FAA 6th Triennial Cabin and Fire Safety Conference

FAA Overview on Testing of Magnesium Alloys for Use in an Aircraft Cabin

Presented to: Triennial Conference, Atlantic City

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Date: October 27, 2010

Key Activities

FAA Policy and Rulemaking ↔ IAMFTWG ↔ SAE Seat Committee

FAA Policy and Rulemaking → Initial Policy Statement

IAMFTWG → Discuss Threats / Potential Areas of Use / Test Based on Threat

SAE Seat Committee → AS8049 rev A review

Initial Lab-Scale Testing

Full-Scale Testing

Lab-Scale Test Development

Final FAA Policy

FAA Policy Statement

Use of Magnesium in Airplane Cabins—Updated 10/07

The FAA has had several recent inquiries regarding the use of magnesium in airplane cabins. Specifically, magnesium alloys have been suggested as substitute for aluminum alloys in seat structure, as well as other applications, due to the potential for weight savings.

The FAA's central concern regarding the use of magnesium in the cabin is flammability. The current regulations do not address the potential for a flammable metal to be used in large quantities in the cabin. Therefore, if such a material were introduced to the cabin, the FAA would have to be convinced that the level of safety was not reduced. Special conditions may be required to establish appropriate criteria. Different magnesium alloys have different susceptibility to ignition, however, magnesium remains a material that, once ignited, is very challenging to cope with using fire extinguishers currently available on aircraft.

The use of magnesium is currently the subject of a task group of the International Aircraft Materials Fire Test Working Group. Depending on the outcome of the task group's work, the FAA may support additional research in this area, to the extent industry can supply materials. This would likely include full-scale testing should the initial assessments suggest there is some potential for acceptable installations. Both the post crash, as well as in-flight, fire scenarios need to be addressed.

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International Aircraft Materials Fire Test Working Group

Meets three times per year…

One meeting held in Atlantic City, New Jersey

One meeting held at host organization in North America

One meeting held at host organization outside the US

Issues and concerns in the area of aircraft materials fire safety testing are discussed with emphasis on the current test methods.

The WG is open to anyone in the international community, including industry, government, and academia with an interest in aircraft materials fire safety and testing

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SAE Aircraft Seat Committee

SAE International Aerospace Standard – AS8049 rev A
"Performance Standard for Seats in Civil Rotorcraft, Transport Aircraft and General Aviation"

SAE Aircraft Seat Committee: Custodian of Standard AS8049

Para 3.3.3 states, "Magnesium alloys shall not be used."

FAA – TSO-C127, Rotorcraft and Transport Airplane Seating Systems
References AS8049

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Initial Laboratory-Scale Testing

