

PUBLICLY
AVAILABLE
SPECIFICATION

**ISO/PAS
21100**

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**Air cargo unit load devices —
Performance requirements and test
parameters**

*Unités de charge de fret aérien — Exigences de performances et
paramètres d'essai*

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

- an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;
- an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/PAS 21100 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 9, *Air cargo and ground equipment*.

ISO/PAS 21100 supersedes, for new unit load device approval applications, ISO 8097:2001, *Aircraft — Minimum airworthiness requirements and test conditions for certified air cargo unit load devices*. However, ISO 8097:2001 will be maintained to support approval of formerly approved unit load devices as well as those whose type or dimensions are not covered in ISO/PAS 21100.

Air cargo unit load devices — Performance requirements and test parameters

1 Scope

1.1 The purpose of this Publicly Available Specification is to establish the minimum requirements for airworthiness approval of air cargo pallets, nets and containers, generally designated as air cargo unit load devices.

NOTE In all countries, standing government regulations apply to air cargo unit load device airworthiness approval. This Publicly Available Specification is intended to provide a uniform technical reference for air cargo unit load device approval, but does not, under any circumstance, supersede the requirements of applicable regulations or the aircraft manufacturer's authority approved Weight and Balance Manual.

1.2 This Publicly Available Specification defines the minimum performance requirements and test parameters for air cargo unit load devices requiring approval of airworthiness for installation in an approved aircraft cargo compartment and restraint system that complies with the cargo restraint and occupant protection requirements of EASA CS-25 or of FAR Part 25, except for the 9,0g forward ultimate inertia force of § 25.561 (b) (3) (ii).

1.3 This Publicly Available Specification applies to airworthiness approved air cargo unit load devices intended for carriage on board civil transport category airplanes of the type certificated under EASA CS-25, *Certification specifications for large aeroplanes*, or FAR Part 25, *Airworthiness standards — Transport category airplanes*, or equivalent regulations.

1.4 This Publicly Available Specification applies exclusively to unit load device airworthiness approval and testing parameters. It does not apply to either aircraft design or aircraft operating requirements, which are provided by the approved Weight and Balance Manual for each aircraft type.

1.5 The following aspects do not directly pertain to air cargo unit load device airworthiness approval and testing, and are defined in other International Standards (see the Normative references and Bibliography):

- ULD design specifications;
- ULD in service damage limits;
- ULD restraint malfunction limitations;
- ULD test methods;
- ULD load distribution models;
- ULD maximum allowable contours;
- ULD C.G. location control means;
- ULD pressure equalization methods;
- ULD utilization guidelines.

1.6 Air cargo unit load devices qualified prior to publication of this Publicly Available Specification were TSO (Technical Standard Order) approved in accordance with the requirements of ISO 8097:2001. This Publicly Available Specification is intended as a TSO approval reference for all new models of unit load devices in the sizes or types it covers, in replacement of previously used ISO 8097.

NOTE ISO 8097 is based on USA National Aerospace Standard NAS 3610:1990, *Specification for Cargo Unit Load Devices*.

1.7 Air cargo unit load devices whose size or type is not covered in this Publicly Available Specification are intended to continue being airworthiness approved in accordance with the requirements of ISO 8097:2001, if their size or type is contained therein, or in accordance with other equivalent criteria if not.

NOTE The requirements for cargo covers are not defined in this Publicly Available Specification, except insofar as net restraint is incorporated therein.

