Federal Aviation Administration

International Aircraft Materials Fire Test Working Group

Update on Flammability Testing of Magnesium Alloy Components

Presented to: IAMFT WG, Cologne, Germany

By: Tim Marker, FAA Technical Center

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Proposed Mag-Alloy Testing at FAA Tech Center

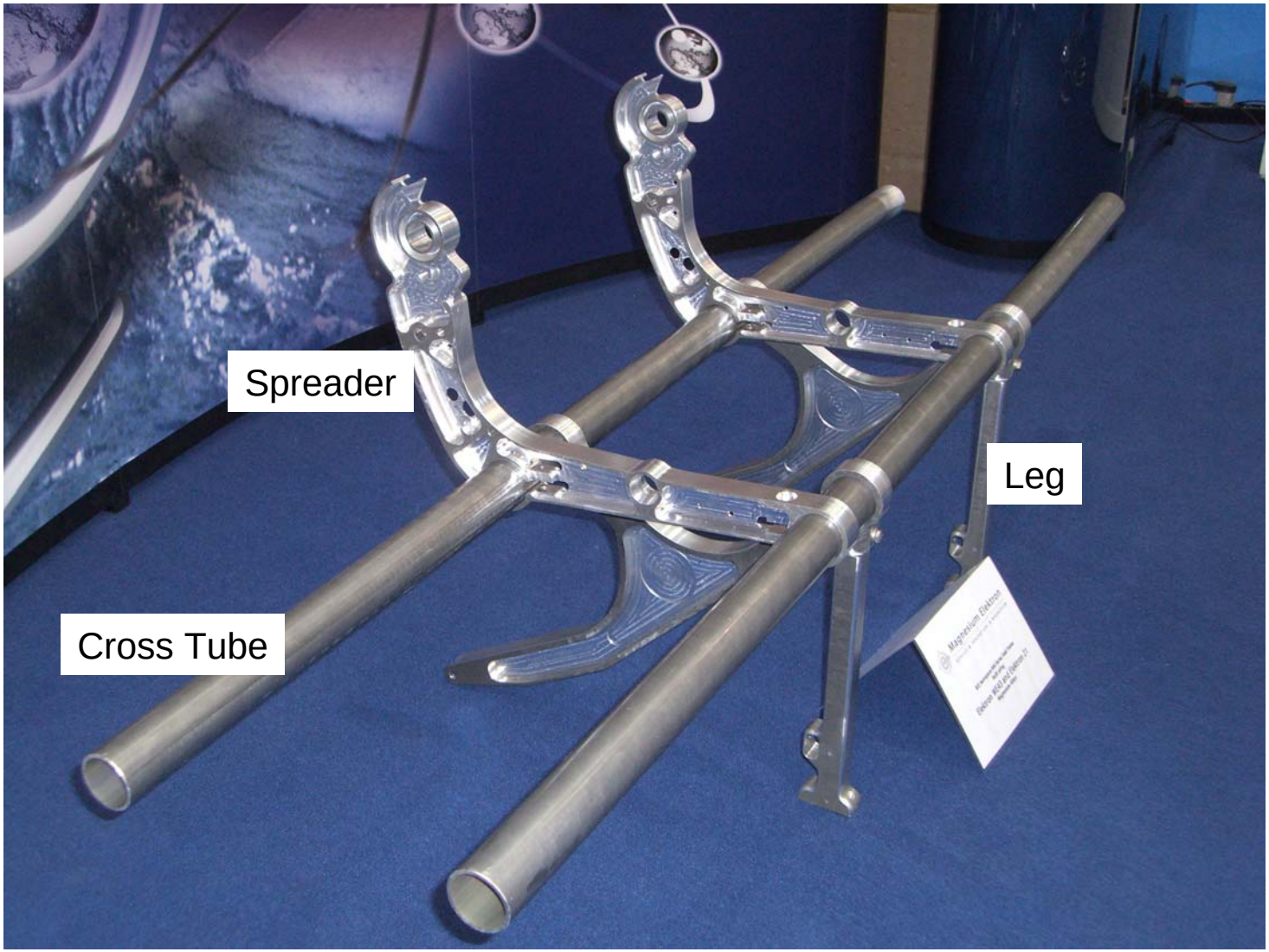
Method: Conduct (several?) baseline tests using OEM aluminum-framed triple seats with FB seat cushions. Tests will simulate a post-crash fire with fuselage rupture, allowing external fire to directly impact the cabin materials.

