



**Federal Aviation
Administration**

International Aircraft Materials Fire Test Working Group

Update on Flammability Testing of Magnesium Alloy Components

Presented to: IAMFT WG, Atlantic City, NJ

By: Tim Marker, FAA Technical Center

Date: October 21, 2009



Proposed Mag-Alloy Testing at FAA Tech Center

Conduct 4 full-scale tests, postcrash fire scenario

~~Baseline using OEM aluminum frames, FB seat cushions~~

~~Baseline using OEM aluminum frames, FB seat cushions~~

Baseline using OEM aluminum frames, FB seat cushions

Substitute good-performing mag alloy in primary structural components

Substitute poor-performing mag alloy in primary structural components

Substitute good-performing mag alloy in all structural components

Expected Outcomes

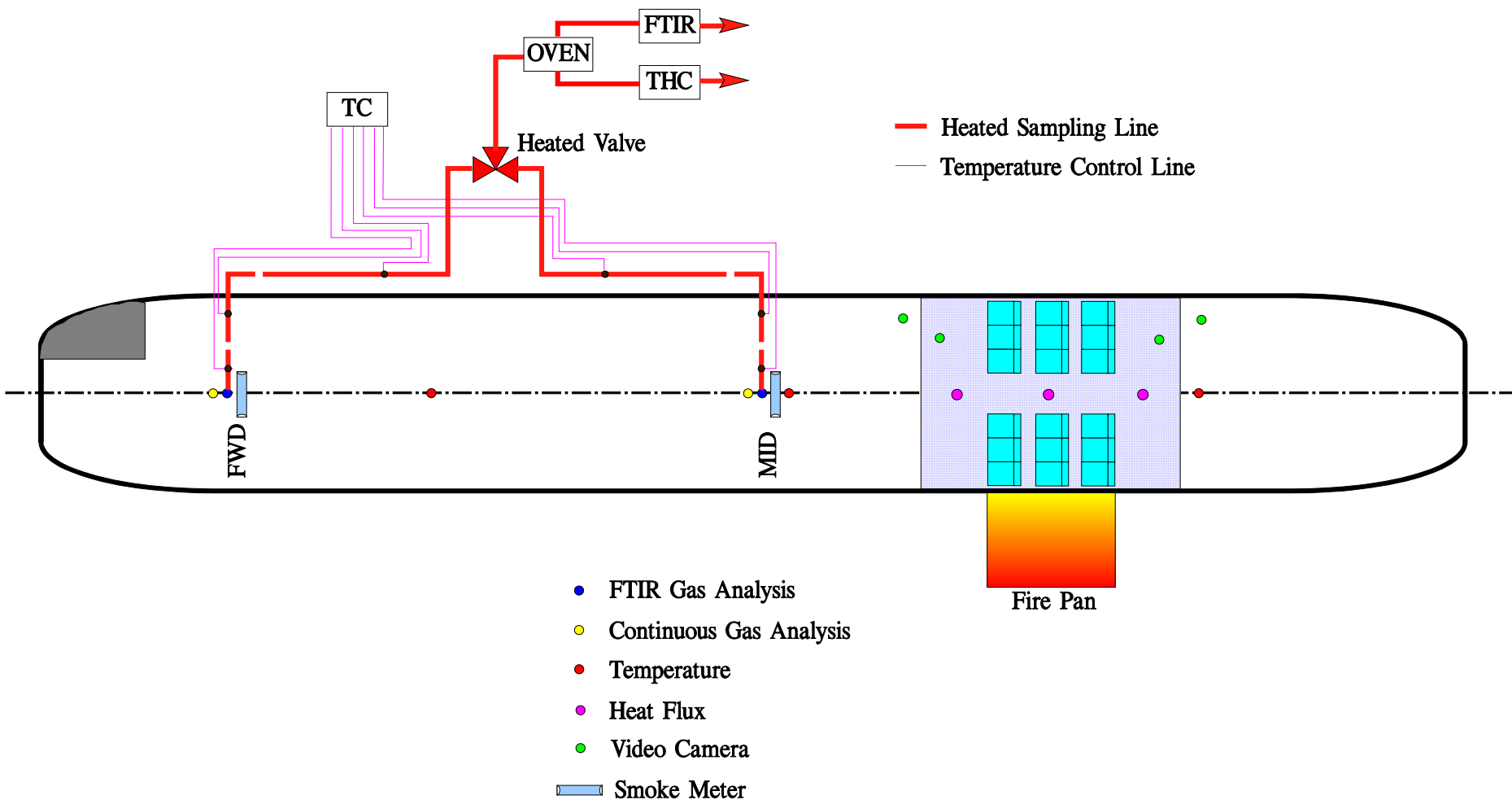
Determine if any additional hazard results

Determine if any difference exists between mag alloys

Primary Seat Components



Full-Scale Test Apparatus



Baseline 1 Test Configuration



Baseline 1 Test Result



Baseline 1 Test Result

Summary of Findings

Test terminated at 3 minutes

Incapacitation reached in less than 3 minutes

Seat backs (cushions, covers, plastics) completely consumed

Seat bottom cushions on LHS heavily involved in fire

Minimal melting of primary seat structure

Baseline 2 Test Configuration



Baseline 2 Test Results (untouched)



Baseline 2 Test Results (panels removed)



Baseline 2 Test Results (panels removed)



What is the extent of damage to the primary components?



Baseline 2 Test Results



Inspection of primary structure



Baseline 2 Test Results



Baseline 2 Test Result

Summary of Findings

Test terminated at 5 minutes 30 seconds

Incapacitation still reached in less than 3 minutes

Seat backs (cushions, covers, plastics) completely consumed

Seat bottom cushions on LHS heavily involved in fire

Minimal melting of primary seat structure

Full-Scale Tests Highlighted Seat Back Flammability



Full-Scale Tests Highlighted Seat Back Flammability



A photograph of the back of an airplane seat. The seat backrest is folded down, revealing a grey storage bin. The bin has a black strap across the top and a white label with the number '120552' and a small 'T' next to it. Below the bin, the seat base is visible with the text 'FASTEN SEAT BELT WHILE SEATED' and 'LIFE VEST UNDER YOUR SEAT' printed on it.

Task Group Minutes 3/4/2009 (Naples)

Repeat baseline test, or move ahead??

