



AEROSPACE RECOMMENDED PRACTICE

ARP5486™

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Air Cargo Pallets - Utilization Guidelines

RATIONALE

ARP5486 has been reaffirmed to comply with the SAE five-year review policy.

FOREWORD

This Aerospace Recommended Practice specifies utilization guidelines to be used when preparing air cargo pallets for carriage 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. Commercial requirements in order to ensure protection of the goods carried may also be addressed where applicable, but do not constitute the document's primary goal. It is intended as a guide toward standard practice, and is subject to change to keep pace with experience and technical advances.

Throughout this ARP, 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 pallet build-up 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 Air cargo pallets and their cargo restraint nets constitute aircraft Unit Load Devices, defined by industry standards and airworthiness certified based on Technical Standard Order (TSO) C90c in accordance with the requirements of NAS 3610. This guarantees their design to be intrinsically safe for flight on board compatible aircraft types. However, actual flight safety also requires these certified pieces of equipment to be properly used: numerous occurrences have demonstrated a certified ULD can nevertheless jeopardize flight safety if loaded or restrained in an inadequate manner.
- 1.1.2 Accordingly, this ARP aims at providing recognized industry standard methods to achieve the best attainable level of safety when preparing air cargo pallets for loading on board aircraft, taking into account the requirements to be met as a result of the ULD's airworthiness certification requisites, the general requirements expressed in the aircraft manufacturers Weight and Balance Manuals, as well as the various potential areas of concern identified based on experience.
- 1.1.3 This ARP therefore provides recommended practical means of compliance with flight safety objectives, intended to be available as a common base for carriers as well as shippers and cargo handling agents when establishing their own in-house publications and staff training programs.
- 1.1.4 This ARP assumes any air cargo pallet prepared shall, prior to release for loading on board an aircraft, be inspected and found satisfactory by competent, suitably trained personnel responsible for checking it meets all applicable flight safety requirements.
- 1.1.5 This ARP shall not, under any circumstance, supersede the requirements of applicable airworthiness regulations (see FAR Part 25) or the aircraft manufacturer's Weight and Balance Manual.

1.2 Field of Application:

- 1.2.1 This ARP is intended to apply to any airworthiness certified air cargo pallet built up from either a single or a number of pieces of commercial cargo, intended to be loaded on lower, main or upper deck of a civil transport aircraft, whether a freighter or a passenger carrying aircraft.
- 1.2.2 Its field of application includes all pallets prepared within ground premises, whether at a shipper's facilities or an airport cargo warehouse, including those intended to be loaded into the aircraft in a "floating" (i.e., not fully system restrained) position requiring tie-down onto the aircraft's structure instead of the pallet's tracks.
- 1.2.3 Its provisions may not entirely apply in the event of "pre-embarked" pallets, i.e. pallets loaded empty into the aircraft to be used as a floor on which cargo is later brought and palletized inside the cargo compartment. In such a case, it pertains to the operator to identify and implement the applicable criteria.

- 1.2.4 This ARP is not intended to apply to air cargo pallets prepared for 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.

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 U.S. Government Regulations: Available from U.S. Government Printg Office, M/S SSOP, Washington DC 20402.

14CFR Part 21	Technical Standard Orders (TSO C90c, Cargo Pallets, Nets and Containers)
14CFR Part 25	Airworthiness Standards: Transport category airplanes (FAR Part 25)
14CFR Part 121	Air carriers certification and operation (FAR Part 121)
FAA AC 120-59	Air carriers internal evaluation program

- 2.1.2 AIA Publications: Available from AIA, 1725 De Sales Street NW, Washington DC 20036.

NAS 3610 Cargo Unit Load Devices, Specification for

- 2.1.3 Airplane Manuals: Available from the relevant aircraft manufacturer(s).

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

- 2.1.4 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale PA 15096-0001.

AS1130F	Air and Air/Surface (Platform) Cargo Pallets
AS1131C	Air and Air/Surface (Platform) Cargo Pallet Nets
AIR1490A	Environmental Degradation of Textiles
AS1491B	Interline Air Cargo Pallets
AS1492B	Interline Air Cargo Pallet Nets
AS1825A	Methodology of Calculating Aircraft Cargo Volume
AS1988A	Cargo Pallet Extenders
AS5385	Cargo Restraint Straps - Design Criteria and Testing Requirements
ARPXXXX	Cargo Restraint Straps - Utilization Guidelines (in preparation)
ARPXXXX	Cargo Shoring Guidelines (in preparation)
AS36100	Air Cargo ULDs - Performance Requirements and Test Parameters (in preparation)

