
**Air cargo equipment — Restraint
straps —**

**Part 1:
Design criteria and testing methods**

Équipement pour le fret aérien — Sangles d'arrimage —

Partie 1: Critères de conception et méthodes 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.

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. www.iso.org/directives

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The committee responsible for this document is ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 9, *Air cargo and ground equipment*.

This second edition cancels and replaces the first edition (ISO 16049-1:2001), which has been technically revised.

ISO 16049 consists of the following parts, under the general title *Air cargo equipment — Restraint straps*:

- *Part 1: Design criteria and testing methods*
- *Part 2: Utilization guidelines and lashing calculations*

Introduction

This part of ISO 16049 specifies the design criteria and testing methods applicable to air cargo restraint straps to be used for tie-down of unitized or non-unitized cargo on board civil transport aircraft.

Throughout this part of ISO 16049, 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 restraint straps. Deviation from recommended criteria should only occur after careful consideration, extensive testing, and thorough service evaluation have shown alternative methods to be satisfactory.

The requirements of this part of ISO 16049 are expressed in the applicable SI units, with approximate inch-pound units conversion between brackets for convenience in those countries using that system.

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Air cargo equipment — Restraint straps —

Part 1: Design criteria and testing methods

1 Scope

This part of ISO 16049 specifies the design criteria and testing methods adequate to guarantee the ultimate load and operational dependability of cargo restraint strap assemblies with a typical rated ultimate tension load capability of 22 250 N (5 000 lbf), as used by the airline industry in order to restrain on board civil transport aircraft during flight:

- a) cargo loaded and tied down onto airworthiness approved air cargo pallets, themselves restrained into aircraft lower deck, main deck or upper deck cargo systems and meeting the requirements of ISO 8097 (NAS 3610) or ISO/PAS 21100, or
- b) non-unitized individual pieces of cargo, or pieces of cargo placed onto an unrestrained ("floating") pallet into either lower deck, main deck or upper deck containerized cargo compartments of an aircraft.

The same restraint strap assemblies can also be used in other applications such as:

- c) non-containerized (bulk loaded) baggage and cargo compartments,
- d) to ensure cargo restraint inside an airworthiness approved air cargo container.

NOTE The ultimate loads allowable on the attachment points available in most aircraft bulk compartments and inside most air cargo containers are significantly lower than 22 250 N (5 000 lbf). This results in the restraint arrangement's ultimate load capability being dictated by the weakest element, i.e. the attachment points. Typical 22 250 N ultimate load restraint straps will therefore be in excess of the requirements for such applications.

Compliance with this part of ISO 16049 provides one means of cargo restraint straps airworthiness approval by Civil Aviation Authorities under TSO / ETSO C-172, in addition to the other requirements therein.

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

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

ISO/TR 8647, *Environmental degradation of textiles used in air cargo restraint equipment*

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

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

1) Endorsement of NAS 3610.

ISO 16049-1:2013(E)

ISO 12118, *Air cargo equipment — Identification of double-stud tie-down fittings having an omnidirectional rated load capacity of 22 250 N (5 000 lbf) or above*

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

ISO/PAS 21100, *Air cargo unit load devices — Performance requirements and testing parameters*

European Aviation Safety Agency CS-25, *Certification Specifications for Large Aeroplanes*²⁾

Japanese Airworthiness Standard Part 3 (Civil Aeronautics Law Article 10 § 4)³⁾

USA Code of Federal Regulations Title 14 CFR Part 25 — *Airworthiness Standards: Transport Category Airplanes*⁴⁾

European Technical Standard Order (ETSO) C-172, *Cargo Restraint Strap Assemblies*

Federal Aviation Administration Technical Standard Order (TSO) C-172, *Cargo Restraint Strap Assemblies*³⁾

NOTE Also see informative references in Bibliography.

3 Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 10254 and the following apply.

3.1

restraint strap assembly

elementary tie-down unit consisting of flat woven textile webbing (one fixed length end and one adjustable end), one tensioning device and two end fittings, used for restraint of cargo on board civil transport aircraft

3.2

tie-down

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

3.3

flat woven textile webbing

conventional or shuttleless woven narrow fabric made of continuous textile fibres, generally with multiple plies, and the prime function of which is load bearing

Note 1 to entry: A characteristic of webbing is its tight woven fabric selvedge.

3.4

tensioning device

mechanical device inducing a tensile force in the load restraint assembly

EXAMPLE Ratchets, winches, over-centre buckles; see examples in [Figure 1](#), C1 and C6.