Then…

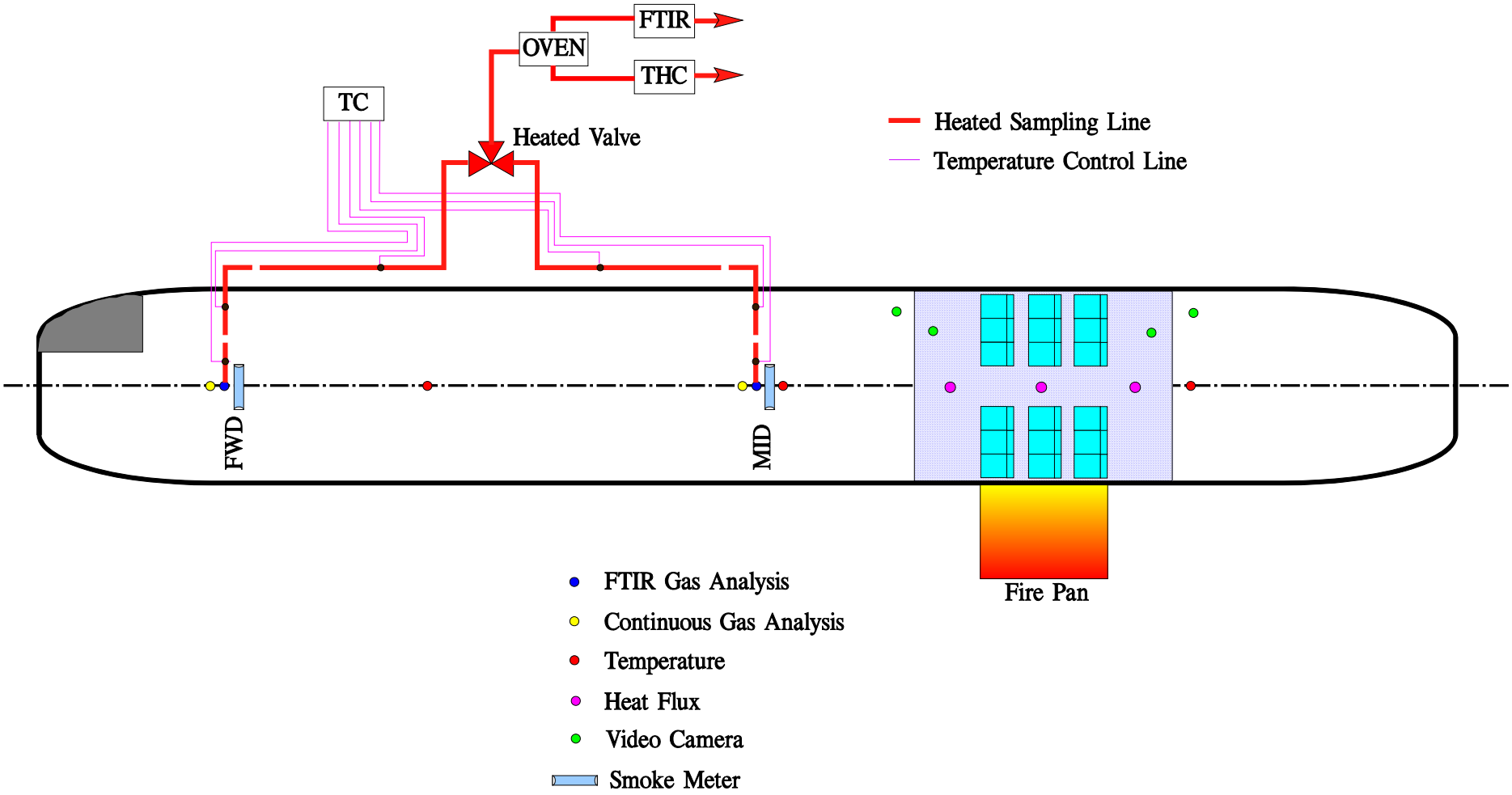
Conduct additional tests in an identical fashion using mag-alloy in the construction of the primary seat components. External fire permitted to burn for 5 minutes, then internal fire permitted to burn for 5 additional minutes before applying water.

