



AEROSPACE RECOMMENDED PRACTICE

ARP5595™

REV. B

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Superseding ARP5595A

(R) Cargo Restraint Straps – Utilization Guidelines

RATIONALE

Revision B was developed to take into account the changes to AS36100 and AS36102 revisions B, including introduction of straps tie-down testing on pallets, as well as recent changes in approved aircraft Weight and Balance Manuals.

FOREWORD

This SAE Aerospace Recommended Practice (ARP) specifies utilization guidelines and the principles to be used in tie-down strength calculations for the use of air cargo restraint straps to perform cargo tie-down on board civil transport aircraft. It identifies the various concerns to be taken into consideration to ensure flight safety, and provides recognized industry standard methods to achieve it. It is intended as a guide toward standard practice, and is subject to change to keep pace with experience and technical advances.

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 cargo tie-down arrangements. 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.

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1. SCOPE

1.1 Purpose

1.1.1 This Aerospace Recommended Practice aims at providing 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 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 meeting the restraint requirements of air cargo pallets approved in accordance with NAS 3610 or AS36100, or
- b. Additional tie-down on aircraft structure when necessitated by pallet maximum gross mass or centre of gravity location, or
- c. 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, or
- d. Individual pieces of load loaded in non-containerized (bulk loaded) baggage or cargo compartments.

1.1.2 This document aims at providing industry recognized means of complying with Airworthiness Authorities general regulations applicable to load securing on board civil transport aircraft (see 14 CFR Parts 25 and 121, in 2.1), and aircraft manufacturers Authority approved Weight and Balance Manuals for each aircraft type as specified therein. It is not the intent of this document to specify when restraint straps should be used, but how they should be used. It shall not, under any circumstance, supersede the requirements of any of these documents, which shall take precedence at all times.

1.1.3 This document therefore provides recommended practical means of compliance with flight safety objectives, intended to be available as a common base for carriers as well as their airport handling agents when establishing their own in-house publications and staff training programs.

1.1.4 This document is not intended to apply to cargo restraint on board military transport aircraft, and does not take into account any specific criteria for military aircraft. Nothing, however, precludes it being used for guidelines in this case, it pertaining to the military operator to identify and implement any additional applicable criteria.

1.2 Field of Application

1.2.1 This document applies to the use of cargo restraint straps that conform to TSO-C172 or to the requirements for cargo restraint straps specified in an aircraft's WBM or WBM Supplement. AS5385, or equivalent ISO 16049-1, specifies design and test criteria for cargo restraint straps that conform to TSO-C172.

The use for primary restraint of a tie-down device other than cargo restraint straps (e.g., chain, rope, wire, or cable made from metallic or synthetic materials) is beyond the scope of this document.

NOTE 1: Where tie-down is performed onto aircraft structure as per 1.1.1 (b) or (c) above, additional restrictions may be stated in the aircraft's Authority Approved Weight and Balance Manual, and shall be complied with.

NOTE 2: Figure 1 details D5 and D6 of AS5385 up to revision C are excluded by latest TSO-C172a and must not be used. AS5385 revision D was amended to remove them.

1.2.2 This document applies to primary cargo restraint ensured onto a pallet or the aircraft structure exclusively by straps. It does not apply to the use of straps, e.g., as protection against cargo shifting, in addition to an approved pallet net. In such a case, refer to 6.2, *Straps Complement*, of ARP5486, *Air Cargo Pallets – Utilization Guidelines*, or equivalent original ISO 16412.

1.2.3 Operating instructions shall be established by the aircraft operator, under operating control of his reporting Authority. The operating instructions shall ensure compliance with the general airworthiness requirements and the applicable aircraft Weight and Balance Manual, Weight and Balance Manual Supplement, or Cargo Loading Manual, and should incorporate the requirements of the present document, or equivalent industry standard (see 2.12).

1.2.4 If there is conflict between this document and an aircraft's WBM or WBM Supplement, the WBM or WBM Supplement takes precedence. This document can only be used when an aircraft's WBM or WBM Supplement specifically approves the use of straps to restrain cargo to a pallet. If restraining cargo to a pallet is not specifically approved in an aircraft's WBM or WBM Supplement, it is the responsibility of the operator to specify the requirements in its operating instructions (see 1.2.3 and 7.3) in conformity with the requirements of its overseeing Authority. It is beyond the scope of this document to specify an analysis method that substantiates restraining cargo to a pallet which is installed in an aircraft.

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, except with approved Weight and Balance Manuals or WBM Supplement (see 1.2.4). Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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.

AS5385	Cargo Restraint Straps – Design Criteria and Testing Methods
ARP5486	Air Cargo Pallets – Utilization Guidelines
AS6554	Cargo Stopper Devices
AS33601A	Track and Stud Fitting for Cargo Transport Aircraft, Standard Dimensions for –
AS36100B	Air Cargo Unit Load Devices – Performance Requirements and Test Parameters
AS36102B	Air Cargo Unit Load Devices – Testing Methods

2.1.2 AIA 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	Cargo Unit Load Devices, Specification for – (Revision 10)
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2.1.3 FAA Publications

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

14 CFR Part 25	Airworthiness Standards: Transport category airplanes (FAR Part 25)
14 CFR Part 121	Air Carriers Certification and Operation (FAR Part 121)
FAA AC 120-59A	Air Carriers Internal Evaluation Program
FAA AC 120-85A	Air Cargo Operations

TSO-C172 Cargo Restraint Strap Assemblies

TSO-C202 Cargo Stopper Devices

2.1.4 Airplane Manuals

Available to operating carriers from the relevant aircraft manufacturer(s).

