
**Air cargo equipment — Air cargo
pallets — Utilization guidelines**

*Équipement de fret aérien — Palettes de fret aérien — Directives
d'utilisation*

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Published in Switzerland

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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.

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 16412 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 9, *Air cargo and ground equipment*.

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Introduction

Air cargo pallets and their cargo restraint nets constitute aircraft unit load devices (ULD), defined by industry standards and airworthiness certified to technical standard order (TSO) C90c in accordance with the requirements of ISO 8097. This guarantees their design to be intrinsically safe for flight on board compatible aircraft types. However, actual flight safety also requires these certified pieces of equipment to be properly used: numerous occurrences have demonstrated a certified ULD can nevertheless jeopardize flight safety if loaded or restrained in an inadequate manner.

Accordingly, this International Standard aims at providing recognized industry standard methods to achieve the best attainable level of safety when preparing air cargo pallets for loading on board aircraft, taking into account the requirements to be met as a result of the pallet's airworthiness certification requisites, the general requirements expressed in the Aircraft Manufacturers' Weight and Balance Manuals, as well as the various potential areas of concern identified based on experience.

The practical means of compliance with flight safety objectives recommended in this International Standard, are intended to be available as a common base for air carriers (operators) as well as shippers and cargo handling agents when establishing their own in-house publications and staff training programmes.

Throughout this International Standard, the minimum essential criteria are identified by use of the key word "shall". Recommended criteria are identified by use of the key word "should" and, while not mandatory, are considered to be of primary importance in providing safe pallet build-up arrangements. Deviation from recommended criteria should only occur after careful consideration and thorough service evaluation have shown alternate methods to provide an equivalent level of safety.

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Air cargo equipment — Air cargo pallets — Utilization guidelines

1 Scope

This International Standard specifies utilization guidelines to be applied when preparing air cargo pallets for carriage on board civil transport aircraft. It identifies the various concerns to be taken into consideration to ensure flight safety, and provides recognized industry standard methods to achieve it. Commercial requirements in order to ensure protection of the goods carried may also be addressed where applicable, but do not constitute the document's primary goal. It is intended as a guide toward standard practice, and is subject to change to keep pace with experience and technical advances.

NOTE In all countries, standing government regulations apply to air cargo unit load devices airworthiness, continuous airworthiness, and air carriers (operators) certification and operations. This International Standard does not, under any circumstance, supersede the requirements of applicable regulations or the aircraft manufacturer's authority approved weight and balance manual.

This International Standard is applicable to any certified air cargo pallet built up from either a single or a number of pieces of commercial cargo, intended to be loaded on lower, main or upper deck of a civil transport aircraft, whether a freighter or a passenger-carrying aircraft. Its field of application includes all pallets prepared within ground premises, whether at a shipper's facilities or an airport cargo warehouse, including those intended to be loaded into the aircraft in a "floating" position. Its provisions may not entirely apply in the event of "pre-embarked" pallets. In such a case it is up to the operator to identify and implement the applicable criteria.

This International Standard is not intended to apply to air cargo pallets prepared for military transport aircraft, and does not take into account any specific criteria for military aircraft. Nothing, however, precludes it being used for guidelines in this case, it being the military operator's responsibility to identify and implement any additional applicable criteria.

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 4117, *Air and air/land cargo pallets — Specification and testing*

ISO 4171, *Air cargo equipment — Interline pallets*

ISO 8097:2001¹⁾, *Aircraft — Minimum airworthiness requirements and test conditions for certified air cargo unit load devices*

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

ISO 16049-1, *Air cargo equipment — Restraint straps — Part 1: Design criteria and testing methods*

1) Endorsement of NAS 3610 10th edition.

ISO 16412:2005(E)

ISO 16049-2, *Air cargo equipment — Restraint straps — Part 2: Utilization guidelines and lashing calculations*

FAR²⁾ 14CFR Part 25, *Airworthiness Standards: Transport category airplanes*

FAR²⁾ 14CFR Part 121, *Air Carriers certification and operation*

Federal Aviation Administration Advisory Circular (AC) 120-59 — *Air Carriers internal evaluation program*

JAR³⁾ Part 25, *Airworthiness Standards: Transport category aeroplanes*

JAR³⁾-OPS 1, *Commercial air transportation (aeroplanes)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

air cargo pallet

any type and size of Class II airworthiness certified aircraft pallet in accordance with ISO 8097:2001

NOTE An air cargo pallet may meet the requirements of either ISO 4117 [heavy duty, stiff, typically 50 mm (2 in) thick, units] or ISO 4171 (most units consist of an aluminium plate base). Used in conjunction with an appropriate pallet net, which may meet the requirements of either ISO 4115 or ISO 4170, it constitutes a complete unit load device.

