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

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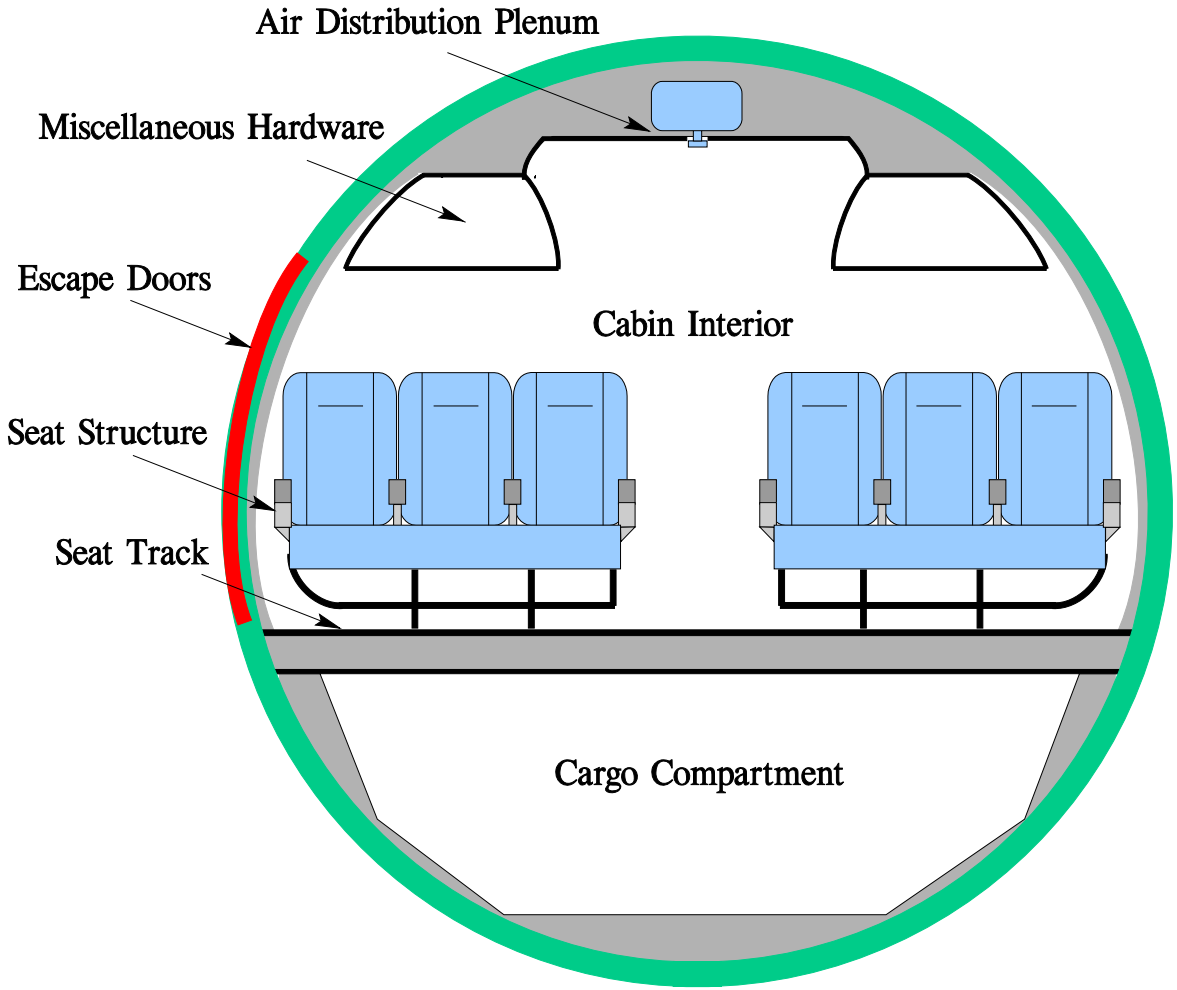
Date: October 21, 2008

Magnesium Alloy Flammability

Background

- Renewed interest in using mag-alloys in commercial aviation
- Current FAA TSO C127 “Rotorcraft and Transport Airplane Seating Systems” makes reference to SAE specification, which bans use of magnesium in seats
- SAE specification references tests conducted 30 years ago at FAATC

Magnesium Alloy Flammability: Potential Use Locations



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.

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

How do we develop an appropriate test method?

Clearly define the threat(s)

Replicate as many aspects of threat conditions as possible

Correlate with results of full-scale testing

Magnesium Alloy Flammability

What Has Been Done?

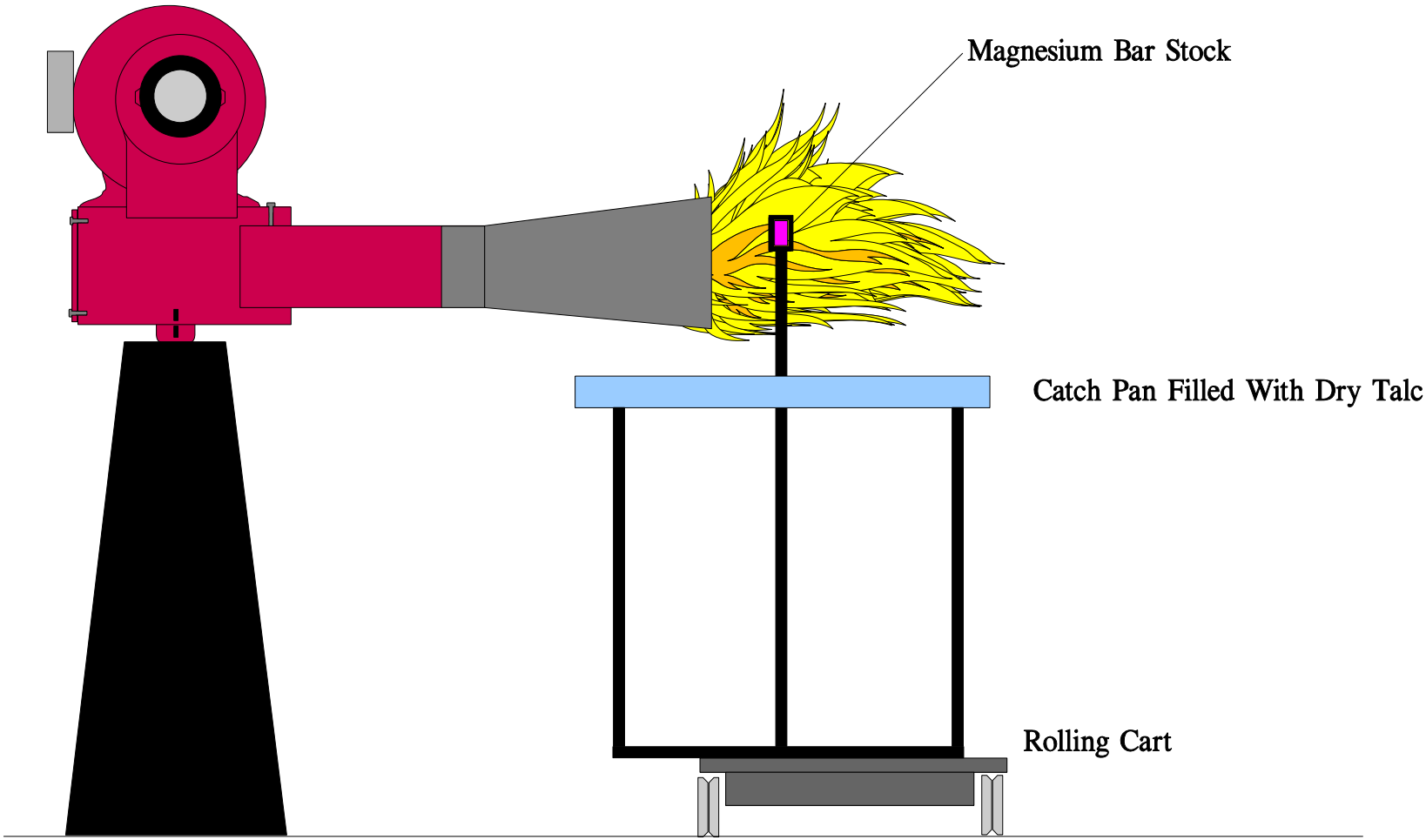
Initial Laboratory Scale “Fact-Finding” Experimentation

