U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Safety Risk Management Involving Items in Aircraft Cargo Compartments

Date: 9/1/21 **AC No:** 120-121
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1 **PURPOSE OF THIS ADVISORY CIRCULAR (AC).** This AC provides guidance in performing a safety risk assessment, as part of Safety Risk Management (SRM), associated with the transport of various types of items in the aircraft cargo compartment and the value of considering the inherent hazardous properties of these items. This document is intended only to provide clarity to the public regarding existing requirements under the law or agency policies. This guidance is not legally binding in its own right and will not be relied upon by the Federal Aviation Administration (FAA) as a separate basis for affirmative enforcement action or other administrative penalty. Conformity with this guidance document is voluntary only and nonconformity will not affect rights and obligations under existing statutes and regulations.

Note: The terms "must" and "will" in this AC indicate a mandatory requirement established by regulation. The term "should" in this AC indicates a recommendation and not a requirement when using the guidance in this AC.

1.1 **"Item" Categories.** The use of the term "items" in this AC addresses the following categories:

- Cargo (including an operator's Company Material (COMAT) or stores);
- Passenger and crew checked baggage;
- Mail; and
- Other equipment used in the transport of cargo, baggage, or mail (e.g., unit load devices (ULD), tracking devices, powered devices).

2 **AUDIENCE.** This AC provides guidance to all U.S. air carriers and U.S. commercial operators[1] that carry items in aircraft cargo compartments.

3 **WHERE YOU CAN FIND THIS AC.** You can find this AC on the FAA's website at https://www.faa.gov/regulations_policies/advisory_circulars and the Dynamic Regulatory System (DRS) at https://drs.faa.gov.

[1] See Title 14 of the Code of Federal Regulations (14 CFR) part 1, § 1.1 for the relevant definitions.

4 BACKGROUND.

4.1 Several catastrophic accidents have occurred since 1980 due to hazards associated with items in aircraft cargo compartments that resulted in fires that overwhelmed the fire protection capability of the aircraft.[2] Following each of these accidents, the FAA made various regulatory changes in an effort to prevent similar outcomes from occurring in the future.

4.2 Some items when carried in an aircraft cargo compartment can introduce hazards that might exceed the capabilities of a certificated aircraft, resulting in an incident or accident. Safety is enhanced when operators identify hazards associated with items carried in aircraft cargo compartments and manage the risks that those hazards pose to the safe operation of the aircraft.

Note: This AC does not cover improper loading of aircraft. Refer to AC 120-85, Air Cargo Operations, which includes methods to secure cargo and comply with the operating limitations of the aircraft.

4.3 Aircraft operators must comply with Title 49 of the Code of Federal Regulations (49 CFR) Parts 171 through 180, Hazardous Materials Regulations (HMR), when accepting hazardous materials (dangerous goods) for transportation by aircraft. However, the aircraft-level risk presented by these items is dependent on additional factors, such as the total quantity and type, potential interactions, and existing risk mitigation measure. The HMR provides segregation requirements in 49 CFR part 175 relating to lithium batteries. These requirements are a basic minimum standard to segregate flammable hazardous materials from lithium batteries. The segregation requirements do not address any limits or concerns that lithium batteries impose in the aircraft cargo compartment at the aircraft systems level.[3]

4.4 The International Civil Aviation Organization (ICAO) amended the International Standards and Recommended Practices (SARPs) of Annex 6, Operation of Aircraft, Part I, International Commercial Air Transport—Aeroplanes[4] (Amendment 44) to add Chapter 15, Cargo Compartment Safety, which establishes three standards:

1. "The State of the Operator shall ensure that the Operator establishes policy and procedures for the transport of items in the cargo compartment, which include the conduct of a specific safety risk assessment."
2. "The elements of the cargo compartment(s) fire protection system as approved by the State of Design or State of Registry, and a summary of the demonstrated cargo

[2] Saudi Arabian Airlines Flight 163, L1011 (08/19/1980); South African Airways Flight 295, B747 (11/28/1987); ValuJet Flight 592, DC-9 (05/11/1996); FedEx Flight 1406, DC-10 (09/05/1996); UPS Flight 1307, DC-8 (02/08/2006); UPS Flight 6, B747 (09/03/2010); and Asiana 991, B747 (07/28/2011).
[3] Title 49 CFR Part 171, § 171.8, Definitions and Abbreviations, defines hazardous material as a "means a substance or material that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and has designated as hazardous under section 5103 of Federal hazardous materials transportation law" (Title 49 of the United States Code (49 U.S.C.) § 5103).
[4] In ICAO documents, "aeroplane" is equivalent to "airplane" in 14 CFR.

compartment fire protection certification standards, shall be provided in the aeroplane flight manual or other documentation supporting the operation of the aeroplane."

