FIRE PROTECTION

CS 25.851 Fire extinguishers

ED Decision 2016/010/R

(See AMC 25.851)

(a) *Hand fire extinguishers*. (See AMC 25.851(a).)

(1) The following minimum number of hand fire extinguishers must be conveniently located and evenly distributed in passenger compartments. (See AMC 25.851(a)(1).):

Passenger capacity	Number of extinguishers
7 to 30	1
31 to 60	2
61 to 200	3
201 to 300	4
301 to 400	5
401 to 500	6
501 to 600	7
601 to 700	8

(2) At least one hand fire extinguisher must be conveniently located in the pilot compartment (see AMC 25.851(a)(2)).

(3) At least one readily accessible hand fire extinguisher must be available for use in each Class A or Class B cargo or baggage compartment and in each Class E or Class F cargo or baggage compartment that is accessible to crewmembers in flight.

(4) At least one hand fire extinguisher must be located in, or readily accessible for use in, each galley located above or below the passenger compartment.

(5) Each hand fire extinguisher must be approved.

(6) The required fire extinguishers located in the passenger compartment must contain an accepted extinguishing agent that is appropriate for the kinds and classes of fires likely to occur where used.

(7) The quantity of extinguishing agent used in each extinguisher required by this paragraph must be appropriate for the kinds of fires likely to occur where used.

(8) Each extinguisher intended for use in a personnel compartment must be designed to minimise the hazard of toxic gas concentration.

(b) *Built-in fire extinguishers*. If a built-in fire extinguisher is provided –

(1) Each built-in fire extinguishing system must be installed so that –

(i) No extinguishing agent likely to enter personnel compartments will be hazardous to the occupants; and

(ii) No discharge of the extinguisher can cause structural damage.

(2) The capacity of each required built-in fire extinguishing system must be adequate for any fire likely to occur anywhere in the compartment where used, considering the volume of the compartment and the ventilation rate. (see AMC 25.851(b)).

(c) Fire-extinguishing agents

(See AMC 25.851(c))

(1) Fire classes against which fire-extinguishing agents may be employed are:

— Class A: Fires involving ordinary combustible materials, such as wood, cloth, paper, rubber and plastics;

— Class B: Fires involving flammable liquids, petroleum oils, greases, tars, oil base paints, lacquers, solvents, alcohols and flammable gases;

— Class C: Fires involving energised electrical equipment where the use of an extinguishing agent that is electrically non-conductive is important.

[Amdt 25/4]
[Amdt 25/8]
[Amdt 25/12]
[Amdt 25/18]

AMC 25.851(a) Hand fire extinguishers

ED Decision 2012/008/R

1 Each extinguisher should be readily accessible and mounted so as to facilitate quick removal from its mounting bracket.

2 Unless an extinguisher is clearly visible, its location should be indicated by a placard or sign having letters of at least 9.5 mm (0·375) inches in height on a contrasting background. Appropriate symbols may be used to supplement such a placard or sign.

[Amdt 25/12]

AMC 25.851(a)(1) Hand fire extinguishers

ED Decision 2012/008/RM

1 The number and location of hand fire extinguishers should be such as to provide adequate availability for use, account being taken of the number and size of the passenger compartments and the location of toilets, galleys, etc. These considerations may result in the number being greater than the minimum prescribed.

2 Where only one hand extinguisher is required it should be located at the cabin crew member station, where provided, otherwise near the main entrance door.

3 Where two or more hand extinguishers are required and their location is not otherwise dictated by consideration of paragraph 1 above, an extinguisher should be located at each end of the cabin and the remainder distributed throughout the cabin as evenly as is practicable.

[Amdt 25/12]

AMC 25.851(a)(2) Hand fire extinguishers

ED Decision 2012/008/R

There should be at least one fire extinguisher suitable for Class B and C fires installed in each pilot's compartment. Additional extinguishers may be required for the protection of other compartments accessible to the crew in flight (e.g. electrical equipment bays) or from consideration of CS 25.851(a)(2).

Based on EU legislation[1], for new installations of hand fire extinguishers for which the certification application is submitted after 31 December 2014, Halon 1211, 1301 and Halon 2402 are unacceptable extinguishing agents.

The hand fire extinguishers and related agents listed in the FAA Advisory Circular AC 20-42D are considered acceptable by the Agency. See AMC 25.851(c) for more information on Halon alternatives.

