
British Standard

Freight containers

Part 2. Specification and testing
of series 1 freight containers

Section 2.2 Thermal containers

Conteneurs pour le transport des marchandises
Partie 2. Spécification et essais des conteneurs de la série 1
Section 2.2 Conteneurs à caractéristiques thermiques

Frachtbeforderungsbehälter
Teil 2. Bestimmungen und Prüfungen der Behälter der Serie 1
Abschnitt 2.2 Behälter mit Wärme-Eigenschaften

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National foreword

This Section of BS 3951, which is one of a series relating to freight containers, has been prepared under the direction of the Packaging and Freight Containers Standards Policy Committee and supersedes BS 3951 : Section 2.2 : 1978, which is withdrawn.

This Section is identical with ISO 1496-2 : 1988 'Series 1 freight containers—Specification and testing—Part 2 : Thermal containers' published by the International Organization for Standardization (ISO).

The main changes from the previous edition are as follows:

- (a) alignment of the text, etc. with BS 3951 : Section 2.1
- (b) introduction of *U* values instead of *K* factors;
- (c) specification of internal height and width dimensions;
- (d) revision of air leakage rates;
- (e) revision of the heat leakage test;
- (f) revision of the performance test under refrigeration;
- (g) revision of annex F;
- (h) introduction of an annex giving information on intermediate sockets for clip-on units;
- (i) introduction of an annex giving a diagrammatic representation of steady-state conditions.

Cross-references

International standard	Corresponding British Standard
	BS 3951 Freight containers Part 1 General
ISO 668 : 1988	Section 1.1 : 1989 Specification for series 1 freight containers : Classification, dimensions and ratings (Identical)
ISO 830 : 1981	Section 1.4 : 1983 Glossary of terminology (Identical)
ISO 1161 : 1984	Section 1.2 : 1985 Specification for corner fittings for series 1 freight containers (Identical)
ISO 6346 : 1984	Section 1.6 : 1985 Specification for coding, identification and marking (Identical)



IEC 144 : 1963

BS 5420 : 1977 Specification for degrees of protection of enclosures of switchgear and controlgear for voltages up to and including 1000 V a.c. and 1200 V a.c.
(Identical)

Other British Standards giving information related to the handling of freight containers are BS 5073 : 1982 'Guide to stowage of goods in freight containers' and BS 5237 : 1985 'Specification for lifting twistlocks'.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Series 1 freight containers — Specification and testing —

Part 2 : Thermal containers

0 Introduction

Grouping of container types for specification purposes:

Part 1

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Part 2

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Part 6

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NOTE — Container groupings for parts 1 and 3 to 6 inclusive are set forth in detail in the relevant parts of this International Standard.

1 Scope and field of application

1.1 This part of ISO 1496 lays down the basic specifications and testing requirements for ISO series 1 thermal containers which are suitable for international exchange and for conveyance by road, rail and sea, including interchange between these forms of transport.

1.2 The container types covered by this part of ISO 1496 are given in table 1.

1.3 The marking requirements for these containers are in accordance with the principles embodied in ISO 6346.

The load-bearing capabilities of equipment installed for hanging cargo shall be clearly marked on the inside of the container.

If containers are given an atmosphere which could be injurious to health until appropriately vented, suitable marks should be placed alongside each point of access.

2 References

ISO 668, *Series 1 freight containers — Classification, dimensions and ratings*.

ISO 830, *Freight containers — Terminology*.

ISO 1161, *Series 1 freight containers — Corner fittings — Specification*.

ISO 6346, *Freight containers — Coding, identification and marking*.

IEC Publication 144, *Degrees of protection of enclosures for low-voltage switchgear and controlgear*.

3 Definitions

For the purposes of this part of ISO 1496, the definitions given in ISO 830 apply. The following definitions correspond to those given in ISO 830, but they have been included, for convenience, in this part of ISO 1496.

3.1 thermal container: Freight container built with insulating walls, doors, floor and roof designed to retard the rate of heat transmission between the inside and the outside of the container.

3.2 insulated container: Thermal container having no devices for cooling and/or heating, either permanently installed or attached.

Table 1 — Classification of thermal containers

Type code designation	Type	Maximum heat leakage ¹⁾ , $U_{\max}$ (W/K), for freight containers				Design temperatures ²⁾			
		1D	1C, 1CC	1B, 1BB	1A, 1AA	Inside		Outside	
						K	°C	K	°C
30	Refrigerated, expendable refrigerant	15	26	37	48	255	− 18	311	+ 38
31	Mechanically refrigerated	15	26	37	48	255	− 18	311	+ 38
32	Refrigerated and heated	15	26	37	48	289 255	+ 16 − 18	311 253	+ 38 − 20
33	Heated	15	26	37	48	289	+ 16	253	− 20
34 35	Spare								
36	Mechanically refrigerated, self-powered	15	26	37	48	255	− 18	311	+ 38
37	Refrigerated and heated, self-powered	15	26	37	48	289 255	+ 16 − 18	311 253	+ 38 − 20
38	Heated, self-powered	15	26	37	48	289	+ 16	253	− 20
39	Spare								
40	Refrigerated and/or heated, with removable equipment, appliance located externally	15	26	37	48	3)		3)	
41	Refrigerated and/or heated, with removable equipment, appliance located internally	15	26	37	48	3)		3)	
42	Refrigerated and/or heated, with removable equipment, appliance located externally	26	46	66	86	3)		3)	
43 44	Spare								
45	Insulated	15	26	37	48	—		—	
46	Insulated	26	46	66	86	—		—	
47 48 49	Spare								

1) The values of $U_{\max}$ for heavily insulated containers (types 30, 31, 32, 33, 36, 37, 40, 41 and 45) are related to an approximate coefficient of heat transfer, K , of 0,4 W/(m².K).

The values of $U_{\max}$ for lightly insulated containers (types 42 and 46) are related to an approximate coefficient of heat transfer, K , of 0,7 W/(m².K).

2) A conversion table for kelvins/degrees Celsius is given for convenience in table 2.

3) This category does not have specified temperature limits; the actual performance is dependent on the capability of the equipment attached in any transport mode.

