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A Review of FAA Aircraft Rescue and Firefighting (ARFF) Research Concerning Freighter Aircraft Fires

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Background

Philadelphia Int'l Airport

Memphis Int'l Airport - TN

Primary Research Objectives

- Provide better guidance to ARFF departments

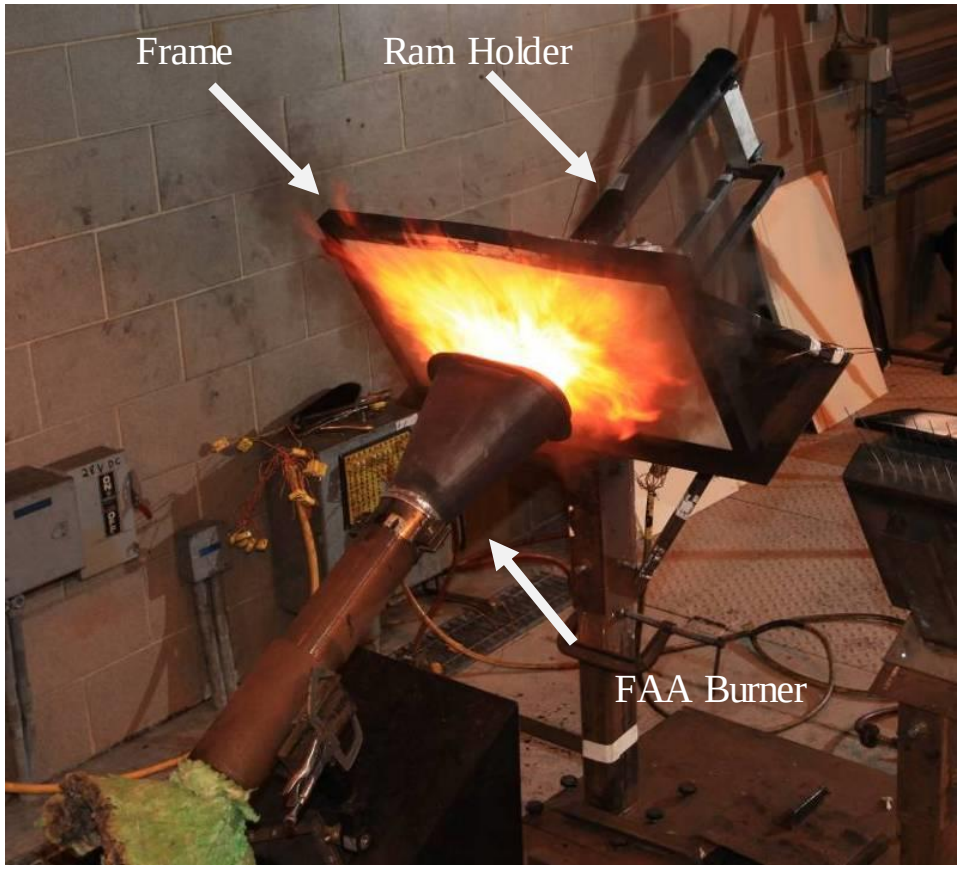
- Establish effective strategies and tactics for interior cargo fire fighting.

Obstacles Faced During Fire Response

Typical ARFF Vehicle at Airports

Cargo Liner Tests

- Objectives:
  - Effects of heat on material properties.
  - Response of mounting system during ASPN operations.