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

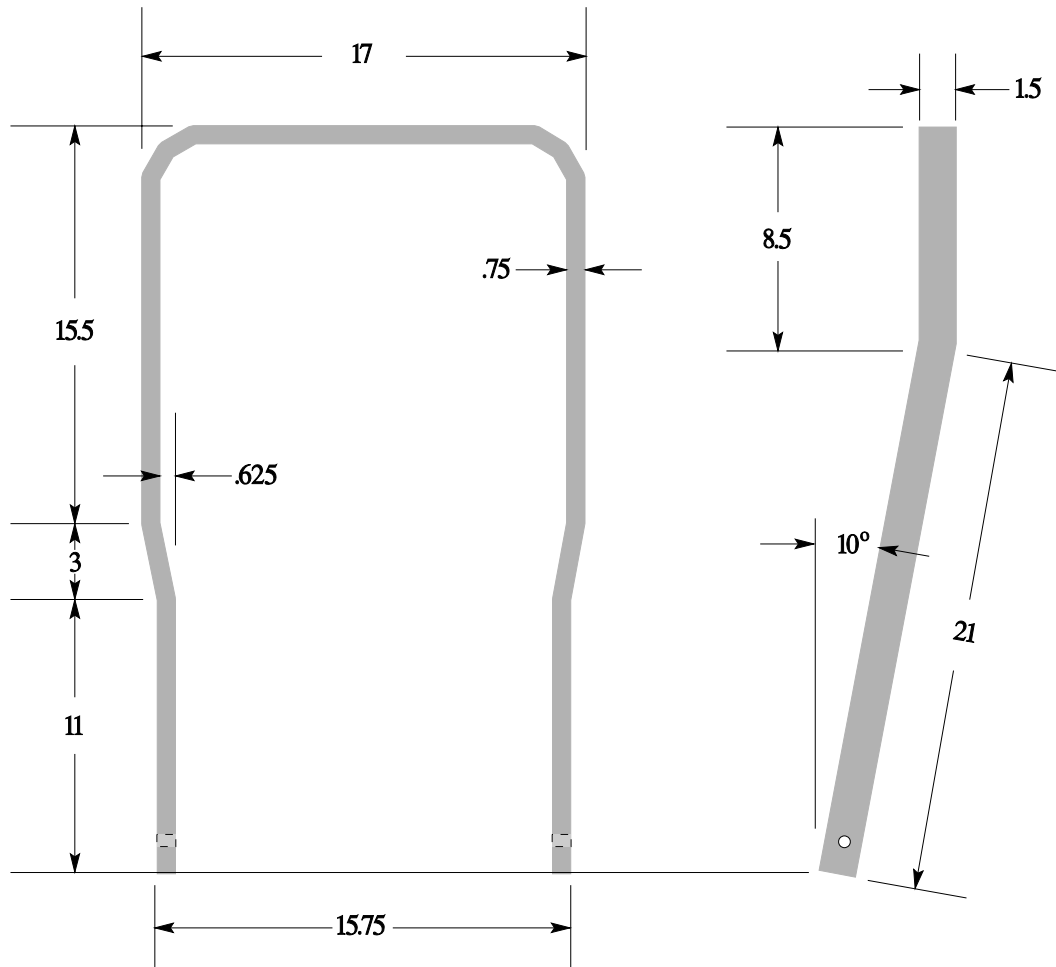
Conduct lab-scale oil burner testing of seat cushions used in testing