3.2

pallet net

any type or size of Class II airworthiness certified aircraft pallet net in accordance with ISO 8097:2001

3.3

operator airline carrier

entity authorized by an Air carrier Operator Certificate (AOC) from its national Civil Aviation Authority to operate civil transport aircraft flights for commercial carriage of passengers, cargo or mail

NOTE The operator holds responsibility for compliance with Civil Aviation Authorities Regulations on its flights, including when the relevant tasks are performed by sub-contractors.

3.4

floating pallet

air cargo pallet loaded into the aircraft over more than one pallet position, and not fully restrained by the aircraft restraint system

NOTE A floating pallet requires cargo tie-down directly on to the aircraft's structure instead of the pallet's tracks.

3.5

pre-embarked pallet

air cargo pallet loaded empty into the aircraft to be used as a floor on which cargo is later brought and palletized inside the cargo compartment

2) FAR, *Federal Aviation Regulations*. FAR 14CFR Part 25 constitutes the U.S.A. government transport aircraft airworthiness Regulations, and Part 121 its Regulations applicable to air carriers certification and operation. They can be obtained from the US Government Printing Office, Mail Stop SSOP, Washington DC 20402-9328, U.S.A.

3) JAR, *Joint Aviation Regulations*. JAR Part 25 constitutes the European government's transport aircraft airworthiness regulations and JAR-OPS 1 its regulations applicable to carriers certification and operation. They can be obtained from JAA Headquarters, Saturnusstraat 8-10, P.O. Box 3000, NL 2130 KA Hoofddorp, Netherlands.

NOTE A pre-embarked pallet may or may not be fully restrained by the aircraft restraint system. If it is not, it is also a floating pallet.

3.6

heavy duty pallet

any type or size of Class I or II certified aircraft pallet in accordance with ISO 8097:2001 and with a base core stiffness (E.I. value) of 25×10^6 N·cm² per centimetre width of core (2×10^6 lb·in² per inch width of core) or more

3.7

pallet extension

pallet wing

device (usually a pair of symmetrical devices) used to extend the contour of an air cargo pallet's load out of its base footprint on the lower deck of wide-bodied aircraft

3.8

wooden pallet

warehouse pallet

any type and size of industrial forkliftable pallet for general use, made of wood or similar materials, used to facilitate handling and stacking of individual pieces of cargo

3.9

shoring

load spreading (method)

spreader stand (equipment)

methods or equipment used to evenly distribute a concentrated cargo load over an air cargo pallet's surface in order to meet the applicable aircraft floor load limitations

3.10

air cargo restraint strap

tie-down strap

elementary tie-down unit consisting of flat woven textile webbing, a tensioning device and two end fittings

[ISO 16049-1]

3.11

lashing GB

tie-down US

methods or equipment used to ensure proper restraint of cargo on to a pallet's edge track or aircraft structure, to replace or complement net restraint when necessary

4 General requirements

4.1 General

4.1.1 Any air cargo pallet and its net shall, prior to release for loading on board an aircraft, be inspected and found satisfactory by competent, suitably-trained personnel who are responsible for checking that it meets all applicable flight safety requirements. See 5.1 and 10.3.

4.1.2 All general requirements in 4.2 to 4.7 shall be met on completion of every pallet build-up process, and checked by the responsible agent prior to pallet release for loading on board an aircraft.

4.2 Mass

4.2.1 The completed pallet's gross mass shall be systematically established by actual weighing on a scale with an accuracy of ± 1 % or better, prior to the pallet being released for loading on to aircraft. This mass shall be entered and used throughout the flight's mass and balance documentation.

4.2.2 The pallet's gross mass shall not exceed its own certified maximum gross mass, as engraved on its edge track, or the rated maximum value for the position it is intended to be loaded on in the aircraft or, when the position or the aircraft type is unknown at the time of build-up, the lowest of the possible (e.g. lower, main or upper deck position) maximum values (whichever is less).

4.3 Area load

4.3.1 The mass loaded on to any given area of significant size (typically more than 10 % to 20 % of the pallet's surface) should meet the maximum area load limitation specified in the weight and balance manual for the lower, main or upper deck position on which it is intended to be loaded in the aircraft.

What shall be taken into account to verify area load limitation is the total bearing area, i.e. that of the outer perimeter defined by all contact points of the load onto the pallet.