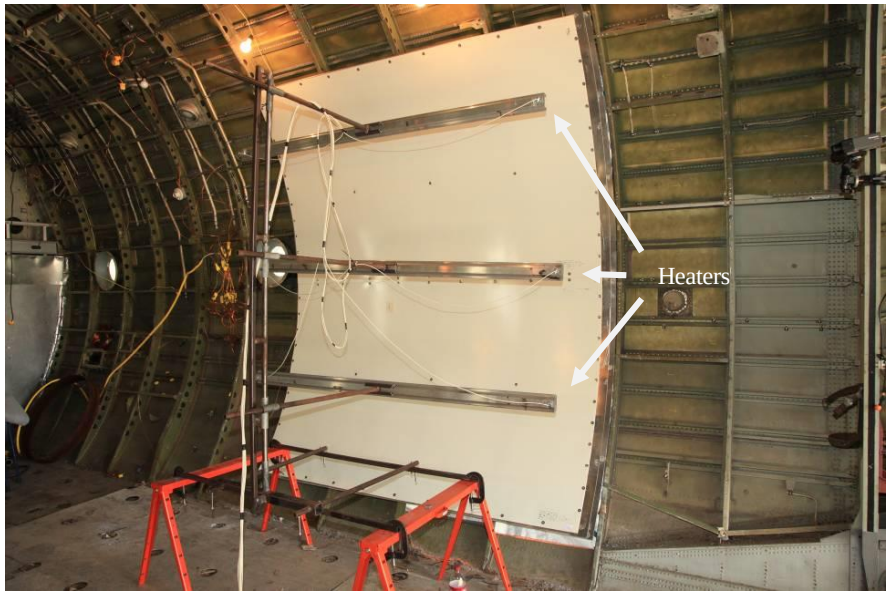


Cargo Liner Test Results

Cargo Liner Full-Scale Test Setup

C130 Test Article

- C130 section was modified to simulate a freighter aircraft including the mounting hardware used
- 3 ft. diameter fire ring with Tekflame fuel
- 3- 7.2kW electric heaters



Cargo Liner Full-Scale Tests- Results

Cargo Liner Tests Findings

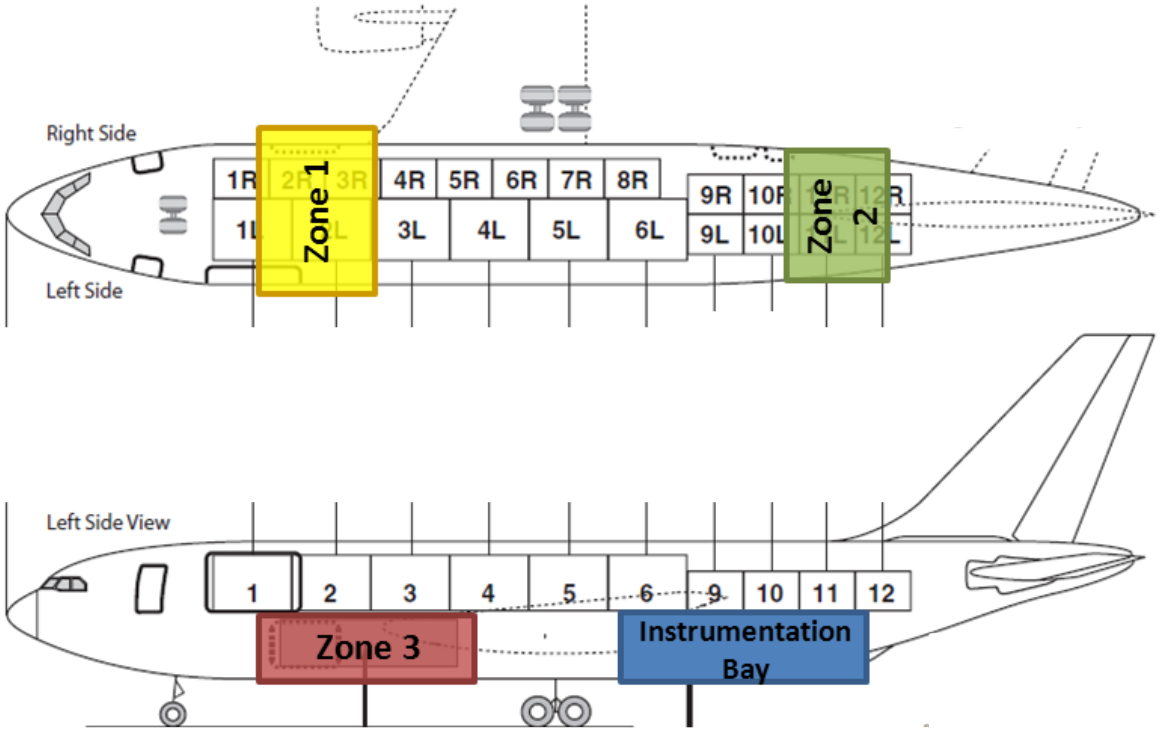
- The small-scale tests were able to determine the following:
  - Under ambient conditions, the ASPN had little trouble penetrating the cargo liner. Two thirds of the nozzle holes protruded through the liner. Test constraints prevented complete penetration of the liner.
  - The heated cargo liner would stretch when penetrated. The amount of stretch under test conditions was enough to block from three to seven of the nine holes on the nozzle, thus blocking 33-77% of the nozzle.