3. "The Operator shall establish policy and procedures that address the items to be transported in the cargo compartment. These shall ensure to a reasonable certainty that in the event of a fire involving those items, it can be detected and sufficiently suppressed or contained by the elements of the aeroplane design associated with cargo compartment fire protection, until the aeroplane makes a safe landing."

4.5 In addition to Annex 6, Annex 18, The Safe Transport of Dangerous Goods by Air, and Annex 19, Safety Management, have applicable standards relating to, and in support of, the topics in this AC. ICAO developed Doc 10102, Guidance for Safe Operations Involving Aeroplane Cargo Compartments, to support the implementation of the new standards in Annex 6, Part I, Chapter 15 for conducting a risk assessment that involves the carriage of items in the airplane cargo compartments. ICAO Doc 10102 may be used to comply with SARPs contained in Annex 6, Part I, Chapter 15. "It places the Safety Risk Management (SRM) concepts espoused in ICAO's Safety Management Manual (SMM) (Doc 9859) into an operationally relevant context."

5 HOW TO USE THIS AC. Although the carriage of items in the aircraft cargo compartment can introduce hazards to aircraft operations, it is possible to mitigate the risks found unacceptable through SRM. This AC provides information relating to risk assessments and potential mitigation strategies specific to items in the aircraft cargo compartment. Refer to 14 CFR Part 5, Safety Management Systems, which applies to certain operators, and AC 120-92, Safety Management Systems for Aviation Service Providers, for regulations and guidance, respectively, for details regarding Safety Management System (SMS) processes and terminology. The FAA encourages all other operators to apply SRM. Operators with an established SMS will continue to follow their process and use it to address the hazards discussed in this document. When using this document, refer to ICAO Doc 10102, check the FAA websites in the paragraphs below for information on cargo safety and mitigations relating to fire events, and consider safety enhancements developed and promoted by industry groups.

5.1 SRM. SRM is a process composed of analyzing the system, identifying the hazards, and analyzing, assessing, and controlling risk. The operator's SRM should ensure the identified hazards are controlled to an acceptable level of risk. Apply SRM to the following:

- Implementation of new systems,
- Revision of existing systems,
- Development of operational procedures, and
- Identification of hazards or ineffective risk controls through the safety assurance process.

5.2 Cargo Safety Website. The FAA has created a cargo safety website to provide considerations to take when managing the complex landscape of air cargo operations. The

website provides links to research, FAA guidance and policy, and industry consensus standards, which can be found at https://www.faa.gov/aircraft/safety/cargosafety/.

5.3 Cargo Fire Safety Website. Regulators and industry frequently conduct research on the interaction between the aircraft and items carried in the aircraft cargo compartments and on the properties of these items during fire events. You can find this at https://www.fire.tc.faa.gov/cargosafety. The FAA will use this site to maintain an up-to-date library of information.

5.4 Commercial Aviation Safety Team (CAST). The CAST, established by the U.S. Government and industry stakeholders, analyzes accident and incident data, and it identifies and implements voluntary interventions or Safety Enhancements (SE) to reduce the commercial aviation accident rate. The complete CAST safety portfolio is at https://www.cast-safety.org/.

6 AIRCRAFT CAPABILITIES TO CONSIDER WHEN APPLYING SRM.

6.1 General. This paragraph provides an overview of the capabilities of the aircraft in preventing, containing, and mitigating a fire. The FAA expects operators to understand the capabilities and limitations of aircraft cargo compartments and consider this information when deciding what to load in those compartments.

6.2 Aircraft Cargo Compartments.

6.2.1 Title 14 CFR part 25 classifies transport category airplane cargo compartments based on their fire protection characteristics and capabilities. Each category of compartment can be susceptible to different conditions. Although there are six classes of compartments in these regulations, Class C and Class E compartments are the ones most commonly found on the transport airplane fleet.

6.2.2 Operators of aircraft certificated in accordance with the standards codified at 14 CFR part 23, 27, or 29 can work with the aircraft manufacturer to determine the characteristics and capabilities of the aircraft cargo compartment.

6.2.3 A Class C compartment is not required to be accessible during flight; therefore, the applicable standard requires it to have a built-in fire extinguishing system that is controllable from the flight deck. The compartment has a fire detector system to give warning at in the flight deck. Hazardous quantities of the suppression agent and products of combustion are designed to be kept from occupied areas. Class C compartments exist on both passenger-carrying and all-cargo airplanes.

