INTERNATIONAL STANDARD

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Air cargo — Insulated containers — Thermal efficiency requirements

Fret aérien — Conteneurs isothermes — Caractéristiques de rendement thermique

Reference number
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Foreword

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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 8058 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles,* Subcommittee SC 9, *Air cargo and ground equipment.*

This second edition cancels and replaces the first edition (ISO 8058:1985), which has been technically revised.

Annex A of this International Standard is for information only.

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Introduction

This International Standard specifies thermal efficiency requirements for air cargo insulated containers of all sizes.

This International Standard does not in any way cancel or reduce the status of the specifications which determine airworthiness, industry, ground handling or any other characteristics of the units.

In preparing this International Standard for compatibility and guidance purposes, the requirements of ISO 1496-2:1996, *Series 1 freight containers — Specification and testing — Part 2: Thermal containers,* have been taken into account as far as procedures for measuring the thermal efficiency are concerned.

Air cargo — Insulated containers — Thermal efficiency requirements

1 Scope

This International Standard specifies the minimum operational requirements for thermal efficiency to ensure that perishable cargoes in insulated standard airborne containers are kept in prime condition during the ground handling and air transportation cycle for a maximum period of 36 h.

It is applicable to all insulated air cargo containers irrespective of their size and designation. It does not provide details concerning refrigerated or heated containers and/or the methods and equipment used to obtain the required thermal effect, such as cryogenic, gaseous or liquid fluids, or mechanical compressors/heaters.

NOTES

1 The term "perishable cargo" refers, for example, to dairy produce, fruit, vegetables, flowers, frozen foods, meat, fish, etc., requiring maintenance of specific temperature ranges during door-to-door transportation involving air transport.

2 It should be noted that throughout this document environmental (atmospheric) temperatures are expressed in commercial values of degrees Celsius/Fahrenheit (°C/°F) and technical (scientific) temperatures are expressed in the International Standard measure, kelvin (K). A temperature conversion table is given for convenience in annex A.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was 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 edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 11242:1996, *Aircraft — Pressure equalization requirements for cargo containers.*

3 Design considerations

3.1 In the design of the container, careful consideration shall be given to the contribution of conduction, convection, radiation and air leakage to the overall thermal efficiency of the unit. At the same time, an optimum balance between insulation, structure, cost and weight shall be a constant design goal.

3.2 The overall temperature range for perishable commodities may be anywhere between + 20 °C (+ 68 °F) and – 25 °C (– 13 °F) during the transport cycle.

3.2.1 During this period of door-to-door transportation, the container may be subjected to outside ambient temperature with extremes of + 45 °C (+ 113 °F) and – 50 °C (– 58 °F) and a relative humidity of up to 100 %.

3.2.2 For design purposes, the container shall perform its protective function within an outside temperature variation, ΔT, within the range of temperature exposure extremes stated in 3.2.1, of 53 °C (95 °F) so as to allow for temperature drops and rises occurring between origin and destination in the air transport cycle.

3.3 Although no specific test is specified in clause 6 for thermal radiation, consideration should be given to commonly encountered environments wherein radiant energy exchange can be minimized.

3.4 The container shall be free of sharp corners and/or crevices which might collect dirt, spillage or odours. No pockets shall exist in the cargo loading space that cannot be reached by conventional cleaning methods.

3.5 The construction shall be such that spillage collects during the transport cycle but runs off during flushing and/or washing. Adequate provision shall be made to ensure that cleaning water can satisfactorily drain from the inside of the container.

3.6 Materials used for the container structure, the interior surfaces and the insulation shall absorb neither moisture nor odours and shall not be functionally affected by daily washing.

3.6.1 Methods of washing shall include flushing using a pressure hose at 689 kPa (100 lbf/in^2), 343 K temperature and strong detergents. Washing may also be carried out by steam cleaning at 383 K.

3.6.2 When washed, the container shall not require the use of odour-neutralizing chemicals.

3.6.3 The container shall withstand freezing temperatures while wet immediately following washing. All valves, seals, doors and controls shall remain operative.