Weight and Balance Manual(s) and Supplements for the aircraft type(s)/sub-type(s) concerned.

2.2 Reference Documents

2.2.1 IATA Publications

Available from International Air Transport Association, Publications Assistant, 800 Place Victoria, P.O. Box 113, Montreal, Quebec H4Z 1M1, Canada, Tel: 1-514-874-0202, www.iata.org.

ULD Regulations:

SS 60/2 Air Cargo Restraint Straps

SS 60/4 Tie-down Fittings

OS 6/07 Restraint Straps Utilization and Tie-down Calculations on a Pallet

Airport Handling Manual:

AHM 450 Standardization of Gravity Forces against which Load must be Restrained

AHM 590 Ramp Handling and Loading Procedures, Training and Qualifications

2.2.2 ISO Publications

Copies of these documents are available online at <http://webstore.ansi.org/>.

or

Available from International Organization for Standardization, ISO Central Secretariat, 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, Tel: +41 22 749 01 11, www.iso.org.

ISO 7166 Aircraft – Rail and stud configuration for passenger equipment and cargo restraint

ISO 8097 Aircraft – Minimum airworthiness requirements and test conditions for certified air cargo unit load devices (endorsement of NAS 3610 Revision 10)

ISO 9002 Quality systems – Model for quality assurance in production, installation and servicing

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 testing methods

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

ISO 16412 Air cargo equipment – Air cargo pallets – Utilization guidelines

ISO 21100 Air cargo Unit Load Devices – Performance requirements and test parameters

2.3 Definitions

For the purposes of the present document, the following definitions apply:

COMPETENT PERSON: Designated person, suitably trained according to ISO 9002 clause 4.18 or equivalent pertinent industry training and proficiency standards, qualified by knowledge and practical experience and with the necessary operating instructions established according to 1.2.3 above.

FITTING (TIE-DOWN): Basic piece of hardware, either single stud (see AS33601 and ISO 7166) or double stud (see ISO 9788), with an omnidirectional capability, allowing to attach (a) strap(s) or other elementary tie-down unit(s) to the floor tracks or tie-down receptacles of an aircraft's structure or the edge tracks of an air cargo pallet. Tie-down fittings most commonly include an attachment ring, but may also be directly sewn onto a strap as a permanent end fitting thereof (see AS5385).

FLIGHT ENVELOPE: For a given aircraft type or sub-type, the set of allowable values for accelerations which may 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.

FLOATING PALLET: An air cargo pallet, or equivalent flat support device, located onto an aircraft's cargo compartment rollerized conveyor but not restrained by the NAS 3610 or AS36100A compatible cargo system, the pallet and its load constituting "nonunitized" cargo and being restrained by a set of straps attached to aircraft structural points.

FORE AND AFT: The directions of restraint, relative to the aircraft structure, determined parallel to the aircraft centreline towards the direction of flight, or opposed to it.

LASHING : Equivalent to "tie-down".

LIMIT LOAD (LL): The maximum load to be expected in service as a result of the certified allowable flight envelope. See 14 CFR Part 25, paragraph 25.301(a). It is two thirds of the ultimate load (see Ultimate Load).

LOAD FACTORS (LIMIT - OR ULTIMATE): The accelerations, expressed as multiples of the standard acceleration of gravity (" g " = 9.8065 m/s²), in each direction of restraint (fore, aft, sides, upward), that will result in limit or ultimate, as is the case, forces on the tie-down arrangement proportional to the mass of the piece of cargo being restrained. They are provided by the Airworthiness Authority Approved Weight and Balance Manual for the aircraft type or sub-type.

PIERCING CARGO: Any 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.

PRIMARY RESTRAINT: Restraint of cargo to the aircraft structure for regulatory load conditions. See AC 120-85A, paragraph 2.4.

RESTRAINT STRAP ASSEMBLY: Basic tie-down unit consisting of flat woven textile webbing (one fixed end and one adjustable end), one tensioning device and two end fittings, used for restraint of cargo on board civil transport aircraft. See AS5385 for design criteria and testing requirements.

SIDES: The directions of restraint, relative to the aircraft structure, determined perpendicular to the aircraft centreline and parallel to its floor, left hand or right hand.

STRAP: For the purpose of the present document, equivalent to "Restraint Strap Assembly".

SUPPLEMENTAL RESTRAINT: Restraint additional to a net, used to prevent cargo shifting or to stabilize it onto a pallet. See AC 120-85A, paragraph 2.4.

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.

TIE-DOWN ARRANGEMENT: Assembly of elementary tie-down devices affixed and tensioned around a piece of cargo in order to ensure its tie-down against each direction of restraint. The geometric layout of such an assembly.