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Air cargo unit load devices — Load distribution model

Unités de charge de fret aérien — Modèle de répartition des charges

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Foreword

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document specifies a reference model for load distribution on air cargo unit load device (ULD) bases, to reflect in a standardized manner maximum allowable centre of gravity (C.G.) eccentricity limitations.

The civil aviation requirements referred to in this document are those concerning certification of transport aircraft and appliances to be installed aboard them, and constitute the set of design and operation requirements internationally agreed in application of International Civil Aviation Organization (ICAO) Annex 8, Airworthiness of aircraft, to the Convention on International Civil Aviation.

Throughout this document, 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 air cargo unit load devices. 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.

Air cargo unit load devices — Load distribution model

1 Scope

This document defines the industry agreed model for load distribution on air cargo unit load devices (ULD) bases to apply the maximum allowable centre of gravity (C.G.) eccentricity.

Its purpose is to establish a common reference load distribution algorithm for:

a) comparable and repeatable ULD testing methods, or equivalent numeric simulations;

b) aircraft structure and cargo systems design assumptions, consistent with existing airframers practices; and

c) definition of operators unit load devices utilization rules and cargo build-up training programs.

It applies to all types of unit load devices intended for use on board civil transport aircraft and airworthiness approved in accordance with the performance requirements and testing parameters of either ISO 21100 or, as applicable, ISO 8097.

It also applies to non-airworthiness approved (non-certified) containers as defined in ISO 4118, the utilisation of which is controlled by the provisions of the aircraft type's Weight and Balance Manual and other airframe manufacturer's documents.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 8097, *Aircraft — Minimum airworthiness requirements and test conditions for certified air cargo unit load devices*

ISO 10254, *Air cargo and ground equipment — Vocabulary*

ISO 21100, *Air cargo unit load devices — Performance requirements and test parameters*

3 Terms and definitions

For the purposes of this document, the terms and definitions of ISO 10254 and the following apply:

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
eccentricity
offset
<centre of gravity> plan view distance between the overall centre of gravity (C.G.) of the unit load device and its contents and the geometric centre of its base, expressed in percentage of the base length and width

3.2
homogeneous cargo
cargo of homogeneous density and of such a nature that the whole weight of each piece is evenly distributed over the whole of that piece's footprint area

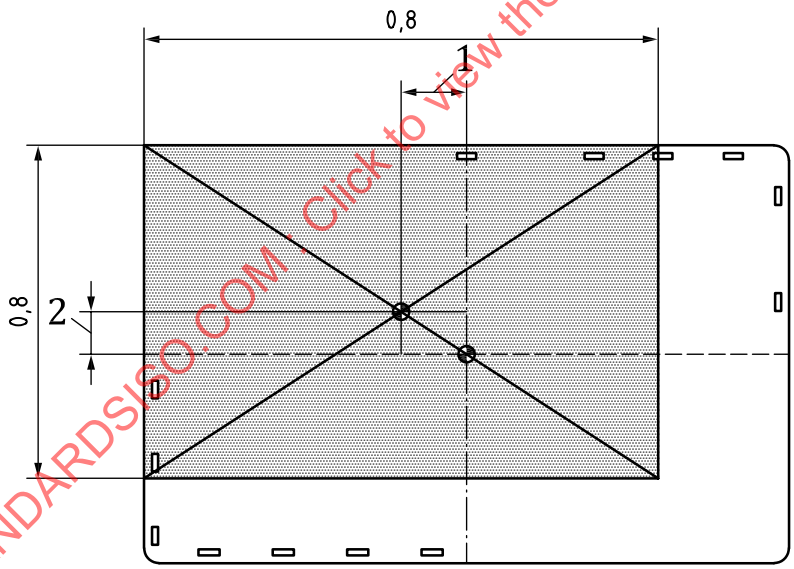
4 Load distribution model

4.1 Principle

4.1.1 Airworthiness approval of each type and size of unit load device includes maximum load centre of gravity (C.G.) eccentricity (offset) allowances at unit maximum gross mass, that are part of its testing and approval (see ISO 21100 or ISO 8097, as applicable, for unit load device configurations and ultimate load criteria).

4.1.2 C.G. eccentricity is expressed and measured in percentage (%) of the ULD's base length or width from the geometric centre of the base. The maximum eccentricity shall be demonstrated under maximum gross mass in accordance with ISO 21100 or ISO 8097, therefore allowed by ULD approval, is ±10 % of base length and width, or ±5 % of length and ±10 % of width for sizes G, H, J, and R ULDs.