3.6.4 Material used on the inside of the container, thus potentially coming in contact with foods and/or pharmaceutical goods, shall be neutral to these cargoes and shall meet applicable sanitary standards.

4 Pressurization

4.1 General conditions

Containers shall be closed at differing terminal altitudes. The critical condition shall be at sea level. Operationally, the container could be subjected to either internal positive or negative pressure. Careful attention to the design of equalization devices (if any) and all seals is important in the control of air leakage heat transfer.

4.2 Pressure equalization

Further to 4.1, if the design of door seals is not adequate to relieve pressure, a pressure equalization device should be installed for two-way equalization. This pressure relief device should be set to operate at 3,45 kPa to 6,89 kPa (0,5 lbf/in^2 to 1 lbf/in^2) pressure differentials.

4.3 Blow-out panel

To compensate for the unique exposure to rapid decompression of a container transported by air, a blow-out panel, or equivalent device, conforming to ISO 11242:1996, 6.3, shall be provided. It shall be installed in such a manner that it will not damage aircraft structure or systems or cause injury in the event of its operation.

NOTE The decompression parameter is based on an event lasting 1 s, involving an ambient pressure change from 81 kPa (11,8 lbf/in^2) to 15 kPa (2,14 lbf/in^2).

5 Airtightness tests

5.1 The container shall be subjected to tests to determine the air leakage rate. These shall be carried out after completion of the applicable operational or limit load tests (if any) required in other specifications related to the specific container involved.

5.2 The temperature inside and outside the container shall be stabilized within 3 K of each other and shall both be within the range of 288 K to 298 K. The container shall be empty and in its normal operational condition with the access doors closed in the normal manner. Any drain openings shall be closed.

5.3 Air shall be introduced through an accurate metering device and a suitable manometer shall be connected to the container by a leakproof connection. The manometer shall not be part of the air supply system. The flow-measuring device shall be accurate to ± 3 % of the measured flow rate, and the manometer on the container shall be accurate to ± 5 %.

5.4 Air shall be admitted to the container to raise its internal pressure to 0,25 kPa ± 0,01 kPa (0,036 lbf/in^2 ± 0,001 5 lbf/in^2) and the air supply regulated to maintain this pressure.

5.4.1 The air leakage rate, expressed in standard atmospheric conditions, should be no more than the values given in table 1, i.e. 40 % of the internal volume per hour. If the measured air leakage is equal to or less than the values given in table 1, the heat transfer results determined in the thermal test (see clause 6) shall be reported without correction for air leakage.

5.4.2 If the measured air leakage exceeds the values in Table 1, but is no more than the values given in table 2, then the U values measured in the thermal test shall be increased by the correction values given in table 3.

5.5 The air pressure shall be increased to between 3,45 kPa and 6,89 kPa (0,5 lbf/in^2 to 1 lbf/in^2) internal pressure. The pressure relief device, or door seal expulsion, shall operate within the positive differential range of 3,45 kPa to 6,89 kPa (0,5 lbf/in^2 to 1 lbf/in^2).

5.6 Upon completion of the tests described in 5.2 to 5.5, there shall be no permanent deformation and the container shall be fully operational. Closures, seals and pressure equalization device shall be intact and functional.

Table 1

Size of container	m^3	4,53	5,09	7,08	10,05	8,49 to 12,74	17,69	16,99	32,16
	ft^3	160	180	250	355	300 to 450	625	600	1136
Typical units		LD-3	LD-1	LD-5	LD-9	Igloos	96 × 125	10 ft	20 ft
Air leakage rate	m^3/h	1,8	2	2,8	4	3,4 to 5	7,1	6,8	12,8
	ft^3/h	64	72	100	142	120 to 180	250	240	455

Table 2

Size of container	m^3	4,53	5,09	7,08	10,05	8,49 to 12,74	17,69	16,99	32,16
	ft^3	160	180	250	355	300 to 450	625	600	1136
Typical units		LD-3	LD-1	LD-5	LD-9	Igloos	96 × 125	10 ft	20 ft
Air leakage rate	m^3/h	3,6	4	5,6	8	6,8 to 10	14,2	13,6	25,6
	ft^3/h	128	144	200	284	240 to 360	500	480	910

