



Boeing Cargo MPS Alternative Agent (CF₃I) Test Results

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Boeing Alternative Agent (CF₃I) Cargo MPS Test Results

- Minimum Performance Standard (MPS) testing of Trifluoroiodomethane (CF₃I) has been conducted in the Boeing MPS test facility, in a cooperative project with Collins.
- Results of the testing have been compared to the performance of Halon 1301 in the same facility.

Target CF ₃ I Volumetric Concentration	
Initial	Sustained
5.3%	3.2%

- Aerosol can explosion simulation tests were successfully completed at 3.2%.
- Surface burning fire tests were successfully completed at 5.3%.
- CF₃I failed to suppress a bulk-load fire at 5.3%.
- CF₃I failed to suppress a bulk-load fire at 8.6%, Testing was halted.
- Containerized-load tests were not conducted.

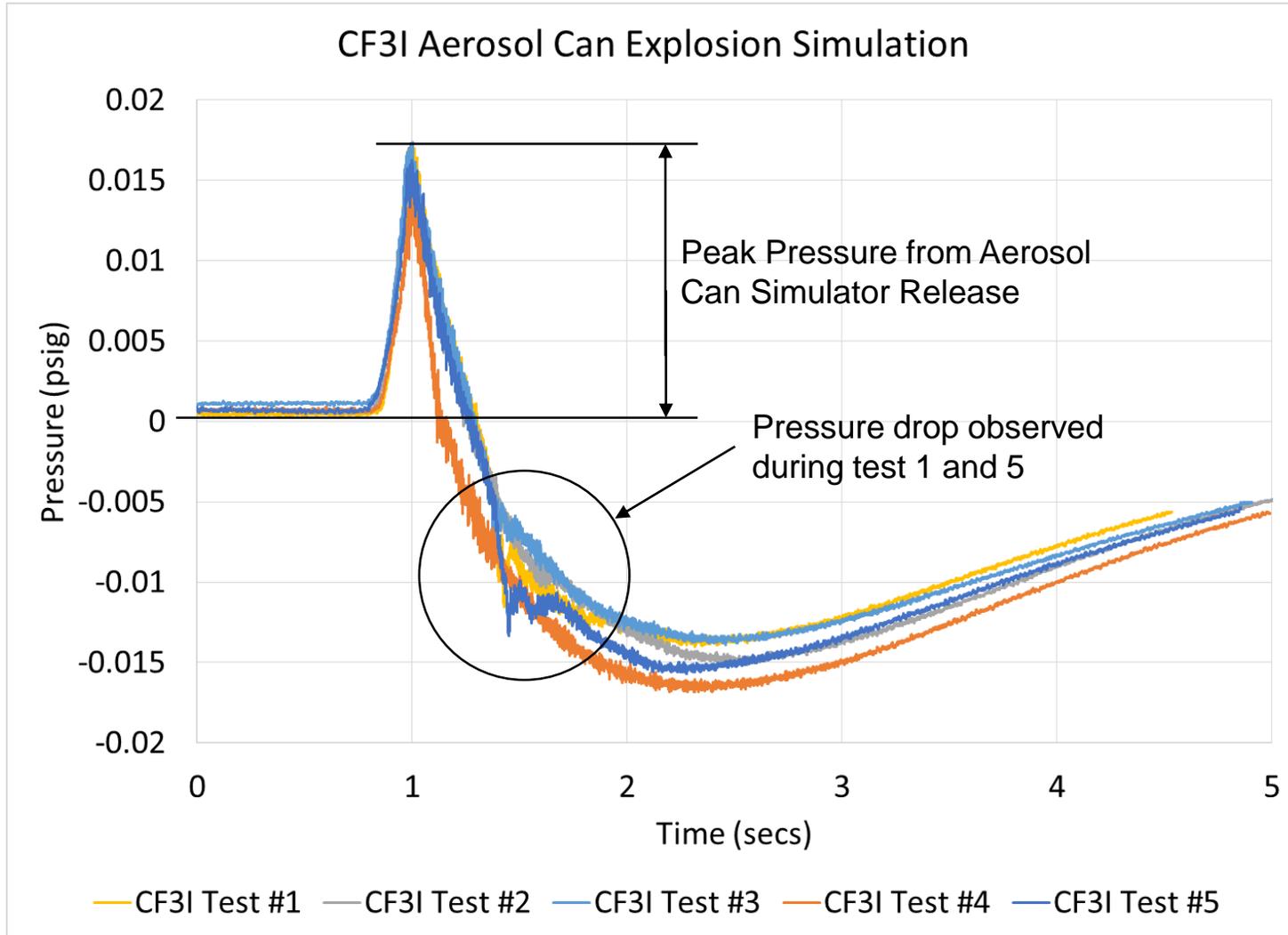
Boeing Alternative Agent (CF₃I) Cargo MPS Test Results

Aerosol Can Explosion Simulation

- 5 CF₃I Aerosol Can Explosion Simulation (ACES) tests were successfully completed in the Boeing MPS test cell.
- All simulations were conducted with a volumetric concentration of CF₃I = 3.2%
- Mixing fans were used to obtain a homogenous mixture of CF₃I.
 - The fans were turned off 30 seconds prior to simulator activation.
- No evidence of an explosion was observed in any of the tests
 - No deflagrations, flames or flashes were observed.
 - No pressure rise exceeding the magnitude of the simulator discharge were observed.

