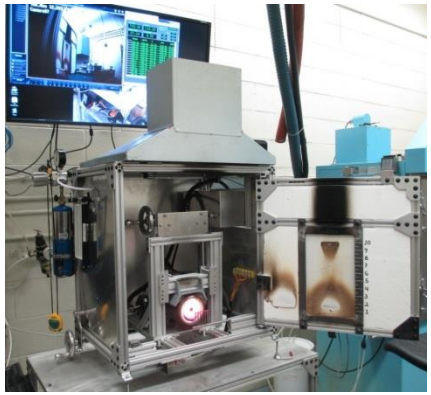
# Development of a Flame Propagation Test Apparatus for Inaccessible Area Materials

Federal Aviation Administration





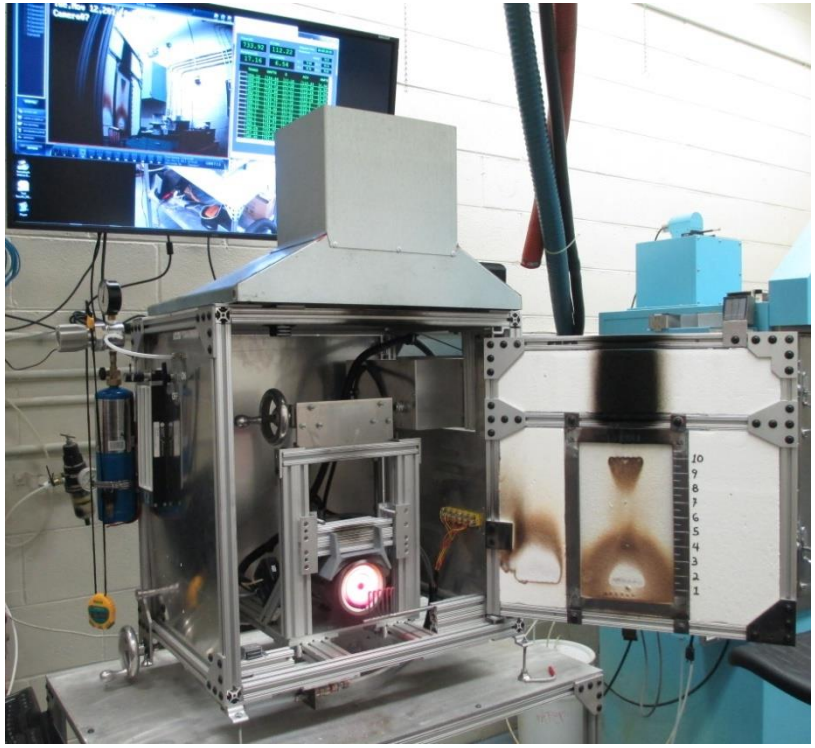
Presented to: IAMFTWG
By: Robert I. Ochs
Date: June 3-4, 2015, Bremen, Germany