6.2.4 A Class E compartment is found only on an all-cargo airplane. Typically, a Class E compartment is the entire cabin of an all-cargo airplane; however, other compartments (e.g., lower-deck, inaccessible cargo compartments) of such airplanes may be classified as Class E compartments. They have a separate, approved smoke or fire detector system to give warning in the flight deck, so that crewmembers can implement fire mitigation procedures. The procedure involves shutting off the ventilating airflow to or within the compartment, which results in reducing available oxygen in the cargo compartment and

decreasing the cargo compartment's pressure. Part 25 does not require a Class E compartment to have a built-in fire suppression system.

6.2.5 All materials used in the construction of the Class C and Class E cargo or baggage compartments are required to meet the applicable test criteria prescribed in Part I of appendix F of part 25 or other approved, equivalent methods. However, the ceiling and sidewall liners of Class C compartments are required to meet the test requirements of Part III of appendix F of part 25 or other approved, equivalent methods. The primary purpose of a cargo liner is to prevent a fire originating in a cargo compartment from spreading to other parts of the aircraft before it can be suppressed or extinguished. A liner defines the boundary of the cargo compartment; it must meet the aforementioned fire resistance criteria, and it aids in control of ventilation. Fires that result in pressure increases (aerosol canisters, lithium ion batteries, etc.) can dislodge fasteners or other means of construction (e.g., fire resistant tape). Fires that produce penetrating debris (e.g., solid material released from aerosol canisters or molten droplets with high heat capacity from primary lithium batteries) can render the liner ineffective from the requirements for smoke/fume penetration, retention of fire suppression agent, and control of ventilation. Failure of the liner can lead to catastrophic loss of an airplane.

6.3 Aircraft Fire Suppression.

6.3.1 Aircraft fire suppression capability is based on fires involving ordinary combustibles (e.g., paper, textiles, and wood). Items carried in aircraft cargo compartments are composed of many different types of materials, including those that are classified as hazardous materials.

6.3.2 The advent of halon-based fire suppression systems brought additional capabilities in Class C compartments for hazards beyond ordinary combustibles, such as flammable fluids and hydrocarbon gases.[5]

6.3.3 Regardless of the class of cargo compartment, no regulation states that the decision to carry items be based on the capability of a fire-suppression system.[6] Therefore, if the capability of the aircraft is limited to ordinary combustibles, a significant amount of items in the aircraft cargo compartment could have the potential to overwhelm the fire protection capability. There are limits to these fire suppression capabilities; however, it is still possible to load items in compliance with current regulatory requirements but exceed the fire suppression capability of the Class C compartment.

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[5] DOT/FAA/AR-TN05/20, Minimum Performance Standard for Aircraft Cargo Compartment Halon Replacement Fire Suppression Systems (2nd Update), quantifies the capabilities that halon suppression agents have to enable the use of replacements.

[6] Per 14 CFR part 25, § 25.851(b)(2), "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."

7 HAZARDS TO ADDRESS WHEN APPLYING SRM.

7.1 Hazards Associated with the Carriage of "Items." This section summarizes the types of items that, when carried in an aircraft cargo compartment, might negatively affect safety. In addition, passengers may introduce hazards in their checked baggage and they frequently carry items that are discussed in this section.

7.1.1 Hazards and Associated Characteristics. Operators should consider the following types of items. While not all-inclusive, this list represents some of the most common hazards related to the carriage of items in the aircraft cargo compartment:

- Items that can act as ignition sources, as they can increase the likelihood that a fire will start. Items that are both an ignition source and a fuel are especially concerning because they can allow any fire that starts to grow and propagate.
- Items that produce combustible gases that can ignite explosively, creating a condition that the fire suppression system cannot suppress (e.g., hydrogen gas).
- Materials that burn at temperatures and heat release rates that are of sufficient quantity to compromise the fire suppression system, even if the fire is suppressed.
- Materials of a quantity and combustion intensity that can compromise the fire suppression system prior to the release of the fire suppressant.
- Materials that are self-oxidizing, meaning they can reduce the suppression agent concentrations required to suppress the fire.

7.1.2 Examples of Common Hazards and Items that Integrate these Hazards. Operators typically load lithium batteries, powered devices, and tracking technologies into aircraft cargo compartments. The following items may exhibit the characteristics described above and should be considered by the operator:

7.1.2.1 Lithium batteries can exhibit unique behavior where an internal short within the battery caused by a manufacturing contaminant or defect, damage during handling, or heat produced from the environment can lead to thermal runaway. Thermal runaway is a chain reaction leading to self-heating and release of a cell's or a battery's stored energy. The release of heat during thermal runaway may heat adjacent cells, forcing them into thermal runaway as well. This process is called propagation. In addition to heat and the potential for fire, lithium cells and batteries in thermal runaway may release flammable gases (e.g., hydrogen, hydrocarbons, and carbon monoxide). Thus, lithium batteries can act as both the ignition source and fuel for a fire. Additionally, the released flammable gas can build up, and if ignited, it can cause an explosion that results in an over-pressure event on the aircraft.

