



# Cargo Compartment Fire Containment Characteristics

ICAO Multidisciplinary Cargo Safety Group  
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# Cargo Compartment classifications

**Annex 8** is setting design standards based on the accessibility of the cargo compartment to a crew member :

- Each cargo compartment accessible to a crew member in a passenger-carrying aeroplane shall be equipped with a fire suppression system
- each cargo compartment not accessible to a crew member shall be equipped with a built-in fire detection system and a built-in fire suppression system

Accordingly, **certification standards** (e.g. FAA Part 25 of EASA CS-25) are defining Cargo compartment classifications:

- **Class A** and **Class B** are cargo compartments accessible to a crew member
- **Class C** and **Class D** are cargo compartments not accessible to a crew member
- **Class E** are are cargo compartments on aeroplanes used only for the carriage of cargo
- **Class F** is a cargo compartment located on the main deck and fitted with means to extinguish or control a fire without requiring a crewmember to enter the compartment



# Cargo Compartment Fire Suppression: General Design Principles

- For certification cargo compartments having to show compliance with different performance standards, no full proof performance test required.
- Cargo compartment fire suppression systems have to be designed against a fire probability of  $1E-7$  per flight hour.
- The design standards are based on fires likely to occur.
  - Mainly class A fire loads: combustible materials such as wood, cloth, paper, rubber, and plastics.
- For not accessible cargo compartments (Class C, D, E) the design principle is to suppress / contain a fire for the rest of the flight, not to extinguish.
- ....



# Transport of Cargo

The main two cargo compartments standards used on large aeroplanes for the transport of cargo (and passenger baggage) are so called **"Class C"** and **"Class E"**

## Freighter Aircraft Only



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**Main Deck Cargo Compartment  
"Class E"**

## Passenger Aircraft



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**Lower Deck Cargo Compartment  
"Class C"**



# Cargo Compartment Fire Protection

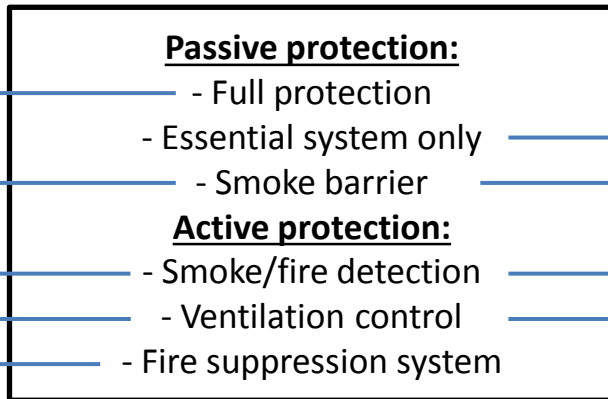
1. **Prevention** → by regulating the load and condition of transport.
2. **Protecting** the outside of compartment from internal hazards created by fire → e.g. heat and fumes/smoke.
3. **Controlling** the fire → combination of active & passive means.

⇒ “Class C & E cargo” cargo compartments acc. to FAR/CS25.857 have different mechanisms

**Lower Deck Cargo Compartment “Class C”**



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**Main Deck “Class E” Cargo Compartment**



“Class E” is for freighter only!