Boeing Alternative Agent (CF₃I) Cargo MPS Test Results

Aerosol Can Explosion Simulation



- The pressure rise from the simulator discharge into CF₃I was similar to the pressure rise observed during discharges into Halon 1301.
- A small pressure drop was observed approximately .5 seconds after discharge during two of the tests.
 - Similar behavior was observed when discharging...
 - into Halon
 - with the igniter on
 - with the igniter off
 - In all cases the pressure rise due to the simulator discharge is the largest pressure response observed.

Boeing Alternative Agent (CF₃I) Cargo MPS Test Results

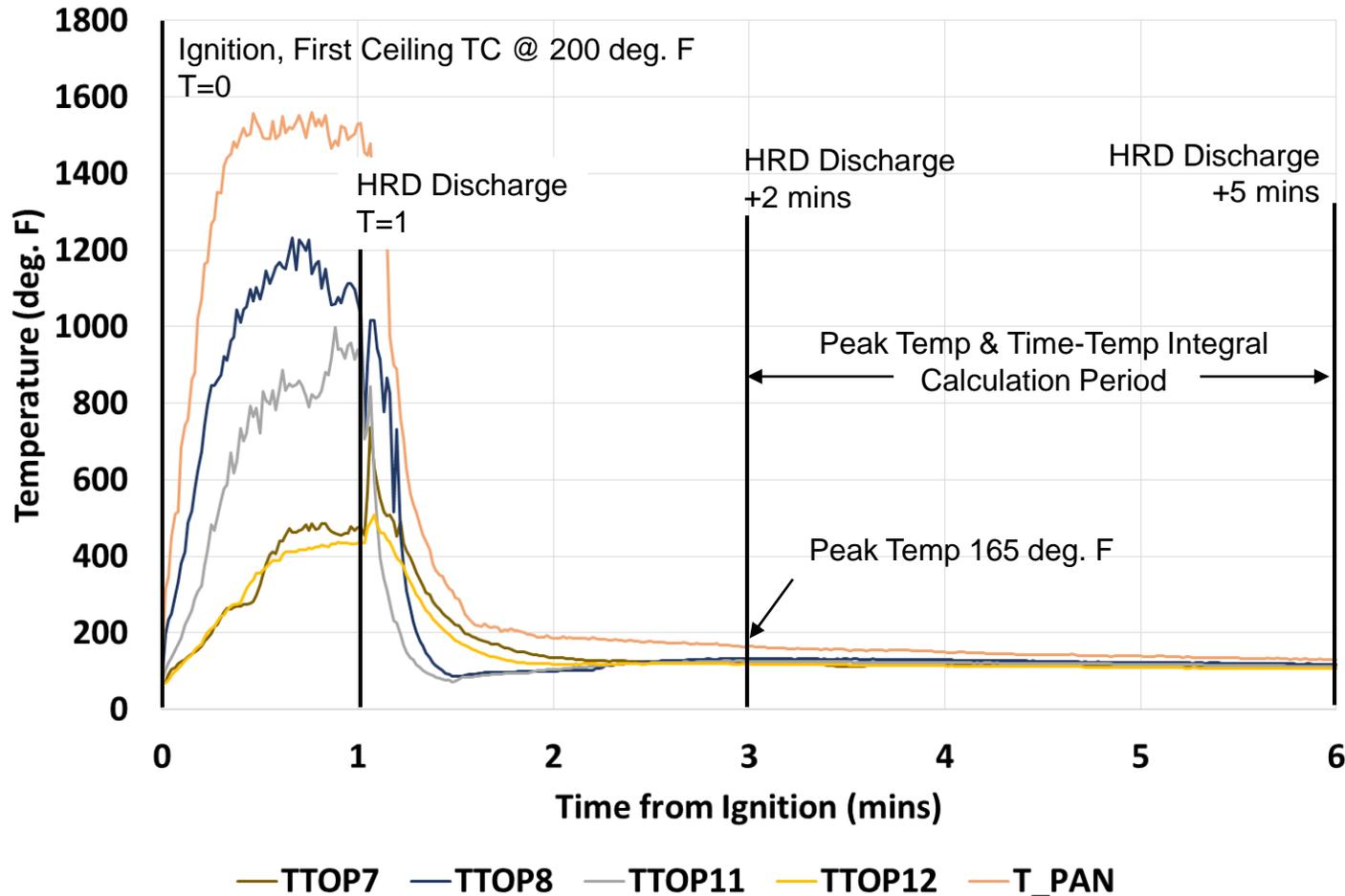
Surface-Burning Fire

- 5 CF₃I Surface-Burning fire tests were successfully completed in the Boeing MPS test cell.
- All test conditions were conducted with a volumetric concentration of CF₃I = 5.3%.
- The fire was consistently extinguished approximately 10 seconds after HRD discharge.
- The peak temperature and time-temperature integral met the Halon 1301 based acceptance criteria.

