



AEROSPACE STANDARD

AS5385™**REV. D**

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Superseding AS5385C

Cargo Restraint Straps - Design Criteria and Testing Methods

RATIONALE

Revision D eliminates D5 and D6 end fittings, revises the flammability test burn rate consistent with FAA regulations amendment 111, and rennumbers paragraphs per current requirements for SAE standards.

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1. SCOPE

1.1 This SAE Aerospace Standard (AS) aims at identifying the design criteria and testing methods adequate to guarantee the ultimate load and operational dependability of cargo restraint strap assemblies with a typical 22250 N (5000 lbf) rated ultimate tension load capability, as used by the airline industry in order to restrain cargo on board civil transport aircraft during flight:

- a. cargo loaded and tied down onto airworthiness certified air cargo pallets, themselves restrained into aircraft lower deck or main/upper deck cargo systems and meeting the requirements of NAS 3610 or AS36100, or
- b. non-unitized individual pieces of cargo, or pieces of, cargo placed onto an unrestrained (“floating”) pallet into either lower deck or main deck containerized cargo compartments of an aircraft.

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

- a. restraint of non-containerized (bulk loaded) baggage and cargo in aircraft compartments,
- b. to ensure cargo restraint inside an airworthiness certified air cargo container.

NOTE 1: The ultimate loads allowable on the attachment points available in most aircraft bulk compartments and inside most air cargo containers are significantly lower than 22250 N (5000 lbf). This results in the restraint arrangements ultimate load capability being dictated by the weakest element, i.e., the attachment points; typical 22250 N (5000 lbf) ultimate load restraint straps will, therefore, be in excess of the allowable for such applications.

1.3 This Standard describes the design criteria for individual restraint strap assemblies, but does not intend specifying in any manner the way they are to be used aboard aircraft to ensure proper restraint throughout the certified flight envelope. Tie-down arrangements shall meet all the applicable requirements of the Airworthiness Authorities approved Weight and Balance Manual for the aircraft type or sub-type concerned, particularly as regards, but not necessarily limited to, ultimate load factors to be taken into account to determine the number of straps to be used in each direction of restraint, maximum angles to be observed with the direction of restraint, minimum spacing of attachment points, etc.

1.4 When restraint strap assemblies are attached to the edge rails of a certified air cargo pallet meeting the requirements of NAS 3610 or AS36100, operating instructions should duly take into account the restraint net attachment point locations on the pallet edge rail and other requirements defined by the appropriate NAS 3610 or AS36100 configuration drawing(s).

1.5 The use of reliable and guaranteed restraint strap assemblies does not alone ensure flight safety: it also requires straps to be used and tie-down to be performed in accordance with operating instructions established by the aircraft manufacturer, by competent, suitably trained, personnel.

1.6 Subject to proper operating instructions as per 1.3 and 1.4 being defined and complied with, using unit restraint strap assemblies manufactured to an adequate design and a tested ultimate load capability is nevertheless deemed necessary in order to ensure flight safety. General utilization guidelines and calculation methods adequate to guarantee the effectiveness and ultimate load strength of tie-down/lashing arrangements performed to restrain cargo on board civil transport aircraft may be found in ARP5595 (or ISO 16049-2 equivalent).

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AIR1490	Environmental Degradation of Textiles
ARP5595	Cargo Restraint Straps - Utilization Guidelines
AS1130	Air and Air/Surface (Platform) Cargo Pallets
AS1491	Interline Air Cargo Pallets
AS33601	Track and Stud Fitting for Cargo Transport Aircraft, Standard Dimensions for
AS36100	Air Cargo Unit Load Devices - Performance Requirements and Test Parameters

2.1.2 NAS Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, www.aia-aerospace.org.

NAS 3610 Rev 10 Minimum Airworthiness Requirements and Test Conditions for Certified Air Cargo Unit Load Devices

2.1.3 ISO Publications

Available at <http://webstore.ansi.org/> or International Standard Organization (ISO), website www.iso.org, or any of the national standards institutes worldwide, members of ISO.

ISO 2076	Textiles - Man-made fibres - Generic names
ISO 7166	Aircraft - Rail and stud configuration for passenger equipment and cargo restraint (updated AS33601 track and stud, see above)
ISO 9788	Air cargo - Double stud tie-down fittings – Design and testing requirements
ISO 16049-1	Air cargo equipment - Restraint straps - Part 1: Design criteria and test requirements
ISO 16049-2	Air cargo equipment - Restraint straps - Part 2: Utilization guidelines and lashing calculations

2.1.4 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

Federal Aviation Regulations Title 14 Code of Federal Regulations (14 CFR) Part 25, Airworthiness Standards: transport category airplanes

Technical Standard Order TSO-C172 – Cargo Restraint Strap Assemblies

2.1.5 U.S. Federal Test Methods Standards

Available at <http://quicksearch.dla.mil/>.

U.S. Federal Test Method Standards No. 191A, Method 4108, Strength and elongation, breaking; textile webbing, tape and braided items

U.S. Federal Test Method Standards No. 191A, Method 5309-1, Abrasion resistance of textile webbing

2.1.6 EASA Publications

Available from European Aviation Safety Agency, Postfach 10 12 53, D-50452 Cologne, Germany, Tel: +49-221-8999-000, www.easa.eu.int.

European Aviation Safety Agency CS-25 (EASA CS), Certification Specification for Large Aeroplanes

European Technical Standard Order ETSO-C172 – Cargo Restraint Strap Assemblies

2.2 Definitions

For the purpose of this Standard, the following definitions apply:

2.2.1 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.