- The full-scale cargo liner tests were able to establish the following:
  - Under ambient conditions, cargo liner does not hinder penetration by an ASPN. The penetrator easily passes through the cargo liner and does not have issues with nozzle clearance.
  - Radiant heat allows the cargo liner to soften, but does not prevent ASPN penetration.
  - The majority of penetrations occurred without significantly obstructing the penetrator nozzle. Furthermore, if the penetrator reaches sufficient distance from the skin of the aircraft, then the penetration is likely to be successful even in the event of cargo liner detachment.

Full-Scale Tests- Test Article

Airbus A310

Full-Scale Tests-Test Zones



Full-Scale Tests- Test ULDs

Modified AAY ULD

LD3 ULD

AAY ULD

Pallet ULD

All ULDs were instrumented with K-type thermocouple

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Full-Scale Tests- Fire Load

- The fire load consisted of 2.5 ±0.2 pounds of single-cut shredded paper placed inside a 18X18X18 cardboard boxes
- AAY containers had 70 boxes.
- The modified half-width container had 35 boxes
- LD3 container had 32 boxes
- The pallet carried 48 boxes

Full-Scale Tests- Test Vehicles

Oshkosh Striker® 3000 with Oshkosh Snozzle® 652 HRET system

- A 65-foot boom with two high-flow turrets, a 45-foot horizontal reach
- ASPN with a flow rate of 345 GPM.
- Penetrating depth of 34 inches
- With the addition of an extension, it has a penetrating depth of 46 inches

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Full-Scale Tests- Test Vehicles

Rosenbauer Panther® 6X6 ARFF with Rosenbauer Stinger® HRET system

- 54-foot boom with a horizontal reach of 37.5 feet
- ASPN with a flow rate of 250 GPM
- Penetrating depth of 20.5 inches

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Full-Scale Tests- Test Scenario

Test Scenario	Type of Test	ULD Type	Nozzle/HRET Used	Test Zone
1	Oxygen Limitation	Full-width	N/A	1
2	Penetration	Half-width	Snozzle®	1
3	Penetration	Half-width	Extended Snozzle®	1
4	Penetration	Half-width	Stinger®	1
5	Penetration	Full-width	Stinger®	1
6	Penetration	Full-width	Extended Snozzle®	1
7	Indirect	Full-width	Stinger®	2
8	Indirect	Full-width	Snozzle®	2
9	Pallet - Indirect	Pallet	Snozzle®	2
10	Lower Cargo Compartment (Cheek Area)	LD3 Container	Stinger®	3
11	Indirect	Full-width	Prototype Nozzle	2

