Guidelines for the Transport of Cargo in the Passenger Compartment

Revision 3

Guidelines for the Transport of Cargo in the Passenger Compartment

1. Request for Approval

1.1 Cargo shall only be transported by operators holding valid Cargo transport approvals with aeroplanes certified under the Airworthiness Standard of Large Aeroplanes.

1.2 Any operators wishing to apply for an approval to carry cargo in the passenger compartment shall contact the Civil Aviation Authority of Thailand (CAAT) in writing and provide the following:

a. Official request letter
b. Safety risk assessments with supporting evidences (refer to section 2.1)
c. Operating procedures to demonstrate that the requirements set out in this guideline can fully be met.

2. Procedures

2.1 Safety risk assessments shall be performed in order to identify hazards, evaluate and mitigate correlated risks related to operating cargo flights using cabin configurations which have been approved for transporting only passengers.

Some examples of possible risks include, but are not limited to, the following:

a. Operator's general knowledge of cargo transport;
b. The detection of any smoke or fire and firefighting capabilities of personnel in the cabin;
c. Qualification and abilities of crew member or other personnel to control and put out fire in the cabin;
d. The provision, location and storage of sufficient firefighting equipment such as portable breathing equipment, fire extinguishers etc. for use by personnel carried in the cabin;
e. Extended Diversion Time Operations (EDTO)
f. Mis-declared / undeclared or hidden dangerous goods
g. Unrestricted access to all cargo shipments
h. Cargo leakage / spillage
i. Unsecured / incorrectly loaded cargo
j. Incorrect loading and unloading sequence
k. Operational weight and balance limits exceedance
l. Qualification of ground staff to prepare and load cargo in accordance with applicable regulations and instructions
m. Occupational Health and Safety (OHS) risks associated with the new procedures.

2.2 Checks shall be made before take-off, before landing and whenever requested by the captain to ensure that cargo is properly stowed and secured.

2.3 Operators shall establish procedures to manage emergencies in the cabin.

2.4 Existing procedures, including emergency procedures, must be reviewed and adapted as necessary.

2.5 Operators shall publish temporary revisions to the Operations Manual (OM) to include the new type of operations and the related procedures.

3. Crew Composition

3.1 Operations without passengers shall still the presence of crew members to survey and access all areas of the cabin during all phases of flight. Any fire that might occur must be timely detected and effectively fought utilizing the available existing emergency equipment.

3.2 Crew members in the cabin have to sit on seats which are not located near the cargo.

4. Loading, Mitigations for Transport of Cargo in the Passenger Compartment including on Passenger Seats

4.1 Exact cargo weight and position in the cabin and in the cargo hold shall be reflected in the mass and balance documentation (load sheet).

4.2 The pilot-in-command shall be provided with information on the content of all the cargo such as through provision of the cargo manifest or other appropriate documentation.

4.3 The operator shall load the aircraft considering the different levels of available fire protections of the loading areas. (i.e. passenger cabin and lower deck cargo compartments).

4.4 Cargo must be adequately restrained to ensure the cargo does not come loose or shift during flight or emergency landing conditions

4.5 For the bulkheads that have a placard indicating maximum capacity, the cargo items stowed in aft of these bulkheads shall not exceed the maximum capacity indicated in the placard.

4.6 The maximum capacity limitations in the required safety placards (on or adjacent to the cargo approved stowage locations) shall not be exceeded. All stowage instructions specified in the placards apply.

4.7 The mass of the cargo shall not exceed the structural loading limits of the floor or seats, as published in the aircraft documentation (e.g. Limitation chapter of the Weight and Balance Manual). Compliance with EASA CS 25.561, 25.787 and 25.789 or FAA 14 CFR Part 25.561, 25.787 and 25.789 is expected.

4.8 The cargo placed in enclosed stowage areas shall not be of such size that they prevent latched doors from being closed securely.

4.9 The cargo items shall be stowed only in a location that is capable of restraining it.

4.10 The cargo stowage location shall be such that, in the event of an emergency evacuation, it will not hinder aisle access and egress.

4.11 The cargo shall not be placed where it can impede access to emergency equipment.

4.12 The cargo shall not be placed where it can impede the visual to the safety instruction sign and placard, emergency equipment, exit.

4.13 The cargo shall be checked to ensure proper stowage in the following instances (at the minimum):

a. Before take-off,

b. Before landing,

c. Under orders of the Pilot in Command (PIC).

4.14 The available aisle(s) shall remain free of cargo to enable access to the cargo to fight a fire.

4.15 Any smoke/ fire within the cabin must be easily detected and effectively fought using the existing emergency equipment. Thoroughly briefed crew members (not part of the flight crew) shall be on-board to survey and access all areas of the cabin during all flight phases. There must be an adequate number of trained crew members acting as fire-fighter (not part of the flight crew) with sufficient amount of firefighting equipment. This equipment may be stowed in the cabin using existing stowage provisions (overhead bins, stowage's) provided that the location is identifiable for the crew. Specific details must be coordinated with the CAAT.

4.16 Crew members in the cabin should use existing cabin crew seats and must not share seat rows with cargo. There must be a clear separation of areas occupied by occupants and those fitted with cargo during taxi, take-off and landing. At least one empty seat row between cargo and reserved occupant seats must be established.

4.17 'Under seat stowage' is allowed only if the seat is equipped with a restraint bar system and the cargo items can be placed fully underneath the seat. The loading of the cargo under each seat should not exceed 9 kg (20 lbs.).

4.18 The cargo packaging shall be able to equalize the pressure so that it can handle the Delta Pressure (DP) during the flight, as applicable.

