Development of In-Flight Flammability Test for Composite Fuselage Aircraft

Federal Aviation Administration

Presented to: International Aircraft Materials Fire Test Working Group – Atlantic City, NJ

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Introduction

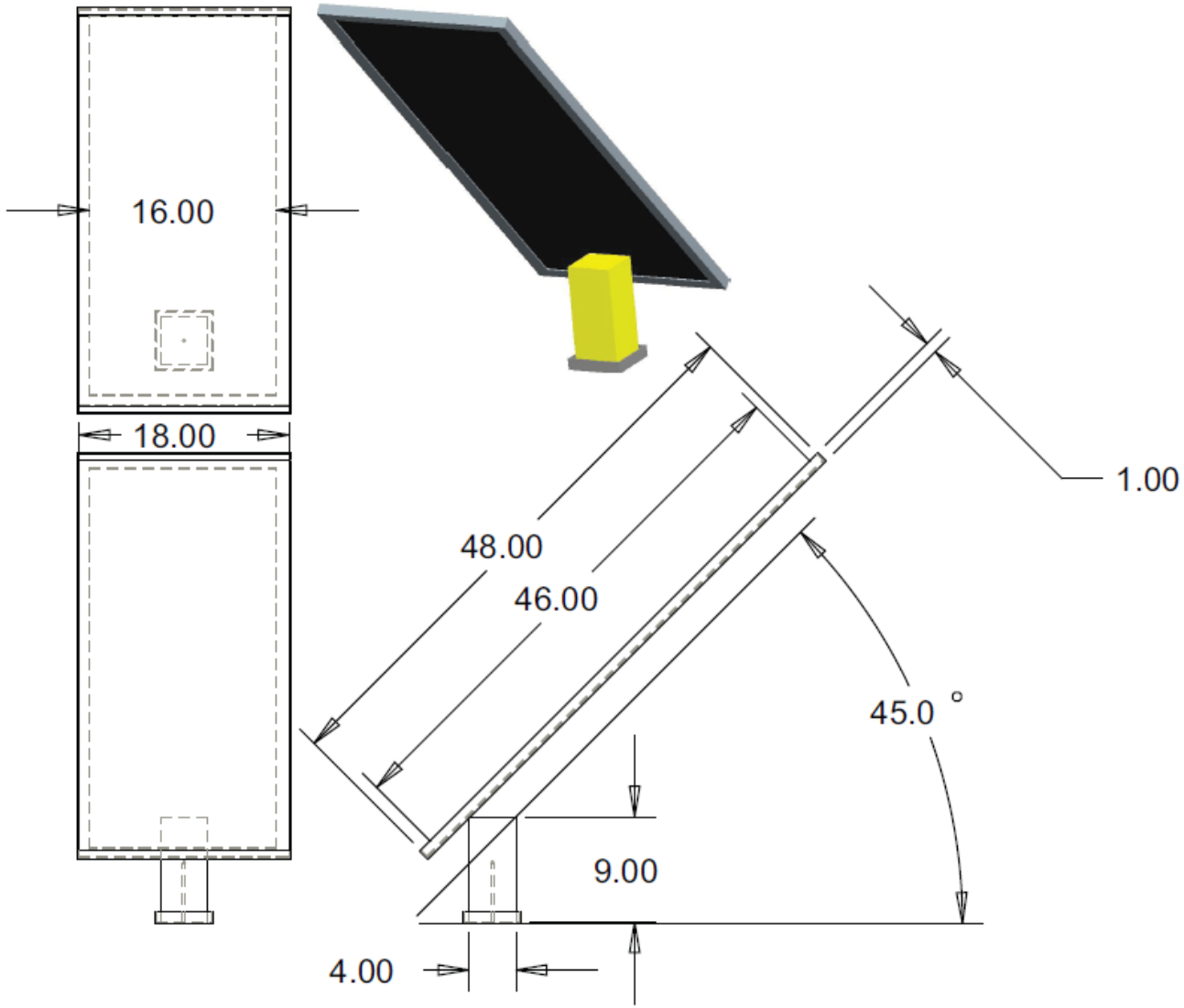
- **Fires in inaccessible areas in aircraft pose a great danger to the safety of the passengers**
- **Modern commercial aircraft are being designed with increased amounts of composite materials in the aircraft fuselage and structures in hidden areas**
- **Composite resins can have a very wide range of flammability**
- **Traditional aircraft fuselage and structures are constructed from aluminum, which does not react when exposed to a hidden fire source in flight**
- **It must be proven that if an aircraft is to be constructed of non-traditional materials, the materials chosen must provide at least an equivalent level of safety to aluminum**
- **Intermediate scale tests have been used to date to show equivalency, but a lab scale test with well defined criteria is necessary for future certification purposes**