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

Primary Seat Components



Full-Scale Test Apparatus



Initial 2 Baseline Tests Highlighted Seat Back Flammability

Back Rest Construction of B/E 990 Seats

Executive Decision to Conduct 3rd Baseline

Procure Additional 990 Seats, fabricate new seat backs

Target is 4 to 4 min 30 sec flashover

Application of water at set time for all remaining tests

Additional thermocouples in seat frames

Additional camera that will not become obscured during test

Conduct lab-scale oil burner testing of seat cushions used in testing

New Seat Back Frame Design

2024 alum box frame, 0.75-inch by 1.5 inch

New Fire Hardened Foam for Seat Back

New Fire Hardened Foam for Seat Back

New Seat Back

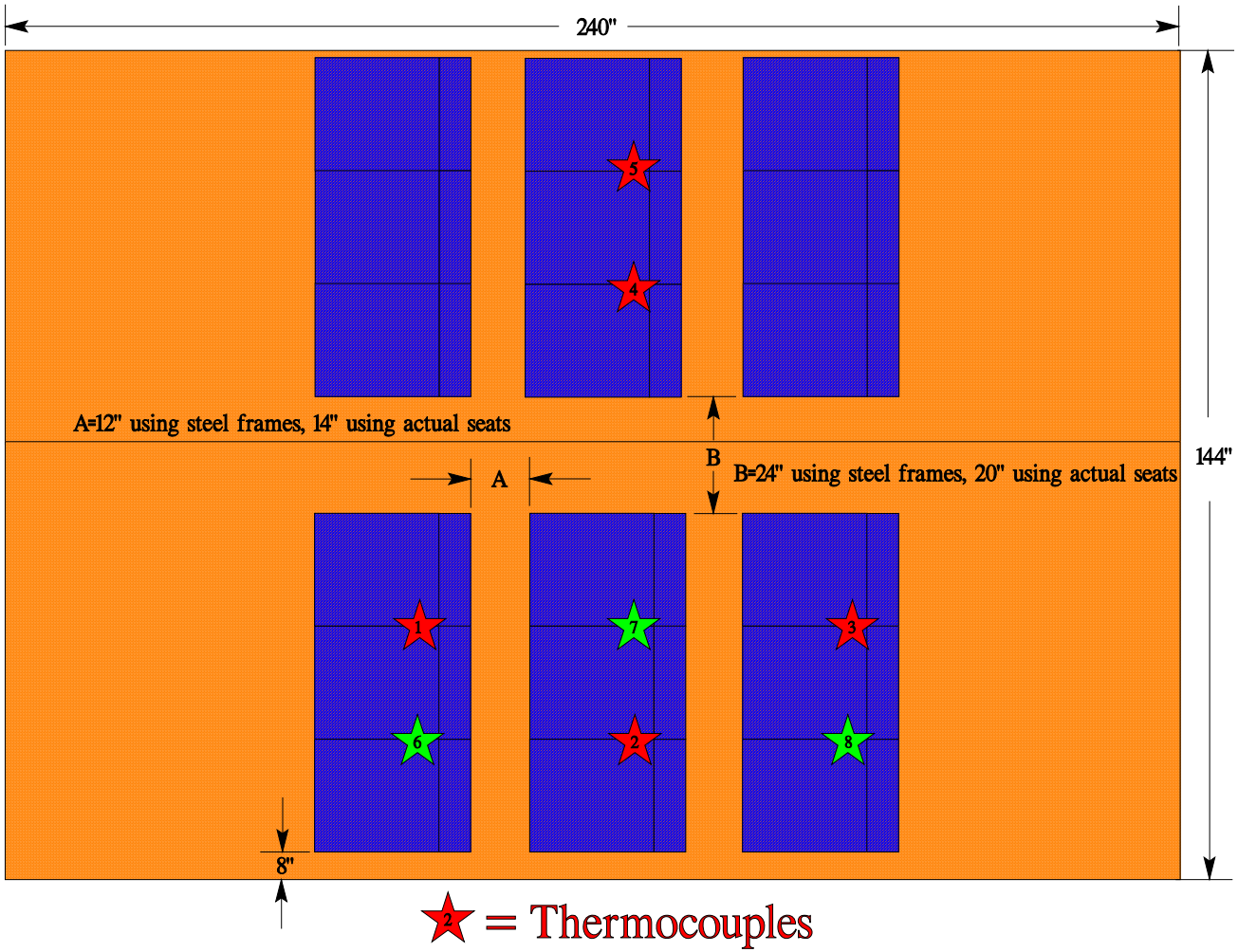