NOTE Area load is not to be mistaken for local load (the load divided by the actual contact area). Local load limitations may or may not be defined in the aircraft's weight and balance manual, but they seldom are critical for aircraft structural safety on typical air cargo pallets. They may raise concern only when they result in significant local deformation of the pallet sheet, which may result in difficulties in moving over roller conveyors (a reliable factual indication of excessive deformation) or affect pallet restraint hardware functionality. This should be taken care of by increasing the actual contact bearing area through intermediate elements, such as wood, plywood or wooden pallets between load supports and pallet sheet.

4.3.2 Whenever the aircraft type is unknown at the time of build-up, a maximum area load limitation of $975 \text{ kg}\cdot\text{m}^{-2}$ (200 lb/ft²) for ISO 4171 type pallets or $1\,950 \text{ kg}\cdot\text{m}^{-2}$ (400 lb/ft²) for ISO 4117 type or heavy duty pallets may be used.

4.3.3 Any deviations in specific circumstances should be allowed only to the extent determined by an operator-performed specific engineering study taking into account the characteristics of the load and the pallet, the overall pallet centre of gravity location, and structural allowances of the aircraft's manufacturer.

4.3.4 Elementary shoring procedures such as using wooden pallets to enlarge a cargo's footprint on the pallet should be considered first and are in many circumstances sufficient to ensure compliance with the maximum area load restriction. In very heavy or concentrated load cases, study and implementation of a proper shoring arrangement may be necessary. See Clause 6.

4.4 Running load

4.4.1 The aircraft floor's maximum running load, in $\text{kg}\cdot\text{m}^{-1}$ (lb/in) measured parallel to the aircraft's centerline, is usually met by complying with the pallet position's maximum permissible gross weight.

4.4.2 For heavy and concentrated loads shorter than the pallet, a running load check may be necessary when the load's dimension measured parallel to the aircraft's centerline exceeds two fuselage frame spacings, i.e. 1,0 m to 1,2 m (40 in to 50 in). In such a case, a shoring calculation taking into account the pallet's stiffness/load distribution effectiveness is required, and may result in the necessity of longitudinal shoring. See Clause 6.

4.4.3 When a piece of cargo overhangs the pallet parallel to the aircraft's centerline and prevents the adjacent pallet position(s) in the aircraft from being occupied, the total running load for the pallet may sometimes be determined based on the total floor length occupied in the aircraft, subject to compliance with the area load limitation and all other requirements of the weight and balance manual, should this result in exceeding the pallet position's own certified maximum gross weight or other limits, with restraint or additional restraint being performed directly on the aircraft structure.

4.5 CG location (plan view)

4.5.1 The pallet load's overall centre of gravity (CG) shall be within the maximum plan view limits specified at maximum gross mass by the pallet's certification configuration in accordance with ISO 8097.

NOTE The pallet's certification configuration in accordance with ISO 8097 is engraved or permanently marked on the pallet edge rail (e.g. "NAS 3610 — 2A6P" for configuration 2A6), at a location selected to remain legible after the pallet has been loaded with cargo.

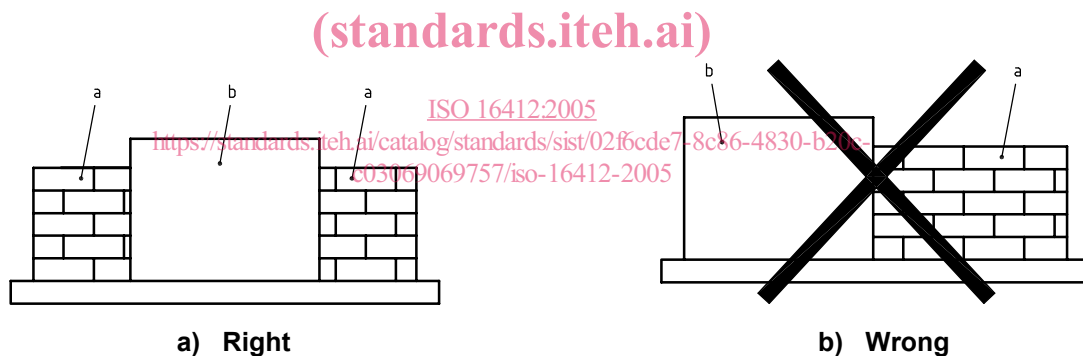
4.5.2 If there is uncertainty about the CG. limits to be used for the pallet on hand, a $\pm 10\%$ of pallet length and width ($\pm 5\%$ in length for ISO 4117 sizes) maximum CG deviation from pallet geometric centre may generally be used (refer to the aircraft's weight and balance manual).

