



**Federal Aviation
Administration**

International Aircraft Materials Fire Test Working Group

Update on Flammability Testing of Magnesium Alloy Components

Presented to: IAMFT WG, Naples, FL

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Date: March 4, 2009



Magnesium Alloy Use in Commercial Aircraft

Industry Question: *Why can't we use Magnesium-Alloy in the construction of an aircraft seat frame?*

Regulatory Response: *Current FAA TSO C-127 "Rotorcraft and Transport Airplane Seating Systems" makes reference to an SAE specification, which bans the use of magnesium in seats.*

Magnesium Alloy Use in Commercial Aircraft



Piece of Magnesium

Industry Rebuttal: The current SAE specification references tests that were conducted 30 years ago! Many technological advancements have taken place in the last 30 years that have significantly reduced the flammability of various magnesium alloys.

Magnesium Alloy Flammability

What are fire threats?

In-Flight Fire



Electrical arc, hidden fire adjacent to mag-alloy component

Postcrash Fire



Direct threat of fire entering cabin, flashover, passenger and firefighter protection

Magnesium Alloy Flammability

What has been done to better evaluate and quantify Magnesium Alloy Flammability?



Oil Burner Testing



Handheld Extinguisher Testing

Handheld Extinguisher Testing of Mag Alloy Samples



burning mag alloy sprayed with 1211

Magnesium Alloy Flammability

What has been done to better evaluate and quantify Magnesium Alloy Flammability?



Miscellaneous Lab-Scale Flammability Testing

Magnesium Alloy Flammability

Preliminary lab scale oil burner testing

Handheld extinguisher testing

Additional lab-scale flammability experimentation

Identify critical elements of preliminary testing

Conduct full scale test using mag-alloy seat frames

Develop lab scale test based on full-scale results

How Should a Full Scale Seat Test Be Conducted?



Test Using OEM Seats

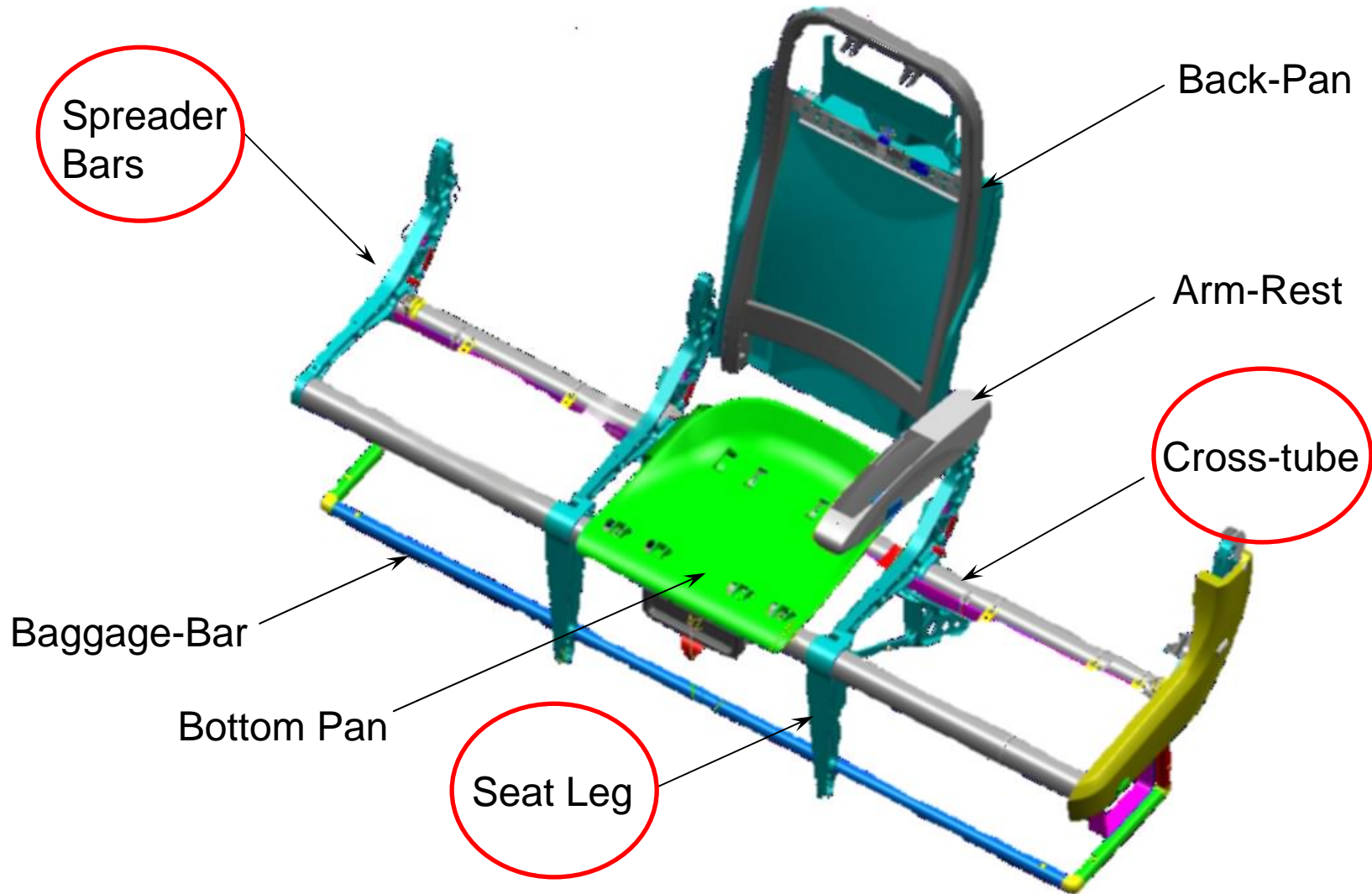


Test Using Mock-up Seats

Typical Seat Assembly



Typical Seat Primary Components



Proposed Mag-Alloy Testing at FAA Tech Center

Conduct 4 full-scale tests, postcrash fire scenario

Baseline using OEM aluminum frames, FB seat cushions

Substitute poor-performing mag alloy in primary structural components

Substitute good-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

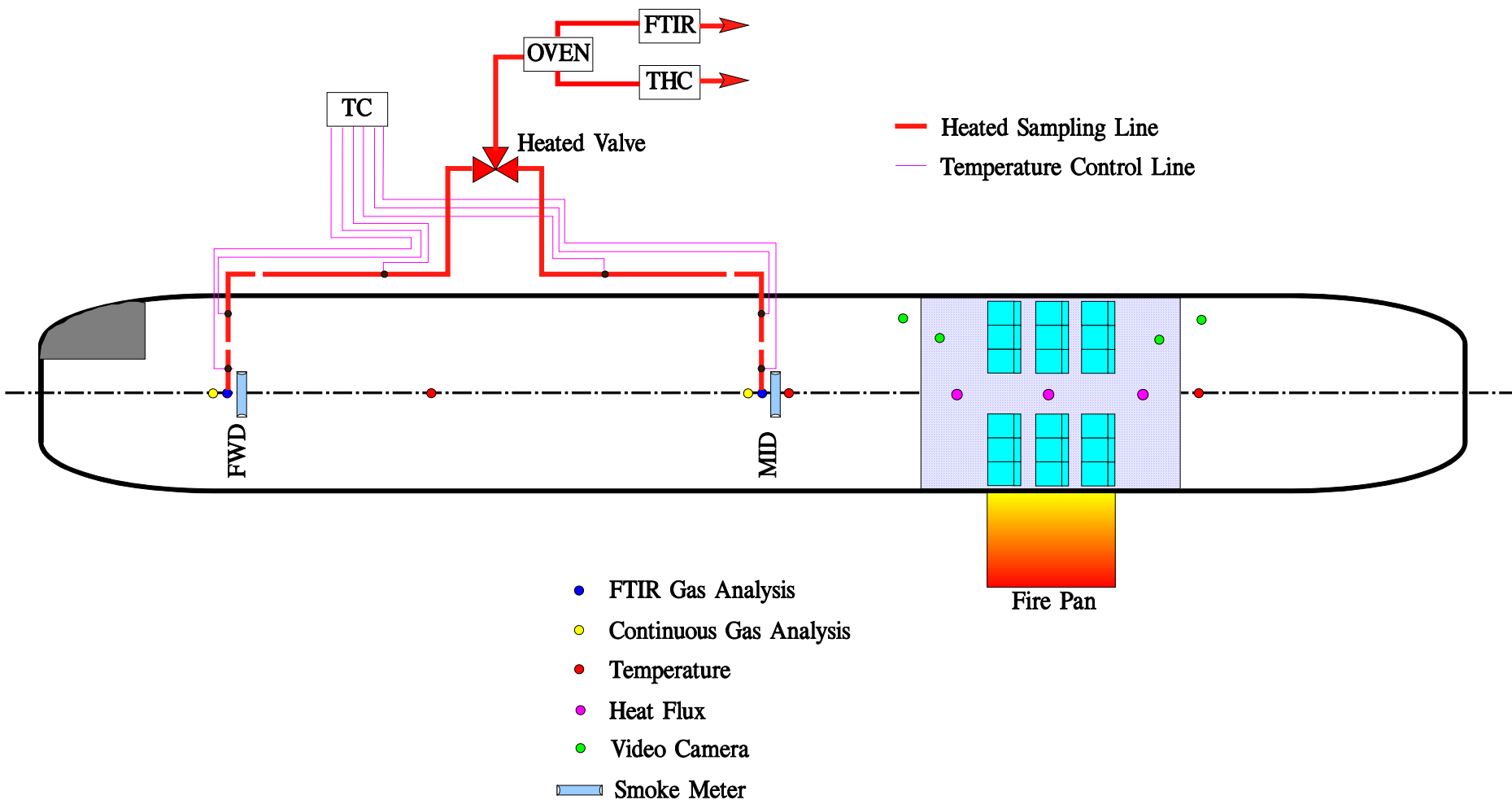
Procurement of B/E Aerospace “990” Seats