2 References and definitions

2.1 Government regulations

The following government regulations are applicable to approval of transport aircraft cargo compartments and therefore to air cargo unit load device approval:

- EU: European Aviation Safety Agency, EASA CS-25, *Certification specifications for large aeroplanes*¹⁾
- Japan: Japanese Airworthiness Standard, Part 3 (Civil Aeronautics Law, Article 10, § 4)²⁾
- USA: Federal Aviation Regulations, Title 14, CFR Part 25 (FAR Part 25), *Airworthiness standards — Transport category airplanes*³⁾

2.2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7166, *Aircraft — Rail and stud configuration for passenger equipment and cargo restraint*

ISO 8097:2001, *Aircraft — Minimum airworthiness requirements and test conditions for certified air cargo unit load devices*

ISO 9788, *Air cargo equipment — Cast components of double stud fitting assembly with a load capacity of 22 250 N (5 000 lb), for aircraft cargo restraint*

ISO 10046, *Aircraft — Methodology of calculating cargo compartment volumes*

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

1) EASA CS-25 constitutes the European Union transport aircraft airworthiness approval regulations. It can be obtained from the European Aviation Safety Agency (EASA), Ottoplatz 1, Postfach 10 12 53, D-50452 Köln, Germany, or at www.easa.eu.int.

2) The Japanese Airworthiness Standard, Part 3 (ISBN 4-89279-661-1) can be obtained from the Civil Aviation Bureau (CAB) of the Ministry of Land, Infrastructure and Transport, Tokyo, Japan.

3) FAR Part 25 constitutes the US government transport aircraft airworthiness approval regulations. It can be obtained from the US Government Printing Office, 732 N. Capitol Street, NW, Washington, DC 20401, USA, or at www.gpoaccess.gov/ecfr.

2.3 Terms and definitions

2.3.1

container <air cargo>

rigid structure which interfaces directly with the aircraft cargo handling and restraint system and alone performs all the functions of a unit load device

2.3.2

cover <cargo>

cover made of flexible material, used to protect cargo on a pallet

NOTE It may or may not incorporate a pallet net or be permanently attached to one. If a net is incorporated or permanently attached to the cover, the performance and testing requirements applicable to nets in this specification are applicable to the net / cover assembly.

2.3.3

net <air cargo pallet>

webbing or rope net for restraining load onto an air cargo pallet

2.3.4

numeric simulation

simulation of physical test condition and reaction of unit load device employing numerical analysis, computational geometry and computer graphics to obtain proof support and design verification, validated by demonstration that parameters, algorithms and analytical methods used provide results of at least equivalent reliability to the outcome of a specified actual test

2.3.5

pallet <air cargo>

unit load device consisting of a flat platform with flat undersurface of standard dimensions, on which goods are assembled and secured by a net before being loaded as a unit onto the aircraft, and which interfaces directly with the aircraft handling and restraint system

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2.3.6

restraint system

equipment for supporting and restraining unit load devices in an aircraft against the ground / flight loads

NOTE It usually consists of such items as rollers, side guides and locks for securing unit load devices to the aircraft structure. It does not include unit load devices, barrier nets and tie-down straps.

2.3.7

unit load device

ULD

device for grouping, transferring and restraining cargo for transit

NOTE It may consist of a pallet with a net or it may be a container.

3 Classification

3.1 Types

Type 1 (Reference only) : Unit load devices (ULDs) designed for use in an approved aircraft restraint system that conforms to all flight and ground cargo restraint and occupant protection requirements of EASA CS-25 or FAR Part 25, including the 9,0g forward ultimate inertia force of § 25.561 (b)(3)(ii).

NOTE Type 1 unit load devices (ULDs) are not shown in this specification. Refer to International Standard ISO 8097:2001 (NAS 3610 Revision 10).

Type 2 : Unit load devices (ULDs) designed for use in an approved aircraft cargo compartment and restraint system that conforms to the flight and ground cargo restraint and occupant protection requirements of EASA CS-25 or FAR Part 25, except for the 9,0g forward ultimate inertia force of § 25.561 (b)(3)(ii), which is complied with either by supplementary installation of a barrier net or bulkhead, or by specifying an approved placement of the ULD in the aircraft.

3.2 Sizes

This specification provides for the following sizes of unit load devices, expressed as nominal dimensions in the overall plan form of a pallet or a container base, in mm (inches) :

NOTE throughout this specification, dimensions are expressed in SI units, with inch/pound system values additionally shown between brackets in order to conform to international air cargo industry usage.

