INTERNATIONAL STANDARD

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Aircraft — Pressure equalization requirements for cargo containers

Aéronefs — Exigences d'égalisation de pression pour les conteneurs de fret

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 11242 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 9, *Air cargo and ground equipment*.

Annexes A, B and C of this International Standard are for information only.

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Introduction

The decrease in ambient pressure with altitude creates a pressure differential between the inside of a cargo container and the outside environment. When the internal volume and/or area of a container are significant, this may, if not properly controlled, result in tremendous forces exerted on the container panels, thus becoming a major flight safety hazard. Incidents were recorded during flight in which overly airtight containers broke down or nearly exploded during climb.

In order to avoid such potentially hazardous situations, it is essential that this problem be clearly identified and taken into account when designing any type of container to be moved regularly or occasionally by air cargo.

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Aircraft — Pressure equalization requirements for cargo containers

1 Scope

Since most modern civil transport aircraft capable of carrying air cargo unit load devices or large-size shipping containers have pressurized cabins and cargo compartments, two different cases must be considered:

a) normal (low airflow) pressure equalization during climb and descent — from the departure airport pressure down to the cruise flight cabin pressure, up to the landing airport pressure;

b) emergency (rapid decompression) pressure equalization in the event of a sudden (possibly "explosive") depressurization of the aircraft fuselage occurring at cruise altitude: this case requires very fast (high airflow) pressure equalization between cruise flight cabin pressure and outer ambient pressure.

This International Standard defines the minimum safety requirements to be met by containers used to transport cargo by civil transport aircraft in either case a) or b) above.

The flight safety requirements specified in this International Standard are applicable to the design of

— aircraft containers for general cargo, as covered by

- ISO 4118 for non-certified lower deck containers,
- ISO 6517 for base-restrained certified containers exclusively for the lower deck of high-capacity aircraft,
- ISO 8323 for air/surface intermodal containers,
- ISO 10327 for certified containers for air cargo;

— air mode insulated containers, as covered by ISO 8058;

— any airtight shipping containers with an internal volume of 1 m^3 $(35\ ft^3)$ or more.

NOTE 1 Most shipping containers/packagings used for air cargo are made of sufficiently low-strength material (e.g. fibreboard) or provide sufficient air leakage (e.g. wooden crates) that they cannot be considered airtight and do not present any significant hazard as a result of pressure equalization.

There are however a number of special containers, notably for the carriage of satellites/space hardware, aircraft spares, sensitive scientific or technical equipment, etc., which are airtight per design (in order to protect the contents against atmospheric pollution) or per construction (because of the quality of sealing and materials used).

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 4118:1996, *Non-certified lower-deck containers for air transport — Specification and testing.*

ISO 6517:1992, *Air cargo equipment — Base-restrained certified containers exclusively for the lower deck of high-capacity aircraft.*

ISO 8058:1985, *Air cargo equipment — Air mode insulated containers — Thermal efficiency requirements.*

ISO 8097:1995, *Aircraft — Minimum airworthiness requirements and test conditions for certified air cargo unit load devices (Endorsement of NAS 3610, 10th edition).*

ISO 8323:1985, *Freight containers — Air/surface (intermodal) general purpose containers — Specification and tests.*

ISO 10327:1995, *Aircraft — Certified aircraft container for air cargo — Specification and testing.*

ICAO, *Technical instruction for the safe transport of dangerous goods by air.*[1)]

IATA, *Dangerous Goods Regulations.*[2)]

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 airtight shipping container: Any container, unless constructed of low-strength materials (fibreboard or equivalent), where the cumulated cross-sectional area of all apertures allowing a flow of air between the inside and the outside of the container is less than 5 cm^2 per cubic metre (0,02 in^2 per cubic foot) of internal container volume.

3.2 pressurized shipping container: Airtight container which is entirely sealed and does not include either means of pressure equalization as described in clause 7 or an expandable volume as described in clause 8.

3.3 normal flight conditions: Flight conditions with cabin/cargo compartment pressure decreasing from standard sea level 101,3 kPa $\left(14{,}4\ \text{lbf/in}^2\right)$ to minimum cruise flight cabin altitude pressure 75 kPa $\left(10{,}7\ \text{lbf/in}^2\right)$ during climb, and increasing back to standard sea level during descent, at the maximum rates given in table 1.