Full-Scale Testing

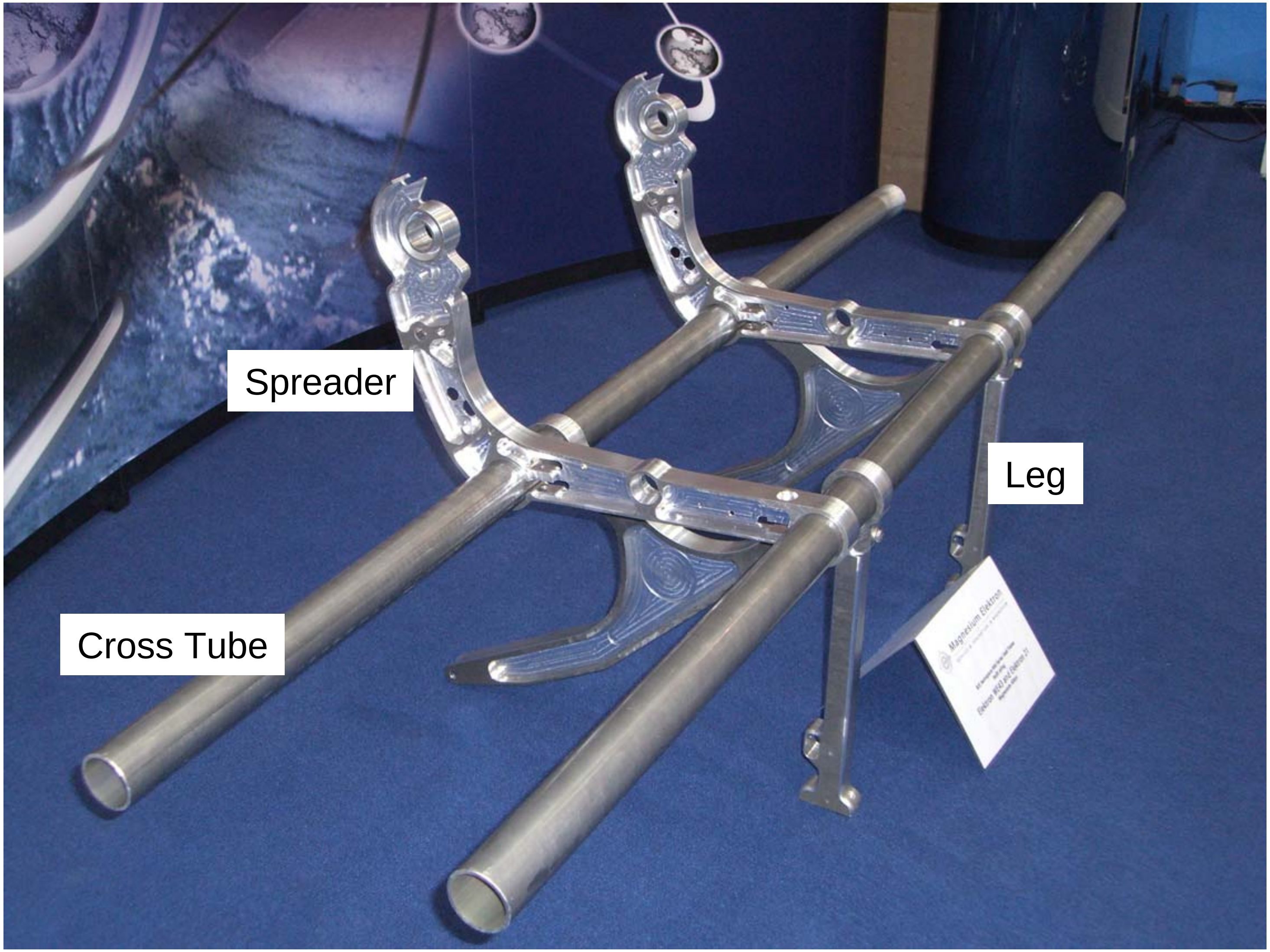
Method: Conduct baseline tests using OEM aluminum-framed triple seats. Tests will simulate a post-crash fire with fuselage rupture, allowing external fire to directly impact the cabin materials.

Then…

Conduct additional tests in an <u>identical fashion</u> using mag-alloy in the construction of the primary seat components. External fire permitted to burn for 5 minutes, then internal fire permitted to burn for 5 additional minutes before applying water.

