



AEROSPACE STANDARD	AS1491™	REV. B
	Issued 1982-03 Reaffirmed 2012-09 Revised 2023-01	
Superseding AS1491A		
(R) Interline Air Cargo Pallets		

RATIONALE

AS1491B has been revised from AS1491A in both format and wording to be harmonized with ISO 4171(). Reference to AS36100 in addition to NAS3610 has been added.

Pallet sizes Q and S designated in the prior revision of this specification as Type III pallets were added and are now covered by AS36100 as Type 2 pallets. All references to Type III pallets along with their performance and test requirements contained in the previous revision of this SAE Aerospace Standard have been removed.

1. SCOPE

This SAE Aerospace Standard specifies the dimensional, design criteria, fabrication, performance, operational, environmental, and testing requirements for interline pallets requiring airworthiness approval for loading onto civil transport aircraft equipped with NAS3610/AS36100 restraint systems and using pallet nets meeting the requirements of AS1492. Type II/2 covers NAS3610/AS36100 code sizes. Type III pallets have been removed from this SAE Aerospace Standard revision.

1.1 Purpose

This SAE Aerospace Standard establishes minimum requirements for pallets used to transport cargo in an approved aircraft cargo compartment with a restraint system that conforms to the flight cargo restraint requirements of Title 14 CFR Part 25, except for the 9.0 g forward ultimate inertia force of § 25.561 (b)(3)(ii) and using pallet nets meeting the requirements of AS1492. The minimum essential criteria are identified by the use of the key word "shall." Recommended criteria are identified by the key word "should" and while not mandatory, are considered to be of primary importance in providing safe air transport pallets. Deviation from the recommended criteria should occur only after careful consideration, extensive testing, and thorough service evaluation have shown alternate methods to be satisfactory.

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 (except where specified by Technical Standard Order). The applicable issue of other publications shall be the issue in effect on the date of the purchase order (design acceptance). 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.

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SAE WEB ADDRESS:

For more information on this standard, visit
<https://www.sae.org/standards/content/AS1491B/>

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
ARP1334	Ground Equipment Requirements for Compatibility with Aircraft Unit Load Devices
ARP36103	Air Cargo Unit Load Devices - Center of Gravity Control Methods
AS1492	Interline Air Cargo Pallet Nets
AS [and EN/JIS-Q] 9100	Quality Management Systems - Requirements for Aviation, Space, and Defense Organizations
AS [and EN/JIS-Q] 9102	Aerospace First Article Inspection Requirement
AS33601	Track and Stud Fitting for Cargo Transport Aircraft, Standard Dimensions for
AS36100	Air Cargo Unit Load Devices - Performance Requirements and Test Parameters
AS36101	Air Cargo Unit Load Devices - Load Distribution Model
AS36102	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.

NAS3610 Cargo Unit Load Devices, Specification for

2.1.3 ISO Publications

Copies of these documents are available online at <https://webstore.ansi.org/> or 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 4116	Air cargo equipment - Ground equipment requirements for compatibility with aircraft unit load devices
ISO 4170	Air cargo equipment - Interline pallet nets
ISO 4171	Air cargo equipment - Interline pallets
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
ISO 21100	Air cargo unit load devices - Performance requirements and test parameters
ISO/TR 8647	Environmental degradation of textiles used in air cargo restraint equipment

2.1.4 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.

IATA ULDR Standard Specification Number 50/0 ULD General Technical Requirements

IATA ULDR Standard Specification Number 50/1 Aircraft Pallet

IATA ULDR Standard Specification Number 50/2 Aircraft Pallet Net

2.1.5 U.S. Government Publications

Federal Aviation Administration Technical Standard Order TSO C90 - Cargo Pallets, Nets and Containers

Federal Aviation Regulations 14 CFR Part 21 - Certification Procedures for Products and Parts

Federal Aviation Regulation Title 14 CFR Part 25, Airworthiness Standards: Transport Category Airplanes

(Advisory Circular 21.1B - Production Certificates (Quality Control data requirements))

(Federal Aviation Administration Order 8120.2B - Production approval and Surveillance Procedures)

(Federal Aviation Administration Order 8120.12 - Use of 'Other Parties' to Supplement Supplier Control Program)

2.1.6 ASME Publications

Available from ASME, P.O. Box 2900, 22 Law Drive, Fairfield, NJ 07007-2900, Tel: 800-843-2763 (U.S./Canada), 001-800-843-2763 (Mexico), 973-882-1170 (outside North America), www.asme.org.