New Seat Back Frame Design

2024 alum box frame, 0.75-inch by 1.5 inch

Front View

Side View



New Seat Back Frame Design

2024 alum box frame, 0.75-inch by 1.5 inch



New Fire Hardened Foam for Seat Frames



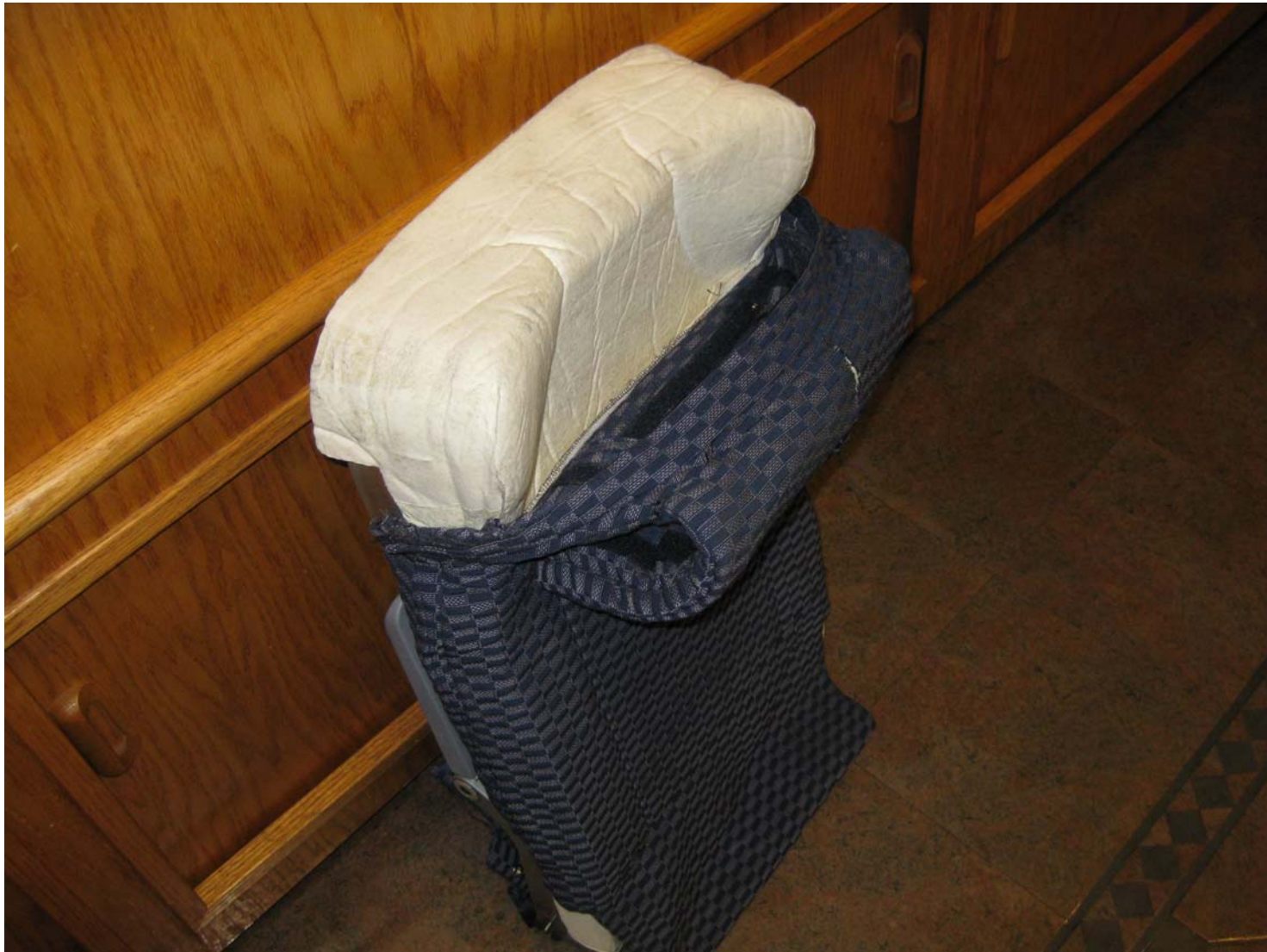
New Fire Hardened Foam for Seat Frames



New Seat Back



New Seat Back with Dress Cover