NOTE: Dry chemical fire extinguishers should not be used in pilot compartments because of the adverse effects on vision during discharge and, if non-conductive, interference with electrical contacts by the chemical residues.

[Amdt 25/12]

AMC 25.851(b) Built-in Fire Extinguishers for Cargo Compartments

ED Decision 2012/008/R

1. PURPOSE.

This AMC sets forth acceptable means, but not the only means, of demonstrating compliance with the provisions of CS-25 related to the built-in fire suppression systems when required for cargo compartments of large aeroplanes. The guidance provided within this AMC has been found acceptable for showing compliance with the provisions of CS 25.855 and 25.857 for built-in fire-extinguishing systems. As with all AMC material, it is not mandatory and does not constitute a regulation. For application to the product, alternate methods may be elected to be followed, provided that these methods are also found by the EASA to be an acceptable means of complying with the requirements of CS-25.

2. RELATED CS PARAGRAPHS.

CS 25.851 "Fire extinguishers"

CS 25.855 "Cargo or baggage compartments"

CS 25.857 "Cargo compartment classification"

CS 25.858 "Cargo compartment fire detection systems"

3. BAN ON HALON 1301.

Halon 1301 is no longer an acceptable extinguishing agent, based on EU Legislation[2], for cargo compartment fire extinction systems to be installed on aircraft types, for which type certification is requested after 31 December 2018. See AMC 25.851(c) for more information on Halon alternatives.

4. BACKGROUND ON CONCENTRATION OF HALON 1301.

Minimal written guidance is available for use in certifying cargo compartment fire-extinguishing or suppression systems. Testing at the FAA Technical Center and other data from standardised fire-extinguishing evaluation tests indicates that the use of averaging techniques may not substantiate that there are adequate concentration levels of fire-extinguishing agent throughout the compartment to effectively suppress a cargo fire.

Cargo fire-extinguishing systems installed in aeroplanes have primarily used Halon 1301 as the fire suppression agent. One widely used method to certify Halon 1301 cargo fire suppression

[1] Commission Regulation (EU) No 744/2010 of 18 August 2010 amending Regulation (EC) No 1005/2009 of the European Parliament and of the Council on substances that deplete the ozone layer, with regard to the critical uses of halon (OJ L 218, 19.8.2010, p. 2).

[2] Commission Regulation (EU) No 744/2010 of 18 August 2010 amending Regulation (EC) No 1005/2009 of the European Parliament and of the Council on substances that deplete the ozone layer, with regard to the critical uses of halon (OJ L 218, 19.8.2010, p. 2).

systems requires an initial concentration of five percent by volume in order to knock down a cargo fire. Subsequent concentration levels should not drop below three percent by volume for the remainder of the flight in order to suppress a cargo fire until it can be completely extinguished by ground personnel following a safe landing.

Since Halon 1301 is approximately five times heavier than air, it tends to stratify and settle after it is released into the cargo compartment. Also, due to temperature differences and ventilation patterns, in a ventilated compartment, Halon 1301 will start to stratify shortly after discharge and the concentration level will decay faster in the upper locations of the compartment than in the lower locations. Halon 1301 will also have a tendency to move aft due to any upward pitch or forward in any downward pitch of the aeroplane in flight. For some products the concentration levels of Halon 1301 have been measured at various locations throughout the cargo compartment and used an arithmetic average of the individual sampling locations to determine an overall concentration level for the cargo compartment. This averaging technique may allow the concentration level to drop below three percent by volume at individual sampling locations near the top of the cargo compartment.

Testing at the FAA Technical Center and other data from standardised fire-extinguishing evaluation tests indicates that the use of averaging techniques may not substantiate that there are adequate concentration levels of fire-extinguishing agent throughout the compartment to effectively suppress a cargo fire. If a cargo fire occurred, and was subsequently suppressed by Halon 1301, the core of the fire could remain hot for a period of time. If the local concentration of Halon 1301 in the vicinity of the fire core dropped below three percent by volume and sufficient oxygen is available, re-ignition could occur. The FAA tests have shown that when the Halon 1301 concentration level drops below three percent by volume and the cargo fire re-ignites, the convective stirring caused by the heat of the fire may be insufficient to raise the local concentration of Halon in the vicinity of the fire. Therefore, compliance testing will require the use of point-concentration data from each sensor and that the probes closest to the cargo compartment ceiling must be at least at the highest level that cargo and baggage can be loaded as specified by the manufacturer and certified by the appropriate airworthiness authority. In addition, certification test data acquisition must include analysis and/or data taken after landing at a time increment which represents the completion of an evacuation.