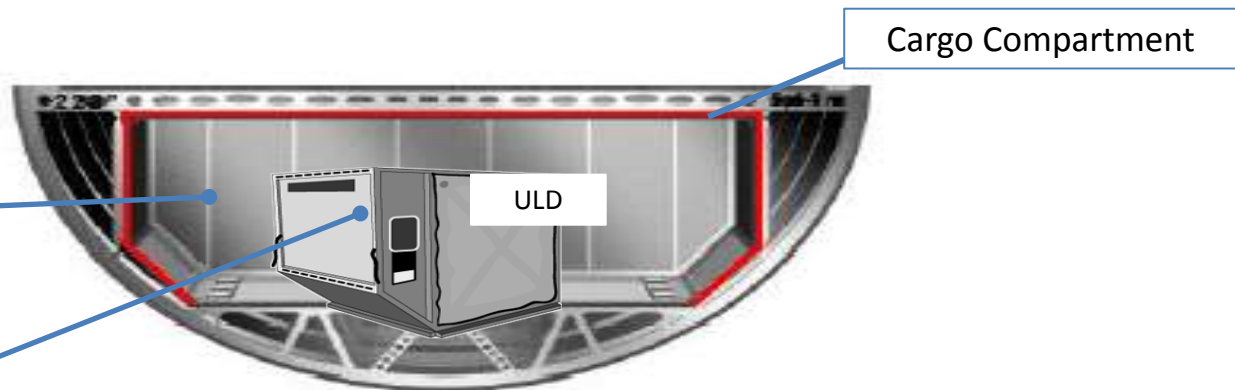
ICAO CSG



# General Cargo Compartment Fires Containment

Fire needs to be detected and controlled at cargo compartment level

It is not required to detect / control a fire at unit load device level



- Delay of fire/smoke detection on aircraft level is expected\*
- Penetration of fire suppression agent from cargo compartment into a unit load device can't be assumed\*\*

\*NTSB Safety Recommendation A-16-001-002

\*\*FAA TechCenter ULD Suppression Agent Penetration Test, May 2015



# Cargo Compartment Classification & Required Performance Standards

The table is listing the performance standards which have to be met by the different cargo compartment classes

Required Design Standards	Description	Class C §25.857(c)	Class E §25.857(e)	Class B §25.857(b)	** Class D §25.857(d)
Fire/Fire Detection §25.858	- Detection within 1min (former TC 5min) - The system must be capable of detecting a fire ... significantly below ... structural integrity of the aeroplane is substantially decreased	X	X	X	-
Built-in Fire Extinguishers §25.851(b) / §25,855(h)	The capacity of ... built-in fire extinguishing system must be adequate for any fire likely to occur ... considering the volume of the compartment and the ventilation rate.	X	-	-	-
Smoke Penetration AC 25-9A / §25,855(h)	No hazardous quantity of smoke or extinguishing agent into occupied compartments. Smoke should be generated until the compartment is completely filled with smoke. Hand within 18 inches cannot be seen	X	X	X	X
Passive Protection §25,855(c)	Ceiling and sidewall liner panels have to be tested again 927°C for 5 min.	X	* -	-	X

\* Only protective covers for equipment to allow continued safe flight and landing. \*\* Class D CC not allowed under FAA approval , no production anymore



# Critical Cargo Compartment Functions

## Passive Protection:

e.g. “Class C” cargo compartment lining  
⇒ has to be tested against **927°C for 5min**

Acc. to Part III Appendix F (CS/FAR 25)

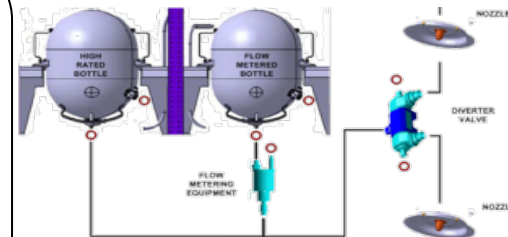


## Active Protection (Class C only):

Fire suppression system (e.g. **Halon 1301**)

The required design concentration has to be controlled until end of flight.

CS/FAR 25.857; AMC/AC 25.851

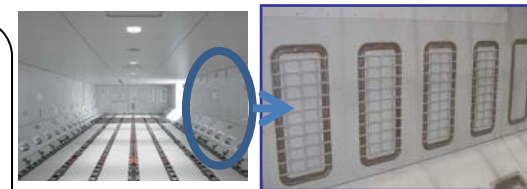


*Note: Class E suppression based on procedure for oxygen starvation*

## Rapid Decompression Features (Class C only):

Panels or other features that open at a specific pressure differential to prevent over pressurization

CS/FAR 25.365







# Critical Cargo Compartment Functions

## Detection:

Smoke/fire detection system.

