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Air cargo — Cargo stopper devices — Design and testing

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Contents

Page

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).

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*.

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 the design, performance and testing requirements for “cargo stopper” devices intended to be used in conjunction with restraint straps for cargo restraint on board civil transport aircraft.

The civil aviation requirements referred to in this document are those relating to operation of transport aircraft. They constitute the set of operation requirements internationally agreed in application of International Civil Aviation Organization (ICAO) Annex 6, *Operation 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 to be of primary importance in providing safe restraint arrangements on board aircraft. 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.

Dimensions are expressed in millimetres, and forces in newtons. Equivalent inch-pound system units are given between brackets for information.

Air cargo — Cargo stopper devices — Design and testing

1 Scope

This document specifies the design, performance and testing requirements for "Cargo Stopper" air cargo restraint accessories with a 22 250 N (5 000 lbf) rated load capacity, to be used in conjunction with air cargo restraint straps meeting ISO 16049-1 (TSO/ETSO – C172), or air cargo restraint slings meeting ISO 20291-1, with the same rated load.

Cargo stopper devices designed to this document are intended to be used in either of the following typical instances:

a) to ensure restraint/tie-down of a piece of cargo that does not lend itself to either direct hooking of tie-down straps or passing a strap around without risk of slippage; a common example is long shaped cargo items with a narrow cross-section, whether or not overhanging from the pallet, individual or in bundles, e.g. pipes or beams; see ISO 16049-2:2020, 7.4;

b) to restrain cargo smaller than the pallet net's mesh, or identified as "piercing" cargo, presenting a hazard to the aircraft in the event of it being released during flight;

c) when a crate containing cargo, even though its cross-section is large enough to be directly tied-down with the pallet net or restraint straps, contains or can contain a heavy item, e.g. a piece of machinery, shaft, or similar, with a cross-section lower than the pallet net's mesh size;

NOTE Such "hidden" items have been known to break free from insufficiently strong crates when subjected to in-flight accelerations, then pass due to their small size through the net mesh restraining the crate and be released into the cargo compartment.

d) to assist in tying-down odd-shaped cargo pieces where it is difficult or not allowed to directly attach tie-down straps or pass them around the load in an effective manner.

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

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

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

ISO 12236, *Geosynthetics — Static puncture test (CBR test)*

ISO 16049-1, *Air cargo equipment — Restraint straps — Part 1: Design criteria and testing methods*

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

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
breaking force
BF
lowest load at which a unit under tensile test exhibits part or complete failure

Note 1 to entry: Deformations are not accounted as a failure.

3.2
interlinking straps
cargo stopper straps sewn at an angle with the *tension straps* (3.4), forming a web to adapt the shape of the piece of cargo but which do not transmit the in-flight loads, to which they are perpendicular

3.3
"piercing" cargo
piece of cargo of a piercing or penetrating nature, such as rods, pipes, extrusions, beams, etc., that could become a projectile under flight operational loads

3.4
tension straps
cargo stopper straps which attach to the pallet through other straps or slings, and transmit in-flight loads, with which they form a low angle

4 Requirements

4.1 Cargo stopper devices (see typical examples in Figure 1) shall be built from sewn lengths of cargo restraint straps grade webbing, performing two different roles:

a) tension straps connecting to the main restraint arrangement straps and able to withstand the same forces;

b) interlinking straps forming a web like structure in order to prevent passage of small cross-section items, stitched together with supplemental continuous flexible material to fill the gaps between tension straps.

4.2 The tension straps shall consist of a single uninterrupted piece of webbing with a rated tension load of at least 22 250 N (5 000 lbf), consistent with that mostly used to manufacture cargo restraint straps. They shall meet the ISO 16049-1 design requirements applicable to the webbing and stitching.

4.3 The tension straps shall be equipped at each end with fittings allowing their attachment to standard cargo restraint straps per ISO 16049-1, or to pallet net rope as appropriate. The fittings may be hooks, rings or D rings, tie-down fittings or pieces of tie-down track, or a combination thereof. No tension device is required.