5. COMPARTMENT CLASSIFICATION.

All cargo compartments must be properly classified in accordance with CS 25.857 and meet the requirements of CS 25.857 pertaining to the particular class involved. In order to establish appropriate requirements for fire protection, a system for classification of cargo or baggage compartments was developed and adopted for large aeroplanes. Classes A, B, and C were initially established; Classes D and E were added later.

a. A Class A compartment is one that is located so close to the station of a crewmember that the crewmember would discover the presence of a fire immediately. In addition, each part of the compartment is easily accessible so that the crewmember could quickly extinguish a fire with a portable fire extinguisher. A Class A compartment is not required to have a liner.

(1) Typically, a Class A compartment is a small open compartment in the cockpit area used for storage of crew luggage. A Class A compartment is not, however, limited to such use; it may be located in the passenger cabin and used for other purposes provided it is located adjacent to a crewmember's station and crewmember remains present during all times when it is used for storage.

(2) Because a Class A compartment does not have a liner, it is absolutely essential that the compartment be small and located close enough to a crewmember that any fire that might occur could be discovered and extinguished immediately. Without a liner to contain it, an undetected or uncontrolled fire could quickly become catastrophic by burning out of the compartment and spreading throughout the aeroplane. All portions of the compartment must be within arms length of the crewmember in order for any fire to be detected immediately and extinguished in a timely manner. Although there may be some exceptions, such as a 'U-Shaped' compartment for example, a Class A compartment greater than 1.42 cubic metres (50 cubic feet) in volume would not typically have the accessibility required by CS 25.857(a)(2) for fighting a fire.

b. A Class B compartment is one that is more remote than a Class A compartment and must, therefore, incorporate a fire or smoke detection system to give warning at the pilot or flight engineer station. Because a fire could not be detected and extinguished as quickly, a Class B compartment must have a liner in accordance with CS 25.855. A Class B cargo or baggage compartment has sufficient access in flight to enable a crewmember to reach all parts of the compartment with the contents of a hand fire extinguisher. There are means to ensure that, while the access provisions are being used, no hazardous quantity of smoke, flames, or extinguishing agent will enter areas occupied by the crew or passengers.

c. A Class C compartment differs from a Class B compartment in that it is not required to be accessible in flight and must, therefore, have a built-in fire-extinguishing system to suppress or control any fire occurring therein. A Class C compartment must have a liner and a fire or smoke detection system in accordance with CS 25.855 and 25.857. There must also be a means to control ventilation and drafts within the compartment and a means to exclude hazardous quantities of smoke, flames, or extinguishing agent from occupied areas.

d. FAR Amendment 25-93 removed the Class D cargo compartment classification for new aeroplanes effective March 19, 1998.

e. A Class E compartment is particular to an all-cargo aeroplane. Typically, a Class E compartment is the entire cabin of an all-cargo aeroplane; however, other compartments of such aeroplanes may be classified as Class E compartments. A fire in a Class E compartment is controlled by shutting off the ventilating airflow to or within the compartment. Additionally, most cargo aeroplanes have smoke/fire procedures that recommend that the crew turn off the ventilating air, don their oxygen equipment, and gradually raise the cabin altitude, between 6096 m (20,000 feet) and 7620 m (25,000 feet), to limit the oxygen supply and help control a fire until the aeroplane can descend to land. A Class E compartment must have a liner and a fire or smoke detection system installed in accordance with CS 25.855; however, it is not required to have a built-in fire suppression system.

6. FIRE EXTINGUISHING OR SUPPRESSION SYSTEMS.

The terms “extinguishing system” and “suppression system” will be used interchangeably in this AMC. The system is not required to extinguish a fire in its entirety. The system is intended, instead, to suppress a fire until it can be completely extinguished by ground personnel following a safe landing.