2) EASA CS-25 constitutes the European governments transport aircraft airworthiness approval Regulations, and it, as well as ETSO C-172, can be obtained from European Aviation Safety Agency (EASA), Otto Platz 1, Postfach 101253, D-50452 Cologne, Germany, or its web site at www.easa.europa.eu.

3) 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, web site www.mlit.jp/en.

4) 14 CFR Part 25 constitutes the USA government transport aircraft airworthiness approval Regulations, and it, as well as TSO C-172, can be obtained from US Government Printing Office, Mail Stop SSOP, Washington DC 20402-9328, or its website at www.gpoaccess.gov/ecfr.

3.5**tension retaining device**

metallic part connecting the webbing by clamping action and retaining the force induced in the tensioning device by hand

EXAMPLE Cam buckles, sliding bar buckles; see example in [Figure 1](#), F.

3.6**end fitting**

metallic device connecting the webbing or the tensioning device to the attachment point on the aircraft structure, the pallet edge rail or the load

Note 1 to entry: See examples in [Figure 1](#), D1 to D6.

Note 2 to entry: The end fittings most commonly used on air cargo restraint straps include:

- a) retainer equipped flat hook (see example in [Figure 1](#), D1);
- b) air cargo tie-down double stud (male) fitting conforming to ISO 9788 and ISO 12118, connected directly (sewn to the webbing; see example in [Figure 1](#), D3) or by an intermediate ring;
- c) piece of aircraft restraint (female) rail conforming to ISO 7166.

3.7**tension force indicator**

device that indicates the tensile force applied to the restraint strap assembly by means of the tensioning device and movement of the load acting on the load restraint device

3.8**length of restraint strap assembly****3.8.1****fixed length**

l_{GF}

length of a fixed end, measured from the force bearing point of the end fitting to the outer turning radius of the connection of the webbing to the tensioning device

Note 1 to entry: See [Figure 2](#).

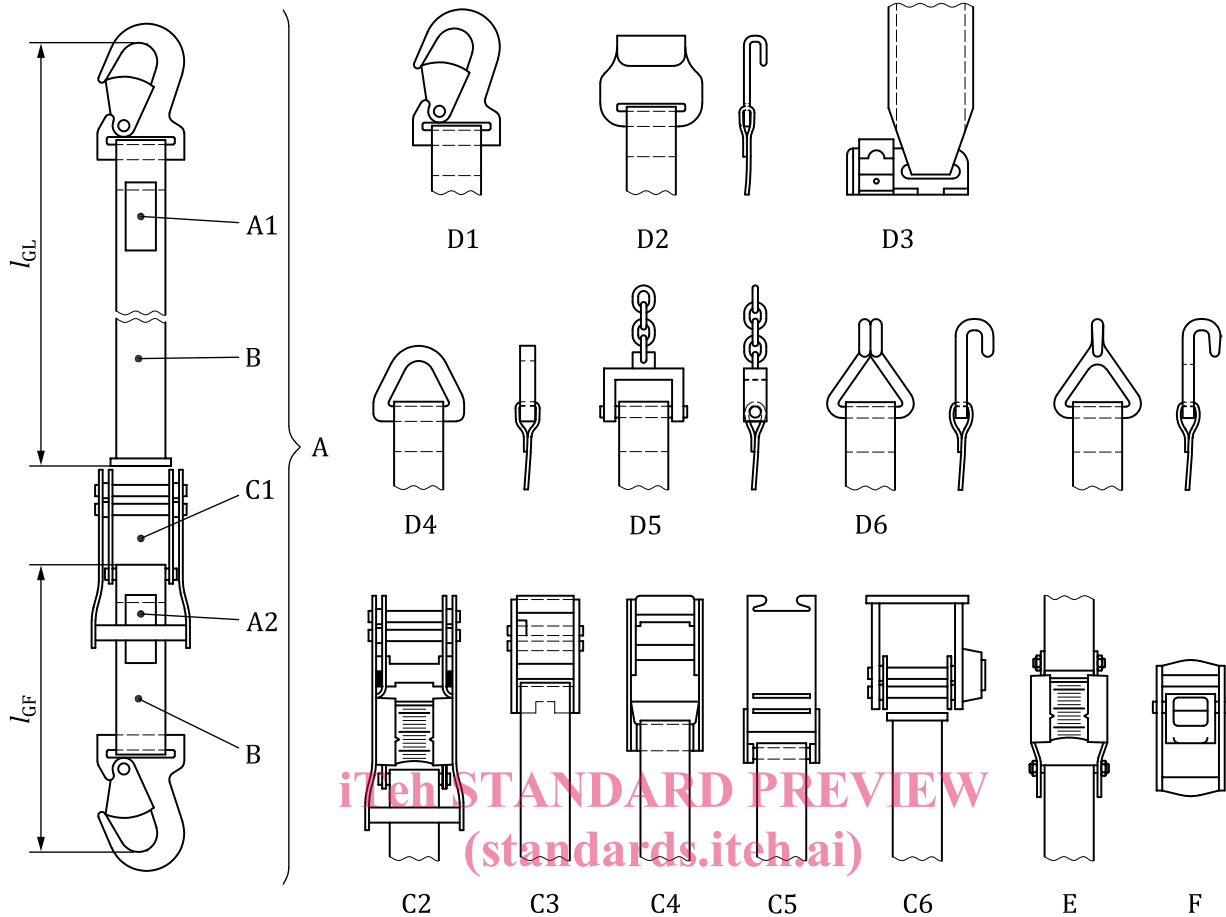
Note 2 to entry: This length can be zero, i.e. the end fitting directly attached to the tensioning device.

