

Review of Class E Cargo Compartments and Shipping Containers

Early Detection and Fire Suppression

Presented to: Ninth Triennial International Aircraft Fire and Cabin Safety Research Conference

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**Federal Aviation
Administration**

Overview

- Section 1 Background
- Section 2 Detection
- Section 3 Suppression
- Section 4 Future Work



Section 1

Background

- Multiple freighter fire accidents
 - Loss of lives
 - Loss of aircraft and cargo
- Led to NTSB recommendations regarding freighter detection and suppression



Section 2

Detection

- How cargo containers impact the airflow around the detection system
- Containment of smoke from a fire inside a container
- Options for container smoke detection systems
- Standardize system performance requirements for the early detection of fires originating within cargo containers



Detection

- FAA report on detection time of similar fire loads in either an empty or fully loaded cargo compartment
 - Fire initiated outside of containers
- Concluded the smoke detectors sounded quicker in loaded compartments than in empty compartments

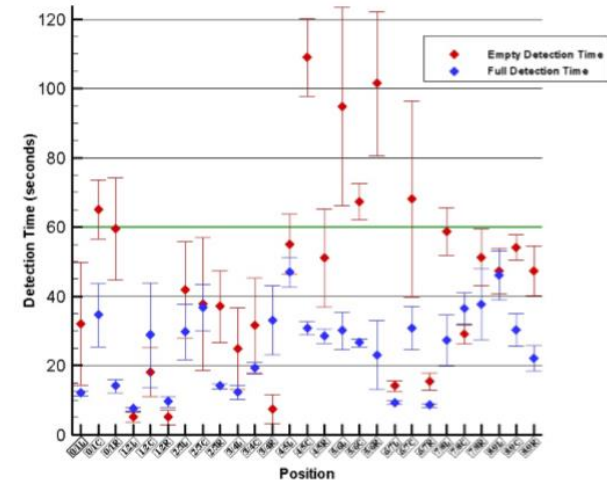


Figure 7. B-727 Empty and Full Test Results

• [DOT/FAA/AR-09/52 Effects of Cargo Loading and Active Containers on Aircraft Cargo Compartment Smoke Detection Times](#) December 2009



Detection

- NTSB report on the detection of fires originating within cargo containers and pallets
- Significant time delay from start of the fire inside the container to detection outside
- The growth of the fires after they become detectable can be extremely fast
- Concludes that significant damage to an aircraft can occur shortly after becoming a detectable fire



•[NTSB Burning characteristics of aircraft cargo containment fires](#) September 10, 2010



Detection

- Ongoing FAA/UMD research on emerging detection technology
 - Aspirating smoke detection (ASD)
 - Wireless detection



- ① ULD
- ② Whittaker detector
- ③ ASD sampling ports
- ④ Light obscuration meter
- ⑤ SGSA

- Smoke detection delay

- [The Scalability of Smoke Density and the Viability of New Detection Methods in Aircrafts](#) 20019



Detection

- FedEx Fire Suppression System
- Network of infrared thermal sensors
 - Pinpoint location of fire

- [FedEx Fire Suppression System](#) August 2, 2007
- [FedEx's Fire Suppression System ICAO](#)



Summary - Detection

- Shipping containers delay smoke detection
 - Detection delay allows for rapid fire growth
 - Potentially becomes a substantial threat
- There are currently no standardized system performance requirements for the early detection of fires originating within cargo containers



Section 3

Suppression

- Depressurization
- Recommendation to require that fire suppression systems be installed in the cargo compartment of all cargo compartments or containers
 - Containment
and/or
 - Passive/Active fire suppression
- Cost benefit analysis



Suppression

- FAA report on the effectiveness of depressurization for suppression
- Depressurization did not prevent flashover of class A fire loads

DOT/FAA/TC-17/39

Federal Aviation Administration
William J. Hughes Technical Center
Aviation Research Division
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Cargo Fire Suppression by Depressurization

November 2017

Final Report

This document is available to the U.S. public
through the National Technical Information
Services (NTIS), Springfield, Virginia 22161.

This document is also available from the
Federal Aviation Administration William J. Hughes
Technical Center at actlibrary.tc.faa.gov.



U.S. Department of Transportation
Federal Aviation Administration

• [Cargo Fire Suppression by Depressurization Presentation](#) October 2010



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Suppression

- FedEx Fire Suppression System
 - Remote Puncture Mechanism
 - Provides a method to apply agent to the inside of a container with no preflight attachment
- Cargo Foam®
 - Air
 - N2
 - Argon
 - Combination



• [FedEx Fire Suppression System](#) August 2, 2007

• [FedEx's Fire Suppression System ICAO](#)



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Relevant Work - Suppression

- FAA presentation on suppression agents ability to penetrate shipping containers when released outside
- Very little suppression agent penetrates inside ULDs



