International Aircraft Systems Fire Protection Working Group

Grenoble, France

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Aircraft Cargo Compartment Fire Detection

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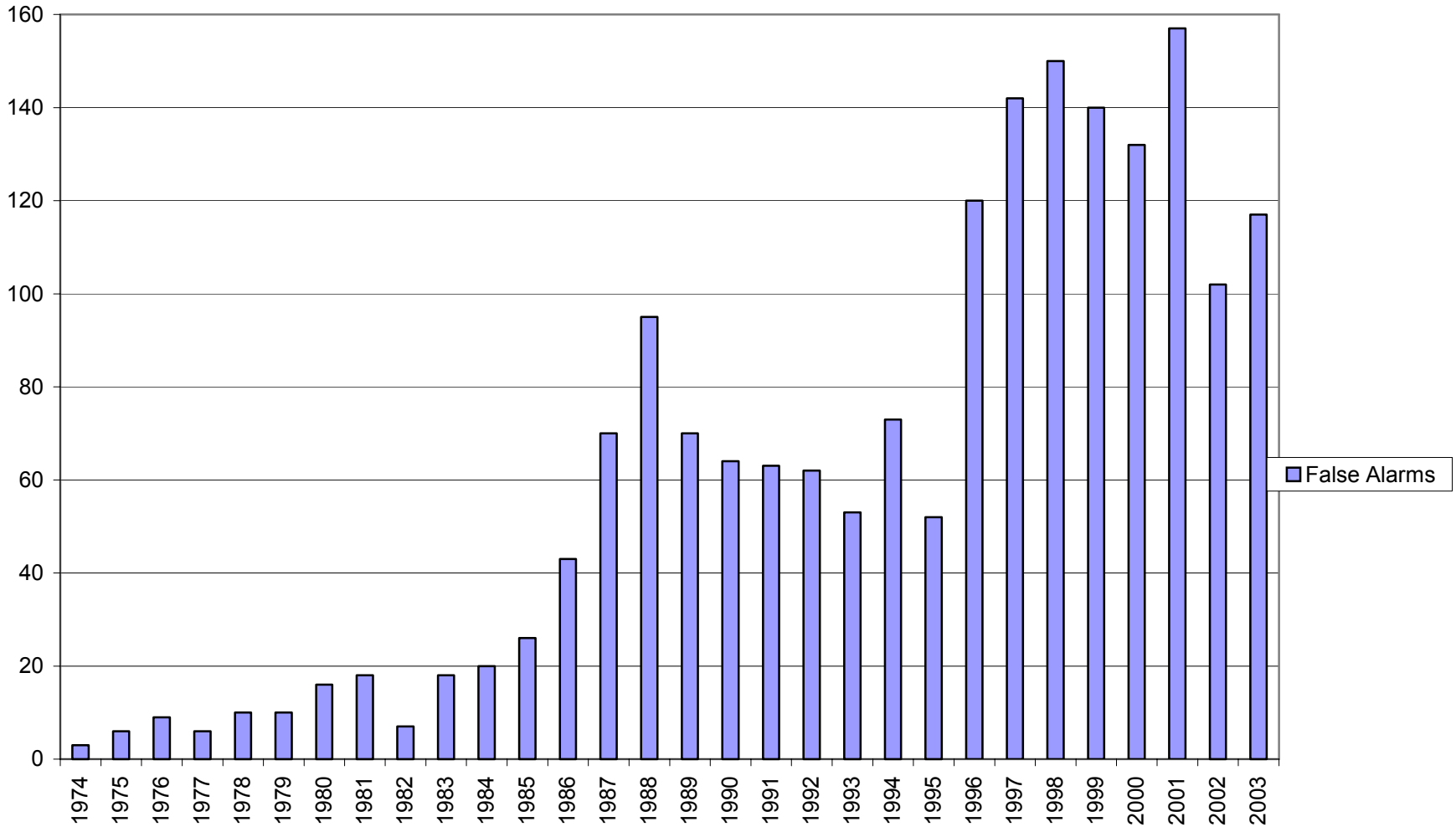
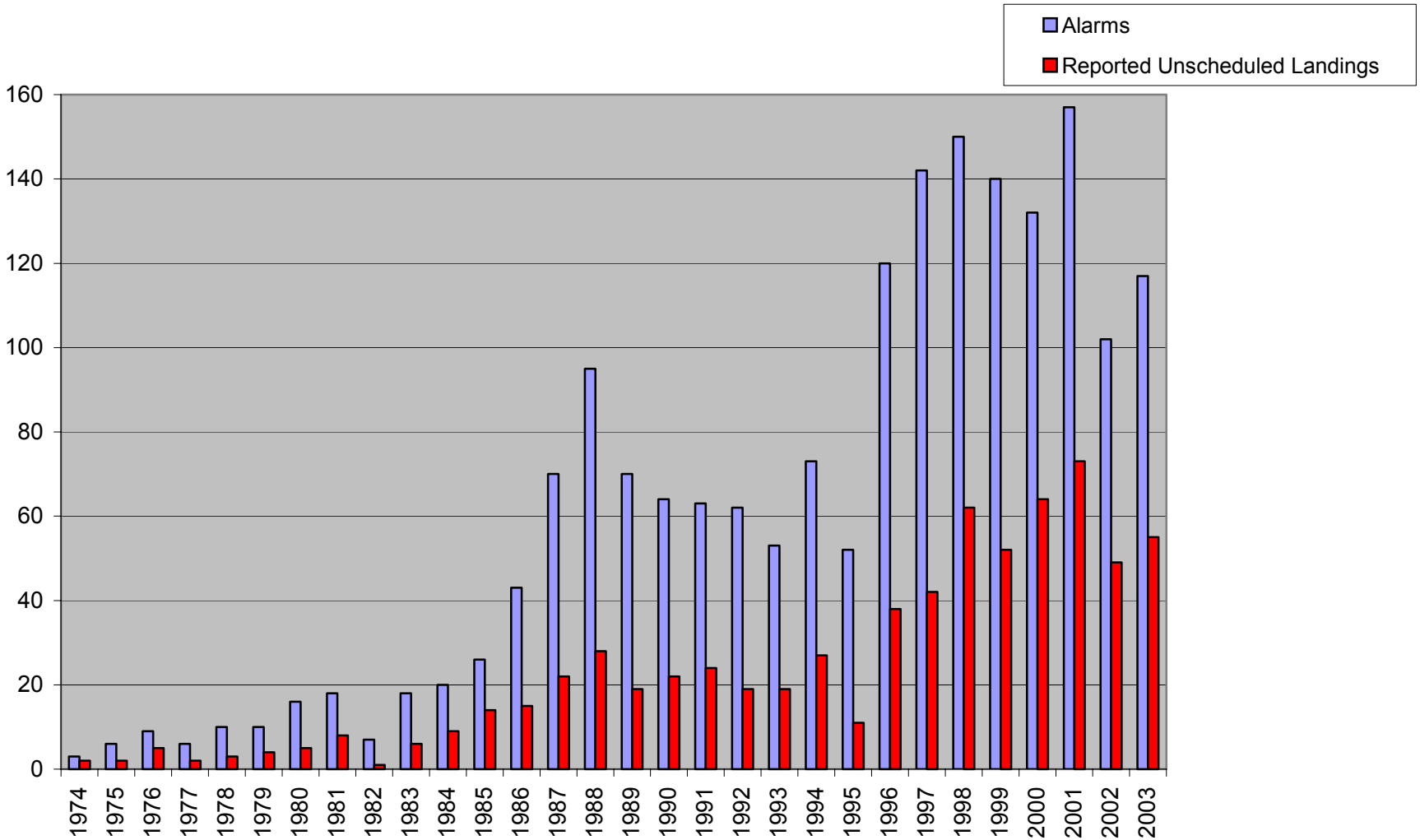
Cargo Compartment False Alarms