2.2.2 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.

2.2.3 FLAT WOVEN TEXTILE WEBBING

Conventional or shuttleless woven narrow fabric made of textile fibers, generally with multiple plies, and the prime function of which is load bearing. A characteristic of webbing is its narrow fabric selvedge.

2.2.4 TENSIONING DEVICE

Mechanical device inducing a tensile force in the load restraint assembly (e.g., ratchets, winches, overcenter buckles). See examples in Figure 1, C1, C2, and C6.

2.2.5 TENSION RETAINING DEVICE

Metallic part connecting the webbing by clamping action and retaining the force induced in the tensioning device by hand (e.g., cambuckles, sliding bar buckles).

2.2.6 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 (see examples in Figure 1, D1 to D4).

NOTE 2: 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 that conforms to either ISO 9788, for restraint of 22250 N (5000 lbf) ultimate load, or AS33601, for lower ultimate loads, connected directly (sewn to the webbing, see example in Figure 1, D3) or by an intermediate ring, or
- c. piece of aircraft restraint (female) rail conforming to AS33601.

2.2.7 TENSION FORCE INDICATOR

A device (see 7.7) that indicates the tensile force applied to the restraint strap assembly by means of the tensioning device and the movement of the load acting on the load restraint device.

2.2.8 LENGTH OF RESTRAINT STRAP ASSEMBLY

2.2.8.1 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 (see Figure 2).

2.2.8.2 Length (l_{GL})

Length of an adjustable end, measured from the free end of the webbing with the minimum possible length engaged into the closed tensioning device to the force bearing point of the end fitting (see Figure 2).

2.2.8.3 Total Length (l)

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

2.2.9 BREAKING FORCE (BF)

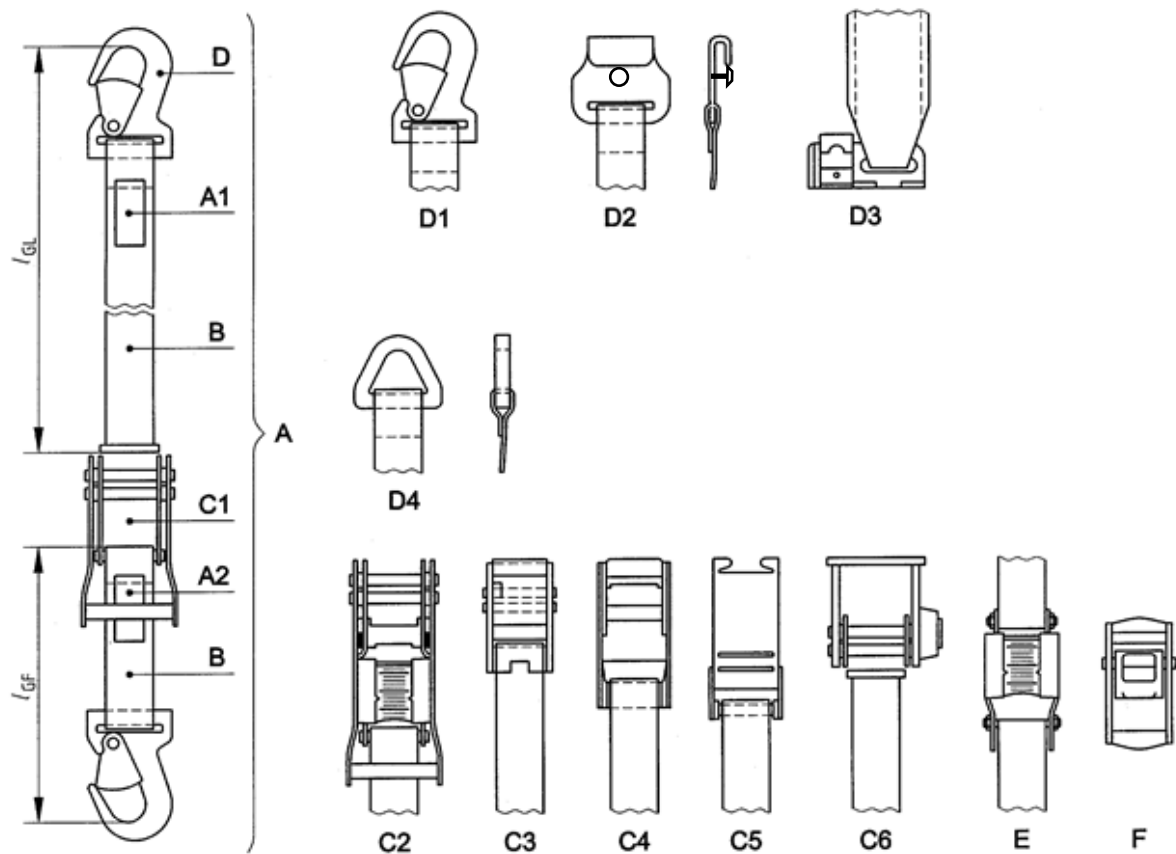
The maximum force that the restraint strap assembly withstands when tested in a complete form, i.e., with tensioning device and end fittings.

2.2.10 HAND FORCE (HF)

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

2.2.11 LIMIT LOAD (LL)

The maximum load to be expected in service. Refer to 14 CFR/EASA CS § 25.301 (a). It is two-thirds of the ultimate load (see hereafter); i.e., 14827 N (3333 lbf) for a typical rated ultimate load of 22250 N (5000 lbf).



- 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 overcenter 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
- E tension force indicator (see also C2)
- F tension retaining device (cambuckle, sliding bar buckle)

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