B/E Aerospace “990” Seats



Full-Scale Test Apparatus



Baseline 1 Test Configuration



Baseline 1 Test Configuration



Baseline Seat Test 1 Conducted on Oct 7, 2008



Baseline 1 Test Result



Baseline 1 Test Result



Baseline 1 Test Result



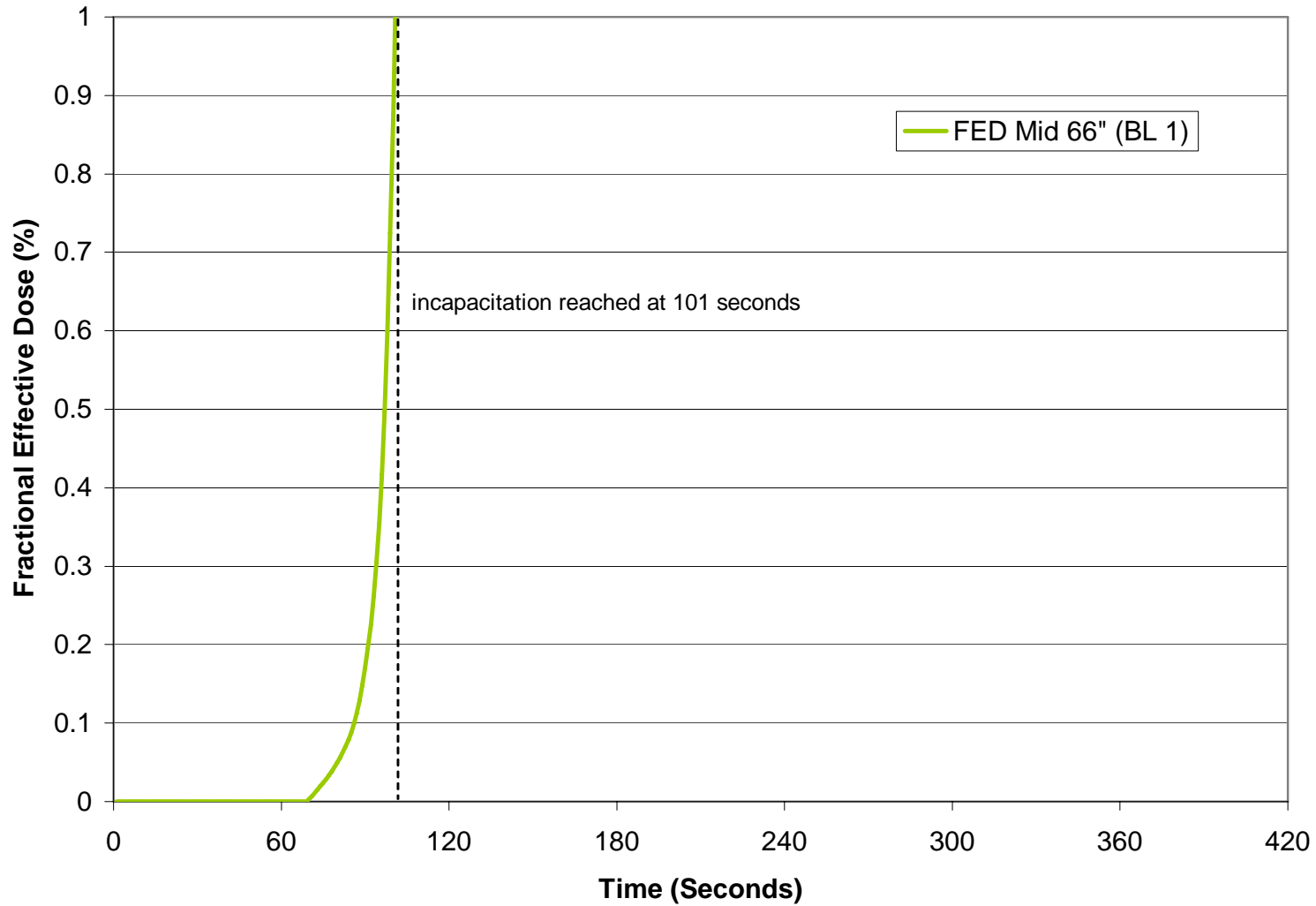
Baseline 1 Test Result



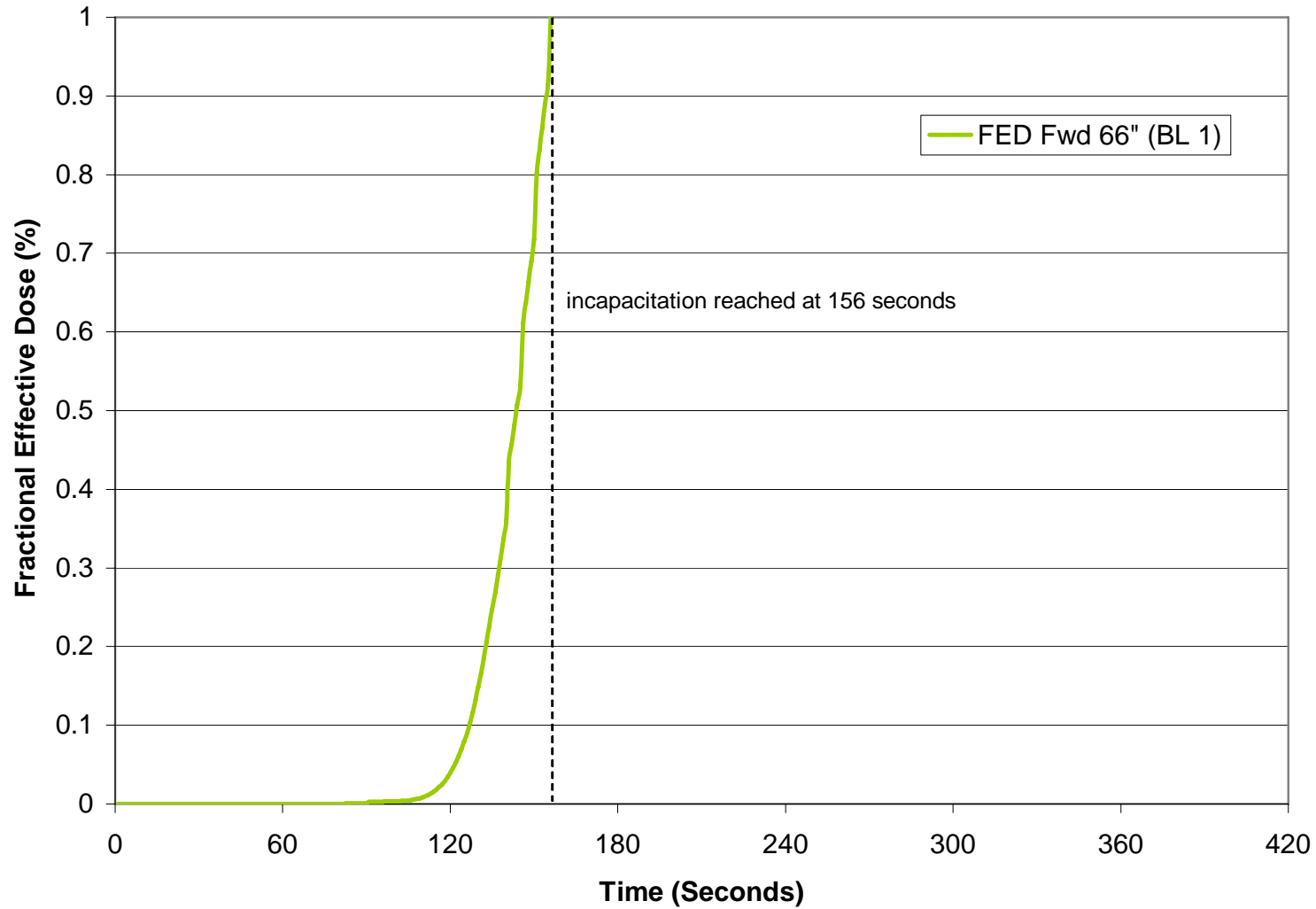
Baseline 1 Test Result



FED Mid Station 5'6"



FED Forward Station 5'6"