7.1.2.2 Operators might employ powered devices to transport perishables, medical supplies, pharmaceuticals, and other items at a specific temperature or humidity on pallets or in containers. Device manufacturers use batteries of multiple types to power these systems, and the manufacturers frequently

integrate electrical wiring, fans, and components that should be able to withstand the handling, loading, and transport environments. Manufacturers provide maintenance manuals and instructions to assist an operator in integrating the containers into their operations. Operators should understand and assess the capabilities and characteristics of powered devices before carrying such devices.

7.1.2.3 Shippers and operators commonly attach tracking devices to containers, nets, or the cargo shipment itself. They are also placed inside of packages that are not part of the consignment. AC 91.21-1, Use of Portable Electronic Devices Aboard Aircraft, provides guidance on certain aspects of the operational use of these devices in aircraft cargo compartments, but does not provide guidance on attaching them to cargo or the prevention of damage. The operator should determine a safe location for placement on items or within shipments to ensure the device does not experience damage or cause damage to the shipment or packaging. The operator should also assess whether the device could become involved in a fire that starts outside the package and whether the device would cause an otherwise suppressible fire to become insuppressible.

7.2 Changes to the HMR. In addition to addressing the hazards above, operators should monitor changes to the HMR. For example, lithium-type batteries offered for transportation are required to meet United Nations (UN) classification test criteria, and updated packaging and marking requirements.

8 OUTCOMES POSED BY ITEMS IN AIRCRAFT CARGO COMPARTMENTS.

8.1 Outcomes Associated with the Carriage of Items. Outcomes are the negative events or effects that a hazard can trigger. One hazard can trigger multiple outcomes and operators should address each outcome. The following is a discussion of the potential outcomes associated with the carriage of items in aircraft cargo compartments and the degree to which current practice mitigates the associated risks. Refer to https://www.fire.tc.faa.gov/cargosafety for a summary of issues the FAA has identified that operators should consider to address fire safety concerns on the aircraft.

8.1.1 Fire Event in an Aircraft Cargo Compartment. Aircraft cargo compartments, suppression systems, and mitigation procedures should protect the aircraft and occupants against fires likely to occur. If items cause a fire, the intensity of the fire is measured in terms of its thermal energy. The energy of the fire can cause direct damage to the aircraft structure and systems, from direct fire penetration or from rising temperatures in the compartment that exceed the temperatures the aircraft was designed to withstand.

8.1.1.1 For Class C and Class E cargo compartments, a fire intensity beyond the capability of the cargo compartment can breach the cargo compartment liners, which can in turn damage the structure, flight controls, or other characteristics. Such damage would affect continued safe flight and landing.

8.1.1.2 For Class C cargo compartments, a fire of sufficient intensity can make the cargo compartment liners porous, allowing the suppression agent to leak, which could lead to an uncontrollable fire.

8.1.2 Overpressure Threat. A unique and significant hazard that may result from a lithium battery thermal runaway event is the expulsion of large quantities of flammable gas. The flammable gas has the potential to collect and ignite, resulting in a significant overpressure event.

8.1.2.1 For a Class C cargo compartment, overpressures that result from a violent combustion of combustible gases can dislodge the cargo compartment liners, which allows the suppression agent to escape. This will also lead to smoke and products of combustion entering occupied areas.

8.1.2.2 For Class C or Class E cargo compartments, overpressures that result from a temperature increase can force smoke and other products of combustion into occupied areas, causing loss of visibility and ingestion of toxic gases. In the extreme, the violent combustion of gases (e.g., explosion) could cause structural damage to the aircraft.

8.1.3 Electromagnetic Interference (EMI). EMI originating from electronic devices has the potential to interfere with the systems that provide navigation and flight guidance. In accordance with 14 CFR §§ 23.2520, 25.1317, 27.1317, and 29.1317, aircraft are designed to resist EMI from external sources. Sources internal to the aircraft are addressed in AC 20-164, Designing and Demonstrating Aircraft Tolerance to Portable Electronic Devices, and in AC 20-190, Aircraft Electromagnetic Compatibility Certification, for the design, and in AC 91.21-1 for the carriage of portable electronic devices (PED). Other than with regard to magnets, the HMR do not address the potential for items in the aircraft cargo compartment to emit electromagnetic radiation.