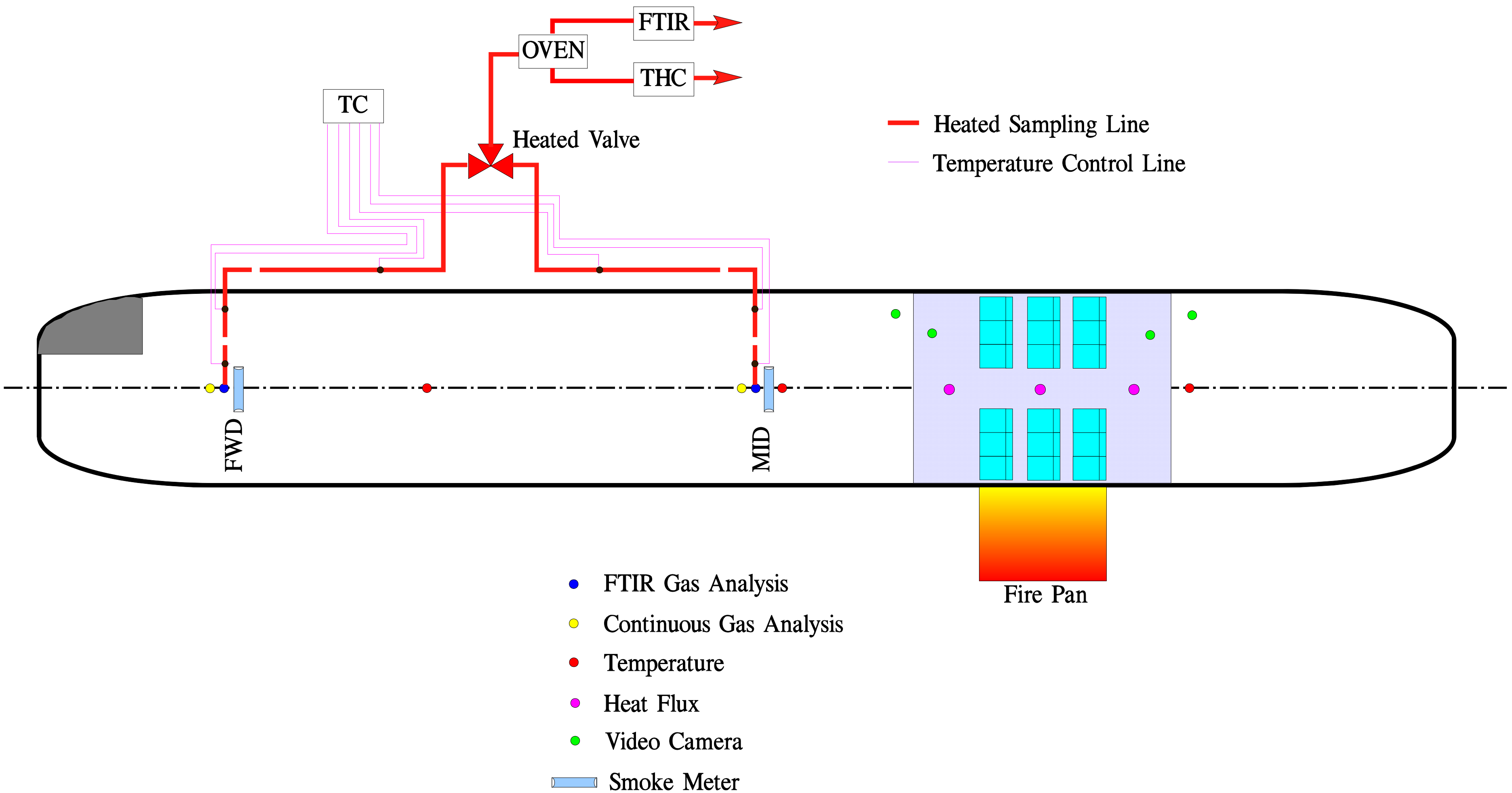
Outcome: Determine if the use of mag-alloy poses additional hazard during the 10-minute event