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 Configuration



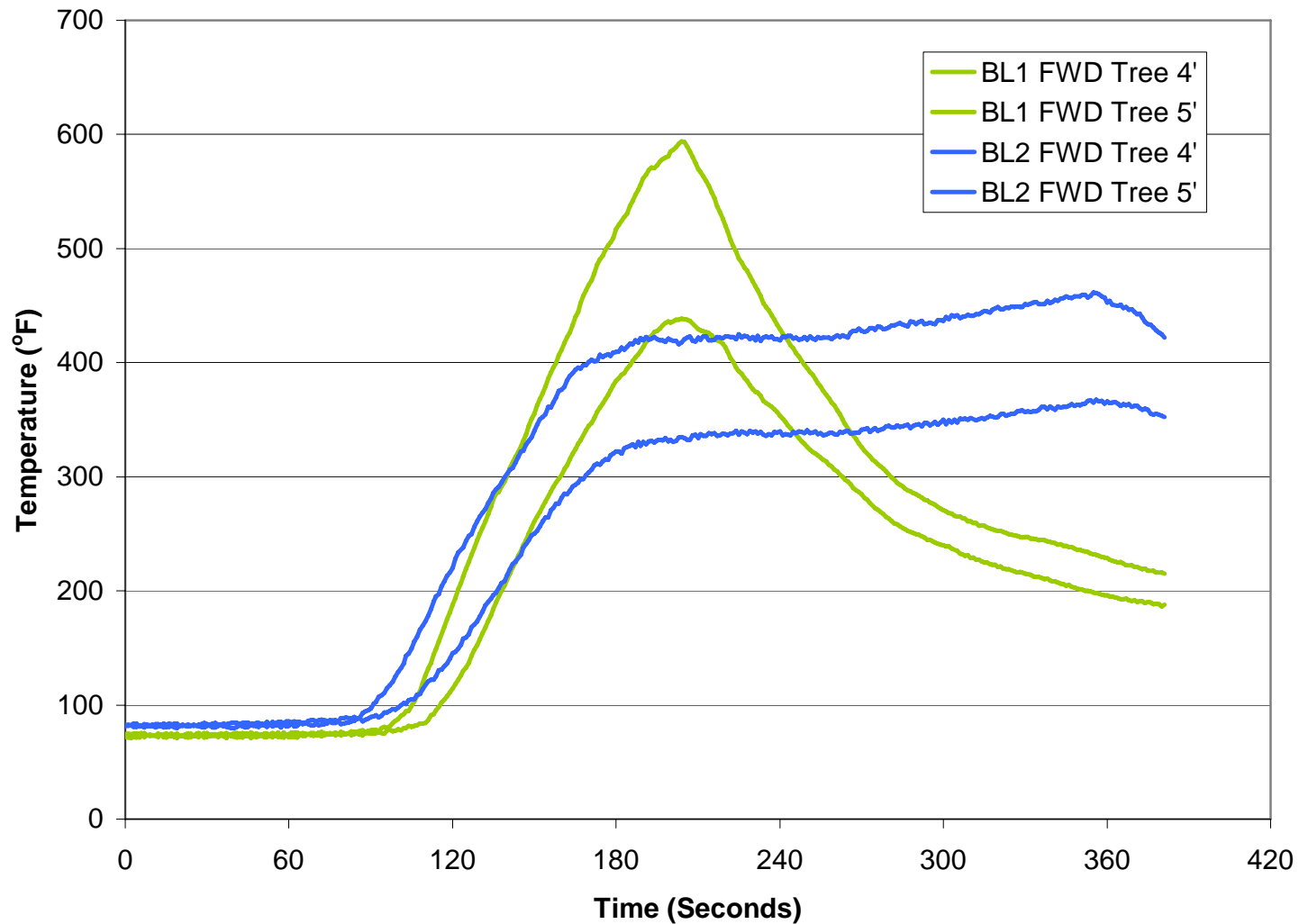
Baseline 2 Test Results



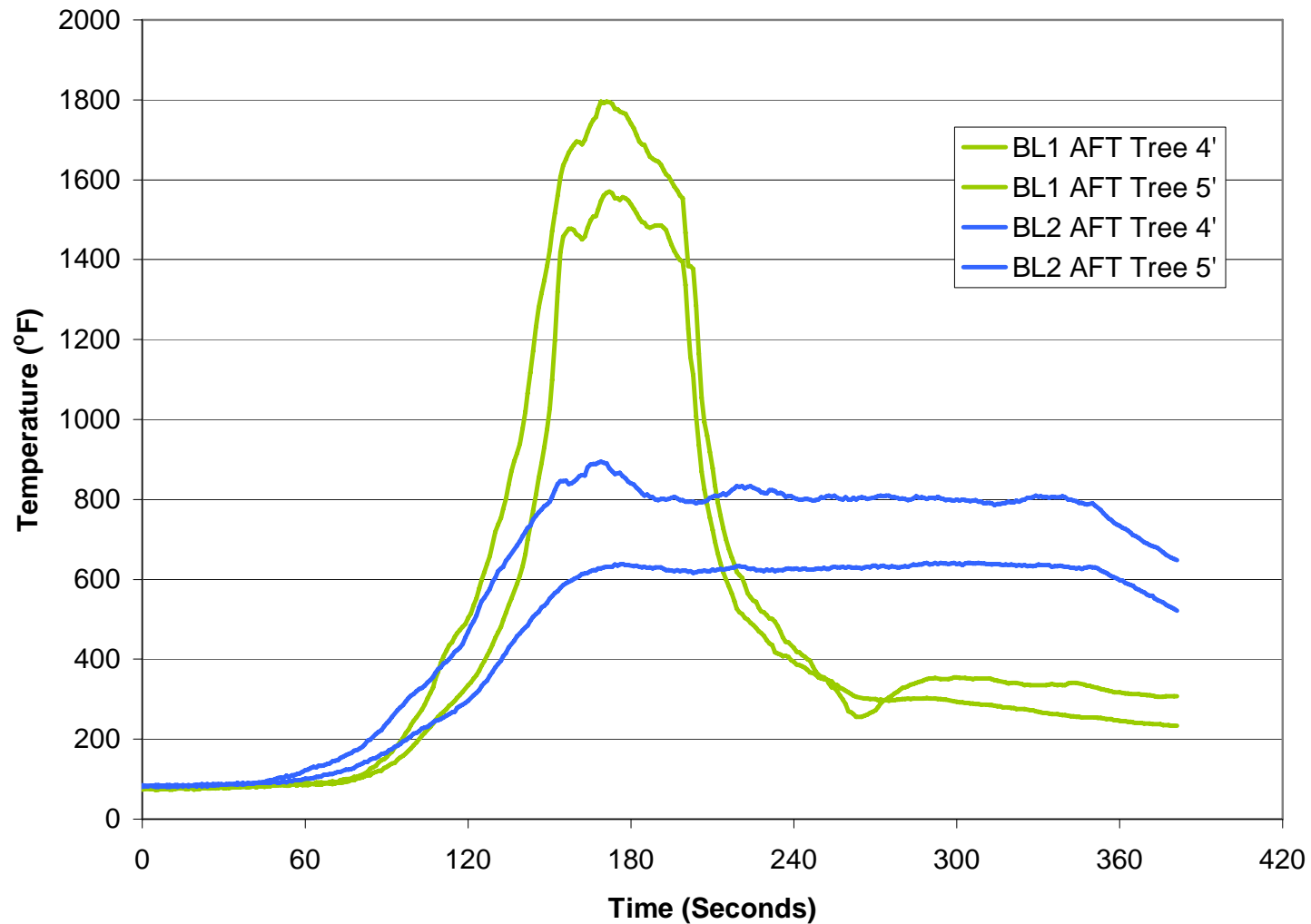
Baseline Seat Test 2 Conducted on Dec 18, 2008