4.1.3 The load distribution on a pallet's surface or a container base corresponding to the certified maximum C.G. eccentricity allowances shall be defined as homogeneous cargo with maximum gross mass occupying a correspondingly reduced area of the base surface. See example (for 10 % simultaneous longitudinal and lateral C.G. offset) in Figure 1:



Key

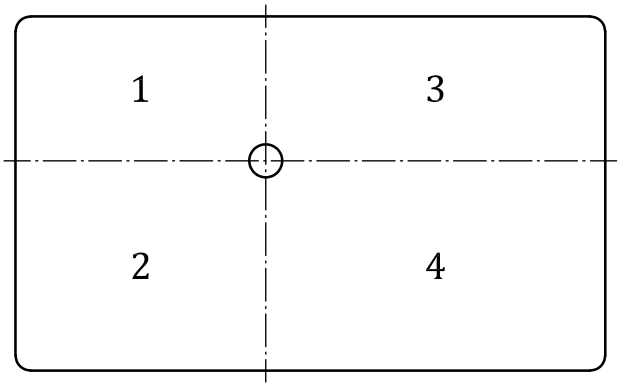
1 10 % of length

2 10 % of width

load footprint

Figure 1 — Load distribution principle

4.1.4 This load distribution principle defines four quadrants on a pallet's surface or a container base, centred on the load's C.G. as shown in Figure 2.



Key

1 right forward quadrant
2 left forward quadrant
3 right aft quadrant
4 left aft quadrant

Figure 2 — Load distribution quadrants

Both for design and operational utilization, each of the quadrants, and particularly most critical quadrant '1', shall be separately considered in conjunction with the cargo loading system (CLS) regarding:

a) aircraft area load and linear (running) load limitations; and

b) load restraint by tie-down on pallet edge tracks.

NOTE When load restraint is ensured by a compatible approved pallet net, this is certified according to the same load C.G. eccentricity criteria as the pallet.

4.1.5 A maximum allowable area load $\frac{m_{MGW}}{S \times 0,64}$ (or : $\frac{m_{MGW}}{S \times 0,72}$ in the case of sizes G, H, J, or R), where S is the ULD base plate area and m_{MGW} the maximum gross mass of the unit load device and its contents, can be derived from the reference load distribution model of 4.1.3. This maximum allowable distributed area load should not be confused with the maximum ULD base area load defined in the relevant ISO 21100 or ISO 8097 ULD configuration sheet, that is intended to specify the minimum load spreading requirements for the base, and protect aircraft conveyor systems and structure against excessive local loading. Accordingly, if the maximum allowable distributed area load, based on the applicable MGW for the intended aircraft position, is:

a) lower than or equal to the maximum ULD base area load: the ULD's maximum certified eccentricity limits are fully applicable;

b) higher than the maximum ULD base area load (which may be the case for, particularly, sizes A and M in certain aircraft main deck applications): the maximum ULD load C.G. eccentricity shall be operationally limited for the MGW concerned, so that the resulting maximum allowable distributed area load does not exceed the maximum ULD base area load.

4.2 Application

4.2.1 When airworthiness testing unit load devices or conducting equivalent numeric simulation for this purpose, the test load shall be distributed (or simulated, as is the case) onto the pallet surface or the container base in accordance with the reference model defined in 4.1.3.

4.2.2 When designing aircraft cargo compartments structure and systems, it is recommended the load distribution assumptions defined in 4.1.3 be used to take into account maximum allowable ULD C.G. deviation limits. However, airframe manufacturers may use for this purpose alternate assumptions, providing aircraft structure and systems compatibility with the reference load distribution model is demonstrated.

4.2.3 When developing detailed unit load devices utilization rules, operators shall use the reference load distribution model as the assumption describing the most critical C.G. eccentricity case. They shall in addition apply any requirements set forth by the aircraft type's Weight and Balance Manual, and may also apply the requirements of Clause 5.

5 Operational C.G. trade-off

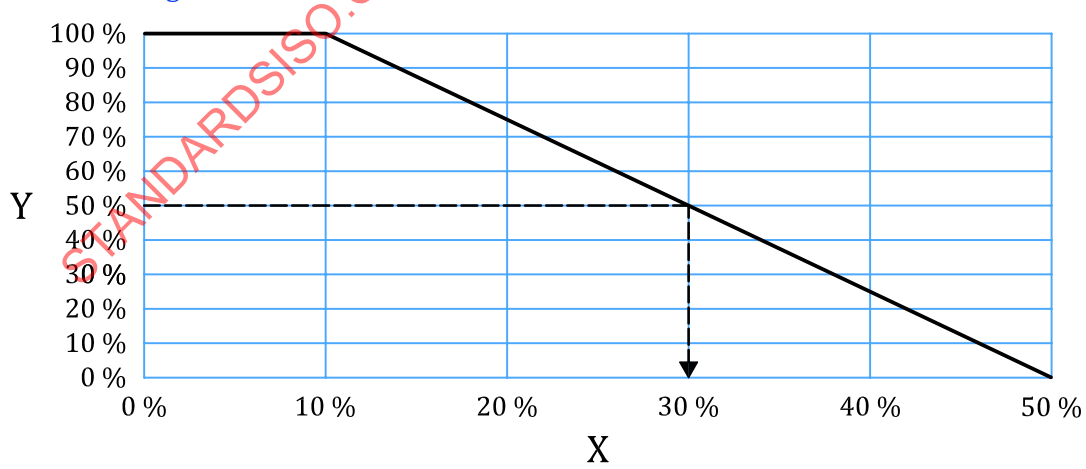
5.1 General

The load distribution model in 4.1.3 is defined at the unit load device's maximum gross mass acceptable in the aircraft zone concerned. When the actual ULD gross mass is lower than this maximum, linear trade-off may be operationally used for increased C.G. eccentricity limits in proportion of the lower gross weight, in accordance with either 5.2 or, exceptionally where unavoidable, 5.3 hereafter.