Primary Seat Components



Full-Scale Testing

Full-Scale Test Apparatus

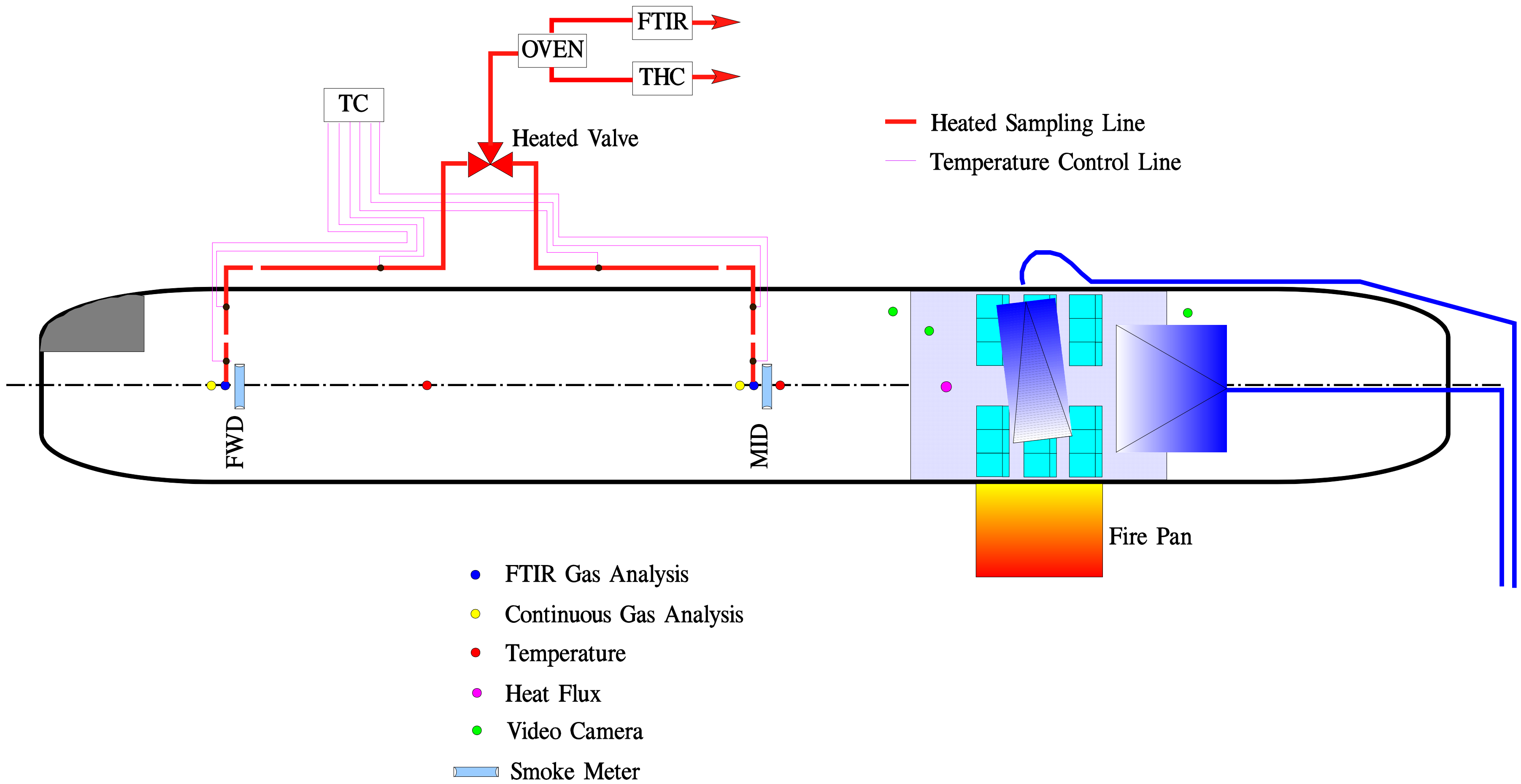


OEM Coach Style Seats w/Modified Back Frame