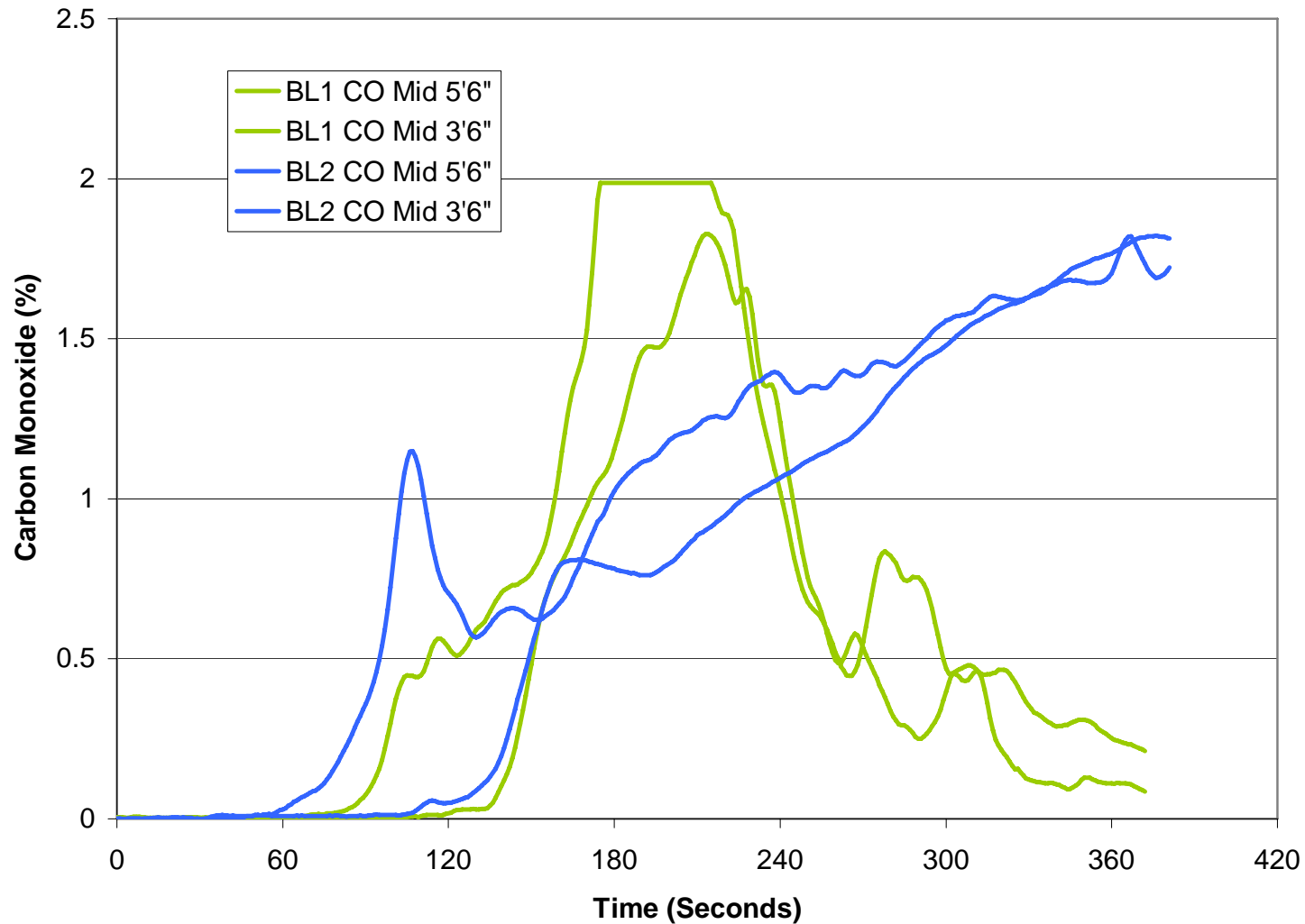
Baseline Comparison Temperature 4' to 5' in Aft Cabin



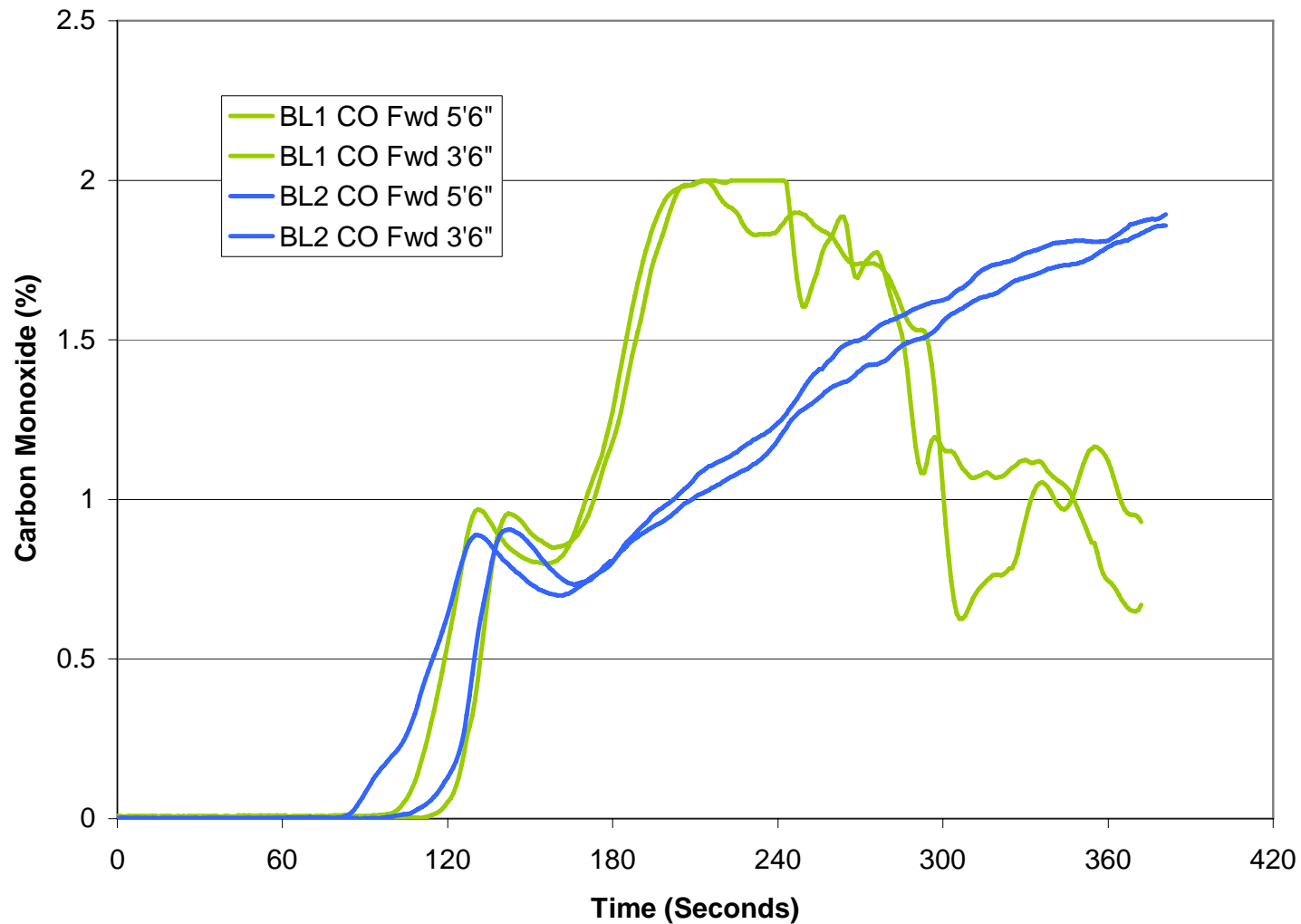
Baseline Comparison Temperature 4' to 5' in Aft Cabin



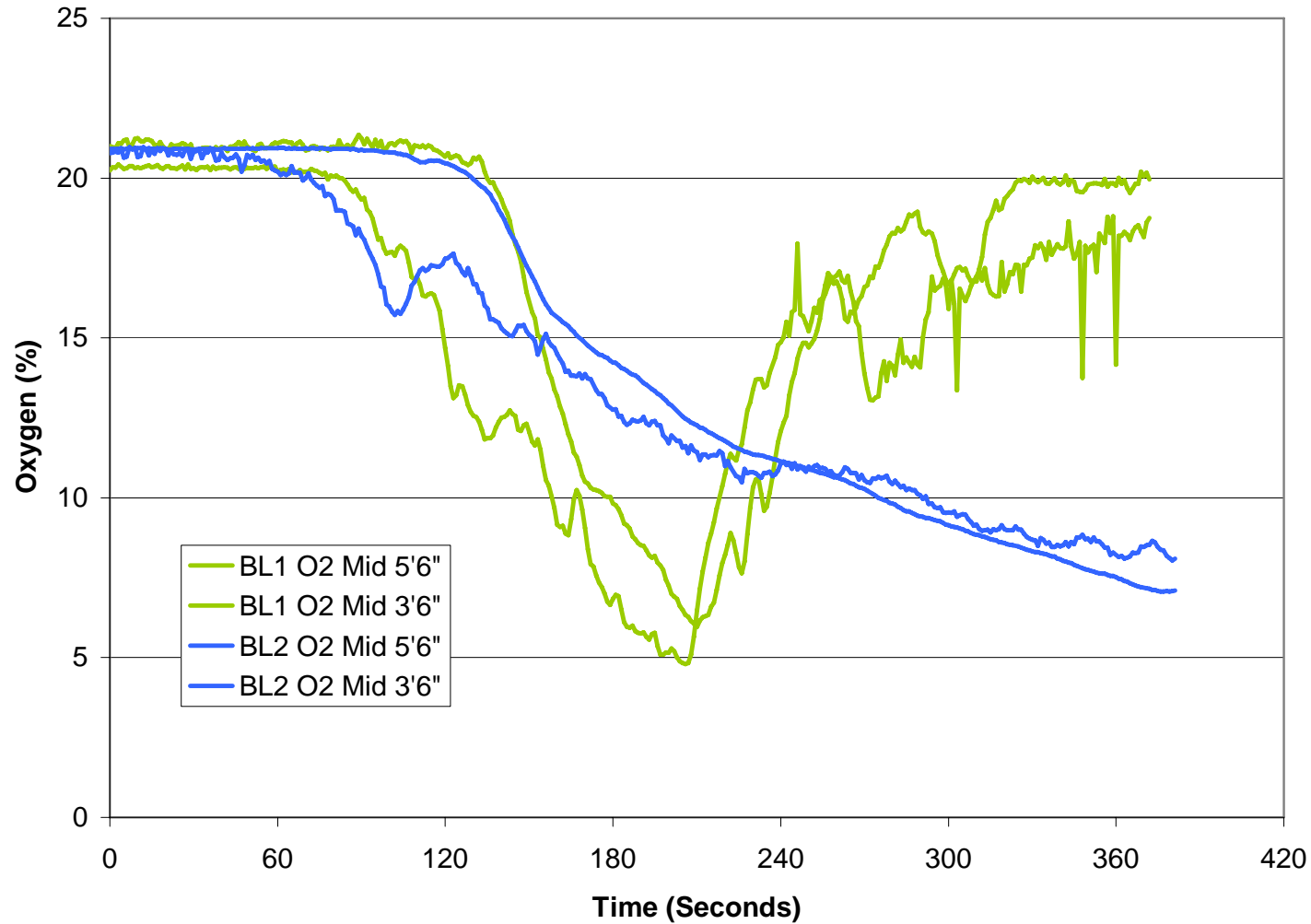
Baseline Comparison Carbon Monoxide at Mid Cabin