2.2 Reference Documents:

2.2.1 ISO Publications: Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002.

ISO 4115	Air cargo equipment - Air/land pallet nets
ISO 4117	Air and air/land cargo pallets - Specification and testing
ISO 4170	Air cargo equipment - Interline pallet nets
ISO 4171	Air cargo equipment - Interline pallets
ISO 8097	Aircraft - Minimum airworthiness requirements and test conditions for certified air cargo unit load devices (endorsement of NAS 3610)
ISO 9002	Quality systems - Model for quality assurance in production, installation and servicing
ISO 10046	Methodology for calculating aircraft cargo volumes
ISO 10254	Air cargo and ground equipment - Vocabulary
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, lashing calculations

2.2.2 IATA Publications: Available from International Air Transport Association, 800 place Victoria, P.O. Box 113, Montréal Quebec H4Z 1M1, Canada.

ULD Technical Manual:

UTM 50/0	Requirements for interlining of ULDs
UTM 50/1	Pallet for NAS 3610 Class II restraint systems
UTM 50/2	Aircraft pallet net
UTM 50/9	16' or 20' pallet for NAS 3610 Class II restraint systems
UTM 60/1	Pallet extensions
UTM 60/2	Cargo restraint straps

Airport Handling Manual:

AHM 330	Preparation for loading of cargo
AHM 376	Acceptance standards for the interchange of transferred ULDs
AHM 534	Weight control of load
AHM 645	Loading precautions for incompatible loads
AHM 671	Securing of load
AHM 677	Handling and loading of BIG or overhang items
AHM 692	Ramp handling and loading procedures, training and qualifications
AHM 810	IATA standard ground handling agreement

Other publications:

Principles of Aircraft Handling (incorporating: ULD Handling guide)

2.3 Definitions:

HEAVY DUTY (- PALLET): Any type or size of NAS 3610 Class I or II certified aircraft pallet with a base core stiffness (E.I value) of $2 \times 105 \text{ lb} \times \text{in}^2/\text{in}$ width of core ($2.5 \times 106 \text{ N} \times \text{cm}^2/\text{cm}$ width of core) or more.

NET (PALLET -): Any type or size of NAS 3610 Class II certified aircraft pallet net meeting the requirements of either AS1492B (ISO 4170, IATA 50/2) or AS1131C (ISO 4115, IATA 50/2).

PALLET (AIR CARGO -): Any type and size of NAS 3610 Class II certified aircraft pallet meeting the requirements of either AS1491B (ISO 4171, IATA 50/1: most consist of an aluminum plate base) or AS1130F (ISO 4117, IATA 50/9: heavy duty, stiffer, typically 2 in/50 mm thick, units). Used in conjunction with an appropriate pallet net, it constitutes a complete unit load device.

PALLET (WOODEN -): Any type and size of industrial forkliftable pallet for general use, made of wood or similar materials, used to facilitate handling and stacking of individual pieces of cargo.

PALLET EXTENSION: Any device (usually a pair of symmetrical devices) used to extend the contour of a pallet load out of its base footprint on the lower deck of wide-body aircraft, meeting the requirements of ARP1988A (IATA 60/1).

SHORING: The methods or equipment used to evenly distribute a concentrated cargo load over a pallet's surface in order to meet the applicable aircraft floor load limitations.

STRAP (AIR CARGO RESTRAINT -): An elementary tie-down unit consisting of flat woven textile webbing, tensioning device and two end fittings, meeting the requirements of AS5385 (ISO 16049-1, IATA 60/2).

TIE-DOWN: The methods or equipment used to ensure proper restraint of cargo onto a pallet's edge track to replace or complement net restraint when necessary. Tie-down guidelines are provided in ARPXXXX (ISO 16049-2, IATA AHM 671).

Also see ISO 10254, Air cargo and ground equipment - Vocabulary.

3. GENERAL REQUIREMENTS:

All of the following general requirements shall be met on completion of every pallet build-up process, and checked by the responsible agent prior to pallet release for loading on board an aircraft:

3.1 Weight:

- 3.1.1 The completed pallet's gross weight shall be systematically established by actual weighing on a scale with a $\pm 1\%$ or better accuracy, prior to the pallet being released for loading on aircraft. This weight shall be entered and used throughout the flight's weight and balance documentation.

3.1.2 The pallet's gross weight shall not exceed (whichever is less) its own certified MGW as engraved on its edge track or the rated maximum value for the position it is intended to be loaded on in the aircraft, or, when the position or the aircraft type is unknown at the time of build-up, the lowest of the possible (e.g., lower deck or main deck position) maximum values.