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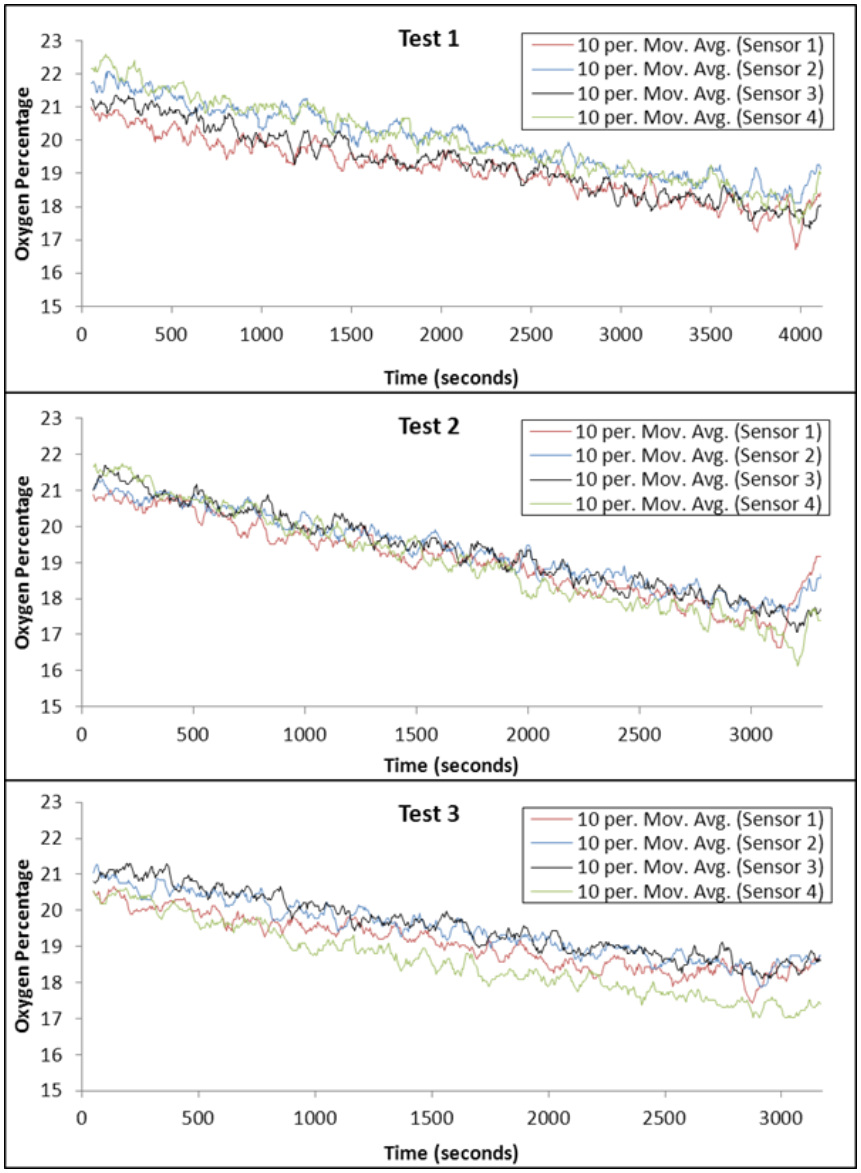
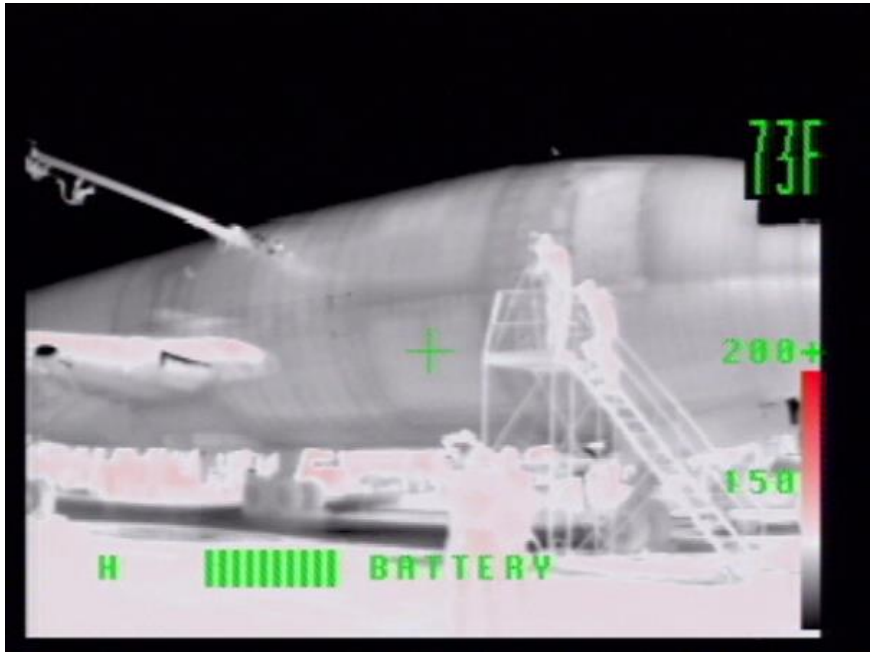
Full-Scale Test Overview