- [Class C Cargo Compartment ULD Suppression Agent Penetration](#) October 2015



Suppression

- FAA presentation on Class E cargo compartment mitigation strategies subjected to Class-A fires
- Oxygen starvation tests showed the Fire Containment Cover (FCC) and Fire Resistant Container (FRC) to be capable of suppressing a class-A fire for over 4 hours



•[Class-E Cargo Compartment Fire Mitigation Strategies Subjected to Lithium Battery Fires](#) October 2016



Suppression

- FAA presentation on Class E cargo compartment mitigation strategies subjected to lithium battery fires
- FCC and FRC were unable to contain bulk shipments of lithium metal or lithium-ion batteries
- Effective April 1 2016, ICAO banned shipment of lithium-ion batteries as cargo on passenger aircraft

Full Scale FCC Test
1,000 Lithium-Ion Battery Fire Load

Highlight Edit
5/3/2016

• [Class-E Cargo Compartment Fire Mitigation Strategies Subjected to Lithium Battery Fires](#) October 2016



Suppression

- A cost-benefit analysis for the installation of fire suppression systems in cargo compartments of cargo planes is conducted
- Halon and likely alternative fire suppression systems are unlikely to be cost beneficial for the main deck cargo compartments of cargo aircraft of any weight category
- However, other fire suppression systems may prove to be cost beneficial

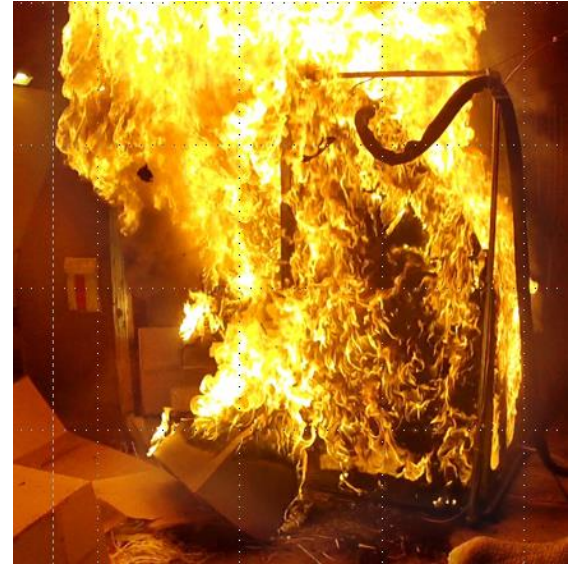
Weight Category	Average Benefit per Aircraft per Year	Total Cost per Aircraft per Year	Cost Benefit Ratio
B	NEGLIGIBLE	\$50,791	N/A
C	\$640	\$156,053	244
D	\$4,100	\$290,182	71
E	\$19,900	\$446,008	22

•[DOT/FAA/AR-09/17 A Cost-Benefit Analysis for the Installation of Fire Suppression Systems in Cargo Compartments of Cargo Airplanes](#) April 2009



Summary - Suppression

- Guidelines of depressurization for Class-E cargo compartments is ineffective
- Fire suppression of cargo compartments and shipping containers is multifaceted and complex
 - Containment
 - Active/passive fire suppression systems
 - Fire load
 - Class-A
 - Hazardous materials



Future Work

- Survey airframe manufacturers and cargo operators on currently applied methods for detection and suppression in cargo compartments and containers
- Consider creating task groups for:
 - Early Detection of Fires in Shipping Containers
 - Suppression in Class E Cargo Compartments and Shipping Containers



References

- [NTSB A-07-97 through - 103](#) December 17, 2007
- [DOT/FAA/AR-09/52 Effects of Cargo Loading and Active Containers on Aircraft Cargo Compartment Smoke Detection Times](#) December 2009
- [A-07-098 Dialogue](#)
- [NTSB Burning characteristics of aircraft cargo containment fires](#) September 10, 2010
- [14 CFR 25.858](#)
- [Cargo Fire Suppression by Depressurization Presentation](#) October 2010
- [DOT/FAA/AR-09/17 A Cost-Benefit Analysis for the Installation of Fire Suppression Systems in Cargo Compartments of Cargo Airplanes](#) April 2009
- [A-07-99 Dialogue](#)
- [Class E Cargo Compartment Fire Suppression](#) November 17-18, 2009
- [FedEx Fire Suppression System](#) August 2, 2007
- [ULD Fire Suppression Certification](#) May 11, 2011
- [NTSB A-12-68 Through -70](#) November 28, 2012
- [The Scalability of Smoke Density and the Viability of New Detection Methods in Aircrafts](#) 2019
- [A-12-068 Dialogue](#)
- [Class-E Cargo Compartment Fire Mitigation Strategies Subjected to Lithium Battery Fires](#) October 2016
- [FAA Update at the SAE-AGE2 Fire Containment Covers & Fire Resistant Containers](#) May 2019
- [The Use of ULD Contained Suppression for Hazardous Air Cargo - Firetrace International](#) May 2012
- [Class C Cargo Compartment ULD Suppression Agent Penetration](#) October 2015
- [A-12-069 Dialogue](#)



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