Boeing Alternative Agent (CF₃I) Cargo MPS Test Results

Surface-Burning Fire

CF3I Surface-Burning Test #4



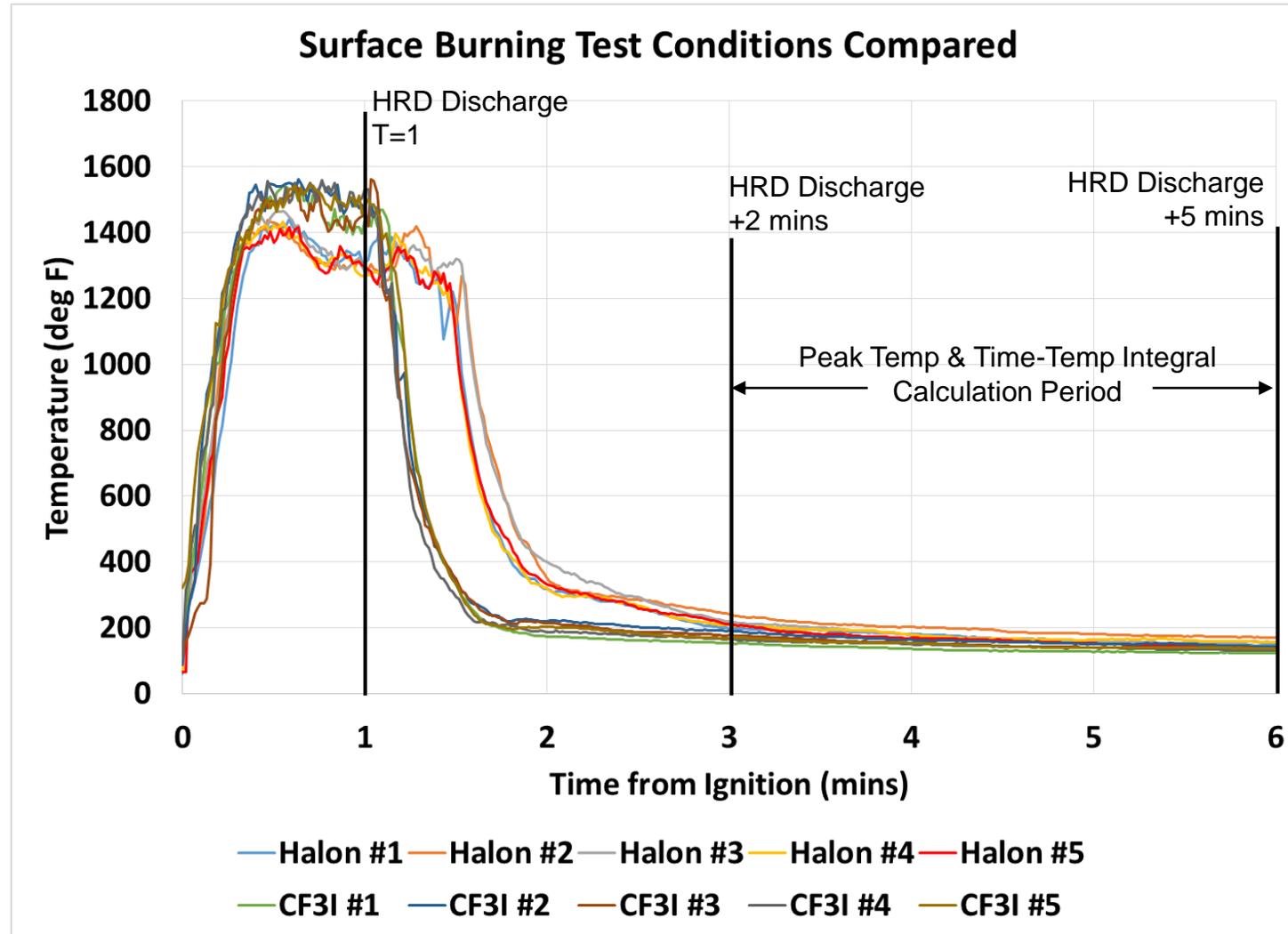
Test sequence

- Ignition
- HRD is activated 1 minute after first ceiling TC reaches 200 deg. F
- Peak temp & time-temp integral calculated over T=HRD+2 through T=HRD+5

Example: Surface-Burning test #4

- T=0: Ignition
- T=0: 200 deg. F
- T=1.0: HRD discharge
- T=3.0: Peak temp = 165 deg. F
- Max time-temp integral: 434 deg. F - min

Boeing Alternative Agent (CF₃I) Cargo MPS Test Results Surface-Burning Fires Compared



- Surface-burning fires were extinguished quicker with CF₃I than Halon 1301.
- Peak temperatures and time-temperature integrals between T=HRD+2 and T=HRD +5 were lower with CF₃I than Halon 1301.