Oxygen Deprivation Test Results



Half-Width Penetration Results

Snozzle ASPN penetrating half-width ULD



Thermal image before extinguishment began

Half-Width Penetration Results

HRET	Test Duration	Water Used (gallons)	Maximum Temperature at Time of Discharge (°F)	Maximum Temperature at End of Discharge (°F)	Maximum Temperature 2 Minutes After Discharge (°F)
Snozzle®	22 m 48 s	575.0	756	119	100
Snozzle®	19 m 30 s	718.8	738	97	106
Snozzle®	18 m 58 s	517.5	987	252	226
Extended Snozzle®	18 m 29 s	345.0	634	160	112
Extended Snozzle®	18 m 38 s	345.0	951	105	100
Extended Snozzle®	25 m 47 s	373.8	989	191	128
Stinger®	18 m 46 s	375.0	595	101	126
Stinger®	18 m 52 s	375.0	874	209	235
Stinger®	23 m 59 s	375.0	891	258	334

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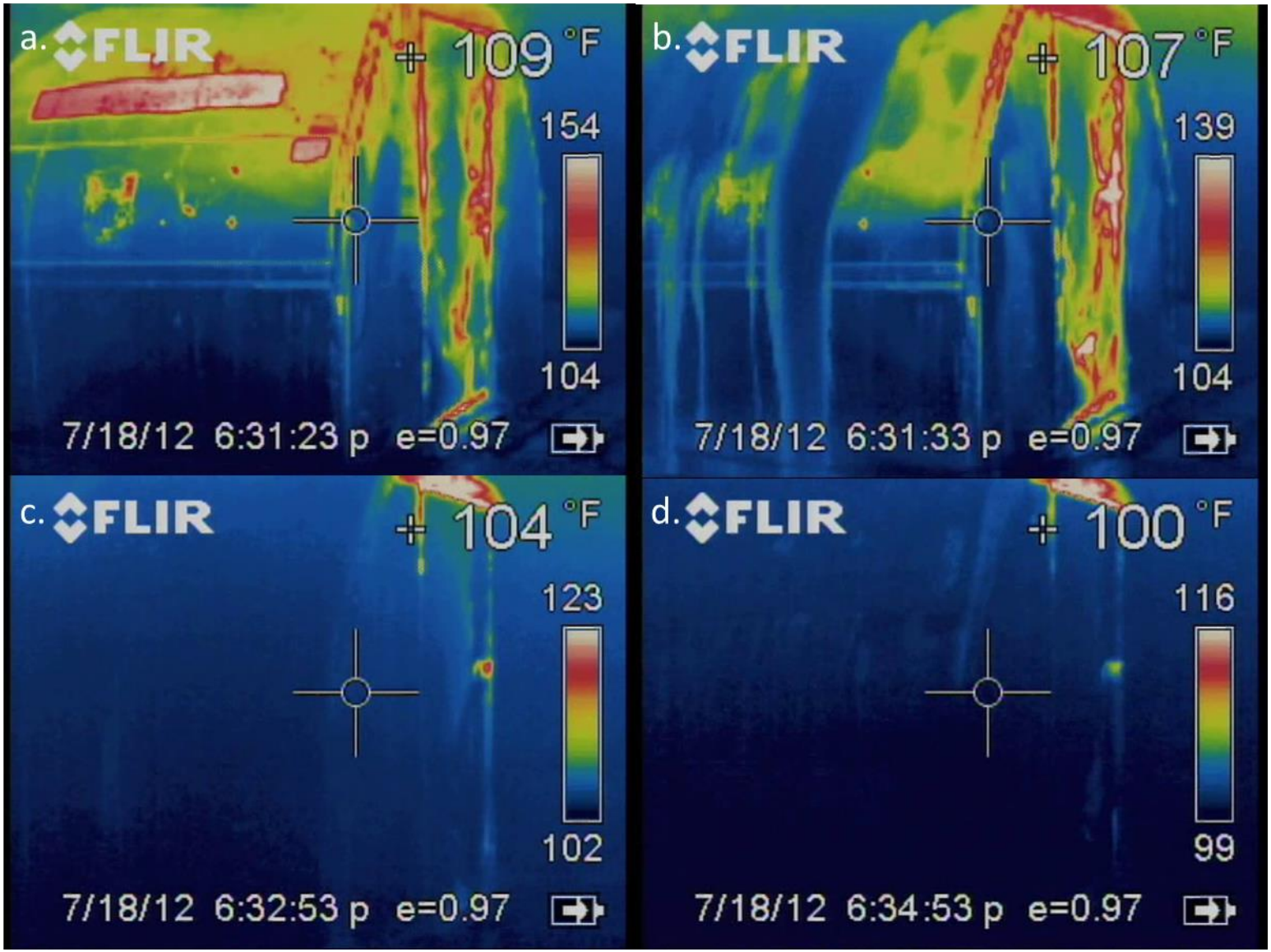
Full-Width Penetration Results