3.4 emergency (rapid decompression) conditions: Cabin/cargo compartment atmosphere dropping linearly from a minimum normal equivalent altitude of 1 830 m (6 000 ft), i.e. a maximum normal pressure of 81 kPa $\left(11{,}8\ \text{lbf/in}^2\right)$ in cruise flight, to the standard ambient pressure at 13 715 m (45 000 ft) altitude of 15 kPa $\left(2{,}14\ \text{lbf/in}^2\right)$ in a duration of 1 s.

4 Environment

4.1 General

The decrease of ambient atmospheric pressure with altitude is described by the international standard atmosphere as shown in annex A.

The maximum operating altitude for modern civil transport aircraft (with the exception of supersonic aircraft which do not carry air cargo containers) is 13 715 m (45 000 ft), corresponding to an ambient pressure of approximately 15 kPa $\left(2{,}14\ \text{lbf/in}^2\right)$ as compared to the standard sea level atmospheric pressure of approximately 101,3 kPa $\left(14{,}4\ \text{lbf/in}^2\right)$.

Table 1

	Cabin altitude rate		Cabin pressure rate	
	m/s	ft/min	Pa/s	$\left(\text{lbf/in}^2\right)$/min
Maximum climb rate	+ 12,7	+ 2 500	− 150	− 1,3
Maximum descent rate	− 7,6	− 1 500	+ 90	+ 0,78

1) Available from the International Civil Aviation Organization, 1000 Sherbrooke Street West, Suite 400, Montreal, Quebec H3A 2R2, Canada.

2) Available from IATA Publications Dept., 2000 Peel Street, Montréal, Québec H3A 2R4, Canada or IATA Publications Dept., Route de l'Aéroport 33, PO Box 672, CH-1215 Genève 15 Aéroport, Switzerland.

4.2 Normal flight conditions

The pressurization systems of modern civil aircraft maintain, during cruise flight at the maximum operating altitude, the cabin and cargo compartment pressure at a maximum equivalent altitude of approximately 2 600 m (8 500 ft), i.e. a minimum pressure of approximately 75 kPa $\left(10{,}7\ \mathrm{lbf/in^2}\right)$.

5 Aircraft containers requirements (general cargo)

5.1 Normal flight conditions

5.1.1 Unless constructed of low-strength (fibreboard or equivalent) material, certified and non-certified aircraft containers for general cargo in accordance with ISO 4118, ISO 6517, ISO 8323 or ISO 10327 shall be designed with a built-in vent area sufficient to cope with normal (low airflow) pressure equalization.

5.1.2 The minimum vent area shall be 5 $\mathrm{cm^2}$ per cubic metre (0,02 $\mathrm{in^2}$ per cubic foot) of container internal volume.

5.1.3 The container door seals area may be considered as part or all of the required minimum vent area, provided any seals occupying the apertures so considered are sufficiently flexible to deflect fully in either direction (in or out) under a pressure differential of between 3,5 kPa and 7 kPa (0,5 $\mathrm{lbf/in^2}$ to 1 $\mathrm{lbf/in^2}$).

5.1.4 The vent area shall be located so that it cannot be inadvertently blocked by cargo, and shall be adequately protected from cargo load shift to ensure this minimum area is maintained in all circumstances.

5.2 Emergency (rapid decompression) conditions

5.2.1 Certified and noncertified aircraft containers for general cargo in accordance with ISO 4118, ISO 6517, ISO 8323 or ISO 10327 shall be designed to be able to ensure high flow pressure equalization in the event of a rapid decompression at cruise altitude, as defined in 3.4, without creating a hazard to the cargo compartment or aircraft structure.

5.2.2 Full-scale tests have indicated that the design and construction of typical aircraft containers meet the above requirement since, when submitted to rapid decompression, the panel joints and notably the door frames immediately deform to the extent of creating sufficient space for the high airflow required, without breaking or projecting parts which could become a hazard to the surrounding structure.