New Back Frame Installed

Mass Production of Seat Back Frames

Dress Cover Installed Over New Back Frame

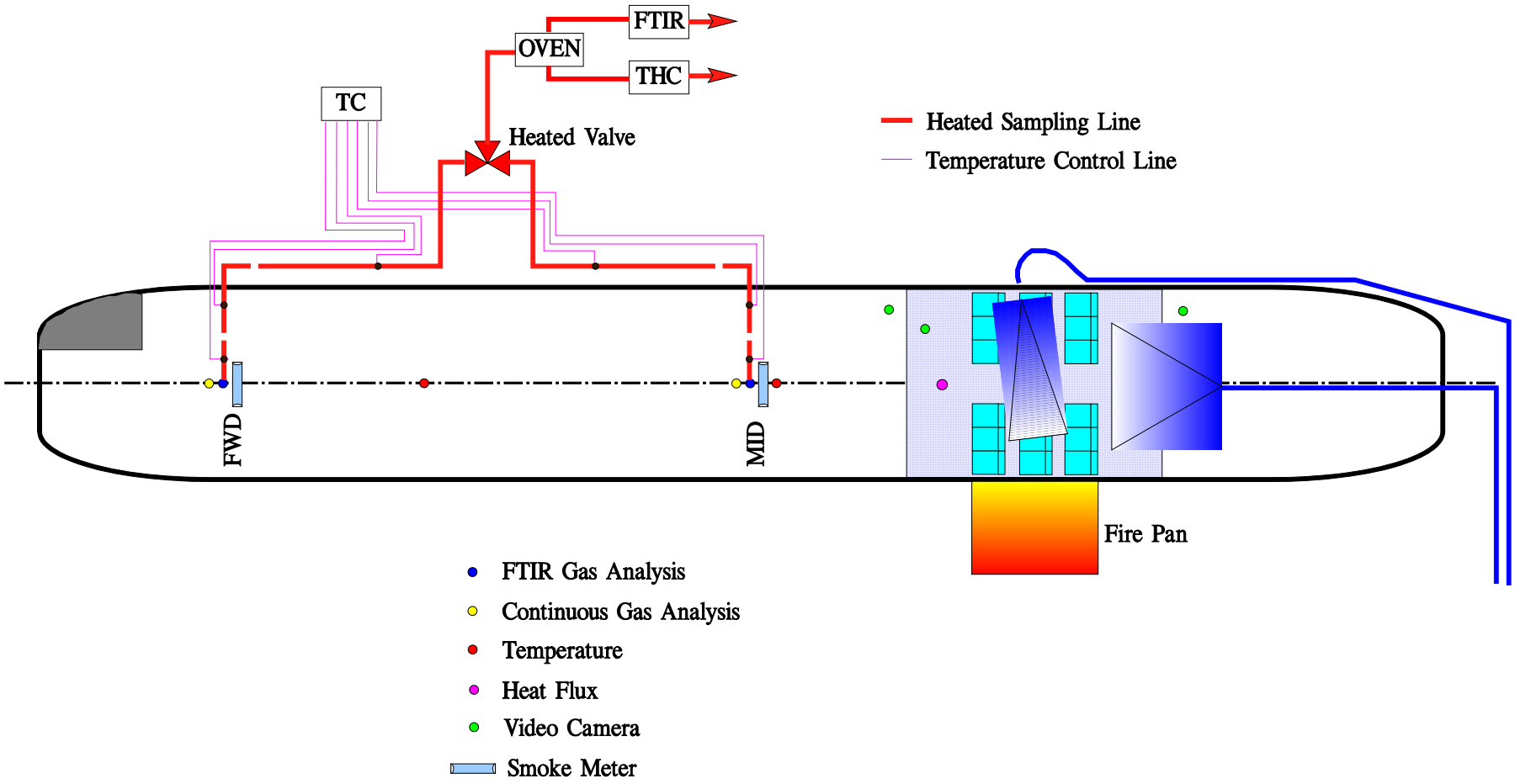
Seat Thermocouples

Additional thermocouples installed in seat leg frames



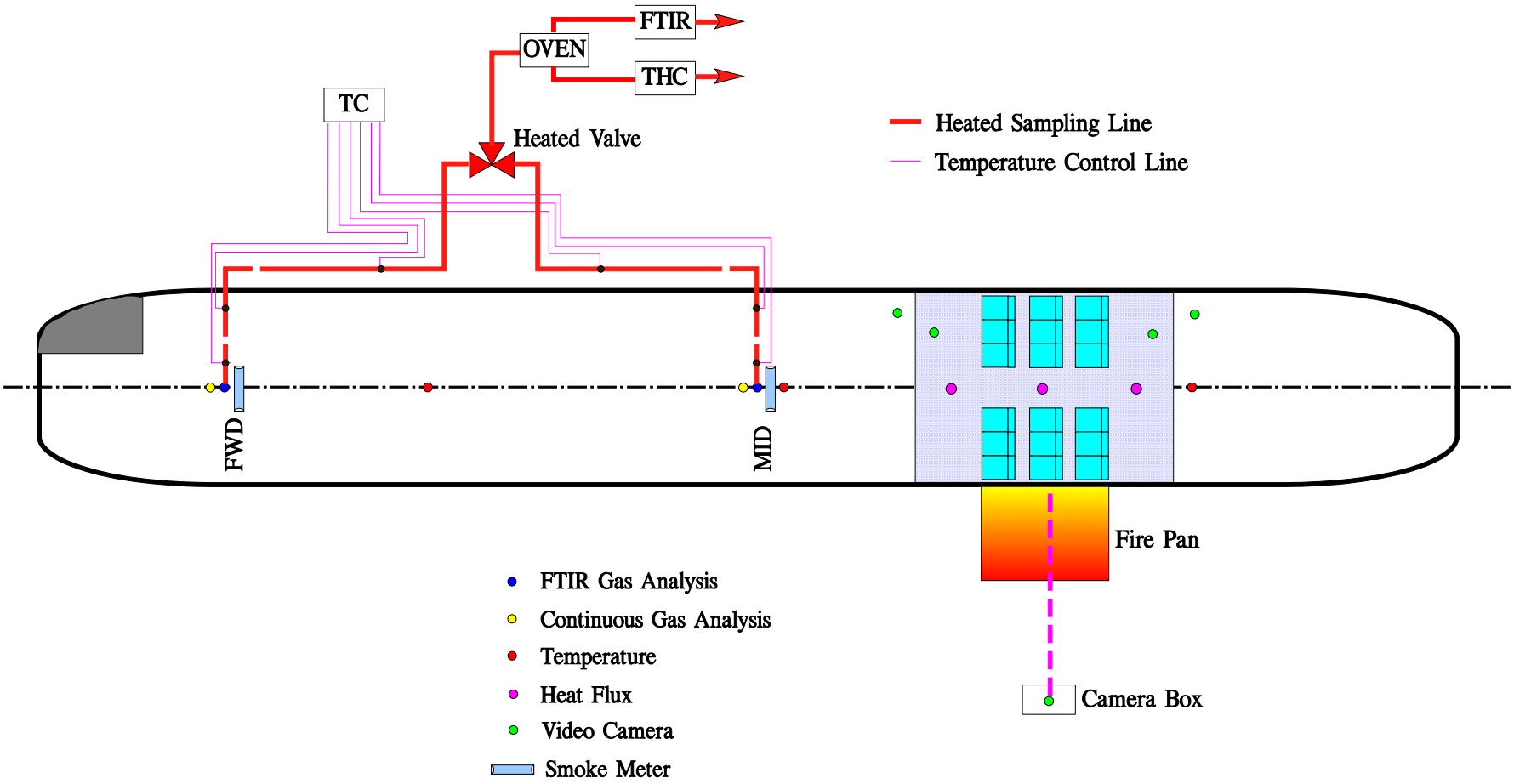
Application of Water Post-Test

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



Camera Location

Additional ‘unobscurable’ video camera used for accurate application of water post test



Baseline 3 Test Configuration

Baseline 3 Test Results

Baseline 3 Test Results

Baseline 3 Test Results

Baseline 3 Test Results

Baseline 3 Test Results

Baseline 3 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 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

Questions on Baseline Full-Scale Testing?