3.8.2**adjustable length**

l_{GL}

length of an adjustable end, measured from the free end of the webbing to the force bearing point of the end fitting

Note 1 to entry: See [Figure 2](#).



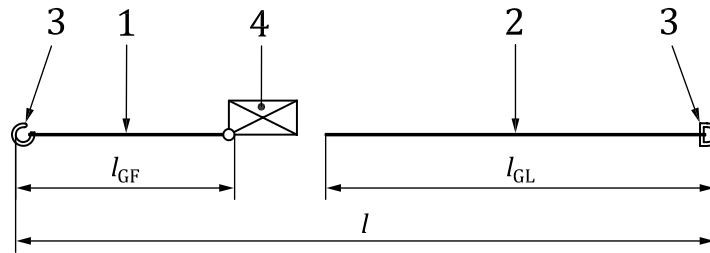
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Key	https://standards.itech.ai/catalog/standards/sist/45dec28f-1443-4e6f-8af8-f505806caab3/iso-16049-1-2013
A	restraint strap assembly (complete)
A1, A2	space for marking (label)
B	webbing
C	tensioning devices
C1	ratchet tensioner
C2	ratchet tensioner with tension force indicator (see also E)
C3	sliding bar buckle
C4, C5	over-centre buckles
C6	lashing winch
D	end fittings
D1	snap hook, flat, swivel or twisted, with retainer
D2	flat hook, with retainer
D3	double stud tie-down fitting (directly sewn onto webbing)
D4	triangle, designed to engage with an anchorage
D5	connector to chain
D6	wire claw hook (single or double)
E	tension force indicator (see also C2)
F	tension retaining device (cam buckle, sliding bar buckle)

Figure 1 — Examples of restraint strap equipment, including tensioning device C, end fitting D and tension force indicator E

3.8.3 total length

$l = (l_{GF}) + (l_{GL}) + \text{length of the tensioning device}$

**Key**

- | | | | |
|---|----------------|---|---|
| 1 | fixed end | 3 | end fitting |
| 2 | adjustable end | 4 | tensioning device or tension retaining device |

Figure 2 — Two-piece restraint strap assembly**3.9****breaking force**

BF

maximum force that the restraint strap assembly withstands when tested in a complete form, i.e. with tensioning device and end fittings, according to 5.5

3.10**hand force**

HF

force applied to the handle of the tensioning device, which creates the tensile force in the restraint strap assembly

3.11**limit load**

LL

maximum load to be expected in service

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Note 1 to entry: See CS-25, JAS Part 3 or FAR Part 25, paragraph 25.301 (a).

Note 2 to entry: It is two thirds of the ultimate load (see hereafter), i.e. 14 827 N (3 333 lbf) for a typical rated ultimate load of 22 250 N (5 000 lbf).

3.12**ultimate load**

UL

limit load multiplied by a safety factor of 1,5

Note 1 to entry: see CS-25, JAS Part 3 or FAR Part 25, paragraph 25.303.

Note 2 to entry: It is used for computation of cargo tie-down arrangements, based on the ultimate load factors defined in the Airworthiness Authorities approved Weight and Balance Manual, in each direction of restraint, throughout the certified flight envelope of the aircraft type. The restraint strap assembly's rated ultimate load is guaranteed not to exceed the measured breaking force (BF).

3.13**residual tension**

tension force which can be measured in the webbing of a strap assembly attached between two fixed points, after its length was adjusted and its tension device was operated and latched with the reference hand force (HF), prior to application of any external load