Boeing Alternative Agent (CF₃I) Cargo MPS Test Results Surface-Burning Summary – Tabular Results

Test	Boeing Halon Baseline		CF3I	
	Max Temp. (deg F)	Max Area (deg F-min)	Max Temp (deg F)	Max Area (deg F-min)
1	232	573	157	405
2	197	507	189	478
3	213	517	177	449
4	204	521	165	434
5	206	484	170	441

Maximum	232	573		
Average	210	520	172	441
Sample Standard Deviation	13	33		
Sum of Std. Dev. + Max.	245	606		
MPS Acceptance Criteria	245	606		

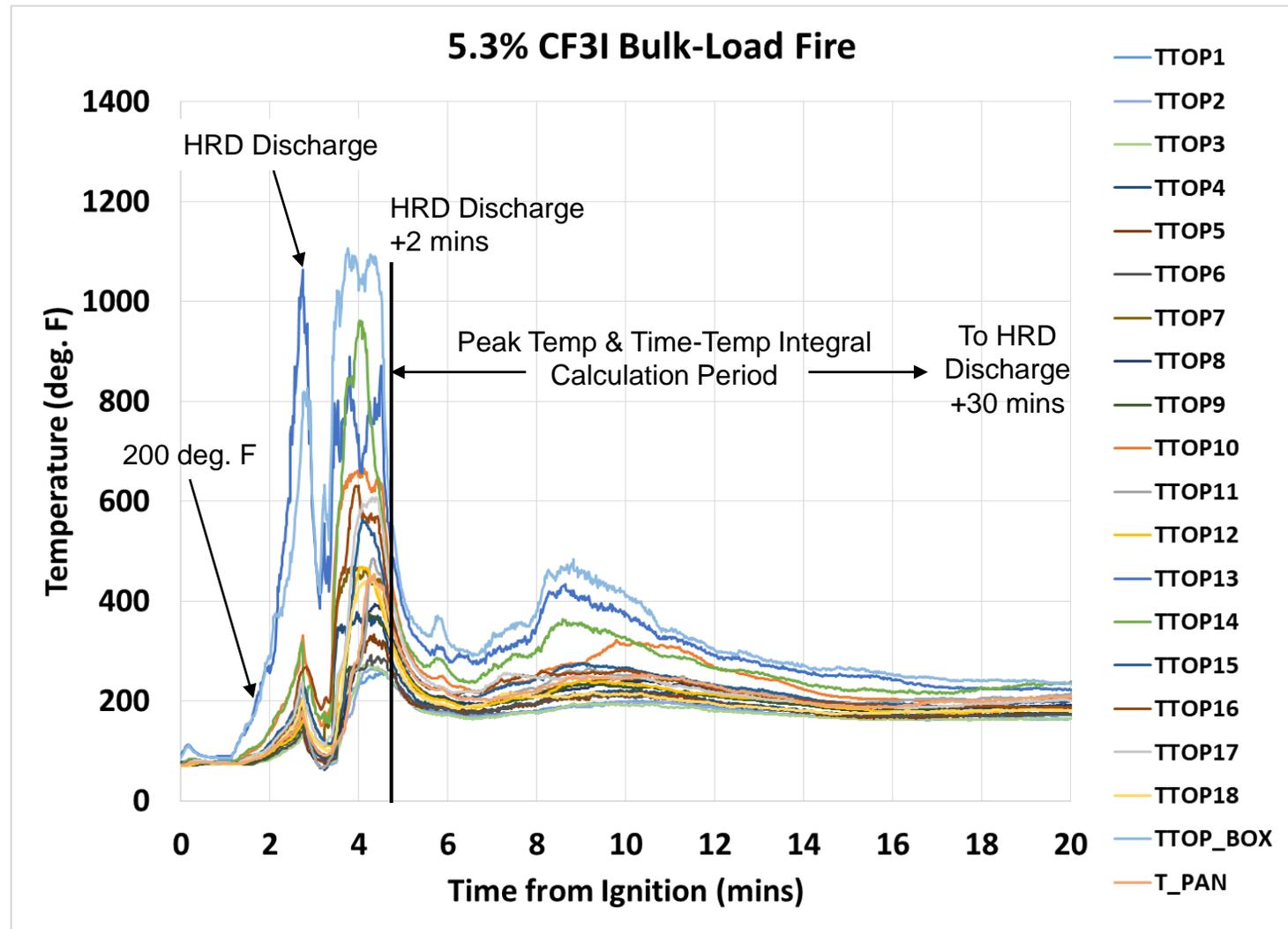
Boeing Alternative Agent (CF₃I) Cargo MPS Test Results

Bulk-Load Fire

- 2 CF₃I Bulk-Load fire tests were completed in the Boeing MPS test cell.
- The first test was conducted with a volumetric concentration of CF₃I = 5.3%
- The second test was conducted with a volumetric concentration of CF₃I = 8.6%
- The fire was not adequately suppressed in either test condition.