Table 2 — Kelvins/degrees Celsius conversion table¹⁾

Kelvin, K	Degrees Celsius, °C
0	– 273,15
273,15	0
253	– 20
255	– 18
288	+ 15
289	+ 16
293	+ 20
298	+ 25
305	+ 32
311	+ 38

1) In the case of temperature differences: 1 K = 1 °C

3.3 refrigerated container (expendable refrigerant): Thermal container using a means of cooling such as

- ice, or
- dry ice, with or without sublimation control, or
- liquefied gases, with or without evaporation control.

It is implicit in this definition that such a container requires no external power supply or fuel supply.

3.4 mechanically refrigerated container: Thermal container served by refrigerating appliance (mechanical compressor unit, absorption unit, etc.).

3.5 heated container: Thermal container served by heat-producing appliance.

3.6 refrigerated and heated container: Thermal container served by refrigerating appliance (mechanical or expendable refrigerant) and heat-producing appliance.

3.7 removable equipment; clip-on unit: Refrigerating and/or heating appliance which is designed primarily for attaching to or detaching from the container when transferring between different modes of transportation.

3.8 located internally: Totally within the external dimensional envelope of the container as defined in ISO 668.

3.9 located externally: Partially or totally outside the external dimensional envelope of the container as defined in ISO 668.

It is implicit in this definition that an appliance located externally has to be removable or retractable to facilitate transport in certain modes.

3.10 battens: Members protruding from the inside walls of the container to hold the cargo away from the walls to provide an air passage. They may be integral with the walls, fastened to the walls or added during cargo loading.

3.11 bulkhead: A partition providing a plenum chamber and/or air passage for either return or supply air. It may be an integral part of the appliance or a separate member.

3.12 ceiling air duct: A passage or passages located in proximity to the ceiling to direct air flow.

3.13 floor air duct: A passage or passages located beneath the cargo support surface to direct air flow.

4 Dimensions and ratings

4.1 External dimensions

The overall external dimensions and tolerances of the freight containers covered by this part of ISO 1496 are those established in ISO 668. No part of the container shall project beyond these specified overall external dimensions.

4.2 Internal dimensions

Internal dimensions of containers shall be as large as possible. They shall be measured from inner faces of battens, bulkheads, ceiling air ducts, floor air ducts, etc., where fitted.

4.3 Minimum internal dimensions

The minimum internal dimensions for ISO series 1 thermal freight containers are specified in table 3.

4.4 Ratings

The values of the rating, *R*, being the gross mass of the container, are those given in ISO 668.

5 Design requirements

5.1 General

All containers shall be capable of fulfilling the following requirements.

The strength requirements for containers are given in diagrammatic form in annex A (these requirements are applicable to all containers except where otherwise stated). They apply to containers as complete units, except as envisaged in 6.1.

The strength requirements for corner fittings (see also 5.2) are given in ISO 1161.

The container shall be capable of withstanding the loads and loadings detailed in clause 6.

As the effects of loads encountered under any dynamic operating condition should only approach, but not exceed, the effects of the corresponding test loads, it is implicit that the capabilities of containers indicated in annex A and demonstrated by the tests described in clause 6 shall not be exceeded in any mode of operation.

Table 3 — Minimum internal dimensions¹⁾

Dimensions in millimetres

Freight container designation	Types	Length ²⁾	Width	Height ²⁾
1C	38, 40, 45	5 650	2 220	2 000
	30, 31, 32, 41	5 300 ³⁾	2 220	2 000
	42, 46	5 770	2 300	2 125
1CC	38, 40, 45	5 650	2 220	2 150
	30, 31, 32, 41	5 300 ³⁾	2 220	2 150
	42, 46	5 770	2 300	2 275
1A	38, 40, 45	11 750	2 220	2 000
	30, 31, 32, 41	11 140 ³⁾	2 220	2 000
	42, 46	11 870	2 300	2 125
1AA	38, 40, 45	11 750	2 220	2 150
	30, 31, 32, 41	11 140 ³⁾	2 220	2 150
	42, 46	11 870	2 300	2 275

1) Minimum internal dimensions for 1B, 1BB and 1D containers are being studied.

2) Some of the height and length specified will be required for air circulation or other special arrangements.

3) Some refrigerated containers built to conform with earlier editions of this part of ISO 1496 are significantly shorter, particularly where a diesel generator is fitted.

Any closure in a container which, if unsecured, could lead to a hazardous situation, shall be provided with an adequate securing system having external indication of the positive securement of that closure in the appropriate operating position. In particular, doors should be capable of being securely fastened in the open or closed position.

The walls, doors, floors and roof of the thermal container shall be insulated in such a manner as to balance, as far as is practicable, the heat transfer through each of them, although the roof insulation may be increased to compensate for solar radiation.

5.2 Corner fittings

All containers shall be equipped with top and bottom corner fittings. The requirements and positioning of the corner fittings are given in ISO 1161. The upper faces of the top corner fittings shall protrude above the top of the container by a minimum of 6 mm¹⁾ (see 5.3.4). The "top of the container" means the highest level of the cover of the container. However, if reinforced zones or doubler plates are provided to afford protection to the roof in the vicinity of the top corner fittings, such plates and their securements shall not protrude above the upper faces of the top corner fittings. These plates shall not extend more than 750 mm¹⁾ from either end of the container but may extend the full width.

5.3 Base structure

5.3.1 All containers shall be capable of being supported by their bottom corner fittings only.

5.3.2 All containers, other than 1D, shall also be capable of being supported only by load transfer areas in their base structure.

5.3.2.1 Consequently, these containers shall have end transverse members and sufficient intermediate load transfer areas (or a flat underside) of sufficient strength to permit vertical load transfer to or from the longitudinal member of a carrying vehicle. Such longitudinal members are assumed to lie within the two 250 mm¹⁾ wide zones defined by the broken lines in figure 24.

5.3.2.2 The lower faces of the load transfer areas, including those of the end transverse members, shall be in one plane located

$$12,5 \pm 5,5 \text{ mm}^{1)}$$

above the plane of the lower faces of the bottom corner fittings and bottom side rail. Apart from the bottom corner fittings and bottom side rails, no part of the container shall project below this plane.

However, doubler plates may be provided in the vicinity of the bottom corner fittings to afford protection to the understructure.

Such plates shall not extend more than 550 mm¹⁾ from the outer end and not more than 470 mm¹⁾ from the side faces of the bottom corner fittings, and their lower faces shall be at least 5 mm¹⁾ above the lower faces of the bottom corner fittings of the container.