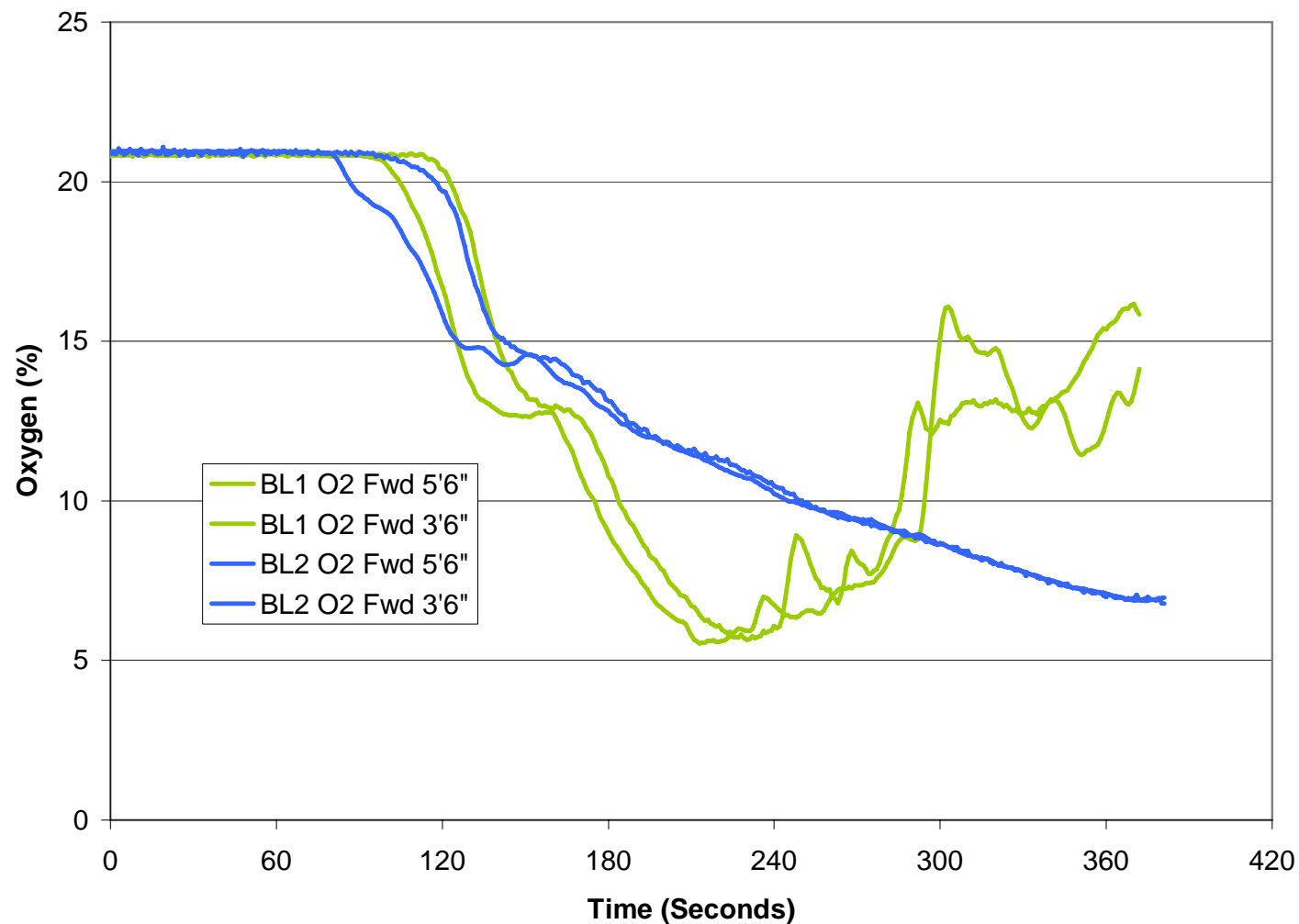
Baseline Comparison Carbon Monoxide at Forward Cabin



Baseline Comparison Oxygen Levels at Mid Cabin



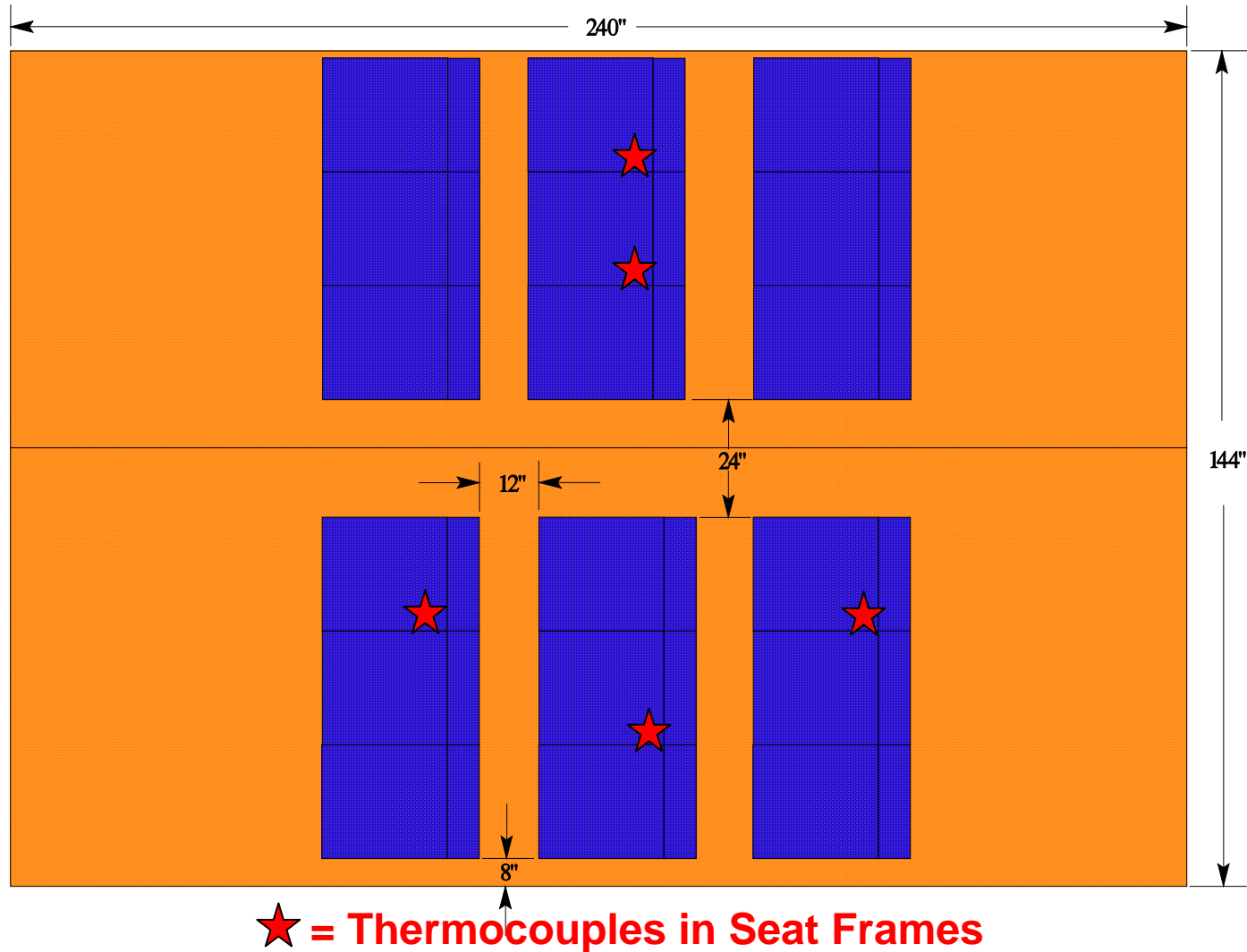
Baseline Comparison Oxygen Levels at Forward Cabin