Boeing Alternative Agent (CF₃I) Cargo MPS Test Results

Bulk-Load Fire

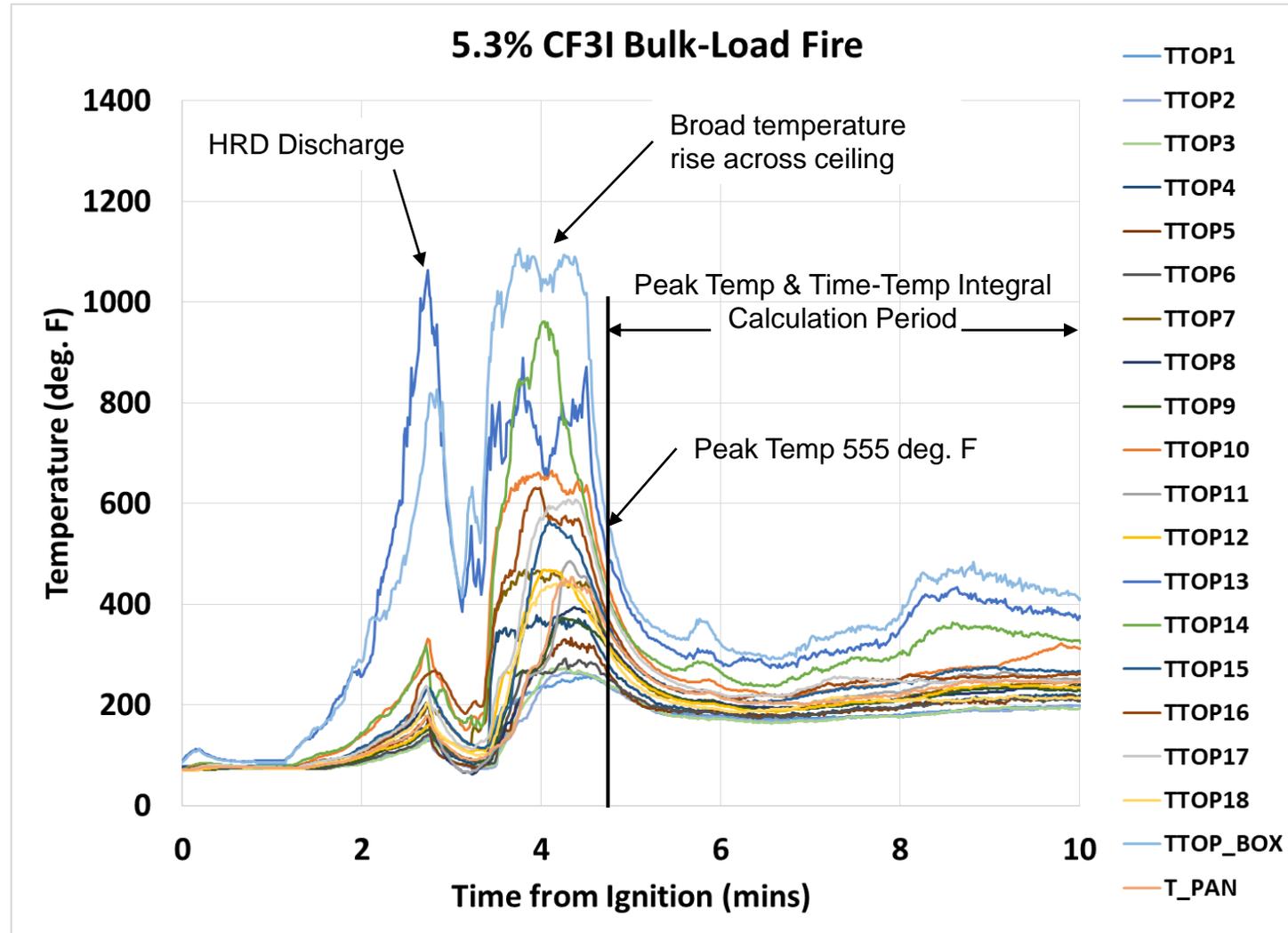


Test sequence

- Ignition
- HRD is activated 1 minute after first ceiling TC reaches 200 deg. F
- LRD is activated after time delay
- Peak temp calculated over T=HRD+2 through end of test (T=HRD+30 or T=HRD+180)
- Time-temp integral calculated over T=HRD+2 through T=HRD+30

