

# The History of Cargo Compartment Fire Protection in Transport Aircraft

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# 1965 25.855 Cargo compartment requirements

- **Cargo compartments must meet one of the class requirements of Title 14 Code of Federal Regulations (CFR) Sec. 25.857.**
  - <http://www.ecfr.gov/>
- **Flight tests to demonstrate extinguishing system and smoke, gas exclusion.**



# 1965 25.857 Cargo Compartment Classification

- ***Class B.*** (1) Sufficient access in flight for crew to effectively reach any part of the compartment with the contents of a hand fire extinguisher;  
(2) No hazardous quantity of smoke, flames, or extinguishing agent, will enter any compartment occupied by the crew or passengers;  
(3) Smoke detector or fire detector system  
(4) There is a fire-resistant lining.



# 1965 25.857 Cargo Compartment Classification

- **Class C. (1) There is a separate approved smoke detector or fire detector system.**  
**(2) There is an approved built-in fire-extinguishing system**
- **(3) Exclude hazardous quantities of smoke, flames, or extinguishing agent, from crew or passengers;**  
**(4) Control ventilation and drafts within the compartment so that the extinguishing agent used can control any fire that may start within the compartment; and**  
**(5) There is a fire-resistant lining.**



# 1965 25.857 Cargo Compartment Classification

- ***Class D.*** (1) A fire occurring in it will be completely confined without endangering the safety of the airplane or the occupants;  
(2) Exclude hazardous quantities of smoke, flames, or other noxious gases, from the crew or passengers;  
(3) Ventilation and drafts are controlled within each compartment so that any fire likely to occur in the compartment will not progress beyond safe limits;  
(4) There is a fire-resistant lining; and  
(5) Consideration is given to the effect of heat within the compartment on adjacent critical parts of the airplane.  
For compartments of 500 cu. ft. or less, an airflow of 1500 cu. ft. per hour is acceptable.



# 1965 25.857 Cargo Compartment Classification

- ***Class E.*** On airplanes used only for the carriage of cargo and in which--
  - (1)** There is a fire-resistant lining;
  - (2)** There is a separate approved smoke or fire detector system;
  - (3)** There are means to shut off the ventilating airflow to, or within, the compartment;
  - (4)** There are means to exclude hazardous quantities of smoke, flames, or noxious gases, from the flight crew; and
  - (5)** The required crew emergency exits are accessible under any cargo loading condition.



# 1965 25.851 Fire extinguishers

- ***Built-in fire extinguishers.*** If a built-in fire extinguishing system is required--
  - (1) The capacity of each system, in relation to the volume of the compartment where used and the ventilation rate, **must be adequate for any fire likely to occur in that compartment**; and
  - (2) Each system must be installed so that--
    - (i) No extinguishing agent likely to enter personnel compartments will be hazardous to the occupants



- **Mid 1960's large transport aircraft used Class D, no Class C compartments.**
- **<https://www.fire.tc.faa.gov/pdf/rd7042.pdf>**
- **Wide body aircraft late 60's early 70's required to use Class C for compartments larger than 2000 cubic feet.**
- **Halon 1301 was accepted as agent.**
- **Requirements: 5% knock down, 3% duration of flight. -Testing on class A materials.**
- **<https://www.fire.tc.faa.gov/pdf/rd71-68.pdf>**



- **Pan American World Airways Clipper Flight 160,**
- **B707 Cargo Aircraft - Boston, Logan Airport**
- **PROBABLE CAUSE: The presence of smoke in the cockpit which was continuously generated and uncontrollable. Source of the smoke could not be established conclusively, the National Transportation Safety Board (NTSB) believes that the spontaneous chemical reaction between leaking acid, improperly packaged and stowed, and the improper sawdust packing surrounding the acid's package.**
- **Operational changes were made post accident.**
- **<http://aviation-safety.net/database/record.php?id=19731103-1>**



- **August 19, 1980, Saudi Arabian Airlines, Flight 163, Lockheed L-1011, HZ-AHK, Riyadh, Saudi Arabia**
- **Cargo fire in-flight in Class D compartment from unknown source. All 301 passengers and crew members died in the accident.**
- **[http://lessonslearned.faa.gov/ll\\_main.cfm?TabID=1&LLID=27](http://lessonslearned.faa.gov/ll_main.cfm?TabID=1&LLID=27)**
- **Post accident testing showed problems with liner requirements.**
- **<https://www.fire.tc.faa.gov/pdf/faa82-156.pdf>**
- **New liner test developed and required**



# 1986 25.855 Cargo compartment requirements

- **Ceiling and sidewall liner panels of Class C and D compartments must meet the test requirements of Part III of Appendix F of this Part or other approved equivalent methods.**