# Introduction

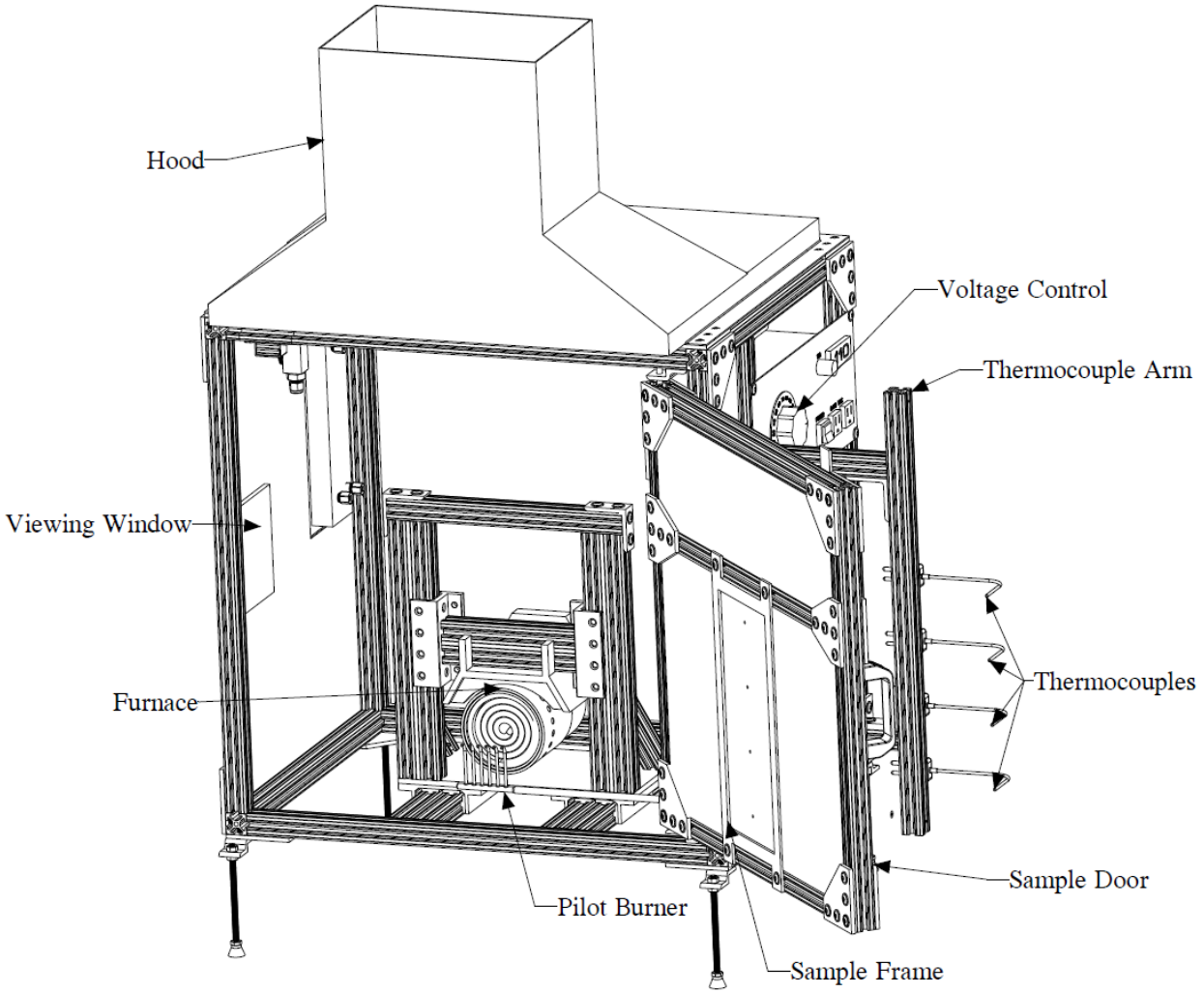
- Carbon fiber composites are being used more frequently in aerospace applications
  - Increased strength
  - Lower density
  - Better corrosion resistance
- New designs of commercial transport airplanes include primary and secondary structure constructed from carbon fiber composites
- Current FAR's do not require flammability testing for fuselage skins or structures, as traditional designs are inherently non-flammable
  - Special Conditions for certification of fire resistance of composite fuselage
  - Must demonstrate level of safety equivalent to or better than traditional constructions
- To continue with the FAA's efforts to enhance in-flight fire safety, materials in inaccessible areas of the cabin should meet a flammability test based on the "block of foam" fire source

# Objective

- Design, construct, and evaluate a new flame propagation test method
  - Determine effectiveness of evaluating flame propagation
  - Determine level of repeatability and reproducibility
- Deliver new test method to FAA Transport Directorate for use in certification of novel design airplanes
  - Inclusion in next-generation fire test requirements
  - Possibly replace current Special Conditions requirements
- Attempt to test other inaccessible area materials on same apparatus
  - Wire insulation
  - Ducts, hoses



# Vertical Flame Propagation Test Apparatus



# What's New?

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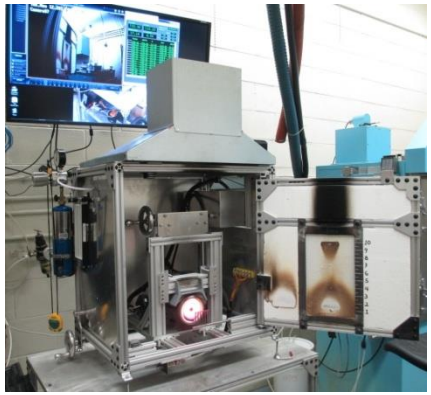