Oil Burner Testing

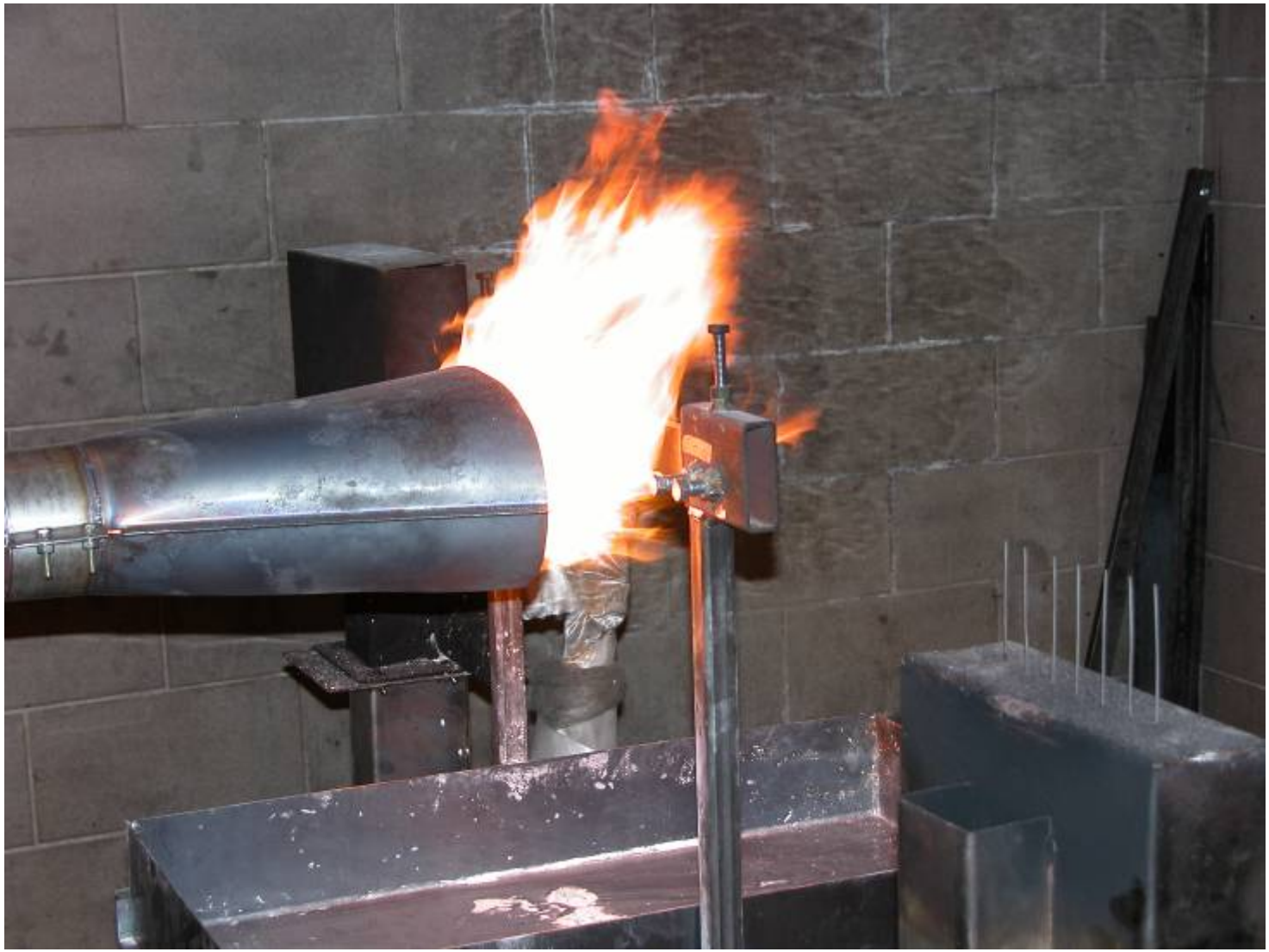
Handheld Extinguisher Testing

Miscellaneous Lab-Scale Flammability Testing

Initial Oil Burner Testing of Mag Alloy



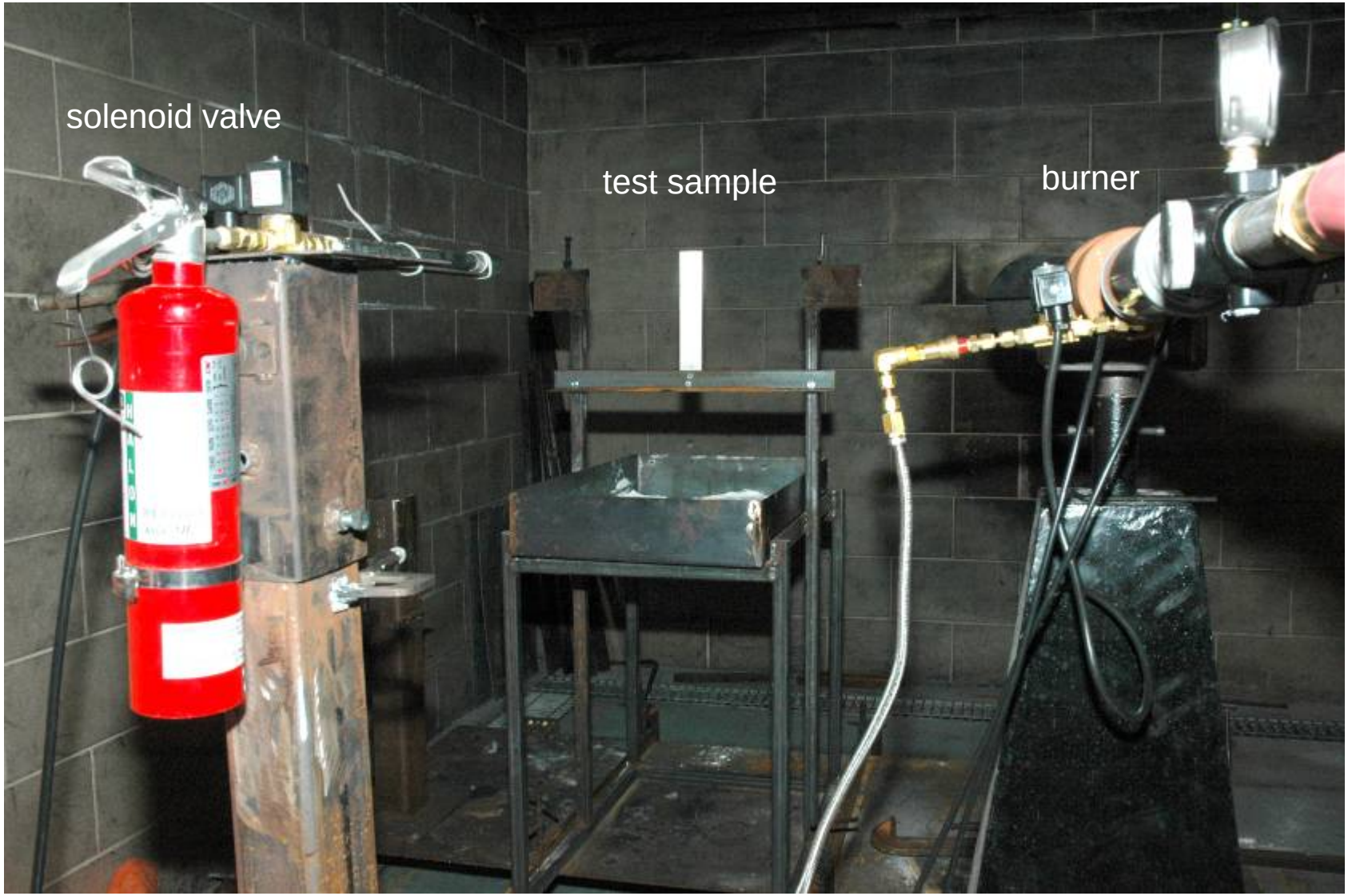
Initial Oil Burner Testing of Mag Alloy



Initial Oil Burner Testing of Mag Alloy

*photo provided by
Magnesium Elektron

Handheld Extinguisher Testing of Mag Alloy Samples



Handheld Extinguisher Testing of Mag Alloy Samples

Handheld Extinguisher Testing of Mag Alloy Samples

Additional Lab-Scale Flammability Testing of Mag Alloy Samples

Flammability of turnings from lathe

Burning mag-alloy turnings

Ignition of thin slice of mag-alloy

Burner test of sample with modified cross section

Ignition of sample with modified cross section

Magnesium Alloy Flammability

Preliminary lab scale oil burner testing

Handheld extinguisher testing

Additional lab-scale flammability experimentation

Identify critical elements of preliminary testing

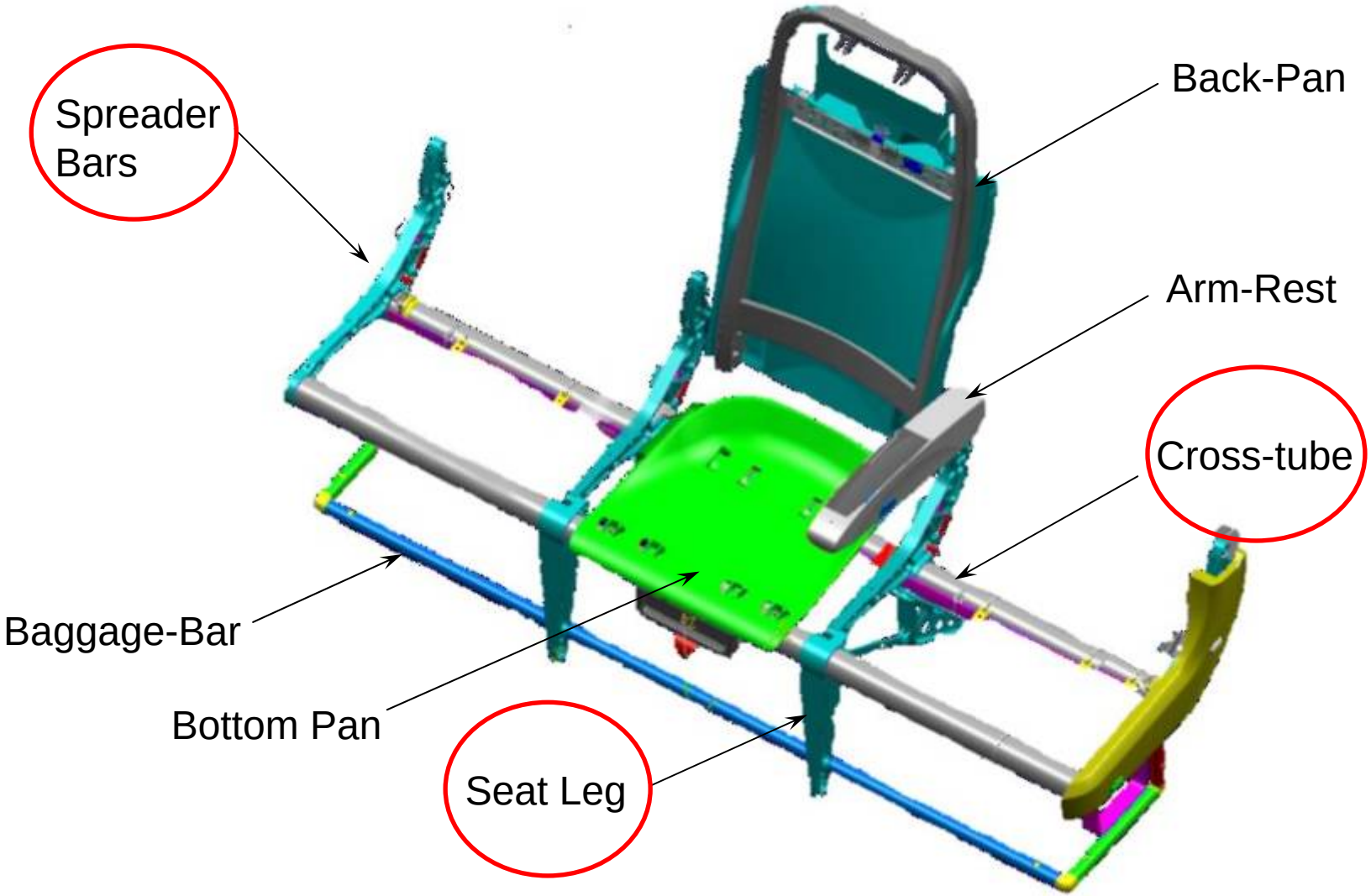
Conduct full scale test using mag-alloy seat frames

Develop lab scale test based on full-scale results

How Should a Full Scale Seat Test Be Conducted?

Typical Seat Assembly

Typical Seat Assembly



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 Seats for Full-Scale Testing

