Does the Cargo Bulk Load Fire Test Failure Mean CF_3I is Inappropriate for Engine/APU Fire Extinguishing Systems, As Well?

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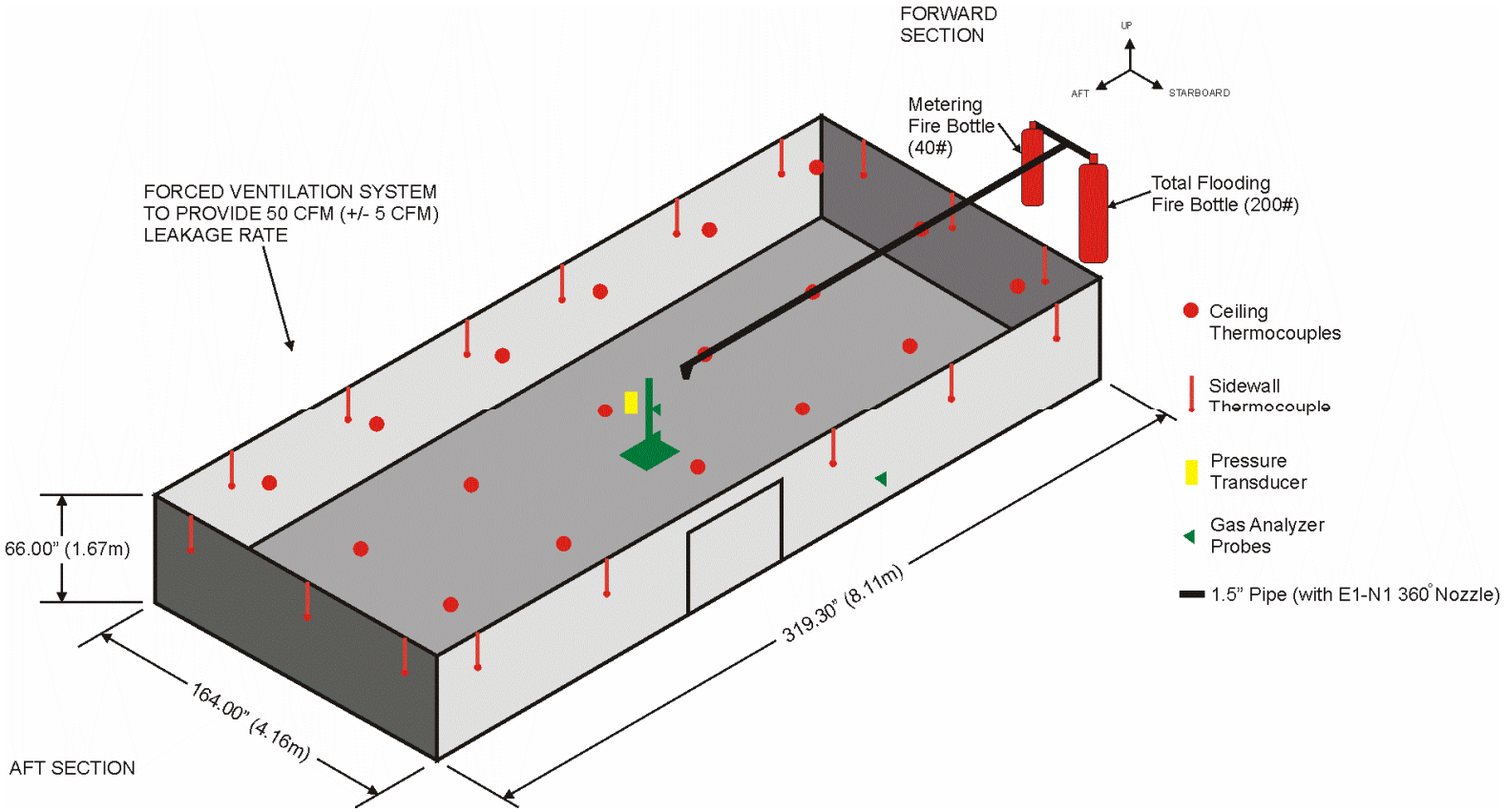
Why is a Propulsion Fire not like a Cargo Fire?