4.19 All smoke and fire detectors shall be maintained as per Maintenance Manual instructions.

4.20 The Air Conditioning system shall be set taking into account the nature of the cargo transported in the cabin and the number and distribution of cabin occupants.

4.21 If nets are used to restrain cargo items, these nets should be European Technical Standard Order (ETSO) approved and any load limitations of these nets including their attachment means should be adhered to. Any deformation of these nets due to the mass of the cargo items restrained under emergency landing, flight or ground loads should be evaluated for contact to other objects in the cabin and be shown not to block emergency evacuation paths nor access to emergency equipment.

5. Airworthiness Aspects for Transport of Cargo in the Passenger Compartment

5.1 Operators may transport cargo in the passenger compartment without design change approval as long as the cargo is placed in the approved stowage locations within the passenger compartment as follows:

a. Overhead stowage bins

b. Stowage compartments

c. Floor mounted stowage (e.g. doghouses)

d. Bulkheads that have a placard indicating maximum capacity

e. Under seat stowage areas

For permanent use, a design change approval is required as detailed in 5.3.

5.2 The temporary transportation cargo in the passenger compartment including on passenger seats shall only be approved when the operator can demonstrate that the conditions described in 4. and the technical guidance which can be found in Annex 1 of this guideline document can be fulfilled. A design change approval is not a prerequisite for the issuance of an Exemption. However, certain design data may support the process.

5.3 Transport of cargo in the passenger cabin under a design change approval

In order to allow transport of cargo on a permanent basis beyond 31 March 2021, a design change approval is required. Except for what allowed by paragraph 5.3.1 below, for transport of cargo restrained on seats as well as in case removal of seats are necessary to allow fixation of cargo onto the aircraft structure, a Major Change or STC application is required.

The type of cargo to be transported in the passenger cabin would need to be under control (no unidentified cargo) and assessed beforehand in the frame of the Supplemental Type Certificate (STC) assessment process.

5.3.1 Transport of medical supplies restrained on passenger seats

a. In the context of the emergency situation created by the Covid-19 pandemic, Approved Design Organizations may reclassify such modification as “Minor Change” and approve such modifications, under their Design Organization Approval (DOA) - privileges, allowing the transportation of medical supplies (e.g. masks, gloves, clothing, etc.) restrained on passenger seats, provided that the transported medical supplies are not classified as dangerous goods. This has to be indicated in the approval documents and Aircraft Flight Manual (AFM) Supplement.

b. For a design change, including a “re-classified” change, in case professional Cabin Crew is specified and is required to perform any function in the frame of the cargo operation, this has an impact on Cabin Crew Operational Suitability Data (CCD) and will require CCD-related change approvals

c. The applicability of these design changes is to be restricted to non-exported airplanes. The DOA shall introduce this limitation in the design change approval sheet.

d. Since this kind of installation is a change in the scope of operation of the aeroplane, and in the absence of dedicated operational requirements covering this kind of operation, the installation and the procedures for operation have to be addressed taking into account the specific configuration of each aeroplane model affected.

6. No Exemption for Transport of Dangerous Goods

6.1 Dangerous goods (with an exemption to vaccines cooled by dry ice) shall not be carried in the passenger cabin and always be carried in the hold and shall be transported under the conditions established by the Technical Instructions.

6.2 Operators need to be cautious of potential hidden dangerous goods that medical supplies and similar cargo shipments may contain.

It is recommended that 'Transport of Cargo in the Passenger Compartment' guidelines by EASA for the required process, including but not limited to the content of the safety risk assessment, crew composition and procedures, and other aspects should be referred to.

Documents published by the industry (aircraft Original Equipment Manufacturers (OEM), SAE) to provide guidance on how to transport cargo in the passenger cabin are referenced in Annex 2.

For more information for transportation of vaccines using dry ice can be found on Annex 3 of this guideline.

Annex 1

1. Further Guidance for Transport of Cargo in the Passenger Compartment

The following guidance addresses in general the transport of cargo on seats, on the cabin floor with seats installed or with seats removed.

Primary objectives to be achieved when using of the passenger cabin for transport of different kind of cargo are:

- Timely fire detection, effective fire-fighting and adequate protection of the occupants from hazardous quantities of smoke and toxic gases;
- Fixation of cargo to ensure occupant safety and prevent changes of aircraft center of gravity, accounting for the structural strength and integrity in normal and emergency conditions;
- Emergency evacuation of occupants.

An applicability list of the below listed areas - depending on the kind of cargo – is provided in Table 1.

1.1 Restrictions to the Kind of Cargo:

The transportation of the following cargo in the cabin shall be prohibited:

a. Dangerous goods (with an exemption to vaccines cooled by dry ice dealt with in the Annex 3 “Transportation of vaccines using dry ice” of this guidelines);
b. Mail;
c. Batteries, including batteries contained in, or packed with, equipment;
d. Cargo of a piercing, dense, rigid, or penetrating nature, or cargo with sharp edges or corners, such as rods, pipes, extrusions, or beams, that could become a projectile hazard during flight operations;
e. Live animals.

1.2 Cabin Preparation:

a. Passenger convenience systems (IFE, in-seat power, galley systems and any other heat generating systems) in the cabin areas in which cargo is transported will have to be disabled or deactivated.
b. Automatic supplemental oxygen systems in the cabin areas in which cargo is transported will have to be removed from the PSU channels, without leaving any opening, or shall be deactivated.
   Note: Chemical O2 generator or decentralized gaseous O2 installed in the PSU channel will start the O2 generation or O2 release when certain temperatures are reached. Based on the possible fire scenario originating from the cargo loaded the O2 systems would need to be removed or deactivated (O2 mask drop prevented to keep the shielding from the container doors).
c. Cargo shall not be stowed in any compartment containing oxygen bottles and/or PBEs, as well as devices containing lithium batteries.

