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Air cargo — Restraint slings —

Part 2: Utilization requirements and recommendations and lashing calculations

Fret aérien — Élingues d'arrimage —

Partie 2: Partie 2 : Exigences et recommandations d'utilisation et calculs d'arrimage



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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

A list of all parts in the ISO 20291 series can be found on the ISO website.

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.

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Introduction

This document specifies utilization requirements and recommendations and the principles to be used in tie-down/lashing strength calculations when using air cargo restraint slings on board civil transport aircraft.

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 of primary importance in providing safe air cargo restraint sling assemblies. Deviation from the recommended criteria should only occur after careful consideration and thorough service evaluation have shown that alternate methods can be used to provide an equivalent level of safety.

The requirements of this document are expressed in the applicable SI units, with approximate converted values in inch-pound units between brackets for convenience in countries using that system.

Sling or cable assemblies made of steel wire rope are intended to be used in lieu of cargo restraint straps meeting the requirements of ISO 16049-1, where straps inherent elongation under tension appears unadvisable for a given tie-down arrangement. Typical examples of loads where substitution of cables for straps throughout a given tie-down arrangement can be advisable are those for which even limited movement during flight can be hazardous, such as heavy vehicles, aircraft engine stands, helicopters, machinery.

On the date of publication of this document, no airworthiness approval procedure by Civil Aviation Authorities is applicable to restraint slings. Their use for cargo restraint, however, remains subject to the requirements of the approved aircraft type or sub-type Weight and Balance Manual.

The use of chains or other rigid devices for tie-down onto civil transport aircraft floor tracks is not covered in this document; it is not recommended due to the possibility of generating excessive stresses in the aircraft structure and is allowable only where explicitly approved in aircraft's authority approved Weight and Balance Manual.

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Air cargo — Restraint slings —

Part 2: Utilization requirements and recommendations and lashing calculations

1 Scope

1.1 This document provides general utilization requirements and recommendations and calculation methods adequate to guarantee the effectiveness and ultimate strength of tie-down/lashing arrangements performed to restrain cargo on board civil transport aircraft during flight, including the following:

a) cargo loaded and tied down onto airworthiness approved air cargo pallets, themselves restrained into aircraft lower deck or main deck or upper deck cargo systems meeting the restraint requirements of air cargo pallets approved in accordance with ISO 8097 (NAS 3610) or ISO 21100, or

b) additional tie-down on aircraft structure when necessitated by pallet maximum gross mass or centre of gravity limits, or

c) non-unitized individual pieces of cargo, or pieces of cargo placed onto an unrestrained pallet (floating pallet) into either lower deck, main deck or upper deck containerized cargo compartments of an aircraft,

when using for this purpose restraint slings (wire rope cables) specified in ISO 20291-1.

1.2 Restraint slings as specified in this document can also be used for permanent or semi-permanent attachment of a special purpose device, such as aircraft engine transport stand (see ISO 11241), horse stall (see ISO 9469), automobile transport device (see ISO 8268) or other, whether or not airworthiness approved, onto an aircraft pallet.

1.3 This document applies to cargo tie-down/lashing arrangements using exclusively air cargo restraint slings conforming to ISO 20291-1.

NOTE Where tie-down is performed onto aircraft structure as per 1.1 b) or c), additional restrictions can be stated in the aircraft's authority approved Weight and Balance Manual.

1.4 This document specifies industry recognized means of complying with airworthiness authorities general regulations applicable to load securing on board civil transport aircraft (see 14 CFR Part 25 and EASA CS-25, CCAR-25 or Japanese Airworthiness Standard Part 3), and aircraft manufacturers authority approved Weight and Balance Manuals for each aircraft type as specified therein.

1.5 The wire rope slings in this document are intended exclusively for restraint purposes on board aircraft and are not intended to be used as lifting slings for handling or any other purpose.

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.

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ISO 8097, *Aircraft — Minimum airworthiness requirements and test conditions for certified air cargo unit load device*[1)]

ISO 9788, *Air cargo — Double stud tie-down fittings — Design and testing requirements*

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

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

ISO 20291-1:2021, *Air cargo — Restraint slings — Part 1: Design and testing*

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 given in 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
tie-down
lashing
fact of restraining cargo movements in relation to an aircraft's structure, throughout the range of relative accelerations resulting from the allowable *flight envelope* (3.3), by means of an appropriate use of a number of elementary tie-down devices against each direction of restraint

[SOURCE: ISO 16049-2:2020, 3.1]

3.2
tie-down arrangement
geometric layout of an assembly of elementary *tie-down* (3.1) devices affixed and tensioned around a piece of cargo in order to ensure its tie-down against each direction of restraint

[SOURCE: ISO 16049-2:2020, 3.2]

3.3
flight envelope
<for a given aircraft type or sub-type> set of allowable values for accelerations which can be encountered during flight in the various directions relative to the aircraft's structure, as determined during the aircraft certification flight testing and certified by the airworthiness authority within the aircraft's type certificate

[SOURCE: ISO 16049-2:2020, 3.3]

3.4
limit load
LL
maximum load to be expected in service as a result of the certified allowable *flight envelope* (3.3) of the aircraft

Note 1 to entry: See 14 CFR Part 25 and CS-25, paragraph 25,301(a).