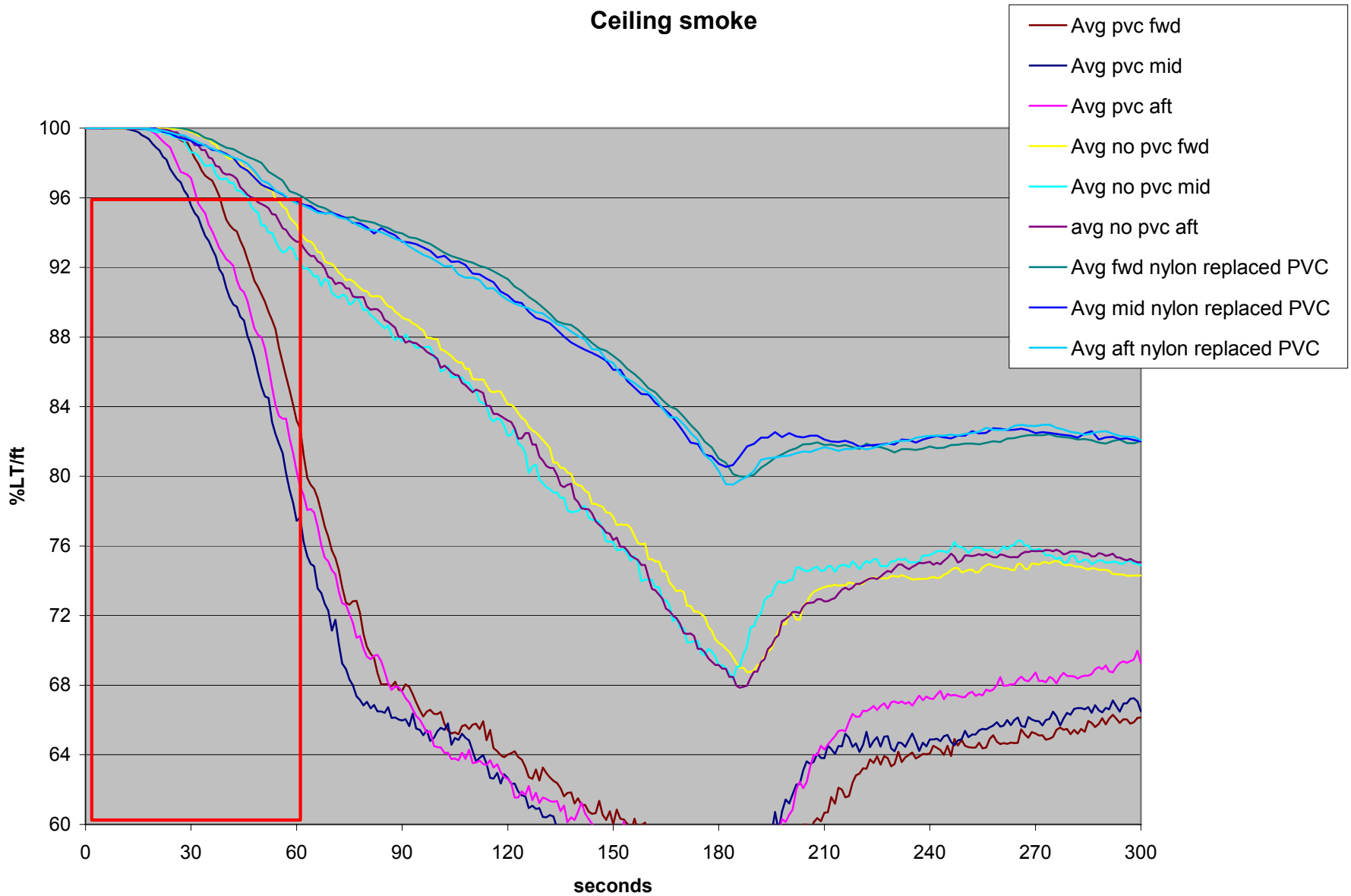
Compiled from FAA Service Difficulty Reports

Unscheduled Landings Caused by Cargo Compartment False Alarms



Resin Block Formulation

Original		Rev.1		Rev. 2	
PVC	22.7g	PVC	0 g	Nylon FR	11.4g
PE	9.1g	PE	13.6g	PE	11.4g
PS	9.1g	PS	13.6g	PS	11.4g
Nylon	9.1g	Nylon	13.6g	Nylon	11.4g
PBT	9.1g	PBT	13.6g	PBT	11.4g
PU	9.1g	PU	13.6g	PU	11.4g


Ceiling smoke
Avg pvc fwd
Avg pvc mid
Avg pvc aft
Avg no pvc fwd
Avg no pvc mid
avg no pvc aft
Avg fwd nylon replaced PVC
Avg mid nylon replaced PVC
Avg aft nylon replaced PVC
%LT/ft
100
96
92
88
84
80
76
72
68
64
60
0
30
60
90
120
150
180
210
240
270
300
seconds