5.2.3 However, it remains necessary, in compliance with ISO 8097 (endorsement of NAS 3610), to verify this requirement by analysis or testing when designing any new type of container, particularly if the new design is intended to be built in a stronger manner than is current industry practice.

6 Requirements for temperature-controlled aircraft containers

6.1 General

It can be required for temperature-controlled aircraft containers, certified or non-certified, in accordance with ISO 8058, that the possibility of a flow of air into/out of the container is minimized in order to improve temperature control efficiency.

Consequently, unless they are designed in accordance with the full requirements of clause 5, temperature-controlled aircraft containers shall be designed with:

a) a built-in vent area or pressure equalization device capable of meeting the normal flight conditions; and

b) a built-in blow-out panel or equivalent device capable of meeting the emergency (rapid decompression) conditions.

6.2 Normal flight conditions

6.2.1 If a built-in vent area is provided, it shall comply with the requirements of 5.1.

6.2.2 If the container is designed to be airtight, a pressure equalization device (valve or equivalent) meeting the requirements of 7.2 shall be provided.

6.3 Emergency (rapid decompression) conditions

6.3.1 Unless the container is designed to the requirements of 5.2.1, it shall be equipped with a blow-out panel or equivalent device in order to cope with the rapid decompression situation in a nonhazardous manner.

6.3.2 The blow-out panel or equivalent device, when fully open, shall provide a minimum cross-sectional area of 100 cm^2 per cubic metre (0,45 in^2 per cubic foot) of container internal volume.

6.3.3 The blow-out panel or equivalent device shall fully open in less than 0,2 s when submitted to a maximum pressure differential from inside of 14 kPa (2 lbf/in^2).

6.3.4 The blow-out panel or equivalent device shall meet the requirements of 5.1.4.

6.3.5 The container door(s) may be used as a blow-out panel, provided its (their) attachment to the container structure meets the requirements of 6.3.3, and, in the case of a certified container, can withstand the ultimate side load required by airworthiness certification.

7 Requirements for airtight shipping containers (with pressure equalization)

7.1 General

Airtight shipping containers, as defined in 3.1, can be filled with atmospheric air (possibly dehydrated) or other (usually neutral) gases. Unless they are of the volumetric expansion type (see clause 8) or the pressurized type (see clause 9), they shall be designed and equipped as follows in order to be acceptable for international civil air transport.

7.2 Normal flight conditions

7.2.1 The container shall be equipped with a (set of) automatic pressure equalization valve(s) or equivalent device(s) in order to meet the normal flight conditions as defined in 3.3.

7.2.2 The (set of) valve(s) or equivalent device(s) shall fully open under a pressure differential of between 3,5 kPa and 7 kPa (0,5 lbf/in^2 to 1 lbf/in^2) in either direction (in or out).

7.2.3 The (set of) valve(s) or equivalent device(s) shall ensure a minimum cumulated airflow of 12 % per minute (0,2 % per second) of the internal container volume, under a pressure differential not exceeding 14 kPa $\left(2\ lbf/in^2\right)$ in either direction (in or out).

NOTE 2 The volumetric airflow through a pressure equalization valve is strongly dependent on the pressure differential: see examples of typical pressure equalization valve characteristics in annex B.

7.2.4 For computing the minimum pressure equalization airflow required, the internal container volume shall be defined as follows:

a) if the container is always to be shipped loaded, use the empty container's inside water volume, less the minimum water volume of the load to be carried;

b) if air transport of the empty container is envisaged, use the empty container's inside water volume.

7.2.5 The pressure equalization valve(s) or equivalent device(s) used shall be capable of operating within a temperature range of – 54 °C to + 71 °C (– 65 °F to + 160 °F), with relative humidity up to 85 %. Their operation shall not be adversely affected by vibration incident to service use, sand, dust, salt spray or rough handling conditions in the trucking and cargo warehouses environment. Their quality of construction shall guarantee their reliability for a minimum of 2 500 cycles from the closed to the open position for both positive and negative pressure differentials.

NOTE 3 Pressure equalization valves meeting the MIL-V-27166 (USAF) specification[2] meet the above requirements.