Full-Width Penetration Results

HRET	Test Duration	Water Used (gallons)	Maximum Temperature at Time of Discharge (°F)	Maximum Temperature at End of Discharge (°F)	Maximum Temperature 2 Minutes After Discharge (°F)
Stinger®	23 m 44 s	375.0	499	352	320
Stinger®	23 m 58 s	375.0	800	580	465
Stinger®	23 m 56 s	375.0	1060	341	278
Extended Snozzle®	19 m	517.5	455	165	138
Extended Snozzle®	24 m	517.5	572	109	109
Extended Snozzle®	19 m 21 s	517.5	1155	640	532

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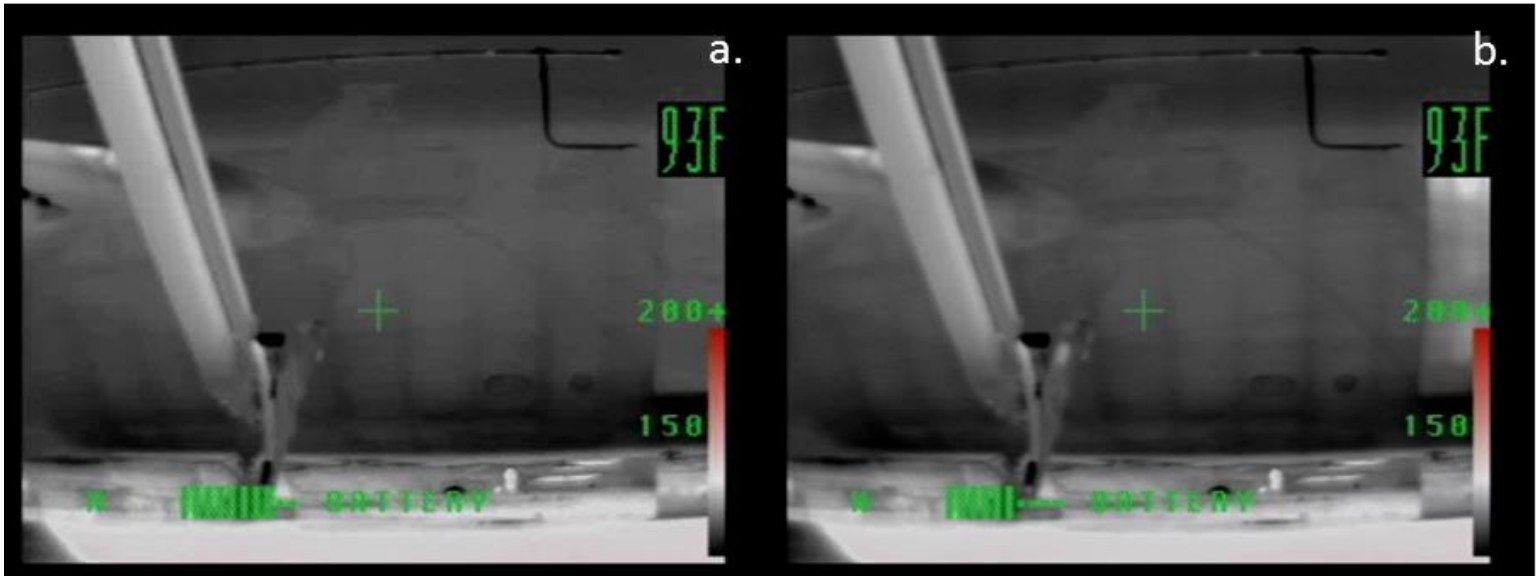
LD3 Penetration Test Results