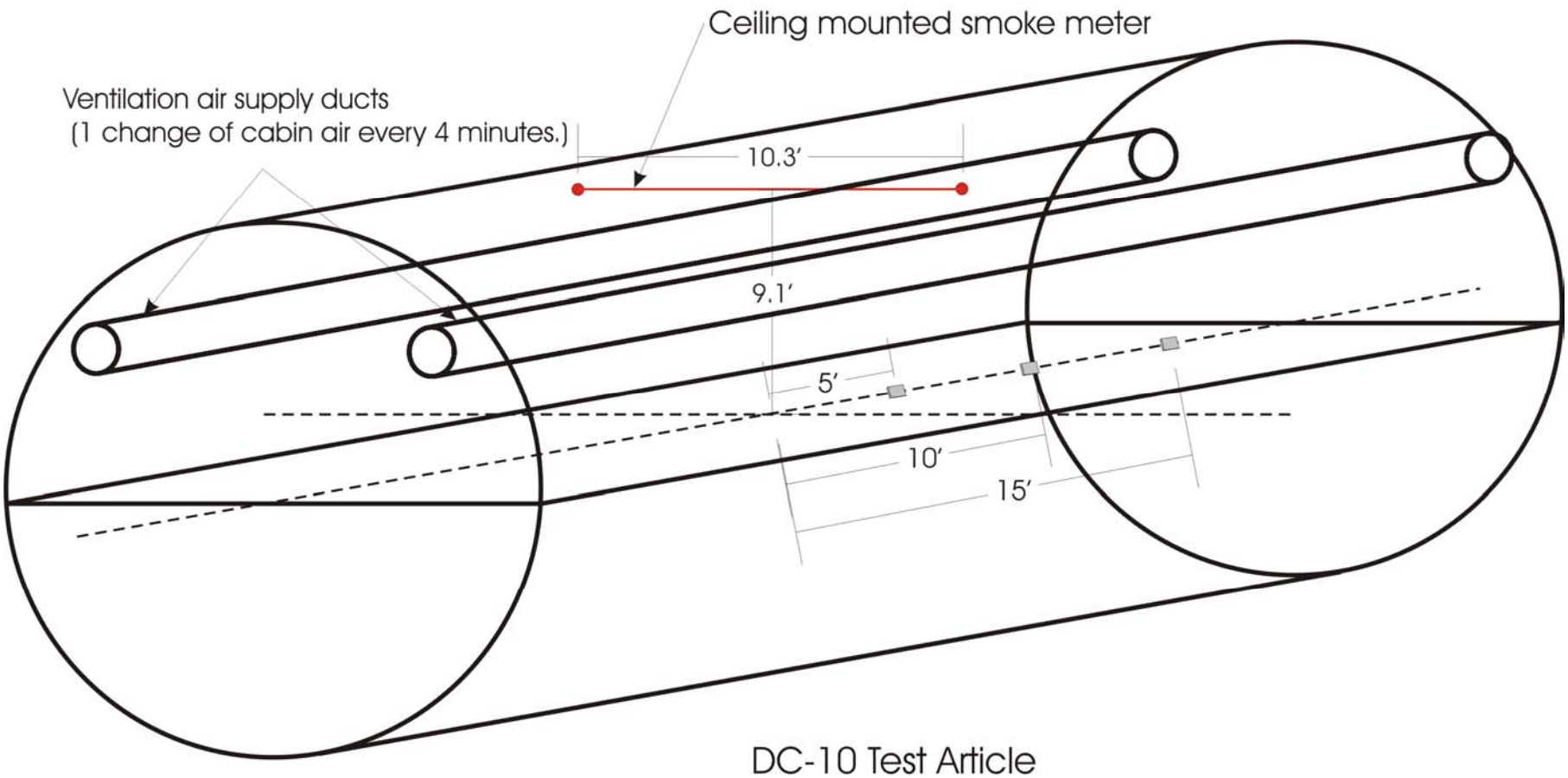
False Alarm Source Testing

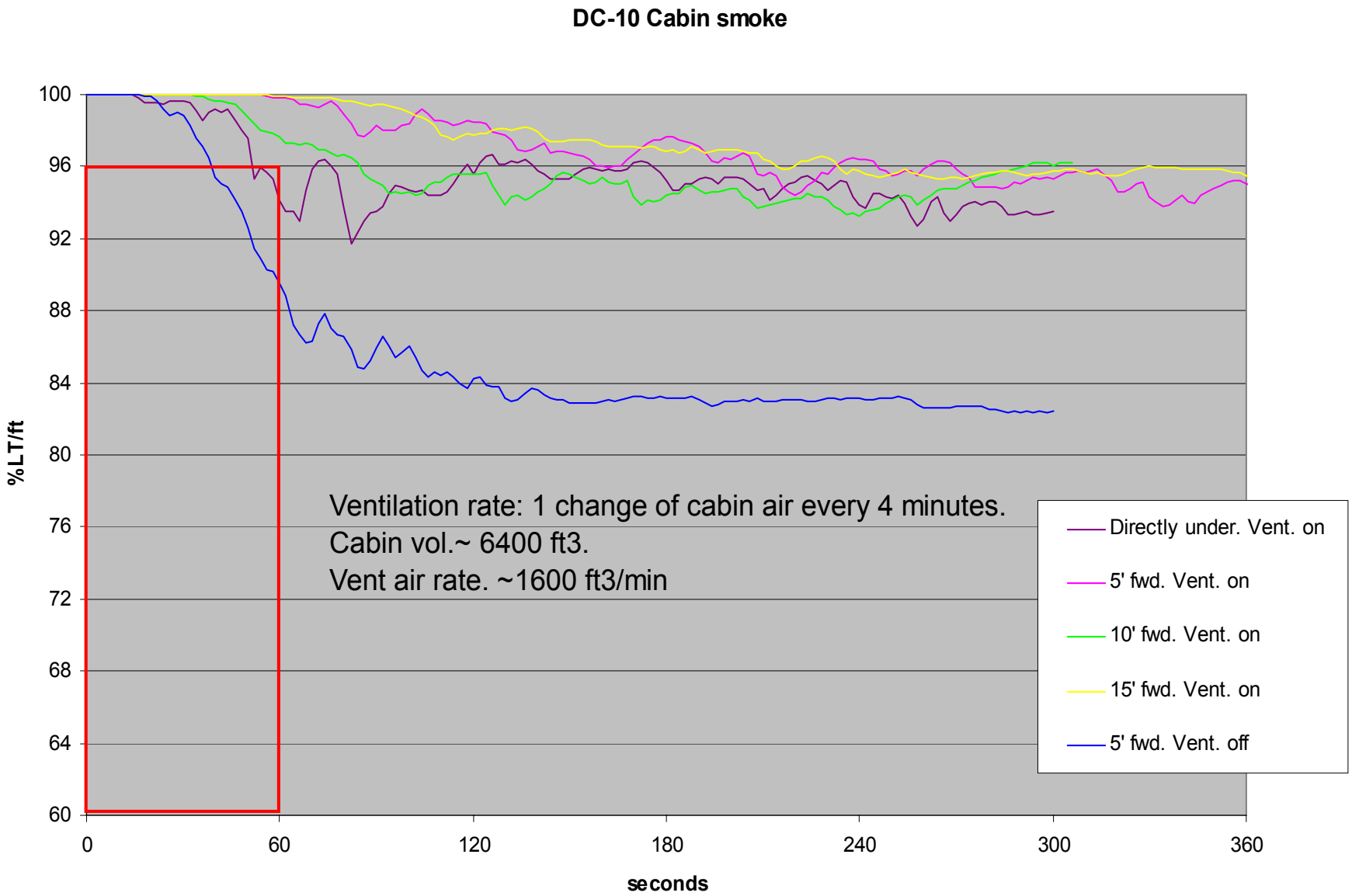
Arizona Test Dust A2

False Alarm Source Testing