Size	Nominal dimension
A	2 235 x 3 175 mm (88 x 125 in)
B	2 235 x 2 743 mm (88 x 108 in)
G	2 438 x 6 058 mm (96 x 238,5 in)
K	1 534 x 1 562 mm (60,4 x 61,5 in)
L	1 534 x 3 175 mm (60,4 x 125 in)
M	2 438 x 3 175 mm (96 x 125 in)
N	1 562 x 2 438 mm (61,5 x 96 in)
P	1 198 x 1 534 mm (47 x 60,4 in)
Q	1 534 x 2 438 mm (60,4 x 96 in)
R	2 438 x 4 978 mm (96 x 196 in)
S	1 562 x 2 235 mm (61,5 x 88 in)

NOTE Size codes C, D, E, F, H, I, J, O have been intentionally omitted in this specification in order to be in agreement with the industry's (IATA ULD Technical Manual) identification coding system.

3.3 Configurations

3.3.1 This specification provides for variations of configuration among pallets, nets and containers of the same type and size, specified in clause 7 and listed in Table 1 hereafter. Variations in pallet/net attachment and special interface requirements between components of unit load devices when affecting airworthiness are specified by the configuration drawings. Configurations are denoted by sequence number and are identified in accordance with clause 3.5 hereafter.

3.3.2 The applicable restraint conditions to be used for testing each unit load device configuration are specified in clause 8 and listed in Table 2 hereafter, based on testing of worst case analysis.

3.3.3 The ULD restraint conditions and ultimate loads included herein are intended to represent a worst case capability for the ULD. They are not intended to represent aircraft cargo handling system restraint designs. Actual aircraft implementations may vary from the ULD test parameters stated herein in such areas as number and spacing of restraints, among others, as long as they stay within the worst case ULD capabilities.

3.4 Forms

Form C = Container

Form N = Net

Form P = Pallet

3.5 Classification identifier

The pallets, nets and containers described in this specification shall be identified by the numbers derived as shown. Types, sizes, configurations and forms shall be limited to those in configuration drawings. "ISO 21100 - 2A7P" = Type 2, Size A (2 235 x 3 175 mm, 88 x 125 in), Configuration sequence A7, Pallet.

4 Performance requirements

4.1 Materials

The suitability and durability of materials used must be established on the basis of experience or tests. Materials must conform to approved industry specifications that ensure their having the strength and other properties specified in the design data.

4.2 Fabrication methods and workmanship

The methods of fabrication used shall produce a consistently sound structure. If the fabrication processes (such as gluing or heat treatment) require close control to reach their objectives, the processes must be performed under an approved process specification. Workmanship shall be consistent with high-grade aircraft manufacturing practices.

4.3 Protection

All components of the unit load devices shall be suitably protected against deterioration or loss of strength in service due to weathering, corrosion, abrasion or other causes where the type of material used requires such protection. The unit load device shall have provisions for ventilation or drainage where necessary for protection.

4.4 Construction

The unit load device shall be constructed to adequately encompass the cargo and shall provide for proper support and restraint of the cargo. All components shall be designed to withstand rough handling. The design shall minimize the possibility of improper installation. All pallet / net attachment devices shall conform with ISO 7166 track and stud configuration, for single stud fittings, or ISO 9788 for double stud fittings.

4.5 Marking

Each pallet, net, and container shall be legibly and permanently marked in an area clearly visible after the article is loaded with cargo, with the following information :

- (1) Name and address of the manufacturer.
- (2) The weight of the article to the nearest kilogram or pound, with the applicable unit.
- (3) The serial number and date of manufacture.

- (4) The part number of the article and its identification in the code system set out in clause 3.5.
- (5) If the article is not omni-directional, the words "FORWARD", "AFT", and "SIDE" must be conspicuously and appropriately placed.
- (6) The burning rate determined for the article under clause 4.7.
- (7) The applicable TSO (Technical Standard Order) approval number.
- (8) Any limitations or restrictions.

