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Air cargo — Restraint slings —

Part 1:
Design and testing

Fret aérien — Câbles d'arrimage —

Partie 1: Conception et essais

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Foreword

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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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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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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.

ISO 20291-1 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 9, Air cargo and ground equipment.

This is the first edition of this document.

ISO 20291 consists of the following parts, under the general title *Air cargo — Restraint slings*:

— *Part 1:Design and testing*

— *Part 2: Utilization guidelines and tie down calculations [in preparation]*

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Introduction

The aim of this Part of ISO 20291 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 the present document are those relating to the design of transport aircraft. They constitute the set of design requirements internationally agreed in 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 recommended criteria should only occur after careful consideration and thorough service evaluation have shown alternate methods to provide an equivalent level of safety.

The requirements of this part of ISO 20291 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 — 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:

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

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2 (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.

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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.

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 could be hazardous, such as: heavy vehicles, aircraft engine stands, helicopters, machinery, etc...

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

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.

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.

NOTE Also see informative references in Bibliography.

ISO 2408, *Steel wire ropes — Requirements*

ISO 3108, *Steel wire ropes — Test method — Determination of measured breaking force*

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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 8097:2001, *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 cables*

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

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

ISO 16049-1, *Air cargo — Restraint straps — Part 1: Design criteria and testing methods (TSO/ETSO C172a)*

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

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

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ISO 20291-2, *Air cargo — Restraint slings — Part 2: Utilization guidelines and lashing calculations [in preparation]*

ISO 21100, *Air cargo unit load devices — Performance requirements and test parameters (TSO/ETSO C90d)*

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CAAC CCAR-25, [1] Airworthiness Standards: Transport Category Airplanes

CS-25,[2] Certification Specifications for Large Aeroplanes

JAS Part 3 (Civil Aeronautics Law Article 10 § 4)[3]

14 CFR Part 25,[4] Airworthiness Standards: Transport Category Airplanes

3 Terms and definitions

For the purpose of this document, the definitions 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

1) CAAC CCAR-25 constitutes the Chinese government transport aircraft airworthiness approval Standards, and can be obtained from the Civil Aviation Authority of China (CAAC).

2) EASA CS-25 constitutes the European governments transport aircraft airworthiness approval Standards, and can be obtained from: European Aviation Safety Agency (EASA), Otto Platz 1, Postfach 101253, D-50452 Cologne, Germany, or at www.easa.europa.eu.

3) The Japanese Airworthiness Standard Part 3 (ISBN 4-89279-661-1) constitutes the Japanese government transport aircraft airworthiness approval Standards, and can be obtained from the Civil Aviation Bureau (CAB) of the Ministry of Land, Infrastructure, Tourism and Transport, Tokyo, Japan, or at www.mlit.go.jp.en.

4) 14 CFR Part 25 constitutes the U.S.A. government transport aircraft airworthiness approval Standards, and can be obtained from: U.S. Government Printing Office, Mail Stop SSOP, Washington DC 20402-9328, or at www.gpoaccess.gov.ec.fr.

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

3.1
restraint sling assembly (type A)
elementary tie-down unit made of steel wire rope cable with end fittings and tension retaining device, used for restraint of cargo on board civil transport aircraft. It consists of 1 (one) fixed length end and one adjustable end, and can be used in conjunction with one or two extensions(s)

3.2
restraint sling extension (type B)
fixed length steel wire rope (cable) with end eyes but no tension retaining device, with or without end fittings, used in conjunction with a restraint sling assembly to extend usable length between attachment points

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 tie-down devices against each direction of restraint

3.4
tensioning device
mechanical device inducing and maintaining a tensile force in the load restraint assembly (e.g. 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

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3.6
end fitting
connecting component
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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 (see examples in Figure 3, D1 to D3)

Note 1 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 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.

3.7
tension force indicator
device that indicates the tensile force applied to the restraint sling assembly (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 to the outer turning radius of the connection of the wire rope to the tension retaining device (see Figure 1)

Note 1 to entry: This length can be zero, i.e. the end fitting directly attached to the tensioning device.

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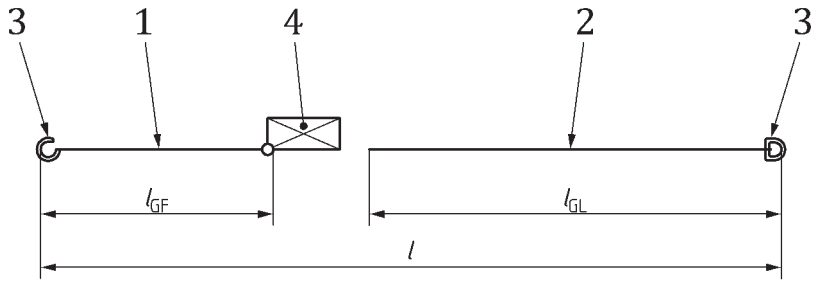
3.8.2
adjustable length (l_{GL})
maximum length of an adjustable end, measured from the tension device to the force bearing point of the end fitting (see Figure 1)

3.8.3
total length (l)
(l_{GF}) + (l_{GL}) + length of the tension retaining device



Key

1 fixed end
2 adjustable end
3 end fitting
4 tension retaining device
l length

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Figure 1 — Adjustable (type A) restraint sling assembly

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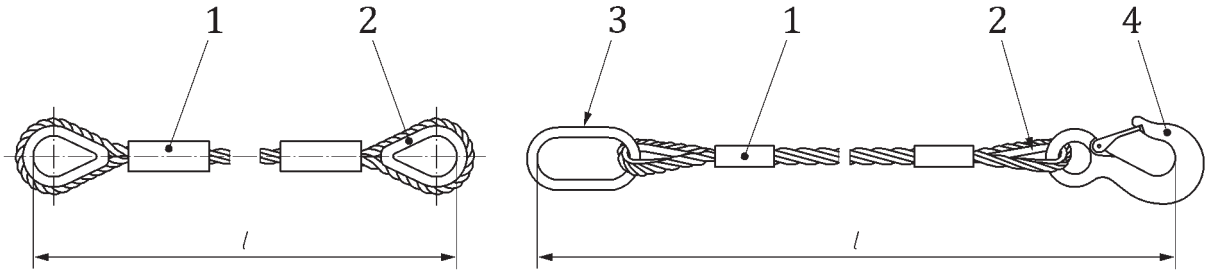
3.9
length of restraint sling extension (l)
length measured between the force bearing points of each terminal, whether thimbles, hooks or rings (see Figure 2)



Key

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

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

3.10
breaking force (BF)
maximum force that the restraint sling assembly withstands when tested in a complete form, i.e. with tension retaining device and end fittings

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3.11
hand force (H_F)
force applied to adjust, latch, or unlatch the restraint sling assembly

3.12
limit load (LL)
maximum load to be expected in service, see CAAC CCAR-25, CS-25, JAS Part 3 or 14 CFR Part 25, § 25.301 (a)

Note 1 to entry: It is two thirds of ultimate load (see 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 multiplied by a safety factor of 1,5, see CAAC CCAR-25, CS-25, JAS Part 3 or 14 CFR Part 25, § 25.303

Note 1 to entry: It is used for computation of cargo tie-down 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 rated ultimate load must not exceed the measured breaking force (BF).

3.14
residual tension
tension force which can be measured in the rope of a cable assembly attached between two fixed points, after its length was adjusted and it was operated and latched with the reference hand force (H_F), prior to application of any external load

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3.15
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

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Note 1 to entry: A competent person can be suitably trained in accordance with 7.2 of ISO 9001:2015, (see[[2]] in Bibliography).

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