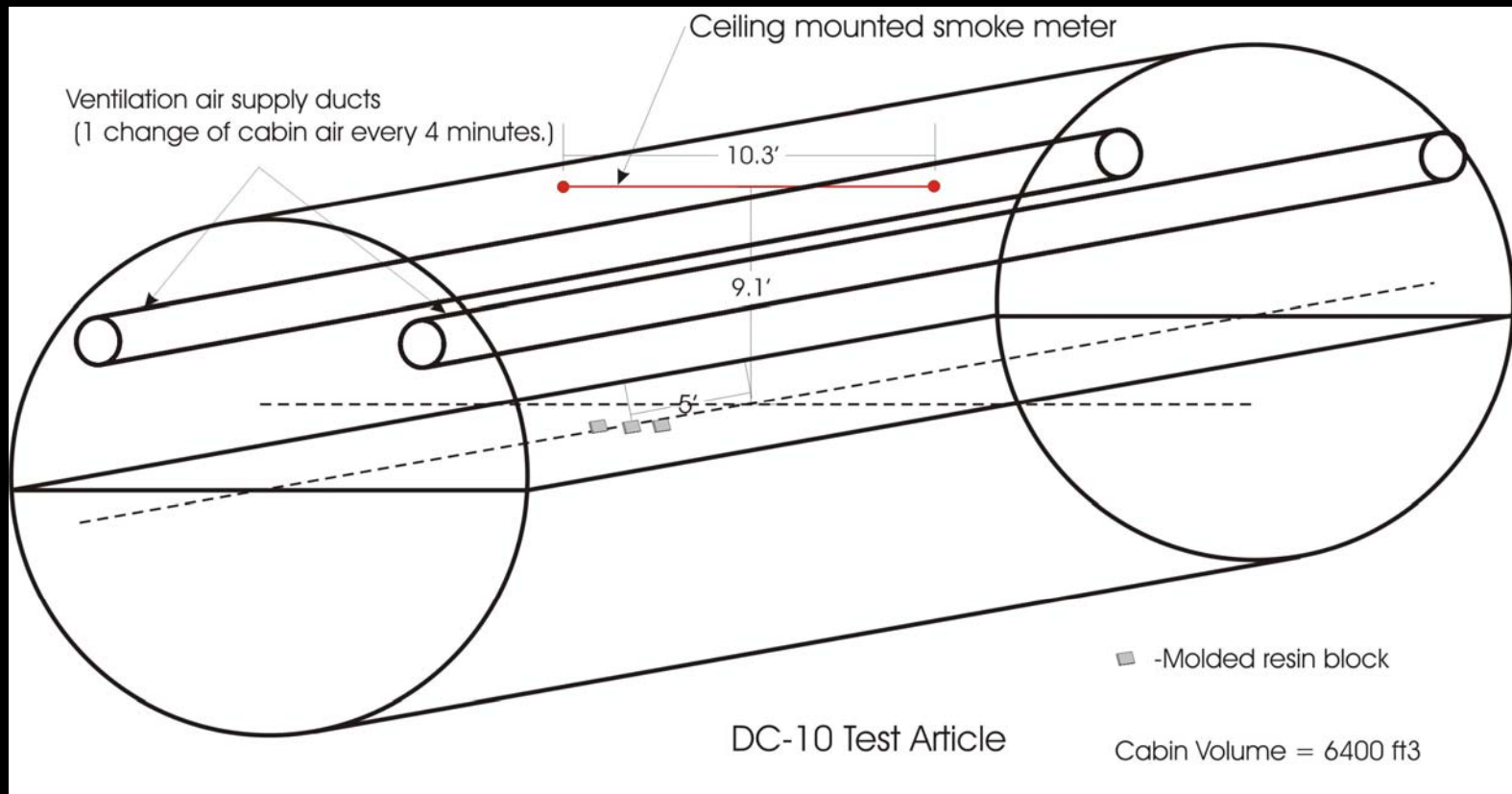
Household Humidifier

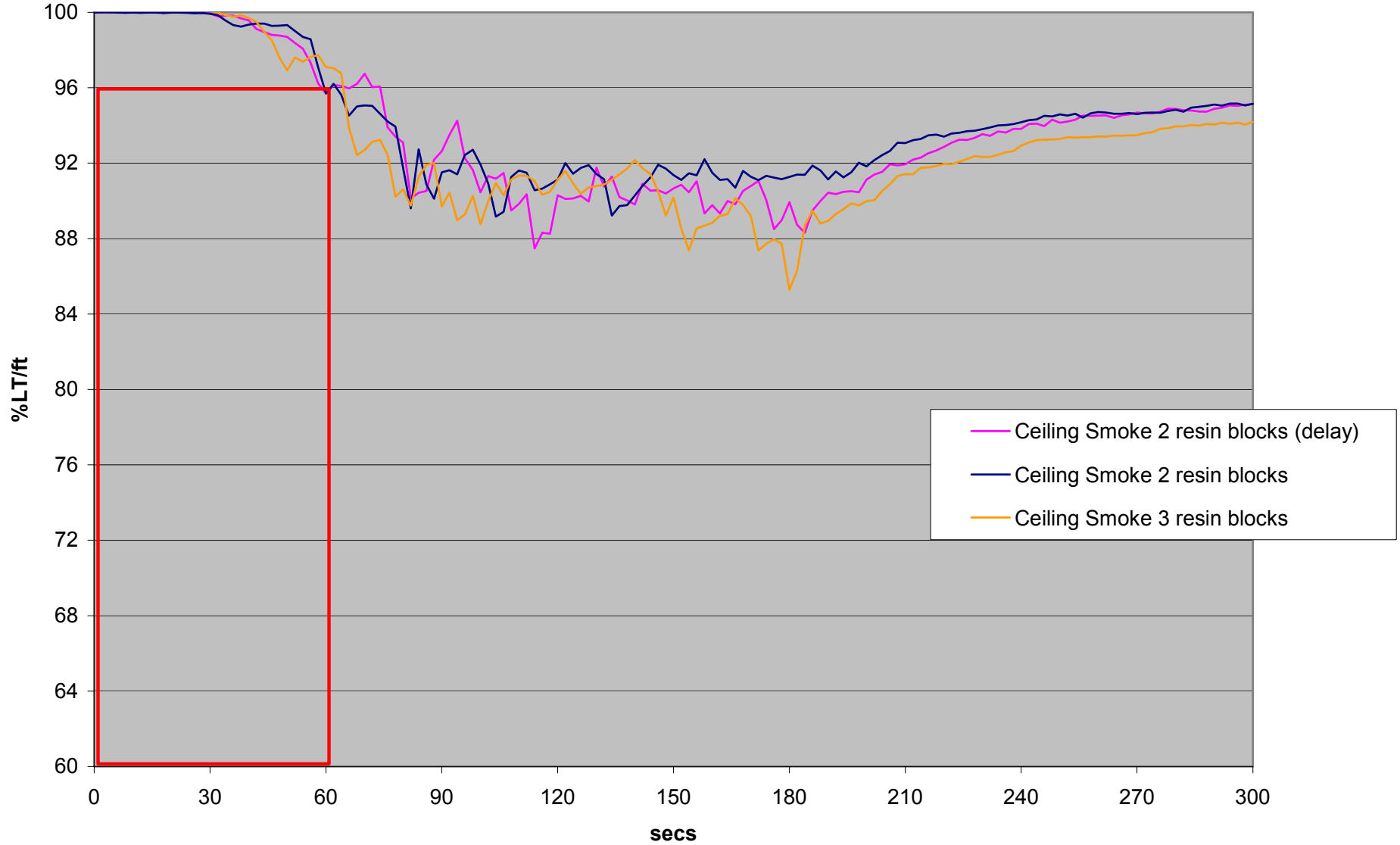
Flaming Resin Block

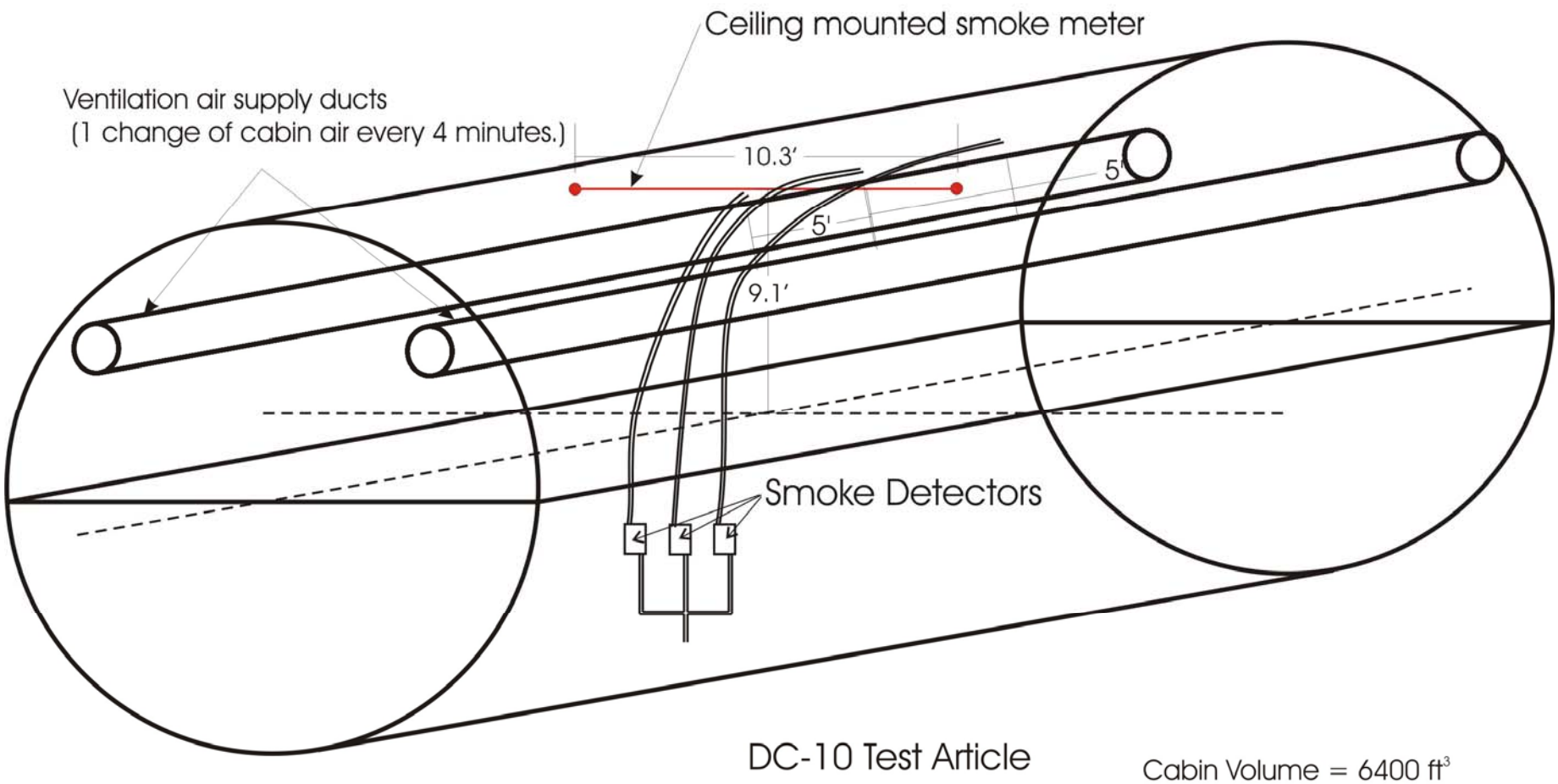


