U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: CARGO COMPARTMENT FIRE SUPPRESSION | **Date:** 10/24/08 | **Initiated By:** ANM-100 | **AC No:** 25.795-5

1. PURPOSE. This advisory circular (AC) describes an acceptable means for showing compliance with the requirements of Title 14, Code of Federal Regulations (14 CFR), part 25, § 25.795(b)(3), "Cargo compartment fire suppression." This section requires that the fire suppression system for the cargo compartment be designed to withstand a sudden and extensive explosion and fire, such as could be caused by an explosive or incendiary device. The means of compliance described in this document provides guidance to supplement the engineering and operational judgment that must form the basis of any compliance findings relative to the design of fire suppression systems for the cargo compartment.

2. APPLICABILITY.

a. The guidance provided in this document is directed to manufacturers and modifiers of large passenger transport airplanes and repair facilities for such airplanes.

b. The material in this AC is neither mandatory nor regulatory in nature and does not constitute a regulation. It describes acceptable means, but not the only means, for demonstrating compliance with the applicable regulations. The FAA will consider other methods of demonstrating compliance that an applicant may elect to present. Furthermore, if we become aware of circumstances that convince us that following this AC would not result in compliance with the applicable regulations, we will not be bound by the terms of this AC, and we may require additional substantiation or design changes as a basis for finding compliance.

c. The material in this AC does not change, create any additional, authorize changes in, or permit deviations from regulatory requirements.

3. RELATED SECTIONS OF 14 CFR. Part 25, §§ 25.851(b), 25.855, 25.857, and 25.858.

4. BACKGROUND.

a. Existing fire protection systems for cargo compartments perform the functions of fire detection and fire suppression. When a fire protection system detects fire within the cargo compartment, it issues a warning to the flightcrew compartment. The flightcrew then activates the fire suppression system to discharge suppression agent into the cargo compartment to extinguish the fire.

b. Prior to the adoption of amendment 25-127, regulations required that a fire suppression system in the cargo compartment be capable of suppressing any fire likely to occur in the compartment. However, these regulations did not require that the system be capable of withstanding the detonation of an explosive or incendiary device. Section 25.795(b)(3) now requires that the fire suppression system for the cargo compartment of an airplane be designed to withstand the effects of an explosive device in the compartment.

c. A draft of this AC was harmonized with the European Joint Aviation Authorities (JAA). The draft provided a method of compliance that both the Federal Aviation Administration (FAA) and JAA found acceptable. Subsequently, the European Aviation Safety Agency (EASA) was formed as the principal aviation regulatory agency in Europe. The FAA will work with EASA to ensure that this proposed AC is harmonized with ACs referred to in EASA’s Certification Specifications.

5. DEFINITIONS. For the purposes of this AC, the following definitions apply:

a. Event: The detonation of an explosive or incendiary device.

b. Suppression Agent: A fluid or gaseous substance discharged into the cargo compartment to suppress or extinguish a fire.

c. Knockdown Discharge: The initial sudden application of suppression agent into the cargo compartment.

d. Follow-on Discharge: If the fire is not extinguished by the initial sudden application (knockdown discharge) of suppression agent, the subsequent application of suppression agent into the cargo compartment to prevent a fire from rekindling by maintaining a specified agent concentration.

e. Storage Vessel: A component containing the suppression agent.

f. Remote Installation: Isolation of a component from exposure to fragments and large deformations resulting from an event in the cargo compartment. An installation is remote if it is outside the compartment and is protected by features that, in the aggregate, meet the criteria discussed in paragraph 8a(2)(a).

6. DISCUSSION.

a. Fire-protection systems in the cargo compartment generally contain a fire detection system and a fire suppression system. Normally, the fire detection system detects fire in a cargo compartment and activates an alarm in the flightcrew compartment. The flightcrew then activates the fire suppression system to discharge suppression agent into the cargo compartment.

b. The fire detection system generally consists of detectors that sample air from the cargo compartment. When sufficient quantities of combustion byproducts enter a fire detector, the detector activates an alarm.

c. The fire suppression system generally consists of storage vessels, distribution tubing or piping, and associated hardware. When the fire suppression system is activated, it releases an initial knockdown discharge of suppression agent to the cargo compartment. The fire suppression system can also provide a follow-on discharge, either at a metered rate or as a single, discrete discharge.

d. Due to the damage that may result from an event, quantities of suppression agent that could be toxic may enter compartments occupied by crew or passengers. The suppression agent, however, presents less of a hazard than the fire.