7. TESTING VOLUMETRIC CONCENTRATION LEVELS.

For the product it should be demonstrated that the cargo fire extinguishing system provides adequate concentration levels of extinguishing agent to combat a fire anywhere where baggage and cargo is placed within the cargo compartment for the time duration required to land and evacuate the aeroplane. A combination of flight-testing and analysis may be used to comply with this requirement. If Halon 1301 is used, an initial minimum concentration of five percent by volume is required to knock down a cargo fire. Subsequent gaseous extinguishing agent should, if required for the duration of the flight, be introduced via a metering or other appropriate system to ensure that point concentration levels do not drop below three percent by volume for the remainder of the flight. The duration of agent application should be determined from route analysis (i.e. the time to travel from the farthest distance expected in route to the nearest adequate airport for landing per applicable operational rules. For Extended Operation with Two-Engine Aeroplanes (ETOPS) AMC 20-6 specify that an analysis or tests should be conducted to show, considering approved maximum diversion in still air (including an allowance for 15-minute holding and/or approach and land), that the ability of the system to suppress or extinguish fires is adequate to ensure safe flight and landing at a suitable airport. The minimum extinguishing agent concentration levels are to be maintained for the required duration throughout the cargo compartment where cargo will be carried, including side to side, end to end, and top to bottom. However, flight test measurements do not have to be made in compartment areas that are designated empty and will not contain cargo.

The fire extinguishing agent concentration levels should be measured at sufficient vertical, horizontal, and longitudinal locations to ensure that sufficient resolution exists to define the variations in fire extinguishing agent concentration levels throughout the cargo compartment in these planes. No averaging techniques are permitted in compliance demonstrations for CS 25.851(b)(2). The only exception to this will be in the event of a sensor failure where interpolation of sensor data from other nearby probes to yield an estimate of missing agent concentration data may be allowed by the Agency. In the event such interpolation is necessary, then a linear interpolation of the data will provide an acceptable means of approximating the missing data.

Sampling locations should also be placed as close as practical to potential leakage or ventilation flow areas (e.g., door seals, vents, etc.) which can disrupt the local concentration levels.

The concentration levels should not be less than the minimum established for that fire extinguishing agent at any point within the compartment. Arithmetic averaging of individual sampling locations to determine the concentration levels is not acceptable. The use of averaged concentration data will no longer be accepted, except in well-defined cases (i.e., during certification tests) where a sensor probe failure occurs and the use of interpolation from adjacent sensor probes is warranted. Compliance with CS 25.851(b) will require the use of point-concentration data from each sensor and that the probes closest to the cargo compartment ceiling must be at least at the highest level that cargo and baggage can be loaded as specified by the manufacturer and certified by the Agency. Other placement of concentration sensor probes within the cargo compartment should be sufficient to substantiate that there are adequate concentration levels of fire extinguishing agent throughout the compartment to effectively control a cargo compartment fire. The sampling rate should be sufficient to establish a concentration level versus time decay curve. In the event that a single sensor displays a suspect time history, the use of an interpolated time averaged value may be acceptable to the Agency. If fire extinguishing agent concentration levels at a probe drop below the minimum requirement, it should be a temporary anomaly of short duration and not observed in adjacent probes. If it could be demonstrated that the temporary anomaly is associated with aeroplane manoeuvres, then the data may be acceptable to the Agency.

Typically there are two type of extinguishing agent dispensing systems, a flood or dump (high rate discharge) system and a metered system. The flood or dump system dispenses the agent with the activation of the system and a selected amount of agent is injected into the compartment to suppress the fire. Once the agent concentration level approaches the minimum sustaining level, i.e., 3%, a second and subsequent discharge of agent takes place to assure the 3% concentration level is maintained for the time necessary to divert to a safe landing. The metered systems usually discharge agent into the compartment for fire suppression (5%) and then adds agent in a prescribed amount to the compartment to maintain the 3% concentration level.

Certification flight test demonstration is required for a “dump” system for the duration of the intended diversion profile. If a metering system is proposed, the system’s acceptability may be demonstrated through a limited flight test, in which a portion of the system is actually tested, and the full capability of the system is demonstrated via analysis. It is recognised that issues such as what compartment size should be tested (smallest or largest), the test duration in flight, and whether reliable analytical methods are available to predict concentration levels for various locations and heights in a given cargo compartment will have an impact on certification tests. EASA concurrence must be obtained for this type of testing and analysis of the product. A sufficient portion of the metering system capability should be demonstrated to provide enough data to establish fire extinguishing agent concentration and behaviour for the remaining flight. It is recognised that aeroplane climb flight phase and the descent flight phase represent dynamic environments and no data need be acquired during these transient flight phases were cabin altitude changes would preclude accurate data acquisition. However, certification data must include analysis and/or data taken after landing at a time increment representative of the completion of an evacuation of all occupants.