B/E Aerospace “990” Seats

B/E Aerospace “990” Seats

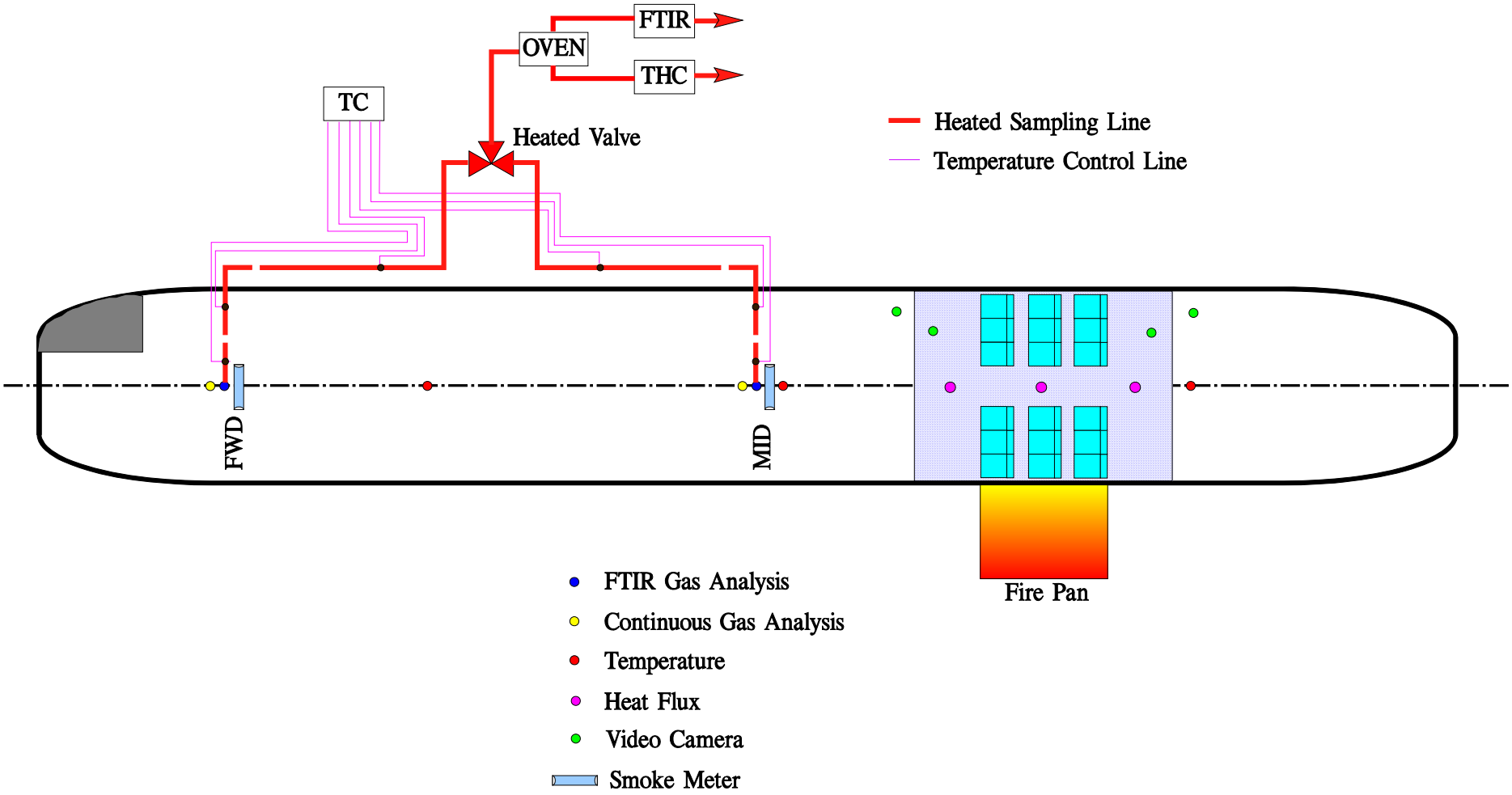
Seats Fully Dressed, Ready for Testing

Full Scale Testing Update

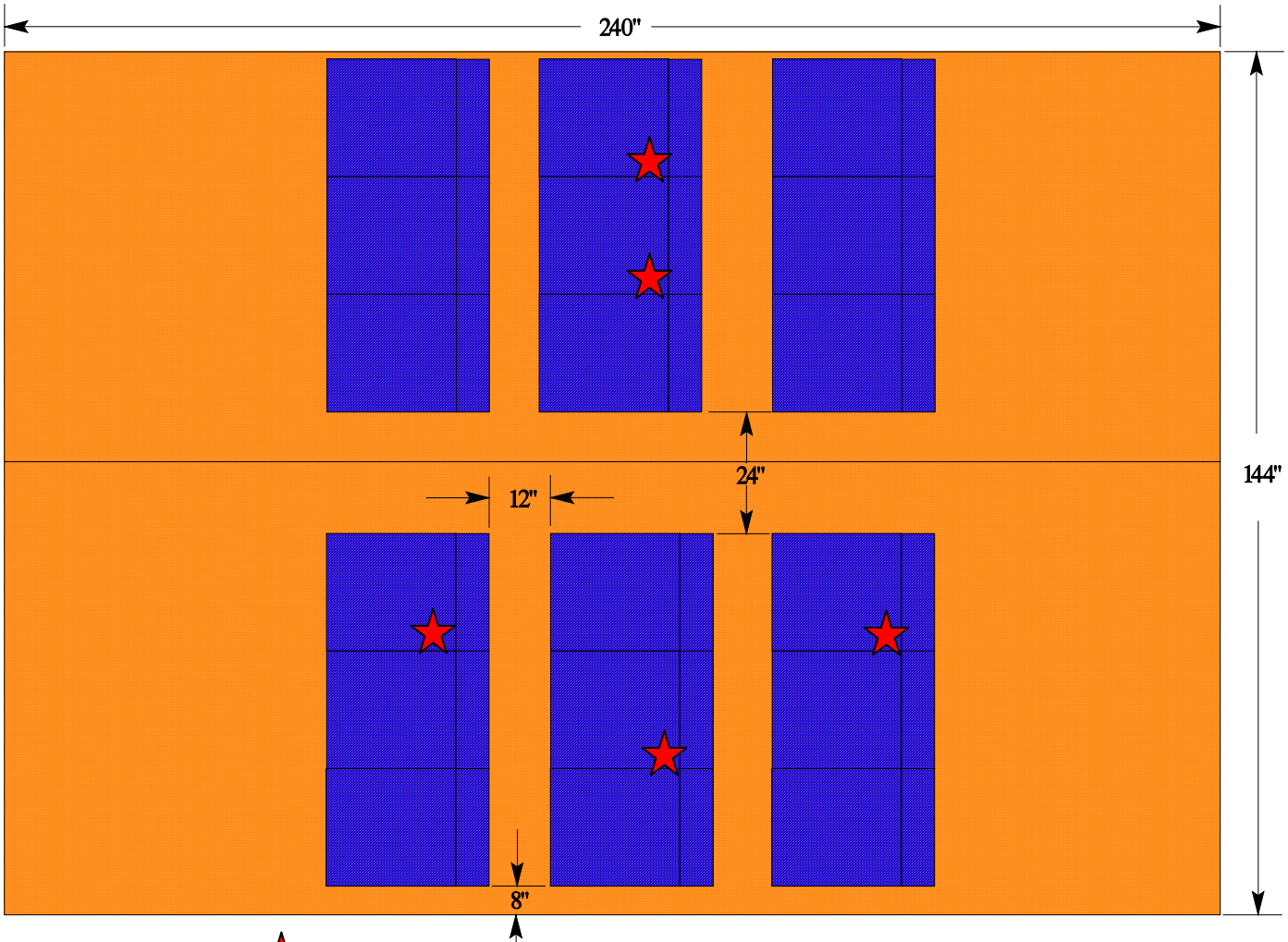
Test Rig Being Prepared

Test Rig Being Prepared

Full-Scale Test Apparatus