- Cargo bulk load test failure resulted from agent breaking down during long exposure to high heat during interval between introduction of agent to compartment and encounter with flame front
- Propulsion systems are designed around very rapid flooding of compartment due to high ventilation rates, which is also modeled in the Halon 1301 replacement candidate NFS fire extinction testing
- Fully developed pool fire more accurately represents propulsion fires, with liquid fuels that are fully engaged in combustion
- The smoldering, slowly growing bulk load fire, with multiple layers of fuel, some of which is engaged in the fire and some of which is not, with several minutes needed for agent to reach all areas of the fire, does not represent a Propulsion fire scenario
  - Pools of fluid gather at low points in a compartment
  - Streams or sprays of droplets from damaged tubes or hoses, spraying or spilling fluid contents into the compartment
- The bulk load fire is not a realistic scenario for Propulsion, which is more accurately represented by the surface burning fire – or especially the Propulsion MPSE fire threats

Cargo Surface Burning Fire Scenario

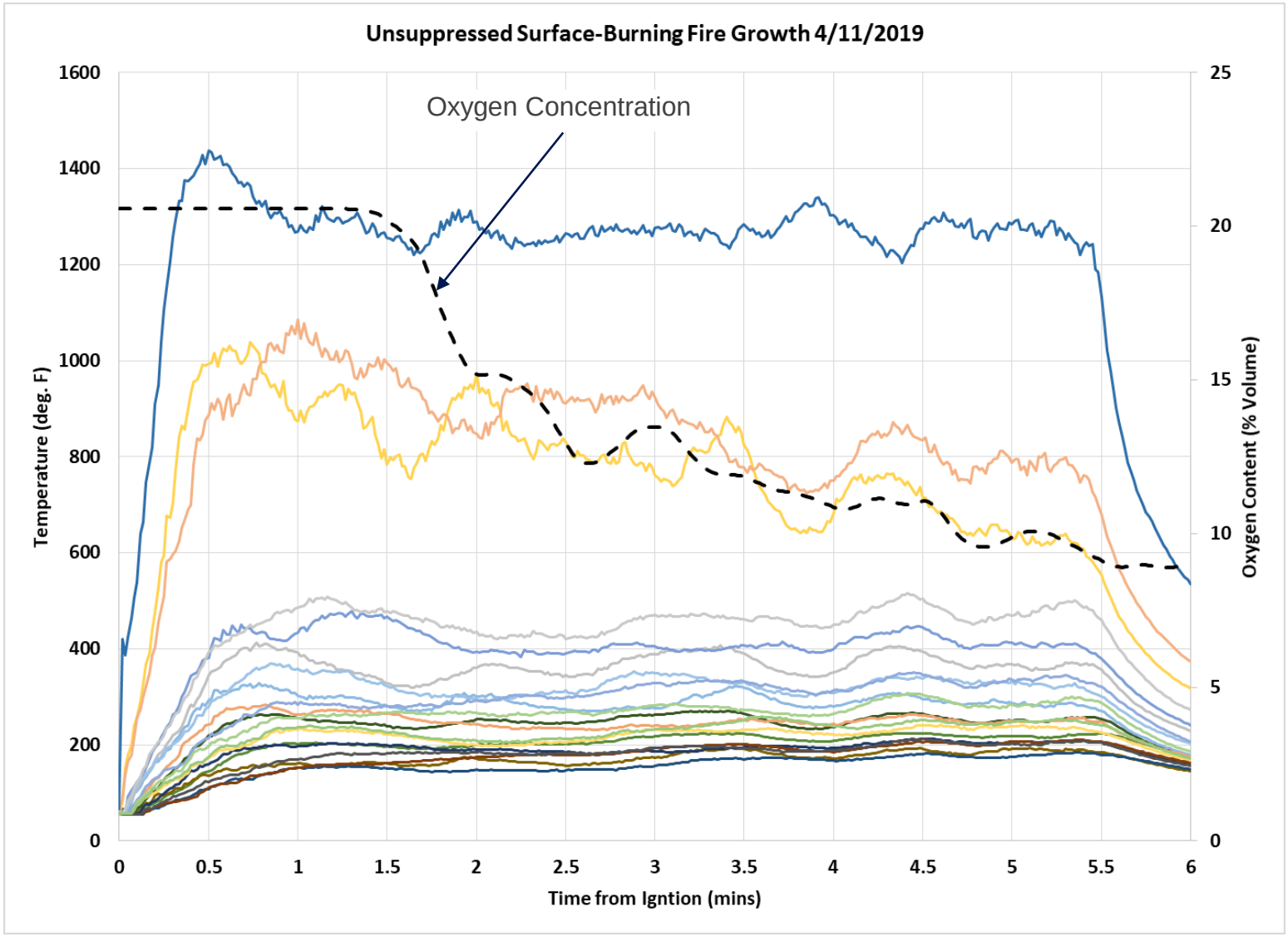


FAA "TC-10" Test Article

Cargo MPS Tests – Surface Burning Fire

- Pan with water (to protect pan from the heat), jet fuel and gasoline (to assist ignition)
- Located 12” from ceiling
- Spark igniter to start fire
- Application of Halon 1301 quickly extinguishes this fire
- This is the most similar fire in the Cargo MPS test series to a Powerplant MPS test