4.3.1 Hooks shall be equipped with a retainer and strong enough to withstand the rated load without deformation.

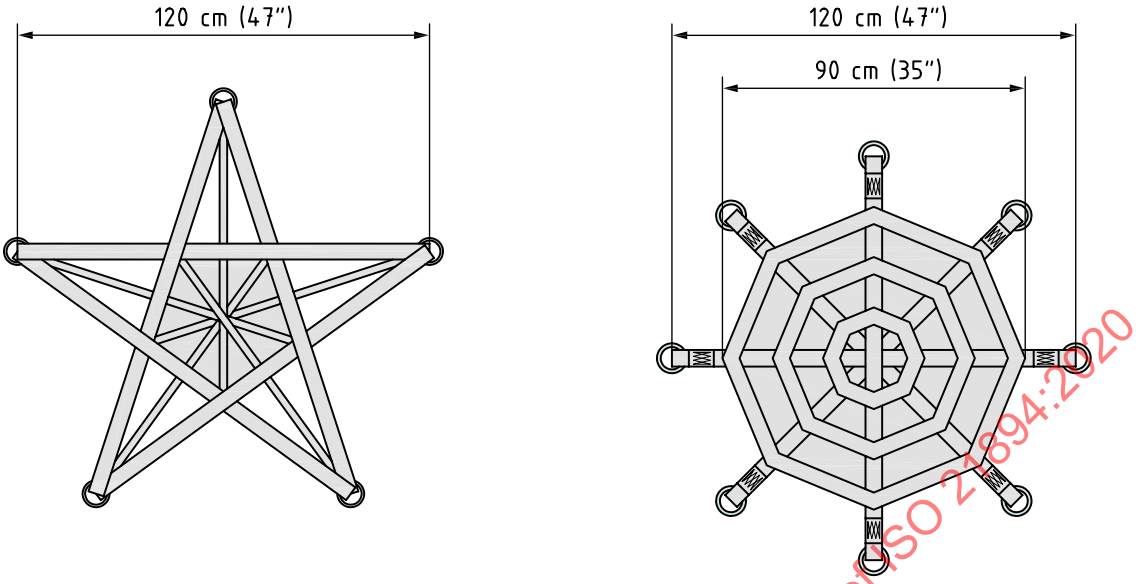
4.3.2 Rings or D rings shall be strong enough to withstand the rated load without deformation. Open rings or open D rings are not permitted. Any gaps in bent wire shall be welded to provide an uninterrupted circumference.

4.3.3 Tie-down fittings where used shall be of the double stud type and conform to the requirements of ISO 9788.

4.3.4 Tie-down track where used shall conform to the requirements of ISO 7166.

4.4 The interlinking straps may be of lesser grade webbing for flexibility, but their assembly shall ensure the total rated tension load of at least 22 250 N (5 000 lbf) between two opposite end fittings. Their geometric arrangement shall form a web ensuring the largest empty space between straps does not exceed a 100 mm (4,0 in) diameter circle. They shall be stitched together and with the tension straps at intersections. Webbing and stitching of tension straps and interlinking straps shall meet the applicable ISO 16049-1 design requirements.

4.5 The total area covered by the web of restraining straps shall be at least more than a typical pallet net's mesh size, i.e. 300 × 300 mm (12 × 12 in) diamond [400 × 400 mm (16 × 16 in) square], thus a minimum of 1 600 cm^2 (250 sq.in). It is recommended to consider total areas up to 4 800 cm^2 (750 sq. in), usually limited by the desired unit's weight and flexibility to adapt to various shapes of cargo. See Figure 1 for examples.



a) Approximately 1 600 cm^2 (250 sq in) covered area b) Approximately 4 800 cm^2 (750 sq in) covered area

Figure 1 — Examples of cargo stoppers

See 4.3 for alternate or additional end fittings.

4.6 In addition, the area covered by the web of tension straps and interlinking straps shall also be covered by a strong tarpaulin section, or other equivalent continuous flexible filling material as puncture-proof as possible, stitched to the straps, in order to prevent passage of smaller items.

4.7 It is presupposed that all materials used in the cargo stopper assembly, including sewing and any treatment, meet the flammability test criteria of 14 CFR Part 25/CS-25 Appendix F, Part I, paragraph (a)(1)(v): it may not have a burn rate greater than 65 mm (2,5 in) per minute when tested horizontally with the apparatus and test procedures required in Appendix F, Part I, paragraph (b)(5).

4.8 All hardware, e.g. rings, hooks, etc. used in the cargo stopper assembly shall be corrosion resistant.

4.9 Cargo stopper devices are used as part of cargo restraint arrangements that meet the Civil Aviation airworthiness requirements. Accordingly, their design and performance shall be substantiated as specified in this document in order to meet the applicable requirements, for example, to obtain TSO C202 approval.