Table 3

Size of container	m^3	4,53	5,09	7,08	10,05	8,49 to 12,74	17,69	16,99	32,16
	ft^3	160	180	250	355	300 to 450	625	600	1136
Typical units		LD-3	LD-1	LD-5	LD-9	Igloos	96 × 125	10 ft	20 ft
Correction	W/K	0,15	0,16	0,24	0,32	0,28 to 0,44	0,6	0,56	1,24

6 Thermal test

6.1 The test is performed to establish the overall heat transfer rate, U, (see 6.5) and thermal transmission factor, K, (see 6.1.4) of the container. The container shall be tested in the exact configuration intended for use. Any options or component configuration alternatives shall be tested in a separate test and appropriately specified, when applicable, in the container performance data on the marking plate described in clause 7.

6.1.1 The U factor applies to only one type of container, and allows the user to easily determine the thermal transfer rate by multiplying the factor by the temperature differential between inside and outside the container. The K factor allows comparison of the insulation performance of a variety of containers with different sizes and contours.

6.1.2 The heat leakage shall be expressed by the total heat transfer rate, U_θ, which is given by the formula

$$U_\theta = \frac{Q}{\theta_e - \theta_i}$$

where

U_θ is the total heat transfer rate, in watts per kelvin[1];

Q is the power dissipated or absorbed by the operation of internal heaters and fans or internal cooling units, in watts;

θ_e is the average outside temperature, in kelvin, which shall be the arithmetic mean of the temperatures recorded at the end of each test interval (see 6.4.7) and measured 100 mm from the walls, at least at the 12 points specified in 6.3.2 and shown in figure 1;

θ_i is the average inside temperature, in kelvin; which shall be the arithmetic mean of the temperatures recorded at the end of each test interval (see 6.4.7) and measured 100 mm from the walls, at least at the 12 points specified in 6.3.1 and shown in figure 2.

6.1.3 The mean wall temperature, θ, shall be expressed in kelvin; by convention:

$$\theta = \frac{\theta_e + \theta_i}{2}$$

[1] 1 W/K = 0,556 W/°F = 0,860 kcal/(h °C) = 1,895 Btu/(h °F)

