SAE Aerospace
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AEROSPACE INFORMATION REPORT

AIR36106

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Air Cargo Unit Load Devices - Use of Airworthiness Reference Documents

RATIONALE

While preparing AS36100 [see that standard], it became clear that difficulties met with the former ULD approval process could be traced back to a lack of understanding of the use and complexity of the technical reference document. It was agreed to develop an " Instructions for use " AIR in order to reduce such difficulties, which would define a uniform industry agreed method of using AS36100. Equivalent information is also provided in this AIR for proper use of NAS 3610 [Revision 10, 1990, referenced by TSO C90c] for consistency and comparison purposes.

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1. SCOPE

1.1 Purpose

1.1.1 This Aerospace Information Report (AIR) provides instructions for intended proper use of Aerospace Standard AS36100 published 2005-02, as the technical reference for airworthiness approval of air cargo unit load devices (pallets, nets and containers) to be loaded on board civil transport aircraft. For consistency and cross-checking purposes, it also includes instructions for proper use of previous NAS 3610 [Revision 10, 1990, referenced in TSO C90c], as commonly understood by the industry.

1.1.2 This AIR does not provide detailed background or rationale for the technical contents of AS36100, which are separately provided in AIR36107, AS36100 background and development record.

1.1.3 AS36100 exclusively defines the general geometric parameters (insofar as they affect restraint on board aircraft), minimum performance requirements and testing parameters of unit load devices. Additional areas as per AS36100 paragraph 1.1, such as continued airworthiness and maintenance requirements, design and testing methods, unit load devices design specifications and accessories, and rules for proper operation/utilization and operating staff training also need to be considered for designing unit load devices, and are covered by other documents, listed in AIR36105.

1.2 Field of Application

1.2.1 This AIR is intended to provide AS36100 users, including Airworthiness Authorities, unit load devices designers, purchasers and operators as well as civil transport aircraft and aircraft cargo systems designers within the industry, with a single agreed method for using AS36100 to determine the applicable airworthiness requirements.

1.2.2 In the same way, it is intended to provide them with the commonly understood though more complex method for using NAS 3610 [Revision 10, 1990, referenced in TSO C90c], to determine the airworthiness requirements applicable to unit load devices approved or to be approved (because their size or type are not covered in AS36100) under TSO C90c.

2. REFERENCES

2.1 Reference Documents

The publications listed herein were duly taken into consideration when developing AS36100 and this AIR. When referring to them, the latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of publication of AS36100 (2005-02) or its latest revision. Nothing in these documents, 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 724-776-4970 (outside USA), www.sae.org

ARP1334 Ground Equipment Requirements for Compatibility with Aircraft Unit Load Devices

ARP1825 Methodology of Calculating Aircraft Cargo Volumes

AS33601 Track and Stud Fitting for Cargo Transport Aircraft, Standard Dimensions for

AS36100 Air Cargo Unit Load Devices - Performance Requirements and Testing Parameters

AS36101 Air Cargo Unit Load Devices - Load Distribution Model

AS36102 Air Cargo Unit Load Devices - Test Methods

ARP36103 Air Cargo Unit Load Devices - Center of Gravity Control Methods

ARP36104 Air Cargo Pallets and Nets Compatibility

AIR36105 Air Cargo Unit Load Devices - Reference Standards [Bibliography]

AIR36107 AS36100 Background and Development Record

NOTE: No revision number is indicated. Check the latest published revision number on the SAE web site. Numerous other unit load device related SAE documents may also be concerned: see AIR36105.

2.1.2 U.S. Government Publications

Available from U.S. Government Printing Office, Mail Stop SSOP, Washington DC 20402-9325, www.gpoaccess.gov/ecfr and the FAA website www.airweb.faa.gov/rgl

Title 14 CFR (FAR) Part 21 - Certification Procedures for Products and Parts, Subpart O — Technical Standard Order Authorizations

FAA Technical Standard Order (TSO) C90, Cargo Pallets, Nets and Containers

Title 14 CFR (FAR) Part 25 - Airworthiness Standards: Transport Category Airplanes

2.1.3 European Union Publications

Available from European Aviation Safety Agency (EASA), Otto Platz 1, Köln Deutz, Postfach 101253, D-50452 Cologne, Germany, www.easa.eu.int

EASA CS-ETSO, Certification Specifications for European Technical Standard Orders.