7.2.6 It is recommended that each pressure equalization valve or equivalent device be equipped with a manual equalization control in order to allow total pressure equalization after landing. This recommendation becomes mandatory in the event that such valve(s) or device(s) are used for temperature-controlled aircraft containers, see 6.2.2.

7.2.7 In order to be acceptable for international civil air transport, airtight shipping containers fitted with pressure equalization valve(s) or equivalent device(s) shall bear the following markings, to be stencilled or printed on a self-adhesive label, in characters at least 6 mm (0,25 in) high in the immediate vicinity of each pressure equalization valve or device:

Pressure equalization valve specification:
Open pressure .... mbar (............. lbf/in^2)
Airflow at 140 mbar (2 lbf/in^2) pressure:
.... m^3/s (.............. ft^3/s)

7.2.8 In the event of the container being filled with a gas other than atmospheric air (possibly dehydrated):

a) such gas, its packaging and ancillary apparatus shall comply with the appropriate requirements of the ICAO Technical Instructions for the safe transport of dangerous goods by air (IATA Dangerous Goods Regulations), valid edition;

and

b) provisions shall be made for partial replenishment of the container for pressure equalization during aircraft descent, without exceeding the airflow capability of the pressure equalization valve(s) or equivalent device(s) installed in accordance with 7.2.1.

7.3 Emergency (rapid decompression) conditions

7.3.1 The container shall be designed to be able to ensure high flow pressure equalization in the event of a rapid decompression at cruise altitude, as defined in 3.4, without creating a hazard to the cargo compartment or aircraft structure.

7.3.2 The above requirement shall be demonstrated by analysis or testing prior to acceptance for air cargo transportation.

7.3.3 If the requirement of 7.3.1 cannot be demonstrated in a satisfactory manner, the container shall be equipped with a blow-out panel or equivalent device in order to cope with the rapid decompression situation in a nonhazardous manner.

7.3.4 The blow-out panel or equivalent device, when fully open, shall provide a minimum cross-sectional area of 100 cm^2 per cubic metre (0,45 in^2 per cubic foot) of container internal volume, as defined in 7.2.4.

7.3.5 The blow-out panel or equivalent device shall fully open in less than 0,2 s when submitted to a maximum pressure differential of 14 kPa (2 lbf/in^2) from inside.

7.3.6 The blow-out panel or equivalent shall be so located that it cannot be inadvertently blocked by the contents of the container, and shall be protected from load shift to ensure this minimum area defined in 7.3.4 is maintained in all circumstances.

7.3.7 The container door(s) may be used as a blow-out panel, provided its (their) attachment to the container structure meets the requirements of 7.3.5.

8 Requirements for volumetric expansion type airtight shipping containers

8.1 General

Certain types of airtight shipping containers, where technical reasons permit no communication whatsoever between the inside and outside atmosphere, are designed in order to cope with the pressure equalization requirements under normal flight conditions by volumetric expansion of the container according to Mariotte's law. The following requirements shall be met in order for them to be acceptable for international civil air transport.

8.2 Normal flight conditions

8.2.1 In order to cope with the pressure equalization requirements met in normal flight conditions (see 3.3), the possible volume expansion shall be a minimum of 35 % of the basic container internal volume.

8.2.2 For computing the minimum volume expansion, the "basic container internal volume" shall be defined as follows:

a) if the container is always to be shipped loaded, use the empty container's inside water volume at standard sea level atmospheric pressure of

101,3 kPa $\left(14,4 \text{ lbf/in}^2\right)$, less the minimum water volume of the load to be carried;

b) if air transport of the empty container is envisaged, use the empty container's inside water volume at standard sea level atmospheric pressure.

8.2.3 In order to ensure that the volumetric expansion of the container during climb will not interfere with or be limited by adjacent structure or other cargo on the flight, the container's maximum expansion volume shall be materialized in the three dimensions by a permanently attached frame or nonairtight rigid cover. This will allow the required expansion volume to be kept free when loading.

8.2.4 In the event of the container being filled with a gas other than atmospheric air (possibly dehydrated), such gas, its packaging and ancillary apparatus shall comply with the appropriate requirements of the ICAO Technical Instructions for the safe transport of dangerous goods by air (IATA Dangerous Goods Regulations), valid edition.

