
Air cargo — Restraint slings —

**Part 1:
Design and testing**

Fret aérien — Câbles d'arrimage —

Partie 1: Conception et essais

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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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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.

Introduction

The aim of this document is to standardize the design and testing requirements for air cargo restraint sling assemblies used as an alternate to restraint straps for tie-down of cargo on board civil transport aircraft.

The civil aviation requirements referred to in this document are those relating to the design of transport aircraft. They constitute the set of design requirements internationally agreed in the application of International Civil Aviation Organization (ICAO) Annex 6, *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 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 inch-pound units conversion 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 inadvisable 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 (see ISO 20291-2).

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Air cargo — Restraint slings —

Part 1: Design and testing

1 Scope

This document specifies the design criteria and testing methods adequate to guarantee the ultimate strength and operational dependability of cargo restraint sling assemblies made of steel wire rope, with a 22,25 kN (5 000 lbf) rated ultimate load capability, as can be used by the airline industry in order to restrain on board civil transport aircraft during flight, including the following:

- 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 21100, or
- 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, to be restrained onto aircraft structure attachment (tie-down) points.

Two types of wire rope restraint slings are defined:

- a) type A: adjustable length restraint sling assemblies, including a tension retaining device and termination fittings attached to the wire rope end eyes;
- b) type B: fixed length restraint sling extensions, to be used in conjunction with a type A cable; extensions are usually terminated at both ends by eyes, without additional fittings, and can be attached through hooks or shackles.

The cables specified in this document are intended exclusively for restraint purposes on board aircraft, and not for use as lifting slings.

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 2408, *Steel wire ropes — Requirements*

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

ISO 4171, *Air cargo equipment — Interline pallets*

ISO 4346, *Steel wire ropes for general purposes — Lubricants — Basic requirements*

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

ISO 7531, *Wire rope slings for general purposes — Characteristics and specifications*

ISO 7597, *Forged steel lifting hooks with latch, grade 8*

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

ISO 8793, *Steel wire ropes — Ferrule-secured eye terminations*

ISO 8794, *Steel wire ropes — Spliced eye terminations for slings*

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

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

ISO 17893, *Steel wire ropes — Vocabulary, designation and classification*

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, ISO 17893 and the following apply.

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

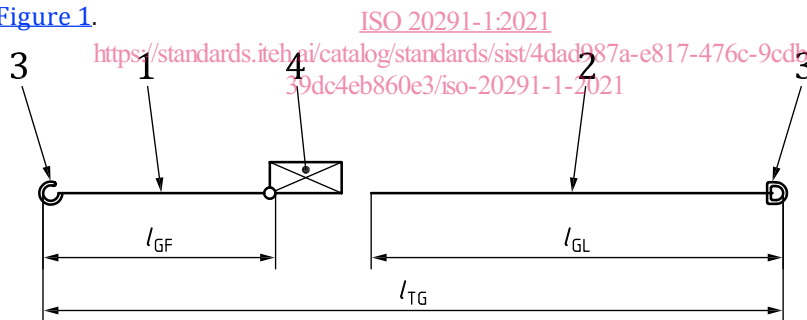
- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1 restraint sling assembly type A

elementary *tie-down* (3.3) unit made of steel wire rope cable with *end fittings* (3.6) and *tension retaining device* (3.5), used for restraint of cargo on board civil transport aircraft

Note 1 to entry: It consists of 1 (one) *fixed length* (3.8.1) end and one adjustable end and can be used in conjunction with one or two extensions(s).

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



Key

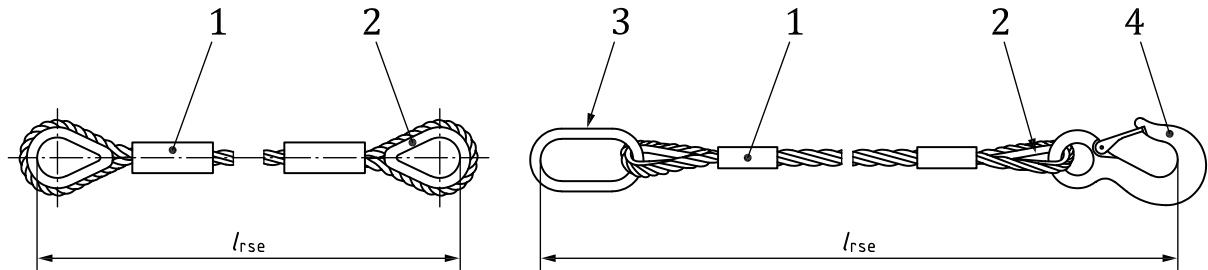
- 1 fixed end
- 2 adjustable end
- 3 end fitting
- 4 tension retaining device
- l_{GF} fixed length
- l_{GL} adjustable length (3.8.2)
- l_{TG} total length (3.8.3)