Fire has to be detected after 1min (for older type certifications it's 5min)

And before significant structural damages

Acc. to CS/FAR 25.857, 25.858

## Smoke Barrier

Protects occupied areas against hazardous quantity of fumes and smoke from typical cargo compartments fires.

- Uses passive barriers and active air control functions.

CS/FAR 25.857; verification means AC 25-9A





# Summary Different Cargo Compartment Performances

The following table relates to a cargo load likely to occur

	Class C	Class E	Class B	Class D
Fire Detection	Smoke detection	Smoke detection	Smoke detection	No Detection
Crew Action	Push button	Set FL 200/250	Hand held fire Ex.	No Action
Aircraft fire fighting means	Built- in fire suppression system	Flight level procedure, reducing oxygen partial pressure	Active fire fighting via hand held extinguisher	Isolation
Fire Fighting Principle	Fire suppression via Inhibition (Halon 1301)	Oxygen starvation	Extinguishing	Fire Containment and Oxygen consumption
Conditions	Until end of flight	Increase of oxygen partial pressure during decent phase	Monitoring	Gradual Increase of oxygen partial pressure during decent phase
Expected steady-state conditions	Cargo Compartment temperature > 200°C	Similar condition as class C cargo	Extinguished	Smoldering fire , depend on oxygen concentration left

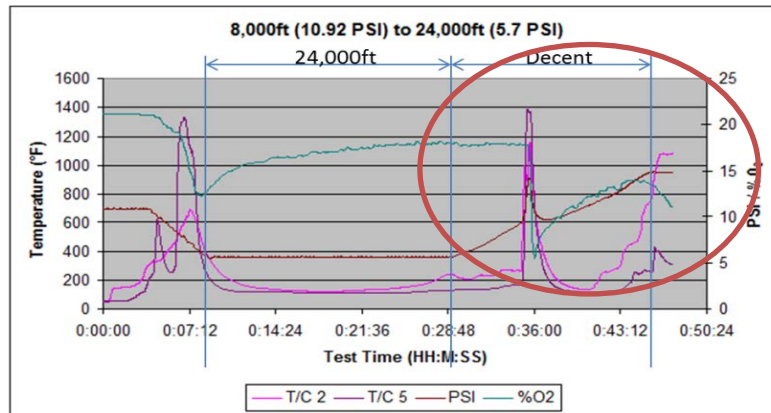
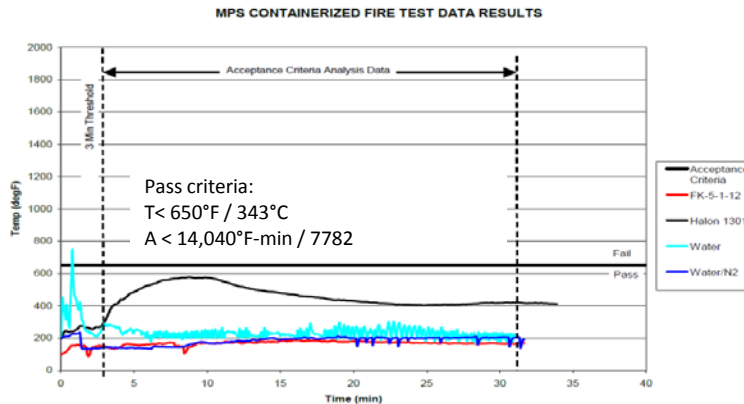


# General Characteristics of Cargo Compartment Fires

Fire has to be suppressed not extinguished!  
Test have shown cargo compartment temperature of a suppressed fire could be far above 200°C

Class E Cargo Compartment

It is assumed that a suppressed fire, containing enough energy, inside a "class E" cargo compartment will re-ignite during the decent phase.





**THANK YOU!**