8.3 Emergency (rapid decompression) conditions

8.3.1 The container shall be designed to be able to ensure high flow pressure equalization in the event of a rapid decompression at cruise altitude, as defined in 3.4, without creating a hazard to the cargo compartment or aircraft structure.

8.3.2 The above requirement shall be demonstrated by analysis or testing prior to acceptance for air cargo transportation.

8.3.3 If the requirement of 8.3.1 cannot be demonstrated in a satisfactory manner, the container shall be equipped with a blow-out panel or equivalent device in order to cope with the rapid decompression situation in a nonhazardous manner.

8.3.4 The blow-out panel or equivalent device, when fully open, shall provide a minimum area of 100 cm^2 per cubic metre (0,45 in^2 per cubic foot) of container internal volume, as defined in 8.2.2.

8.3.5 The blow-out panel or equivalent device shall fully open in less than 0,2 s when submitted to a maximum pressure differential of 14 kPa $\left(2 \text{ lbf/in}^2\right)$ from inside.

8.3.6 The blow-out panel or equivalent shall be located so that it cannot be inadvertently blocked by the contents of the container, and protected from load shift to ensure the minimum area as defined in 8.3.4 is maintained in all circumstances.

8.3.7 The container door(s) may be used as a blow-out panel, provided its (their) attachment to the container structure meets the requirements of 8.3.5.

9 Requirements for pressurized type airtight shipping containers

9.1 A "pressurized" shipping container can be pressurized at standard sea level pressure [101,3 kPa (14,4 lbf/in^2)]. If it is not, i.e. its internal pressure is the standard sea level pressure, it will become pressurized during flight. The following requirements shall be met for such containers.

9.2 In order to guarantee that the container does not present a hazard to the cargo compartment or aircraft structure, both in normal flights conditions, as defined in 3.3, and in emergency (rapid decompression) conditions, as defined in 3.4, the container shall be proof-tested for differential pressure prior to acceptance for international civil air transport.

9.3 The minimum proof-test differential pressure shall be 1,2 times the difference of the extreme inner and outer pressures to which the container may be submitted, including the event of an emergency (rapid decompression). If p, expressed in kilopascals, is the nominal absolute pressure inside the container, the minimum proof-test differential pressure Δp, expressed in kilopascals, shall be determined as follows:

a) If 0 kPa $< p \leqslant$ 58 kPa $\left(8,3 \text{ lbf/in}^2\right)$:

$$\Delta p \text{ min.} = 1,2\ (101,3 - p)$$

NOTE 4 In this case, the required proof-test is usually performed as part of standard manufacturing industry practice for any vacuum/low pressure type packagings/containers.

b) If $p >$ 58 kPa $\left(8,3 \text{ lbf/in}^2\right)$:

$$\Delta p \text{ min.} = 1,2\ (p - 15)$$

NOTE 5 In this case, particularly if the container's nominal internal pressure is standard sea level, this requirement resulting from the rapid decompression case is often overlooked by the shipper or shipping container's manufacturers. Similarly, if the container's internal pressure is over standard sea level, the proof tests performed are usually based only on the pressure differential with sea level, which can be insufficient to guarantee the container's integrity in the event of a rapid decompression in flight. Hence, it is essential to draw the attention of the shipper and/or shipping container's manufacturer to the required proof-tested differential pressures for air transportation.

9.4 Pressurized shipping containers which were proof-tested for differential pressure in order to meet the requirements in this clause for international civil air transport shall bear the following markings, to be stencilled or printed on a self-adhesive label in a conspicuous position, in characters at least 12,7 mm (0,50 in) high:

> Pressurized container:
>
> Internal pressure: .... mbar (............. lbf/in^2)
>
> Proof test pressure differential:
>
> .... mbar (............. lbf/in^2)

9.5 In the event of the container being filled with a gas other than atmospheric air (possibly dehydrated), such gas, its packaging and ancillary apparatus shall comply with the appropriate requirements of the ICAO Technical Instructions for the safe transport of dangerous goods by air (IATA Dangerous Goods Regulations), valid edition.