Surface Burning Fire

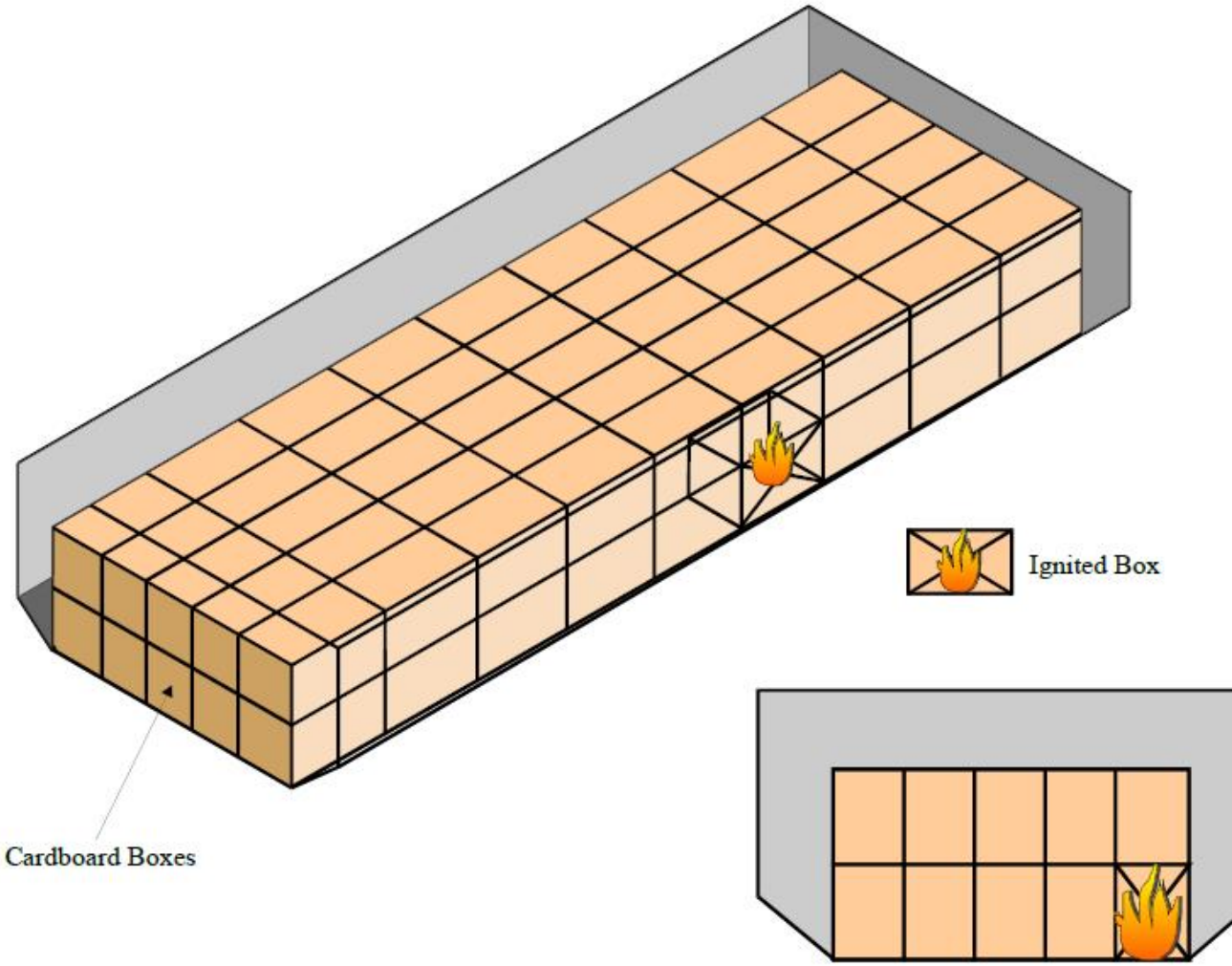


Surface Burning Fire – Fully Engaged

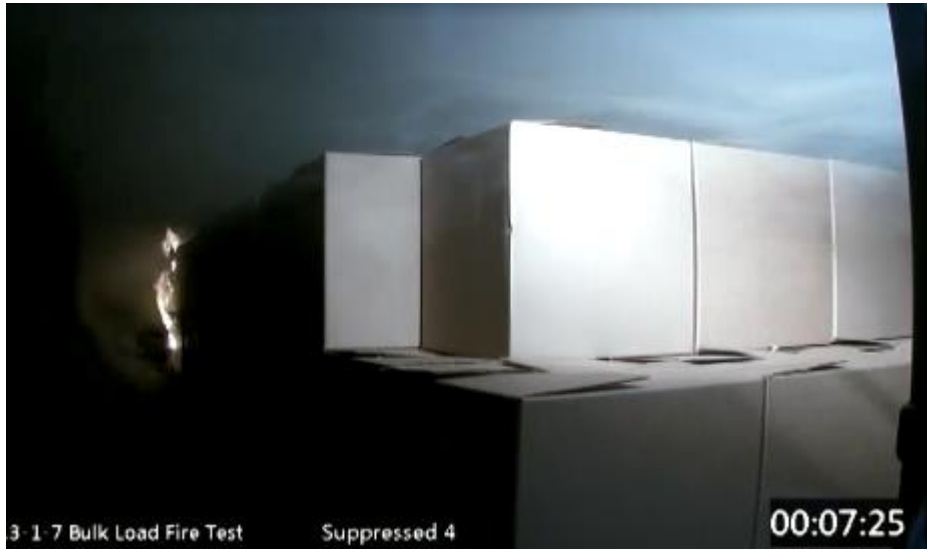
Entire exposed surface is involved in combustion

