International Aircraft Materials Fire Test Working Group Meeting

Seat Cushion and Cargo Liner Oil Burner Update

Presented to: International Aircraft Materials Fire Test Working Group

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Introduction

• Updated Chapters 7 and 8 of the Handbook
  – Seat cushion and cargo liner burner configuration
  – Cargo burner test results
  – Seat cushion and cargo liner interlab studies
  – Muffler foam insert tests
  – Air pressure regulator

• Planned Projects
  – Cone alloy comparison
  – Test cell ventilation testing
Handbook Updates
NexGen Burner Background

- The original concept was to retain the same internals from the Park burner for use in the NexGen burner in order to keep burner performance similar.

- After trialing numerous stator/turbulator configurations with little success, other options were considered.

- Oil burners on the market today no longer use stators and turbulators.

- Flame retentions heads (FRH) are now used in their place:
  - Generate a more efficient and complete combustion
  - Simpler in design
  - Relatively easier to produce.
Current Burner Configuration

- FRH proven to work for seat and cargo burner
- Goal to make all burners the same using new igniterless stator and spark plug configuration
- Disadvantages of FRH
  - Stamped steel part (tolerance concerns)
  - Spacer tube required in draft tube
  - Static plate not a “tight” fit (fuel nozzle alignment issues)
  - Use of internal igniters and wires (airflow disruption)
  - No set method of positioning igniter wires
  - FRH and static plate may change in design or become obsolete in the future
Current Burner Configuration

• Igniterless stator configuration currently being tested for use with seat cushion and cargo liner oil burner test method
• Testing has shown using the igniterless stator for cargo liner is repeatable
• Will test igniterless burner for use with seat cushion test method when facilities become available (renovations currently underway)
• No machining required to convert to igniterless stator configuration except for adding threading boss for spark plug
Temperature Profiles 4 inches above Backface of Conolite Cargo Liner using Igniterless Stator Configuration

- Conolite 1
- Conolite 2
- Conolite 3
- Conolite 4
- Conolite 5
- Conolite Avg
Temperature Profiles 4 inches above Tedlar Coated Cargo Liner using Igniterless Stator Configuration

- Tedlar 1
- Tedlar 2
- Tedlar 3
- Tedlar 4
- Tedlar 5
- Tedlar Avg

Time (sec)
Temperature (F)
Round Robin Studies

• Currently have planned “mini” interlab study for both seat cushion and cargo liner oil burner test methods
• 4 labs participating for seat cushion
  – 3 different cushion types per lab (3 of each type)
• 3 labs participating for cargo liner
  – 2 different liner types per lab (5 of each type)
• Participating labs kept to a minimum due to time constraints and available burner stators/cones
• Materials to be shipped first week of March
Round Robin Studies

• Test results needed for seat and cargo before a decision can be made regarding final burner configurations
• Cargo liner tests have shown excellent repeatability within the FAA lab
• No seat tests have been performed as of yet
• Final copy of updated chapter 8 for cargo liner is currently under review
• Updated chapter 7 to be released when test data is available
Muffler Foam Insert

• A 3” diameter by 12” long reticulated foam cylinder is required to be used in the burner muffler

• Testing showed minimal effect on test results

• Reduce burner noise from ~95 to ~82 decibels

• Similar to light road traffic vs. a subway train
Temperature Profiles for Burner with and without Foam Insert in Muffler

![Graph showing temperature profiles](image)

- **No Foam Avg**
- **With Foam Avg**

- **X-axis:** Time (sec)
- **Y-axis:** Temperature (°F)
Muffler Foam Insert

- Foam insert can have a tendency to discharge from the muffler into the burner tube

- Recommend using safety wire of a diameter of ~0.032 inches inside muffler in a cross-type pattern to restrain foam
Muffler Foam Insert

• New and old style mufflers have slightly different inner and outer diameters, although, still share the same McMaster-Carr part number
  – Old 3” outer diameter
  – New 2 5/8” outer diameter

• Testing planned to determine if this will impact burner performance
Air Pressure Regulator

- Constant air pressure control is crucial for repeatable burner test results
- Many regulators commercially available not suitable for use with the NexGen burner
- Quality concerns (even new)
- Some pressure regulators may vary by +/- 3 psi or more
- Handbook requires air pressure maintain 45 +/- 1 psi
- Recommend McMaster-Carr regulator part # 49305K23 with an operating range of 0-55 psi
- Alternative regulators planned for testing
Planned Projects
Cone Alloy Comparison

- Current standard for burner cone alloy is 310 stainless steel
- Cones have been found to deform by up to ½ inch or more after a moderate number of heat cycles
- Plans to test 625 Inconel and Hastelloy X alloy cones compared to 310 SS
- Burn for 2 minutes, cool for 10-15 minutes, repeat
Cone Alloy Comparison

• Used cone (left) and new cone (right) show the difference in shape after testing

• Used cone changed from 11 x 6 in. to 11.375 x 5.5 in.
Lab Variables

- **NexGen should always perform the same if assembled and operating correctly**

- **Differences in the test lab setups are likely the cause of data discrepancies among test labs**

- **Test cell size, ventilation hood height, airflow in the test cell are can impact burner test results**
Test Cell Size

- Heat from the flame can be reradiated back toward test sample from nearby walls
- Larger test cells would show less of this effect
- Ambient air temperature can increase quickly in smaller test cells
Ventilation Hood Height

- The height of the ventilation hood can impact on test results

- A hood located close to the sample can pull more hot air and heat away from the sample resulting in a lowered temperature reading

- Hood should be close enough to remove smoke but not too close as to affect test results
Test Plan

• Recently purchased two NIST traceable Dwyer Instrument model 641-6-LED anemometers for use in ventilation airflow testing
• Minimize test cell volume using partitions
• Maximize test cell volume in full scale lab
• Test cell sizes in between
• Vary ventilation fan speed
• Recommend ventilation airflow for labs based on test results
Handbook Discussion
Summary of Handbook Updates

• **Incorporate NexGen burner into Handbook**

• **Recent burner changes**
  – Igniterless stator and cone-mounted spark plug
  – Flame temperature “check” (1700° F +/-100° F) using 1/8” thermocouples
  – Fuel and air pressure gauges required to be NIST approved (or equivalent) and have an accuracy of +/-2% or less
  – Muffler foam insert required

• **Discussion regarding suggestions or concerns during task group meetings**
Questions?