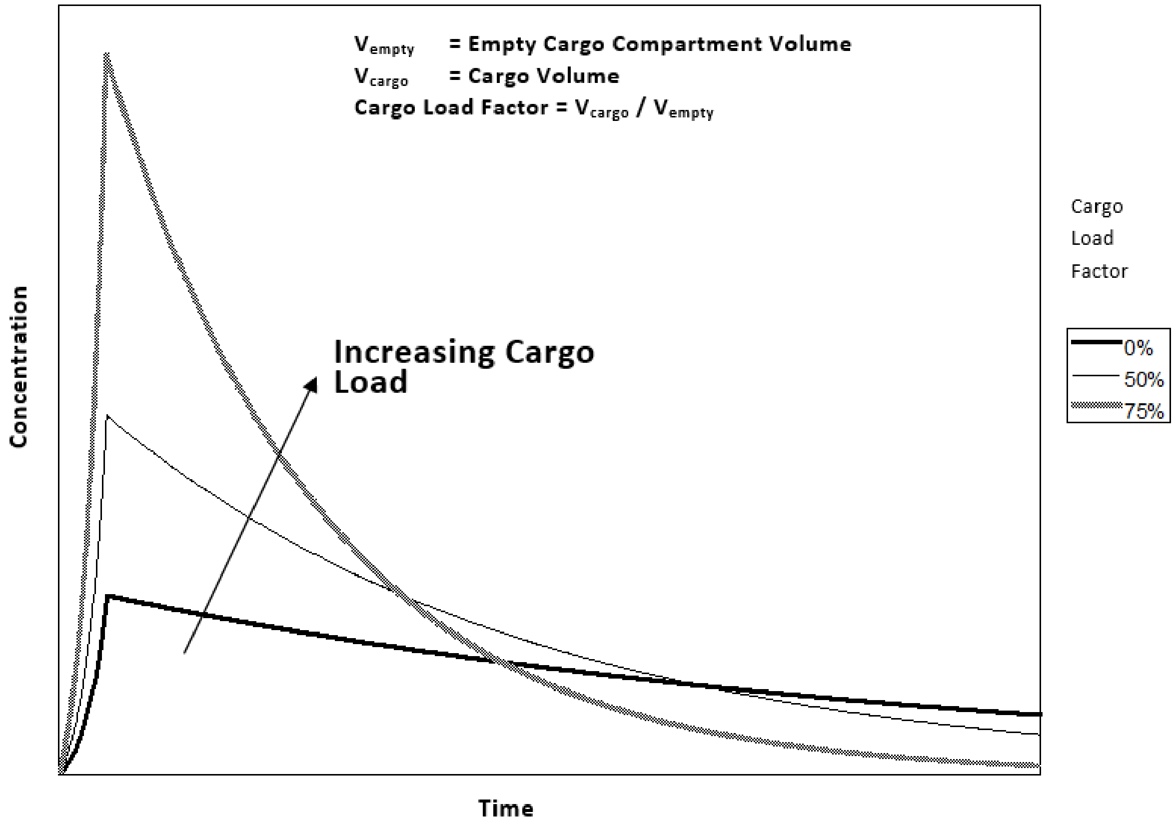
Acceptable extinguishing agents, alternative to Halon and based on internationally recognised Minimum Performance Standards (MPS), like e.g. Report No. DOT/FAA/AR-00-28, Development of a Minimum Performance Standard for Aircraft Cargo Compartment Gaseous Fire Suppression Systems, dated September 2000, may be accepted by the Agency. In the absence of internationally accepted concentration levels, the Agency will initiate a Certification Review Item addressing the use of an alternate fire-extinguishing agent.

8. AEROPLANE TEST CONDITIONS FOR USE OF HALON 1301 IN CARGO COMPARTMENTS.

Flight tests are required to demonstrate function and dissipation of the fire extinguishing agent or simulant in a cargo compartment. For certification tests, the aeroplane and relevant systems should be in the type design configuration.