Dimensions in millimetres

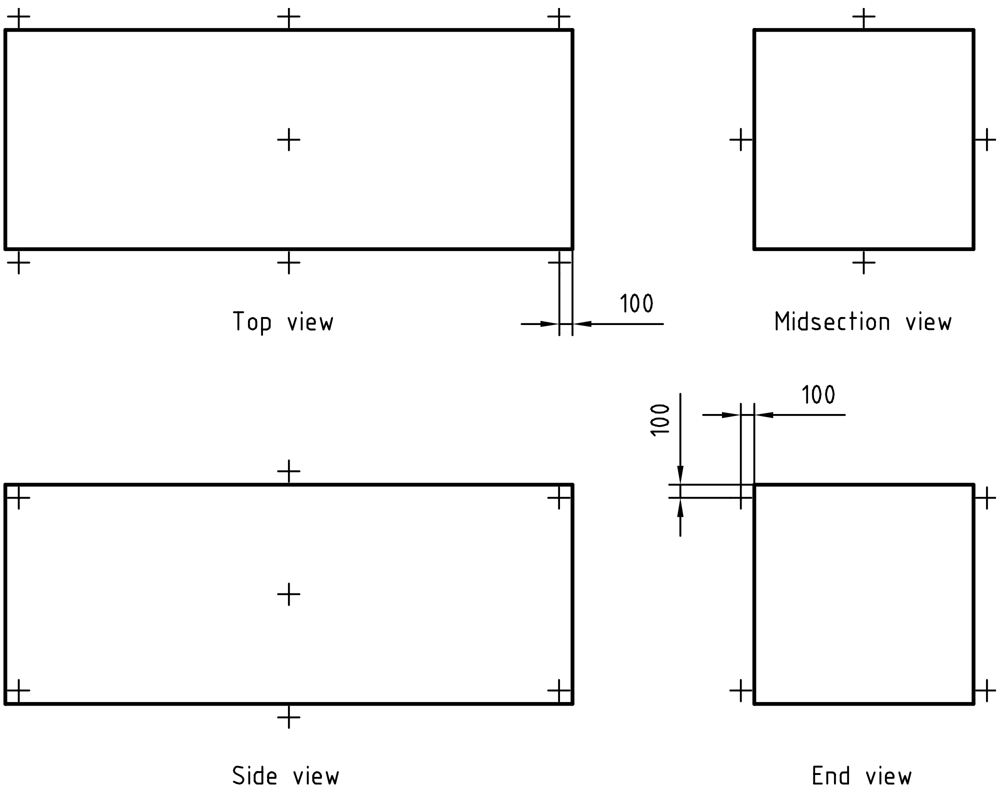

Figure 1 — Outside air temperature measurement points

Dimensions in millimetres

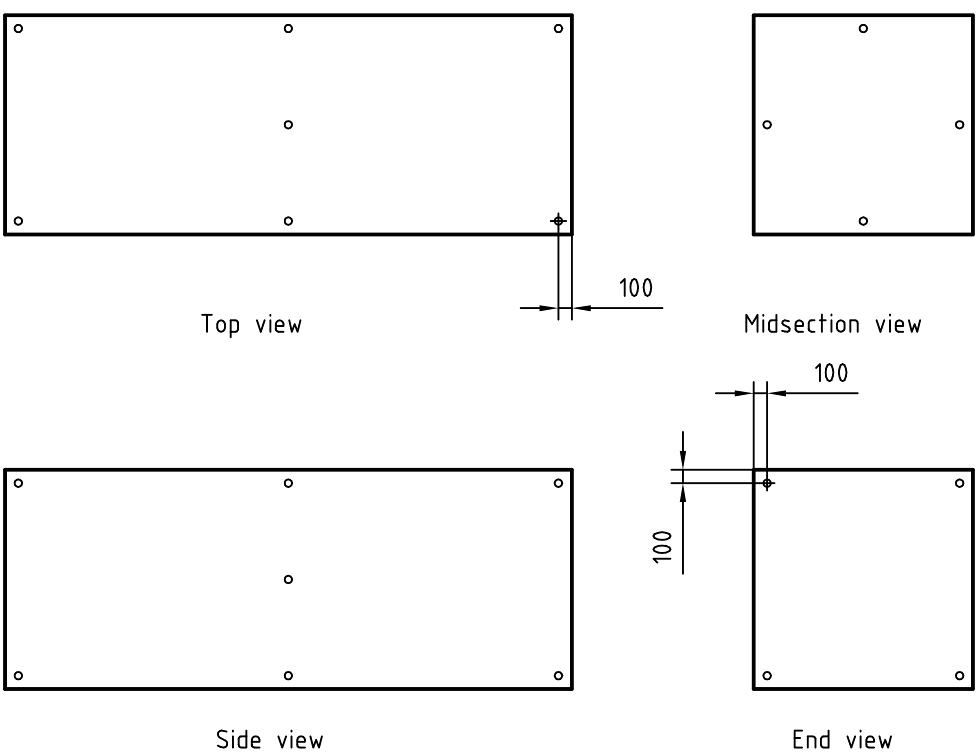

Figure 2 — Inside air temperature measurement points

6.1.4 The coefficient of heat transfer, K, expressed in watts per square metre kelvin, is such that

$$K = \frac{U_\theta}{S}$$

where

U_θ is as defined in 6.1.2;

S is the mean surface area of the container, in square metres, which is the geometric mean of the inside surface area S_i and the outside surface area S_e; by convention:

$$S = \sqrt{S_i \times S_e}$$

If areas are corrugated, the projected area shall be used.

6.2 The test shall be performed under steady-state conditions using the internal heating method. All measuring systems shall be selected and calibrated to result in the following root-mean-square average accuracies:

— temperatures: ± 0,5 K;

— power: ± 2 % of the quantity measured.