1) 6 mm = 1/4 in
 750 mm = 29 1/4 in
 250 mm = 10 in
 $12,5 \pm 5,5 \text{ mm} = 1/2 \pm 3/16 \text{ in}$

550 mm = 22 in
 470 mm = 18 1/2 in
 5 mm = 3/16 in

5.3.2.3 The transfer of load between the underside of the bottom side rails and carrying vehicles is not envisaged. The transfer of load between side rails and handling equipment should only occur when provisions have been made in accordance with 5.9.1 and 5.9.2.

5.3.2.4 Containers having all their intermediate transverse members spaced 1 000 mm¹⁾ apart or less (or having a flat underside) shall be deemed to comply with the requirements laid down in 5.3.2.1.

5.3.2.5 Requirements for containers not having transverse members spaced 1 000 mm¹⁾ apart or less (and not having a flat underside) are given in annex B.

5.3.3 For 1D containers, the level of the underside of the base structure is not specified, except insofar as it is implied in 5.3.4.

5.3.4 For all containers under dynamic conditions, or the static equivalent thereof, with the container having a load uniformly distributed over the floor in such a way that the combined mass of the container and test load is equal to 1,8 *R*, no part of the base of the container shall deflect more than 6 mm¹⁾ below the base plane (lower faces of the bottom corner fittings).

5.3.5 The base structure shall be designed to withstand all forces, particularly lateral forces, induced by the cargo in service. This is particularly important where provisions are made for securing the cargo to the base structure of the container.

5.4 End structure

For all containers other than 1D, the sideways deflection of the top of the container with respect to the bottom of the container, at the time it is under full transverse rigidity test conditions, shall not cause the sum of the changes in length of the two diagonals to exceed 60 mm¹⁾.

NOTE — It should be noted that the rigidity of the end structure of a container fitted with an internally located refrigeration unit is not necessarily equal to the sum of rigidities of container and unit, but is also dependent on the way in which the unit is fitted.

5.5 Side structure

For all containers other than 1D, the longitudinal deflection of the top of the container with respect to the bottom of the container, at the time it is under full longitudinal rigidity test conditions, shall not exceed 25 mm¹⁾.

5.6 Walls

Where openings are provided in end or side walls, the ability of these walls to withstand tests Nos. 5 and 6 shall not be impaired.

5.7 Door opening

Each container shall be provided with a door opening at least at one end.

All door openings and end openings shall be as large as possible.

The usable width shall correspond with the appropriate minimum internal dimension given in table 3.

The usable height shall be as close as practicable to the appropriate minimum internal dimension given in table 3.

5.8 Sanitary and taint-free requirements

Attention is drawn to the need for the proper choice of materials for the container and refrigerator/heating appliances to prevent adverse effects in cargo, especially foodstuffs. Any relevant national or international requirements should also be considered.

The interior surface and container structure shall be so constructed as to facilitate cleaning, and the structure and the insulation shall not be functionally affected by cleaning methods, for example steam cleaning and detergents normally used.

No pockets shall exist inside the container that cannot be reached by conventional cleaning methods.

If drains are fitted, adequate provision shall be made to ensure that cleaning water can drain satisfactorily from the inside of the container.

5.9 Requirements — Optional features

5.9.1 Fork-lift pockets

5.9.1.1 Fork-lift pockets used for handling 1CC, 1C and 1D containers in the loaded or unloaded condition may be provided as optional features.

Fork-lift pockets shall not be provided on 1AA, 1A, 1BB and 1B containers.

1) 1 000 mm = 39 3/8 in

6 mm = 1/4 in

60 mm = 2 3/8 in

25 mm = 1 in

5.9.1.2 Where a set of fork-lift pockets has been fitted as in 5.9.1.1, a second set of fork-lift pockets may, in addition, be provided on 1CC and 1C containers for empty handling only.

NOTE — The(se) additional pocket(s) which may in fact be one pocket paired with an existing pocket, provided in accordance with 5.9.1.1, should be centred as closely as possible about the centre of gravity of the empty container.

5.9.1.3 The fork-lift pockets, where provided, shall meet the dimensional requirements specified in annex C and shall pass completely through the base structure of the container so that lifting devices may be inserted from either side. It is not necessary for the base of the fork-lift pockets to be the full width of the container but it shall be provided in the vicinity of each end of the fork pockets.

5.9.2 Grappler arms or similar devices

Fixtures for handling all containers by means of grappler arms or similar devices may be provided as optional features. The dimensional requirements for such fixtures are specified in annex D.

5.9.3 Gooseneck tunnels

Gooseneck tunnels may be provided as optional features in containers 1AA and 1A. The dimensional requirements are specified in annex E and, in addition, all other parts of the base structure shall be as specified in 5.3.

5.9.4 Drains

Cargo space drains, if required to operate when carrying cargo, should be protected by fittings which open automatically above normal internal operating pressure. If required for cleaning of the interior of the container, they shall be provided with manual closures.

Consideration should be given to applicable customs and health requirements.

5.9.5 Water connections

For appliances requiring water connections, the inlet and outlet interfaces shall conform to annex F.

Water-cooled appliances shall either be self-draining or incorporate the facility to drain the unit in order to prevent the water from freezing.

The water inlet and outlet connections shall be so located at the machinery end of the container that, to an observer facing that end, they appear in the lower right-hand quarter.

5.9.6 Air inlets and outlets

Where series 1AA, 1CC and 1C containers are designed for ducted air systems and for use with externally located removable equipment, the air inlet and outlet openings shall conform to clauses G.1, G.2 and G.3, respectively, in annex G.

5.9.7 Intermediate sockets for clip-on units

Where intermediate sockets are provided for use of clip-on units, they shall be located and designed as shown in annex H.

6 Testing

6.1 General

6.1.1 Unless otherwise stated, containers complying with the design requirements specified in clause 5 shall, in addition, be capable of withstanding the tests specified in 6.2 to 6.18 inclusive, as applicable.