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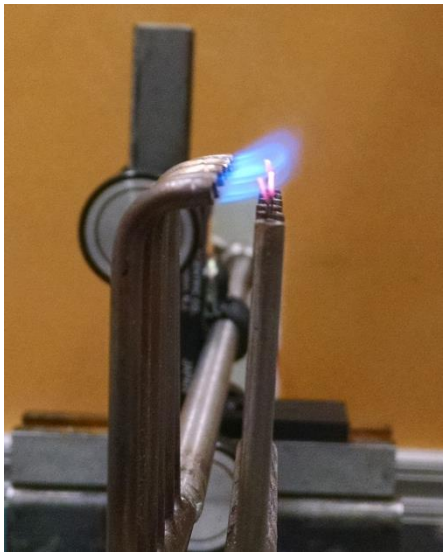
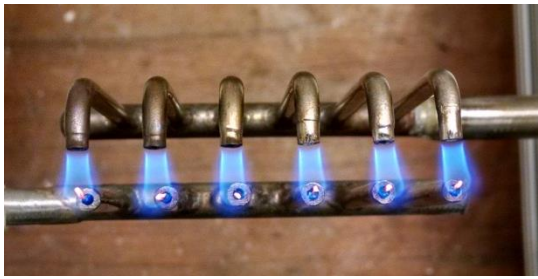
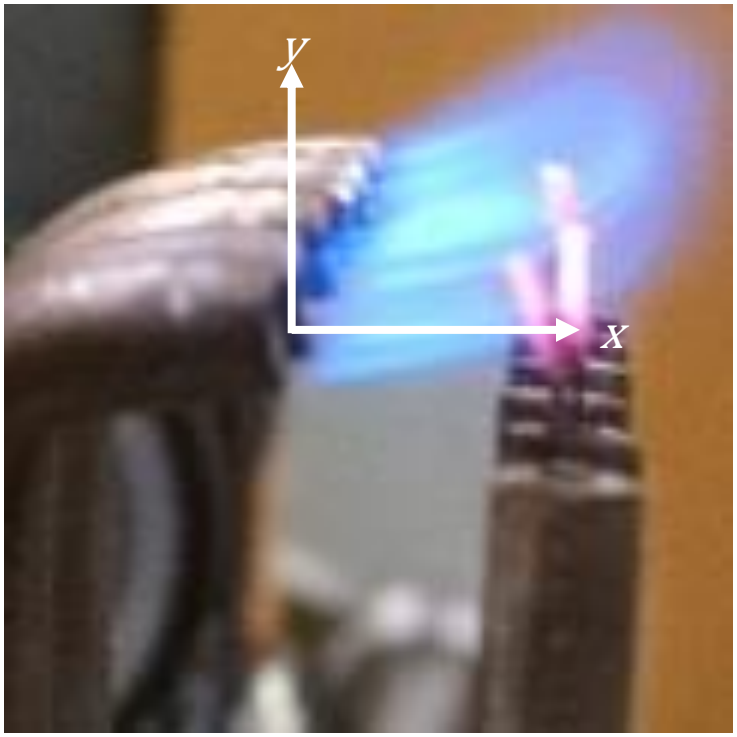
# Flamelet Temperature Measurement

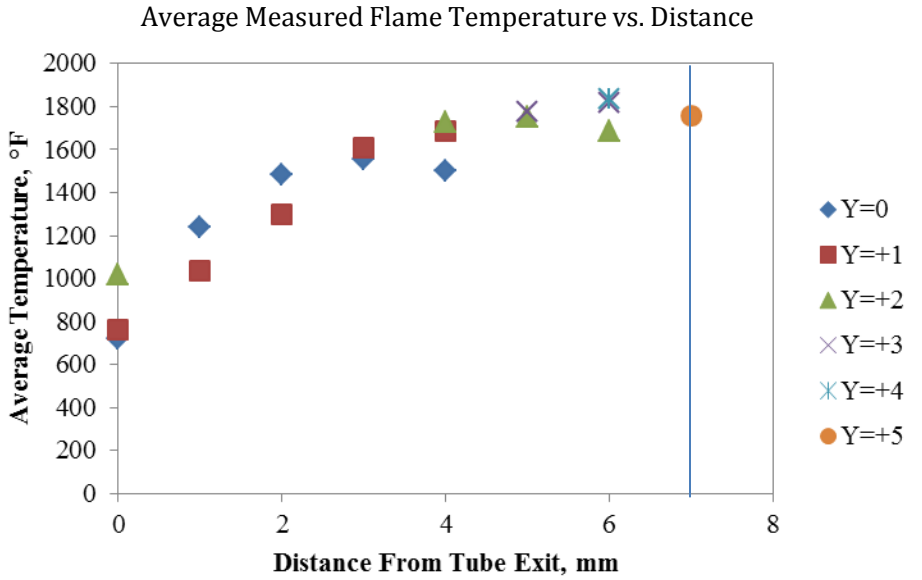
- New VFP under construction
  - Base being used to traverse thermocouples through pilot flames
- Small thermocouples used to assess relative flame temperature
  - 24 AWG, .02” diameter
- An old pilot burner was used to align and traverse thermocouples
- Very difficult to have all 6 thermocouples in the same spot in each flame
  - These measurements are only approximations, and are being used to evaluate the relative difference in measured flame temperature as a function of distance