Adding fuel raises the level of the flame, but the full surface is still engaged

Bulk Load Fire Scenario

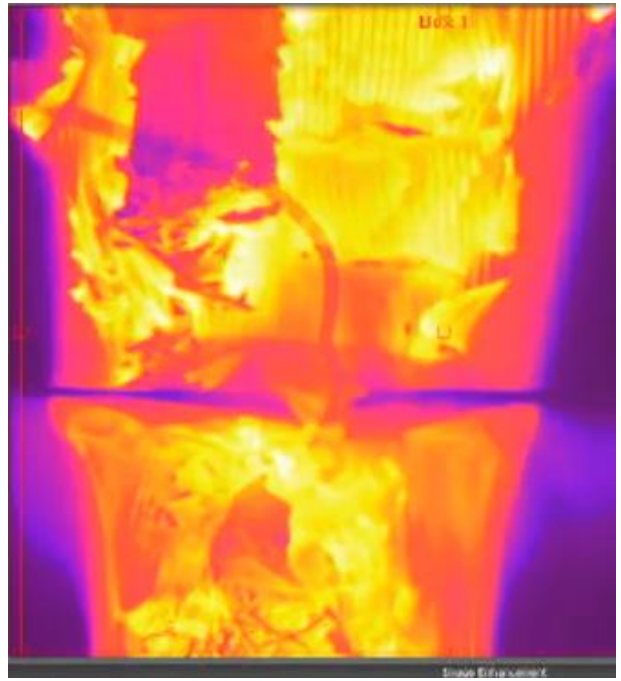


Cargo MPS Tests – Bulk Load Fire

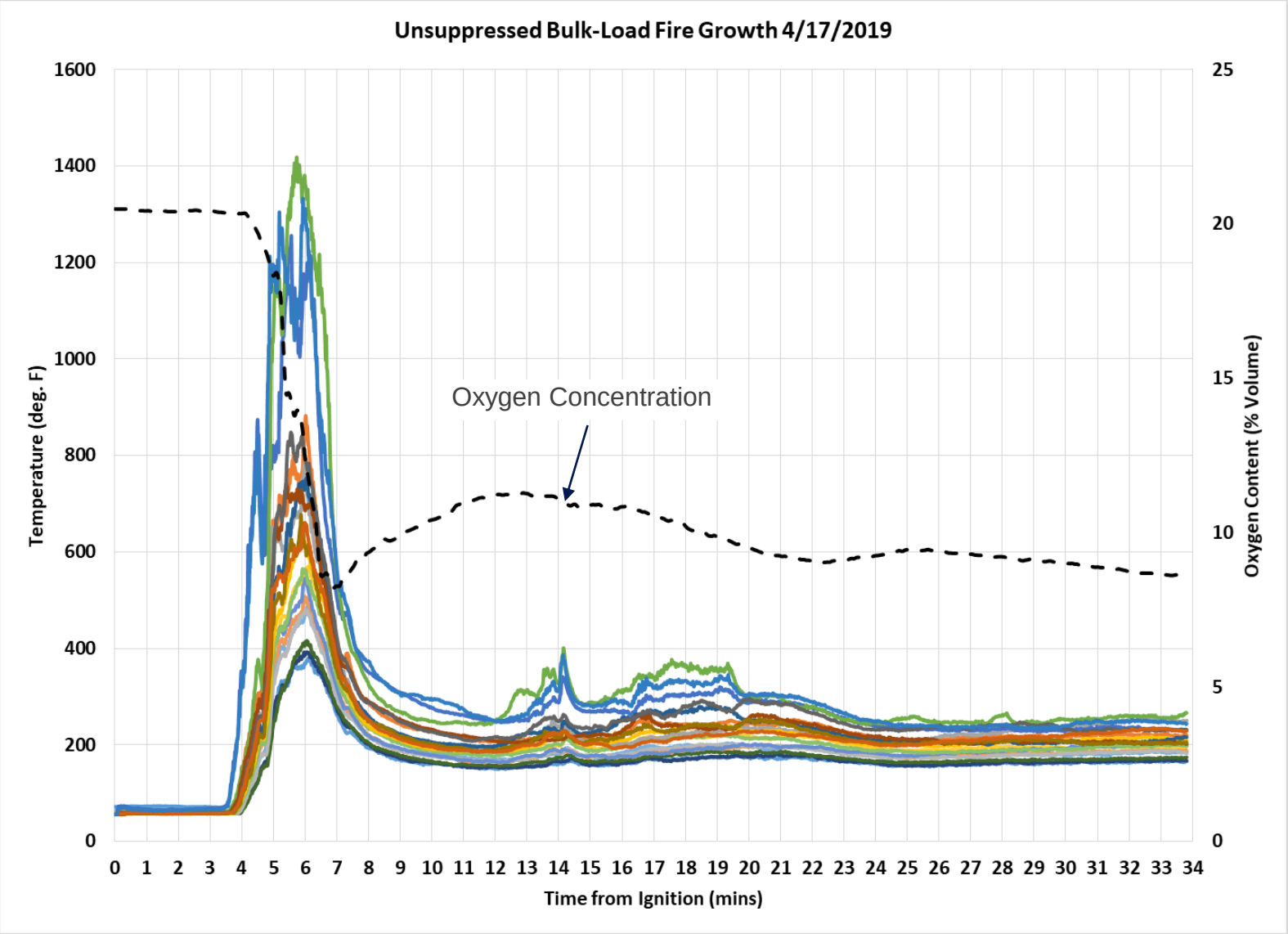


- These images are just prior to halon suppression during one of our test runs
- The ignition box and the one above it are in a flaming fire
- Application of Halon 1301 quickly knocks down flames and results in a smoldering suppressed fire

- 173 boxes (30% of volume) loaded in the compartment
- Ignition starts in a bottom outboard box
- The fire then spreads to adjacent boxes
- Suppression is delayed until 60 seconds after ceiling temperatures reach 200F, which creates a deep-seated, smoldering fire after halon suppression