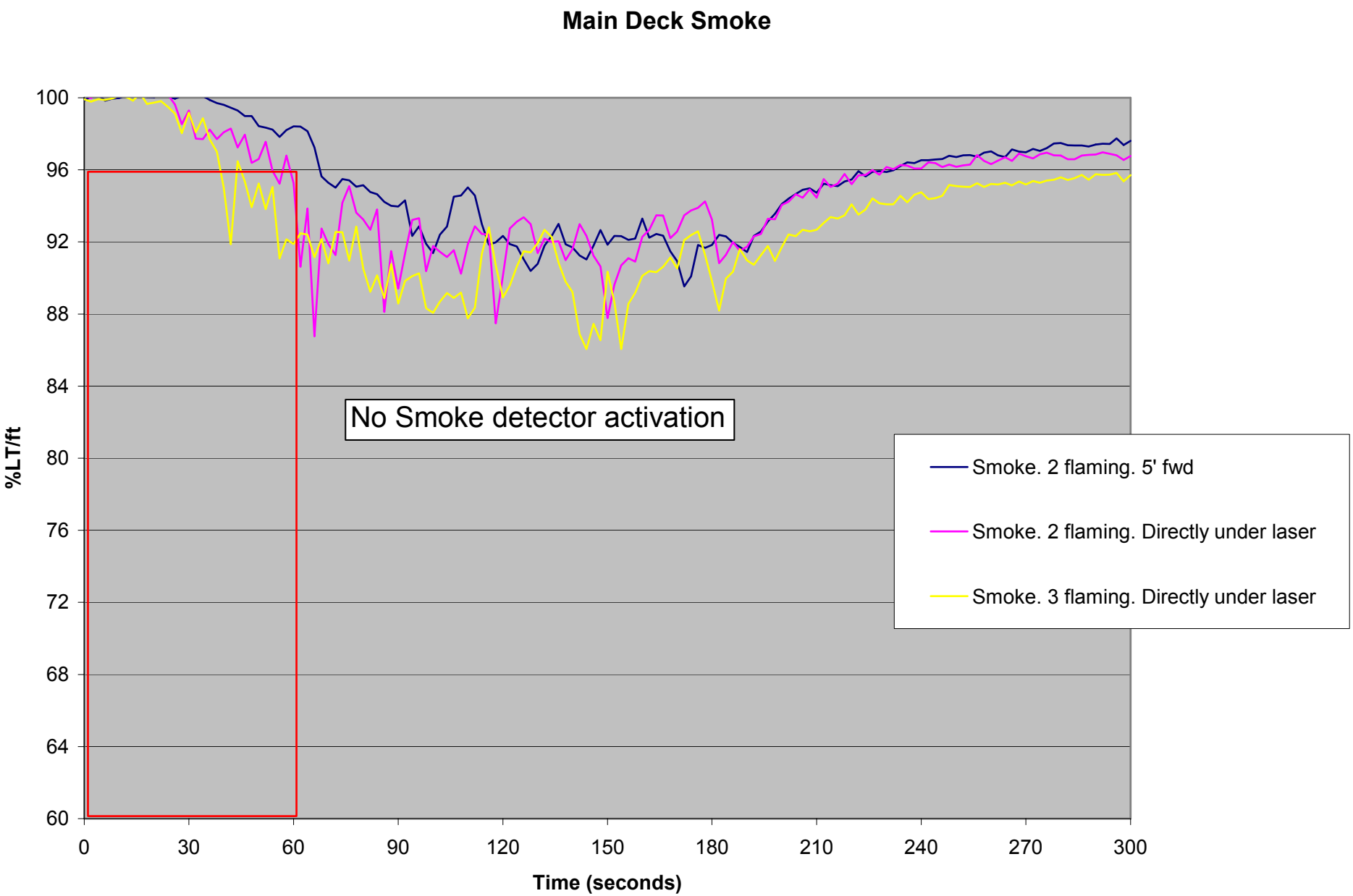

DC-10 Cabin smoke
100
96
92
88
84
80
76
72
68
64
60
%LT/ft
0
60
120
180
240
300
360
seconds
Ventilation rate: 1 change of cabin air every 4 minutes.
Cabin vol.~ 6400 ft3.
Vent air rate. ~1600 ft3/min
Directly under. Vent. on
5' fwd. Vent. on
10' fwd. Vent. on
15' fwd. Vent. on
5' fwd. Vent. off