The requirements of an approved aircraft Weight and Balance Manual take precedence in the event of a conflict.

5.2 One direction trade-off

When the ULD gross mass is lower than the maximum allowable at the intended aircraft position, the allowable C.G. offset in one direction only, either longitudinal or lateral, may be increased proportionally in accordance with Figure 3.



Key

X C.G. offset

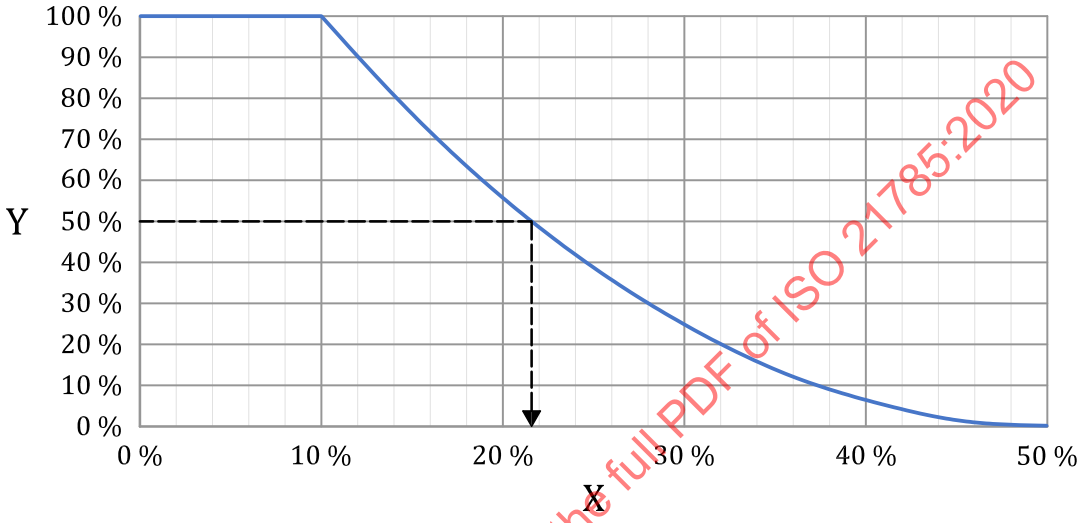
Y mass

Figure 3 — Longitudinal or lateral allowable C.G. offset

Figure 3 illustrates, as an example, that for a payload weighing only 50 % of the aircraft zonal or position limit, the lateral or longitudinal C.G. offset may vary up to ±30 % instead of ±10 % at maximum gross mass.

5.3 Two directions trade-off

When the ULD gross mass is lower than the maximum allowable at the intended aircraft position, the allowable C.G. offset in both directions simultaneously, longitudinal and lateral, may be increased in accordance with Figure 4.



Key

X C.G. offset

Y mass

Figure 4 — Longitudinal and lateral allowable C.G. offset

Figure 4 illustrates, as an example, that for the same payload weighing only 50 % of the aircraft zonal or position limit, the lateral and longitudinal C.G. offset may vary up to only ±20 % each, instead of ±30 % under the conditions of 5.2.

5.4 Required precautions

5.4.1 Whether at maximum gross mass or the lower gross mass trade-off limitations of 5.2 or 5.3, the load distribution model shall not be used as a method for actually distributing cargo on a pallet or container base at ULD build-up: if a piece or a stack of cargo will occupy only part of the pallet's or container's base surface, it should be centred on the base and not in a corner. If only a partial load is planned, stacking should start in the pallet or container base centre area rather than at an edge.

5.4.2 During ULD build-up, all steps should be taken, insofar as feasible due to the nature, shape and density of cargo to be loaded, to provide a loaded ULD C.G. location as close as possible to its geometric centre. When the nature or shape of cargo makes this impossible in practice, the objective should be to limit C.G. offset to one direction only, either longitudinal or lateral, not exceeding the maximum allowable offset in that direction. Only as a last resort, when dictated without alternative by the nature or shape of cargo, should both longitudinal and lateral maximum C.G. offsets be simultaneously used.

5.4.3 Detailed recommended methods to ensure control of the loaded ULD's C.G. offset within the objectives stated in 5.4.2 should be provided in the Operator's procedures, with the corresponding staff training requirements and good loading practices.