The refrigeration and/or heating equipment (for example components, framework, panelling, battens, ductwork, bulkheads) need not necessarily be in place when the container is tested except where specified for a particular test. But if any of the main parts or frameworks of the refrigeration and/or heating equipment is not in position for any structural test, the ability of that part or framework to withstand the appropriate proportion of any relevant cargo loading and/or the forces or accelerations to which the container and equipment may be subjected in the service for which it was designed shall be established independently. If parts of the refrigeration and/or heating equipment which contribute to the strength or integrity of the container in service are not in position for structural testing, substitute framework and/or panelling may be employed during such testing provided that such substitute components are secured in the same manner as the equipment itself and do not provide greater strength than the equipment would have provided.

The test for heat leakage (test No. 15) shall be used to measure the heat leakage rate from the container, which determines its class. The tests described in 6.17 and 6.18 (test Nos. 16a and 16b) establish a standard method for testing the performance of mechanical and liquid expendable refrigeration units respectively, when used in conjunction with a container of known class.

The tests for weather-proofness (test No. 13), for airtightness (test No. 14), for heat leakage (test No. 15) and for performance under refrigeration (test No. 16) shall be carried out in sequence after completion of tests Nos. 1 to 12.

6.1.2 The symbol P denotes the maximum payload of the container to be tested, that is,

$$P = R - T$$

where

R is the rating;

T is the tare.

NOTE — R , P and T , by definition, are in units of mass. Where test requirements are based on the gravitational forces derived from these values, those forces, which are inertial forces, are indicated thus:

R_g , P_g , T_g

the units of which are in newtons or multiples thereof.

The word "load", when used to describe a physical quantity to which units may be ascribed, implies mass.

The word "loading", for example as in "internal loading", implies force.

6.1.3 The test loads or loadings within the container shall be uniformly distributed.

6.1.4 The test load or loading specified in all of the following tests are the minimum requirements.

6.1.5 The dimensional requirements to which reference is made in the requirements sub-clause after each test are those specified in

- the dimensional and design requirement clauses of this part of ISO 1496;
- ISO 668;
- ISO 1161.

6.2 Test No. 1 — Stacking

6.2.1 General

This test shall be carried out to prove the ability of a fully loaded container to support a superimposed mass of containers, taking into account conditions on board ships at sea and relative eccentricities between superimposed containers.

The test force to be applied to each pair of corner fittings and the superimposed mass that the test force represents are specified in table 4.

6.2.2 Procedure

The container shall be placed on four level pads, one under each bottom corner fitting.

The pads shall be centralized under the fittings and shall be substantially of the same plan dimensions as the fittings. The container shall have a load uniformly distributed over the floor in such a way that the combined mass of the container and the test load is equal to $1,8 R$.

The container shall be subjected to vertical forces, applied either to all four corner fittings simultaneously or to each pair of end fittings, at the appropriate value specified in table 4. The forces shall be applied through a test fixture equipped with corner fittings as specified in ISO 1161, or equivalent fittings which have imprints of the same geometry (i.e. with the same external dimensions, chamfered aperture and rounded edges)

as the lower face of the bottom corner fitting specified in ISO 1161. If equivalent fittings are used, they shall be designed to produce the same effect on the container under the test loads as when corner fittings are used.

In all cases, the forces shall be applied in such a manner that rotation of the planes through which the forces are applied and on which the container is supported is minimized.

Each corner fitting or equivalent test fitting shall be offset in the same direction by 25,4 mm¹⁾ laterally and 38 mm¹⁾ longitudinally.

Table 4 — Forces to be applied in stacking test

Freight container designation	Test force per container (all four corners simultaneously)		Test force per pair of end fittings		Superimposed mass represented by test force	
	kN	lbf	kN	lbf	kg	lb
1A and 1AA	3 392	763 200	1 696	381 600	192 000	423 320
1B and 1BB	3 392	763 200	1 696	381 600	192 000	423 320
1C and 1CC	3 392	763 200	1 696	381 600	192 000	423 320
1D	896	201 600	448	100 800	50 800	112 000

NOTE — The test force of 3 392 kN per container is derived from the superimposed mass of eight containers stacked on top of one container all of which being rated to 24 000 kg (52 920 lb) and an acceleration force of 1,8 g. [The corner posts of such containers are known as having been tested to 86 400 kg (190 480 lb).]

6.2.3 Requirements

On completion of the test, the container shall show neither permanent deformation which will render it unsuitable for use nor abnormality which will render it unsuitable for use, and the dimensional requirements affecting handling, securing and interchange shall be satisfied.

6.3 Test No. 2 — Lifting from the four top corner fittings

6.3.1 General

This test shall be carried out to prove the ability of a container, other than a 1D container, to withstand being lifted, from the four top corner fittings, with the lifting forces applied vertically, and the ability of a 1D container to withstand being lifted from the top corner fittings with the lifting forces applied at any angle between the vertical and 60° to the horizontal, these being the only recognized methods of lifting these containers by the four top corner fittings.

This test shall also be regarded as proving the ability of the floor and base structure to withstand the forces arising from acceleration of the payload in lifting operations.

1) 25,4 mm = 1 in
38 mm = 1 1/2 in

6.3.2 Procedure

The container shall have a load uniformly distributed over the floor in such a way that the combined mass of the container and test load is equal to $2R$, and it shall be carefully lifted from all four top corners in such a way that no significant acceleration or deceleration forces are applied.

For a container, other than a 1D container, the lifting forces shall be applied vertically.

For a 1D container, lifting shall be carried out by means of slings, the angle of each leg being at 60° from the horizontal.

After lifting, the container shall be suspended for 5 min and then lowered to the ground.

6.3.3 Requirements

On completion of the test, the container shall show neither permanent deformation which will render it unsuitable for use nor abnormality which will render it unsuitable for use, and the dimensional requirements affecting handling, securing and interchange shall be satisfied.

6.4 Test No. 3 — Lifting from the four bottom corner fittings

6.4.1 General

This test shall be carried out to prove the ability of a container to withstand being lifted, from its four bottom corner fittings, by means of lifting devices bearing on the bottom corner fittings only and attached to a single transverse central spreader beam above the container.

6.4.2 Procedure

The container shall have a load uniformly distributed over the floor in such a way that the combined mass of container and test load is equal to $2R$ and it shall be carefully lifted from the side apertures of all four bottom corner fittings in such a way that no significant acceleration or deceleration forces are applied.