The cargo compartment should be empty for the above test. However, as shown in Figure 8-1, a compartment with cargo may be more time critical than an empty compartment for minimum fire extinguishing agent concentration levels. The time critical nature depends on several factors. Even with a pure “dump” system, having cargo does not necessarily mean a marginally performing system during an empty cargo compartment test will result in a “bad” system with cargo. Also, metering systems, if designed properly, are relatively insensitive to the cargo load factor.

Figure 8-1. Effect of Cargo Load on Halon 1301 Concentration Levels



A specific example of the effect of cargo compartment loading is shown in Figure 8-2, using the Appendix 1 simulation. If the volume of the compartment is decreased to represent increasing cargo load percentages and the leakage rate and initial Halon quantity are kept constant, then the initial Halon concentrations increase and the concentration decay rates also increase. Using this approach, the concentration in an empty compartment will decay to 3% faster than a loaded compartment up to a load percentage of about 65.6%. With compartments loaded to a higher percentage than 65.6%, the concentration will fall below 3% faster than an empty compartment.

This simulation of cargo loading assumes that the Halon concentration is homogeneous throughout the compartment and that the volume taken up by the loaded cargo is uniformly distributed throughout the compartment. Note: Both of these assumptions are not true in an actual loaded compartment so caution should be exercised to relate the measurements taken in an actual loaded compartment in flight.

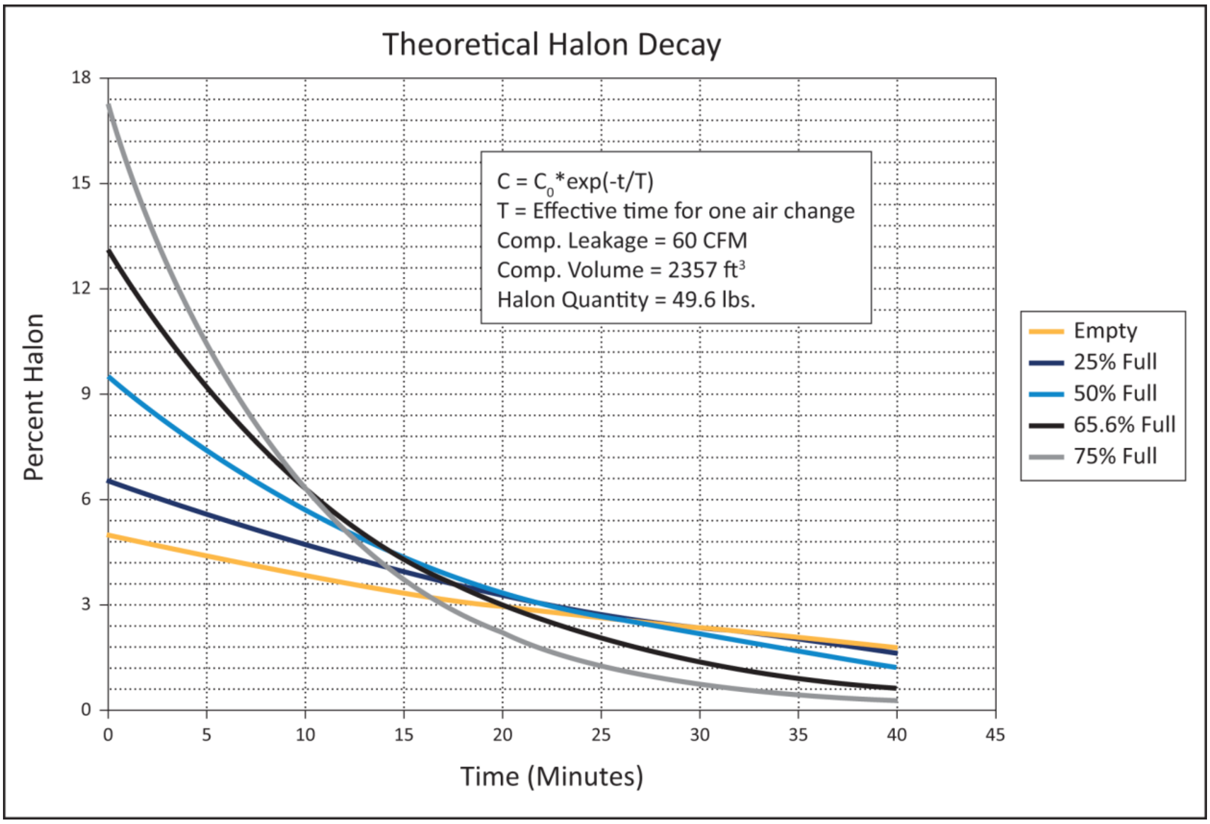


Figure 8-2

Analysis should be provided to ensure that the suppression agent concentration levels will not fall below the minimum requirement with a cargo load factor as follows:

a. For cargo compartments using only standard cargo containers, the maximum possible volume occupied by containerised cargo should be determined for the product and this value be used as the cargo load factor. This maximum volume becomes an aeroplane limitation.