Seat Configuration & Location



★ = Thermocouples in Seat Frames

Full-Scale Test Apparatus

Full-Scale Test Apparatus

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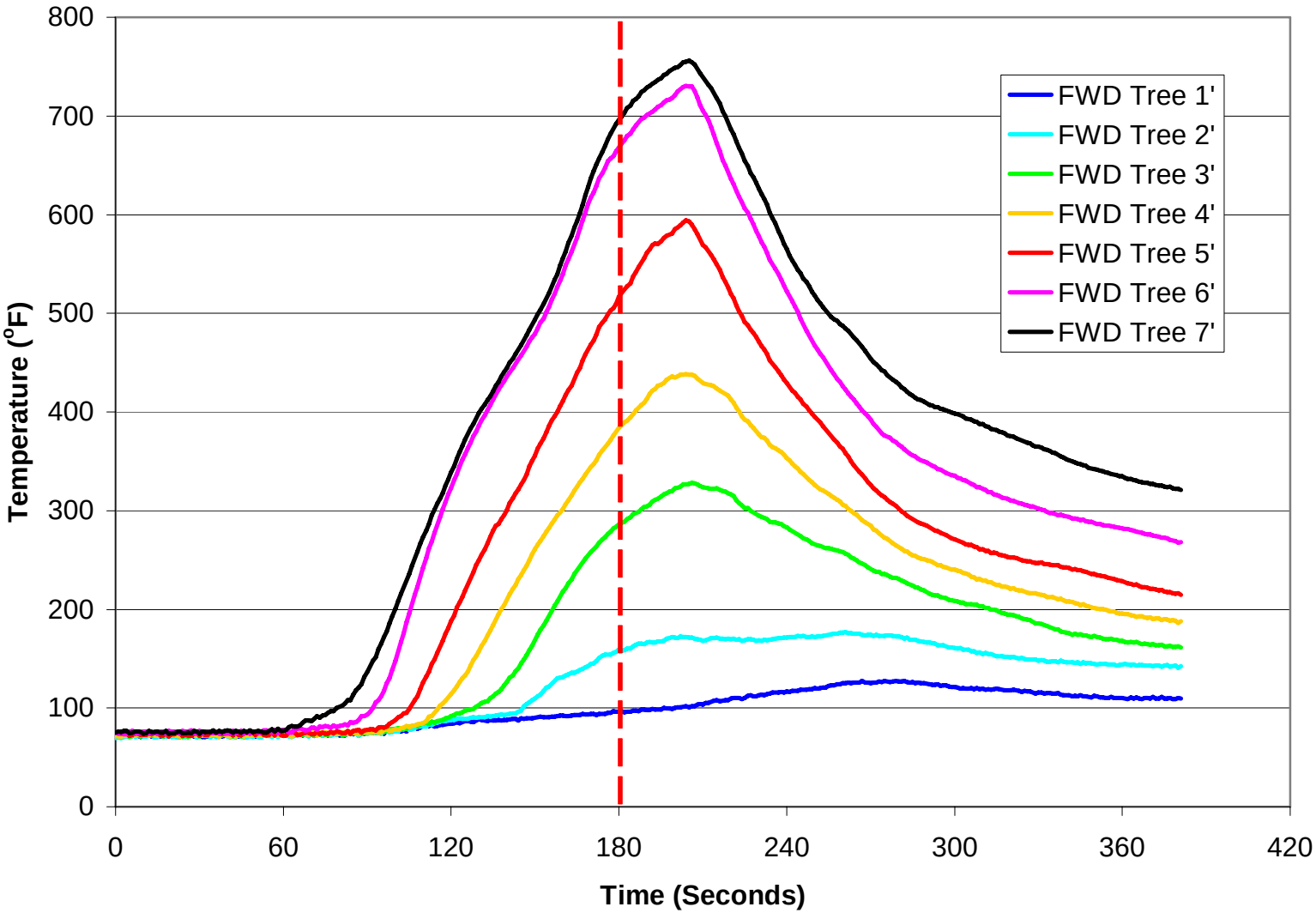
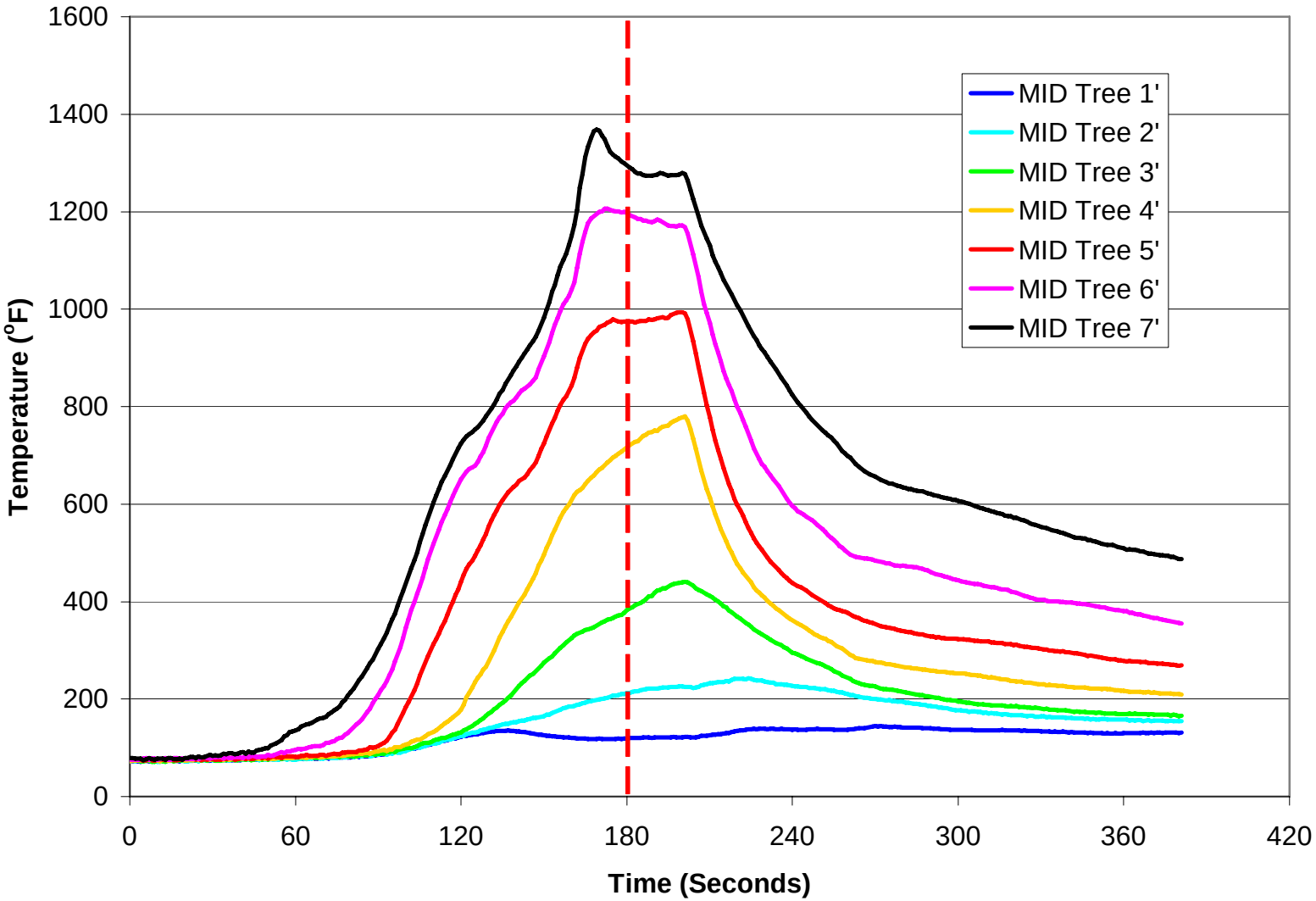
Full-Scale Test Apparatus