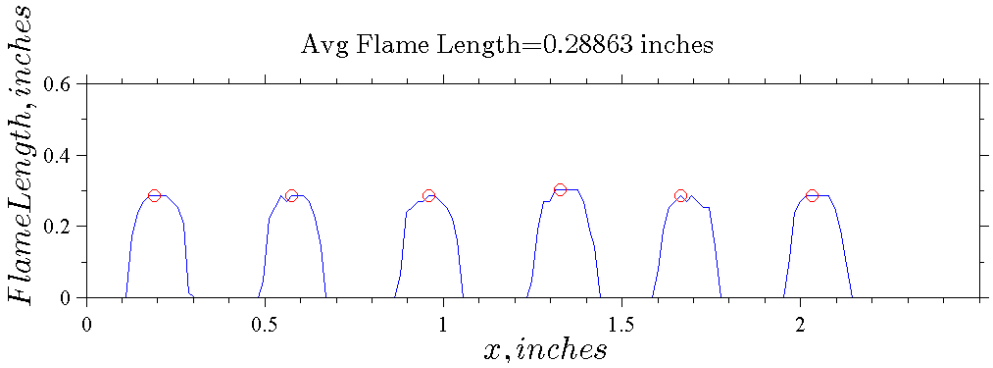




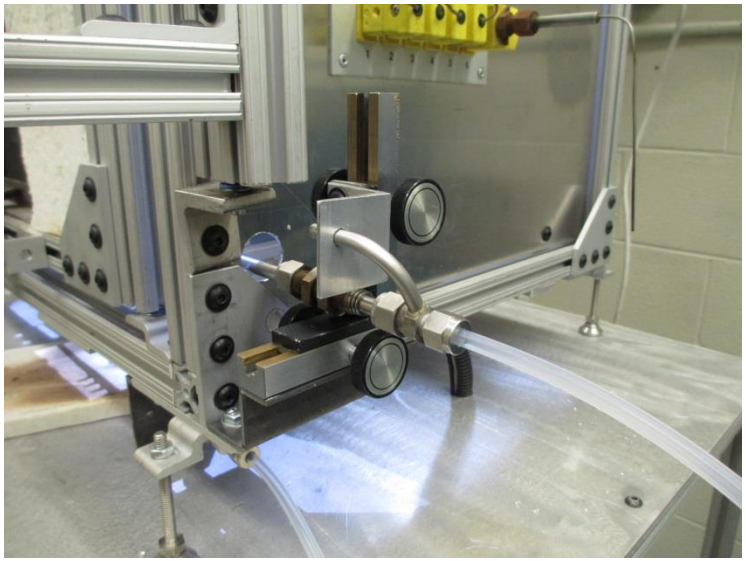
# Flame Temperature Measurement

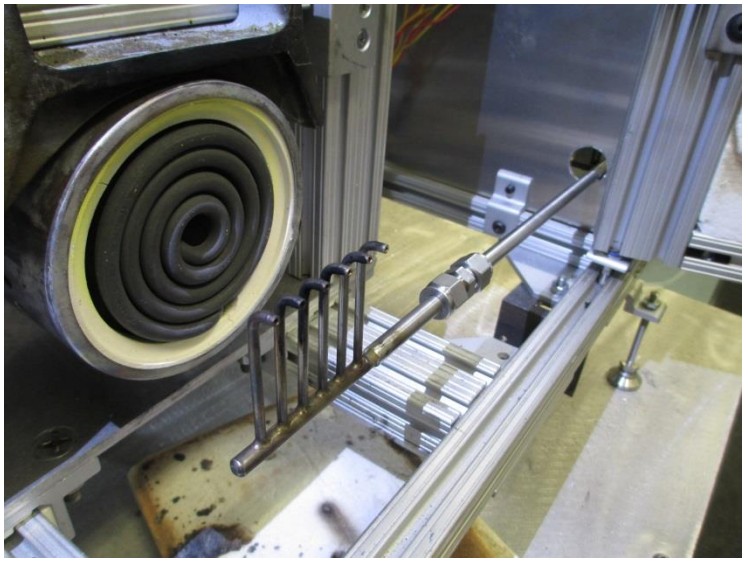


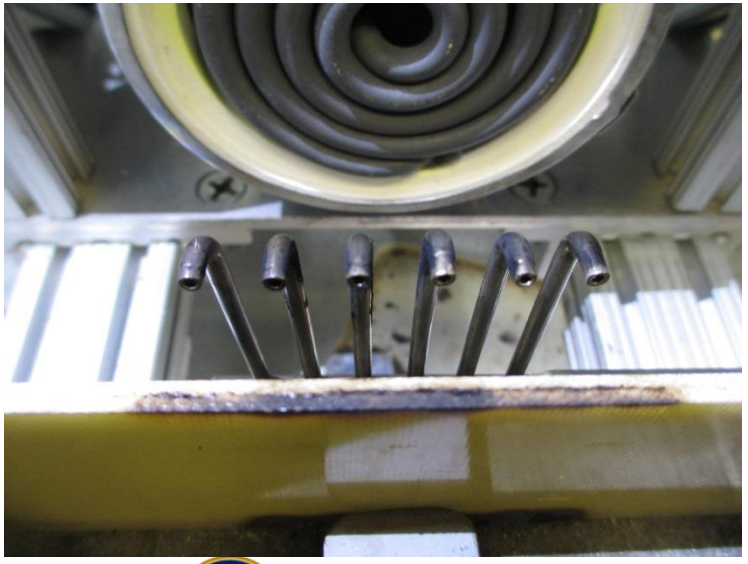