New Back Frame Installed



Tray Table and Arms Attached to Frame



Mass Production of Seat Back Frames

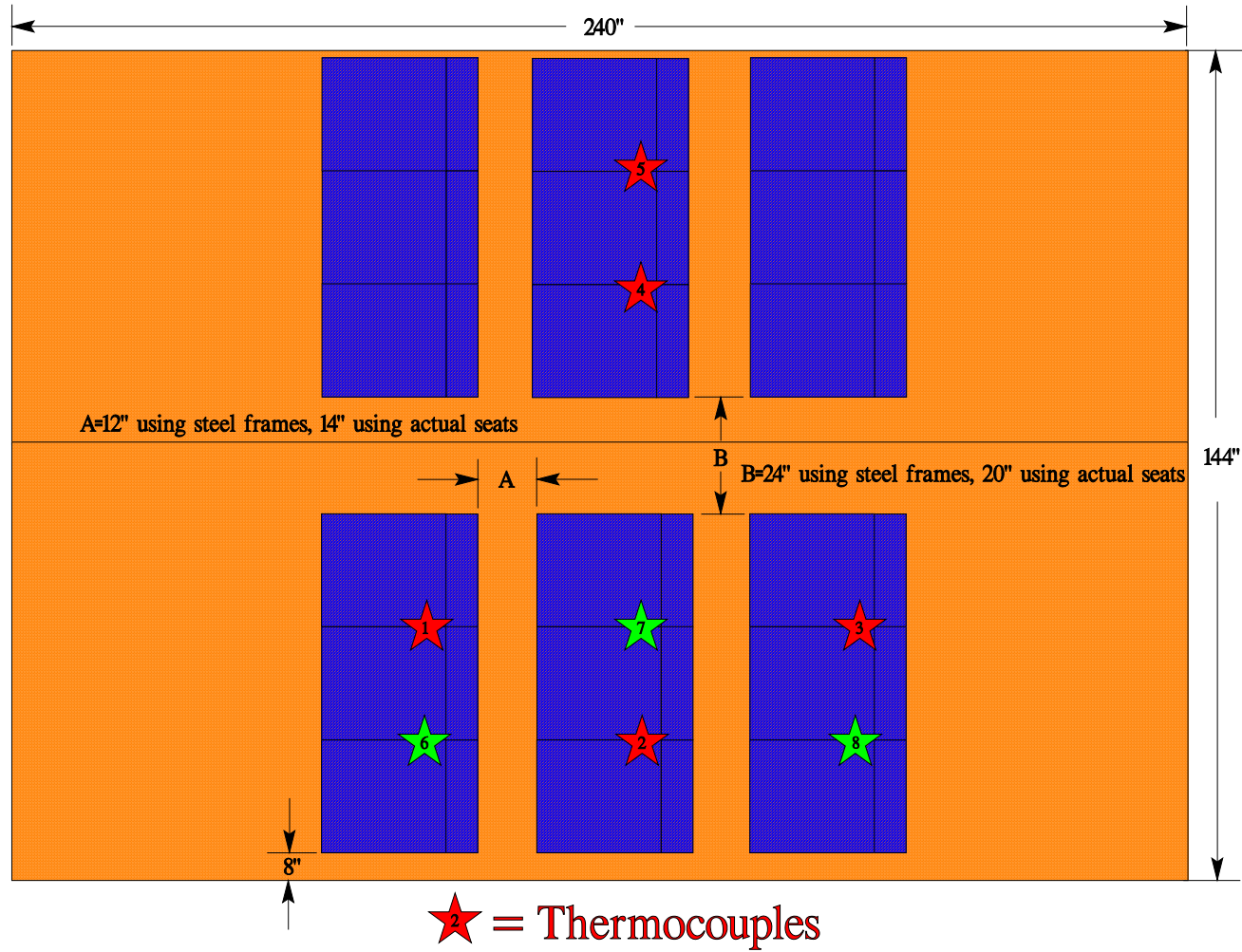


Dress Cover Installed Over New Back Frame



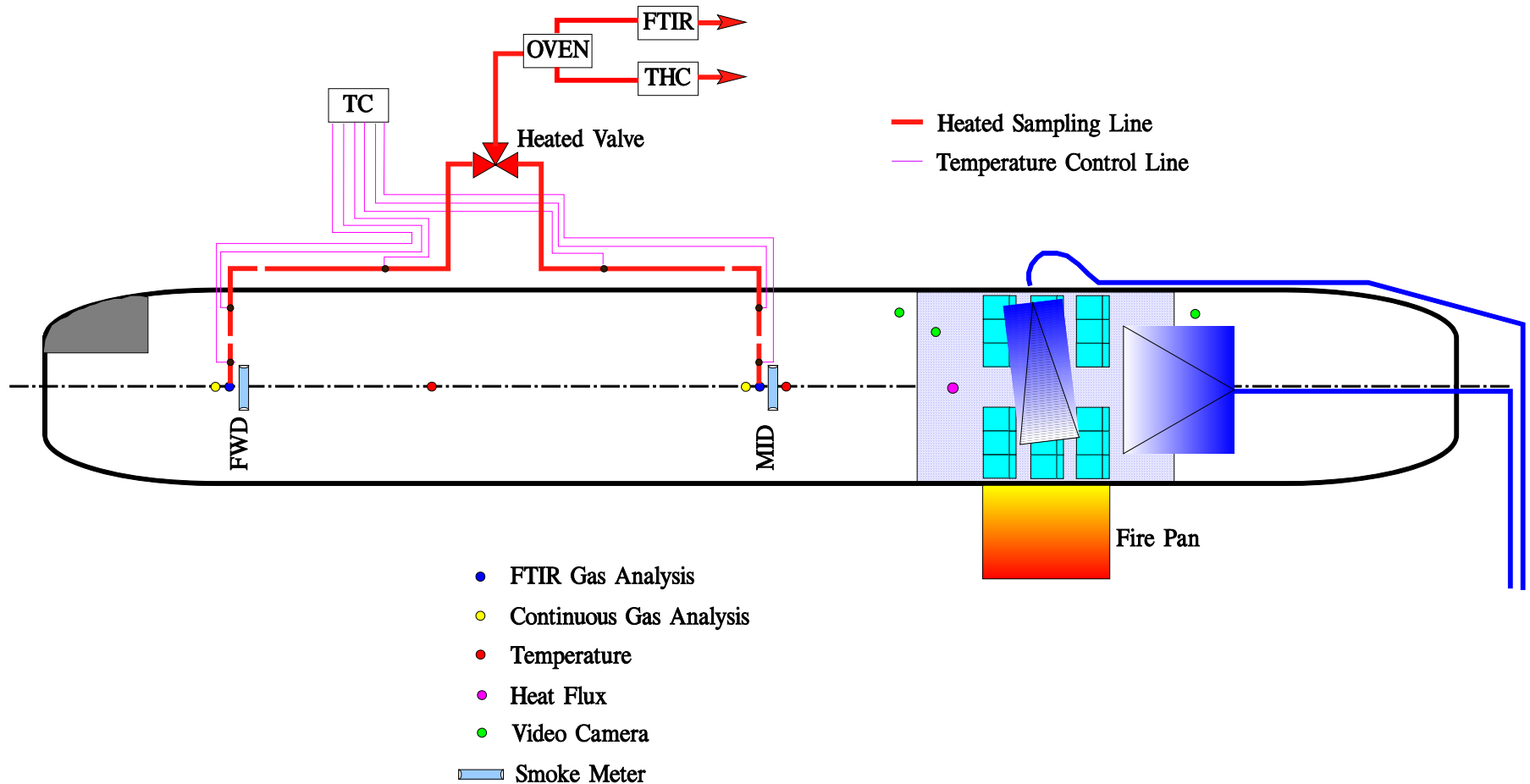
Seat Thermocouples

Additional thermocouples installed in seat leg frames



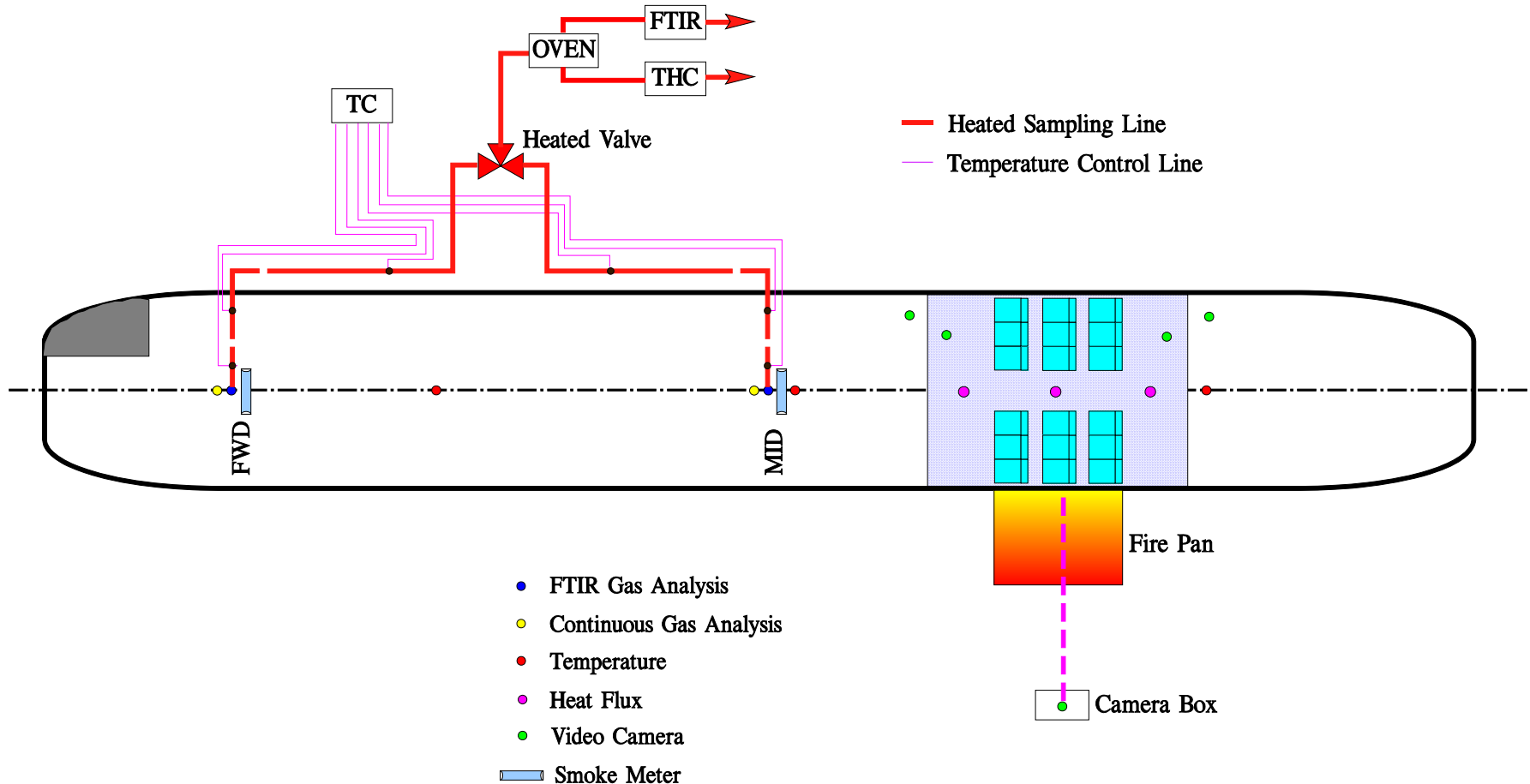