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 Test Configuration

WE-43 Test Configuration

WE-43 Test Results

WE-43 Test Results

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 Configuration

AZ-31 Test Results

AZ-31 Test Result

Summary of Findings

Pan fire extinguished at 5 minutes using AFFF

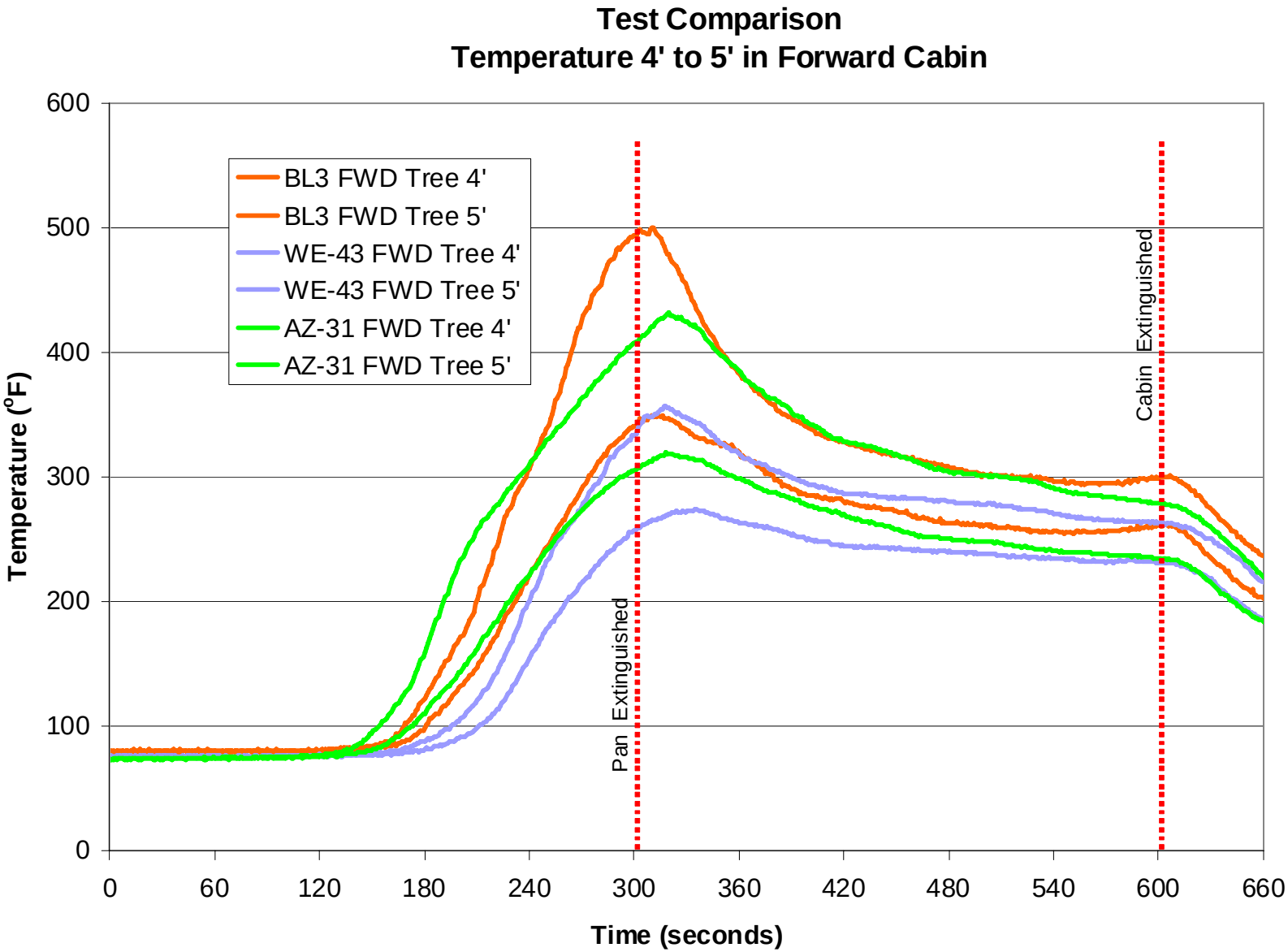
Interior fire extinguished at 10 minutes using water

Incapacitation reached in 4 min 33 sec at forward location

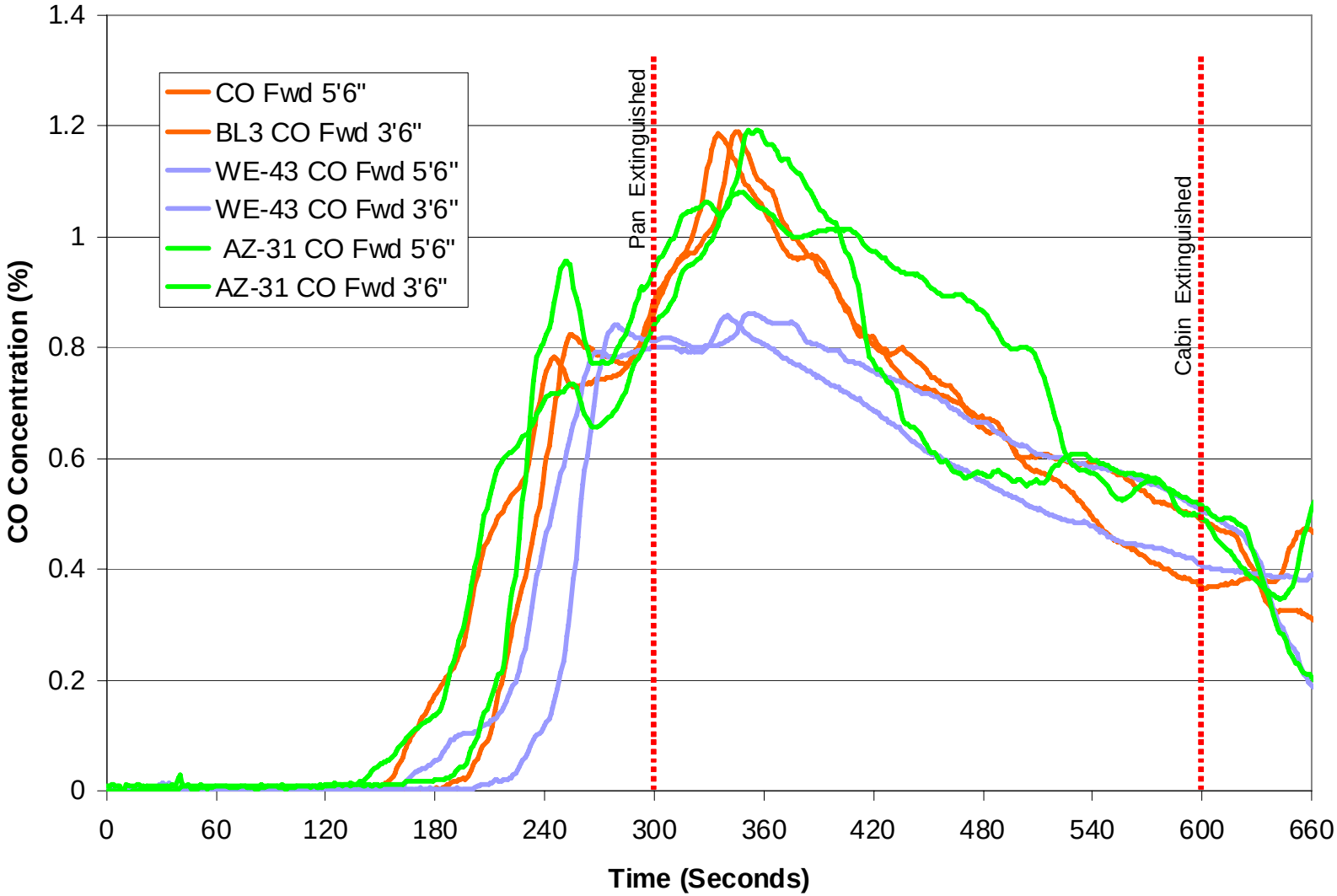
Seat backs (cushions, covers, plastics) mostly consumed on port side; largely intact on starboard side