Boeing Alternative Agent (CF₃I) Cargo MPS Test Results

Bulk-Load Fire



Results

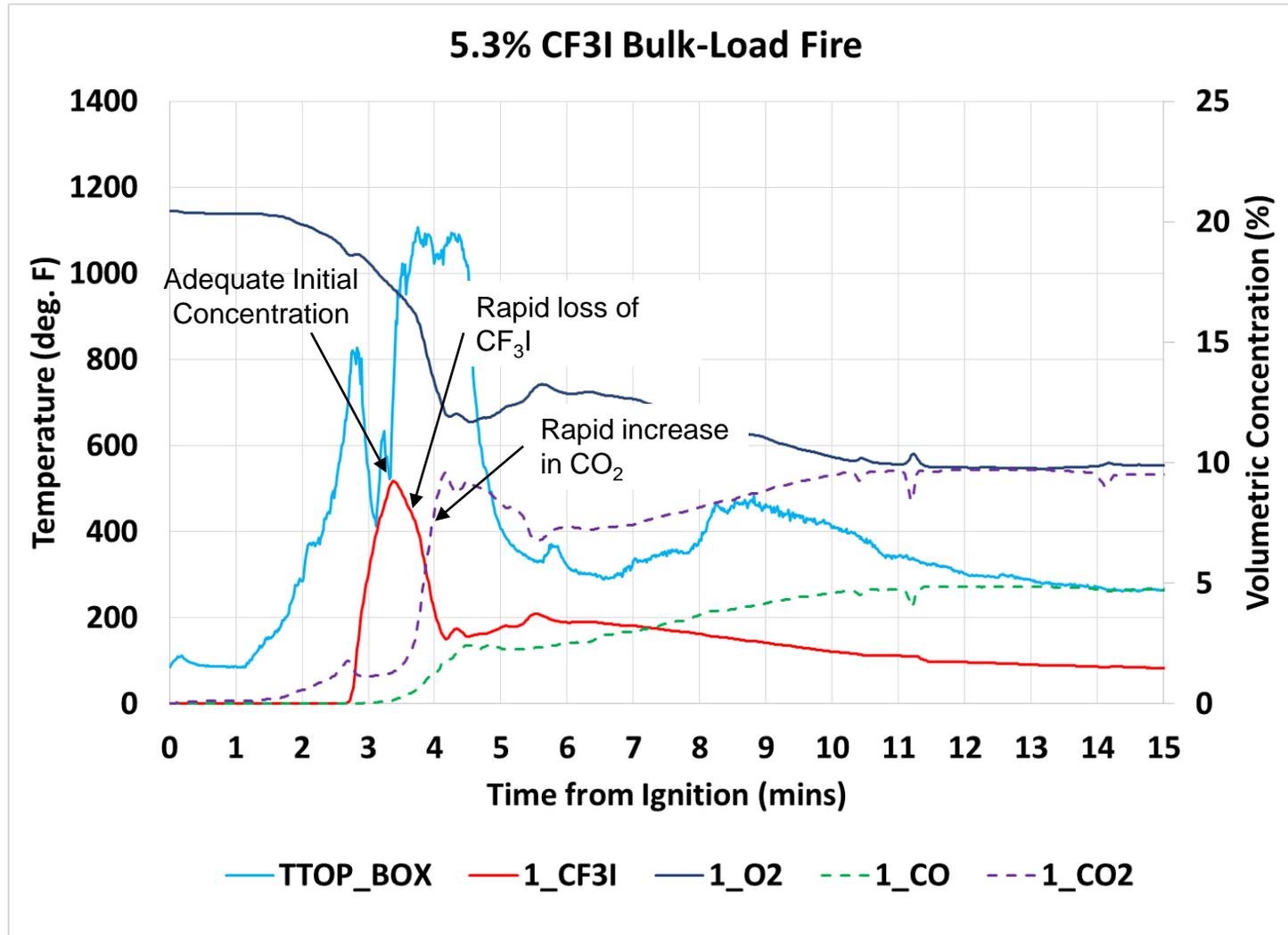
- 5.3% CF₃I failed to suppress the bulk-load fire.
- The peak temperature of 555 deg. F is 100 degrees hotter than the Halon 1301 baseline acceptance criteria.
- The time-temperature integral of 7605 deg. F-min is within the Halon 1301 baseline acceptance criteria.

What caused the failure?

- Was the target initial concentration obtained?
- Was the CF₃I distribution throughout the compartment adequate?

Boeing Alternative Agent (CF₃I) Cargo MPS Test Results

Bulk-Load Fire



CF₃I was converted into CO, CO₂ and HF before it could effectively suppress the bulk-load fire.

