The same heat flux transducer was used at each lab.

Heat Flux Measurements
Burner Cone Tests: a quick comparison test was made on two different cones. A significant difference was found between the two tests. What are the key parameters: exit plane shape, material thickness, effect of exterior strengthening ring, etc.

Room Size Tests

Future Work:

Determine exact cause of small variation in heat flux readings (room size, environmental factors, etc.) Determination of effect of various cones on test results.

<u>Analysis and Design of FAA Fire Test Burner</u> – R. Ochs (FAATC)

Motivation
Objectives: Identify key parameters, improve design
Methodology
Particle Image Velocimetry (PIV): is a whole-flow-field visualization technique that provides instantaneous velocity vector measurements in a cross-section of a flow.
PIV Methodology: PIV relies on laser light scattered by particles following a flow, resolution and range dictated by particle velocity
PIV for Fire Safety: Material fire test methods dependent upon accuracy of test methods (fire test methods involve burners), analysis of post-crash fuel fires, visualization of fluid flow within an enclosure, sprays (water mist, extinguishment agent sprays)
Photo of FAA Fire Safety's PIV Laboratory – will analyze both Park and NexGen Oil Burners in the near future (nozzle spray, air flow, combined air flow and fuel flow, analysis of flame).
PIV System Validation: validation measurements must be performed initially, jet, jet is similar to a Bunsen burner.
Acquired Data – Fuel Nozzle (this has been done at FAATC PIV laboratory)
Acquired Data – Burner Air Flow
Future Work: refinement of PIV skills, create test matrix, perform measurements, analysis of data

<u>Update on Flammability Testing of Magnesium Alloy Components</u> – T. Marker (FAATC)

Magnesium Alloy Flammability Background: renewed interest in using mag-alloys in commercial aviation, current FAA TSO C127 "Rotorcraft and Transport Airplane Seating Systems" makes reference to SAE specification. SAE specification explicitly bans the use of magnesium in seat frames.

Magnesium Alloy Use Potential Locations: air distribution plenum, seat tracks

What Has Been Done?

Oil burner testing
Handheld extinguisher testing
Miscellaneous testing

Chart of Results of Mag Alloy Tests Using Oil Burner
Findings of Oil Burner Testing: none of the mag alloy bar samples melted prior to 2 minutes, 78% of samples (18 of 23) continued to burn after burner flame removed, 22% of samples (5 of 23)self extinguished within 5 seconds, sample performance largely dependent on alloy type and section thickness
Critical Elements of Postcrash Lab Test for Magnesium: orientation of sample, time to reach melting, flame duration/exposure time, ignition following melting (y/n)
Handheld Extinguisher Testing of Mag Alloy Samples: Summary: 7 tests conducted on ignited mag-alloy samples, Halon 1211 least effective at extinguishing, water most effective.
Preliminary lab scale fact-finding testing, handheld extinguisher testing, define critical elements of preliminary testing (these have been completed)
Future Work: conduct full-scale test using mag-alloy seat frames (proof of concept), develop lab scale test based on full-scale results.

Explanation of plans of how to conduct full-scale test using mag-alloy seat frames.
Initial Planned Testing at FAATC: Full-Scale Fire Testing (3 seats) – baseline using OEM aluminum frames, fire-blocked seat cushions/ substitute poor-performing mag alloys, substitute good performing mag alloys.
Interim Task Group Meeting at FAATC (2/21/08): Conclusion: conduct 4 full-scale tests (aluminum baseline test, poor performing mag-alloy used in primary components, good performing mag-alloy used in primary components, good performing mag-alloy used in all components)

Full-scale testing update: showed photos of previous test set-up to give indication of how the full-scale tests will be set-up, B707 fuselage, fully fire hardened interior, aircraft grade carpet, .25 inch thick crushed-core Nomex honeycomb panels (meets 65/65), diagram of test apparatus was shown and described, seat configuration and location (sketch)
Procurement of Seats for Full-Scale Testing: These had to be 16G seats. FAATC was looking to acquire 24 triples. B/E Aerospace “990” seats were acquired from Avianor, an aircraft spares company located in Canada. The seats purchased did not have seat cushions and back upholstery and cushions. One seat has been disassembled and sent to have mag alloy parts copied and produced. Six sets of good performing mag-alloy, and six sets of poor performing mag-alloy components will be produced, then they will be reassembled and the tests will be conducted. A final test will be conducted in which all of the aluminum components will be replaced with a good-performing mag-alloy material.

Future Considerations: manufacturer’s perspective necessary to determine value of developing new test methodology. George Danker asked when the tests will be conducted: Tim estimates the tests will start in mid-July. People are invited to come to the FAATC to witness the tests. They may want to wait until the second or third set of tests after baseline tests are completed. Jim Davis offered to check to see if the components they would otherwise be throwing out could work as backup materials for the seats.