3.1.3 Compliance with the other limitations listed in 3.2 through 3.5 hereafter shall also be checked.

3.2 Area Load:

3.2.1 The load on any given area of significant size (typically more than 10 to 20% of the pallet's surface) should meet the maximum area load limitation specified in the Weight and Balance Manual for the lower, main or upper deck position it is intended to be loaded on in the aircraft.

NOTE: What shall be taken into account to verify area load limitation is the total bearing area, i.e. that of the outer perimeter defined by all contact points of the load onto the pallet.

Area load is not to be mistaken for local load (the load divided by the actual contact area): local load limitations may or may not be defined in the aircraft's Weight and Balance Manual, but they seldom are critical for aircraft structural safety on typical air cargo pallets. They may raise concern only when they result in significant local deformation of the pallet sheet, which may result in difficulties to move over roller conveyors (a reliable factual indication of excessive deformation) or affect pallet restraint hardware functionality. This should be taken care of by increasing the actual contact bearing area through intermediate elements, such as wood, plywood, or wooden pallets between load supports and pallet sheet.

3.2.2 Whenever the aircraft type is unknown at the time of build-up, a maximum area load limitation of 200 lb/ft² (975 kg/m²) for AS1491B (ISO 4171, IATA 50/1) pallets or 400 lb/ft² (1950 kg/m²) for AS1130F (ISO 4117, IATA 50/9) or heavy duty pallets may be used.

3.2.3 Any deviations in specific circumstances should be allowed only to the extent determined by an operator performed specific engineering study taking into account the characteristics of the load and the pallet, the overall pallet CG location, and structural allowances of the aircraft's manufacturer.

3.2.4 Elementary shoring procedures such as using wooden pallets to enlarge cargo's footprint on the pallet should be considered first and are in many circumstances sufficient to ensure compliance with the maximum area load restriction. In very heavy or concentrated load cases, study and implementation of a proper shoring arrangement may be necessary: see 5 hereafter.

3.3 Running Load:

3.3.1 The aircraft floor's maximum running load, in lb/in (kg/m) measured parallel to the aircraft's centerline, is usually met by complying with the pallet position's maximum allowable gross weight.

- 3.3.2 For heavy and concentrated loads shorter than the pallet, a running load check may be necessary when the load's dimension measured parallel to the aircraft's centerline exceeds two fuselage frames spacings, i.e. 40 to 50 in (1.0 to 1.2 m). In such a case, a shoring calculation taking into account the pallet's stiffness/load distribution effectiveness is required, and may result in the necessity of longitudinal shoring: see Section 5 hereafter.
- 3.3.3 When a piece of cargo overhangs out of the pallet parallel to the aircraft's centerline and prevents the adjacent pallet position(s) in the aircraft from being occupied, the total running load for the pallet may sometimes be determined based on the total floor length occupied in the aircraft, subject to compliance with the area load limitation and all other requirements of the Weight and Balance Manual and, should this result in exceeding the pallet position's own certified maximum gross weight or other limits, restraint or additional restraint being performed directly onto the aircraft structure.

3.4 C.G. Location (Plan View):

The pallet load's overall Center of Gravity (C.G.) shall be within the maximum plan view limits specified at maximum gross weight by the pallet's certification NAS 3610 configuration.

NOTE: The pallet's certification NAS 3610 configuration is engraved or permanently marked on the pallet edge rail (e.g. "NAS 3610 - 2A6P" for configuration 2A6), at a location selected to remain readable after the pallet was loaded with cargo.

- 3.4.1 If there is uncertainty about the CG limits to be used for the pallet on hand, a $\pm 10\%$ of pallet length and width ($\pm 5\%$ in length for AS1130F, ISO 4117, IATA 50/9 sizes) maximum CG deviation from pallet geometric center may generally be used (refer to aircraft Weight and Balance Manual).
- 3.4.2 For a load lower than the pallet position's maximum gross weight, CG deviation in excess of 10% may be considered subject to the stated rules and requirements in the aircraft's Weight and Balance Manual : linear extrapolation of maximum allowable CG limits vs pallet position maximum gross weight may generally be applied, if required, in one direction only.
- 3.4.3 Whenever possible, which is in most circumstances, it is recommended never to simultaneously use maximum allowable CG deviation in both the pallet's length and width directions.
- 3.4.4 The methods to be used to control the load's overall CG location vary depending on its nature:
- for a heavy single piece of cargo, the piece's CG location should be marked by the shipper or, if not, physically measured balancing the piece with a forklift or equivalent lifting means,
 - for homogeneous nature and density package cargo, CG location can be assessed and controlled by ensuring an even level of stacking throughout the pallet's surface,
 - in the event of significantly different densities of cargo being loaded on the same pallet, care should be taken when stacking to ensure symmetrical loading (see example in Figure 1).