Lifting forces shall be applied at

- 30° to the horizontal for 1AA and 1A containers;
- 37° to the horizontal for 1BB and 1B containers;
- 45° to the horizontal for 1CC and 1C containers;
- 60° to the horizontal for 1D containers.

In each case, the line of action of the lifting force and the outer face of the corner fitting shall be no farther apart than 38 mm¹⁾. The lifting shall be carried out in such a manner that the lifting devices bear on the four bottom corner fittings only.

The container shall be suspended for 5 min and then lowered to the ground.

1) 38 mm = 1 1/2 in

6.4.3 Requirements

On completion of the test, the container shall show neither permanent deformation which will render it unsuitable for use nor abnormality which will render it unsuitable for use, and the dimensional requirements affecting handling, securing and interchange shall be satisfied.

6.5 Test No. 4 — Restraint (longitudinal)

6.5.1 General

This test shall be carried out to prove the ability of a container to withstand longitudinal external restraint under dynamic conditions of railway operations, which implies acceleration of 2 g.

6.5.2 Procedure

The container shall have a load uniformly distributed over the floor in such a way that the combined mass of the container and the uniformly distributed test load is equal to R , and it shall be secured longitudinally to rigid anchor points through the bottom apertures of the bottom corner fittings at one end of the container.

A force of $2Rg$ shall be applied horizontally to the container through the bottom apertures of the other bottom corner fittings, first towards and then away from the anchor points.

6.5.3 Requirements

On completion of the test, the container shall show neither permanent deformation which will render it unsuitable for use nor abnormality which will render it unsuitable for use, and the dimensional requirements affecting handling, securing and interchange shall be satisfied.

6.6 Test No. 5 — Strength of end walls

6.6.1 General

This test shall be carried out to prove the ability of a container to withstand forces under the dynamic conditions referred to in 6.5.1.

6.6.2 Procedure

The container shall have each end tested when one end is blind and the other equipped with doors. In the case of symmetrical construction, one end only need be tested. The container shall be subjected to an internal loading of $0,4Pg$. The internal loading shall be uniformly distributed over the wall under test and arranged to allow free deflection of the wall.

6.6.3 Requirements

On completion of the test, the container shall show neither permanent deformation which will render it unsuitable for use nor abnormality which will render it unsuitable for use, and the dimensional requirements affecting handling, securing and interchange shall be satisfied.

6.7 Test No. 6 — Strength of side walls

6.7.1 General

This test shall be carried out to prove the ability of a container to withstand the forces resulting from ship movement.

6.7.2 Procedure

The container shall have each side wall tested. In the case of symmetrical construction, one side only need be tested.

Each side wall of the container shall be subjected to an internal loading of $0,6 P_g$. The internal loading shall be uniformly distributed, applied to each wall separately and arranged to allow free deflection of the side wall and its longitudinal members.

6.7.3 Requirements

On completion of the test, the container shall show neither permanent deformation which will render it unsuitable for use nor abnormality which will render it unsuitable for use, and the dimensional requirements affecting handling, securing and interchange shall be satisfied.

6.8 Test No. 7 — Strength of the roof

6.8.1 General

This test shall be carried out to prove the ability of the roof of a container to withstand the loads imposed by persons working on it.

If the roof is intended to carry a hanging cargo, a test shall be carried out to prove the ability of the container to carry a minimum total hanging load of $1\,490\text{ kg/m}^1$ of usable inside container length. A vertical acceleration of 2 g shall be taken into account.

6.8.2 Procedure

A load of 300 kg^1 shall be uniformly distributed over an area of $600\text{ mm} \times 300\text{ mm}^1$ located at the weakest area of the roof of the container.

If the roof is intended to carry a hanging cargo, a load of twice the service load or twice $1\,490\text{ kg/m}^1$, whichever is greater, shall be attached to the roof in a manner simulating normal service loadings, while the container is supported by its four bottom corner fittings only.

6.8.3 Requirements

On completion of the test, the container shall show neither permanent deformation which will render it unsuitable for use nor

abnormality which will render it unsuitable for use, and the dimensional requirements affecting handling, securing and interchange shall be satisfied.

6.9 Test No. 8 — Floor strength

6.9.1 General

This test shall be carried out to prove the ability of a container floor to withstand the concentrated dynamic loading imposed during cargo operations involving powered industrial trucks or similar devices.

6.9.2 Procedure

The test shall be performed using a test vehicle equipped with tyres, with an axle load of $5\,460\text{ kg}^1$ [i.e. $2\,730\text{ kg}^1$ on each of two wheels]. It is to be so arranged that all points of contact between each wheel and a flat continuous surface lie within a rectangular envelope measuring 185 mm^1 (in a direction parallel to the axle of the wheel) by 100 mm^1 and that each wheel makes physical contact over an area within this envelope of not more than $142\text{ cm}^2\text{ }^1$. The wheel width shall be nominally 180 mm^1 and the wheel centres shall be nominally 760 mm^1 . The test vehicle shall be manoeuvred over the entire floor area of the container. The test shall be made with the container resting on four level supports under its four bottom corner fittings, with its base structure free to deflect.

6.9.3 Requirements

On completion of the test, the container shall show neither permanent deformation which will render it unsuitable for use nor abnormality which will render it unsuitable for use, and the dimensional requirements affecting handling, securing and interchange shall be satisfied.

6.10 Test No. 9 — Rigidity (transverse)

6.10.1 General

This test shall be carried out to prove the ability of a container, other than a 1D container, to withstand the transverse racking forces resulting from ship movement.

6.10.2 Procedure

The container in tare condition (T) shall be placed on four level supports, one under each corner fitting, and shall be restrained against lateral and vertical movement by means of anchor devices acting through the bottom apertures of the bottom corner fittings. Lateral restraint shall be provided only at a bottom corner fitting diagonally opposite to and in the same end frame as a top corner fitting to which force is applied. When testing the two end frames separately, vertical restraint shall be applied only at the end frame under test.