4.5.3 For a load lower than the pallet position's maximum gross mass, CG deviation in excess of 10% may be considered subject to the stated rules and requirements in the aircraft's weight and balance manual. Linear extrapolation of maximum permissible CG limits versus pallet position maximum gross mass may generally be applied, if required, in one direction only.

4.5.4 Whenever possible, which is in most circumstances, it is recommended never to simultaneously use maximum permissible CG deviation in both the pallet's length and width directions.

4.5.5 The methods to be used to control the load's overall CG location, vary depending on their nature:

- for a heavy single piece of cargo, the piece's CG location should be marked by the shipper or, if not, physically measured balancing the piece with a forklift or equivalent lifting means;
- for package cargo of homogeneous nature and density, the CG location can be assessed and controlled by ensuring an even level of stacking throughout the pallet's surface;
- in the event of significantly different densities of cargo being loaded on to the same pallet, care should be taken when stacking to ensure symmetrical loading (see example in Figure 1).



- a Low density.
b High density.

Figure 1 — Examples of high and low density mix

4.6 CG location (height)

4.6.1 The pallet load's overall centre of gravity (CG) shall be within the maximum height limit specified at maximum gross mass by the pallet's certification configuration in accordance with ISO 8097 or the aircraft's weight and balance manual.

NOTE The pallet's certification configuration, in accordance with ISO 8097, is engraved or permanently marked on the pallet edge (e.g. "NAS 3610 — 2A6P" for configuration 2A6), at a location selected to remain legible after the pallet has been loaded with cargo.

4.6.2 If there is uncertainty about the maximum CG. height to be used for the pallet on hand, a maximum of half the pallet contour's maximum height may, in most cases, be used, when the contour height does not exceed 2,44 m (8 ft).

4.6.3 For a load lower than the pallet position's maximum gross mass, greater CG heights may be considered, subject to the stated rules and requirements in the aircraft's weight and balance manual. Linear extrapolation of maximum permissible CG height versus pallet position maximum gross mass may generally be applied, if required.

4.6.4 Whenever possible, which is in most circumstances, it is recommended never to simultaneously use maximum permissible CG deviation in both the height and plan view directions.

4.6.5 The methods to be used to control the load's overall CG height vary depending on their nature:

- for a heavy single piece of cargo, the piece's CG height should be marked by the shipper or, if not, calculated or physically measured;
- for stacked smaller cargo, overall CG height can be assessed and controlled by ensuring any higher density cargo is loaded first at the bottom of the pallet stack: see 5.2.2.

4.7 Contour

4.7.1 The pallet load, once completed, shall not exceed the maximum permissible pallet contour for the aircraft position on which it is intended to be loaded. In most circumstances this is one of the standard contours defined by the industry for either lower deck or main/upper deck loading on commonly operated transport aircraft types (see 4.7.3).

Where an aircraft pallet position has a special contour and cannot safely accommodate a pallet built up to a standard industry contour, the operator shall provide pallet build-up agents with a precise definition of the maximum contour to be met, and should, where useful, consider mandating the use of a pallet contour template as a means of checking it.

4.7.2 The principles for defining maximum permissible pallet contours are specified in ISO 10046: the pallet contour's minimum clearance from the aircraft internal envelope shall be 100 mm (4 in), 75 mm (3 in) on the top. Net hardware may be within this clearance, providing it remains at any point at least 50 mm (2 in) clear from the aircraft envelope.

4.7.3 Except where cargo overhang (see 4.7.4) is allowed, the maximum pallet contour's outer plan view limits shall be vertical and inset by a minimum of 50 mm (2 in) from the pallet's outer edges. The net hardware may be within this clearance, providing it remains at any point inside the vertical planes of the pallet edges.

NOTE The industry-agreed standard pallet contours are shown in IATA ULD Technical Manual 50/0 ^[20] Appendix E, and are compatible with the aircraft types listed in that manual's Appendix F.

4.7.4 Cargo overhang outside the thus defined maximum pallet contour may be allowed only horizontally, and where sufficient clear space exists at the intended aircraft position. Any overhanging cargo shall keep a minimum 50 mm (2 in) clearance from any part of the aircraft internal envelope or any adjacent pallet position. Appropriate additional restraint is required (see 8.2).

4.7.5 Where geometric constraints dictate loading by pallet rotation through the compartment door, the overhang allowance shall ensure that a minimum 50 mm (2 in) clearance from the door frame, and from any part of the aircraft envelope, can be kept at all times through the loading and offloading process.

5 Installation

5.1 Condition check

5.1.1 Each pallet and its net shall be systematically inspected by competent personnel and checked to be in an operative condition prior to being built-up and released for loading on an aircraft.