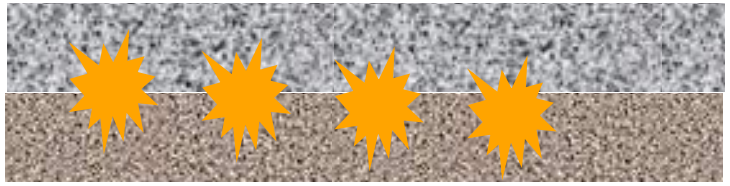


Bulk Load Fire – Typical Example



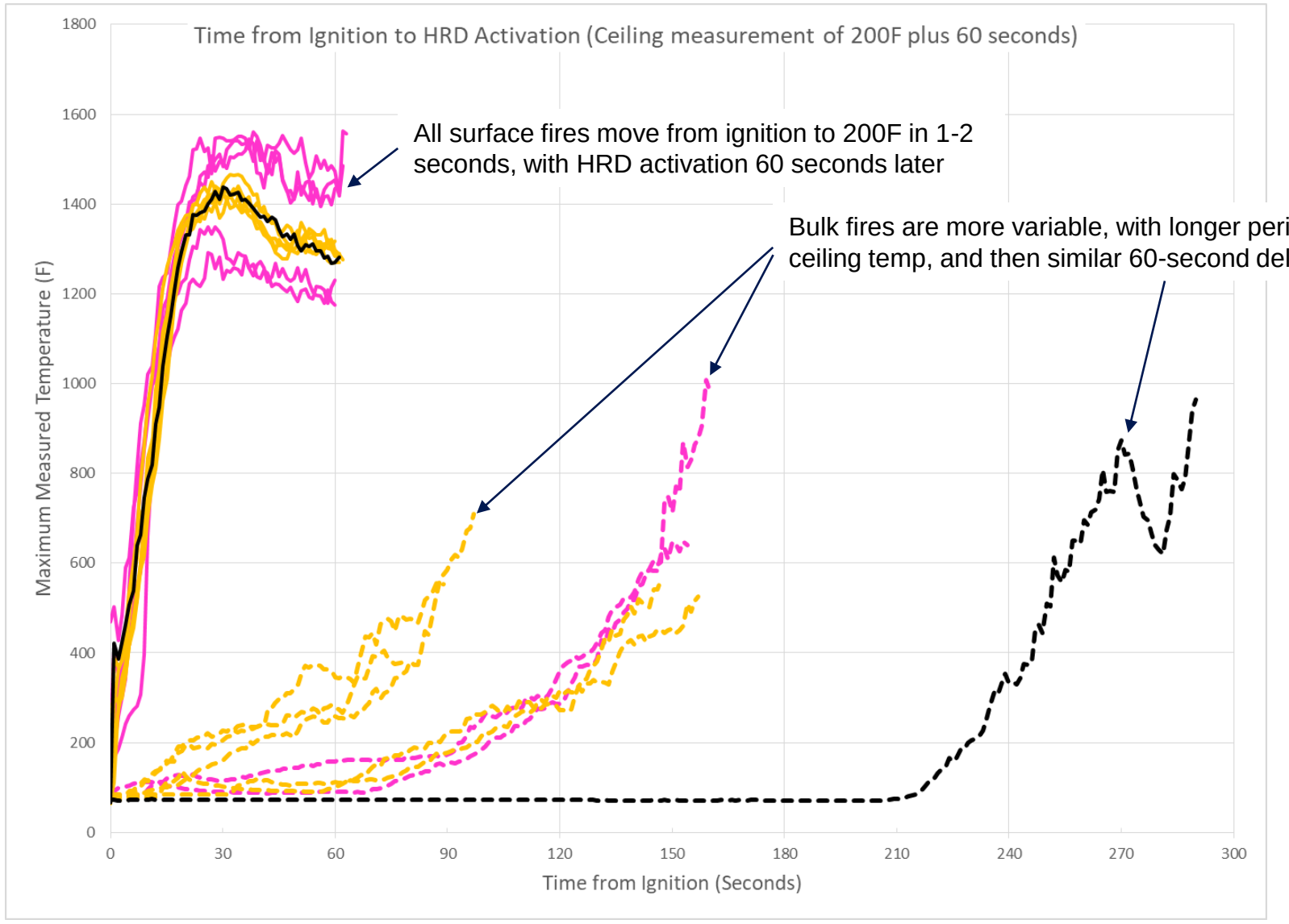
Bulk Load Fire – Not Fully Engaged

Flame may sit at the surface, but