¹⁾ $1\,490\text{ kg/m} = 1\,000\text{ lb/ft}$	$185\text{ mm} = 7\frac{1}{4}\text{ in}$
$300\text{ kg} = 660\text{ lb}$	$100\text{ mm} = 4\text{ in}$
$600\text{ mm} \times 300\text{ mm} = 24\text{ in} \times 12\text{ in}$	$142\text{ cm}^2 = 22\text{ in}^2$
$5\,460\text{ kg} = 12\,000\text{ lb}$	$180\text{ mm} = 7\text{ in}$
$2\,730\text{ kg} = 6\,000\text{ lb}$	$760\text{ mm} = 30\text{ in}$

Forces of 150 kN¹⁾ shall be applied either separately or simultaneously to each of the top corner fittings on one side of the container in lines parallel both to the base and to the planes of the ends of the container. The forces shall be applied first towards and then away from the top corner fittings.

In the case of a container with identical ends, only one end need be tested. Where an end is not essentially symmetrical about its own vertical centreline, both sides of that end shall be tested.

For allowable deflections under full test loading, see 5.4.

6.10.3 Requirements

On completion of the test, the container shall show neither permanent deformation which will render it unsuitable for use nor abnormality which will render it unsuitable for use, and the dimensional requirements affecting handling, securing and interchange shall be satisfied.

6.11 Test No. 10 — Rigidity (longitudinal)

6.11.1 General

This test shall be carried out to prove the ability of a container, other than a 1D container, to withstand the longitudinal racking forces resulting from ship movement.

6.11.2 Procedure

The container in tare condition (*T*) shall be placed on four level supports, one under each corner fitting, and shall be restrained against longitudinal and vertical movement by means of anchor devices acting through the bottom apertures of the bottom corner fittings. Longitudinal restraint shall be provided only at a bottom corner fitting diagonally opposite to and in the same side frame as a top corner fitting to which force is applied.

Forces of 75 kN¹⁾ shall be applied either separately or simultaneously to each of the top corner fittings on one end of the container in lines parallel both to the base of the container and to the planes of the sides of the container. The forces shall be applied first towards and then away from the top corner fitting.

In the case of a container with identical sides, only one side need be tested. Where a side is not essentially symmetrical about its own vertical centreline, both ends of that side shall be tested.

For allowable deflections under full test loading, see 5.5.

6.11.3 Requirements

On completion of the test, the container shall show neither permanent deformation which will render it unsuitable for use nor abnormality which will render it unsuitable for use, and the dimensional requirements affecting handling, securing and interchange shall be satisfied.

6.12 Test No. 11 — Lifting from fork-lift pockets (where fitted)

6.12.1 General

This test shall be carried out on any 1CC, 1C or 1D container which is fitted with fork-lift pockets.

6.12.2 Procedure

6.12.2.1 1CC, 1C or 1D containers fitted with one set of fork-lift pockets

The container shall have a load uniformly distributed over the floor in such a way that the combined mass of container and test load is equal to $1,6 R$ and it shall be supported on two horizontal bars, each 200 mm¹⁾ wide, projecting $1\,828 \pm 3$ mm¹⁾ into the fork-lift pockets, measured from the outside face of the side of the container. The bars shall be centred within the pockets.

The container shall be supported for 5 min and then lowered to the ground.

6.12.2.2 1CC or 1C containers fitted with two sets of fork-lift pockets

The test described in 6.12.2.1 shall be applied to the outer pockets.

A second test shall be applied to the (additional) inner pockets. The procedure for this second test shall be as required in 6.12.2.1 except that in this case the combined mass of the container and test load shall be equal to $0,625 R$, and the bars shall be placed in the inner pockets.

6.12.3 Requirements

On completion of the test, the container shall show neither permanent deformation which will render it unsuitable for use nor abnormality which will render it unsuitable for use, and the dimensional requirements affecting handling, securing and interchange shall be satisfied.

1) 150 kN = 33 700 lbf
75 kN = 16 850 lbf
200 mm = 8 in
 $1\,828 \pm 3$ mm = $72 \pm 1/8$ in

6.13 Test No. 12 — Lifting from the base at grapple arm positions (where fitted)

6.13.1 General

This test shall be carried out on any container which is fitted with fixtures for being lifted by grapple arms or similar devices with lifting positions as detailed in annex D.

6.13.2 Procedure

The container shall have a load uniformly distributed over the floor in such a way that the combined mass of the container and the uniformly distributed test load is equal to $1,25 R$, and it shall be supported at the four positions where provision has been made for the equipment envisaged in 6.13.1, over an area of $32 \text{ mm} \times 254 \text{ mm}^{(1)}$ centrally located at each of the four positions, clear of the safety lips.

The container shall be supported for 5 min and then lowered to the ground.

6.13.3 Requirements

On completion of the test, the container shall show neither permanent deformation which will render it unsuitable for use nor abnormality which will render it unsuitable for use, and the dimensional requirements affecting handling, securing and interchange shall be satisfied.

6.14 Test No. 13 — Weatherproofness

6.14.1 General

This test shall be carried out on door seals, exterior gasketed joints and other openings which are fitted with closing devices. If a refrigeration unit is fitted, all electrical and other enclosures and exposed components on the unit shall be tested.

6.14.2 Procedure

A stream of water shall be applied to the area being tested from a nozzle of $12,5 \text{ mm}^{(1)}$ inside diameter, at a pressure of about $100 \text{ kPa}^{(1)}$ (corresponding to a head of about $10 \text{ m}^{(1)}$ of water) on the upstream side of the nozzle. The nozzle shall be held at a distance of $1,5 \text{ m}^{(1)}$ from the container under test, and the stream shall be traversed at a speed of $100 \text{ mm/s}^{(1)}$.

Procedures involving the use of several nozzles are acceptable provided that each joint or seam is subjected to a water loading no less than that which would be given by a single nozzle.

6.14.3 Requirements

On completion of the test, no water shall have leaked into the container or into any electrical enclosures, and the refrigeration unit shall function properly (see 7.3.11).

6.15 Test No. 14 — Airtightness test

6.15.1 General

This test shall be carried out after all structural tests have been completed and prior to the heat leakage test (test No. 15). The temperatures inside and outside the container shall be stabilized within 3 K of each other and shall both be within the range of 288 to 298 K (see table 2 for conversion to degrees Celsius).

6.15.2 Procedure

The container shall be in its normal operating condition and shall be closed in the normal manner. The refrigeration and/or heating equipment shall be in place, except that, where the container is designed for use with removable equipment and the container has closures at the interface(s), the equipment shall not be in position and the closures shall be shut. All drain openings shall be closed. An air supply through a 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 $\pm 3 \%$ of the measured flow rate, and the manometer on the container shall be accurate to $\pm 5 \%$.