<u>Special Conditions for Passenger Airplanes, Seats with Non–Traditional, Large Non-Metallic Panels</u> – T. Marker (FAATC)

Relates to FAA Notice 25-06-13-SC for 737 airplanes, must meet smoke and heat release rating per the rule
Memorandum 97-112-39, Guidance for Flammability Testing of Seat/Console Installations, October 17, 1997. Memo noted that large surface area panels must comply with heat release and smoke emissions tests. Definition of this type of panel: a panel with exposed surface areas greater than 1.5 square feet installed per seat place, etc.
Final Rule Amendment 25-83: panel size was defined in this rule.

Scott Campbell described the confusion with the interpretation of these special conditions and the explanation that Alan Sinclair of the FAA Transport Airplane Directorate provided on them during a DER seminar he attended. Tim commented that Alan Sinclair wrote these special conditions. Antonio Chiesa requested that Alan Sinclair be present at the next Materials Working Group meeting.
Tim went over the Final, Special Conditions. Dan Slaton commented on the 1997 letter relating to interpretation issues on furniture-like structures. Dan Slaton asked if it would be interesting to get the smoke and heat release data on the seat cushion fabrics and foams that will be used in the mag-alloy full-scale tests?

<u>OSU and NBS Testing Update</u> – T. Marker (for Mike Burns)

2007 Independent Mini-Study: OSU Test Results of tests conducted during this mini-study were presented.
NBS Test Results were presented.
Review of mini-study findings posted on FAA Fire Safety website – Mike Burns would like to know if other labs have similar problems.
NBS Furnace: FAATC has been notified that any manufacturing defect previously noted has been corrected.
NBS Photometric System Round Robin is currently being conducted at participating labs. Please contact Mike Burns at the FAATC if you would like to participate (609-485-4985, or Mike.Burns@faa.gov).
The FAA is in the process of updating Chapter 6 of the Aircraft Materials Fire Test Handbook, comments will be accepted by Mike Burns through August 2008.

<u>Toxicity Testing of Burnthrough Compliant Insulation Systems</u> – T. Marker (FAATC)

Apparatus for Evaluating Toxic Gas Decomposition Products
Lab-scale apparatus for evaluating toxic gas decomposition products
FTIR and THC Sampling System Used in Lab-Scale Testing – system diagram shown and explained
Table listing of some of the gases measured by FTIR
Material Systems Tested in Lab-Scale Apparatus
Graphs shown:

PAN Insulation Test Using FTIR Analysis
PAN Insulation Test Using Gas Analyzers
FG/Ceramic Barrier Insulation Test Using FTIR Analysis
Structural Composite Material Test Using FTIR Analysis
Comparison of Box Test Results at 5 Minutes
A Technical Note will be published in approximately 1-2 months
Full-Scale Test Article for Evaluating Decomposition Products of Burnthrough Compliant Insulation Systems and Non-Metallic Fuselage Structure: photos of test set-up, schematic of the system including location of instrumentation
FTIR and THC Sampling Systems Used in Full-Scale Testing
Full-Scale Test Results, PAN Insulation System: pre-test photo
Full-Scale Test PAN Metallized PVF – FTIR results
Comparison of FTIR and Gas Analyzers for Full-Scale PAN Met Test
Full-Scale Test Results, Ceramic Barrier Insulation II, Gas Analyzer
Full-Scale Test Results, Structural Composite System: pre-test photo, post-test photos, gas analyzer and FTIR results
Fractional Effective Dose Comparison, Forward Station, 66” Height – graph (PAN FED, Ceramic Barrier FED, and Composite Skin FED).

How does this data compare to a small-scale test and what do we do with this data?

Explanation of Determination of Gas Concentration Scaling Factor
Gas Concentration Scaling, Findings: analysis only considers volumetric aspects, analysis assumes perfect mixing, analysis does not consider surface area affects, not all of the gases scale similarly.