- Initial CF₃I concentrations were confirmed to be correct.
- A rapid loss of CF₃I (red curve) occurred shortly after HRD discharge.
- At the same time, a large amount of CO (green curve) and CO₂ (purple curve) were created.
- Subsequent analysis of gas samples determined that very high quantities of HF were produced.

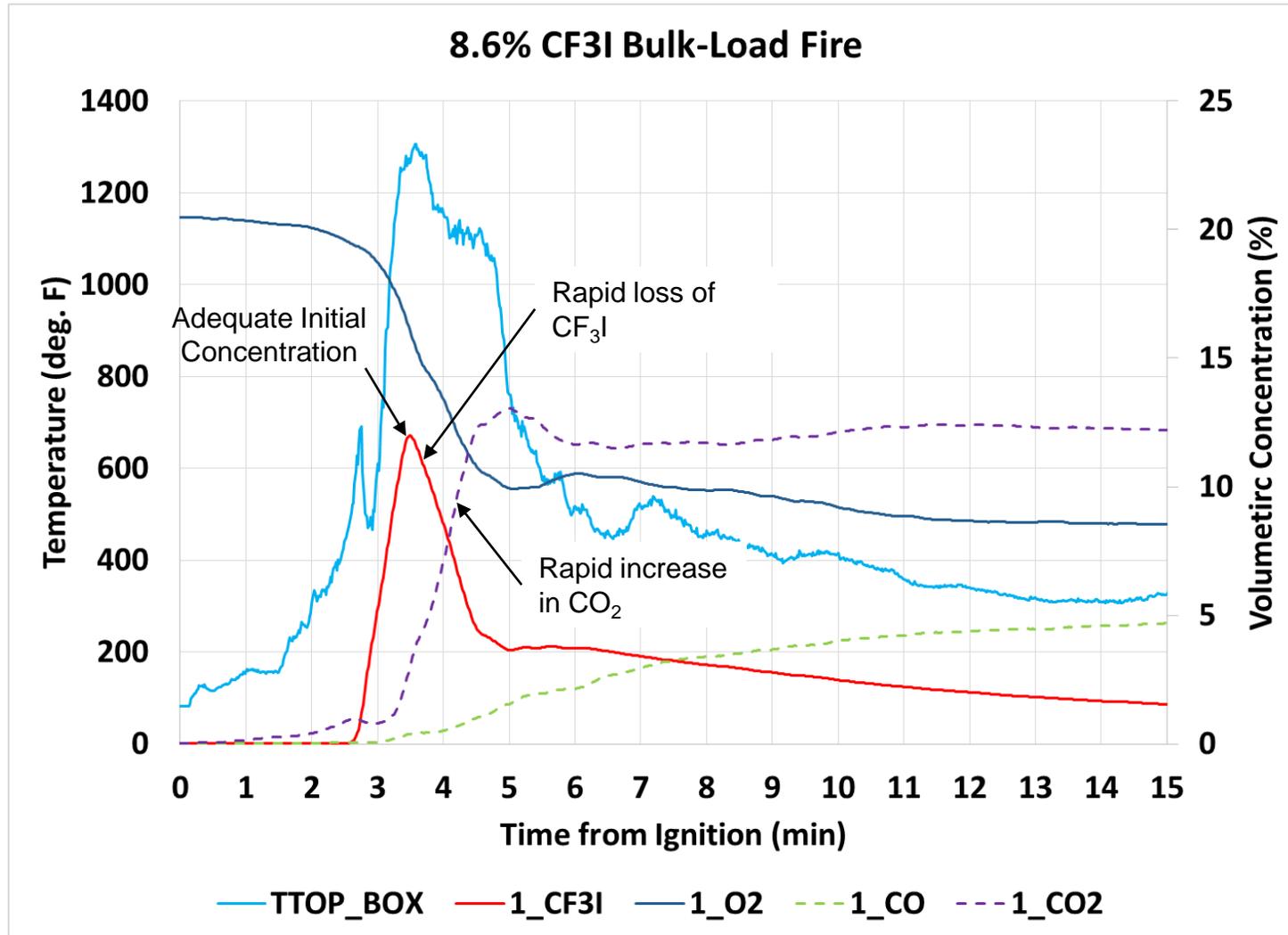
Boeing Alternative Agent (CF₃I) Cargo MPS Test Results

Bulk-Load Fire

- Agent distribution tests confirmed that CF₃I concentrations were largely homogenous throughout the test cell.
 - Agent distribution was confirmed in both an empty compartment and a bulk-load configuration.
- The target initial CF₃I concentration was increased to 8.6% and the bulk-load fire test repeated.

Boeing Alternative Agent (CF₃I) Cargo MPS Test Results

Bulk-Load Fire



Once again, CF₃I failed to suppress the bulk-load fire.

The same rapid loss of agent and creation of CO and CO₂ was observed.