1.3 Cargo Loading:

a. It is not required to install a 9g barrier and a smoke barrier to protect the flight deck and cabin occupants. Cargo shall be restrained so that each cargo installation meets airworthiness standard EASA CS 25.561 or FAA 14 CFR Part 25.561 and other applicable structural requirements.

b. In each section of the cabin where cargo is transported:

- there shall be at least one longitudinal aisle meeting the minimum width dimensions specified in airworthiness standard EASA CS 25.815 or FAA 14 CFR Part 25.815 for aeroplanes with a seating capacity of 10 or less passengers.
- Cargo shall be loaded so that there is sufficient access to the cargo to allow effective fire-fighting.
- For twin-aisle aeroplanes in which seats are not removed and are used to restrain cargo, there shall be an unloaded seat row to allow crossing from one aisle to the other. To the extent possible the unloaded seat row shall be located at equal distance from the available cross-aisles required by airworthiness standard EASA CS 25.813 or FAA 14 CFR Part 25.813.

c. Floor path marking may be removed or obscured by cargo in areas that are not going to be used as evacuation paths by the cabin occupants.

d. Features that allow decompression shall be maintained, i.e. pallets or cargo shall not obstruct decompression vents or flow.

e. When cargo is loaded on the floor:

- The height of the cargo shall not exceed 127 cm (50 inches) (approximately the height of a typical economy class seat).
- The volume of each cargo loading area, whether on a pallet or directly tied to the floor shall not exceed 3.54m³ (125 ft³).
- A lateral access should be provided fore and aft of each cargo loading area as noted below. To allow for appropriate access to the cargo and for firefighting the following should be provided:
  - A longitudinal aisle(s) width of at least 51 cm (20”). Each longitudinal aisle must enable a crewmember to traverse it while walking upright
  - A lateral access fore and after of each loading area of at least 38 cm (15”) wide
  - Access provisions shall be unobstructed including from the cargo restraint means
- In addition, Limitations applicable to the mass, distribution and method of restraint of the cargo shall be established based on guidance from the aircraft OEM.

f. Cargo loaded on a seat shall not exceed 22.5kg (50 lbs) per seat place or 50 kg(110lbs) in a single package per triple seat respectively. Underseat stowage of up to 9 kg. (20 lbs) per seat place is allowed in addition to this limitation. The cargo shall not extend above the seatback height. Potential restraint methods might include:

- **Seat tracks** (after removing the plastic row-to-row track cover), based on guidance from the aircraft OEM. Attach netting over the seat and boxes. Secure the net to the seat track. Ensure that the net is moderately taut so as to maintain an aisle width for in-flight surveillance of smoke and fire.
- **Seat belts or seat belt shackles.**
  Add additional strapping attached to or going around the forward and top side of the boxes. This strapping to be attached to the buckled and cinched down seat belt (seat belt does not go around box since it doesn't adequately restrain the box in forward and up directions).
- **Seat beams** (located immediately below the seat bottom cushion)
  Strap the forward and top side of the boxes to the forward and aft beams by routing the straps under the seat.
- **Seat legs**
  Strap the forward and top side of the boxes to the front legs and to the aft legs by looping the straps around the legs.

1.4 Safety Equipment

a. Portable oxygen equipment must be provided for each crew member whose duties on board include fire detection and fire-fighting in the cabin. The equipment shall meet airworthiness standard EASA CS 25.1439 (b) (1),(2) and 25.1443 (e) or FAA 14 CFR Part 25.1439 (b) (1),(2) and 25.1443(e) , and shall be carried by the crew members during their inspections.

b. Appropriate protective garments (e.g. fire gloves, etc.) shall be stored adjacent to the crew member's stations.

c. In addition to the extinguishers already installed in the cabin, the need for additional firefighting capabilities should be evaluated by considering the cargo to be transported (e.g. expected class of fire).
The following additional fire extinguishers would provide adequate firefighting capabilities in case of no cargo restrictions other than no dangerous goods on the passenger deck:

- Two Underwriters Laboratories (UL)2A (2-1/2 gallon) rated water portable fire extinguishers, or an equivalent amount of water, and
- At least two fire extinguishers with a minimum UL 4A-80B:C rating or equivalent. Four UL 2A-10B:C extinguishers is considered equivalent.

d. Extinguishers should be located next to fire-fighters station(s) or at other locations that the operator determines would be more effective in providing fire protection.

1.5 Environmental Control System (ECS) Settings

Normal Procedures

ECS settings shall be adapted considering the number aircraft occupants. If the ECS system is configured with Gasper outlets they should be in close / off position at all phases of flight.

Emergency Procedures

In the event of a fire in the cabin it should be ensured that the ventilation system is set to low flow. The existing Smoke, Fire, Fumes FCOM procedures (which includes possible divert, don oxygen masks, establish crew communications, re-circulation fans switched off, Smoke Fumes Checklist) must be followed.

1.6 Procedures and documentation:

Existing procedures, including emergency procedures, must be reviewed and adapted as necessary.