Figure 1 — Adjustable (type A) restraint sling assembly

3.2 restraint sling extension type B

fixed length (3.8.1) steel wire rope (cable) with end eyes but no *tension retaining device* (3.5), with or without *end fittings* (3.6), used in conjunction with a *restraint sling assembly* (3.1) to extend usable length between attachment points

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



Key

- 1 ferrule
- 2 thimble
- 3 end fitting (ring)
- 4 end fitting (hook)

l_{rse} length of restraint sling extension (3.9)

Figure 2 — Fixed length (type B) restraint sling extensions

3.3 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 devices against each direction of restraint

3.4 tensioning device

mechanical device inducing and maintaining a tensile force in the load restraint assembly

EXAMPLE Lever, ratchet, winch, cam, over-centre device, or equivalent.

3.5 tension retaining device

part connecting to the wire rope and retaining any force induced between the ends of the assembly

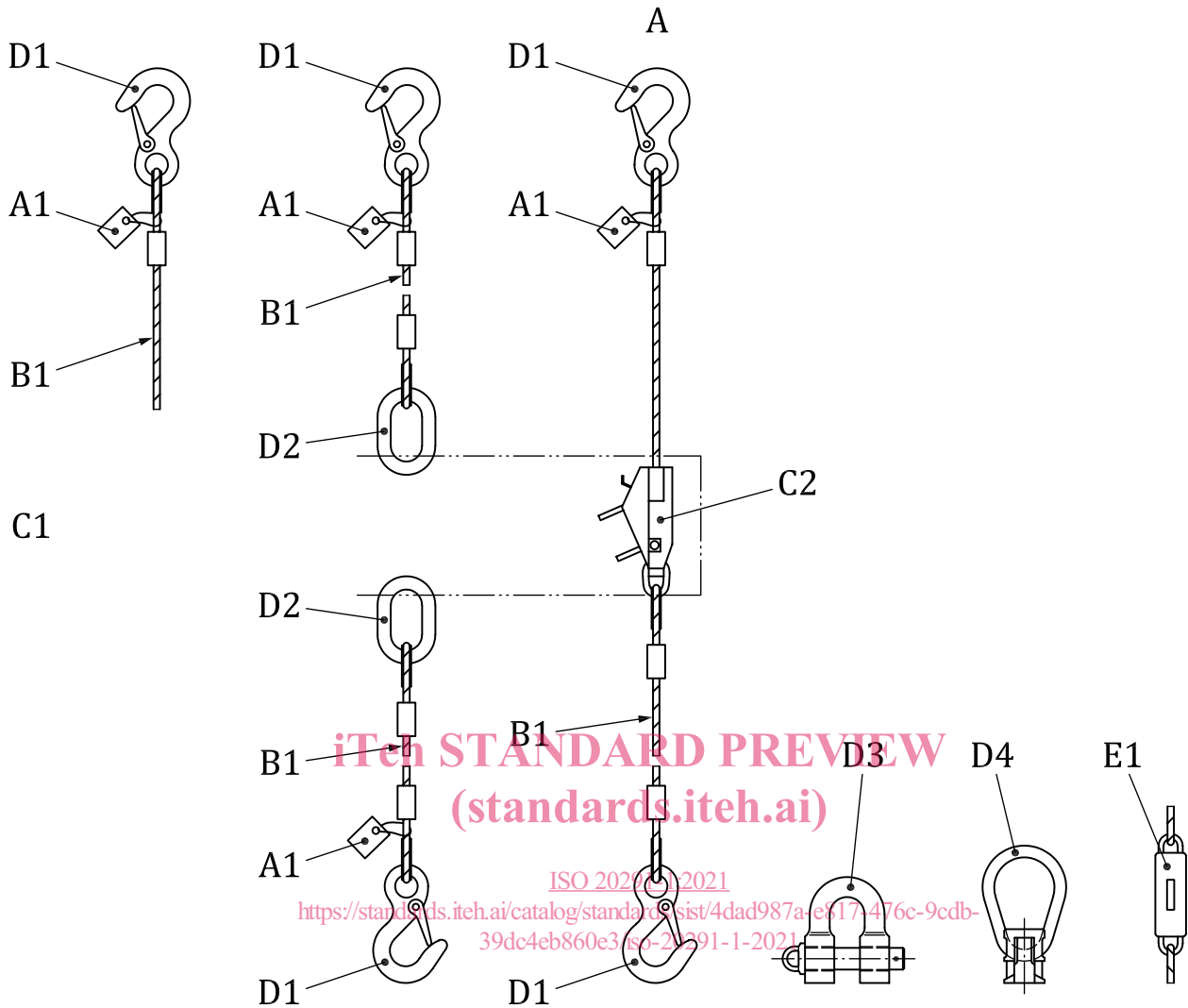
3.6 end fitting connecting component

metallic device connecting a wire rope end to the attachment point on the aircraft structure, the pallet edge track, another restraint element, or the load to be restrained

Note 1 to entry: See examples in [Figure 3](#), D1 to D3.

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

- a) retainer or latch equipped hook (see example in [Figure 3](#), D1),
- b) air cargo *tie-down* (3.3) double stud (male) fitting (see example in [Figure 3](#), D4) conforming to ISO 9788, connected to the cable directly or through an intermediate ring,
- c) ring (see example in [Figure 3](#), D2) or wire rope end loop (eye) compatible with hooks.



- Key**
- | | |
|--|---|
| A restraint sling assembly (complete) | D connecting elements |
| A1 marking (label) | D1 hook with retainer or latch |
| B tension holding element | D2 end ring |
| B1 steel wire rope | D3 shackle with steel pin |
| C tensioning device (3.4) (optional) | D4 double stud tie-down fitting |
| C1 possible tension arrangement | E1 tension force indicator (3.7) |
| C2 example of rope tensioner | D connecting elements |

Figure 3 — Examples of restraint sling equipment

3.7 tension force indicator