European Technical Standard Order (ETSO) C90, Cargo Pallets, Nets and Containers.

EASA CS-25, Certification Specifications for Large Aeroplanes.

2.1.4 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, 1990, referenced by TSO C90c]

2.1.5 International Standards

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org, or International Organization for Standardization, 1, rue de Varembe, Case postale 56, CH-1211 Geneva 20, Switzerland, Tel: +41 22 749 01 11, www.iso.org, or any of the national Standards Institutes worldwide, Members of ISO.

ISO 4116 Air cargo equipment - Ground equipment requirements for compatibility with aircraft unit load devices

ISO 7166 Aircraft - Rail and stud configuration

ISO 8097 Aircraft - Minimum airworthiness requirements and test conditions for certified air cargo unit load devices [4th edition, 2001, referenced by ETSO C90c]

ISO 9788 Air cargo equipment - Cast component of double-stud fitting assembly with a load capacity of 22 250 N (5 000 lbf) for aircraft cargo restraint

ISO 10046 Aircraft - Methodology of calculating cargo compartments volume

ISO 11242 Aircraft - Pressure equalization requirements for cargo containers

ISO 21100 Air cargo unit load devices - Performance requirements and testing parameters [in preparation, ETSO pending]

2.1.6 IATA Standards

IATA Standard Specifications concerning air cargo unit load devices are published in the IATA Unit Load Devices Technical Manual (UTM), available from the 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

2.2 Terms and Definitions

For the purposes of the present AIR and listed documents, the following terms and definitions apply unless otherwise defined in the document:

CIVIL TRANSPORT AIRCRAFT: An aircraft, type certificated under 14CFR Part 25 or EASA CS-25, operated for civil commercial transport of passengers or freight, and capable of carrying air cargo unit load devices for baggage or freight.

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.

INSTALLATION: The fact of installing a unit load device for flight into an aircraft's cargo compartment and restraint system.

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

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 net before being loaded as a unit onto the aircraft, and which interfaces directly with the aircraft handling and restraint system.

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 rollers, 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.

TYPE 1 ULD: A unit load device designed for use in an approved aircraft restraint system that conforms to all flight and ground cargo restraint and occupant protection requirements of Title 14 CFR Part 25, including the 9.0g forward ultimate inertia force of § 25.561 (b)(3)(ii).

TYPE 2 ULD: A unit load device designed for use in an approved aircraft cargo compartment and restraint system that conforms to the flight and ground cargo restraint and occupant protection requirements of Title 14 CFR Part 25, except for the 9.0g forward ultimate inertia force of § 25.561 (b)(3)(ii), which is complied with either by supplementary installation of a barrier net or bulkhead, or by specifying an approved placement of the ULD in the aircraft.

UNIT LOAD DEVICE (ULD): Device for grouping, transferring and restraining cargo for transit. It may consist of a pallet with a net or it may be a container.

UTILIZATION: All actions pertaining to operational use of a unit load device, including inspection, build-up, securing, ground transport, loading, and installation aboard aircraft.

3. GENERAL

3.1 Unit Load Devices

3.1.1 The purpose of using AS36100 or NAS 3610 is to determine performance requirements and test parameters for airworthiness approval of a unit load device (container, pallet net or pallet).

3.1.2 This process is independent from the aircraft type(s) the unit load device is to be carried on. It only determines ultimate load capabilities under defined restraint conditions, for airworthiness approval under a ULD configuration of Technical Standard Order TSO C90. The aircraft parameters (structural requirements, certified flight envelope load factors in each direction, actual restraint system) determine the maximum allowable capability of a ULD with a given TSO configuration code at a given position in the aircraft. This is published for the operators in the Authority approved Weight and Balance Manual (WBM) for the aircraft type or sub-type concerned, that controls ULD utilization.

NOTE: The approved Weight and Balance Manual may be issued by either:

- the aircraft Type Certificate (TC) owner, usually the aircraft's manufacturer, or
- a Supplemental Type Certificate (STC) holder.

In either case, it defines the Authority approved methods and parameters of installation of unit load devices on board the aircraft, and shall be systematically referred to and complied with.

3.1.3 Only Type 2 ULDs of the most commonly used sizes are specified in AS36100 (see § 4). Type 1 ULDs, commonly referred to as "9 g", and other sizes are specified only in NAS 3610 [Revision 10, 1990, referenced by TSO C90c] (see Section 5).