The Airplane Flight Manual (AFM) shall be revised as required to include the following:

a. Minimum number of additional crew members in the cabin:
    1. Minimum of two additional crew members whose duties are to detect and fight a fire, and relay information to the flight crew.
    2. For twin aisle and other large long range airplanes, a minimum of 3 additional crew members will likely be needed. Additional crewmembers above 3 should be justified based on a risk assessment. The number of cabin occupants should be minimized to the number necessary to satisfy item 1.
b. The additional crew members must be trained on:
    1. Fire-fighting procedure
    2. Use of the emergency equipment, including portable oxygen systems
    3. Operation of emergency exits and evacuation procedures
c. The additional crew members must make a visual inspection of the cargo on a regular basis including prior to Taxi, Take-off and Landing (TT&L).
d. When making the inspection required above, the additional crew members must carry portable oxygen equipment (see section Safety Equipment).
e. Provisions must be available to allow the flight crew members to notify the crew members in the cabin in case of a decompression.
f. Seats that must be occupied during TT&L and emergency scenarios such a turbulence or decompression (possibly ensuring visibility of cargo).
g. A new cabin fire emergency procedure based on manual fire-fighting.

2. Return to Passenger Service

Before the aircraft is used for passenger service, the operator shall ensure the return of the cabin back to the configuration certified for passenger transportation. Operators are reminded that if the operator wishes to make these changes permanent, then a design change approval is required.

Applicability of sections in Annex 1 depending on the restrictions to the kind of cargo			
	Restrictions to the kind of cargo As per paragraph 1.4	**Restrictions to the kind of cargo** Positive list of kind of cargo	**Restrictions to the kind of cargo** Medical supplies only
Cabin preparation	✓	✓ (except that deactivation/removal of supplemental oxygen systems may not be required, depending on the type of cargo)	N/A
Cargo loading	✓	✓	✓
Safety equipment	✓	✓ (with adaptations, as appropriate, depending on the type of cargo transported in the cabin)	✓ (with adaptations, as appropriate)
ECS settings	✓	✓ (with adaptations, as appropriate)	✓
Procedures and documentation	✓	✓ (with adaptations, as appropriate)	✓ (with adaptations, as appropriate)
Appendix to Annex 1	✓	✓	✓

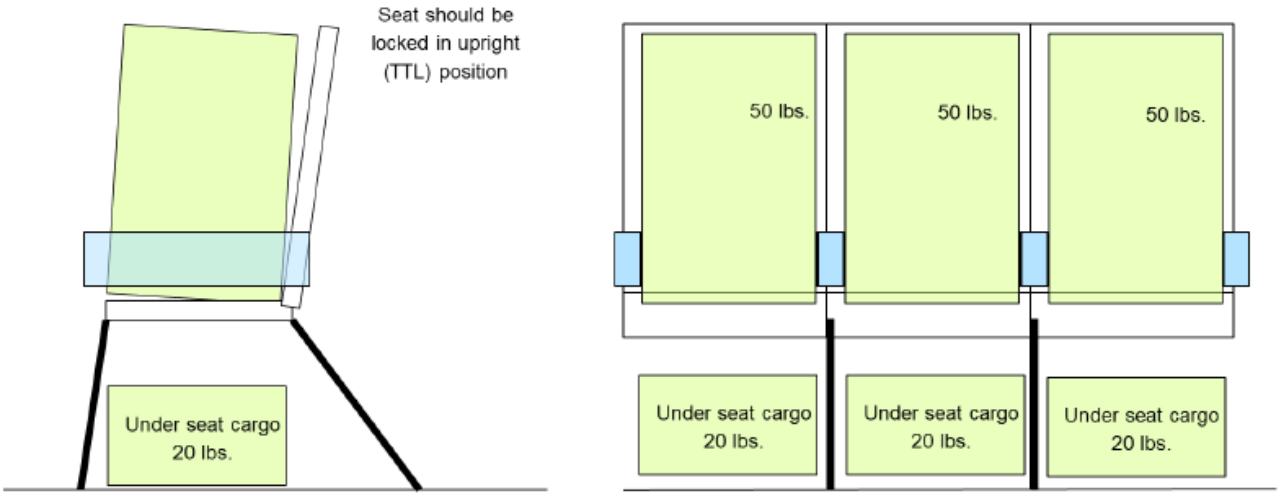
Table 1 - Applicability of sections in Annex 1 depending on the restrictions to the kind of cargo.

Appendix to Annex 1

Example for loading cargo on seats

Interim cargo carriage on seat for 3 boxes maximum 22.5kg (50 lbs)

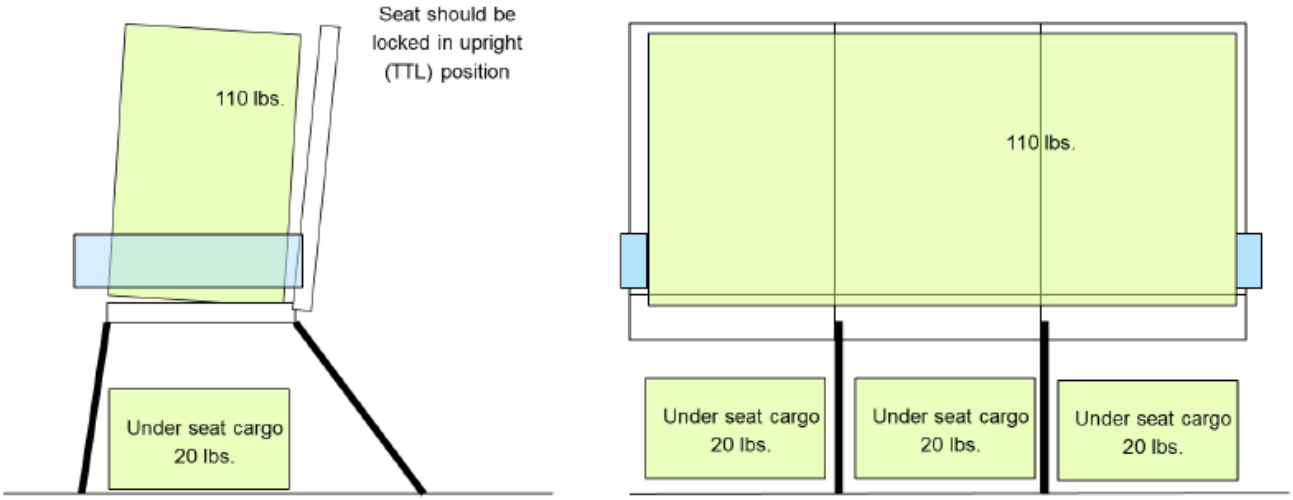
Maximum height of cargo not higher than top of seat backrest.