 device that indicates the tensile force applied to the *restraint sling assembly* (3.1)

Note 1 to entry: See example in [Figure 3, C](#).

3.8 length of restraint sling assembly

3.8.1 fixed length

l_{GF}

length of a fixed end, measured from the force bearing point of the *end fitting* (3.6) to the outer turning radius of the connection of the wire rope to the *tension retaining device* (3.5)

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

Note 2 to entry: This length can be zero, i.e., the end fitting directly attached to the *tensioning device* (3.4).

3.8.2 adjustable length

l_{GL}

maximum length of an adjustable end, measured from the tension device to the force bearing point of the *end fitting* (3.6)

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

3.8.3 total length

l_{TG}

sum of *fixed length* (3.8.1), *adjustable length* (3.8.2) and length of the *tension retaining device* (3.5)

3.9 length of restraint sling extension

l_{rse}

length measured between the force bearing points of each terminal, whether thimbles, hooks or rings

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

3.10 breaking force BF

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maximum force that the *restraint sling assembly* (3.1) withstands when tested in a complete form, i.e. with *tension retaining device* (3.5) and *end fittings* (3.6)

3.11 hand force HF

force applied to adjust, latch, or unlatch the *restraint sling assembly* (3.1)

3.12 limit load LL

maximum load to be expected in service

Note 1 to entry: See CAAC CCAR-25, CS-25, JAS Part 3 or 14 CFR Part 25, § 25,301 (a).

Note 2 to entry: It is two thirds of *ultimate load* (3.13), i.e. 14,8 kN (3 333 lbf) for a rated ultimate load of 22,2 kN (5 000 lbf).

3.13 ultimate load UL

limit load (3.12) multiplied by a safety factor of 1,5

Note 1 to entry: See CAAC CCAR-25, CS-25, JAS Part 3 or 14 CFR Part 25, § 25,303.

Note 2 to entry: It is used for computation of cargo *tie-down* (3.3) arrangements, based on the ultimate load factors defined in the aircraft Weight and Balance Manual in each direction of restraint, throughout the certified flight envelope of the aircraft type. The *restraint sling assembly's* (3.1) rated ultimate load must not exceed the measured *breaking force* (BF) (3.10).