Application of Water Post-Test

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



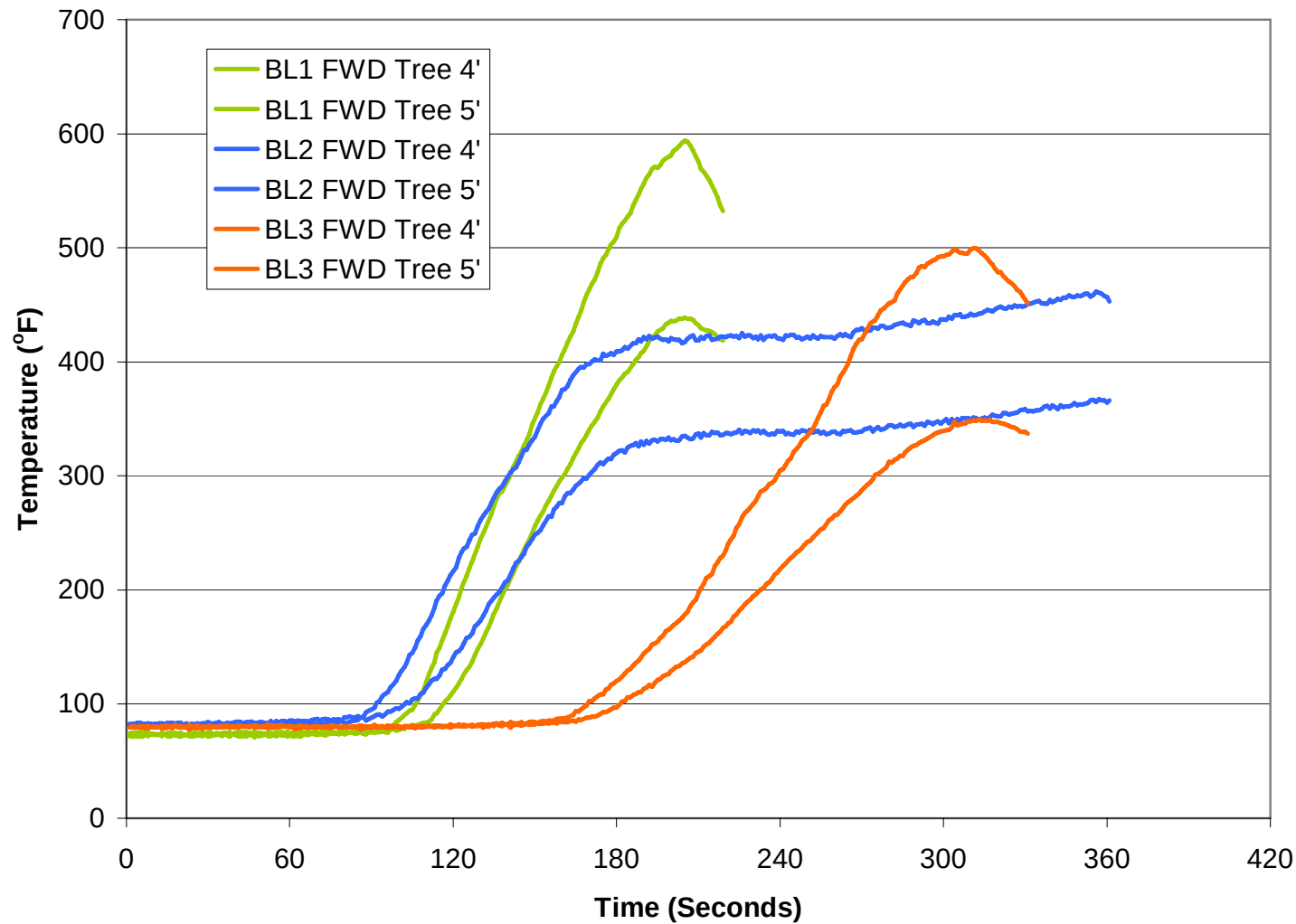
Baseline 3 Test Results



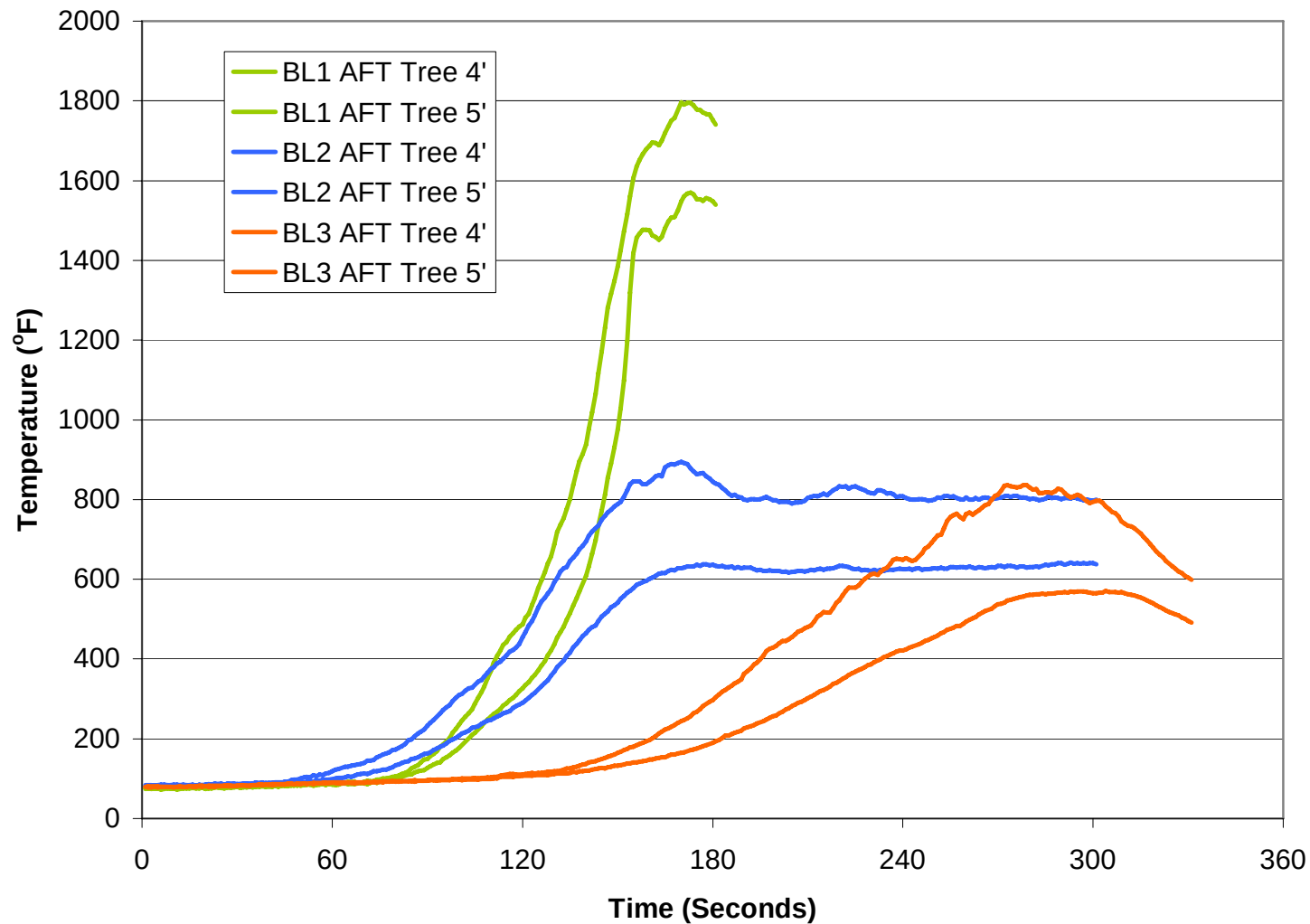
Baseline 3 Test Results



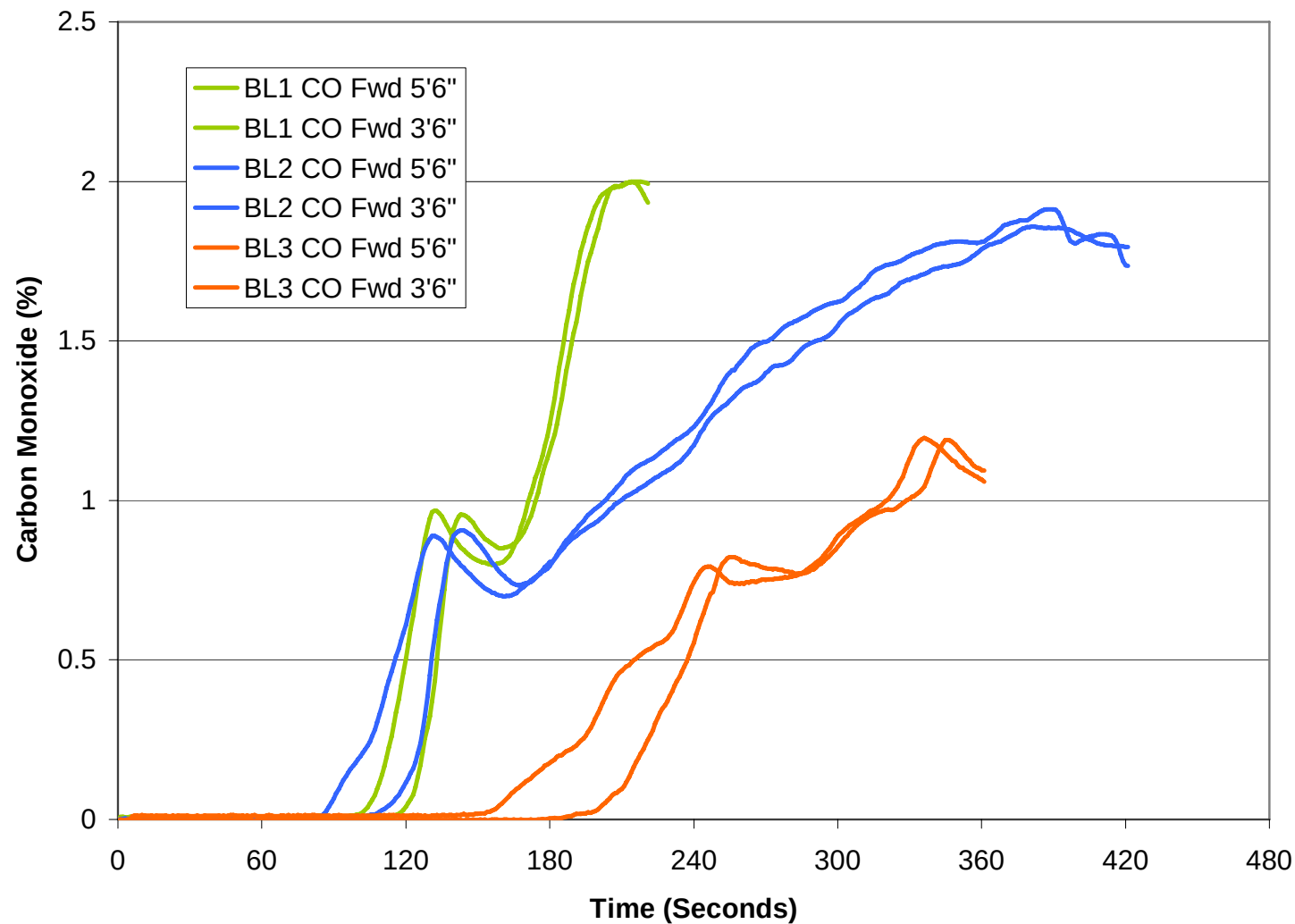
Baseline Comparison Temperature 4' to 5' in Forward Cabin



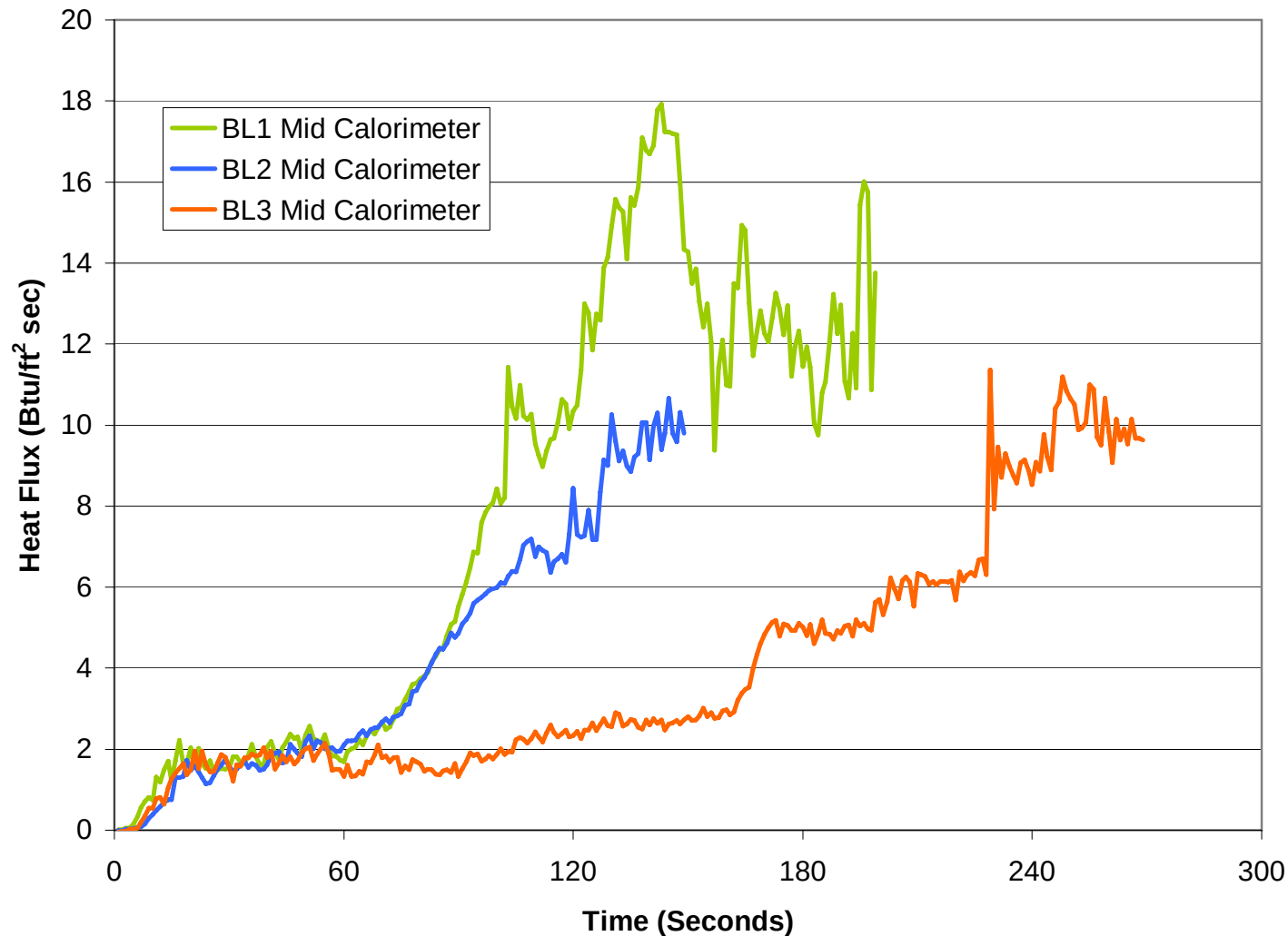
Baseline Comparison Temperature 4' to 5' in Aft Cabin



Baseline Comparison Carbon Monoxide at Forward Cabin



Baseline Comparison Heat Flux in Center of Test Area



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 31 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

...Time to move ahead with mag-alloy testing...