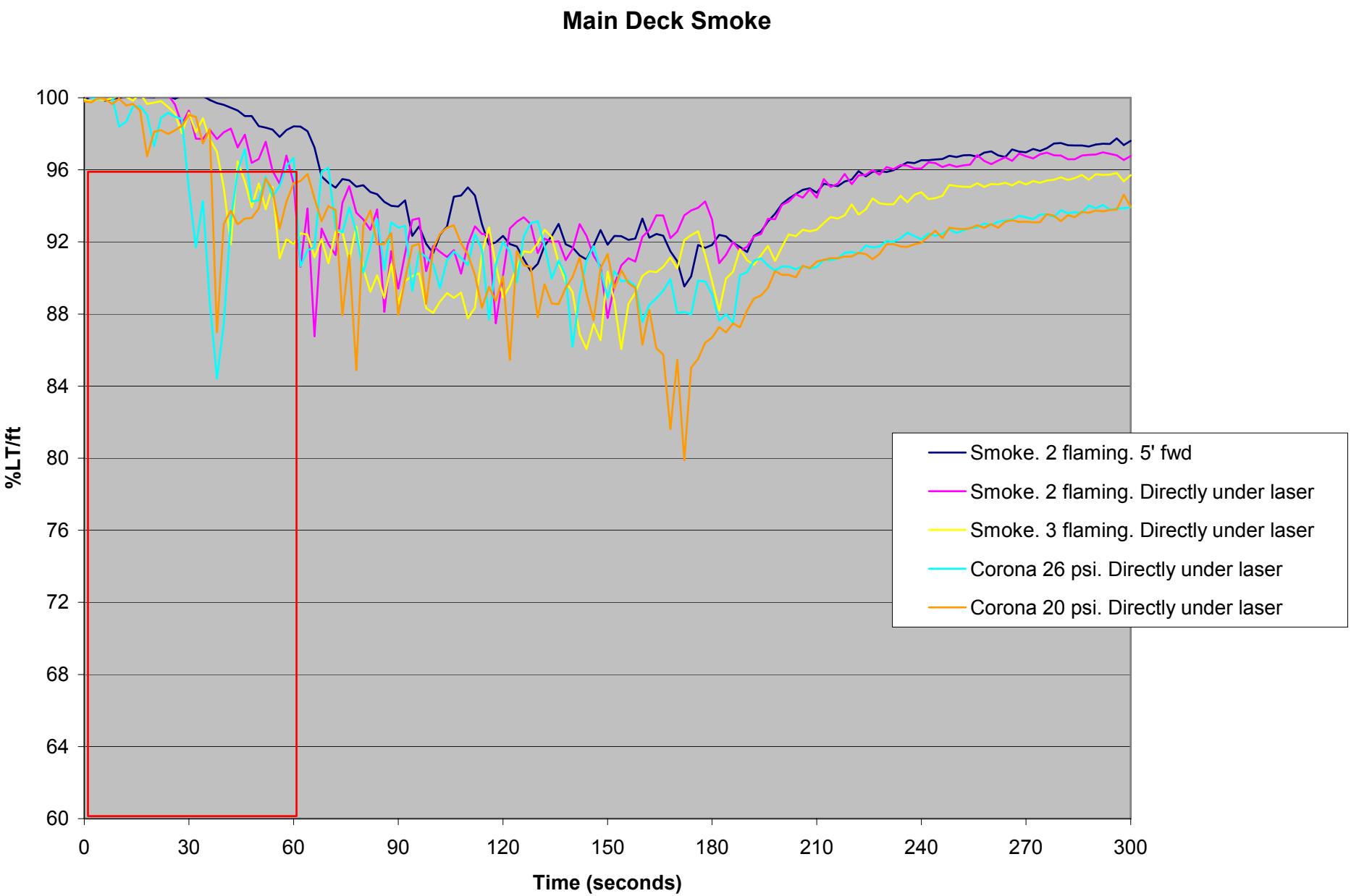
Main deck smoke
Multiple resin blocks

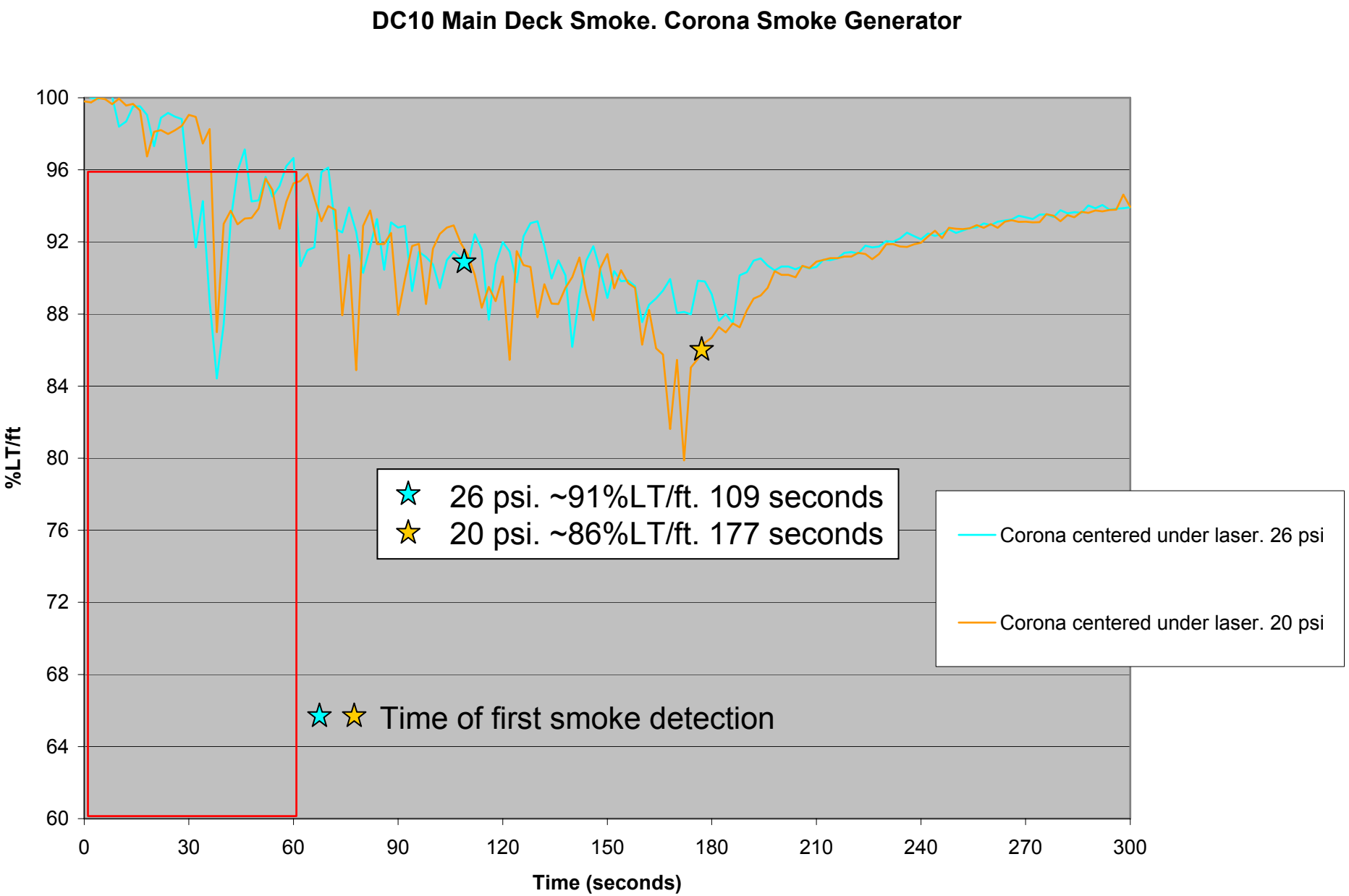


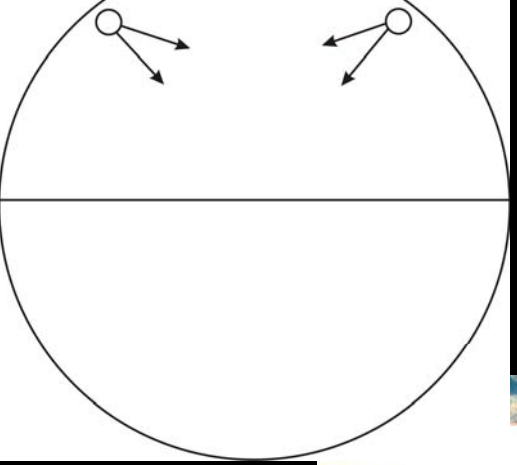

Main deck smoke. Resin blocks 5' aft of smoke meter
100
96
92
88
84
80
76
72
68
64
60
%LT/ft
0
30
60
90
120
150
180
210
240
270
300
secs
Ceiling Smoke 2 resin blocks (delay)
Ceiling Smoke 2 resin blocks
Ceiling Smoke 3 resin blocks

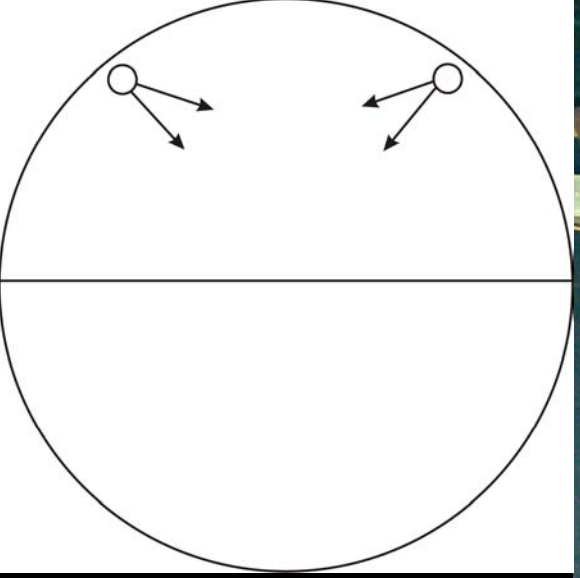

Ceiling mounted smoke meter
Ventilation air supply ducts
(1 change of cabin air every 4 minutes.)
10.3'
5'
5'
9.1'
Smoke Detectors
DC-10 Test Article
Cabin Volume = 6400 ft3