8.1.4 Corrosion. Some operators are required to have a Corrosion Prevention Control Program, in accordance with § 121.367, Maintenance, Preventive Maintenance, and Alterations Programs. The corrosion control program is embedded in the original maintenance program. Information and recommended procedures can be found in manufacturers' published manuals and in AC 43-4, Corrosion Control for Aircraft. The packaging requirements in the HMR are designed to minimize leaking. Proper handling of cargo is equally important to avoid leaks or damage to packaging that could potentially result in the aircraft structure being exposed to corrosive substances. Corrosion is a chronic issue that operators should manage in the course of aircraft maintenance, but if acute exposure to corrosive substances occurs from the cargo, operators should consider implementing additional controls.

9 INPUT FROM MANUFACTURERS.

9.1 Design Approval Holders (DAH). DAHs, including type certificate (TC) and Supplemental Type Certificate (STC) holders, possess additional technical information to

support a proper risk assessment. This information may include specifications, capabilities, and certification requirements of pertinent aircraft systems.

9.2 Additional Information from Manufacturers. In addition to information regarding classes of aircraft cargo compartments and the minimum performance standards (MPS) used to qualify them, aircraft manufacturers or modifiers may have published or made available information regarding their specific aircraft.

10 CONDUCTING A RISK ASSESSMENT.

10.1 Following the completion of a system analysis, an operator conducts an SRM of the identified hazards and their associated consequences. The risk assessment involves determining the probability that a consequence will occur and assessing the severity of that consequence.[7] A hazard may have many associated consequences, each of which a valid risk assessment would consider.

10.2 An operator's risk assessment should consider the types of operations and items carried. A flight-by-flight risk assessment is not always necessary.

10.3 An operator's risk assessment should consider the safety of the transport supply chain. From origin to destination, many entities with varying responsibilities and capabilities handle cargo along the supply chain, such as shippers, postal operators, freight forwarders, ground handlers, and other operators. An operator should consider any data that may help them assess the probability, which could include the following:[8]

- Damage to items through any part of the supply chain;
- Shippers deliberately or unintentionally offering hazardous materials for transport without declaring them;
- Shippers improperly classifying, packing, marking, or labelling hazardous materials;
- Freight forwarders accepting undeclared hazardous materials from shippers;
- Hazardous materials prohibited in the mail; and
- Passengers carrying prohibited hazardous materials in baggage.

10.4 If an operator were to deviate from the operations that defined the initial risk assessment, then the operator should re-examine the assessment to determine whether new hazards have been introduced or whether the consequences or risks associated with existing hazards have changed. Significant changes in the type or amount of a hazardous material, or a change in the types of containers upon which the operator relies on to mitigate a fire, are examples of deviations from the initial risk assessment.

[7] Refer to AC 120-92 for guidance on risk assessments and other components of SRM.
[8] Refer to ICAO Doc 10102, § 4.2, Safety Risk Probability, and § 5.2, Mitigation Strategies to Address the Likelihood of Occurrence.

10.5 The operator should monitor the effectiveness of existing risk controls to determine their effectiveness over time. The risk assessment should be re-examined in accordance with SRM, as safety management activities mitigate safety risks before they result in aviation accidents or incidents.

11 RISK CONTROLS.

11.1 General. Part 5, § 5.5 defines a "risk control" as a "means to reduce or eliminate the effects of hazards." Safety risk controls mitigate "unacceptable" levels of risk, and the operator must evaluate whether the risk will be acceptable with the proposed safety risk control applied before the safety risk control is implemented. Controls, which can be implemented in the form of preventive or mitigation measures, can affect both the likelihood and severity of outcomes. While not all-inclusive, below are controls that an operator can consider. Refer to https://www.fire.tc.faa.gov/cargosafety for information and research regarding controls.

11.2 Preventive Controls. Controls can increase operator confidence that items they will carry are accurately described and prepared for transport. This reduces the likelihood that unknown hazards are present.

11.2.1 An operator may choose to limit from whom it will accept shipments. This might be through direct agreements with specific shippers. The operator may also implement policies and procedures on specific criteria needed to become a shipper from which the operator will accept shipments.

11.2.2 An operator may place controls on the items it agrees to carry. To be effective, structured processes, process measurements, and controls should be in place to implement the limitations in the operator's policies.

11.2.3 An operator may place controls on the quantity of any given items it agrees to carry to reduce the risk to an acceptable level.

11.2.4 Locating and separating specific items that are not compatible with one another is a preventive control. Although some requirements related to segregation of different types of hazardous materials exist, they do not fully address the potential for the items to interact destructively in the event of a fire. An operator may implement controls to avoid concentrating items of a given type in a single area (i.e., limiting the quantity at specific locations). An operator might also take steps to isolate items that can interact with one another. Implementing controls to avoid combining certain items in one location may reduce the chances that a fire would exceed the capability of the aircraft. For example, because ignition sources can increase the likelihood that a fire will start at a particular location, an operator should separate potential ignition sources from flammable fluids. Separating potential fuel from the ignition source will reduce the potential for the fire to grow and become uncontrollable.