Interim cargo carriage on seat for 1 box maximum 50kg (110 lbs)

Maximum height of cargo not higher than top of seat backrest.

Cargo restraint means are not shown.



Appendix 2 to Annex 1

Recommended Procedures for Loading and Unloading Cargo

The below recommended procedure is an example. The recommended loading / unloading sequence depends on the aircraft type.

Sequence for loading:

- First, load the lower forward cargo compartment
- Next, load the main deck from the front to the back
- Last, load the lower center/aft cargo compartments (lower cargo compartment aft of the wing)

Sequence for unloading:

- Reverse order from loading sequence

Annex 2 – Industry Guidance

The following documents were sent by certain aircraft Original Equipment Manufacturers (OEM) to provide guidance on how to transport cargo in the passenger cabin:

- Airbus SAS : FOT-999-0028-20-00
- ATR: OIM2020/003
- The Boeing Company : MOM-MOM-20-0239

Guidance on how to restrain cargo on seats can be found in SAE ARP 4049 Cargo Restraint on Aircraft Passenger Seats – Main Passenger Cabin.

Annex 3 - Transportation of Vaccines Using Dry Ice

1. Background and Scope

Several COVID-19 vaccines have been developed in the past months by the pharmaceutical industry. Within a short timeframe, the COVID-19 vaccines will be ready to be distributed worldwide.

It is expected that large quantities of COVID-19 vaccines will be transported by airfreight, which may introduce challenges for the supply chain as well as for the airline operators.

Some COVID-19 vaccines may need to be maintained at sub-zero temperatures during transport, and some may even require a temperature-controlled environment of below -70°C. The cooling can reliably be ensured by the use of dry ice (frozen CO_2). Dry ice, however, is classified as a dangerous good.

The use of dry ice in large quantities on board an aircraft may raise hazard particularly when transported on the main (passenger/cargo) deck of a large aeroplane.

Compliance with the requirements for the transport of dangerous goods on board the aircraft (Regulation Air Operator Certificate Requirement (AOCR) Chapter 3 Item 3 Carriage of Dangerous Goods and ICAO Doc 9284 'Technical Instructions for the Safe Transport of Dangerous Goods by Air') is the responsibility of each operator.

The purpose of this Annex is to provide guidance and recommendations to operators for the transport of dry ice in excess of that already permitted in the operators' operations manual or other applicable manuals or documents (e.g. aircraft TCH/OEM Service Letter; regulatory AC) in order to reduce the introduction of additional risks (safety and health) to the aircraft systems and its occupants.

Most aircraft OEM provided revised information on their aircraft maximum capabilities to transport dry ice. It is the operator's responsibility to assess the risks associated with the transportation of increased quantities of dry ice.

2. Definitions and Abbreviations

Dry Ice: Carbon Dioxide Solidified (CO_2).

Sublimation: The process of converting a solid substance (Dry Ice, Solid CO_2) into gas (CO_2 gas).

Occupants: in this context any person on board, be it flight crew, cabin crew or supernumerary.

OEM: Original Equipment Manufacturer.

Dangerous Goods: articles or substances which are capable of posing a hazard to health, safety, property or the environment and which are shown in the list of dangerous goods in the Technical Instructions or which are classified according to those Instructions (as per ICAO annex 18 definition).

3. Chemical and Toxicity Aspects of Dry Ice

Dry ice sublimates at -78°C to gaseous carbon dioxide (CO2). Carbon dioxide is heavier than air, colour- and odourless. Carbon dioxide at low concentration (below 0.5%) has little, if any, toxicological effects. At higher concentrations (>5%), it causes the development of hypercapnia and respiratory acidosis. Concentrations of more than 10% carbon dioxide may cause convulsions, coma, and death by affecting the respiratory function and causing excitation followed by depression of the central nervous system.

Consequently, dry ice is classified as dangerous goods. The use of dry ice as refrigerant raises technical and operational challenges on board of the transport-category aeroplanes. The conversion rate of dry ice to gaseous CO_2 will vary depending on package insulation, dry ice particle/pellets size, surrounding temperature, and cabin pressure.

4. Airworthiness Standards

As per certification specification for large aeroplanes EASA CS-25, article 25.831(b)(2) and FAA 14 CFR Part 25.831(b)(2), the carbon dioxide concentration during flight must be shown not to exceed 0.5 % by volume (sea level equivalent) in compartments normally occupied by passengers or crewmembers. For the purpose of this sub-paragraph, "sea level equivalent" refers to conditions of 25° C (77° F) temperature and 1.013.2 hPa (760 millimeters of mercury) pressure.