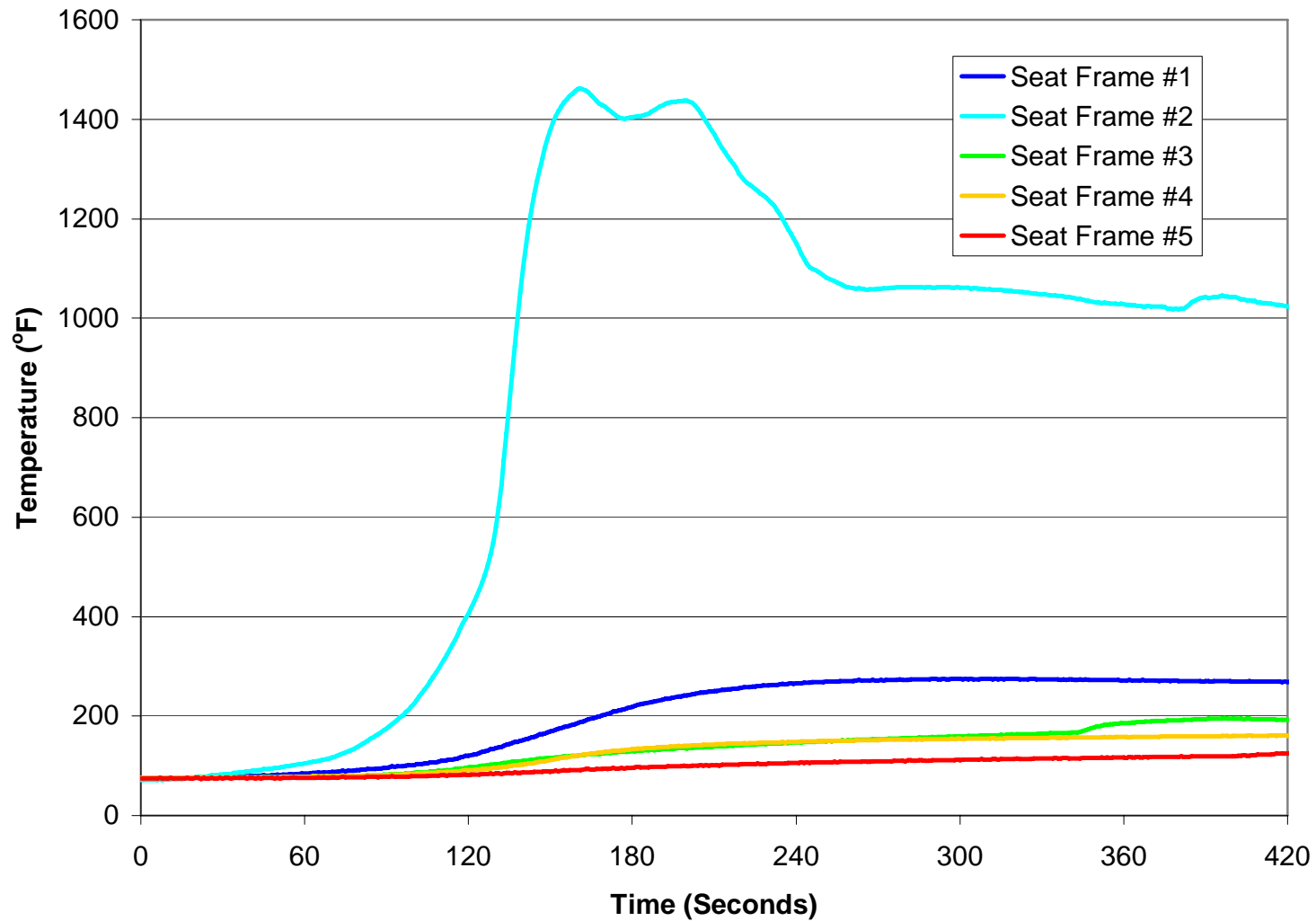
Installation of Thermocouple in Leg Component