Discussion of FTIR and Toxicity Limits – Louise Speitel (FAATC)

A copy of Louise's presentation is available at www.fire.tc.faa.gov

Outline:

Purpose
Toxicity Measures for 5 minute exposures
Toxicity references
Other Hazard Measurements
Allowable 5 Minute Box Toxicity Limits
Setting Lab Scale Gas Concentration Limits

Development of a Lab-Scale Flammability Test for Composite Fuselage – R. Ochs (FAATC)

There is a need to evaluate the fire properties of a composite fuselage

Evaluation of Flame Propagation Risk

Development of Lab-Scale Test: possibly use a radiant panel test apparatus
Previous Work on Composites: FAA Report DOT/FAA/AR-07/57 ("Flammability Properties of Aircraft Carbon-Fiber Structural Composite")
Material Details: resin is primary fuel for reactions, thermal conductivity was measured with a home-built apparatus.
Flame Spread Experiments: critical heat flux was found from cone calorimeter measurements, apparatus was developed in the work of Panagiotou and Quintiere
Status: work is in the initial phase right now, initial work will involve tooling with the radiant panel and different composite material plaques to observe how the material behaves

Medium Scale Test for CFRP In-Flight Fire – H.P. Busch (Airbus)

Motivation: FAA proposed substantiation – the suggestion to determine the flame propagation risk of a CFRP fuselage is:
Fire Source Investigation: determination of heat flux and temperature generation of the FAA-PU block
Diagram of location of measurement points
Heat flux density
Temperature profile
Test Set Up: photos and schematic
Material behavior: graph
Temperature Propagation
Test Result: photos – Airbus statement: the sample of 1200 mm x 1000 mm is sufficient to validate the flame propagation risk of CFRP fuselage design, smoke and toxicity could be determined in the NBS chamber under modified test condition.

Development of a New Flammability Test for Aircraft Ducting – J. Reinhardt (FAATC)

This presentation was given by Tim Marker (for John Reinhardt) during the March 2008 Materials Working Group meeting in Brazil. John Reinhardt presented it again at the Niagara Falls meeting for the benefit of those that did not attend the one in Brazil.
Background
Project Objective: to develop a fire test method for aircraft ducting materials
Work Breakdown Structure: review historical information, meet with stakeholders, define new fire threat, test methods selection, material selection, material testing, evaluate test methods, select/modify selected test method, verify test method, and publish test method – this work has been completed.
Final report: DOT/FAA/AR- 08/4 published February 11, 2008, is available at www.fire.tc.faa.gov

Development of an Improved Fire Test Method and Criteria for Aircraft Electrical Wiring – J. Reinhardt (FAATC)

Project Charter: develop a fire test method for aircraft electrical wiring that can adequately discriminate between poorly performing materials and well performing materials

John explained Pat Cahill's test that initiated this work.

Scope Statement: this project will focus on the flammability characteristics of aircraft wiring insulation only.
Work Breakdown Structure: review historical information, meet with stakeholders, define fire threat, test method selection, material selection, material testing, evaluate test method, select/modify selected test method, verify test method, and publish test method. Under the material testing activity section, John presented fire test data (60 degree flammability test, microscale combustion calorimeter and intermediate-scale fire test) of the selected 22 wires and cables. He met with task group members and discussed the test protocol to be used in the radiant heat panel test; the selected test is a combination of the 60 degree flammability test with the radiant heat panel test. A round robin activity was requested once the protocol has been designed and tested.

Project Status: 61% completed

Oil Burner Seat Test – Restraint of Leather Seat Cushions During Testing – T. Marker (FAATC)

Photos of vertical and horizontal configurations

There is currently no guidance on restraint of these materials during testing in the *Aircraft Materials Fire Test Handbook*.

Radiant Panel News – T. Marker (for P. Cahill)

The Series 93 controller is being phased out. The new controller is called the EZ-Zone^{TM} PM Controller.

WEDNESDAY, JUNE 18, 2008

Participatory Discussion Groups

Magnesium Alloy Flammability and the Full-Scale Testing of Seats – T. Marker

Jim Davis: Are you going to be looking at the performance of the seat structure only? If the fire blocking system is marginally performing, it may affect what you are trying to accomplish with the

baseline test. Jim will take a look at the seats of this type that they have at their facility and get back to Tim on what type of seat cushion./fire block systems they have.
Dan Slaton: You used 4 seats for the lightweight seat cushion testing, why 6 seats for this one? Tim: I try to keep the full-scale seat testing to within their series and try not to compare what we are currently doing to what we have done in the past (ie: tests conducted in 2008 to tests that were conducted in 2005). We have to run with a realistic, current seat configuration.
Rob Ayerst: What about testing magnesium alloys in other aircraft applications? Tim: we have to see how they perform in the full-scale seat tests and then decide where to go from there as far as other applications.
Antonio Chiesa: what plans are you making regarding fire fighting during this test? Tim: it would be helpful to have some type of water spray that would simulate crash-fire rescue in there to see what type of reaction we get (either water or AFFF, because that's what the CFR team would be using). It is important to see what reaction the magnesium alloy has to the fire fighting agent. We will have to make an agreement on what agent will be used for this and keep it the same for the entire test series.
Peter Busch: what about fighting an inflight fire? Tim: we haven't thought about how we would configure an inflight fire test with alloy materials. We are starting with the post-crash fire scenario and will take it from there.
Jim Peterson: Assume there is one magnesium alloy that does not perform badly. How would you arrange for the industry to be able to use this – how would it work with the certification side? Tim: that is more of a regulatory question. A test method would have to be developed such as the oil burner test. I understand your question, but at this point, it is many steps from where we are before we get to that point.
Dan Slaton: will you let us know the test schedule even the baseline? Tim: send me an email and let me know what test you are interested in viewing, and we will work it out. No problem with viewing the baseline tests if you are more interested in that. There is limited space, so we will have to work something out regarding the number of people who can view each test (ie: lottery-type system).