ASME Y14.5 Dimensioning and Tolerancing

2.1.7 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM G99 Standard Test Method for Wear Testing with a Pin-on-Disk Apparatus

2.2 Definitions

CONTAINER (AIR CARGO -): A rigid structure which interfaces directly with the aircraft cargo handling and restraint system and alone performs all the functions of a unit load device.

PALLET (AIR CARGO -): A unit load device consisting of a flat platform with flat undersurface of standard dimensions, on which goods are assembled and secured by a pallet net before being loaded as a unit onto the aircraft, and which interfaces directly with the aircraft handling and restraint system.

NET (AIR CARGO -): A webbing or rope net for restraining load onto an air cargo pallet.

NUMERIC SIMULATION: Simulation (e.g., computer model) of physical test condition(s) and reaction(s) of pallet employing numeric analysis, computational geometry and computer graphics to obtain proof support and design verification, as validated by demonstration to other parties' and/or airworthiness authorities' satisfaction that parameters, algorithms, and analytical methods used in such a simulation provide results of at least equivalent reliability to the outcome of a specified actual test.

RESTRAINT SYSTEM: Equipment for supporting and restraining unit load devices in an aircraft against the ground/flight loads. It usually consists of such items as side guides and locks for securing unit load devices to the aircraft structure. It does not include unit load devices, barrier nets and tie-down straps.

UNIT LOAD DEVICE (ULD): Device for grouping, transferring, and restraining cargo for transit.

3. CLASSIFICATION AND IDENTIFICATION

The pallets covered by this SAE Aerospace Standard shall be of the following type, sizes, and configurations:

3.1 Type

Pallets are Type II/2 as defined in NAS3610/AS36100, designed for use in approved aircraft restraint systems.

3.2 Type II/2 Basic Pallet Sizes

This SAE Aerospace Standard provides for the following NAS3610/AS36100 defined pallet sizes, expressed as nominal dimensions in the overall plan form of the pallet, in mm (inches) (see Table 1).

Table 1 - Type II/2 pallet sizes

Size Code	Nominal Dimension
A	2235 x 3175 mm (88 x 125 inches)
B	2235 x 2743 mm (88 x 108 inches)
G	2438 x 6058 mm (96 x 238.5 inches)
K	1534 x 1562 mm (60.4 x 61.5 inches)
L	1534 x 3175 mm (60.4 x 125 inches)
M	2438 x 3175 mm (96 x 125 inches)
N	1562 x 2438 mm (61.5 x 96 inches)
Q	1534 x 2438 mm (60.4 x 96 inches)
R	2438 x 4978 mm (96 x 196 inches)
S	1562 x 2235 mm (61.5 x 88 inches)
T	3175 x 4978 mm (125 x 196 inches)
U	1397 x 2438 mm (55 x 96 inches)

3.3 Type II/2 Pallet Classification Identifier

The pallet classification identifier shall reflect its NAS3610/AS36100A configuration and ultimate load rating. Pallets shall be identified by the airworthiness approval classification identifier code marked on them, e.g.:

“NAS3610 - 2A3P” = Type 2, size A (2235 x 3175 mm, 88 x 125 inches), ULD configuration 2A3, Pallet [example for pallets approved under TSO C90c based on NAS3610 requirements], or

“AS36100 - 2A7P” = Type 2, size A (2235 x 3175 mm, 88 x 125 inches), ULD configuration A7, Pallet [example for pallets approved under TSO C90d based on AS36100A requirements].

3.4 Basic Pallet Configuration

The pallet consists of two basic components - core and edge rails - forming an essentially flat panel designed to transport cargo on aircraft systems. The aircraft systems are defined as follows:

- a. Ball Mat:

ball diameter	25.4 mm (1 inch)
basic ball pitch	127 mm (5 inches)

- b. Roller System:
- | | |
|---------------------------------------|-----------------------|
| pallet maximum overhang on major axis | 362 mm (14.25 inches) |
| pallet maximum overhang on minor axis | 254 mm (10 inches) |
| roller maximum pitch on major axis | 673 mm (26.5 inches) |
| roller maximum pitch on minor axis | 254 mm (10 inches) |
| minimum roller diameter | 25.4 mm (1 inch) |
| minimum roller length | 50.8 mm (2 inches) |
- c. Swivel Caster:
- | | |
|------------------------|--------------------|
| minimum wheel diameter | 25.4 mm (1 inch) |
| minimum contact length | 50.8 mm (2 inches) |
| maximum caster pitch | 305 mm (12 inches) |

3.5 Clearance Dimensions

For Type II/2 pallet lock and side vertical restraint overlap, refer to NAS3610/AS36100.