# Traverseable Pilot Burner









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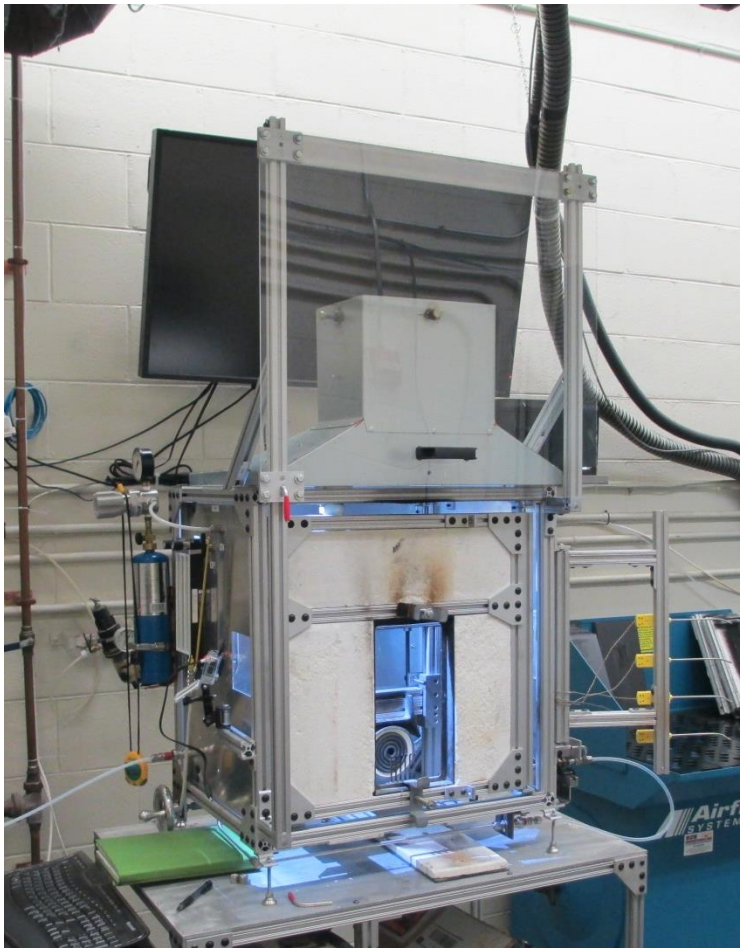
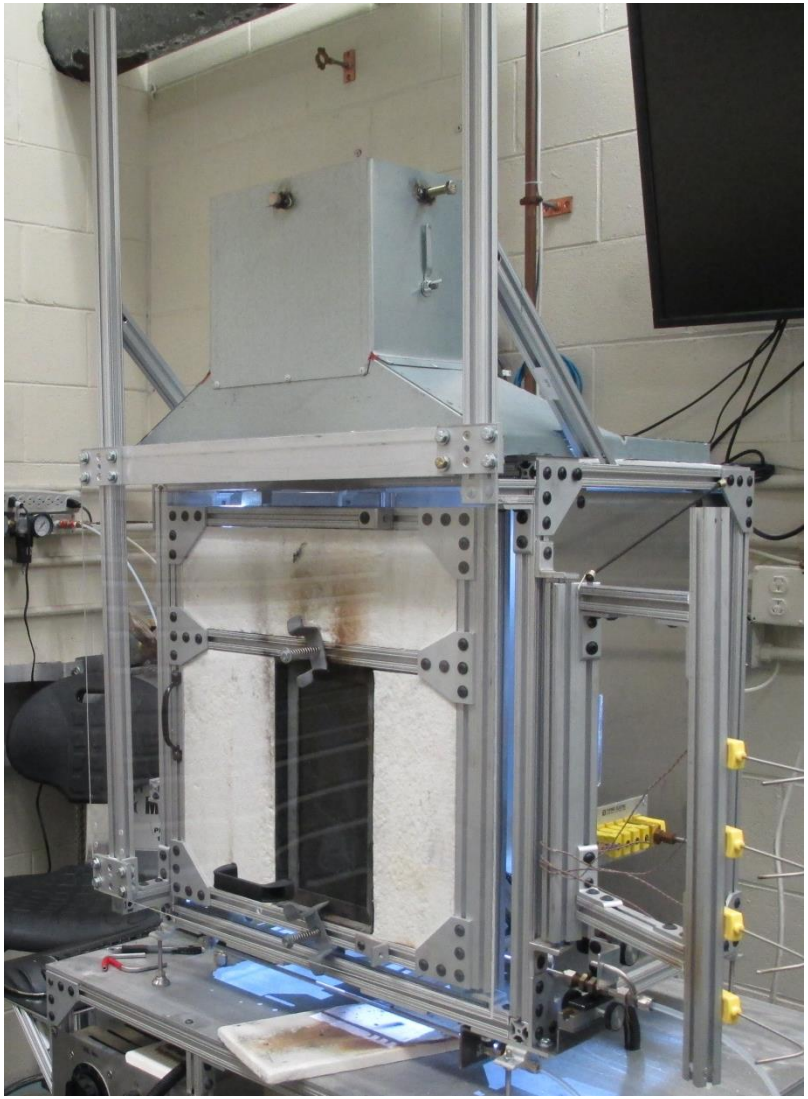