Note 2 to entry: It is two thirds of the *ultimate load* (3.5).

1) Endorsement of NAS 3610 revision 10, TSO/ETSO/CTSO/JTSO C-90c.

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[SOURCE: ISO 16049-2:2020, 3.4, modified — The abbreviated term "LL" has been removed; Note 1 to entry has been added.]

3.5
ultimate load
UL
limit load (3.4) multiplied by a safety factor of 1,5

Note 1 to entry: See 14 CFR Part 25 and CS-25, paragraph 25, 303.

Note 2 to entry: It is used for the calculation of cargo *tie-down arrangements* (3.2), based on the ultimate load factors defined in the airworthiness authority approved Weight and Balance Manual, in each direction of restraint, throughout the certified *flight envelope* (3.3) of the aircraft type.

[SOURCE: ISO 16049-2:2020, 3.5, modified — The abbreviated term "UL" has been removed; in Note 1 to entry, references to CCAR-25 and JAS Part 3 have been removed.]

3.6
fore
direction of restraint, relative to the aircraft structure, determined parallel to the aircraft centreline towards the direction of flight

[SOURCE: ISO 16049-2:2020, 3.6]

3.7
aft
direction of restraint, relative to the aircraft structure, determined opposed to the aircraft centreline towards the direction of flight

[SOURCE: ISO 16049-2:2020, 3.7]

3.8
side
direction of restraint, relative to the aircraft structure, determined perpendicular to the aircraft centreline and parallel to its floor, left-hand or right-hand

[SOURCE: ISO 16049-2:2020, 3.8]

3.9
upward
upward direction relative to the aircraft structure

[SOURCE: ISO 16049-2:2020, 3.9]

3.10
load factor
acceleration, expressed as multiples of the standard acceleration of gravity ("g" = 9,80665 $m.s^{-2}$), in each direction of restraint [*fore* (3.6), *aft* (3.7), *sides* (3.8), *upward* (3.9)], that will result in limit or ultimate, as is the case, forces on the *tie-down arrangement* (3.2) proportional to the mass of the piece of cargo being restrained

Note 1 to entry: The load factors are provided by the Airworthiness Authority approved Weight and Balance Manual for an aircraft type or sub-type.

Note 2 to entry: The load factors may be limit or ultimate.

[SOURCE: ISO 16049-2:2020, 3.10]

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3.11
strap
restraint strap assembly
basic *tie-down* (3.1) unit consisting of flat woven textile webbing (one fixed end and one adjustable end), one tensioning device and two end *fittings* (3.12), used for restraint of cargo on board civil transport aircraft

Note 1 to entry: See ISO 16049-1 for description, design criteria and testing requirements.

[SOURCE: ISO 16049-2:2020, 3.11, modified — "restraint strap assembly" has been changed to an admitted term.]

3.12
fitting
tie-down fitting
basic piece of hardware, either single stud (see ISO 7166) or double stud (see ISO 9788), with an omni-directional capability, allowing to attach *straps* (3.11) or other elementary *tie-down* (3.1) units to the floor tracks or tie-down receptacles of an aircraft's structure or the edge tracks of an air cargo pallet

Note 1 to entry: Tie-down fittings used in conjunction with restraint slings are double stud (ISO 9788) and include an attachment ring.

[SOURCE: ISO 16049-2:2020, 3.12, modified — "fitting" has been added as a preferred term; a new Note 1 to entry has replaced the original one.]

3.13
floating pallet
air cargo pallet, or equivalent flat support device, located onto an aircraft's cargo compartment rollerized conveyor but not restrained by the cargo system, the pallet and its load constituting "non-unitized" cargo and being restrained by a set of *straps* (3.11) attached to aircraft structural points

3.14
competent person
designated person, suitably trained, qualified by knowledge and practical experience and with the necessary instructions to enable the required tests and examinations to be carried out

Note 1 to entry: A competent person can be suitably trained in accordance with ISO 9001:2015, 7.2 or equivalent pertinent industry training and proficiency standards.

Note 2 to entry: See 4.1 for the operating instructions.

4 General requirements

4.1 Operating instructions for the use of cargo restraint slings, established by the aircraft operator under control of his overseeing Civil Aviation Authority, shall take into account the general airworthiness requirements and the applicable aircraft Weight and Balance Manuals, and should incorporate the requirements of this document, or equivalent industry standards (see Bibliography).

4.2 In addition, operating instructions for restraint slings attachment to edge tracks of a certified air cargo pallet meeting the requirements of ISO 8097 (NAS 3610) or ISO 21100 shall take into account the general requirements of their appropriate configuration drawing(s) as to tie-down points locations and load capabilities.

Compatibility of pallet tracks with a 22,25 kN (5 000 lbf) ultimate load on ISO 9788 double stud tie-down fittings is guaranteed by pallet airworthiness approval in reference to ISO 21100:2017, 4.10.3, which requires this capability. Earlier pallet approvals under ISO 8097 (NAS 3610) or ISO 21100:2014 did not explicitly require it, so that it is recommended to verify it by tests on a sample pallet of the model concerned. SAE AS 36102 provides the appropriate testing method.

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