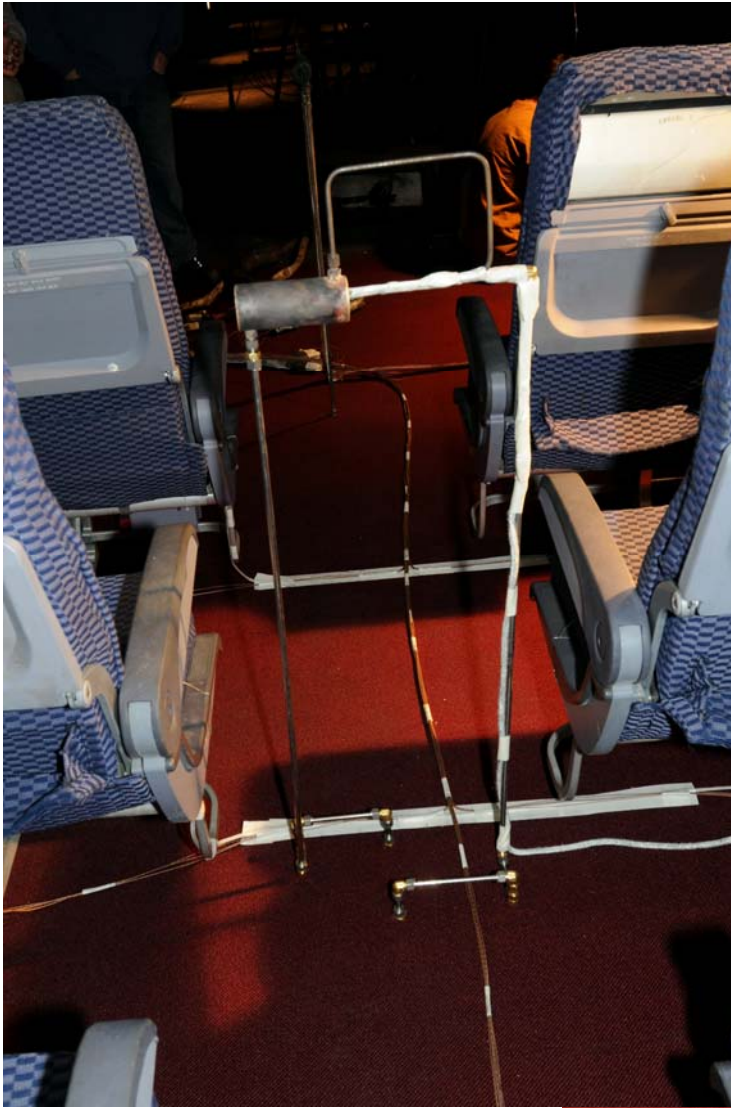
Seat Configuration & Location



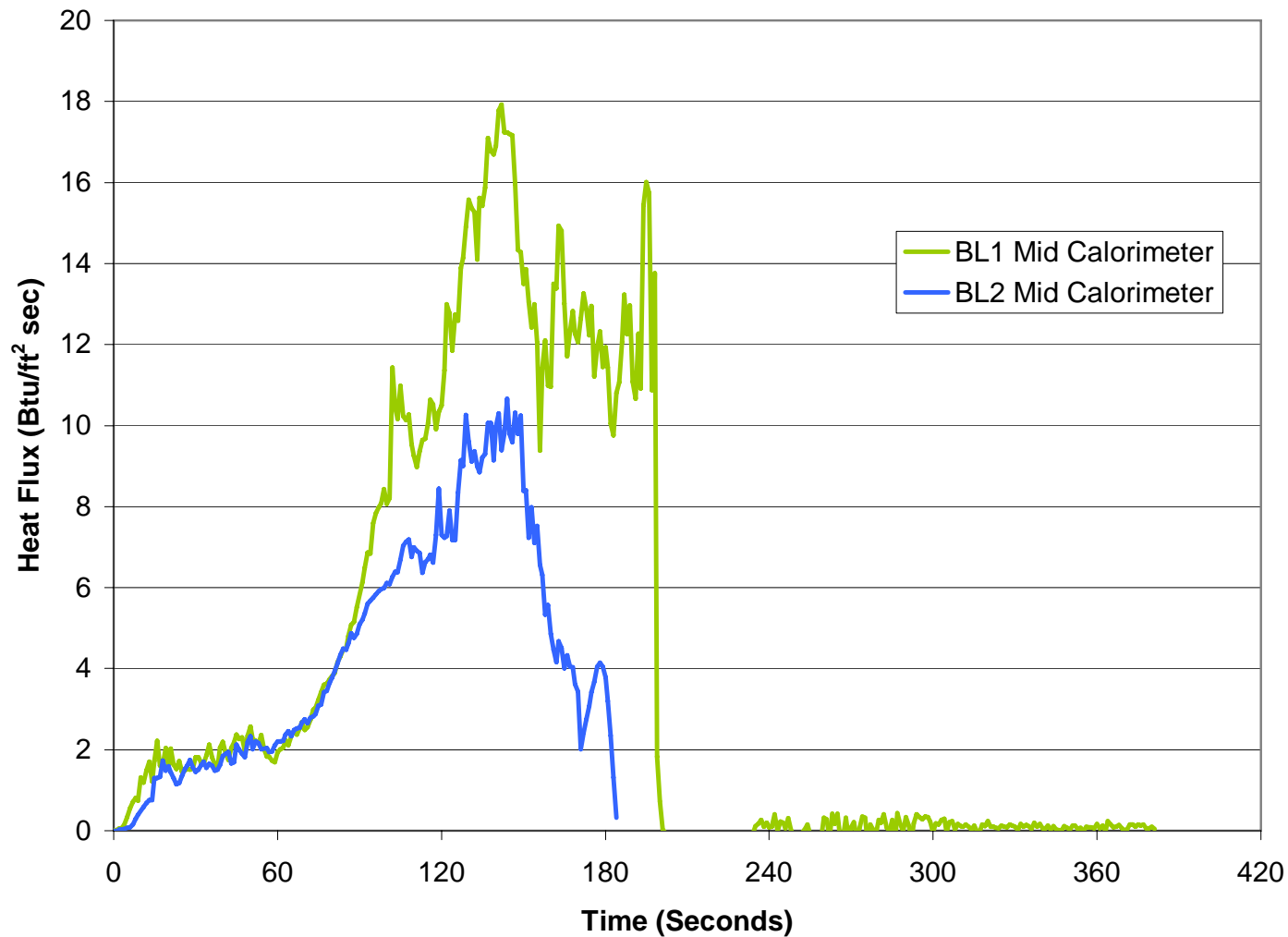
Seat Frame Temperatures



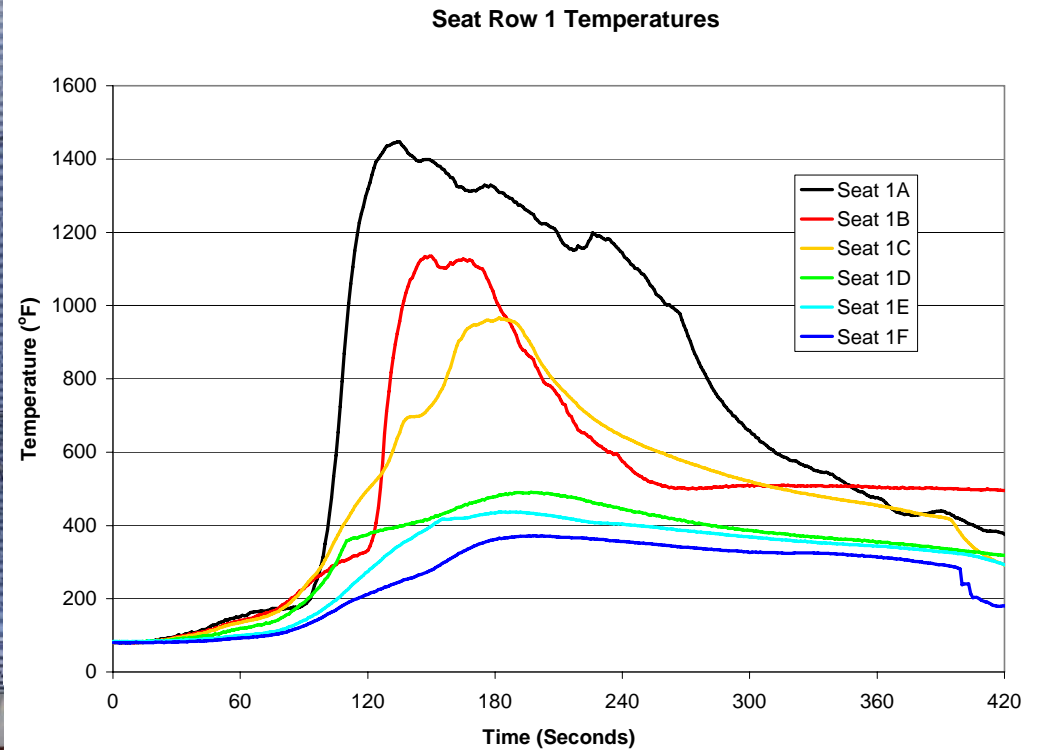
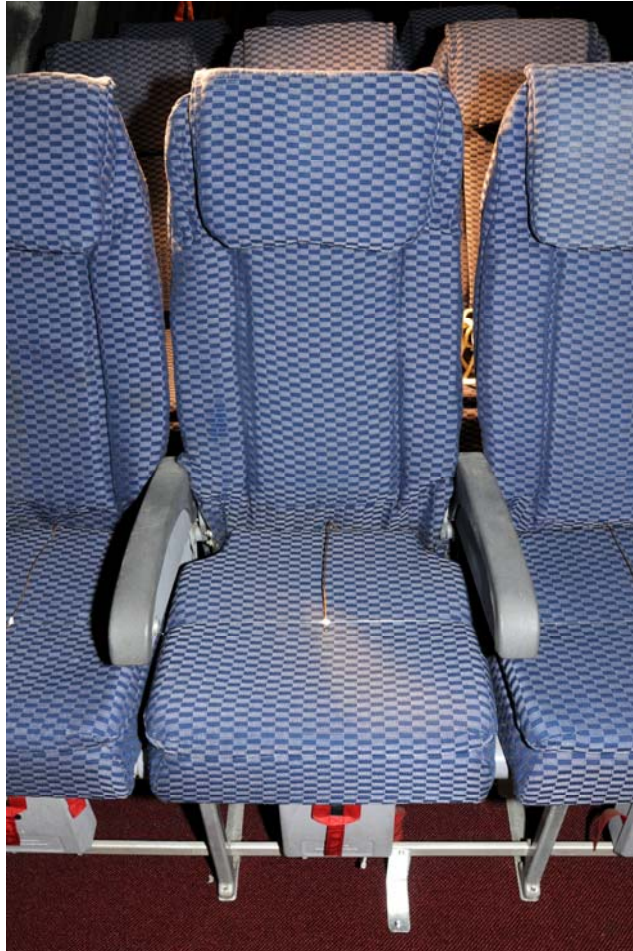
Installation of Heat Flux Transducers



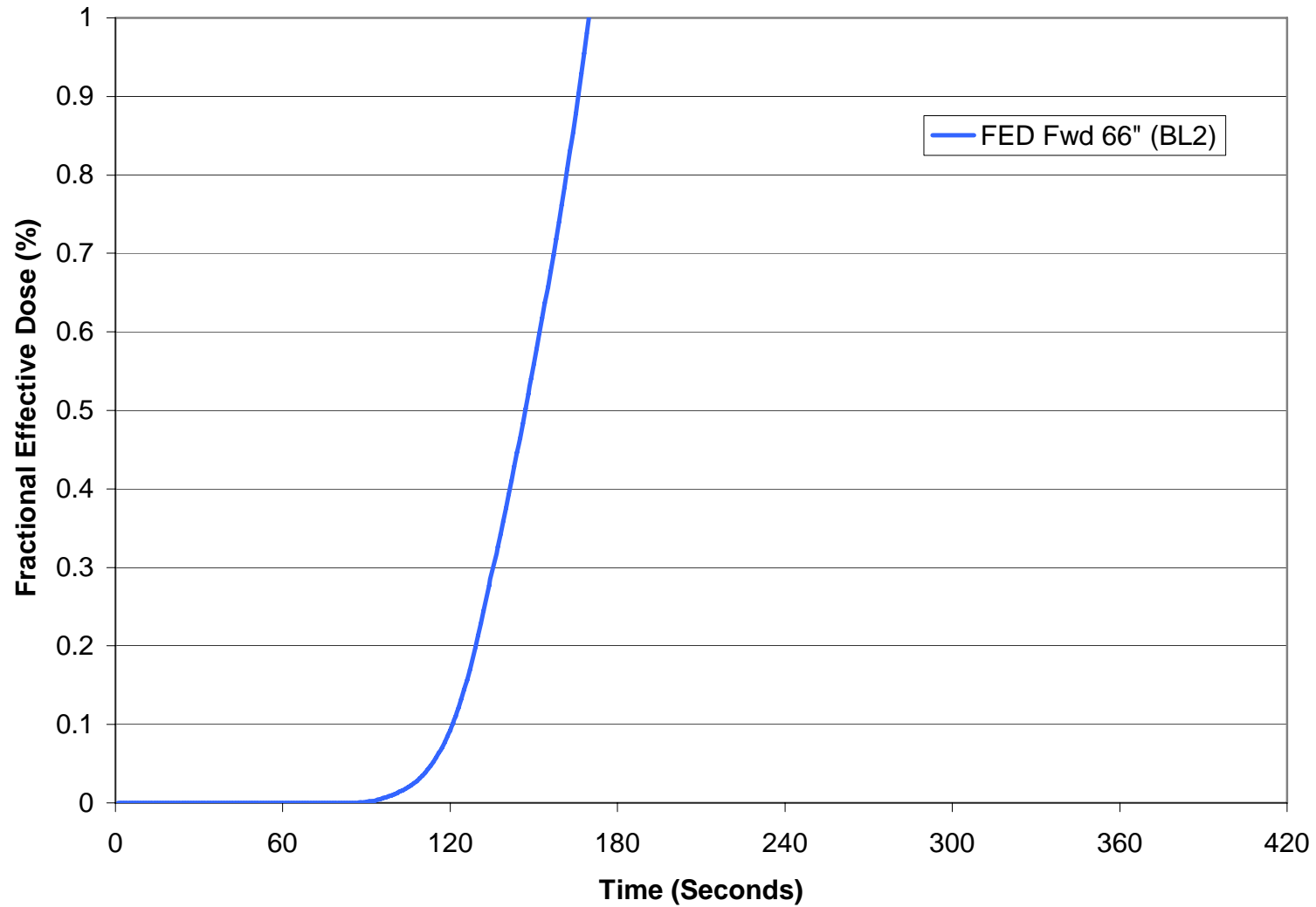
Baseline Comparison Heat Flux in Center of Test Area