<u>Burnthrough Compliant Insulation Toxicity</u> – T. Marker/L. Speitel

Box test discussion.

Dan Slaton: industry is looking for performance criteria (what are the values we would have to stay below?). We need to talk about the test method first. It doesn't seem like there is a correlation from the full-scale test to this box test. Tim: We were trying to create a test that is easy to conduct/run. Dan: I think you need to get back to a full-scale test and scale it down, so the box test is more realistic. Tim: what I'm hearing is that industry does not want the simplified version of allowable decomposition limits in the box test. You would rather have the allowable limits based on the toxicity in a full-scale test. Dan: that is not exactly what we are saying. Tim: we have factored in so many levels of safety at each iteration. Rob Ayerst: It may be there is a test already in existence that correlates to the full-scale test (such as an existing smoke and toxicity test). Louise: we feel very strongly that we have to match the threat of a full-scale test for this to correlate at all, and that is what Tim did in the design of this test. Scott: originally, I thought the scope of this work was looking at the toxicity of composites and now it seems that we are looking at toxicity of insulation materials. Tim; we started out with the composites. We also had to look into burnthrough compliant systems to determine if there is a contribution from the materials themselves. This is meant to be guidance material not a new regulation. Louise: we matched the box test configuration as closely as we could for correlation with the full-scale test. Dan: it seems as though the scaling in the box test has not been validated. Tim: there is definitely some type of scaling between the full-scale and lab-scale box test. Obviously, the concentration in the small-volume box test should be much much greater than what we saw in the full-scale tests. Our volumetric calculations tell us it should be about 22 times greater, however, we haven't seen that correlation across the board for all gases measured, just a few. Louise tried to explain why some of the gases do not scale the way we would expect, but the bottom line is that we are trying to establish some realistic, conservative allowable limits for decomposition products using the box test. By doing this, it eliminates the need to run full-scale tests in the future, every time a minor change is made to the basic structure (for example changing the resin in a composite structure).

NexGen Burner – R. Ochs

The drawings are available now so labs can build a NexGen burner. Francisco: It would be good to have the tolerances included. Rob suggested using standard tolerances. Has the FAA looked into a cooling system other than a cooler filled with ice. Rob: At the Airbus lab they use a refrigerator/freezer which keeps a constant temperature throughout the day.
Rob proposed running a Round Robin with insulation blankets. There is interest in this Round Robin, so Rob will coordinate with the participating labs.

Contamination – D. Slaton

This task group is in the process of writing a summary report on all its activities (airline contamination survey, in-service insulation blanket evaluations, flammability testing of contaminants, aging methodologies, contamination risk mitigation methodology and roadmap). Dan reviewed the recommendations of each of the following areas (airline contamination survey, in-service insulation blanket evaluation, flammability testing of contaminants, aging methodologies, contamination risk mitigation methodology and roadmap).

Ray Cherry presented status of Contamination Risk Mitigation Methodology and Roadmap and the proposed route forward. The current initiative by the industry does not accommodate aging of thermal acoustic insulation and hence the Task Group needs to decide how this issue is to be addressed.

Electrical Arc Fault Simulation for Testing of Aircraft Materials – this test rig was developed by RGW Cherry & Associates. Objective: the purpose of developing an arc fault test rig is to simulate arcs. It is for research purposes not for regulatory purposes. Culham Lighting Limited (U.K.) advised on the arc and devised an arc generator. Ray reviewed the achievements to date (rig has been commissioned and the methodology for testing defined, flame speed measurements) – next steps: testing with contaminants (CICs and cleaning fluids).

Inflight Flame Propagation of Composite Materials – R. Ochs

Rob's plan at this time is to develop a lab-scale test so that the foam block test does not have to be conducted for each composite material configuration. Rob will conduct some intermediate-scale tests before developing and going to lab-scale tests.

Next Meeting

October 21-22, 2008, Trump Taj Mahal Hotel-Casino, Atlantic City, New Jersey.