Air shall be admitted to the container to raise the internal pressure to $250 \pm 10 \text{ Pa}^{(1)}$ and the air supply regulated to maintain this pressure.

Once steady test conditions have been established, the air flow required to maintain this pressure shall be recorded.

6.15.3 Requirements

For all containers other than those with additional door openings, the air leakage rate, expressed in standard atmospheric conditions, shall not exceed $10 \text{ m}^3/\text{h}^{(1)}$. For each additional door opening (e.g. side doors) provided, an extra rate of $5 \text{ m}^3/\text{h}^{(1)}$ shall be granted.

¹⁾ $32 \text{ mm} \times 254 \text{ mm} = 1,25 \text{ in} \times 10 \text{ in}$

$12,5 \text{ mm} = 0,5 \text{ in}$

$100 \text{ kPa} = 14,5 \text{ psi}$

$10 \text{ m} = 33 \text{ ft}$

$1,5 \text{ m} = 5 \text{ ft}$

$100 \text{ mm/s} = 4 \text{ in/s}$

$250 \pm 10 \text{ Pa} = 25 \pm 1 \text{ mmH}_2\text{O} = 1 \pm 3/64 \text{ inH}_2\text{O}$

$10 \text{ m}^3/\text{h} = 355 \text{ ft}^3/\text{h}$

$5 \text{ m}^3/\text{h} = 180 \text{ ft}^3/\text{h}$

NOTE — The pressure-decay method may be used as an alternative, but in this case a correlation should be established between the constant pressure method and the pressure-decay method during prototype testing.

6.16 Test No. 15 — Heat leakage test

6.16.1 General

6.16.1.1 This test shall be carried out to establish the heat leakage for the container. It shall be carried out after successful completion of the airtightness test (test No. 14). It shall be performed with the refrigeration and/or heating equipment in place, with all openings closed. Where the container is designed for use with removable equipment and the container has closures at the interface(s), the equipment shall not be in position and the closures shall be shut.

6.16.1.2 The inner heating method only shall be used. This test requires the establishment of a heat balance. A heating device shall be placed inside the (insulated) body of the container and thermal equilibrium shall be established between the power of the heating device(s) and associated fan(s), and the heat flowing out through the insulation. All instruments and devices shall be selected and calibrated as follows:

- temperature-measuring devices: $\pm 0,5$ K
- power-measuring device: ± 2 % of quantity measured
- flowmeter system: ± 3 %

6.16.1.3 The heat leakage shall be expressed by the total heat leakage rate, U_{θ} , which is given by the following formula:

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

where

U_{θ} is the total heat leakage rate, in watts per kelvin;

Q is the power, in watts, dissipated by the internal heater(s) and fan(s);

θ_i is the average inside temperature, in kelvins, which shall be the arithmetic mean of the temperatures recorded at the end of each test interval (see 6.16.2.5) and measured 100 mm¹⁾ from the walls, at least at the twelve points shown in annex I;

θ_e is the average outside temperature, in kelvins, which shall be the arithmetic mean of the temperatures recorded at the end of each test interval (see 6.16.2.5) and measured 100 mm¹⁾ from the walls, at least at the twelve points shown in annex I;

θ is the mean wall temperature, in kelvins; by convention:

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

1) 100 mm = 4 in

2 m/s = 6 ft/s

6.16.2 Procedure

6.16.2.1 Test data for determining the heat leakage of the container shall be taken for a continuous period of not less than 8 h during which the following conditions shall be satisfied:

- a) the test shall be performed with a mean wall temperature chosen between 293 K and 305 K (see table 2 for conversion to degrees Celsius) and a temperature difference between inside and outside of not less than 20 K;
- b) the maximum difference between the warmest and coldest inside points at any one time shall be 3 K;
- c) the maximum difference between the warmest and coldest outside points at any one time shall be 3 K;
- d) the maximum difference between any two average inside air temperatures, θ_i , at different times shall be 1,5 K;
- e) the maximum difference between any two average outside air temperatures, θ_e , at different times shall be 1,5 K;
- f) the maximum percentage between the lowest and the highest power dissipation $\frac{W - h}{h}$ shall not exceed 3 % of the lowest figure.

NOTE — The requirements specified above, which define the steady-state conditions or the degree of equilibrium, are illustrated in annex J.

6.16.2.2 The electric heating element(s) shall be operated at temperatures sufficiently low to minimize radiation effects. The heat from the element(s) shall be distributed by a fan or fans delivering a quantity of air sufficient, but not exceeding the level necessary, to ensure that the temperature distribution inside the body of the container is within the limits laid down in 6.16.2.1. The fan(s) should be in the body of the container. If the test is run with a mechanical refrigeration unit (MRU) installed, no action should be taken to prevent the movement of small quantities of air through the MRU. Such fans as the MRU may contain shall not be run.

If it is required that this test be performed with the fan(s) of the MRU running, the test report shall draw attention to this fact. The heat leakage value, U , measured — which in this case shall include the power consumption of the evaporator fan(s) — should not be expected to conform to the classification given in table 1.

6.16.2.3 Air should be circulated over the exterior surfaces of the container at a velocity not exceeding 2 m/s¹⁾ at points approximately 100 mm¹⁾ from the mid-length of the side walls and the roof of the container.

6.16.2.4 All of the temperature-measuring instruments placed inside and outside the container shall be protected against radiation.

6.16.2.5 Sets of readings shall be recorded at intervals of not more than 30 min.

6.16.3 The heat leakage, U , in watts per kelvin, shall be calculated from the average of the 17 or more sets of readings taken during the continuous period of not less than 8 h for which steady-state conditions were maintained, using the following formula:

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

where $n \geq 17$.

The value of U obtained from this formula shall be recorded together with the mean of the mean wall temperature(s) which were maintained during the test period. The value of U , corrected to the standard mean wall temperature of 293 K, should also be recorded. The correction should be made using a curve relating U to mean wall temperature.

NOTE — Since the test described in this clause may be carried out under conditions different from those at which the unit may operate and since the refrigeration and/or heating equipment will not be running during the test, care should be taken when using the value of U obtained from this test to calculate performance under service conditions.