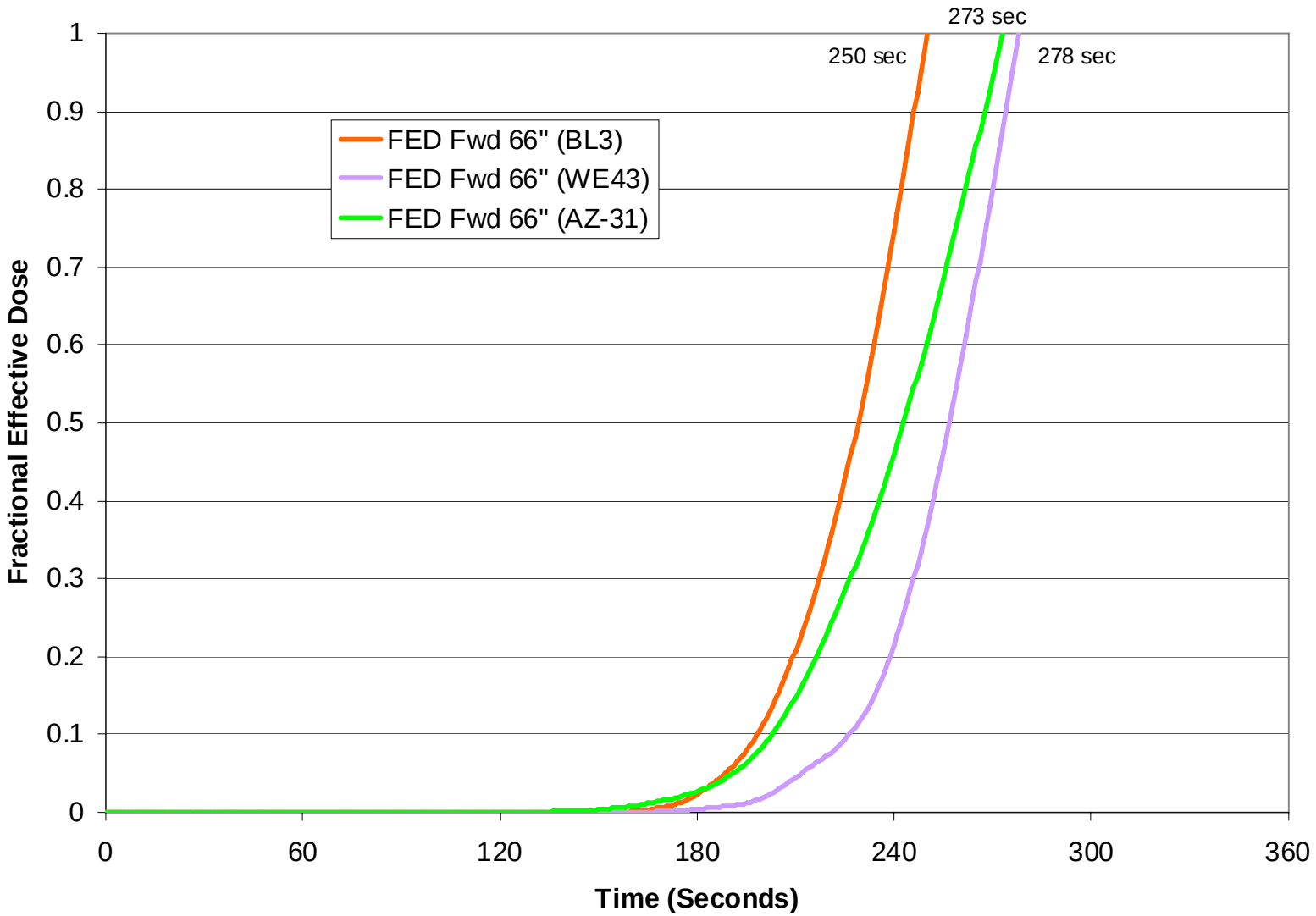
Seat bottom cushions on port side heavily involved in fire