7. ASSUMPTIONS. The guidance provided in paragraph 8 of this AC, as to demonstration of compliance with § 25.795(b)(3), is based upon the following assumptions:

a. Explosive and incendiary devices produce similar consequences with respect to the fire protection systems.

b. Explosive and incendiary devices produce surface fires. Based on several explosive tests conducted in cargo compartments by the FAA, deep-seated fires are extremely rare in such events.

c. Existing requirements for cargo compartment liners are adequate. The reasons for this assumption are the following:

(1) In the case of an event, the resultant fire will be a surface fire, and the knockdown discharge system will extinguish the fire even if the liner is breached.

(2) Cargo compartment liners are flame-penetration resistant, in accordance with § 25.855(c).

d. The fire detection system in the cargo compartment requires no protection from explosive and incendiary devices. The reasons for this assumption are the following:

(1) If the event is small, there will be no effect on the fire detection system.

(2) If the event is large enough to affect the integrity of the fire detection system, the passengers or crew will notice the event (from either visible or audible cues). If smoke or odors are present, the crew will be aware that they need to discharge suppression agent to the cargo compartment. In addition, the flightcrew can determine the failure of the affected fire detection system in the specific compartment. As a result, no changes are required to make the fire detection systems resistant to an event.

e. No additional suppression agent is required. Existing suppression agent requirements are adequate, as discussed in paragraph 7c(1) of this AC.

f. Halon suppression agents satisfy the intent of this requirement from the standpoint of fire suppression. However, the production of Halon has been banned because of environmental concerns that the chemical contributes to depletion of the ozone layer. Although the supply of Halon is not an immediate concern, Halon will not be available indefinitely. The FAA worked with the International Halon Replacement Working Group (now called the International Aircraft Systems Fire Protection Working Group) to establish minimum performance standards for new suppression agents that are "equivalent" to the existing Halon agents. The minimum performance standards have been published in DOT/FAA/AR-TN05/20, dated June 2005. The FAA intends to use these criteria as guidance for approval of suppression agents in the future. Therefore, the FAA expects that the requirements of § 25.795(b)(3) will not affect the type of suppression agents to be used in the future.

g. The airplane's pressure shell remains intact during one of these events, even though some structural components within the airplane may fail or be damaged.

h. Most components of the fire suppression system require no protection against a pressure wave resulting from an event. The pressure wave from an event is assumed to act uniformly around the components—as observed from several experimental trials—and would not normally cause pressure damage to these components. However, any component that projects a surface area greater than four square feet would require structural reinforcement to counter the inability of the pressure wave to propagate uniformly around large objects.

Note: Any single dimension greater than four feet may be assumed to be only four feet in length.

i. The mechanisms that produce threatening damage are from large-scale deformations and fragmentation. An event can induce sizeable loads on large surfaces, causing components of the suppression system attached to these surfaces to deflect beyond safe limits. In addition, high-energy fragments from an event can puncture distribution lines and storage vessels. And, therefore, these system elements need protection as discussed below.

8. DEMONSTRATION OF COMPLIANCE. The assumptions specified in paragraph 7 of this AC lead to the conclusion that the only parts of the fire protection system in the cargo compartment affected are the parts that store, activate, and distribute suppression agent. The means of compliance with § 25.795(b)(3), described below, address only those parts of the fire protection system and only that damage, which results from fragments and large deformation of a supporting structure.

a. Storage and Activation Components. Storage components and any electrical devices, including wiring, or any mechanical devices attached to the storage components to activate them would require protection.

(1) A general assessment of the vulnerability of these components should include consideration of the following factors:

(a) The location of the storage and activation components relative to a potential event;

(b) The physical arrangement of any feature—such as a cargo compartment liner—between the storage and activation components and the potential event; and

(c) The potential effect of displacement of the storage and activation components from those features due to the displacement or deformation of the features.

(2) Any of the following three approaches will demonstrate compliance for the storage and activation components of the fire suppression system:

(a) Protection of components. Components installed in an area that is not remote from a cargo compartment should be protected. Section 25.795(b)(3) requires that storage and activation components or protective barriers must withstand impacts from 0.5-inch diameter 2024-T3 aluminum spheres (representing a nominal fragment) traveling 430 feet per second. A ballistic resistance of 0.09-inch thick 2024-T3 aluminum offers an equivalent level of protection. Barriers with dimensions beyond those described in paragraph 7h and the supporting structures designed to protect components should be able to tolerate a 15 pound per square inch (psi) local static pressure load.