# 1986 25.857 Cargo Compartment Classification

- **Class D: The compartment volume does not exceed 1,000 cubic feet.  
For compartments of 500 cu. ft. or less, an airflow of 1500 cu. ft. per hour is acceptable.**



- **November 28, 1987, South African Airways Flight 295, Mauritius, Indian Ocean**
- **Cargo fire in-flight in Class B cargo compartment on “Combi” aircraft. All 159 passengers and crew members died in the accident.**
- **[http://lessonslearned.faa.gov/ll\\_main.cfm?TabID=1&LLID=33](http://lessonslearned.faa.gov/ll_main.cfm?TabID=1&LLID=33)**
- **Testing showed changes needed to Class B concept.**
- **<https://www.fire.tc.faa.gov/pdf/96-5.pdf>**
- **Post accident changes made to class B compartments, Combi aircraft compartments changed to class F.**



- **May 11, 1996, ValuJet Airlines Flight 592, McDonnell Douglas Model DC-9-32, N904VJ, Everglades, Near Miami Florida**
- **Cargo fire in-flight in Class D compartment of passenger aircraft. All 110 passengers and crew members died in the accident.**
- **The NTSB determined the fire was initiated by the actuation of one or more chemical oxygen generators which were being improperly carried as cargo.**
- **[http://lessonslearned.faa.gov/ll\\_main.cfm?TabID=1&LLID=10](http://lessonslearned.faa.gov/ll_main.cfm?TabID=1&LLID=10)**
- **Post accident testing showed limitation of Class D compartments and problems with dangerous goods carried.**
- **Post accident changes in the U.S. include: Elimination of Class D cargo compartments, Over-packs for oxygen transport and the development of a minimum performance standard for cargo fire suppression systems.**
- **<https://www.fire.tc.faa.gov/pdf/00-28.pdf>**



# 1990 25.855 Cargo compartment requirements

- **Ceiling and sidewall liner panels of Class C compartments must meet the test requirements of Part III of Appendix F of this part or other approved equivalent methods.**



# 1989 121.314 Cargo and baggage compartments

- **After March 20, 1991, each Class C or D compartment, as defined in § 25.857 of Part 25 of this Chapter, greater than 200 cubic feet in volume in a transport category airplane type certificated after January 1, 1958, must have ceiling and sidewall liner panels which are constructed of:**
  - (1) Glass fiber reinforced resin;**
  - (2) Materials which meet the test requirements of Part 25, Appendix F, Part III of this Chapter; or**
  - (3) In the case of liner installations approved prior to March 20, 1989, aluminum.**



# 1998 121.314 Cargo and baggage compartments

- **After March 19, 2001, each Class D compartment, regardless of volume, must meet the standards of Secs. 25.857(c) and 25.858 of this Chapter for a Class C compartment unless the operation is an all-cargo operation in which case each Class D compartment may meet the standards in Sec. 25.857(e) for a Class E compartment.**



- **DC10-10CF, N68055, NEWBURGH/STEWART, NEW YORK, U.S.A., 05-SEP-1996** [https://www.fire.tc.faa.gov/adb/adb/ADBview\\_text.asp?REF=19960905B](https://www.fire.tc.faa.gov/adb/adb/ADBview_text.asp?REF=19960905B)
  - **DC8-71F, N748UP, PHILADELPHIA, PENNSYLVANIA, U.S.A., 07-FEB-2006** <https://www.fire.tc.faa.gov/ADB/adb/ADBview.asp?REF=20060207A>
  - **B747-44AF, N571UP, DUBAI, UNITED ARAB EMIRATES, 03-SEP-2010** [https://www.fire.tc.faa.gov/ADB/adb/ADBview\\_text.asp?REF=20100903A](https://www.fire.tc.faa.gov/ADB/adb/ADBview_text.asp?REF=20100903A)
  - **B747-400F, HL-7604, JEJU ISLAND, SOUTH KOREA, 27-JUL-2**
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- **Operational and dangerous goods packaging changes.**
  - **Cost/Benefit for Class E fire suppression system.**
  - <https://www.fire.tc.faa.gov/pdf/09-17.pdf>



# 2016 25.855 Cargo compartment requirements

- The compartment must meet one of the class requirements of Sec. 25.857.
- (b) Each of the following cargo or baggage compartments, as defined in § 25.857, must have a liner that is separate from, but may be attached to, the airplane structure:
  - - (1) Any Class B through Class E cargo or baggage compartment, and
    - (2) Any Class F cargo or baggage compartment, unless other means of containing a fire and protecting critical systems and structure are provided.
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  - (c) Ceiling and sidewall liner panels of Class C cargo or baggage compartments, and ceiling and sidewall liner panels in Class F cargo or baggage compartments, if installed to meet the requirements of paragraph (b)(2) of this section, must meet the test requirements of part III of appendix F of this part or other approved equivalent methods.