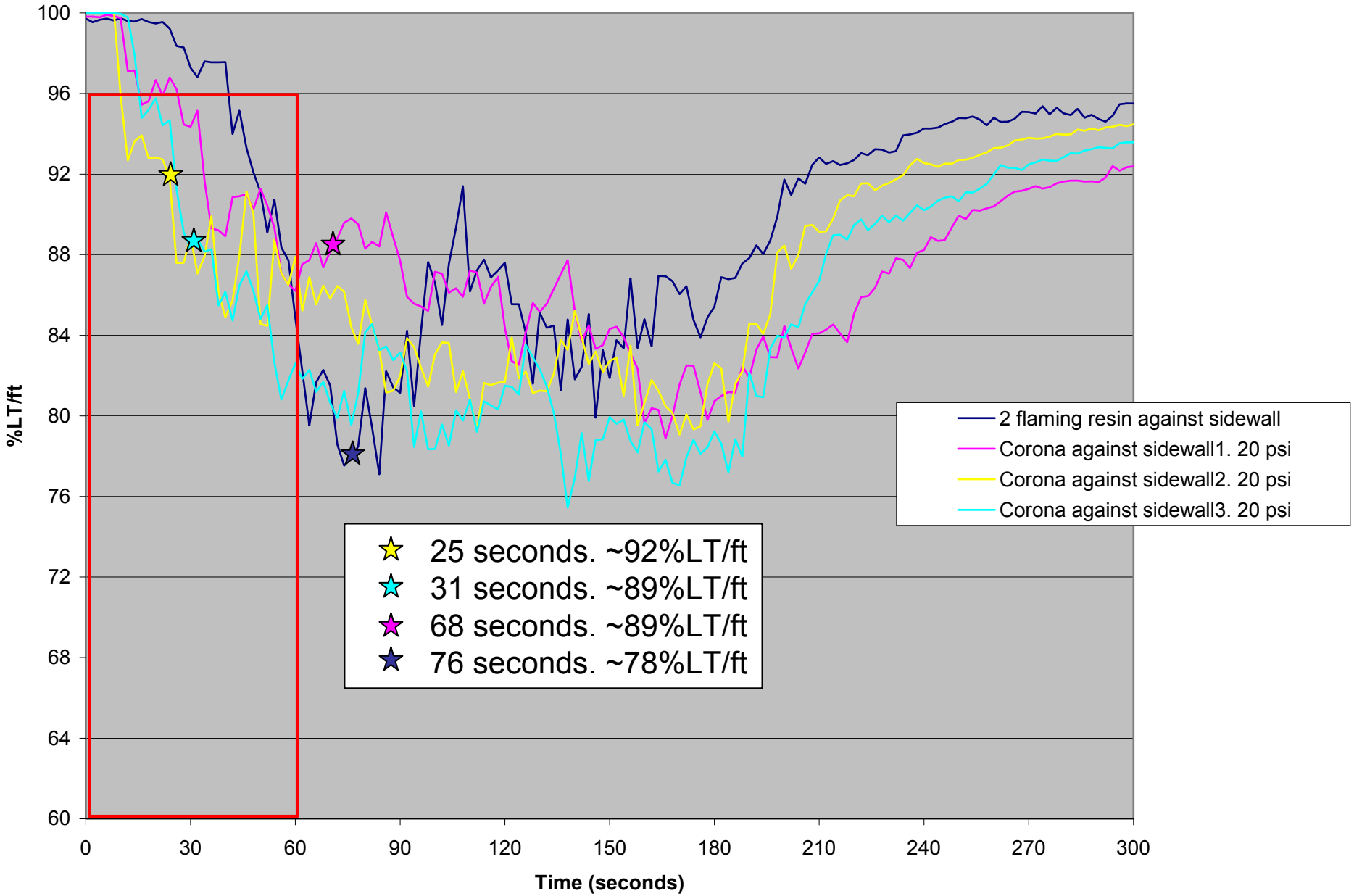

Main Deck Smoke
100
96
92
88
84
80
76
72
68
64
60
%LT/ft
0
30
60
90
120
150
180
210
240
270
300
Time (seconds)
No Smoke detector activation
Smoke. 2 flaming. 5' fwd
Smoke. 2 flaming. Directly under laser
Smoke. 3 flaming. Directly under laser


Main Deck Smoke
100
96
92
88
84
80
76
72
68
64
60
%LT/ft
0
30
60
90
120
150
180
210
240
270
300
Time (seconds)
Smoke. 2 flaming. 5' fwd
Smoke. 2 flaming. Directly under laser
Smoke. 3 flaming. Directly under laser
Corona 26 psi. Directly under laser
Corona 20 psi. Directly under laser


DC10 Main Deck Smoke. Corona Smoke Generator
%LT/ft
100
96
92
88
84
80
76
72
68
64
60
0
30
60
90
120
150
180
210
240
270
300
Time (seconds)
26 psi. ~91%LT/ft. 109 seconds
20 psi. ~86%LT/ft. 177 seconds
Time of first smoke detection
Corona centered under laser. 26 psi
Corona centered under laser. 20 psi






100
96
92
88
84
80
76
72
68
64
60
%LT/ft
0
30
60
90
120
150
180
210
240
270
300
Time (seconds)
2 flaming resin against sidewall
Corona against sidewall1. 20 psi
Corona against sidewall2. 20 psi
Corona against sidewall3. 20 psi
25 seconds. ~92%LT/ft
31 seconds. ~89%LT/ft
68 seconds. ~89%LT/ft
76 seconds. ~78%LT/ft

PRESENT STATUS

- The smoke quantity produced by multiple (2-3) burning resin blocks can accumulate into detectable levels in less than one minute in a well ventilated main deck compartment. The location and ventilation pattern determines if this will occur.

- Typical smoke detectors presently in use respond very differently to liquid particles from smoldering fires or artificial smoke generators than they do to smoke from flaming fires. Smoke obscuration alone is not predictive of detector response time.

Sandia CFD Model Development

- Sub model for heat transfer to the compartment walls and ceiling is under development and will be implemented shortly.
- A series of 15 validation experiments have been conducted in the DC-10 lower lobe cargo compartment. The comparison between the validation experiments and the model predictions will be completed after the heat transfer sub model has been implemented into the code. More validation tests are planned.
- A preliminary list of initial code testers has been compiled. The target date for initial tester evaluation to begin is September 2004.
- Initial discussion have begun on the method for the public release of the code.

Future Work

- Continue with main deck smoke testing.
- Develop “dry ice” false alarm scenario. Test new detectors to false alarm sources.
- Continue testing to support CFD model validation.
- Attempt to identify a “smoke” source with appropriate particle size and optical properties. Combine gas species of interest to the smoke source and recommend settings/generation rates appropriate for detector certification tests in various cargo compartments.

New Project

Evaluate the effect of contaminants (lubricating oil, hydraulic fluid, etc.) introduced into aircraft ventilation systems and the resulting hazards that result in the flight deck and passenger cabin.