5 Testing

5.1 Load test

5.1.1 Cargo stopper devices shall be load tested prior to delivery in order to demonstrate the rated loads specified in 4.2 and 4.4. Three test specimens randomly selected from the same production batch shall be used for each test, and the test results recorded for each specimen. The rated ultimate load (UL) shall not exceed the lowest recorded breaking force (BF).

5.1.2 The test shall consist of applying steps 1, 3, 4 and 5 of the load test defined for restraint straps in ISO 16049-1:2020, 5.5 between both ends of any of the assembled tension straps. Testing is deemed successful if rupture occurred at a load higher than the rated ultimate load (UL), and any damage observed under the ultimate load did not exceed the allowances.

5.2 Puncture test

5.2.1 The filling tarpaulin material shall be tested for puncture resistance. Five wetted specimens shall be tested using the apparatus, plunger and methodology of ISO 12236, at a pushing rate of (50 ± 10) mm/min [(2 ± 3/8) inch/min].

5.2.2 The mean push-through force in kN (lbf) measured at full puncture through the material shall be recorded.

5.3 Flammability test

5.3.1 It is presupposed that the webbing and gap-filling material in their production condition, after any treatment, are both tested for flammability performance in accordance with 14 CFR Part 25/CS-25 Appendix F, Part I, paragraph (a)(1)(v). See 4.7 for minimum performance requirements.

5.3.2 The flammability test shall be performed on a minimum of three each webbing or gap-filling material specimens, and the results averaged. The results shall be recorded in the test report to be provided to the purchaser at or before time of delivery of each production batch.

5.4 Other tests

5.4.1 Due to the limited overall length of the device, no elongation test is required.

5.4.2 Due to the absence of tensioning devices or other moving parts, no cycling test is required.

5.5 Test report

5.5.1 A test report including the results of the tests in 5.1 and 5.2 shall be provided to the purchaser by the manufacturer.

5.5.2 The test report shall include, or be accompanied by, a certificate of conformity with the requirements of the present document and a Component Maintenance Manual (CMM) or Component Maintenance Sheet (CMS) indicating any limitations applicable in the event of damage.

5.5.3 In the event of the tests being performed or duplicated by the purchaser or a third party, the same report filing requirements apply.

6 Markings

6.1 Each cargo stopper unit shall bear a permanently affixed label, indicating at least:

— if applicable (Authority approval), TSO marking: "TSO-C202" (or "CTSO", "ETSO", "JTSO", as appropriate);

— "ISO 21894";

— manufacturer's identification, part number, and serial number if applicable;

— weight to the nearest kg or lb (optional);

— rated ultimate load between two opposite end fittings in daN, and optionally in lb:

  — "2 225 daN (5 000 lbf)";

— burn rate measured in accordance with 5.3 (optional);

— date of manufacture if applicable (see 6.2);

— production batch number and expiry date if applicable (see 6.2).

6.2 Consideration shall be given to available data regarding potential environment degradation of the component straps and filling material. This may result in either an appropriate safety factor being used in selecting the materials (no time limit), or an expiry date after which the rated performance level may not be maintained. In the second case, the date of manufacture and expiry date shall be marked.

6.3 Any other markings (e.g. customer/operator, etc.) are optional.

7 Quality control

7.1 Design and production

7.1.1 Design, testing and production of cargo stopper devices complying with this document should be performed within the framework of design and manufacturing quality assurance systems recognized by the regulatory airworthiness authorities, as required for TSO approval.

When the manufacturer operates under such an authority recognized quality assurance system, the test sampling rates specified in 7.1.3 may vary, but shall provide at least the same level of confidence.

7.1.2 For device initial type testing, at least three specimens randomly selected from a batch produced according to the intended production locations and methods shall constitute one sample and be tested in accordance with 5.1 through 5.3.

7.1.3 For continuous production control, samples shall consist of three specimens randomly selected from the current production batch, and be tested, prior to delivery, in accordance with 5.1. The recommended minimum number of such samples to be tested is shown in Table 1.

Table 1 — Number of samples

Number of units	Number of samples
up to 1 000	1
1 000 to 5 000	2
5 000 to 10 000	3
over 10 000	add 1 every 10 000

7.2 Operation

7.2.1 Cargo stopper devices shall be used for cargo restraint in accordance with the general tie-down guidelines specified in ISO 16049-2.

7.2.2 The air carrier (Operator) shall be responsible for ensuring procurement and exclusive use of cargo stopper devices complying with this International Standard.