not fully spread or engage

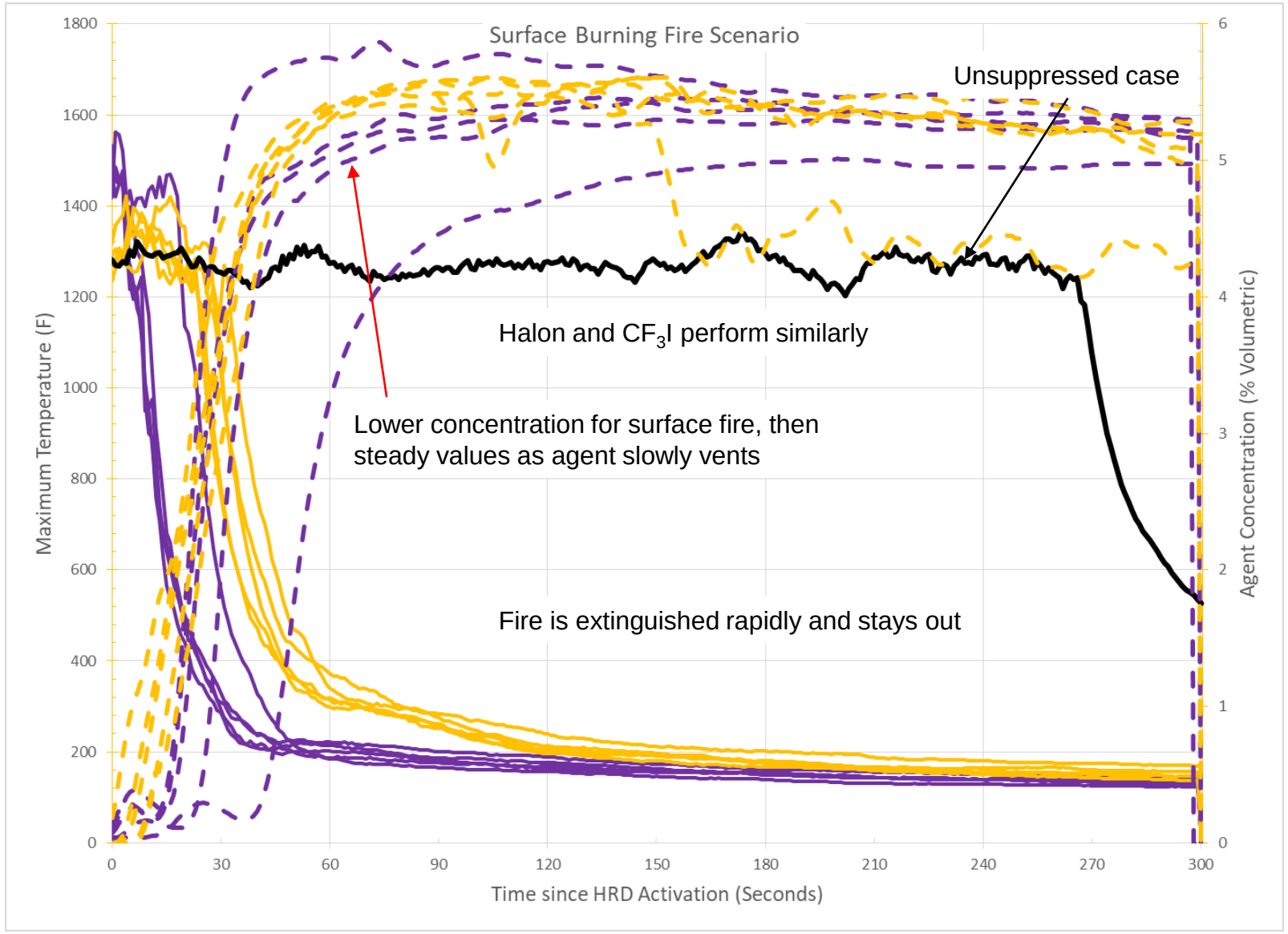


Fuel added on top may sit unengaged, or begin smoldering
Fire extinguishing agent may not encounter the flame front