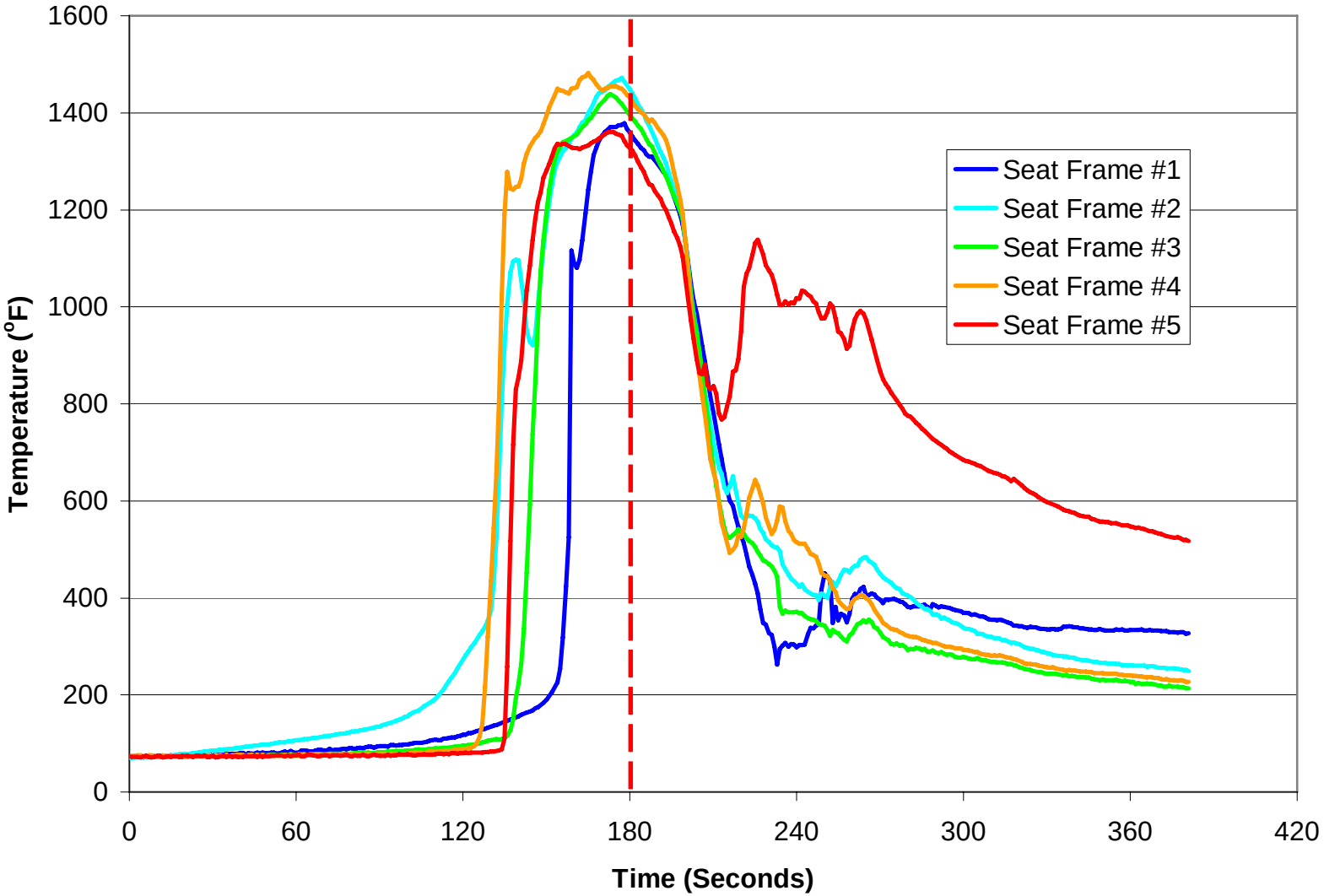
Forward Cabin Temperatures



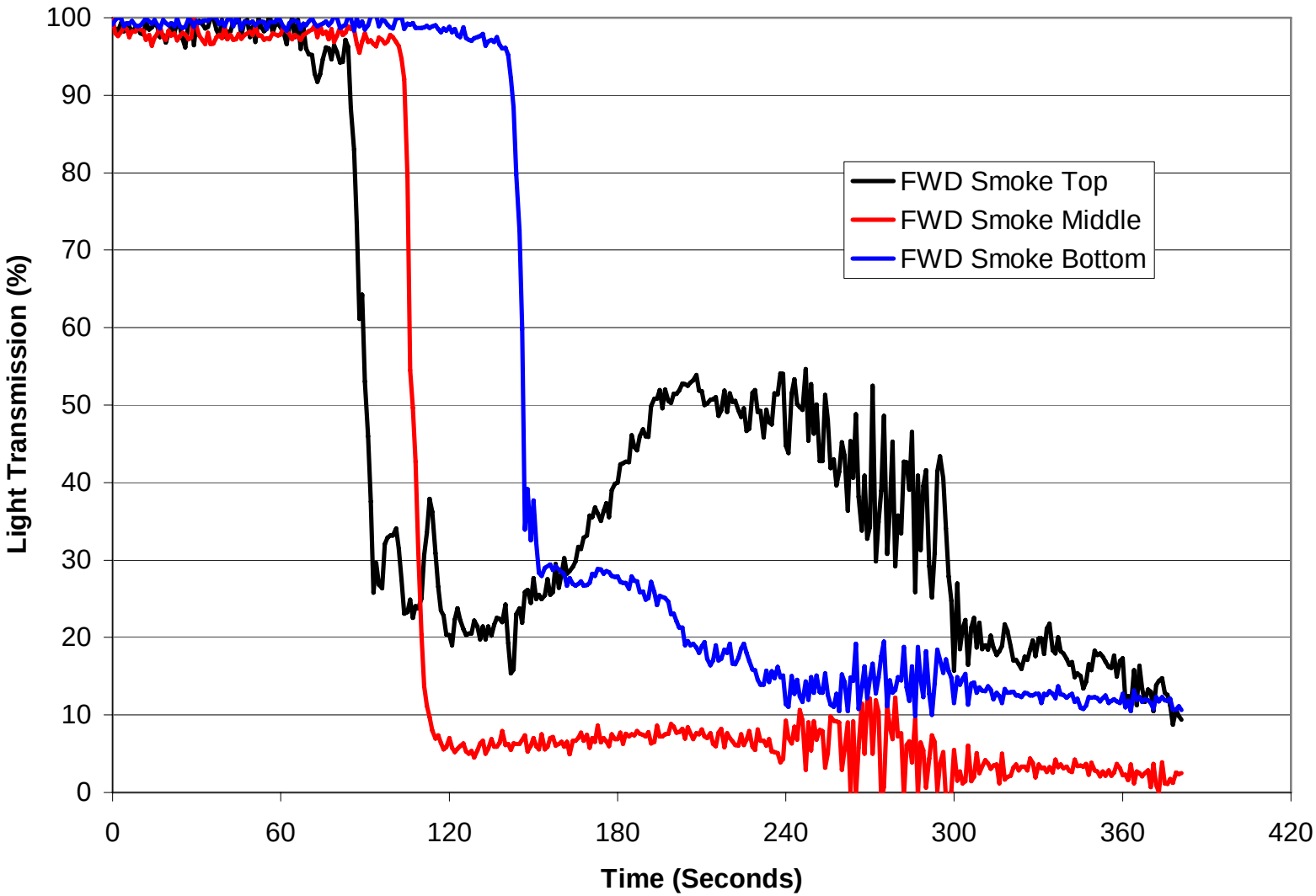
Mid Cabin Temperatures



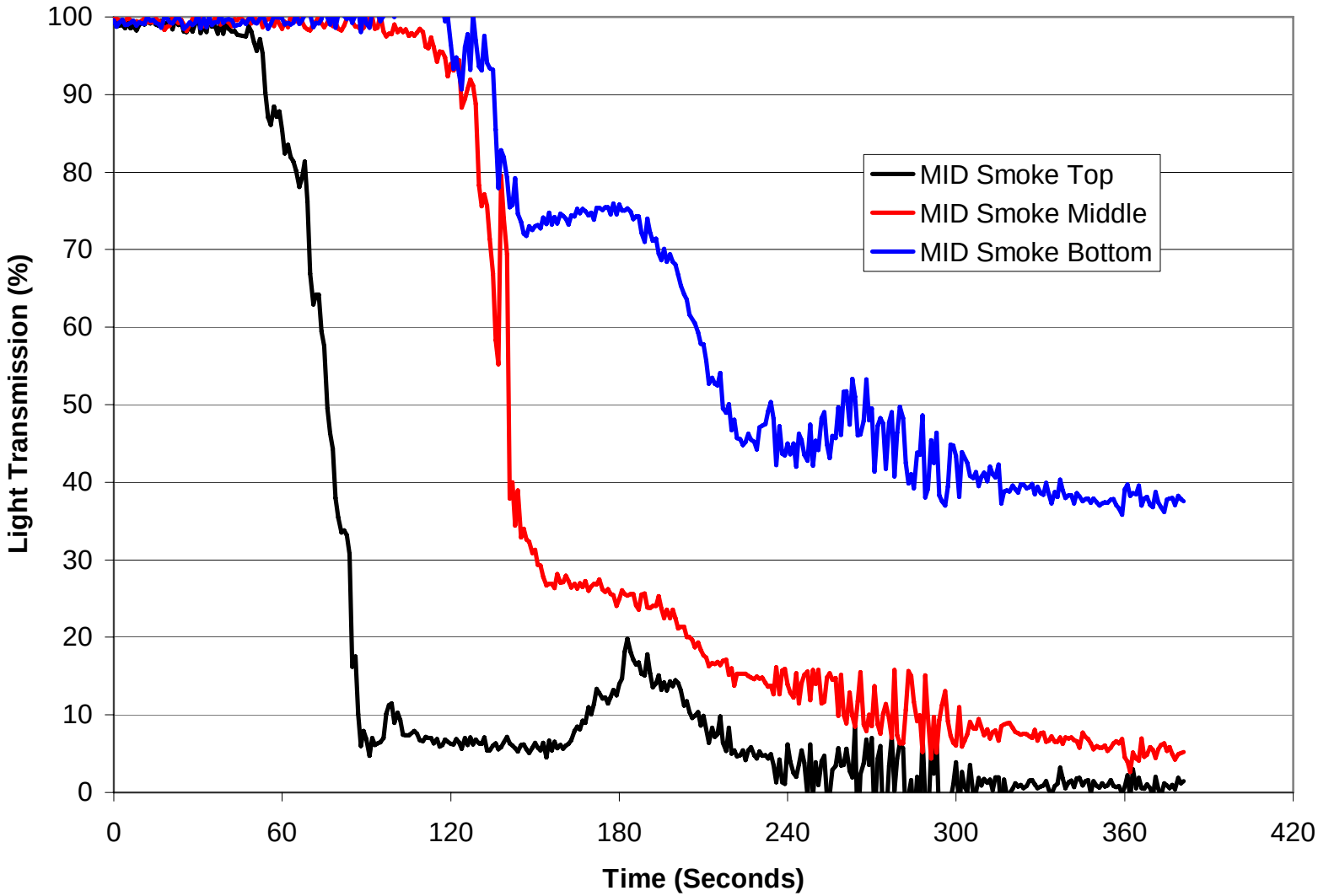
Seat Frame Temperatures



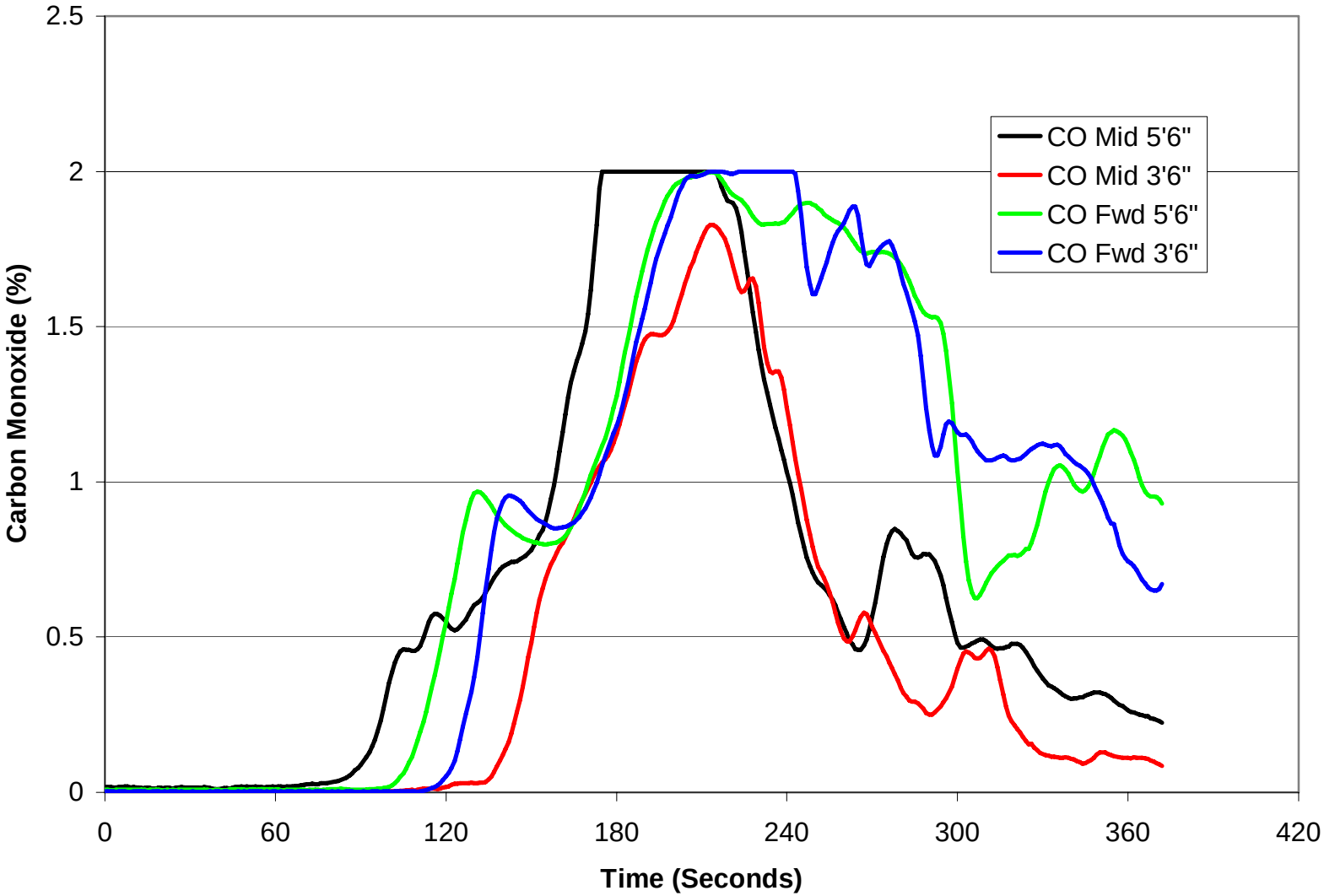
Forward Smoke Levels



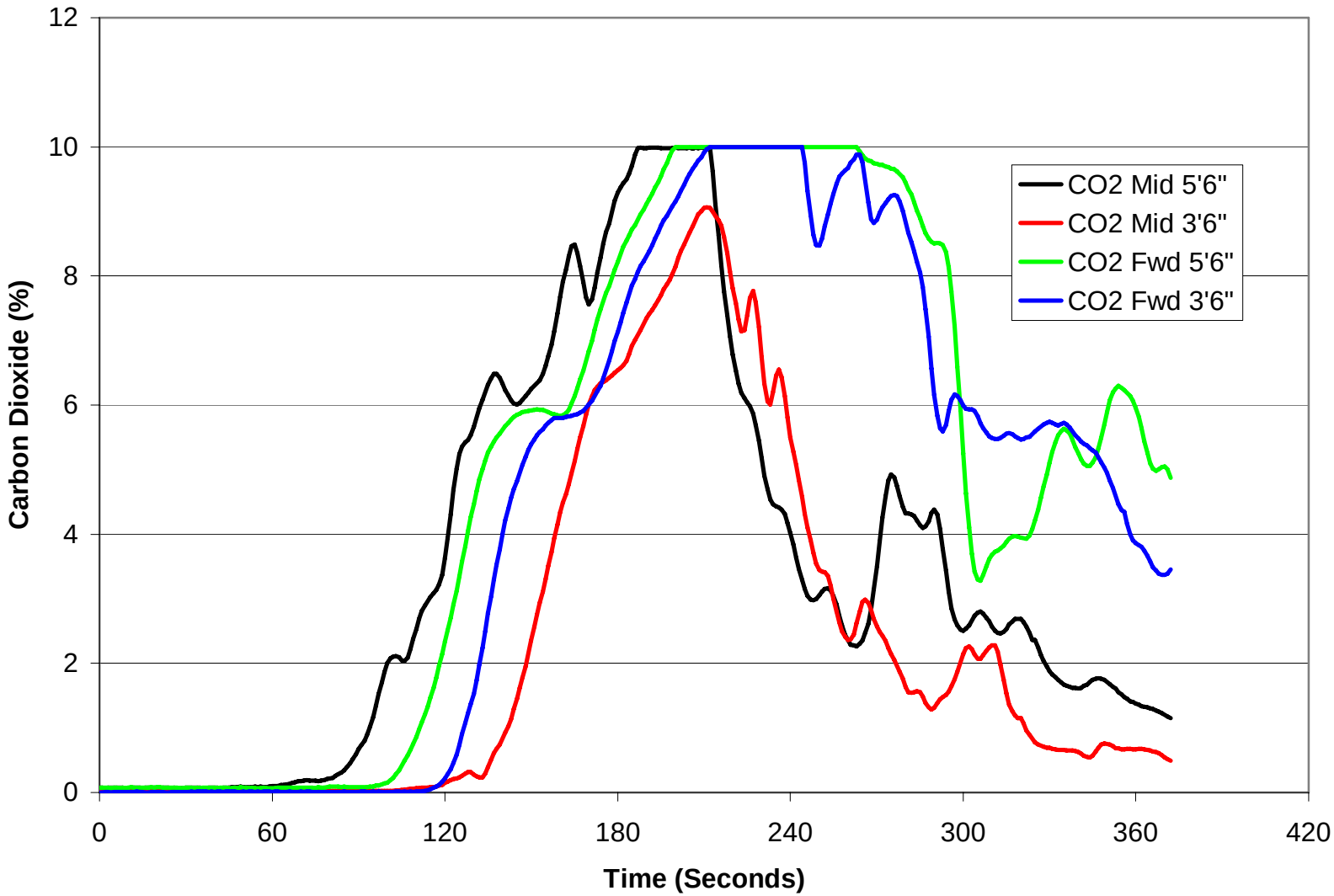
Mid Smoke Levels