WE-43 Test Configuration



WE-43 Test Configuration



WE-43 Test Configuration



WE-43 Test Configuration



WE-43 Test Results



WE-43 Test Results



WE-43 Test Results



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

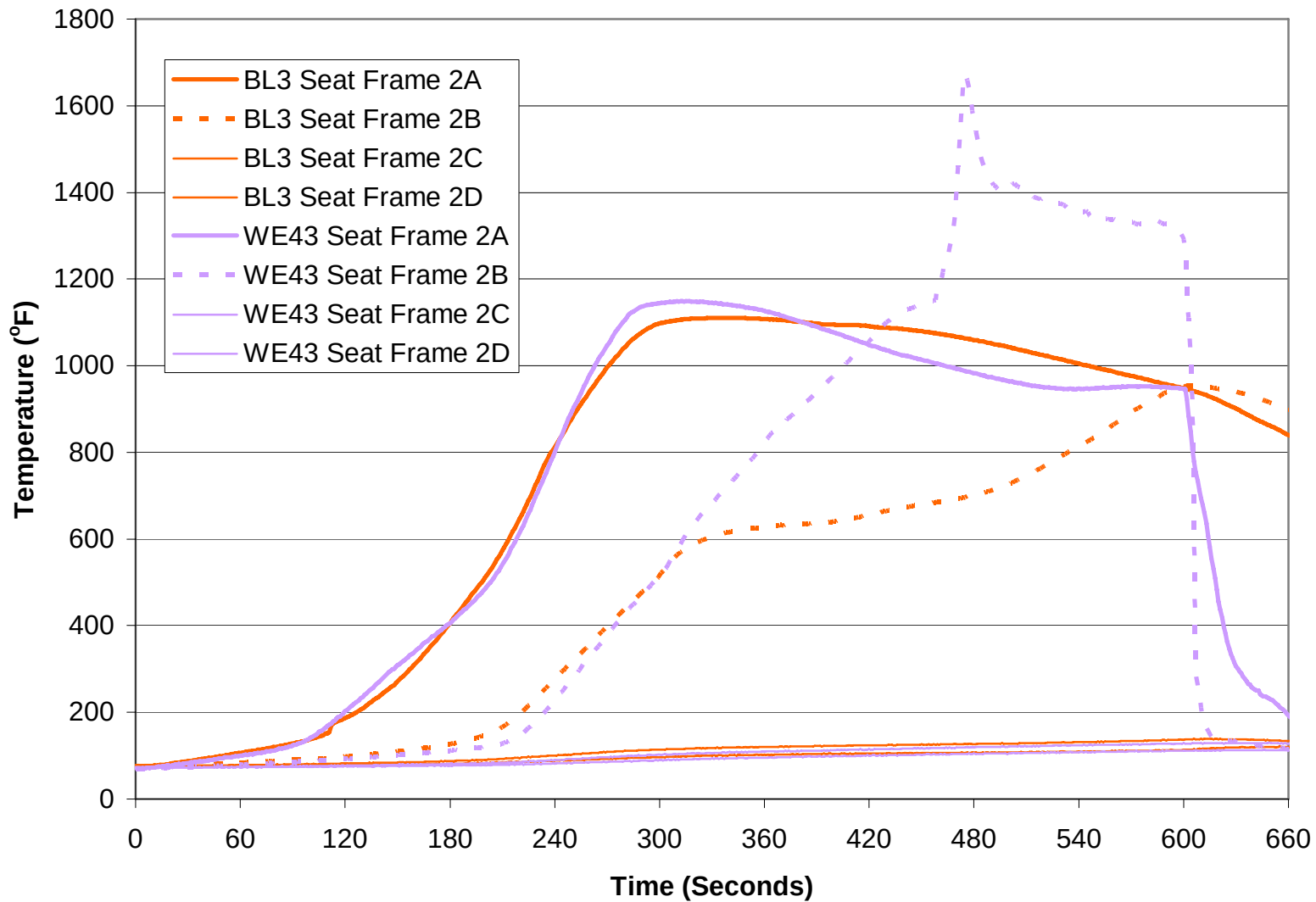
Incapacitation reached in 5 min 5 sec at forward location

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

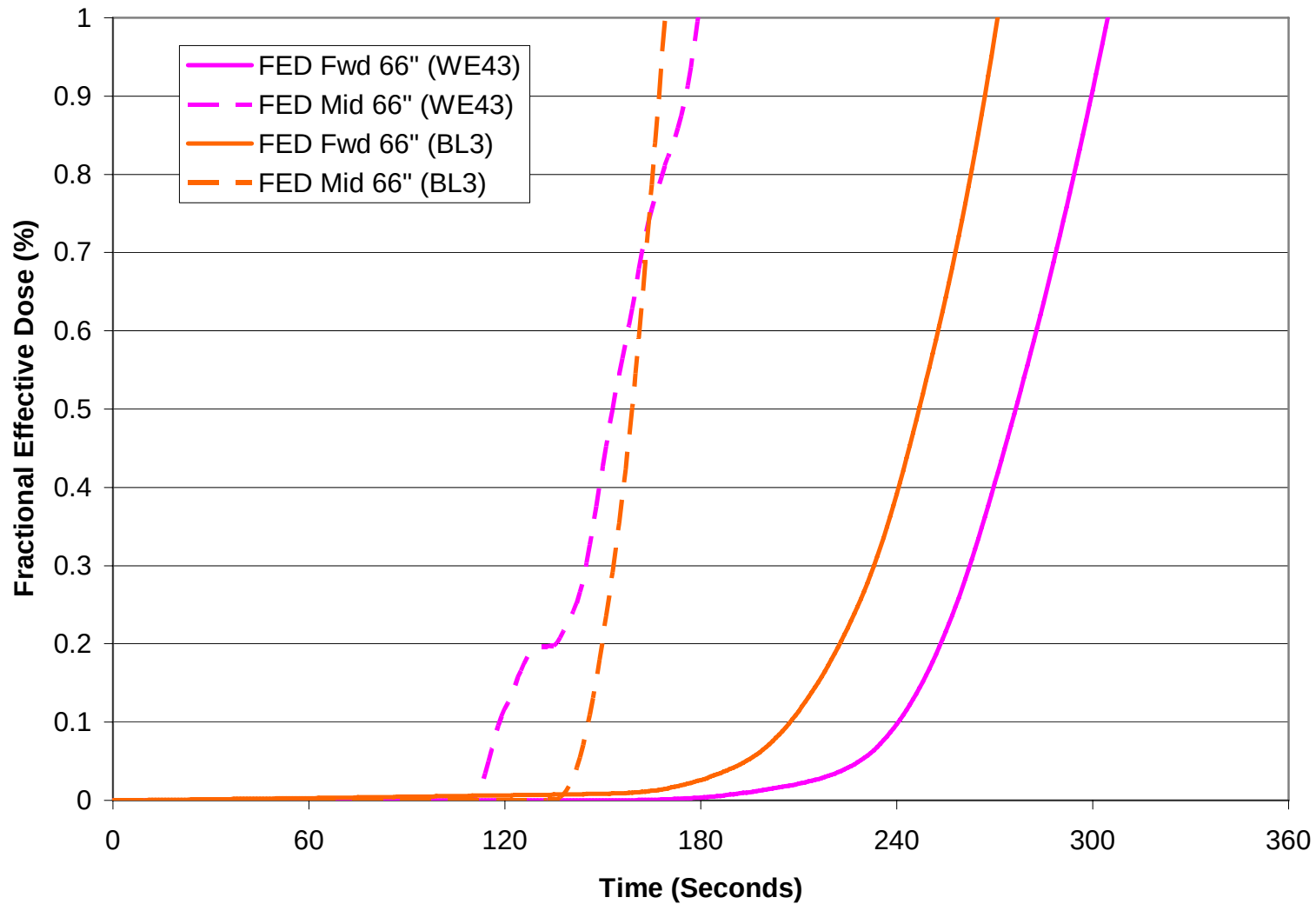
Seat bottom cushions on port side heavily involved in fire