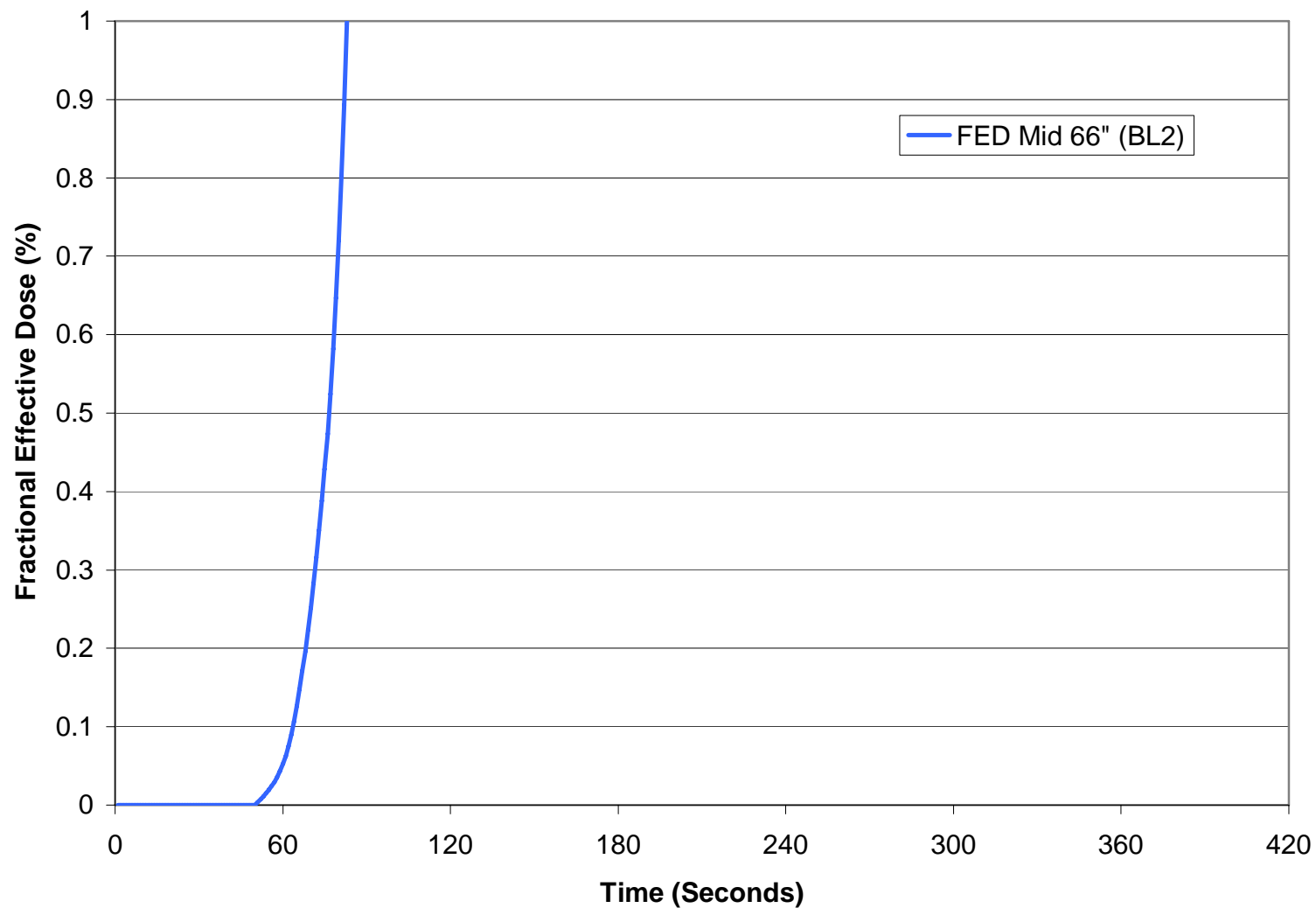
Installation of Thermocouples on Seat Surface



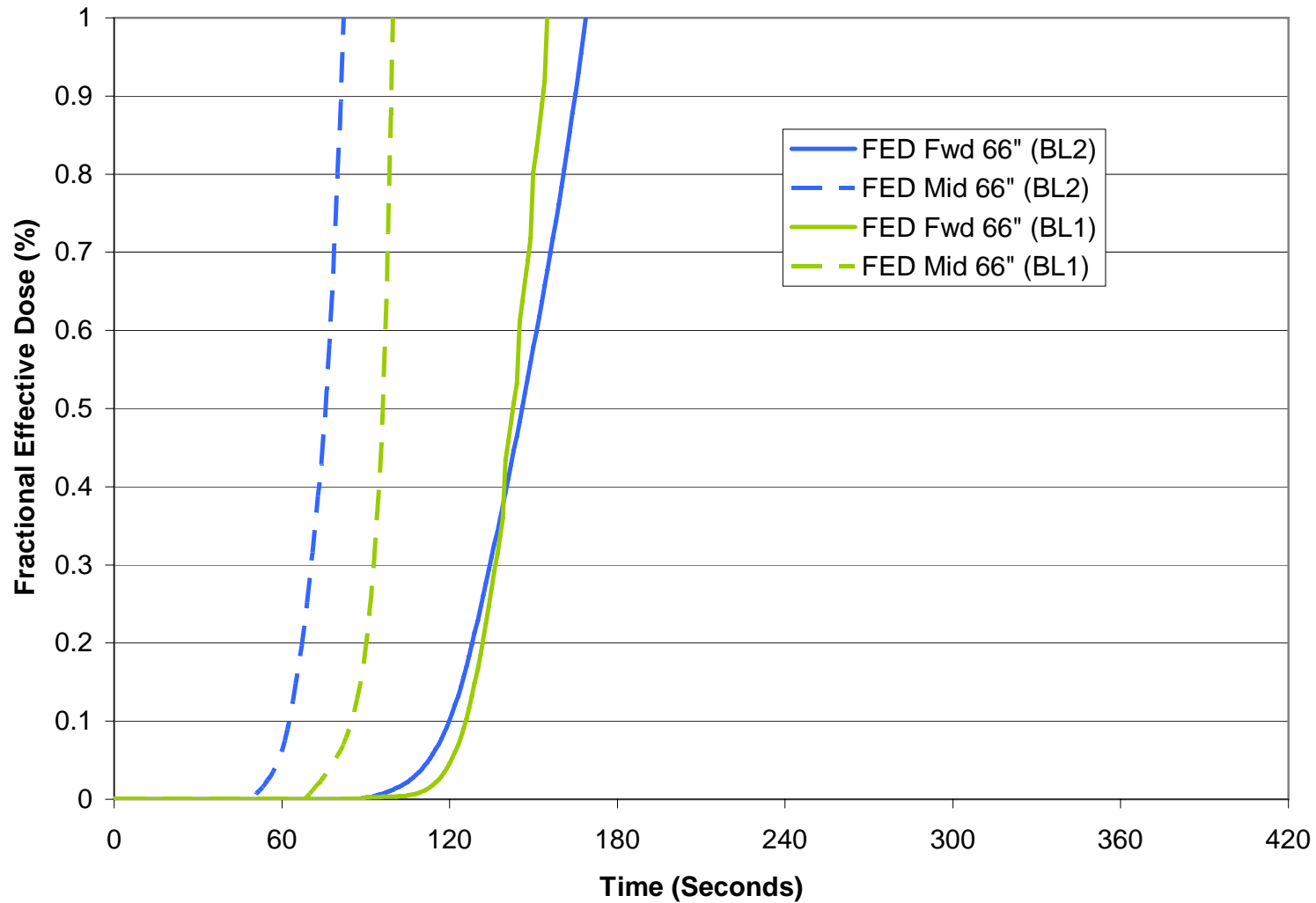
FED Forward Station 5'6"



FED Mid Station 5'6"



FED Comparison, Baseline 1 and 2



Baseline 2 Test Results (untouched)



Baseline 2 Test Results (panels removed)



Baseline 2 Test Results (panels removed)



Baseline 2 Test Results

(seats removed from fuselage)



Baseline 2 Test Results

(seats removed from fuselage)



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 Results



Comparison of Two Baseline Tests Conducted in 2008



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 lab test/tests will be developed.

Next Steps

Continue with assembly of seats using mag-alloy components

Finalize additional test parameters (test duration, use of water)

Prepare for test using WE43 mag-alloy components

If good-performing mag-alloy results in elevated hazard level:

Terminate?

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

Proceed with test of poor-performing mag-alloy

Industry Welcome to “Look Over Our Shoulder”