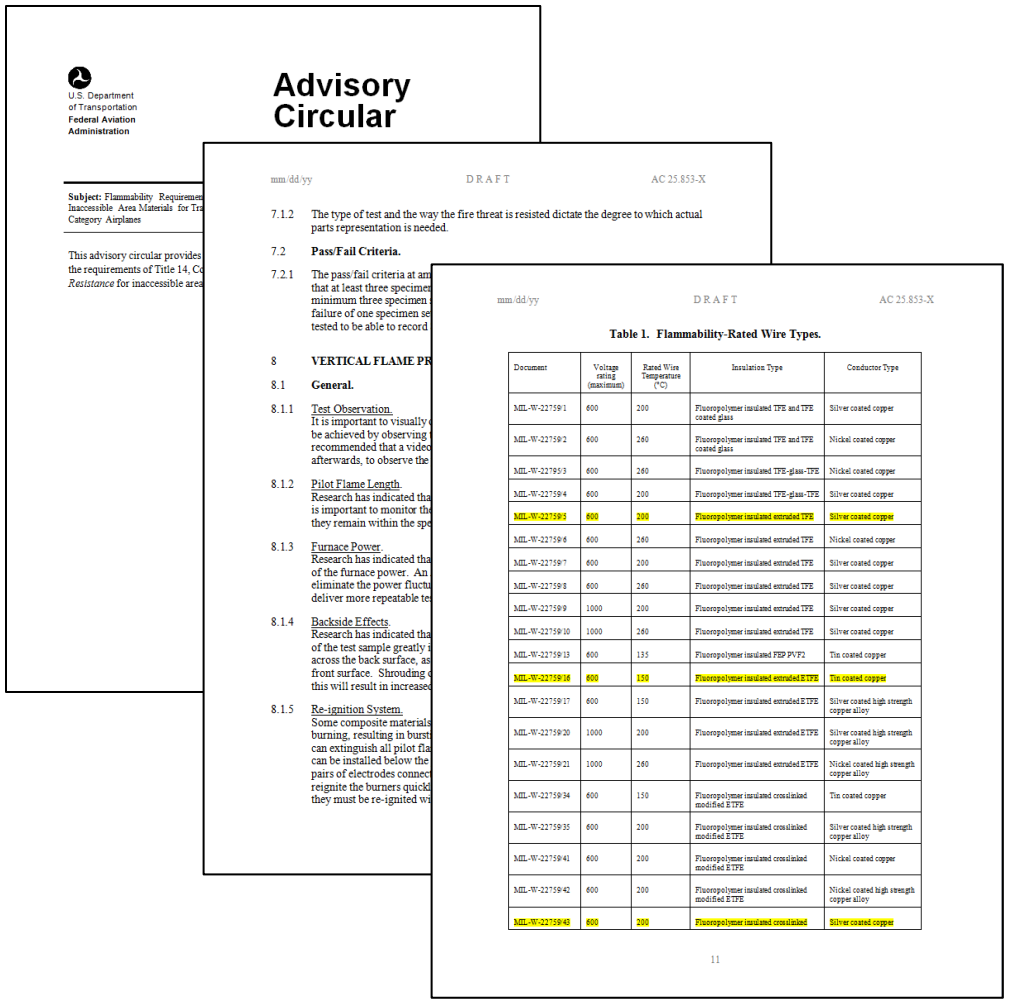
# Built-On Sash Hood



# Next Steps

- Gather large quantity of composite samples for testing
  - Similar to original comparative test series
    - CFRP panels from 4-12 plies
    - Unidirectional tape and woven fabric layup
  - Obtain enough samples to adequately assess repeatability at different pilot flame distances and flame lengths
  - Once a distance and length is chosen, perform tests on other machines, determine reproducibility

# Development of Advisory Circular


U.S. Department of Transportation
Federal Aviation Administration

**Advisory Circular**

mm/dd/yy D R A F T AC 25.853-X

7.1.2 The type of test and the way the fire threat is resisted dictate the degree to which actual parts representation is needed.

7.2 **Pass/Fail Criteria.**

7.2.1 The pass/fail criteria at am
that at least three specimen
minimum three specimen
failure of one specimen se
tested to be able to record

8 **VERTICAL FLAME PR**

8.1 **General.**

8.1.1 Test Observation.
It is important to visually
be achieved by observing
recommended that a video
afterwards, to observe the

8.1.2 Pilot Flame Length.
Research has indicated tha
is important to monitor th
they remain within the spe

8.1.3 Furnace Power.
Research has indicated tha
of the furnace power. An
eliminate the power fluctu
deliver more repeatable te

8.1.4 Backside Effects.
Research has indicated tha
of the test sample greatly i
across the back surface, as
front surface. Shrouding
this will result in increase

8.1.5 Re-ignition System.
Some composite materials
burning, resulting in burst
can extinguish all pilot fla
can be installed below the
pairs of electrodes connec
reignite the burners quickl
they must be re-ignited wi

mm/dd/yy D R A F T AC 25.853-X

**Table 1. Flammability-Rated Wire Types.**

| Document | Voltage rating (maximum) | Rated Wire Temperature (°C) | Insulation Type | Conductor Type |
|---|---|---|---|---|