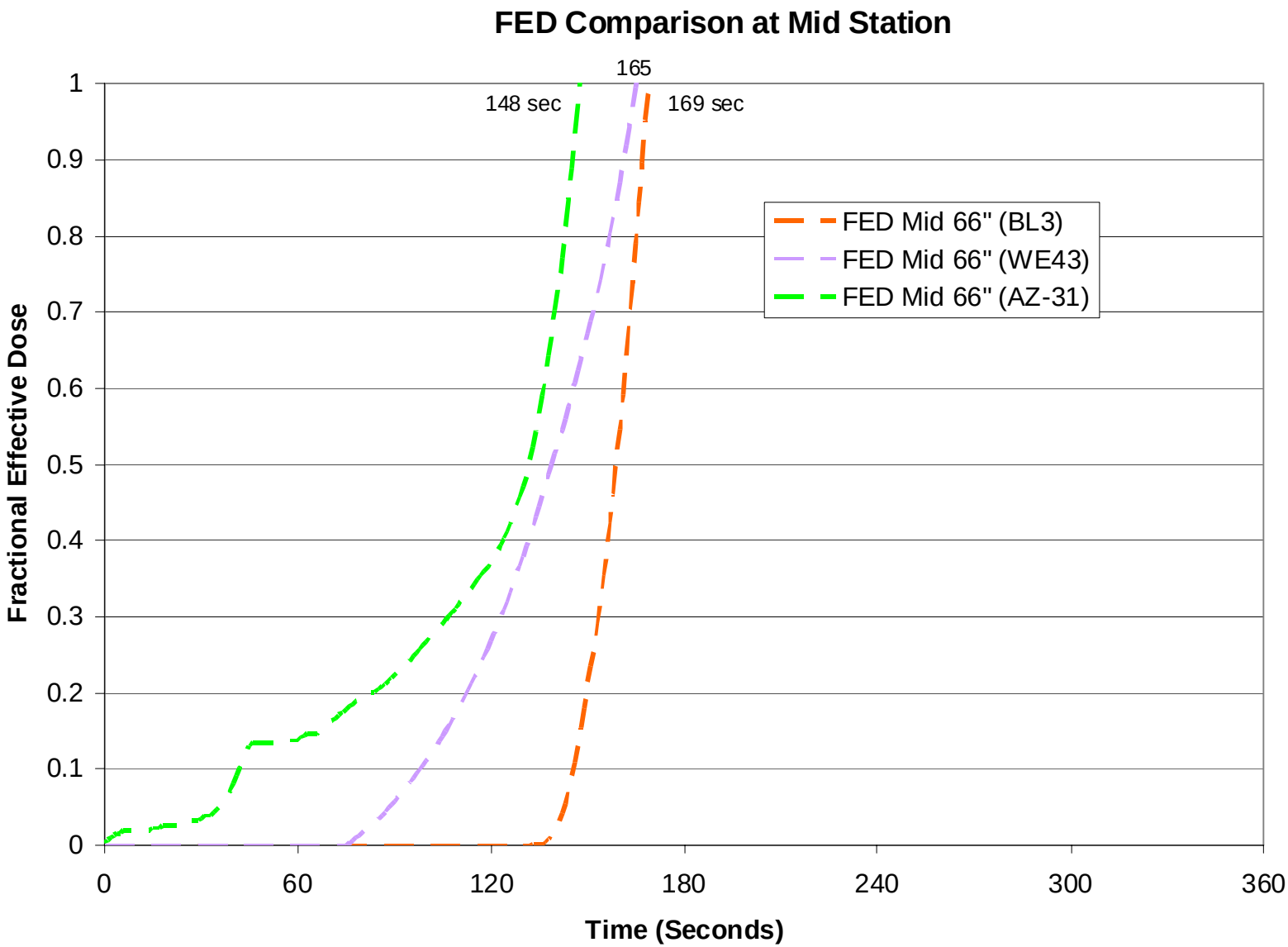
Increased melting of primary seat structure compared to baseline 3 test


Test Comparison
Temperature 4' to 5' in Forward Cabin
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
Temperature (°F)
Time (seconds)
0
100
200
300
400
500
600
0
60
120
180
240
300
360
420
480
540
600
660

Test Comparison
Carbon Monoxide at Forward Cabin




FED Comparison at Forward Station
273 sec
250 sec
278 sec
FED Fwd 66" (BL3)
FED Fwd 66" (WE43)
FED Fwd 66" (AZ-31)
Fractional Effective Dose
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
60
120
180
240
300
360
Time (Seconds)


FED Comparison at Mid Station
165
148 sec
169 sec
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Fractional Effective Dose
FED Mid 66" (BL3)
FED Mid 66" (WE43)
FED Mid 66" (AZ-31)
0
60
120
180
240
300
360
Time (Seconds)

Additional Full-Scale Tests (since last meeting)

Conducted test with seats using WE-43 extrusions in back frame and baggage bar on 4/20/10

Conducted test with seats using WE-43 extrusions in back frame and baggage bar on 5/13/10 (repeat)

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 BL3, 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

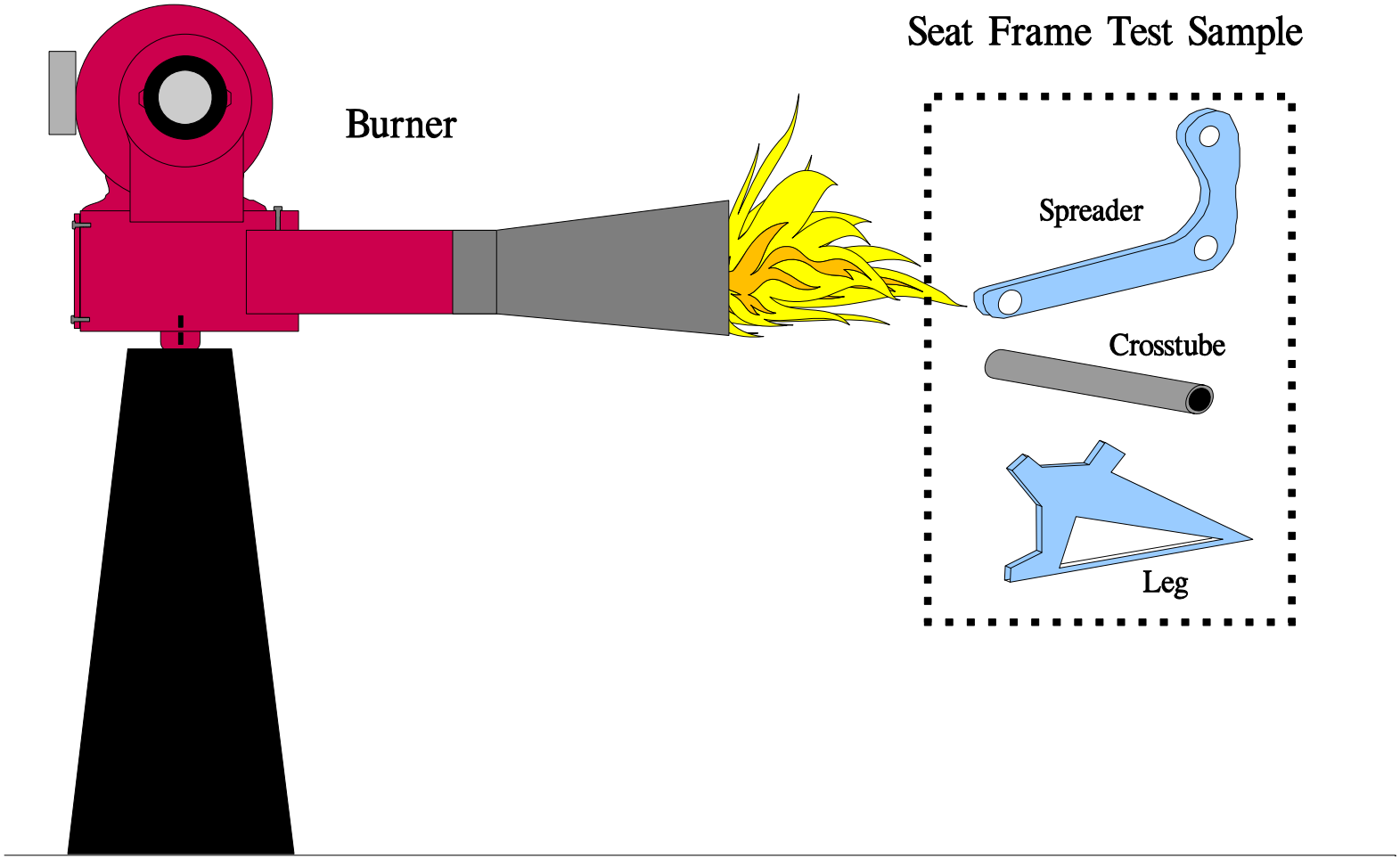
- slightly better for mag-alloys at forward location
- slightly worse for mag-alloys at mid location
- More severe fire condition caused more rapid incapacitation during "all-mag" tests