Increased melting of primary seat structure compared to baseline 3 test

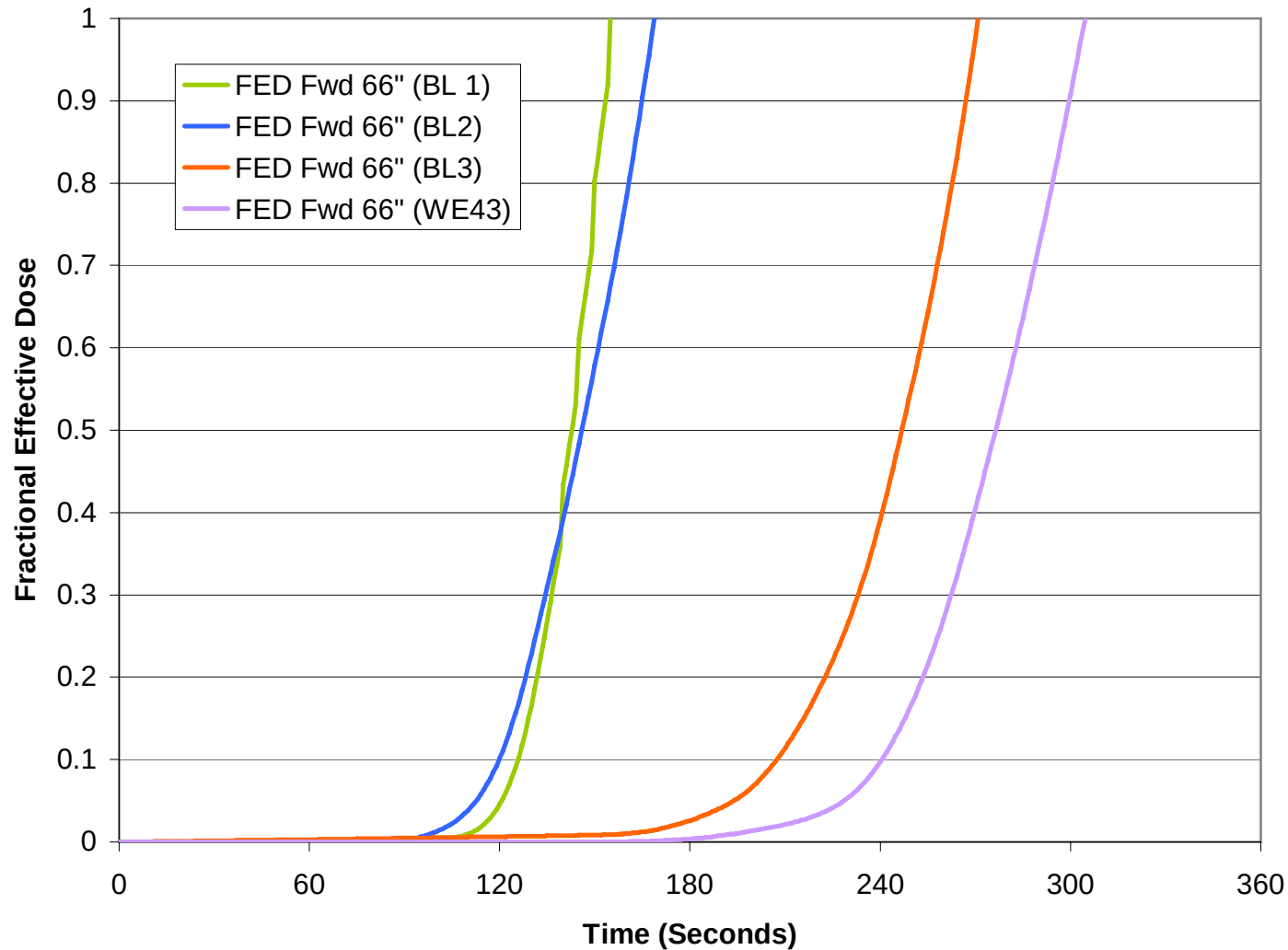
Seat Frame Temperature Comparison



FED Comparison, Baseline 3 and WE43



FED Comparison at Forward Cabin



Next Steps

Continue with assembly of seats using new back cushions/covers

Prepare for test using AZ31 mag-alloy components

If poor-performing mag-alloy does not result in elevated hazard level:

??????

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.

Industry Welcome to “Look Over Our Shoulder”



Industry Welcome to “Look Over Our Shoulder”



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63 of many

Baseline Seat Test 3 Conducted on July 7, 2009



WE-43 Mag-Alloy Seat Test 2 Conducted on Sept 10, 2009



Comparison of Baseline 3 and Mag-Alloy Tests



Weight of Individual Components

Component	Aluminum weight (g)	WE43 weight (g)	WE43 Weight savings (%)	AZ31 weight (g)	AZ31 Weight savings (%)
Leg post	345.7	334.5	3.24	324.2	6.22
Leg body	1120	715	36.16	694.5	37.99
cross tube	1130	960	15.04	978.6	13.40
spreader, window end	695	405	41.73	377.8	45.64
spreader, mid	825	530	35.76	516.9	37.35
spreader, aisle end	920	560	39.13	527.7	42.64

Avg weight savings

28.51

30.54