In case of main deck cargo compartments that are intended to be accessible during flight or the transport of cargo in the passenger compartment, the above-mentioned criterion is considered applicable.

For cargo compartments that are fully segregated from the passenger compartment and non-accessible during flight, there may be no such requirement specified in EASA CS-25 and FAA 14 CFR Part 25. However, an excessive CO_2 concentration in the specific cargo compartments, if not detected, could be unsafe for the personnel on ground (loading/unloading processes).

5. Dedicated Risk Assessment

For the transport of vaccines using dry ice in excess of the limit specified in the operations manual or other applicable documents (e.g. aircraft TCH/OEM Service Letter or similar), the operator should perform a specific risk assessment. Such risk assessment may require getting in contact with the TC and/or STC holder and should propose appropriate operating procedures in order to adequately mitigate the identified risks. This risk assessment should at least cover:

5.1 The vaccine and its characteristics for transport as cargo (i.e. packaging, handling, etc);

5.2 The data trackers and loggers (see link in Item 9);

5.3 The amount and effects of dry ice to be carried (including weight and balance considerations) and the associated sublimation rate with validation of the assumed rates vs. all operational scenarios.

5.4 The possible need for CO_2 detectors to mitigate the identified risks;

5.5 If applicable, the aircraft ventilation system's operational characteristics, performance, controls, selections-settings in all operational procedures for normal/abnormal/emergency operational scenarios and phases of operation (including applicable MEL provisions);

5.6 All other relevant aircraft and systems configurations (including applicable MEL provisions);

5.7 The location of the cargo on board and the interaction with other cargo;

5.8 The aircraft occupancy (whether occupants are allowed on board or not);

5.9 The procedures and training of on-board occupants, ground handling and other relevant staff;

5.10 The analysis of ambient temperatures on the ground (at departure and arrival), which may lead to a higher sublimation rate (particularly when flying to warm areas);

5.11 The potential pressure build-up as a result of gas released from the packaging;

5.12 The impact of potential departure delays, extended taxi-in/out and additional time needed on the ground (e.g. for de-icing);

5.13 The consequences of diversion and specific airport ground-handling consideration;

5.14 The possible diversion times and the need to use alternative routes where necessary;

5.15 The extended loading time needed in case of transport in the passenger cabin, which may result in excessive CO_2 concentration.

The risk assessment should ensure that all relevant technical and operational aspects have been taken into account.

1. Technical Considerations – Safety of Flight

Vaccines cooled by dry ice should preferably be transported in the existing lower-deck cargo compartments. In case vaccines, cooled by dry ice, need to be transported on the main (passenger/cargo) deck, additional technical aspects should be considered.

6.1 Ventilation and Pressurisation System

a. MEL considerations

For aircraft dispatch, the air conditioning, air supply and the distribution/ventilation system should use configurations recommended by the manufacturer.

b. AFM considerations

The AFM procedures for ventilation should be reviewed and adapted in the operator's standard operating procedures to consider carriage of dry ice under normal and failure cases.

To mitigate the risk of higher concentrations of CO_2 (above 0.5%), it is recommended that the ventilation and pressurisation system is fully operational, i.e. all air-conditioning packs should be running at all times.

In case of partial failure of the ventilation system in flight, the situation has to be carefully evaluated in order to decide if the flight may continue to destination. The OEM guidance should account for a single next critical failure to enable continuation of the flight, while total failure of the ventilation system in flight should lead to an immediate diversion to the nearest suitable airport.

Note 1: Running the air-conditioning systems at maximum volume may lead to an additional risk when opening the doors due to potential residual overpressure. The operator should consider this hazard when drafting the operational procedures for the transportation of vaccines.

Note 2: The operator should consider the case of build-up of CO_2 concentration in the cabin as a possible emergency situation and should develop a procedure to require the donning of oxygen masks for the remaining duration of the flight.

6.2 Oxygen System

a. MEL considerations

For aircraft dispatch the crew oxygen systems should be fully operative.

b. AFM considerations

The AFM procedures for the use of oxygen should be reviewed and adapted in the Operator Standard Operating Procedures to consider carriage of dry ice under normal and failure cases (e.g. failure of the ventilation systems), including the case of detection of dangerous concentration of CO_2 (if applicable).

6.3 CO_2 Detectors

Based on the risk assessment (see Item 5 above), the operator should determine whether CO_2 detectors should be used for the flight deck and any other occupied area of the aircraft (e.g. passenger cabin).

If the amounts of dry ice to be transported (refer to aircraft OEM specifications, supplier packaging details and other guidance material, see also Item 9) is in excess of that specified in the operations manual or other relevant manuals and in the guidance provided by the OEM, or if dry ice is loaded on the main (passenger/cargo) deck, the use of CO_2 monitors/detectors is recommended in all compartments in which dry ice is being transported. Such detectors should be adequately located and should timely and reliably detect dangerous concentrations of CO_2 in the aircraft. If the detectors are power supplied by lithium ion batteries, the additional fire risk must be assessed and mitigated accordingly.

Note: "Use" in this context means physically installed in the aircraft or – alternatively – portable devices. If CO_2 sensors and monitoring systems are used, the operator should ensure that these devices do not interfere with the aircraft systems and do not affect the safe operation of the aircraft. Portable CO_2 detectors are considered Portable Electronic Devices (PED). Recent/frequent calibration of CO_2 detectors must be ensured. At least two sensors should be available in case of a sensor disagree.