Baseline Test Configuration

Application of Water Post-Test

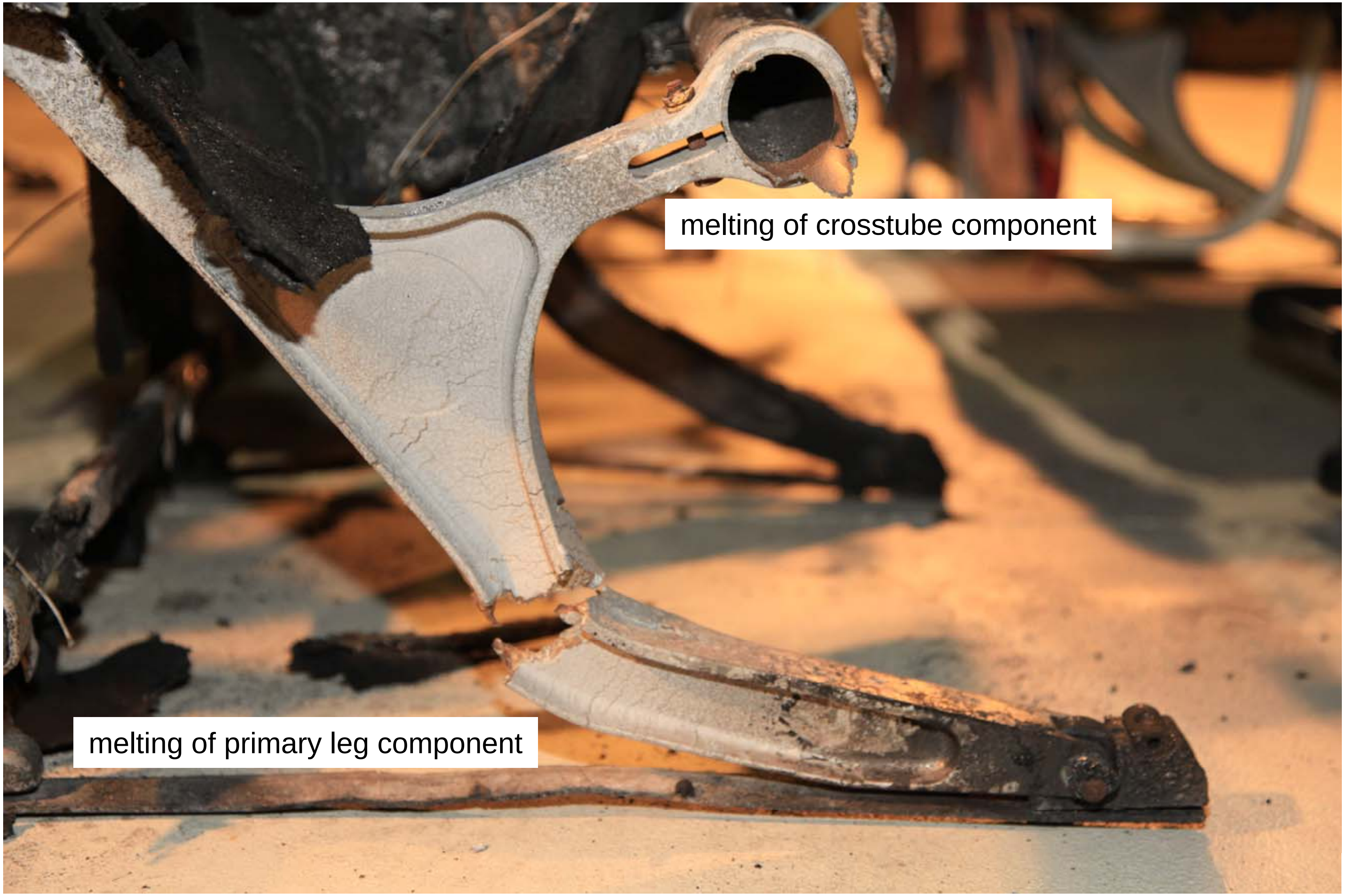
water applied at end of all tests (not just magnesium), for similarity