11.2.5 An operator might use scanning technologies, supplemental to their security protocols, to detect various hazardous materials. Such mechanisms support the detection and removal of an item before it is loaded onto the aircraft.

11.2.6 An operator may seek advice from aircraft manufacturers regarding areas of the aircraft that might have additional capability beyond the nominal capability provided by a compartment that meets the minimum standards for its classification.

11.2.7 Where an aircraft has more than one class of cargo compartment, an operator may elect to place only certain types of cargo in a particular class of compartment. For example, loading flammable items in a Class C compartment with active fire suppression versus loading in a Class E compartment that uses passive fire suppression (oxygen starvation) might mitigate the risk should a fire occur.

11.2.8 Common items, such as PEDs or batteries, carried by passengers and crew may introduce risk. Operators should address damaged items carried onboard the aircraft or damaged during flight.

11.3 Fire Containment Controls. In the event an operator cannot attain an acceptable level of risk, the operator should employ additional controls to mitigate risk, such as:

11.3.1 Packaging can prevent an event occurring at the package level from becoming an aircraft level event. An operator may require that certain hazardous materials be shipped in packaging that would prevent a failure inside the package from becoming an uncontrollable event by ensuring the effects of the failure are not spread outside the package. For example, reducing the state of charge of a shipment of batteries or requiring a specific type of packaging may allow the package to contain a failure of a battery. The benefit of this approach is that the effects of the event being mitigated are less at the package level than what can occur at the aircraft level.

11.3.2 Fire Resistant Containers (FRC) can provide passive means to contain Class A[9] fires. Technical Standard Order (TSO)-C90e, Unit Load Devices, provides performance and testing requirements for the design and production approval of an FRC. An operator may choose to utilize such ULDs in order to mitigate not only Class A fires, but also small hazardous material fires. If an operator decides to employ FRCs to mitigate hazardous material fires, refer to research at https://www.fire.tc.faa.gov/cargosafety to learn more about how various FRCs have performed during research tests. An operator may elect to utilize FRCs for:

1. All of their containerized cargo operations,
2. Specific items, or
3. Specific flight operations.

Note: TSO-C90 does not address smoke detection within the aircraft as a result of a fire starting under the fire containment cover.

11.3.3 Fire Containment Covers (FCC) can be used over non-containerized, palletized cargo to provide enhanced fire safety similar to an FRC and for similar fires (Class A plus small hazardous materials fires). Refer to TSO-C203 and https://www.fire.tc.faa.gov/cargosafety

[9] Refer to AC 20-42, Hand Fire Extinguishers for Use in Aircraft, for description of fire classifications.

for information on the required performance of these covers and additional research to supplement the information in the TSO. An operator may elect to utilize FCCs for:

1. All palletized cargo operations,
2. Specific items, or
3. Specific flight operations.

Note: TSO-C203 does not address smoke detection within the aircraft as a result of a fire starting under the fire containment cover.

11.3.4 An operator may implement a fire suppression system where none is required, such as in a Class E cargo compartment or within a ULD. An operator might modify an existing suppression system to be more effective by increasing the amount of suppression agent to increase the available concentration, thereby increasing the number of hazardous materials against which the agent is effective. For example, Halon 1301 at a 3 percent concentration (typically considered effective for fire suppression) is not effective against a specific hydrocarbon gas ignition, for which a concentration around 10 percent is effective. These types of modifications may require a change to the type design and issuance of an STC.

11.3.5 The route of flight can be a mitigation by choosing to operate so that the time to diversion airports is reduced, allowing a shorter time to initiate a landing in an emergency. Selection of a route of flight that avoids highly populated areas is a potential mitigation when transporting certain specified articles and substances.

11.3.6 In the event that the other controls and mitigations listed above have not been effective, the crew may experience smoke in the flight deck that reduces visibility below that which is necessary to see either the primary flight instruments or out of the windshield. Protective breathing equipment is already required,[10] but might not provide visibility when smoke is dense and continuous. There are means to physically displace smoke in order to make the flight critical instruments and electronic systems visible in the event of significant loss of visibility in the flight deck. Some devices may also provide a clearer view out of the windshield. A manufacturer should align any vision augmentation system with the capability and duration of the protective breathing system.

11.3.7 The operator should ensure the amount of breathable oxygen onboard is sufficient to allow the flightcrew to land the aircraft in the event of an in-flight fire.