6.4 Cargo Locations (Lower and Main Deck Cargo Compartments and Passenger Cabin)

Vaccines cooled with dry ice should preferably be transported in lower-deck cargo compartments. It is recommended to use the cargo compartment that is located to the next outflow valve, in order to effectively ensure that even in the case of partial or complete failure of the ventilation and pressurisation system during flight, the CO_2 will be ventilated overboard.

A minimum number of occupants should be onboard for fire detection and fire-fighting purposes. Vaccines cooled with dry ice may be transported in the passenger cabin when the associated risks are sufficiently mitigated. Details are addressed below in 6.5 and 6.6.

6.5 Occupants on Board (Their Roles and Location, Equipment, etc.)

a. Flight crew

The operator should take all necessary steps to avoid that the flight crew is harmed by carbon dioxide incapacitation or intoxication.

Flight crews should have been properly trained prior to the flight on the hazards and risks of transporting dry ice and on the procedures related to the operation.

b. Other occupants

Passengers should not be allowed onboard if dry ice is transported in excess of the limit specified in the operations manual or other applicable documents (e.g. aircraft TCH/OEM Service Letter or similar).

Any other occupants onboard should only be allowed if required under demonstrated urgent operational needs (e.g., additional flight crew for the return flight or additional persons needed for the cargo handling).

If occupants, that are not considered flight crew, need to be onboard, they should be protected against a potential CO_2 intoxication by the following means:

- Have access during all phases of flight to approved supplemental oxygen equipment ready to be used.
- Have been properly trained prior to the flight on the use of that oxygen equipment.

- Have been properly trained prior to the flight on the hazards and risks of transporting dry ice and on the procedures related to the operation. And
- In addition, CO_2 detectors should be available in the cabin (see 6.4).

Any seating position identified for a potential occupancy during any phase of the flight should pose no additional risk to its occupants, in particular in case of a CO2 incapacitation/intoxication.

6.6 Interaction with Other Cargo

Live animals may not be transported in cargo compartments if dry ice is also transported therein at the same time. Any interaction with other cargo should be assessed and mitigated by the operator and the shipper.

2. Technical Considerations – Ground Handling

When loading and unloading boxes filled with dry ice, awareness should be raised that there can be carbon dioxide present in concentrations that potentially endanger human health. Staff engaged in the loading and unloading process should be properly trained and prepared for this. They should be trained on the specific risks and hazards and the special procedures related to this cargo. The operator and the ground-handling provider should implement special procedures to ensure that there is no health or safety risk for the staff performing the loading and unloading of dry ice packages. In doing this, the operator and ground-handling provider should consider, as a minimum, the following:

7.1 Loading

a. Methods to ensure that only packaging compliant with the applicable regulations is loaded on board;

b. Procedures for reporting and addressing damaged/leaking packages.

7.2 Unloading

a. Instructions on precautions to be taken when opening cargo or cabin doors;

b. A second person always outside the cargo bay or cabin to monitor entrance and trigger the alarm in case of an incident;

c. Procedures for reporting and addressing damaged/leaking packages.

7.3 Ensure proper ventilation before entering a cargo compartment containing dry ice.

7.4 Minimize ground time without ventilation.

7.5 Carry a CO_2 detector when entering cargo compartments.

7.6 Develop emergency procedure in case of an incident or accident.

3. Operation Considerations

Operators transporting dry ice must have an approval for the transport of dangerous goods in accordance with ICAO Annex 6, Part I, Chapter 14 and with Air Operator Certificate Requirement (AOCR) Chapter 3 Item 3 Carriage of Dangerous Goods. In accordance with the requirements established in such regulations, operators shall have specific training and procedures for the transport of dangerous goods. The training and procedures have to be approved by CAAT and should be in accordance with ICAO Annex 18 and ICAO Doc 9284, Technical Instructions for the Safe Transport of Dangerous Goods. This should all be reflected in the Operations Manual.

It is possible to obtain an approval for the transport of certain dangerous goods. Thus, an operator may hold an approval to transport only dry ice. The scope of the approval needs to be taken into consideration before accepting any shipment of the vaccine.

Additionally, operators need to perform a risk assessment which includes the specificities of dangerous goods transport (as from November 2020, ICAO Annex 6, Chapter 15 also calls for such a risk assessment). Additional guidance contained in ICAO Doc 10102 may also be considered. The table – 2 “Requirement for carriage of quantities of dry ice in excess of that previously specified by operator for the aircraft type” show the transportation of COVID-19 vaccines specific risk assessment.

To ensure the transport is done safely, operators transporting quantities of dry ice in excess of that specified in the operations manual or other applicable documents (e.g. OEM/TCH Service Letter or equivalent) should consider additional mitigation actions. The training, procedures and risk assessment mentioned above must take into consideration the specific conditions of this transport. These must also include all the technical considerations mentioned before and apply to all the staff involved and all the stages of the operation, from the acceptance to the unloading.

The operator may additionally consider the following:

- Lower the temperature in the cargo compartment as much as possible to minimise the sublimation rate;
- Evaluate the potential for cargo containing dry ice to be loaded as late as possible and unloaded as early as possible to minimise the potential exposure of ground staff to elevated levels of CO_2 in the cargo compartment.