Objective

- **Develop a lab-scale test to determine the propensity of a non-traditional fuselage material to propagate a flame or to sustain flaming combustion when subjected to a standardized hidden fire threat**
- **Test criteria is to be based upon intermediate scale testing**
  - Standard fire source used to simulate a hidden fire
    - 4” x 4” x 9” untreated urethane foam block
    - 10cc of heptane soaked into foam to provide more uniform burning
  - Various materials of similar mass and rigidity will be tested, both aircraft grade and non-aircraft

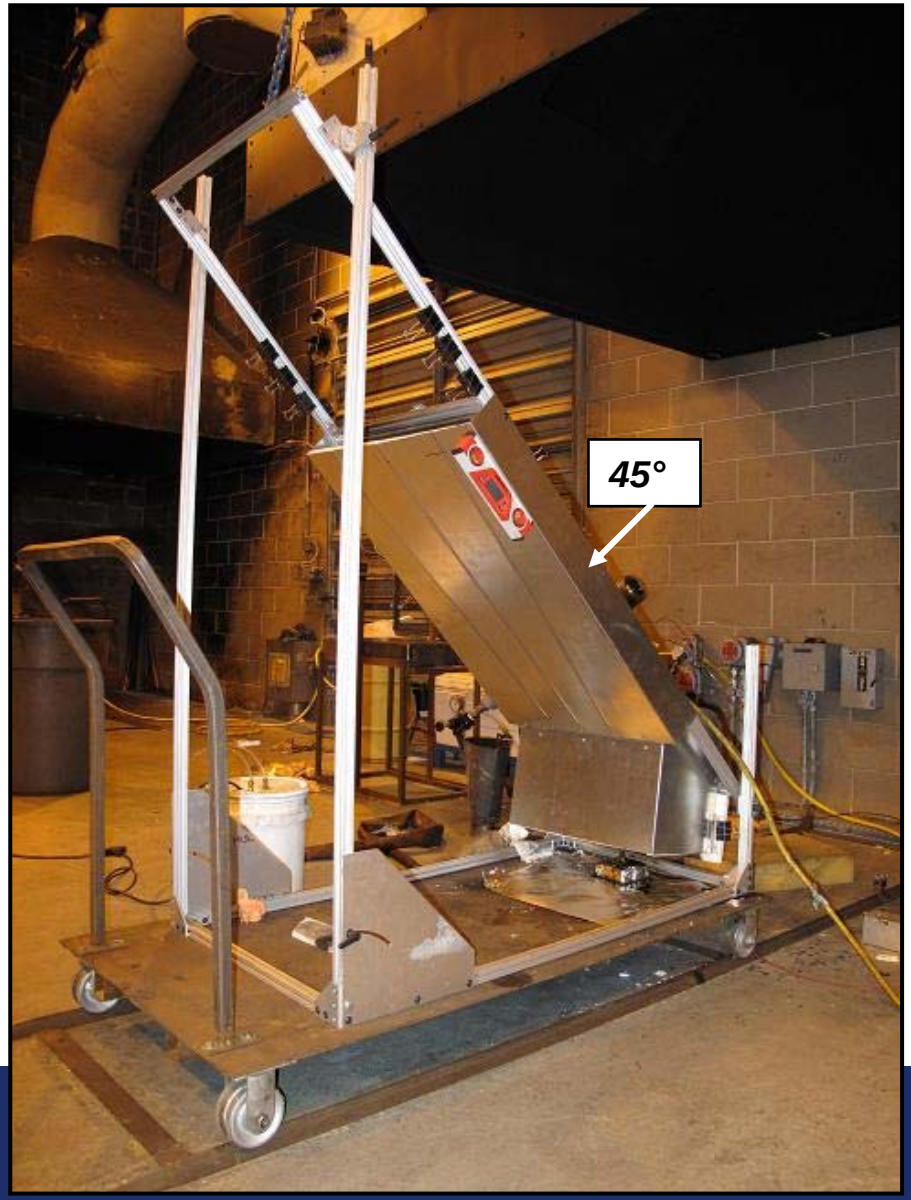
Test Configuration Intermediate Scale

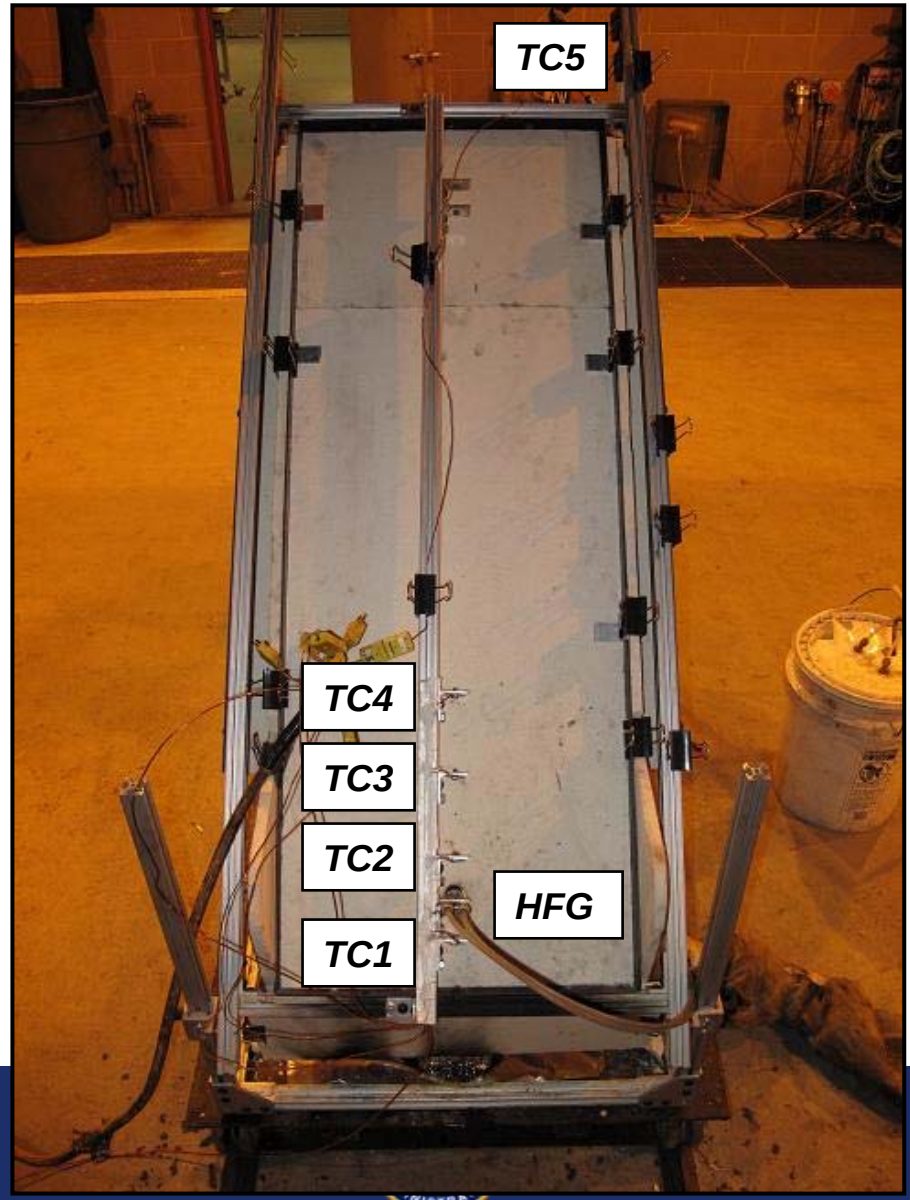
- **Panel Construction**
  - 18” x 48”, varying thicknesses
  - Solid laminates
  - Thin laminates (<10 plies) sandwiching honeycomb core
- **Panel at various angles to foam block**
- **Flat panels only, no curvature**
- **No structural members**
- **Fire source – untreated urethane foam block, 4” x 4” x 9”**