6.17 Test No. 16a) — Test of the performance of a container under refrigeration by a mechanical refrigeration unit (MRU)

6.17.1 General

6.17.1.1 This test shall measure the ability of a container when fitted with a particular MRU, either an “integral” or “clip-on” unit, to maintain a given inside temperature, θ_i , at a given outside temperature, θ_e ,

- for a period of 8 h without additional heat load above that leaking through the walls of the container, and
- for a further period of 4 h during which electrical heater(s) and fan(s) inside the container provide an additional heat load equal to at least 25 % of the total heat leakage rate for the containers as determined in the heat leakage test (test No. 15), i.e.

$$\text{Additional heat load} = 0,25 \times U (\theta_e - \theta_i)$$

6.17.1.2 This test shall be carried out on a container which has already been subjected to the heat leakage test (test No. 15).

6.17.1.3 The container shall be equipped with instruments for the measurement of

- a) outside and inside air temperatures as envisaged in 6.16.1.3 and annex I;
- b) the power supplied to heater(s) and fan(s).

The outside air flow at a point adjacent to the mid-point of one of the sides of the container shall be determined.

The container under test shall be equipped with instruments for the measurement of

- a) the energy consumption of heater(s) and fan(s) inside the container;
- b) return and supply air temperatures (dry bulb) inside the container — a minimum of two sensors shall be used for each of these (i.e. four in all);
- c) the temperature of the air at the inlet to the condenser, where an air-cooled condenser is used.

6.17.2 Test conditions

6.17.2.1 The outside temperature shall be as specified for the class of container under test (see table 1).

6.17.2.2 The inside temperature shall not exceed the specified temperature for the class of container under test (see table 1); this is understood to be the average of the temperature measured by the 12 sensors inside the container.

6.17.2.3 The outside air velocity shall not exceed 2 m/s¹⁾ at a distance of 100 mm¹⁾ from the side of the container.

6.17.2.4 The inside air velocity shall be as produced by the evaporator fans and fans associated with heaters.

6.17.3 Test procedure

6.17.3.1 The required inside and outside temperatures shall be established. Floor drains, defrost drains (where fitted) and relief valves shall be in their normal operational states, and doors and vent devices shall be closed in the normal manner.

6.17.3.2 At this point the unit may be defrosted; if this is done, steady-state conditions shall be re-established prior to continuing the test.

1) 2 m/s = 6 ft/s
100 mm = 4 in

6.17.3.3 The unit shall be run (after steady-state conditions have been established) for a period of 8 h with the temperature cycling about a constant level. After this period of operation, the heater(s) and fan(s) described in 6.17.1.1 shall be turned on. After steady-state conditions have been re-established, the test shall continue for a further 4 h.

6.17.3.4 During the periods of 8 h and 4 h of steady-state operation, the inside and outside temperatures and the power consumed by the heater(s) and fan(s) shall be recorded at intervals not exceeding 30 min.

6.17.4 Requirements

The equipment shall be capable of maintaining the average inside temperature at the level specified (see table 1) for a period of at least 8 h and then for a further period of at least 4 h with additional heat load provided as specified in 6.17.1.1.

NOTES

1 If desired, the energy consumption of the MRU may be measured during this test by means of an electric power-metering device and, if appropriate, a fuel-metering device.

2 It may also be advisable to measure temperatures at evaporator outlet and at compressor suction, and discharge and pressure at compressor inlet and outlet (especially where a prototype MRU is involved), so that in the event of a shortfall in performance there may be sufficient data to allow the fault to be diagnosed.

6.18 Test No. 16b) — Test of the performance of a container with refrigerating equipment which uses a liquid expendable refrigerant (LER)

6.18.1 General

6.18.1.1 This test shall measure the ability of a container when fitted with a particular LER, either an "integral" or "clip-on" unit, to maintain a given inside temperature, θ_i , at a given outside temperature, θ_e ,

- for a period of 8 h without additional heat load above that leaking through the walls of the container, and
- for a further period of 4 h during which electrical heater(s) and fan(s) inside the container provide an additional heat load equal to at least 25 % of the total heat leakage rate for the containers as determined in the heat leakage test (test No. 15), i.e.

$$\text{Additional heat load} = 0,25 \times U (\theta_e - \theta_i)$$

6.18.1.2 This test shall be carried out on a container which has already been subjected to the heat leakage test (test No. 15).

6.18.1.3 The container shall be equipped with instruments for the measurement of

- a) outside and inside air temperatures as envisaged in 6.16.1.3 and annex I — any temperature sensors inside the container directly in the path of the incoming stream of refrigerant shall be moved out of this stream;
- b) the power supplied to heater(s) and fan(s).

The outside air flow at a point adjacent to the mid-point of one of the sides of the container shall be determined.

6.18.2 Test conditions

6.18.2.1 The outside temperature shall be as specified for the class of container under test (see table 1).

6.18.2.2 The inside temperature shall not exceed the specified temperature for the class of container under test (see table 1); this is understood to be the average of the temperatures measured by the 12 sensors inside the container.

6.18.2.3 The outside air velocity shall not exceed 2 m/s¹⁾ at a distance of 100 mm¹⁾ from the side of the container.

6.18.2.4 This inside air velocity shall be as produced by the refrigerating equipment and fans associated with heaters.

6.18.3 Test procedure

WARNING — All personnel shall be made aware of the likely hazard of the accumulation of concentrations of nitrogen or carbon dioxide within the container, test chamber or adjacent confined spaces, and shall not be allowed to enter until the spaces are declared safe.

6.18.3.1 The container shall be placed in the environment specified for the relevant level of testing, and the temperature shall be allowed to stabilize. The test shall not commence until inside, wall and outside temperatures are within 3 K of each other. Floor drains, defrost drains (where fitted) and relief valves shall be in their normal operational states, and doors and vent devices shall be closed in the normal manner.

6.18.3.2 The refrigerant vessels shall be charged to their design capacities, but shall be left in a stand-by state while the container is brought into temperature equilibrium with its surroundings. The refrigerating system shall then be started to cool the container under test to the operational temperature. The refrigerant vessels shall then be topped-up to their design capacity and the container shall be maintained at or below the operational temperature for 8 h using only those temperature-control devices fitted as normal equipment.

1) 2 m/s = 6 ft/s
100 mm = 4 in