# 1998 25.857 Cargo Compartment Classification

- **Removed Class D**



## 2016 25.857 Cargo Compartment Classification

- **Class B:**
- **There is sufficient access in flight to enable a crewmember, standing at any one access point and without stepping into the compartment, to extinguish a fire occurring in any part of the compartment using a hand fire extinguisher; (2) When the access provisions are being used, no hazardous quantity of smoke, flames, or extinguishing agent, will enter any compartment occupied by the crew or passengers;**
- **(3) There is a separate approved smoke detector or fire detector system to give warning at the pilot or flight engineer station**



## 2016 25.857 Cargo Compartment Classification

- **Class C:**
- **(1) There is a separate approved smoke detector or fire detector system to give warning at the pilot or flight engineer station. (2) There is an approved built-in fire extinguishing or suppression system controllable from the cockpit.**
- **(3) There are means to exclude hazardous quantities of smoke, flames, or extinguishing agent, from any crew or passengers;**
- **(4) There are means to control ventilation and drafts within the compartment so that the extinguishing agent used can control any fire that may start within the compartment**



# 2016 25.857 Cargo Compartment Classification

- **Class E:**
- **(2) There is a separate approved smoke or fire detector system to give warning at the pilot or flight engineer station;**
- **(3) There are means to shut off the ventilating airflow to, or within, the compartment, and the controls for these means are accessible to the flight crew in the crew compartment;**
- **(4) There are means to exclude hazardous quantities of smoke, flames, or noxious gases, from the flight crew compartment; and**
- **(5) The required crew emergency exits are accessible under any cargo loading condition.**



# 2016 25.857 Cargo Compartment Classification

- **Class F: Cargo or baggage compartment must be located on the main deck and is one in which—**
  - (1) There is a separate approved smoke detector or fire detector system to give warning at the pilot or flight engineer station;**
  - (2) There are means to extinguish or control a fire without requiring a crewmember to enter the compartment; and**
  - (3) There are means to exclude hazardous quantities of smoke, flames, or extinguishing agent from any compartment occupied by the crew or passengers.**



## 2016 25.851 Fire extinguishers

- The capacity of each required built-in fire extinguishing system **must be adequate for any fire likely to occur in the compartment where used**, considering the volume of the compartment and the ventilation rate. The capacity of each system is adequate if there is sufficient quantity of agent to extinguish the fire or suppress the fire anywhere baggage or cargo is placed within the cargo compartment for the duration required to land and evacuate the airplane.



## **The way forward:**

- 1. Class C & E compartments have different fire control requirements.**
- 2. Class C compartment have been very effective. (no fatal accidents)**
- 3. Class E compartments have had problems and cost effective improvements are being explored. (containers, with or without suppression and covers)**



# Class C Compartments

## (Passenger Aircraft)

- **Present:**

- Bulk shipment of lithium metal and lithium ion batteries forbidden.
- Airlines to do System Safety Assessment (SSA).
- Suppression system must be able to control “fires likely to occur.”
- Testing has shown that current Halon 1301 systems cannot control lithium metal or lithium ion battery fires.



# Class C Compartments

## (Passenger Aircraft)

- **When is a lithium battery fire one that is likely to occur?**
  - Must be determined by airline doing SSA.
    - When carried on every flight – Likely.
    - When not carried on any flights – Unlikely.
    - Likely to occur, somewhere in-between.
- **How can an airline control the percentage of flights that lithium batteries are carried?**



# Class C Compartments

(Passenger Aircraft)

- **Other methods to make lithium battery fires not fires that are likely to occur.**
  - Packaging that reduces the risk of lithium batteries being involved in a fire to a level that is acceptable. (no longer a fire likely to occur)
  - Adding additional controls in the compartments such that lithium or lithium ion battery fires can be controlled. Examples might be Covers, Containers, and/or additional suppression agent/system.



# Class E Compartments (Freighters)

- **Present:**
  - Bulk carriage of both lithium metal and lithium ion batteries allowed.
  - Lithium ion batteries must be at a state of charge of 30% or less.
  - Airlines to do System Safety Assessment (SSA).
  - Other fire hazards being addressed



# Class E Compartments (Freighters)

- **Reduce the risk of the bulk carriage of lithium batteries to an acceptable level.**
  - Reduced state of charge for lithium ion batteries
    - Effect on batteries with equipment?
  - Packaging requirements for lithium metals
  - Packaging requirements for lithium ions
  - Cargo Containers, with or without suppression
  - Fire Containment Covers
  - Separation