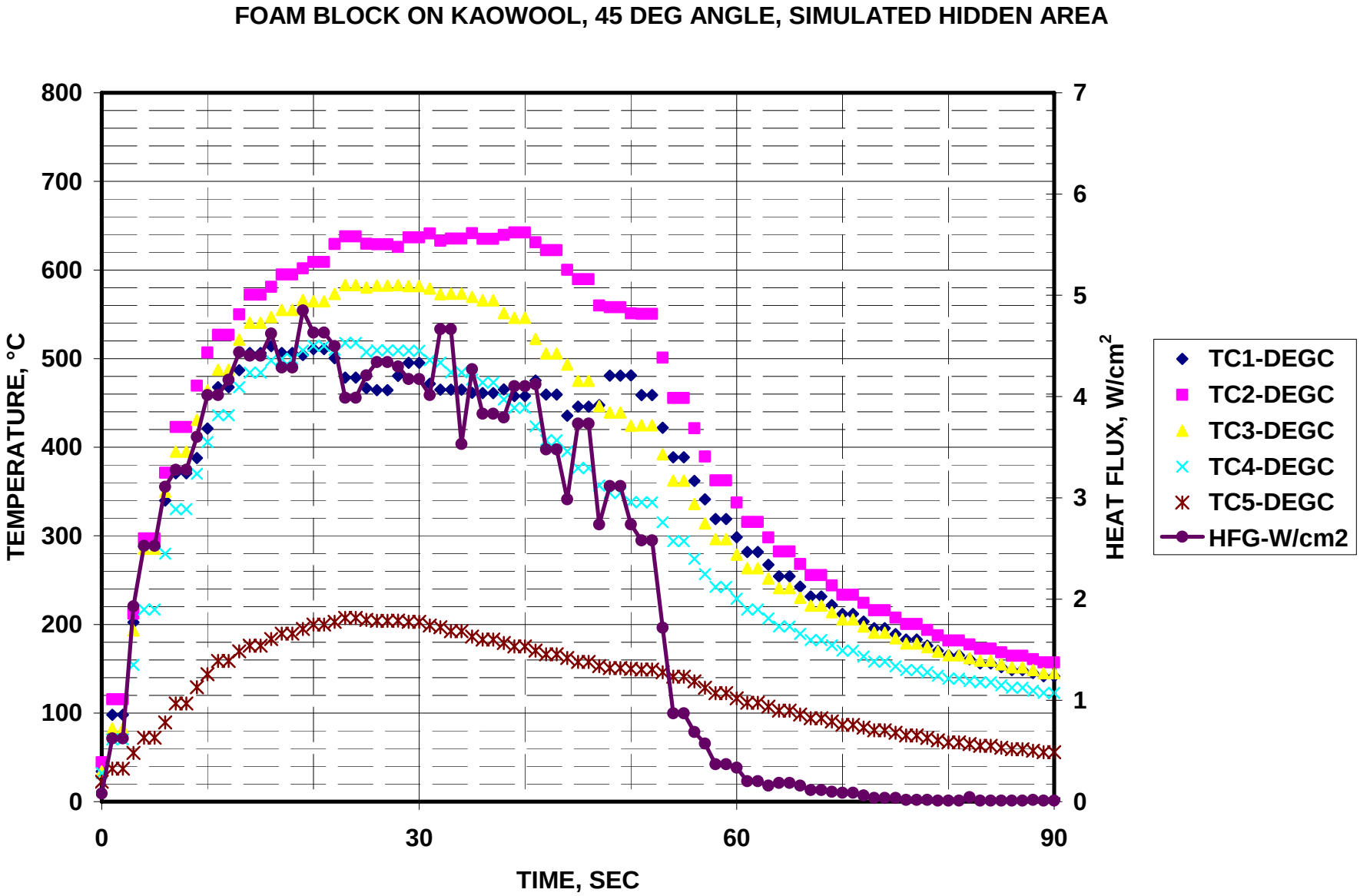


Original Test Rig

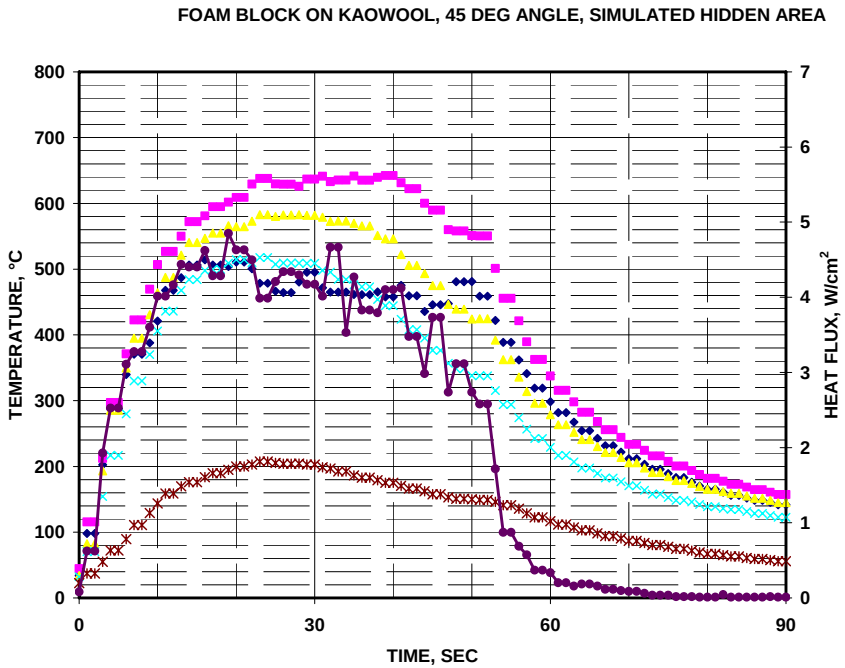
Updated Test Rig



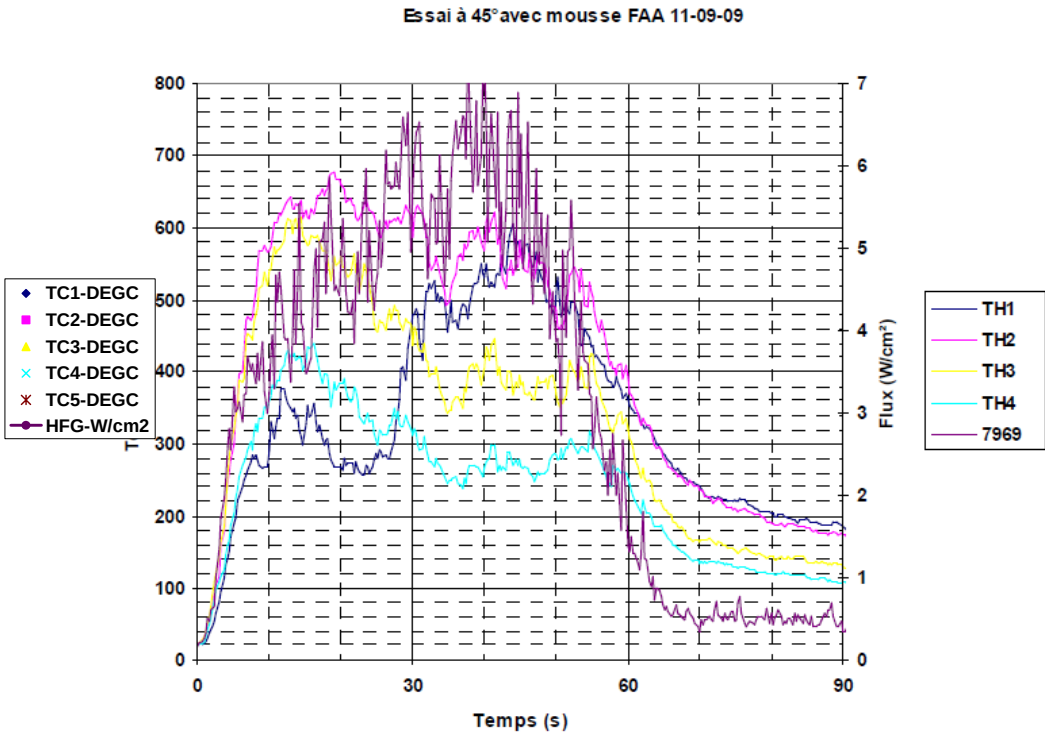



FOAM BLOCK ON KAOWOOL, 45 DEG ANGLE, SIMULATED HIDDEN AREA
TEMPERATURE, °C
HEAT FLUX, W/cm2
TIME, SEC
0
100
200
300
400
500
600
700
800
0
1
2
3
4
5
6
7
0
30
60
90
TC1-DEGC
TC2-DEGC
TC3-DEGC
TC4-DEGC
TC5-DEGC