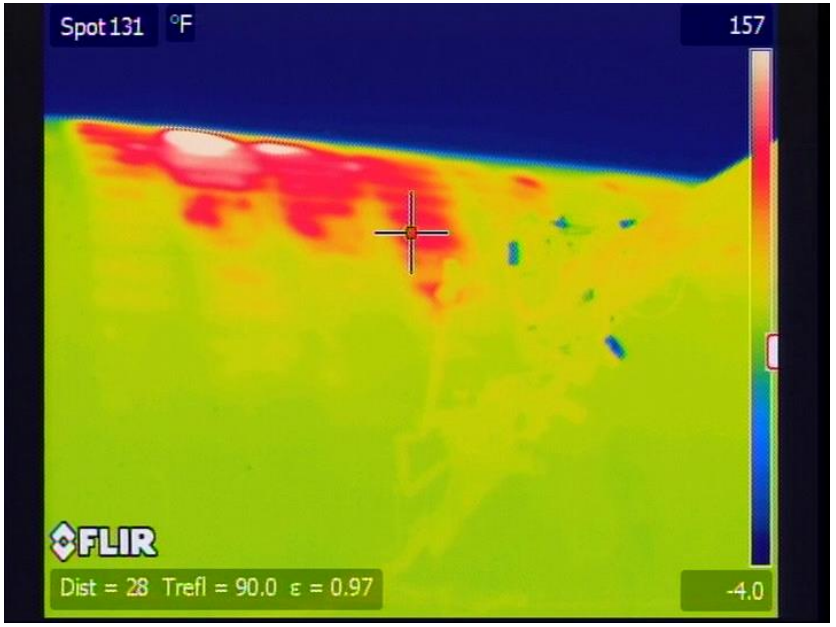


Thermal images at (a) t = 0 s and (b) t = 909 s

LD3 Penetration Test Results

HRET	Test Duration	Water Used (gallons)	Maximum Temperature at Time of Discharge (°F)	Maximum Temperature at End of Discharge (°F)	Maximum Temperature 2 Minutes After Discharge (°F)
Stinger®	29 m 02 s	387.5	546	424	382
Stinger®	29 m 30 s	500.0	875	850	636
Stinger®	19 m 21 s	750.0	922	737	590

Full-Width Indirect Penetration Results



FLIR images right before extinguishment began

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Full-Width Indirect Penetration Results