| MIL-W-22759/1 | 600 | 200 | Fluoropolymer insulated TFE and TFE coated glass | Silver coated copper |
| MIL-W-22759/2 | 600 | 260 | Fluoropolymer insulated TFE and TFE coated glass | Nickel coated copper |
| MIL-W-22759/3 | 600 | 260 | Fluoropolymer insulated TFE-glass-TFE | Nickel coated copper |
| MIL-W-22759/4 | 600 | 200 | Fluoropolymer insulated TFE-glass-TFE | Silver coated copper |
| MIL-W-22759/5 | 600 | 200 | Fluoropolymer insulated extruded TFE | Silver coated copper |
| MIL-W-22759/6 | 600 | 260 | Fluoropolymer insulated extruded TFE | Nickel coated copper |
| MIL-W-22759/7 | 600 | 200 | Fluoropolymer insulated extruded TFE | Silver coated copper |
| MIL-W-22759/8 | 600 | 260 | Fluoropolymer insulated extruded TFE | Silver coated copper |
| MIL-W-22759/9 | 1000 | 200 | Fluoropolymer insulated extruded TFE | Silver coated copper |
| MIL-W-22759/10 | 1000 | 260 | Fluoropolymer insulated extruded TFE | Silver coated copper |
| MIL-W-22759/13 | 600 | 135 | Fluoropolymer insulated FEP PVF2 | Tin coated copper |
| MIL-W-22759/16 | 600 | 150 | Fluoropolymer insulated extruded ETFE | Tin coated copper |
| MIL-W-22759/17 | 600 | 150 | Fluoropolymer insulated extruded ETFE | Silver coated high strength copper alloy |
| MIL-W-22759/20 | 1000 | 200 | Fluoropolymer insulated extruded ETFE | Silver coated high strength copper alloy |
| MIL-W-22759/21 | 1000 | 260 | Fluoropolymer insulated extruded ETFE | Nickel coated high strength copper alloy |
| MIL-W-22759/34 | 600 | 150 | Fluoropolymer insulated crosslinked modified ETFE | Tin coated copper |
| MIL-W-22759/35 | 600 | 200 | Fluoropolymer insulated crosslinked modified ETFE | Silver coated high strength copper alloy |
| MIL-W-22759/41 | 600 | 200 | Fluoropolymer insulated crosslinked modified ETFE | Nickel coated copper |
| MIL-W-22759/42 | 600 | 200 | Fluoropolymer insulated crosslinked modified ETFE | Nickel coated high strength copper alloy |
| MIL-W-22759/43 | 600 | 200 | Fluoropolymer insulated crosslinked | Silver coated copper |