HFG-W/cm2

FAATC, ENCLOSED



CEAT, NOT ENCLOSED

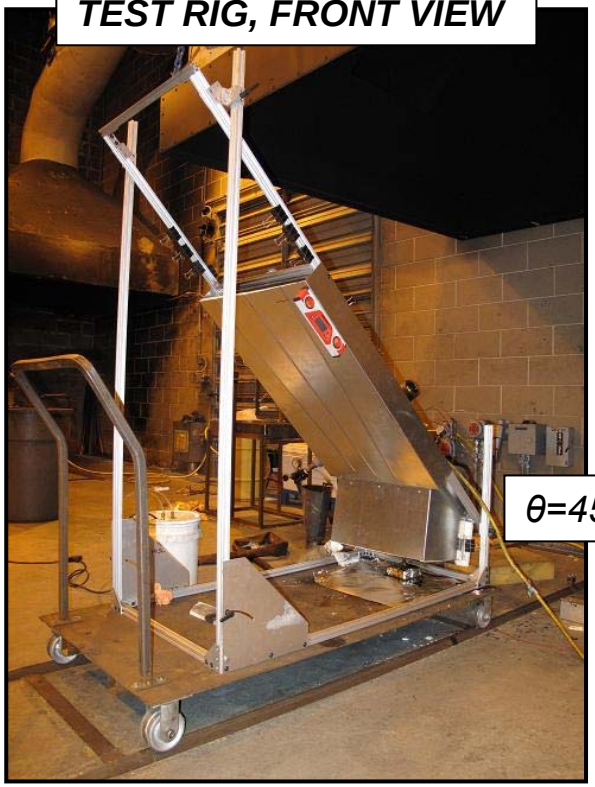


TEMPERATURES AGREE WELL

HEAT FLUX IS LOWER AT FAATC THAN AT CEAT

FOAM BLOCK AND TEST RIG SHOW GOOD REPRODUCIBILITY AT DIFFERENT LABS

TEST RIG, FRONT VIEW



θ=45°

½" Plywood

¼" Sandwich Panel

TEST RIG, FRONT VIEW

TEST RIG, REAR VIEW


URETHANE FOAM BLOCK
4” X 4” X 9”