Baseline Test Result

Baseline Test Result

Baseline Test Result



Baseline Test Summary

Pan fire extinguished at 5 minutes using AFFF

Interior fire extinguished at 10 minutes using water

Incapacitation reached in 4 min 10 sec at forward location

Seat backs (cushions, covers, plastics) mostly consumed on port side; largely intact on starboard side

Seat bottom cushions on port side heavily involved in fire

Increased melting of primary seat structure compared to previous baseline tests

Mag-Alloy Full-Scale Testing

- WE-43 (good-performing material)
- AZ-31 (poor-performing material)
- WE-43 in primary + back frame + baggage bar
- WE-43 in primary + back frame + baggage bar (repeat)

WE-43 Test Configuration

WE-43 Test Configuration

WE-43 Test Results

WE-43 Test Result

Summary of Findings

Pan fire extinguished at 5 minutes using AFFF

Interior fire extinguished at 10 minutes using water

Incapacitation reached in 4 min 38 sec at forward location

Seat backs (cushions, covers, plastics) mostly consumed on port side; largely intact on starboard side

Seat bottom cushions on port side heavily involved in fire

Increased melting of primary seat structure compared to baseline 3 test

AZ-31 Test Configuration

AZ-31 Test Results

AZ-31 Test Result

Summary of Findings

Pan fire extinguished at 5 minutes using AFFF

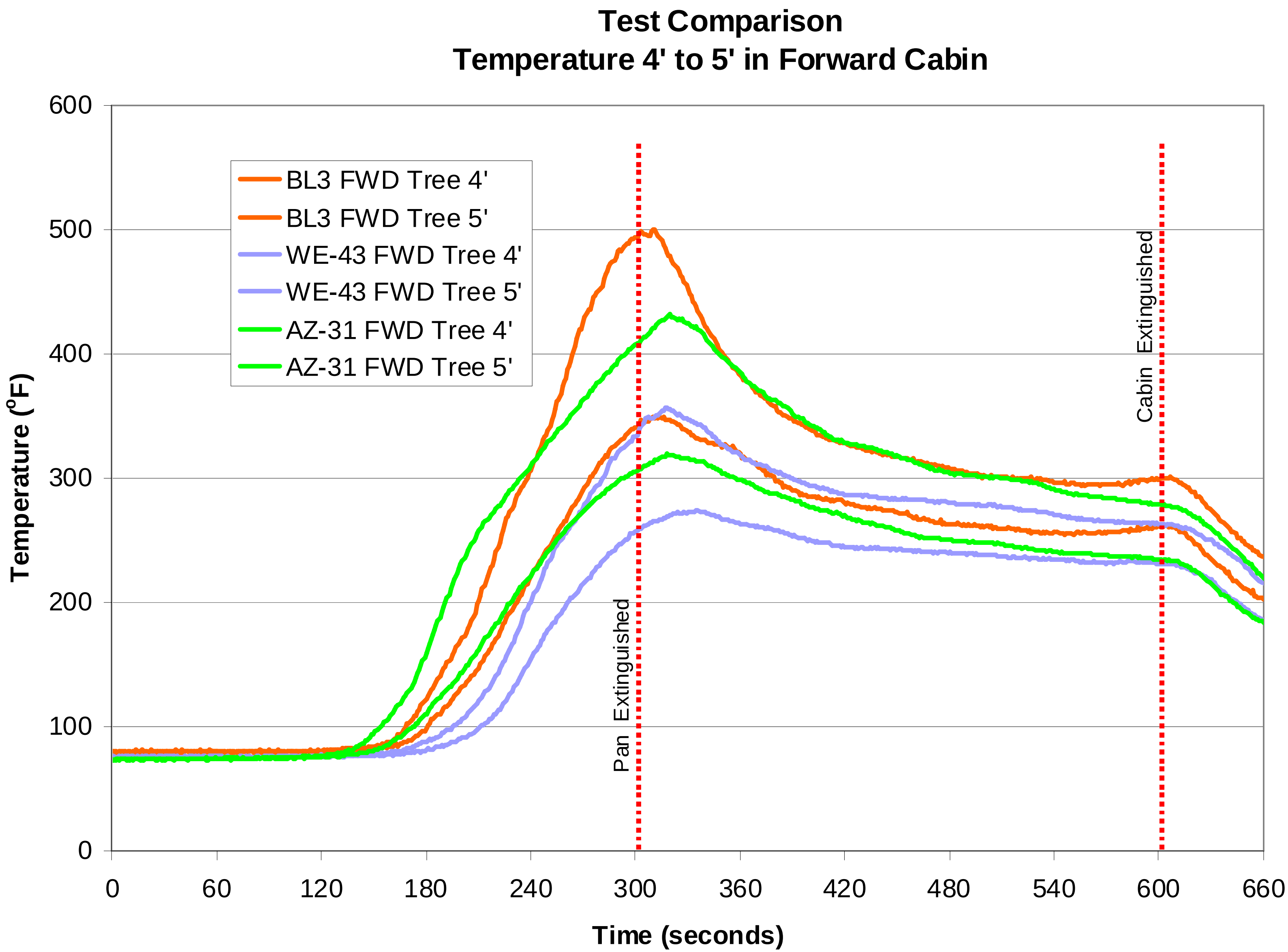
Interior fire extinguished at 10 minutes using water