12 REQUEST FOR INFORMATION.

- The current edition of the CFRs is available at https://www.ecfr.gov.

[10] Refer to Part 25, § 25.1439, Protective Breathing Equipment; 14 CFR Part 91, § 91.211, Supplemental Oxygen; 14 CFR Part 121, § 121.337, Protective Breathing Equipment; and 14 CFR Part 135, § 135.89, Pilot Requirements: Use of Oxygen.

- Current editions of ACs are available on the FAA website at https://www.faa.gov/regulations_policies/advisory_circulars/ and on the Regulatory and Guidance Library (RGL) at https://rgl.faa.gov.

13 AC FEEDBACK FORM. For your convenience, the AC Feedback Form is the last page of this AC. Note any deficiencies found, clarifications needed, or suggested improvements regarding the contents of this AC on the Feedback Form.

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APPENDIX A. RELATED REGULATIONS AND STANDARDS

A.1 Title 14 of the Code of Federal Regulations (14 CFR).

A.1.1 Part 5, Safety Management Systems.

A.1.2 Part 23, Airworthiness Standards: Normal Category Airplanes. Section 23.2325, Fire Protection.

A.1.3 Part 25, Airworthiness Standards: Transport Category Airplanes.

- Section 25.851, Fire Extinguishers.
- Section 25.853, Compartment Interiors.
- Section 25.855, Cargo or Baggage Compartments.
- Section 25.857, Cargo Compartment Classification.
- Section 25.858, Cargo or Baggage Compartment Smoke or Fire Detection Systems.
- Section 25.1439, Protective Breathing Equipment.

A.1.4 Part 27, Airworthiness Standards: Normal Category Rotorcraft.

- Section 27.853, Compartment Interiors.
- Section 27.855, Cargo and Baggage Compartments.

A.1.5 Part 29, Airworthiness Standards: Transport Category Rotorcraft.

- Section 29.853, Compartment Interiors.
- Section 29.855, Cargo and Baggage Compartments.

A.1.6 Part 91, General Operating and Flight Rules.

- Section 91.211, Supplemental Oxygen.
- Section 91.525, Carriage of Cargo.

A.1.7 Part 121, Operating Requirements: Domestic, Flag, and Supplemental Operations.

- Section 121.285, Carriage of Cargo in Passenger Compartments.
- Section 121.287, Carriage of Cargo in Cargo Compartments.
- Section 121.306, Portable Electronic Devices.
- Section 121.337, Protective Breathing Equipment.

- Section 121.367, Maintenance, Preventive Maintenance, and Alterations Programs.
- Section 121.589, Carry-on Baggage.

A.1.8 Part 125, Certification and Operations: Airplanes Having a Seating Capacity of 20 or More Passengers or a Maximum Payload Capacity of 6,000 Pounds or More; and Rules Governing Persons on Board Such Aircraft.

- Section 125.183, Carriage of Cargo in Passenger Compartments.
- Section 125.185, Carriage of Cargo in Cargo Compartments.
- Section 125.204, Portable Electronic Devices.

A.1.9 Part 135, Operating Requirements: Commuter and On Demand Operations and Rules Governing Persons On Board Such Aircraft.

- Section 135.87, Carriage of Cargo Including Carry-on Baggage.
- Section 135.89, Pilot Requirements: Use of Oxygen.
- Section 135.144, Portable Electronic Devices.

A.2 Title 49 of the Code of Federal Regulations (49 CFR), Transportation. Refer to Subtitle B, Other Regulations Relating to Transportation, Chapter I, Pipeline and Hazardous Materials Safety Administration, Department of Transportation, Subchapter C, Hazardous Materials Regulations, as applicable.

A.3 International Civil Aviation Organization (ICAO).

- Annex 6 , Operation of Aircraft.
- Annex 18, The Safe Transport of Dangerous Goods by Air.
- Annex 19, Safety Management.
- Doc 9284, Technical Instructions for the Safe Transport of Dangerous Goods by Air.

APPENDIX B. REFERENCE MATERIAL

B.1 Advisory Circulars (AC) (current editions).

- AC 20-164, Designing and Demonstrating Aircraft Tolerance to Portable Electronic Devices.
- AC 20-190, Aircraft Electromagnetic Compatibility Certification.
- AC 25.795-5, Cargo Compartment Fire Suppression.
- AC 25-18, Transport Category Airplanes Modified for Cargo Service.
- AC 25.857-1, Class B and F Cargo Compartments.
- AC 43-4, Corrosion Control for Aircraft.
- AC 60-22, Aeronautical Decision Making.
- AC 91.21-1, Use of Portable Electronic Devices Aboard Aircraft.
- AC 120-80, In-Flight Fires.
- AC 120-85, Air Cargo Operations.
- AC 120-92, Safety Management Systems for Aviation Service Providers.