PANEL IN PLACE FOR TESTING

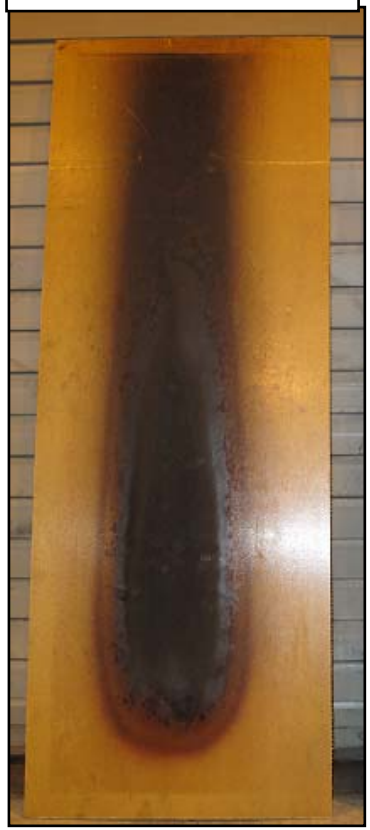
½” Plywood

45° un-insulated

72° insulated

¼” Sandwich Panel

45° un-insulated



72° insulated

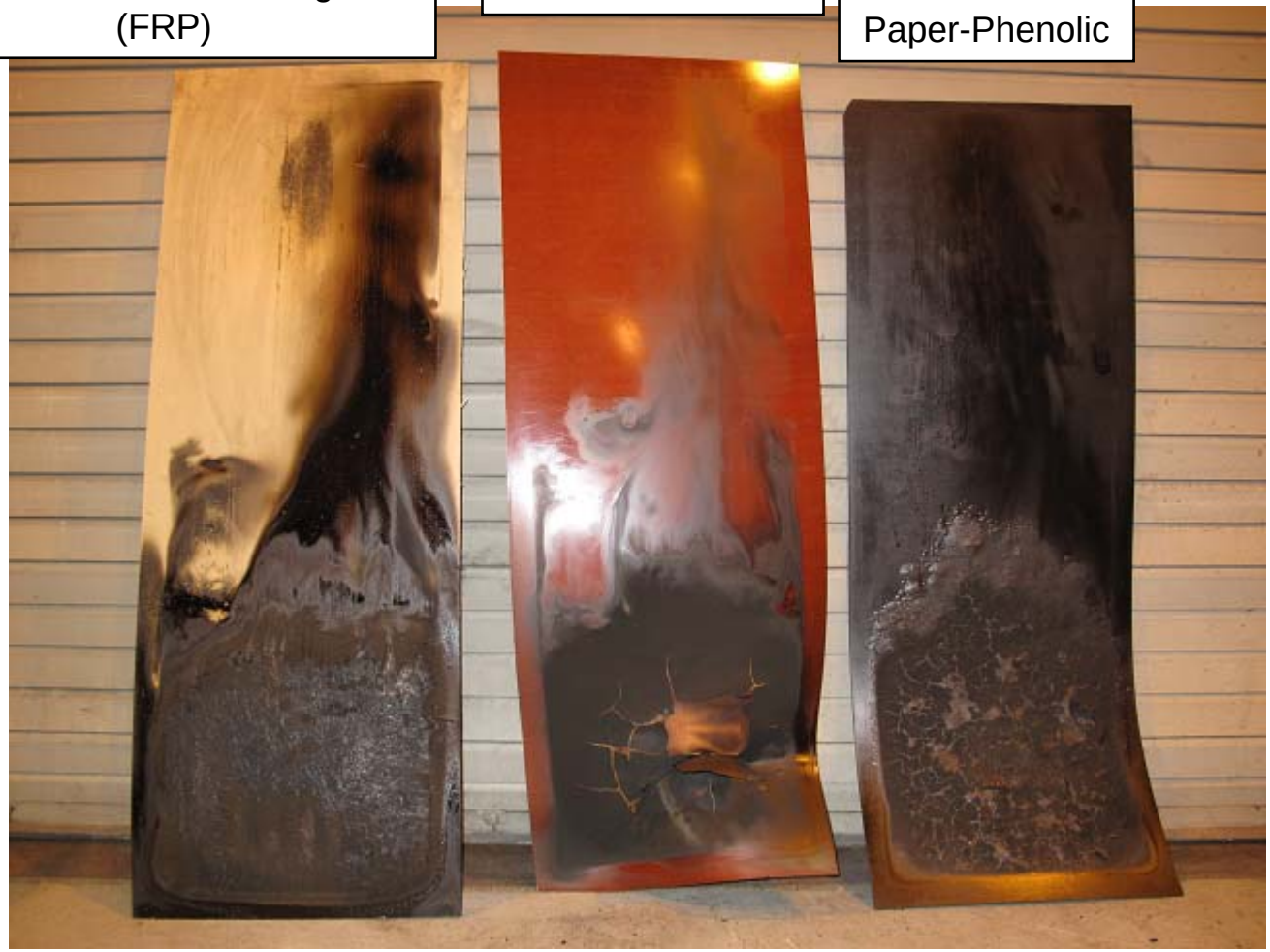
Structural fiberglass (FRP) no activity after foam block subsided

Premium structural fiberglass (FRP) severe black smoke up to 6 minutes after foam block ignition

Premium structural fiberglass (FRP)