3.6 Dimensioning and Tolerancing

It is recommended that dimensioning and tolerancing be done in accordance with ASME Y14.5.

4. REQUIREMENTS

4.1 General Construction

- 4.1.1 The design, materials, and construction of the pallet shall be of aircraft quality. Maintainability and repairability shall be a factor in the design to assure the minimum need for maintenance and to ease and minimize cost for maintenance and repair.
- 4.1.2 The pallet surfaces and edges shall present no rough or sharp edges potentially injurious to personnel or cargo.
- 4.1.3 Bottom surface of pallet shall be flat.
- 4.1.4 The pallet assembly shall comply with the applicable design loads in Section 5, the structural and environmental requirements in Section 6, and the performance requirements in Sections 7 through 12.
- 4.1.5 Refer to NAS3610/AS36100 for more general requirements of pallet material selection.

4.2 Pallet Core

- 4.2.1 The pallet core shall be enclosed on all four sides with an edge rail. Where the pallet core is of the sandwich type construction, the upper and lower skin shall be enclosed by the edge extrusion. In all cases, the design of the edge rail/core connection and the edge rail corner connection shall be adequate to ensure the integrity of the assembly under the impact and bridging loads expected in service.
- 4.2.2 Refer to NAS3610/AS36100 for more information on pallet construction.

4.3 Pallet Edge Rails and Corners

- 4.3.1 Lower edge of pallet including corner sections shall be as shown in Figure 1.
- 4.3.2 The edge rail shall incorporate a continuous restraint track to AS33601 dimensions as shown in NAS3610/AS36100 appropriate pallet size and configuration.
- 4.3.3 The pallet corners shall have a 63 mm (2.5 inch) \pm 12.7 mm (0.50 inch) radius in plan view. Each corner shall meet the vertical dimensions shown in Figure 1.

5. DESIGN LOADS

5.1 Maximum Gross Weight and Ultimate Load Criteria

- 5.1.1 The Type II/2 pallet shall be used in conjunction with a pallet net per AS1492 to restrain the maximum gross weight listed in Table 2.

Table 2 - Type II/2 pallet maximum gross weight

Size Code	Nominal Dimension	Maximum Gross Weight (MGW)
A	2235 x 3175 mm (88 x 125 inches)	6804 kg (15000 pounds)
B	2235 x 2743 mm (88 x 108 inches)	5897 kg (13000 pounds)
G	2438 x 6058 mm (96 x 238.5 inches)	11340 kg (25000 pounds)
K	1534 x 1562 mm (60.4 x 61.5 inches)	1587 kg (3500 pounds)
L	1534 x 3175 mm (60.4 x 125 inches)	3175 kg (7000 pounds)
M	2438 x 3175 mm (96 x 125 inches)	6804 kg (15000 pounds)
N	1562 x 2438 mm (61.5 x 96 inches)	3402 kg (7500 pounds)
Q	1534 x 2438 mm (60.4 x 96 inches)	2449 kg (5400 pounds)
R	2438 x 4978 mm (96 x 196 inches)	11340 kg (25000 pounds)
S	1562 x 2235 mm (61.5 x 88 inches)	3402 kg (7500 pounds)
T	3175 x 4978 mm (125 x 196 inches)	16450 kg (36266 pounds)
U	1397 x 2438 mm (55 x 96 inches)	2706 kg (5966 pounds)

5.1.2 Ultimate Load Criteria

For Type II/2 pallets ultimate load criteria, refer to NAS3610 Table II or AS36100 Section 7 as appropriate for the given type.

5.2 Pallet Net

- 5.2.1 The pallet net assembly required to react these loads shall be constructed so that it adequately encompasses the pallet load with all fittings attached to the pallet in locations shown in NAS3610/AS36100 as appropriate (refer to AS1492).

5.3 Design and Test Requirements

- 5.3.1 The Type II/2 pallet shall meet the critical performance, design, and test requirements in accordance with NAS3610/AS36100 for Class II systems defined therein.
- 5.3.2 Refer to ISO 4171 Sections 9 and 10 for horizontal/vertical load test procedures.

6. STRUCTURAL AND ENVIRONMENTAL PERFORMANCE REQUIREMENTS

6.1 Impact Against Locks

The Type II/2 pallet assembly shall withstand, without damage, an impact of a fully loaded pallet striking the locks as defined in NAS3610, Figures 8 and 10 or Figures 34 and 35 as applicable, or AS36100 Section 8.

6.2 Pallet Rigidity

The minimum pallet rigidity (EI) shall be 429 Nm² per meter (3800 lb-in² per inch) width/length of the pallet.