The table 2 – “Requirement for carriage of quantities of dry ice in excess of that previously specified by operator for the aircraft type”

a) hazards associated with the properties of the items to be transported;	
Hazard Description	Information to support hazard assessment
Carriage of large quantities of dry ice (CO2, solid)	- The sublimation of dry ice may result in significant concentrations of gaseous CO2 in aircraft - Gaseous CO2 will replace oxygen in aircraft compartments and may interfere with the breathing abilities of the occupants - High concentrations of CO2 can lead to unrecognized degradation of cognitive functioning and asphyxiation. It causes suffocation by displacing and diluting the amount of oxygen in the air, leading to hypoxia (lack of oxygen) and is toxic to brain functioning
b) capabilities of the operator	
	- Operators must ensure that their dangerous goods training programme, operational procedures and safety management system address the requirements applicable to transport of dry-ice (including the acceptance, handling, loading and carriage of cargo containing dry ice) during both ground and flight operations. - Pilot and crew training on specific conditions and procedures can improve pilot decision-making in the event of a CO2 detector alert or other system abnormalities - Training for loading and unloading precautions for ground/service crews
c) operational considerations;	
	- The operators' determination of the maximum amount of dry ice it will allow in a cargo compartment based on the aircraft manufacturer's recommendations, operational considerations for the air conditioning system, and the sublimation rate. - An accurate determination of the dry ice sublimation rate is necessary to determine the quantity of dry ice that may be safely transported - Sublimation rate can be affected by ambient compartment temperature and pressure, amount of insulation surrounding the dry ice, type of container, amount of surface area of the dry ice, and the temperature of the cargo being cooled by the dry ice

The table – 2 “Requirement for carriage of quantities of dry ice in excess of that previously specified by operator for the aircraft type” (Continued)

	- As the dry ice sublimates, a loss of weight occurs that may affect the aircraft center of gravity - CO2 sensors installed or carried in the aircraft to recognize hazardous concentrations of CO2 and to implement effective risk controls - Aircraft ventilation during normal procedures, to include engine start, less than all engine taxi, aircraft de-icing, and with MEL deferred items - Aircraft ventilation during abnormal and emergency procedures to include abnormal and emergency operations and flight during air system component failure.
d) capabilities of the aircraft and its systems;	
	- The environmental control system on the aircraft must be suitable for the quantity of dry ice intended to be carried, including flow mode, air recirculation control, MEL deferred items, and possible malfunctions en-route - Additional guidance specific to each aircraft types and models, if any, should be obtained from the aircraft manufacturer.
e) containment characteristics of unit load devices;	
	- None
f) packing and packaging;	
	- Compliance with packing requirements detailed in the Technical Instructions
g) safety of the supply chain for items to be transported;	
	- None
h) quantity and distribution of dangerous goods items to be transported	
	- As determined by the operators' safety risk assessment taking into considerations of items a) to g)

4. Additional Guideline

9.1 EASA Guidelines

https://www.easa.europa.eu/the-agency/coronavirus-covid-19

- EASA guidelines for the transportation of cargo in the passenger cabin (issue 5): https://www.easa.europa.eu/newsroom-and-events/news/easa-publishes-issue-5-guidelines-transport-cargo-passenger-compartments
- EASA generic deviation on the transportation of cargo in large aeroplane passenger cabins: https://www.easa.europa.eu/document-library/product-certification-consultations/deviation-transportation-cargo-passenger
- EASA generic deviation on the transportation of cargo in large aeroplane passenger cabins: https://www.easa.europa.eu/newsroom-and-events/news/easa-published-guidelines-use-cargo-tracking-devices-relation-covid-19

9.2 Aircraft Manufacturer Guidelines

Airbus

- Website: https://w3.airbus.com/
- Guidance: ISI (In Service Information) Reference 25.50.00011

Boeing

- Website: https://www.myboeingfleet.com/ReverseProxy/Authentication.html
- Guidance:
  - 707-SL-21-006-(Latest Revision) - Service Letter – “Recommended Allowable Dry Ice Carriage Limits”
  - 727-SL-21-020--(Latest Revision) - Service Letter – “Recommended Allowable Dry Ice Carriage Limits”
  - 737-SL-21-033--(Latest Revision) - Service Letter – “Recommended Allowable Dry Ice Carriage Limits”
  - 747-SL-21-055--(Latest Revision) - Service Letter – “Recommended Allowable Dry Ice Carriage Limits”
  - 757-SL-21-036--(Latest Revision) - Service Letter – “Recommended Allowable Dry Ice Carriage Limits”
  - 767-SL-21-044--(Latest Revision) - Service Letter – “Recommended Allowable Dry Ice Carriage Limits”

- 777-SL-21-001--(Latest Revision) - Service Letter – “Recommended Allowable Dry Ice Carriage Limits”
- 787-SL-21-002--(Latest Revision) - Service Letter – “Recommended Allowable Dry Ice Carriage Limits”
- MOM-MOM-20-0053-01B (Latest Revision) - Multi-Operator Message – “Information – 2019-nCov Coronavirus Infection Control Guidance as Related to Commercial Aircraft”
- MOM-MOM-20-0239(Latest Version) - Multi-Operator Message – “Information – All Model Guidelines for Passenger Airplane Carriage of Cargo”
- MOM-MOM-20-0863-01B (Latest Revision) – Multi-Operator Message – “Dry Ice Carriage during the COVID-19 Coronavirus Pandemic”

Embraer

- Website: https://www.flyembraer.com
- Guidance: Airplane Operations Manual (AOM) - Dry Ice Transportation.

9.3 International Guidance

- FAA Advisory Circular 91-76A, "Hazard Associated with Sublimation of Solid Carbon Dioxide (Dry Ice) Aboard Aircraft"
- IATA guidance for Vaccine and Pharmaceutical Logistics and Distribution
  https://www.iata.org/en/pressroom/pr/2020-11-16-01/
  https://www.iata.org/en/programs/cargo/