Canvas-Phenolic

Paper-Phenolic



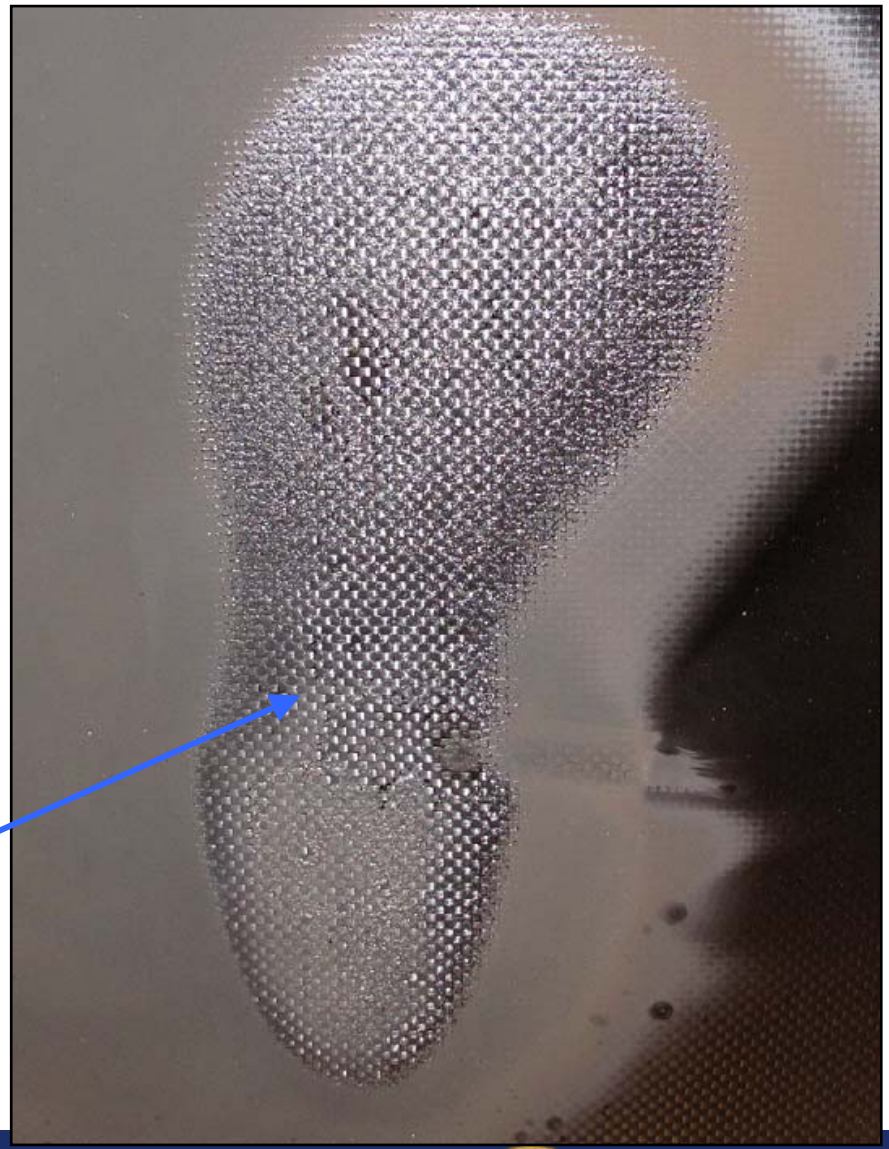
Park Advanced Composite Materials

Woven Carbon Fabric Composite

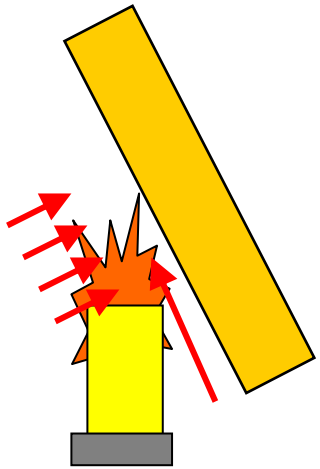
Unidirectional Carbon Fiber Laminate

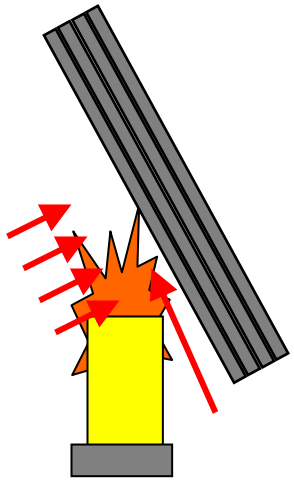
Woven Carbon Fabric Composite

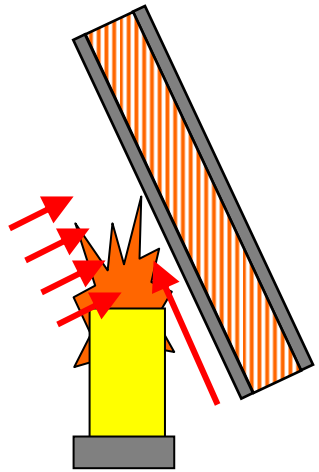
Woven Carbon Fabric Composite



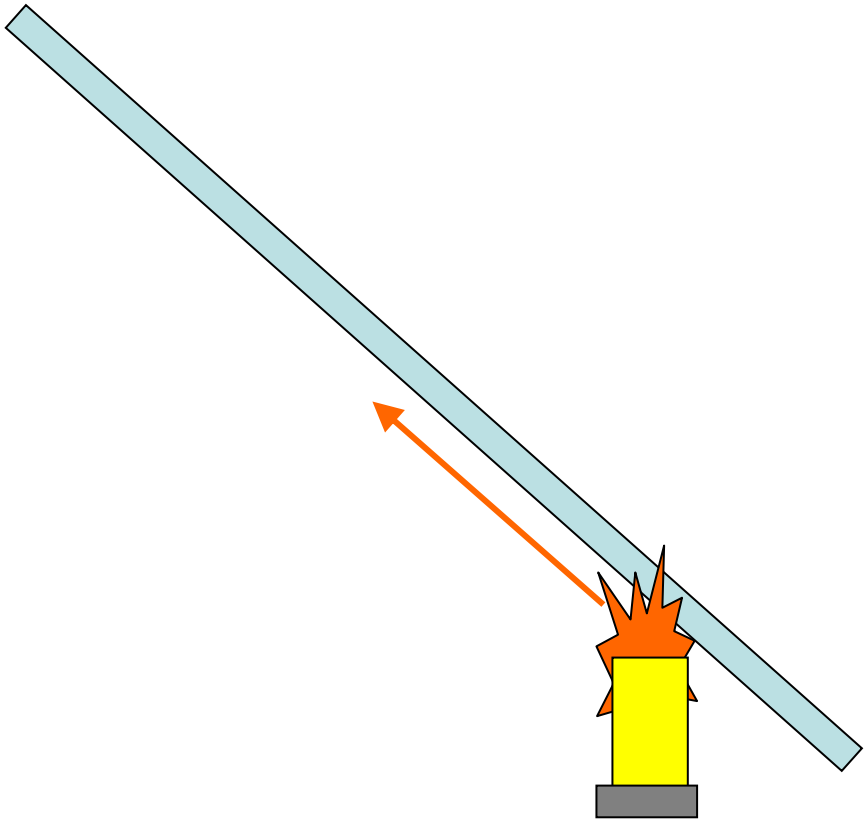
Solid Materials	Laminates	Honeycomb Sandwich Panels







Intermediate Scale



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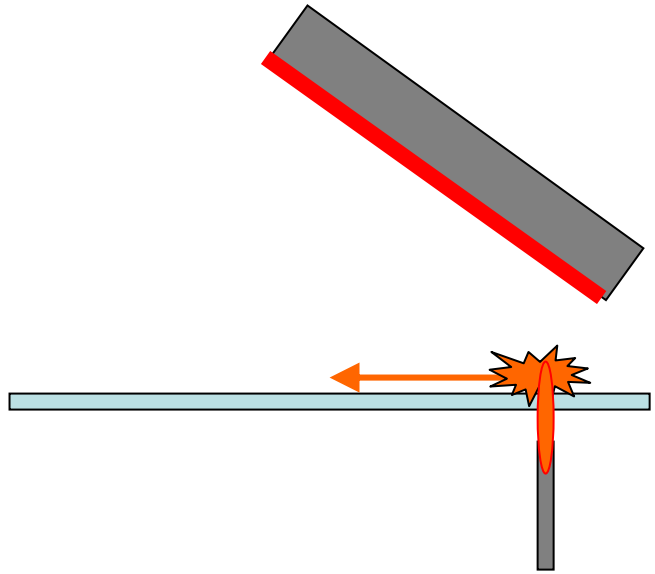
Lab Scale



Test Configuration
Lab Scale

- **Use identical materials from intermediate scale**
  - Sample size 12” x 24”
- **Use radiant panel apparatus for lab scale testing**
  - Develop test parameters based on intermediate scale results
    - Calibration heat flux
    - Pre-heat
    - Flame impingement time

Summary

- **Preliminary intermediate scale testing has commenced with various materials**
  - Plywood
  - FRP fiberglass
  - Honeycomb panels
- **Seek to obtain panels of similar materials in solid laminates, honeycombs, varying thicknesses**
- **Install thermocouples and video on test rig to track flame propagation during test**
- **Rank materials according to performance**
- **Correlate ranking on lab scale tests**

Composites Task Group

- **Discuss approach to intermediate scale flame propagation**
- **Materials**
- **Lab scale test parameters**

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