b. For all other configurations, a minimum cargo load factor of 75% by volume should be used for the product."

Appendix 1 to this AMC provides guidance on analysing Halon 1301 concentration levels.

The suppression system certification test should be conducted, as a minimum, during steady-state cruise with a maximum cabin-to-ambient pressure differential. The ventilation system should be configured per the aeroplane flight manual (AFM) procedures for a cargo compartment fire. The system should also be demonstrated acceptable for unpressurised flight conditions unless there is a restriction on unpressurised flight for the aeroplane.

It should be noted that cargo compartment leakage rates would vary between aeroplanes. This is especially significant for changes introduced by supplemental type certificate (STC) modifying aeroplanes that have been in service. Some preliminary testing should be done to determine the maximum leakage rates seen/expected in service. For new type designs the issue of wear and tear on the compartment should also be addressed when establishing the decay rate in a brand new aircraft at the factory.

9. USE OF SIMULANTS FOR CERTIFICATION TESTING

The aviation industry may continue to use Halon in cargo fire suppression applications in relation to new application for type certificate, until the end of 2018..

The EPA/EU are allowing the aviation industry to use Halon to demonstrate system functionality as long as a simulant or alternate extinguishing agent or alternate fire-extinguishing system cannot be used in place of the Halon during system or equipment testing for technical reasons. It should be noted, however, that certain states continue to ban the release of Halon for testing. The FAA Technical Center and the International Aircraft Systems Fire Protection Working Group are concentrating efforts on evaluating alternative fire-extinguishing agents and the use of simulants during certification testing. The EASA plans to approve a simulant which can be used in place of Halon 1301 during certification tests of aircraft fire-extinguishing systems to predict actual Halon 1301 volumetric concentration levels. When approved, the use of a simulant will be the preferred method for demonstrating compliance.

As of the date of this AMC, no suitable simulant for cargo compartment gaseous fire extinguishing systems has been identified. However, should the EASA be approached with the intent of utilise for the product a simulant in lieu of a Halon 1301 system or other gaseous fire extinguishing system then the recommended approach would be to perform testing which meets the Minimum Performance Standards for that application as developed by the International Aircraft Systems Fire Protection Working Group. To ensure acceptable successful means of compliance the same information as outlined above in paragraph 7 should be provided.

A simulant is defined in this AMC as a chemical agent that adequately imitates the discharge and distribution characteristics of a given extinguishing agent. It need not be an actual fire suppressant. For certain cases due to cost of the extinguishing agent, problems with supply of the extinguishing agent, etc; it may be more appropriate for the application to utilise a simulant. The Agency would require adequate analysis and testing be accomplished to establish the validity of the simulant. As a minimum, corroborating information would need to be provided as to the detailed chemical analysis of the simulant and evaluation testing of the fire extinguishing system operated with the simulant which demonstrates the equivalent behaviour. To ensure acceptable means of compliance, the following must be provided:

(1) The test data and distribution profiles using the simulant which meet the certification criteria as expressed below and in the Minimum Performance Standards as developed by FAA Technical Center as part of the International Aircraft Systems Fire Protection Working Group. (See Paragraph 15 for the listing of the references.)

(2) A system description document that includes a description of the distribution of the simulant under the test conditions in the cargo compartment.

(3) A detailed test plan.

(4) Chemical data which describes the simulant and any toxicity data.

For the application the distribution of the simulant must be described as compared with Halon 1301 under the following conditions:

a. Given the same filling conditions, the simulant is loaded into the fire extinguisher bottle based on an equivalent liquid fraction to the Halon 1301 charge weight required. This is an equivalent statement to the mass of the simulant being a specific percentage of the Halon 1301 charge weight required.