
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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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

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 undesirable 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.

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.

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.