6.3 The temperatures shall be measured in accordance with 6.3.1 and 6.3.2.

6.3.1 The inside air temperature shall be measured 100 mm from the walls at least at the following 12 points (see figure 2):

a) the eight inside corners of the container;

b) the centres of the side walls, floor and ceiling.

6.3.2 The outside air temperature shall be measured 100 mm from the walls at least at the following 12 points (see figure 1):

a) the eight outside corners of the container;

b) the centres of the side walls, underside and roof.

6.4 Test data for determining the heat leakage of the container shall be taken after an appropriate soak period to stabilize the wall temperature for a continuous period of not less than 8 h during which the conditions specified in 6.4.1 to 6.4.8 shall be satisfied.

6.4.1 The test shall be performed with a mean wall temperature chosen between 293 K and 311 K, and a temperature difference between inside and outside of not less than 20 K.

NOTE It should be noted that a standard mean wall temperature of 293 K should be used for rating thermal containers because it allows a better determination of all factors involved in the in-service conditions in which the containers will be operated, and facilitates comparison of different containers by owners and users. It also eliminates misunderstanding in applying the total heat transfer rate values for different mean wall temperatures. Appropriate correction factors may be employed for the specific insulation material using a curve relating to mean wall temperature. For example, several testing laboratories use the formula:

$$K_{293} = K_{\theta_m} \times \left[1 - \frac{293 - \theta_m}{200}\right]$$

where

K_{293} is the K factor at mean wall temperature 293 K;

θ_m is the mean wall temperature;

K_{θ_m} is the K factor at θ_m.

6.4.2 The maximum difference between the warmest and coldest points inside at any one time shall be 3 K.

6.4.3 The maximum difference between the warmest and coldest points outside at any one time shall be 3 K.

6.4.4 The maximum percentage difference between the lowest and the highest power dissipation values in watts shall not exceed 3 % of the lowest figure.

6.4.5 The maximum difference between any two average inside air temperatures, θ_i, at different times shall be 1,5 K.

6.4.6 The maximum difference between any two average outside air temperatures, θ_e, at different times shall be 1,5 K.

6.4.7 All readings shall be recorded at intervals of not more than 30 min.

6.4.8 All temperature measuring instruments placed inside and outside the container shall be designed so as to render the effect of radiation negligible.

6.5 Calculate the total heat leakage, U, in watts per kelvin, from 17 or more sets of readings over a continuous test period:

$$U = \frac{1}{n}\sum_{1}^{n} U_\theta$$

where $n \geqslant 17$.

6.6 Calculate the mean of the mean wall temperature(s), θ_m, for the test period:

$$\theta_m = \frac{1}{n}\sum_{1}^{n} \theta$$

where $n \geqslant 17$.

6.7 During any test the outside air velocity shall not exceed 2 m/s (6,6 ft/s) at a distance of 100 mm (4 in) from the container.

6.8 No test method shall result in frost build-up which could affect the test result in any way.

7 Markings

7.1 The markings required for handling shall include the following information:

a) the total heat transfer rate, U, expressed in watts per degree Celsius;

b) the applicable mean wall temperature, θ_m, expressed in degrees Celsius.

7.2 The plate shall be 60 mm × 125 mm and permanently affixed to the container with black bold lettering 10 mm high with the following format:

Heat transfer rate..	W/°C [Btu/(h °F)]
Mean wall temperature	°C (°F)

Annex A
(informative)

Temperature measurement conversion table

Temperature conversions for the values used in this International Standard are given in table A.1.

Table A.1

Kelvin K	**Degrees Celsius** °C	**Degrees Fahrenheit** °F
0	–273,15	–459,7
273,15	0	32
223,15	–50	–58
248,15	–25	–13
283,15	10	50
288,15	15	59
293,15	20	68
298,15	25	77
305,15	32	89,6
311,15	38	100,4
343,15	70	158
383,15	110	230
NOTE For the purposes of temperature differences, 1 K = 1 °C = 1,8 °F.		

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