Incapacitation reached in 4 min 33 sec at forward location

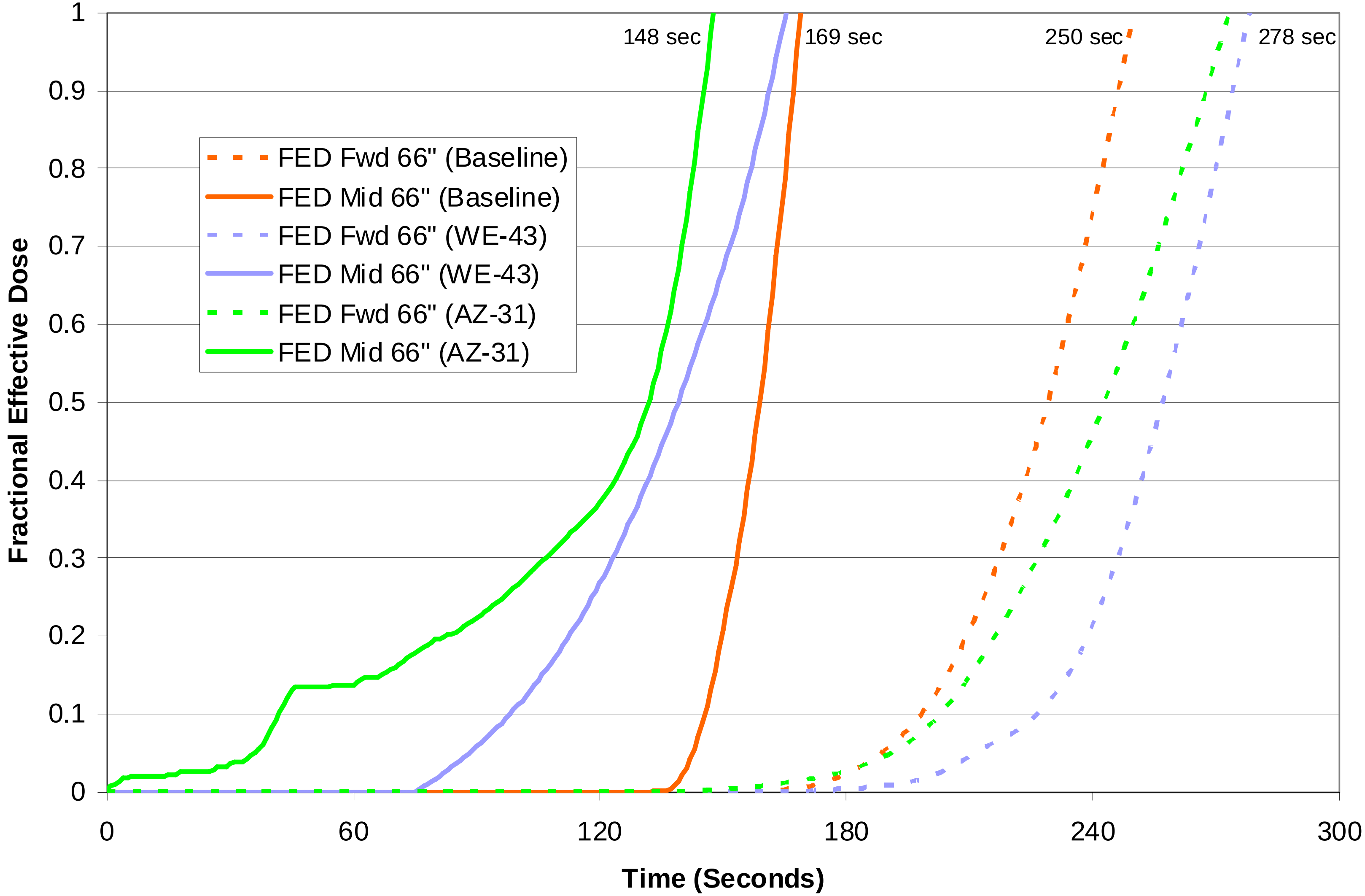
Seat backs (cushions, covers, plastics) mostly consumed on port side; largely intact on starboard side

Seat bottom cushions on port side heavily involved in fire

Increased melting of primary seat structure compared to baseline 3 test


Test Comparison
Temperature 4' to 5' in Forward Cabin
600
500
400
300
200
100
0
Temperature (°F)
0
60
120
180
240
300
360
420
480
540
600
660
Time (seconds)
BL3 FWD Tree 4'
BL3 FWD Tree 5'
WE-43 FWD Tree 4'
WE-43 FWD Tree 5'
AZ-31 FWD Tree 4'
AZ-31 FWD Tree 5'
Pan Extinguished
Cabin Extinguished

Cabin Survivability Comparison



WE-43 All-Mag Test

WE-43 All-Mag Test

WE-43 All-Mag Test

All-Mag Repeat Test

All-Mag Repeat Test

All-Mag Repeat Test

Summary of Full-Scale Testing

For baseline and mag-alloy tests, pan fire extinguished at 5 min, water applied at 10

Slight flashing of burning mag-alloy during water application for WE-43 test

Noticeable difficulty extinguishing burning mag-alloy during AZ-31 test

Incapacitation results very similar for baseline and mag-alloy tests

- slightly better for mag-alloys at forward location
- slightly worse for mag-alloys at mid location
- More severe fire condition caused more rapid incapacitation during "all-mag" tests