4.6 Inspection provisions

There shall be means to allow close examination of each part requiring inspection, adjustment, or lubrication.

4.7 Fire protection

The materials used in the construction of pallets, nets, and containers shall meet the appropriate provisions set forth in EASA CS-25 or FAR Part 25 Appendix F.

4.8 Rapid decompression

Unit load devices shall be designed to protect the airplane structure and the occupants as result of a sudden release of pressure. The suitability of the design shall be established by analysis and / or tests or numeric simulation. See ISO 11242 for guidance as to possible methods.

4.9 Dimensions and tolerances

Each pallet, net and container of a given configuration shall conform to the requirements specified by the drawing for that configuration. General tolerances for all configuration drawings, unless otherwise noted, are $\pm 0,01$ mm for two places decimals, $\pm 0,1$ mm for one place decimals, ± 1 mm without a decimal (in inches : $\pm 0,01$ for three place decimals, $\pm 0,03$ for two place decimals, $\pm 0,1$ for one place decimals).

4.10 Strength

4.10.1 Ultimate load criteria

4.10.1.1 Ultimate loads for each unit load device configuration are specified in the page defining that configuration. These loads shall be considered as acting separately, except as noted, and shall be applied in accordance with the specified center of gravity limits, which shall be taken into account simultaneously.

4.10.1.2 Longitudinal eccentricity is expressed in percentage of the longitudinal dimension of a pallet or container base, and it is measured from the lateral centerline of the pallet or container base. Longitudinal dimensions correspond to the forward and aft directions specified by the plan views in applicable figures.

4.10.1.3 Lateral eccentricity is expressed in percentage of the lateral dimension of a pallet or container base, and it is measured from its longitudinal centerline. Plus and minus signs indicate forward and aft directions from the lateral centerline, and right and left directions from the longitudinal centerline of the pallet or container base respectively.

4.10.1.4 Center of gravity height is expressed in mm (inches) above the bottom surface of pallet or container base.

4.10.2 Restraint criteria

Restraint system details for each restraint condition are specified by the figure referenced in restraint drawing. Tolerances for the restraint system are the same as those specified in clause 4.9 for configuration drawings.

4.10.3 Pallets and nets

4.10.3.1 If a pallet (or net) is to be substantiated individually, a qualified net (or pallet) of the same configuration code may be assumed for analysis or used for test. A qualified and compatible net (or pallet) of different configuration code may be used provided it equals or exceeds the strength requirements of the pallet (or net) being substantiated. For substantiating a net, any net tensioning devices shall be engaged : a pallet needs not be used for testing, provided that all net fittings are at the locations specified in the unit load device configuration.

4.10.3.2 Pallet edge tracks and net fittings shall conform to the geometric and tolerance requirements of ISO 7166 or, in the case of double stud fittings, ISO 9788, or equivalent with at least equal ultimate strength.

4.10.3.3 All net fittings incorporating a single tie-down stud for attachment to pallets shall have a minimum ultimate load capacity of 8 900 N (2 000 pounds) in all directions, horizontal to vertical. Double stud tie-down fittings shall have a minimum ultimate load capacity of 17 800 N (4 000 pounds) in all directions, horizontal to vertical. The load application point shall be 21 mm (0,83 inch) or less from the head end of the stud.

4.10.3.4 Except where otherwise stated, all track-type tie down receptacles incorporated in the pallet construction shall have a minimum ultimate load capacity of 8 900 N (2 000 pounds), or 17 800 N (4000 pounds) for a double stud receptacle, in all directions, horizontal to vertical. The load application point shall be 23 mm (0,90 inch) or more from the bottom of the track groove.

4.10.3.5 Pallet / net tie down fittings, other than stud and track type fittings, shall have a minimum ultimate load capacity of 8 900 N (2 000 pounds) in all directions, horizontal to vertical.