B.2 Orders (current editions).

- Order 8000.369, Safety Management System.
- Order 8040.4, Safety Risk Management Policy.
- Order VS 8000.370, Aviation Safety (AVS) Safety Policy.
- Order VS 8000.367, Aviation Safety (AVS) Safety Management System Requirements.

B.3 Technical Standard Orders (TSO).

- TSO-C90e, Unit Load Devices.
- TSO-C203, Fire Containment Covers (FCC).

B.4 Commercial Aviation Safety Team (CAST) Safety Enhancements (SE). These SEs can be found in the CAST Safety Portfolio at https://www.cast-safety.org.

- SE027, Risk Assessments and Management.
- SE028, Process to Inform Personnel and Flight Crew.
- SE125, Cargo Hazardous Materials (HazMat) Processing.
- SE127, Cargo—Fire Containment.
- SE131, Safety Culture.

- SE223, Cargo—Hazardous Material Fires—Prevention and Mitigation.
- SE224, Cargo—Hazardous Material Fires—Enhanced Fire Detection Systems (R-D).
- SE225, Cargo—Hazardous Material Fires—Containment and Suppression (R-D).
- SE226, Cargo—Hazardous Material Fires—Enhanced Protection of Occupants and Aircraft.

B.5 International Civil Aviation Organization (ICAO).

- Doc 9859, Safety Management Manual (SMM).
- Doc 10102, Guidance for the Safety Operations Involving Aeroplane Cargo Compartments.
- Doc 9734, Safety Oversight Manual.

APPENDIX C. RELATED REGULATIONS

Note: The following table provides a summary of characteristics of cargo compartments codified at 14 CFR §§ 25.851, 25.855, 25.857, and 25.858. For operators of parts 23, 27, and 29 aircraft using this guidance to understand the aircraft capabilities and the aircraft interface with the cargo items, determine the characteristics of your cargo compartments that most closely align with the classes below.

Table C-1. Summary of Characteristics of Cargo Compartments

	Class A	Class B	Class C	Class D[11]	Class E	Class F
Fire Detection	Detection via crew	Automatic smoke detection	Automatic smoke detection	No detection	Automatic smoke detection	Automatic smoke detection
Principal Crew Action	Hand-held fire extinguishing	Hand-held fire extinguishing	Activate fire suppression system	No action unless indication of fire is present—then land as soon as possible	Depressurize and set generally at FL 200/250	Depends on design
Aircraft Firefighting Means	Active firefighting via hand-held extinguisher	Active firefighting via hand-held extinguisher	Built-in fire suppression system	Isolation	Flight level procedure, reducing oxygen partial pressure	Depends on design
Firefighting Principle	Extinguishing	Extinguishing	Fire suppression via inhibition (Halon 1301)	Fire containment and oxygen consumption	Oxygen starvation	Depends on design
Expected Post-Fire Suppression Conditions or Actions	Monitoring	Monitoring	Until end of flight	Increase of oxygen partial pressure during descent phase	Increase of oxygen partial pressure during descent phase	Depends on design
Design Steady-State Conditions (Objective)	Extinguished	Extinguished	Suppressed fire with cargo compartment temperature potentially >200°C	Smoldering fire, depending on oxygen concentration left	Similar condition as Class C cargo	Depends on design

[11] Due to several uncontrollable fires in Class D compartments, they were eliminated by Amendment 25-93, effective March 19, 1998. Refer to 63 Federal Register (FR) 8032 (Feb. 17, 1998). As explained in Amendment 25-93, Class D cargo compartment standards pre-dating Amendment 25-93 are inadequate. Therefore, the FAA does not approve new Class D cargo compartments in airplanes with a certification basis pre-dating Amendment 25-93.

Advisory Circular Feedback Form

If you find an error in this AC, have recommendations for improving it, or have suggestions for new items/subjects to be added, you may let us know by contacting the Flight Standards Directives Management Officer at 9-AWA-AFB-120-Directives@faa.gov.

Subject: AC 120-121, Safety Risk Management Involving Items in Aircraft Cargo Compartments

Date: _____

Please check all appropriate line items:

☐ An error (procedural or typographical) has been noted in paragraph _____ on page _____.

☐ Recommend paragraph _____ on page _____ be changed as follows:

_____

_____

☐ In a future change to this AC, please cover the following subject:
(Briefly describe what you want added.)

_____

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☐ Other comments:

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_____

☐ I would like to discuss the above. Please contact me.

Submitted by: _____ Date: _____