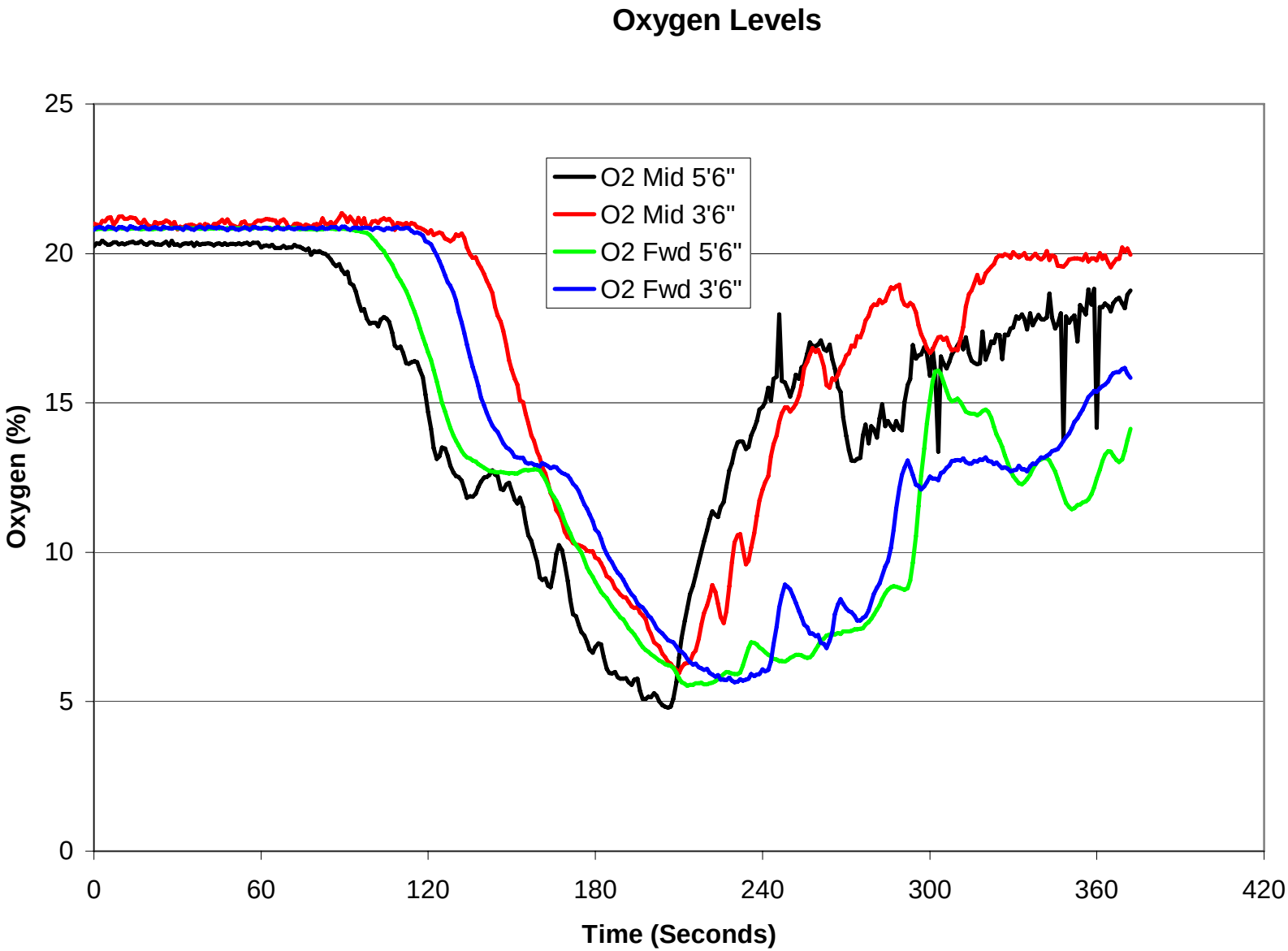


Carbon Monoxide Levels

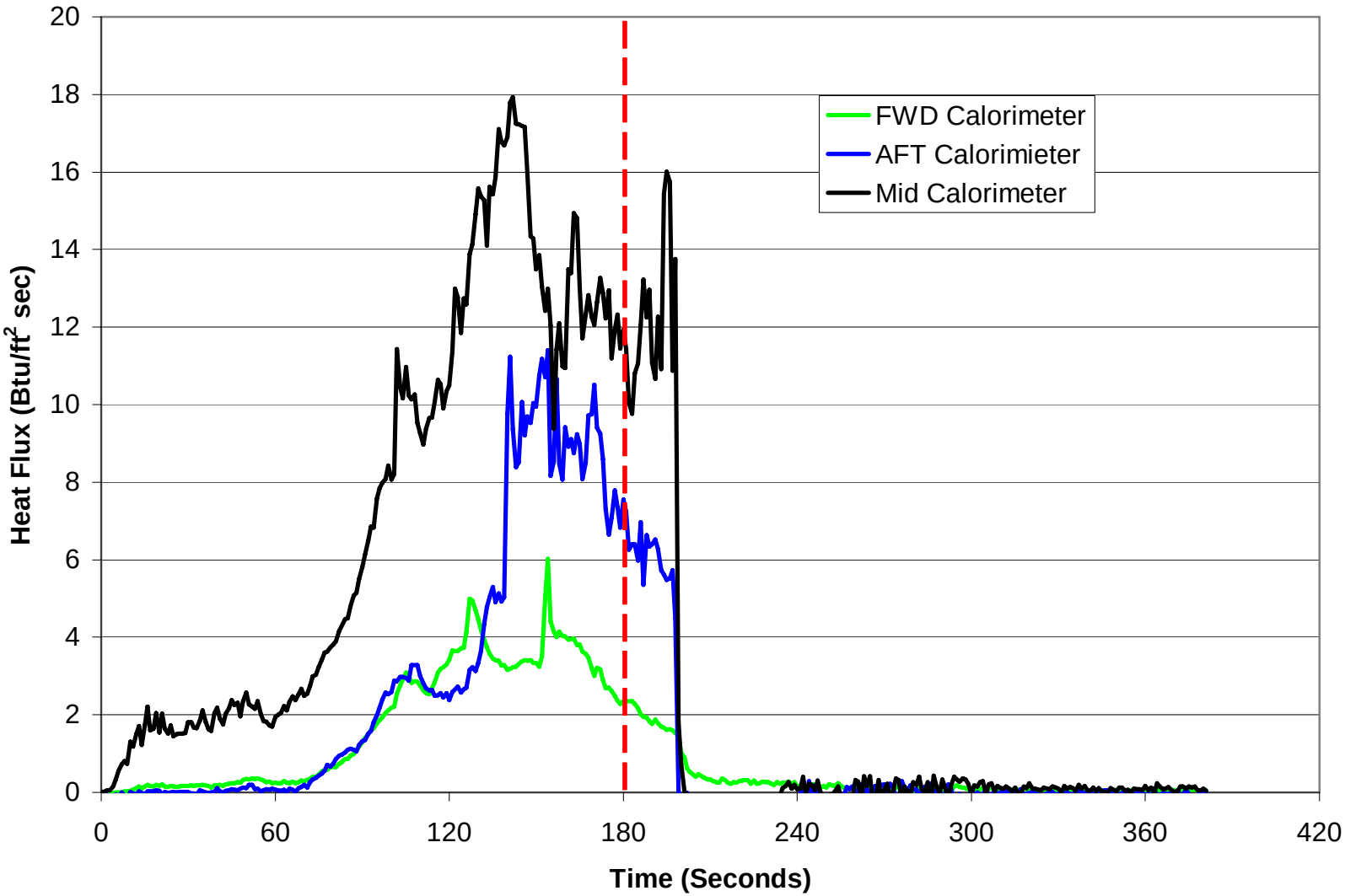


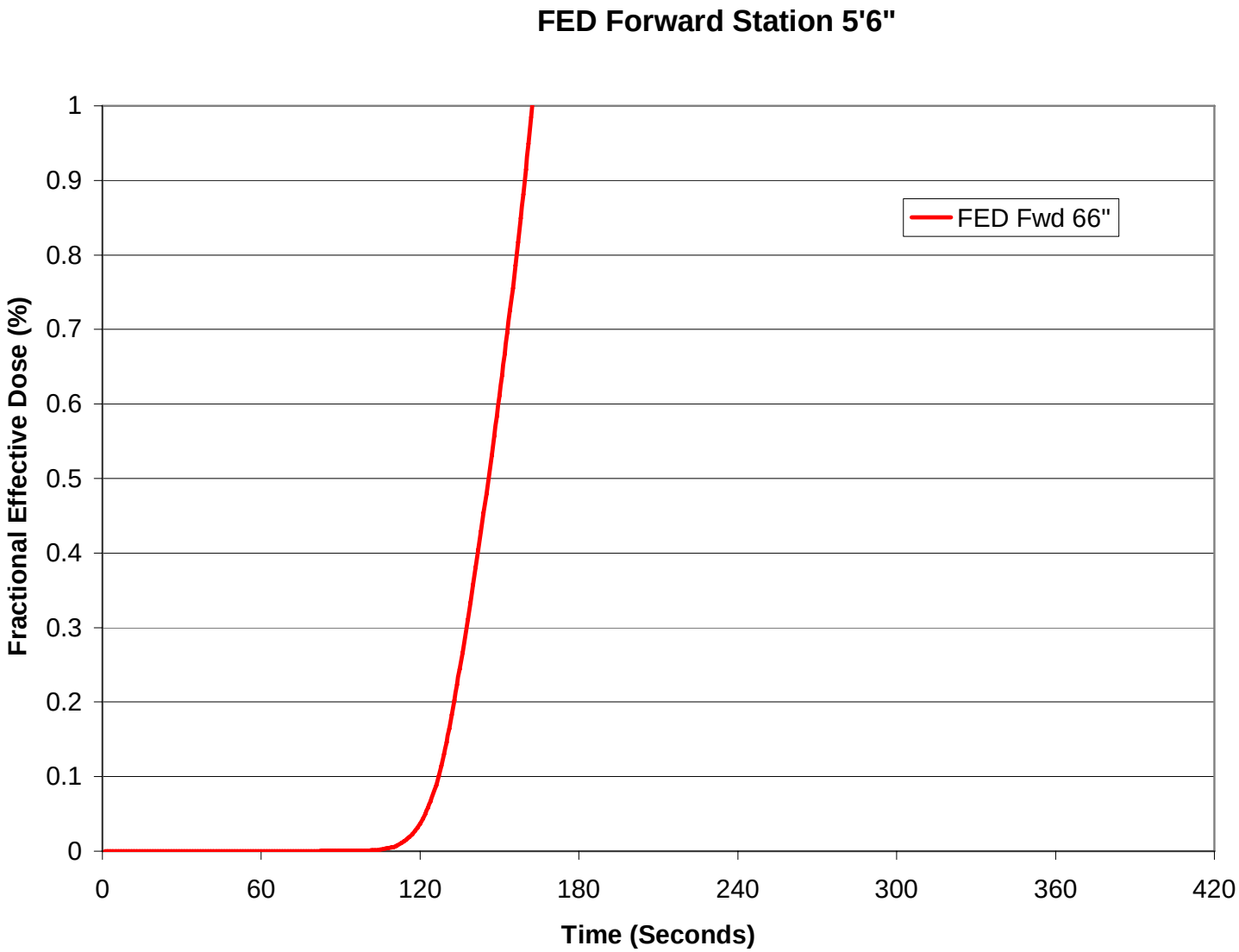
Carbon Dioxide Levels

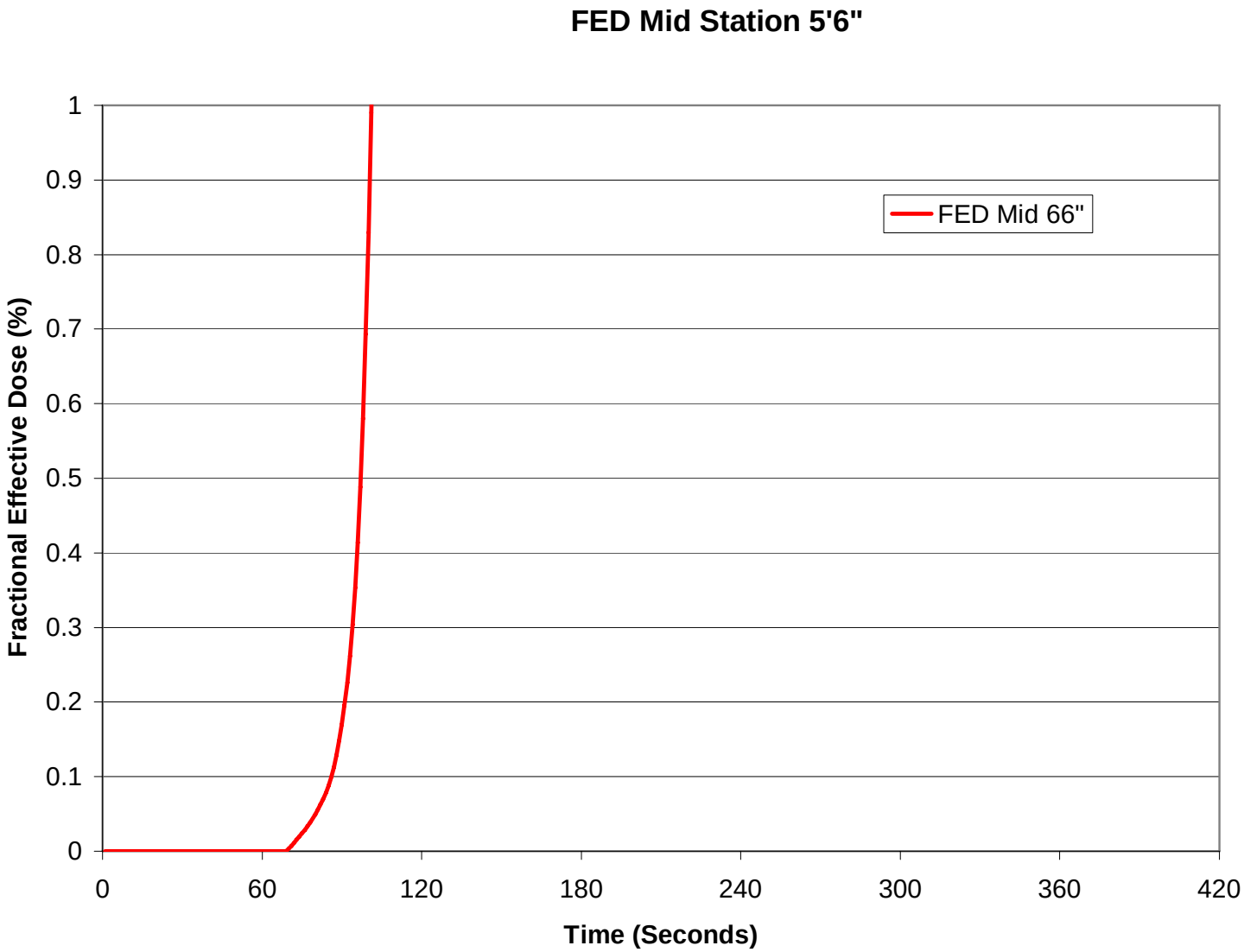



Oxygen Levels
O2 Mid 5'6"
O2 Mid 3'6"
O2 Fwd 5'6"
O2 Fwd 3'6"
Oxygen (%)
25
20
15
10
5
0
0
60
120
180
240
300
360
420
Time (Seconds)

Heat Flux Levels




FED Forward Station 5'6"
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
420
Time (Seconds)
FED Fwd 66"


FED Mid Station 5'6"
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
420
Time (Seconds)
FED Mid 66"

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

Conduct additional baseline test with zero wind condition

Determine which baseline result is appropriate

Continue with good-performing mag-alloy test using chosen condition

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

Disassembly/Reassembly with Mag-Alloy Parts

Baseline Seat Test Conducted on Oct 7, 2008

Full-Screen View of Seat Test Conducted on Oct 7, 2008