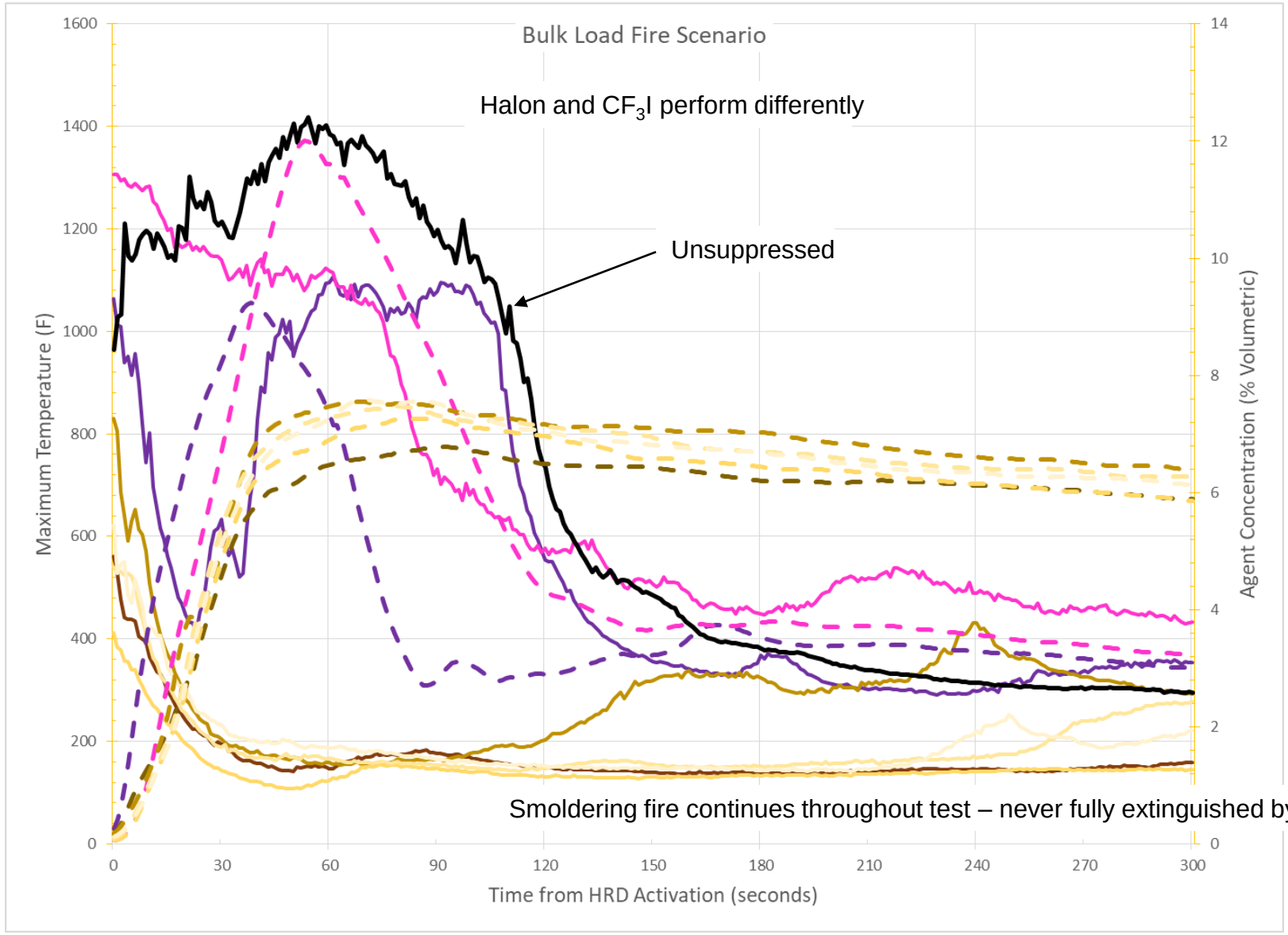
Fire Behavior from Ignition to Suppression Activation



Surface Burning Fires - Suppression



Bulk Load Fires - Suppression



Smoldering fire continues throughout test – never fully extinguished by either agent

Conclusions

- Cargo bulk load test is not representative of Propulsion fire scenarios
- Careful review of cargo testing and Propulsion testing reveals no threat of bulk-load style failure in an engine or APU application
- Bulk load scenario represents a deep-seated smoldering fire within a layered set of fuel, in which not all layers are involved, and combustion does not cover full extent of fuel load
- CF_3I is acceptable and safe for use in foreseeable Propulsion fire scenarios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