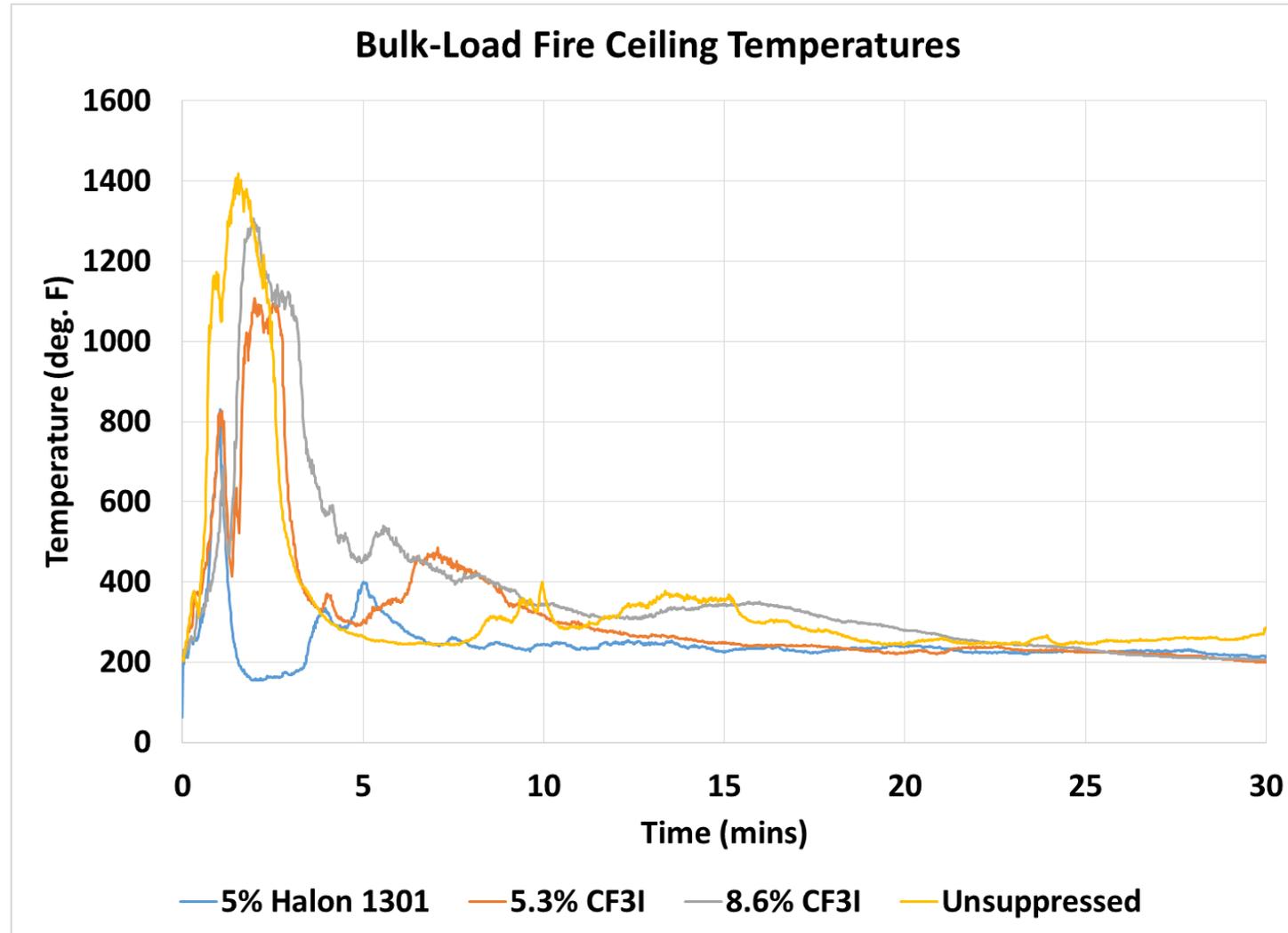
Gas analysis showed high levels of HF were created.

It is not expected that further, reasonable increases in CF₃I concentration would reliably suppress the bulk-load fire.

Further MPS testing of CF₃I was halted at this point.

Boeing Alternative Agent (CF₃I) Cargo MPS Test Results

Bulk-Load Fires Compared



The resultant temperature profile with CF₃I was similar to an unsuppressed fire controlled by oxygen consumption.

Boeing Alternative Agent (CF₃I) Cargo MPS Test Results

Test Result Summary

	CF3I Aerosol Can Explosion Simulation
Flash seen in no more than 1 in 5 test conditions	No flashes in any test condition
Evidence of Explosion (Visual or pressure rise)	None

	Surface-Burning		Bulk-Load		Containerized-Load	
	Acceptance Criteria	CF3I (Average)	Acceptance Criteria	CF3I (Average)	Acceptance Criteria	CF3I (Average)
Peak Temperature (deg. F)	245	172	455	Fire was not suppressed	516	Not Conducted
Time-Temperature Integral (deg. F - min)	606	441	7787		12570	