(b) Remote installation of components. Components installed in an area that is remote from the cargo compartment (see paragraph 5f) are acceptable. Credit may be taken for any permanent barriers between the cargo compartment and the component that can be shown to offer protection from fragments and/or large deformation. Barriers with dimensions beyond those of paragraph 7h and their supporting structures—which are designed to isolate components and meet the criteria for remote installation—should be able to tolerate a 15 psi static pressure load in combination with any other applicable design loads.

(c) Redundancy of components. Redundant storage and activation components that are separated in accordance with § 25.795(c)(2) are sufficient.

b. Distribution Components. Either of the following approaches separately or in combination will satisfy compliance for the distribution components of the fire suppression system:

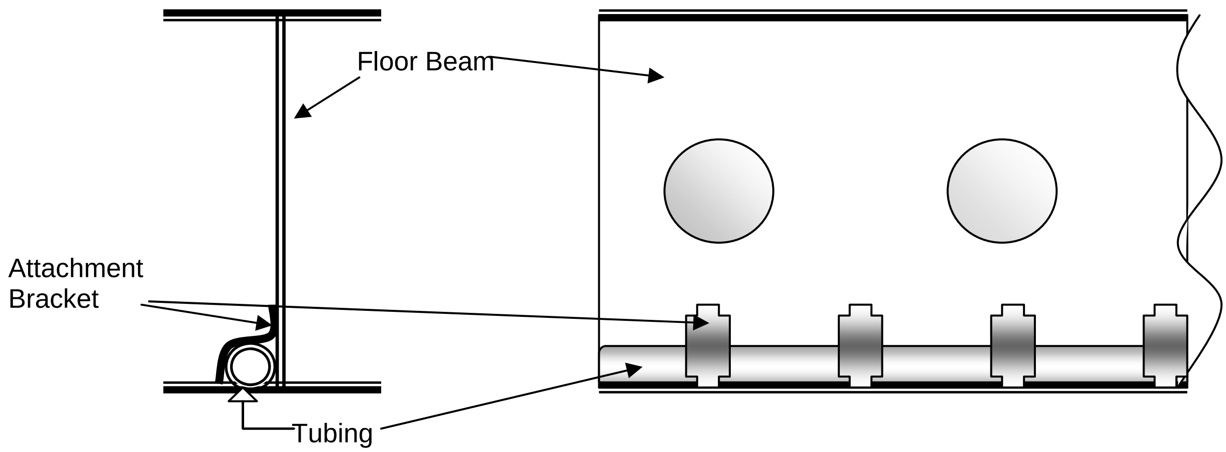
(1) Redundancy of tubing. Redundant tubing that is separated in accordance with § 25.795(c)(2) is sufficient. No additional measures will be necessary.

(2) Protection of tubing:

(a) Shielding. Shielding and/or inherent protection of the tubing should be able to withstand fragment impacts from 0.5-inch diameter 2024-T3 aluminum spheres traveling 430 feet per second; and

(b) Tubing and tubing supports. The design of the tubing should incorporate features that minimize the risk of rupture or failure of the tubing due to relative displacement of the structure to which it is attached. This design may include flexibility in the tubing and/or its mountings. In the absence of test evidence or alleviating rationale, one should allow for a minimum displacement of 6 inches in any outward direction from a single point force applied anywhere along the tubing, except where such displacement would go beyond the fuselage contour. This allowance will compensate for relative displacement of support structures or adjacent materials from the tubing due to an event in the cargo compartment. Frangible attachments or other features that will preclude rupture or failure of the tubing may also be incorporated. In this context, 'outward' is relative to the cargo compartment. An example of an alleviating rationale would be a distribution system coupled to substantial structure, such as a floor beam so that relative displacement was not possible along the floor beam. (See Figure 1.) In that case, the locations where relative displacements were likely would be defined and limited, and the mitigating features could be focused on those areas.

Figure 1. System Couple to Structure



(3) Nozzle. Since the nozzle(s) itself must be free to discharge suppression agent, it cannot be practically shielded. The nozzle should be included when assessing tolerance to displacement of attachments, but does not need to be protected from fragments.

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