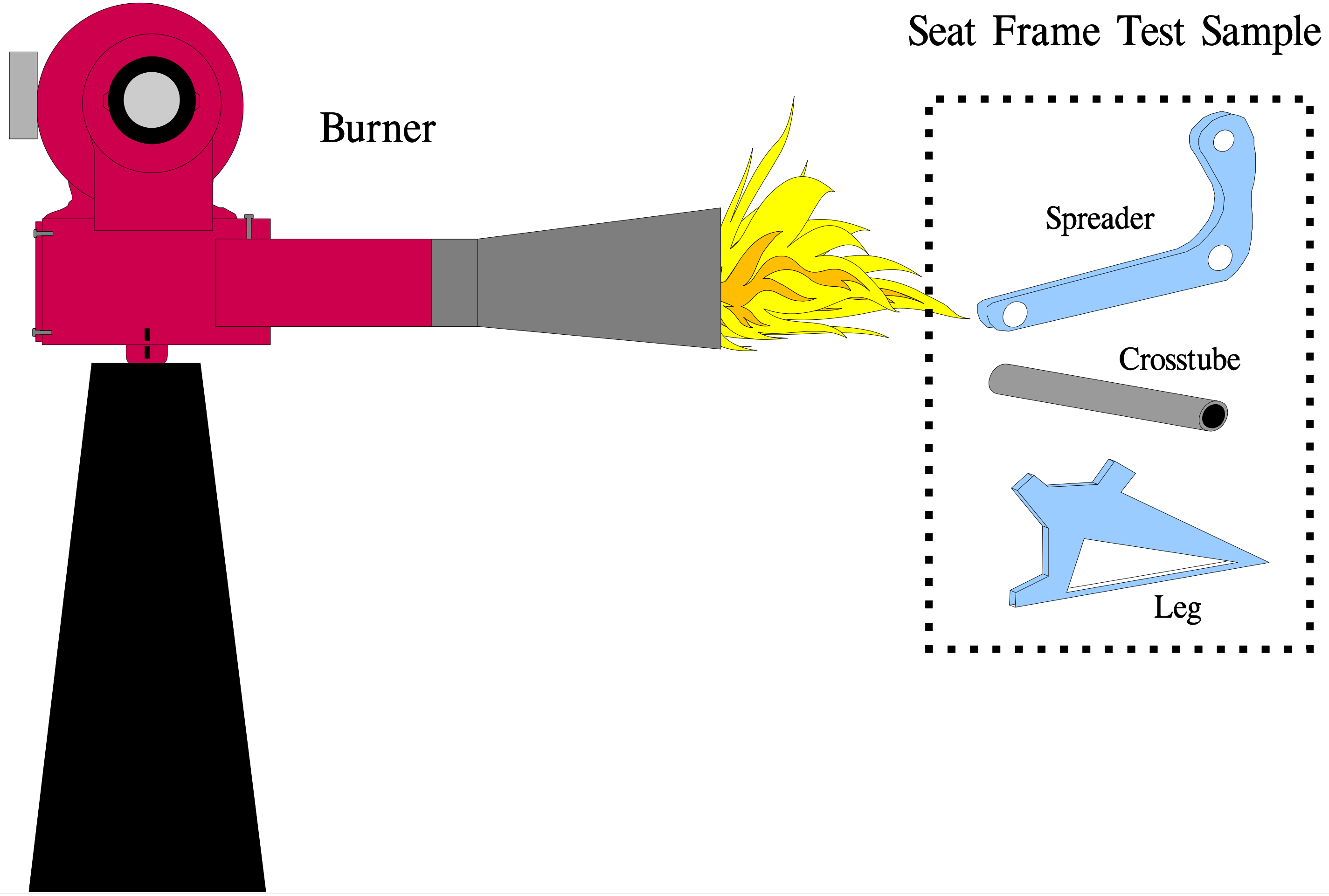
Future Considerations

All full-scale test results would help define an appropriate lab-scale test method or methods, which is the primary goal of the research.

Although post crash full-scale test results will help in determining the safe application of magnesium in seat frames, other scenarios and testing will also be used.

If magnesium alloys are determined safe for use in seat frames, a representative lab test/tests will be developed.

Development of a Lab-Scale Test



Development of a Lab-Scale Test

Items to Consider…

Thermal Insult

- Duration
- Size
- Intensity

Test Sample

- Size
- Geometry
- Orientation

Test Parameters

- Melting Time
- After Flame Time
- Weight Loss?

Possible Lab-Scale Test Structure