Next Steps

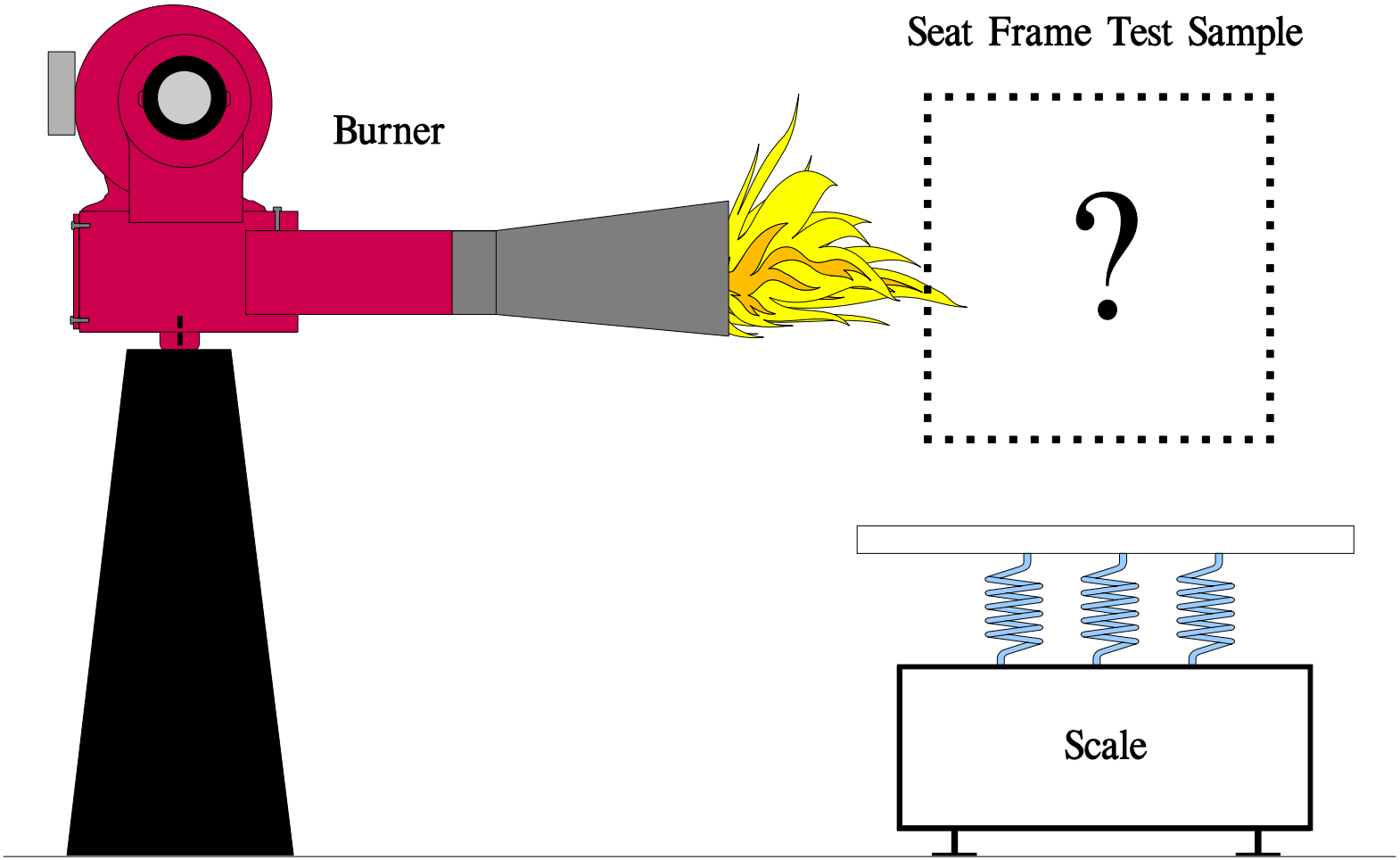
Comparison of all test results, study data, generate report

Lab test development??

Test Method Development



Test Method Development



Test Method Development

Items to Consider…

Thermal Insult

- Duration
- Size
- Intensity

Test Sample

- Size
- Geometry
- Edge Effects?

Test Parameters

- Melting Time
- After Flame Time
- Weight Loss

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.