6.3 Temperature Environment

The structural and operational integrity of the pallet assembly shall be maintained in a temperature environment from -54 to +71 °C (-65 to +160 °F).

6.4 Deterioration

All components of the pallet shall be protected against deterioration or loss of strength which will cause the pallet not to meet its performance specifications.

6.5 Skin Stiffness

Skin stiffness shall be such that both upper and lower surfaces shall be capable of supporting a force of 1.33 kN* (300 pounds) on a 25.4 mm (1 inch) diameter steel ball.

* 1N = 0.225 lbf

1 kN = 10³N

7. LOCAL INDENTATION (PERFORMANCE)

7.1 Test Procedures

7.1.1 Apply a force of 8.9 kN* (2000 pounds) by a steel roller, 50.8 mm (2.0 inches) long by 25.4 mm (1.0 inch) diameter per Figure 2.

7.1.2 Apply a force of 8.9 kN* (2000 pounds) parallel to the base over an area of 5.08 mm (0.2 inch) long by 4.75 mm (0.187 inch) wide per Figure 2.

7.2 Test Result

The maximum indentation (permanent set) allowed at any location of the pallet shall not cause loss of strength which will cause the pallet to not meet performance specifications (Figure 2).

* 1N = 0.225 lbf

1 kN = 10³N

8. BRIDGING AND CRESTING (PERFORMANCE)

8.1 Test Procedures

8.1.1 Conduct these tests on an aircraft equivalent system meeting the requirements defined in 3.4. Roller bed bridging and cresting points shall be located at least one pallet length apart. Load the pallet to its maximum uniformly distributed gross mass. Move the pallet on a roller bed across a stepped junction with another similar roller system with the height difference at the junction being not less than 152 mm (6 inches). At the point balance (cresting) position on the edge of the higher platform, hold the pallet for a minimum period of 5 seconds.

8.1.2 The rear end of the pallet shall then be allowed to drop from the higher platform onto the lower roller platform.

8.1.3 Repeat the test 20 times.

8.2 Test Result

Upon completion of the test the pallet shall show neither permanent deformation nor abnormality which will render it unsuitable for use and the dimensional requirements affecting handling, securing and interchange shall be satisfied.

9. IMPACT LOADS (PERFORMANCE)

9.1 Test Procedure

9.1.1 Load the pallet to its maximum uniformly distributed gross mass. Move the pallet on a roller bed to impact against solid stops with a velocity of 0.61 m/s (2 ft/s). Do this for 250 impacts for each of the following test conditions. The size and position of the stops shall be as described in NAS3610, Figures 8 and 10 or Figures 34 and 35 as applicable, or AS36100 Section 8 for the Type II/2 pallet.

9.1.2 Move parallel to major dimension of pallet and impact against base.

9.1.3 Move parallel to minor dimension of pallet and impact against base.

9.2 Test Result

9.2.1 The maximum allowable permanent deformation after any series of 250 impact tests is 3.30 mm (0.13 inch).

9.2.2 Upon completion of the test, the pallet shall show neither permanent deformation nor abnormality which will render it unsuitable for use, and the dimensional requirements affecting handling, securing and interchange shall be satisfied.

10. BALL LOAD CAPACITY (PERFORMANCE)

10.1 Test Procedure

The pallet base surface or a representative portion thereof shall be subjected to a force of 4 kN* (900 pounds) on a 25.4 mm (1 inch) diameter steel ball.

10.2 Test Result

There shall not be permanent indentation in excess of 0.51 mm (0.020 inch).

* 1N = 0.225 lbf
1 kN = 10³N

11. PERFORMANCE ON BALL UNITS

11.1 Test Procedure

The base or representative portion thereof shall be subjected to a uniformly distributed load of 14.0 kg (31 pounds) supported by four 25.4 mm (1 inch) diameter steel ball units on a 127 mm (5 inch) grid pattern. The base shall be moved over the units for a minimum of 5000 passes along a fixed line in each of two directions, 90 degrees to, and intersecting each other. The length of the stroke shall be approximately 305 mm (12 inches).

11.2 Test Result

At the conclusion of the test, there shall be no evidence of deterioration of the base/ball unit interface surface.

12. ABRASION (WEAR) RESISTANCE FOR PALLET ASSEMBLY MATERIALS

12.1 Test Procedure

Three samples of the pallet assembly material will be subjected to a test method equivalent to ASTM G99.

12.2 Test Results

The average of weight loss shall not exceed the following values:

After 1000 Revolutions: 0.015 g

After 2000 Revolutions: An additional 0.005 g

After 5000 Revolutions: An additional 0.030 g

Up to a TOTAL of 0.050 g