Indirect ULD Fire

ULD post-test condition

Full-Width Indirect Penetration Results

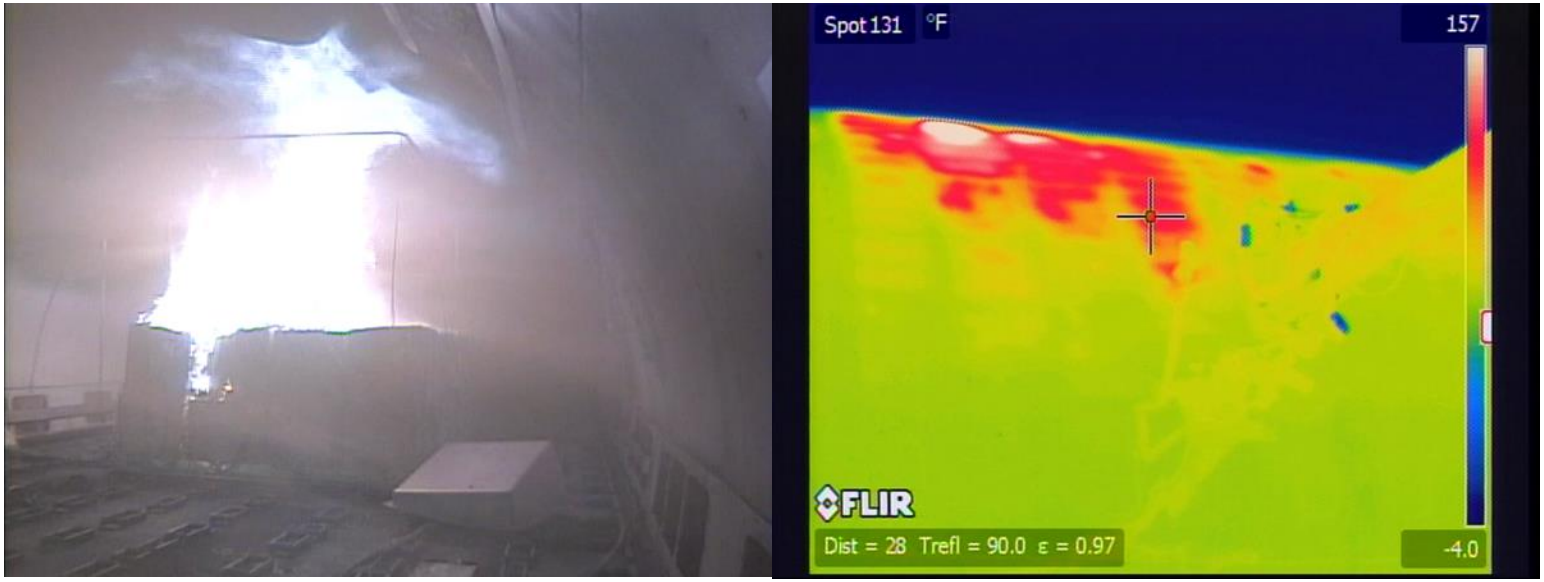
Snozzle® 651 ASPN Spray Pattern

Full-Width Indirect Penetration- Prototype Nozzle

HRET	Test Duration	Water Used (gallons)	Maximum Temperature at Time of Discharge (°F)	Maximum Temperature at End of Discharge (°F)	Maximum Temperature 2 Minutes After Discharge (°F)
Stinger®	6 m 09 s	395.8	1767	689	512
Stinger®	10 m 27 s	625.0	912	468	487
Stinger®	11 m 20 s	625.0	926	339	390
Snozzle®	6 m 30 s	609.5	688	536	569
Snozzle®	6 m 17 s	690.0	1013	833	830
Snozzle®	7 m 57 s	690.0	911	695	649
Prototype	6 m	517.5	1046	155	269
Prototype	6 m 6 s	690.0	1070	182	482
Prototype	7 m 17 s	724.5	1697	443	398

Pallet Fire Results

HRET	Test Duration	Water Used (gallons)	Maximum Temperature at Time of Discharge (°F)	Maximum Temperature at End of Discharge (°F)	Maximum Temperature 2 Minutes After Discharge (°F)
Snozzle®	30 m 7 s	753.3	1418	191	170
Snozzle®	7 m 36 s	730.3	1753	142	143
Snozzle®	6 m 41 s	690.0	1656	225	126



Interior and exterior images before extinguishment began

Full-Scale Test Findings

- Oxygen deprivation tests proved to be inconclusive. Although oxygen levels decreased in each test, an oxygen-deprived atmosphere (12% oxygen or less) was not achieved after at least 45 minutes of burning.

- All HRET piercing technologies successfully pierced through the aircraft, cargo liner, and test container when containers were adjacent to the interior fuselage wall. Once all piercing technologies penetrated the test container in the main cargo compartment, the ASPNs successfully controlled the fire inside the container.

- ASPNs with longer penetration depth provided better extinguishment efficiency when compared to their shorter depth counterparts. This was more apparent during lower cargo compartment penetration tests

Full-Scale Test Findings

- When commercially available ASPNs were used for an indirect attack, some water spray reached the test container, but small fires continued to burn inside the container when water discharge ended.

- FLIR and TIC cameras could not detect thermal signatures from the exterior of the aircraft unless fire was impinging directly on the fuselage skin or if the fuselage wall had no liner or insulation.

Questions?