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4.10.4 Base performance

4.10.4.1 Minimum base area loads for each unit load device configuration are specified in the page defining that configuration. These loads shall be applicable to any area representing at least 10% of the total base area, while the unit load device is supported by the aircraft system. All unit load devices (containers or pallets) bases shall have a minimum area load capacity of 10 kPa (209 lb/ft²).

4.10.4.2 All ULD base edges shall have a minimum vertical EI value of $5 \times 10^7 \text{ N.cm}^2$ ($1.75 \times 10^6 \text{ lb.in}^2$).

4.10.4.3 The base edge profiles shall be rounded or chamfered in order to ensure a smooth interface with aircraft unit load device conveyance and restraint systems.

4.11 Environmental degradation

The materials used in the construction of pallets, nets and containers shall take into account the effects of environment conditions, such as temperature, humidity and U.V. degradation, expected in service.

5 Tests

5.1 Test requirements

Tests and / or analysis or numeric simulation shall be conducted as necessary to show compliance with this specification.

5.2 Test parameters

Tests for any given ULD configuration shall be conducted using the maximum ultimate loads and center of gravity deviations shown in this specification for that ULD configuration, with the ULD being restrained in accordance with the indicated testing restraint condition(s). Analysis or numeric simulation, if used, shall use the same assumptions.

Pallets shall be tested in combination with an approved net of the same size and configuration. Nets do not need to be tested in combination with a pallet, but their attachment fittings shall be located in accordance with the applicable ULD configuration drawing.

5.3 Test methods

The method(s) used for testing any ULD configuration shall ensure conformity with the testing conditions and ultimate load parameters specified for that configuration in this specification. Ultimate load shall be applied in each specified direction for a minimum duration of 3 seconds, in accordance with EASA CS-25 or FAR Part 25 § 25.305 (b). Analysis or numeric simulation, if used, shall provide an equivalent assurance of conformity guarantee. A test and / or analysis report shall be established to record the details of the method(s) used and substantiate the results obtained.

NOTE When two ULD sides (e.g. opposite ones) and the corresponding restraint conditions are identical, testing can be performed on one side only.

5.4 Test results

Under ultimate load, the tested ULD or parts thereof may exhibit damage or permanent deformation, but shall not deform or rupture to the extent of discharging its contents. Analysis or numeric simulation, if used, shall confirm that the ULD would not deform or rupture to the extent its contents would be discharged under the test conditions.

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6 Additional

6.1 Intended use

Type 2 nets, pallets, and containers (ULDs) described in this specification are intended for use only in an approved aircraft cargo compartment and restraint system where compliance with the 9,0 g forward ultimate inertia force of EASA CS-25 or FAR Part 25 § 25.561 (b)(3)(ii) is achieved either by supplementary installation of a barrier net or bulkhead, or by specified approved placement of the ULD in the aircraft.

NOTE Type 1 unit load devices (ULDs) are not shown in this specification. Refer to International Standard ISO 8097:2001 (NAS 3610 Revision 10).

6.2 Unit load device capacities

Maximum gross weight capacities are not shown for the unit load devices covered by this specification. Actual gross weight limits for a device in a given airplane are determined in compliance with EASA CS-25 or FAR Part 25 and listed in the Approved Weight and Balance Manual for that airplane.

6.3 Container contours

Performance and testing parameters are independent from container contours, which hence are not shown in this specification. Maximum allowable container contours shall provide clearance from the relevant aircraft cargo compartment's inner envelope. Guidelines for this purpose are provided in ISO 10046.

6.4 Pallet configurations

Pallet configuration drawings indicate net attachment points. Continuous edge track is allowable all around the pallet's periphery, except where differently noted.

7 Unit load device configurations

7.1 Unit load devices configurations, characteristics, and ultimate load capacities shall conform to the relevant ULD configuration page of this specification.

NOTE The net attachment points shown on ULD configuration drawings do not, or not entirely, apply to containers.

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