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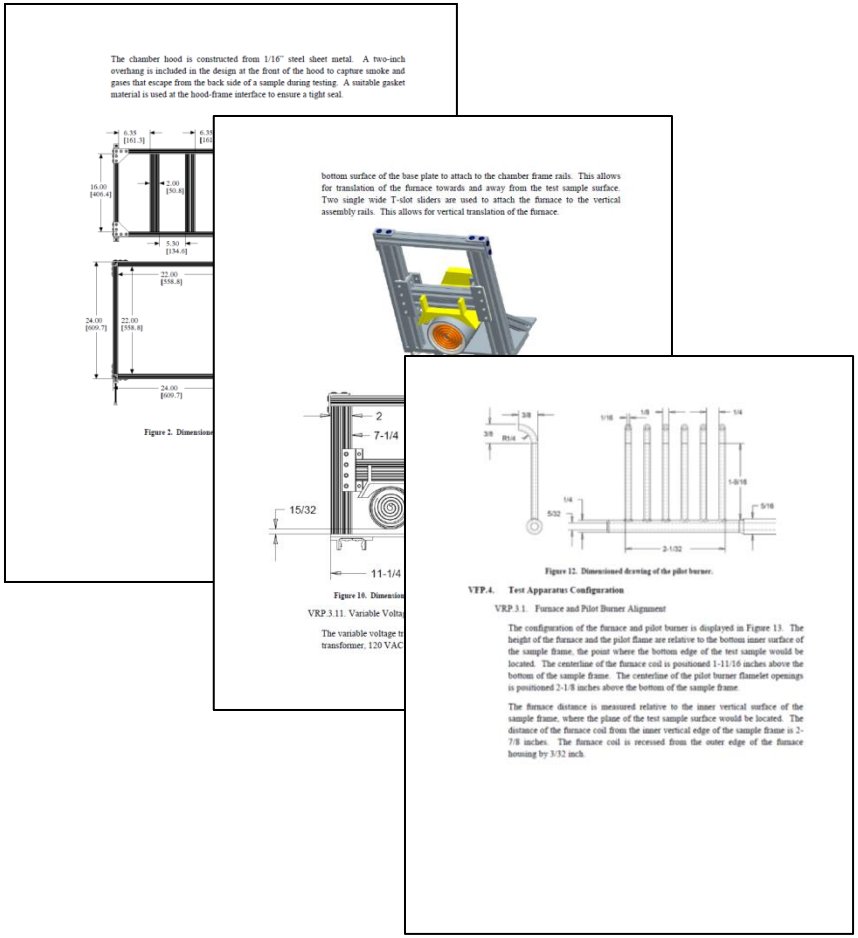
- Currently developing guidance material
  - General VFP Guidance
  - Composite Fuselage & Structure
  - Ducts
  - Wire Insulation
    - Approved wire list from AC 43.13-1B
- Received input from task group
  - *Thanks!*
- Currently reviewing comments and incorporating into document

# Draft Handbook Chapter with Drawings

- Draft Handbook chapter will be shared with task group
- Comments are encouraged and appreciated
- Still in draft form and not fully complete



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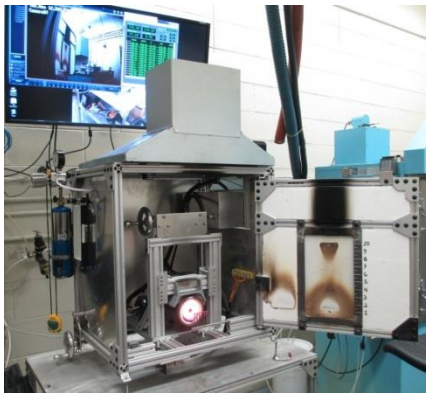

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