3.2 Aircraft Restraint Systems

3.2.1 AS36100 or NAS 3610 are not intended or suitable for the purpose of designing aircraft unit load devices restraint systems or defining the sole requirements there for. Particularly, the restraint conditions (RCs) shown in these documents (e.g., Section 8 of AS36100) do not intend to represent actual aircraft restraint cases, but to define a uniform ultimate load capability assessment system for the unit load devices themselves, regardless of the aircraft restraint system's actual geometry.

3.2.2 However, any aircraft restraint systems for civil transport aircraft - unless intended for special purposes - should be designed to be capable of restraining unit load devices TSO C90 approved in accordance with either of these airworthiness reference documents.

3.2.3 Accordingly, AS36100 or NAS 3610 ULD restraint conditions are intended only for testing or analysing the ultimate load performance of the ULDs. The capability for the same TSO approved ULD within a given actual aircraft restraint system must be derived from that established performance level, taking into account the differences with the reference ULD testing condition.

4. USE OF AS36100

4.1 Sequence

The following sequence should be used when referring to AS36100:

Step 1: Determine the base size, ULD type and ULD form (Container, Net, Pallet) desired.

Step 2: Go to the ULD configuration (UC) sheet for the base size to determine the geometric requirements for the size and form, the minimum base area load requirements, the required ultimate loads and Center of Gravity (CG) eccentricities.

Step 3: Determine the applicable testing restraint condition (RC) by going to the relevant RC sheet(s).

Paragraphs 4.2, 4.3 and 4.4 hereafter provide the details and, where useful, interpretations for each of steps 1, 2 and 3.

4.2 ULD Identification

4.2.1 Check the list of ULD configurations (UC) sheets provided in Table 1. If the desired ULD type or base size is not shown therein, refer to NAS 3610 [Revision 10, 1990, referenced by TSO C90c] (see Section 5). A single ULD configuration (UC) sheet is shown in AS36100 for any given base size.

4.2.2 Container/net contours are not shown or defined in AS36100, since the ULDs are base restrained hence the ULD performance and testing requirements are the same regardless of contour. The maximum allowable contour for each container or net model should be determined in accordance with the principles recommended in ARP1825, Methodology of calculating aircraft cargo volumes (equivalent to ISO 10046). Standard container contours agreed by the airline industry are shown in the IATA ULD Technical Manual Standard Specification (SS) 50/0, together with their identification code.

NOTE: Container or net contours, however, indirectly affect performance and testing requirements through the maximum Center of Gravity (CG) height that can be reached as a result of the selected contour's maximum height. Check paragraph 4.3.7 hereafter.

4.3 ULD Configuration

4.3.1 Check if the ULD configuration (UC) sheet allows for the ULD form desired, and check the geometry of the considered ULD against the minimum requirements shown in the figures of the UC for the base size.

4.3.2 The indicated features, exact dimensions, minimum and maximum values shown on the UC are mandatory, except where an option is shown, and except where a TSO deviation was requested and granted by the Authority at ULD approval. In this case, however, attention is drawn on the fact that operational difficulties may result in certain aircraft or industry systems, depending on the nature of the deviation: a thorough survey of such potential difficulties and their expected consequences is recommended prior to applying for or granting such a deviation.

4.3.3 The fabrication tolerance intervals shown are mandatory. Where none is specified, the general tolerances of AS36100 § 4.9 apply, as a function of the number of decimals in the indicated nominal dimension in either mm or inches.

NOTE: The fabrication tolerance intervals shown apply to a new unit, at airworthiness testing or first article inspection and delivery to the purchaser. They include an allowance for some in-service wear on those parts (mostly base edges) most likely to encounter it. Operational tolerances for in-service units, normally specified in the Weight and Balance Manual, Maintenance Manual or other aircraft manufacturer documentation, are aircraft specific and may in some cases extend somewhat over the AS36100 tolerances, but no assumption about it may be applied to ULD design and fabrication.

4.3.4 The base tracks for net attachment on pallet or container bases shall meet the geometry, dimensions and tolerances of AS33601 (ISO 7166 is equivalent). Net attachment fittings shall meet either the above standards or, for double stud fittings, fully compatible ISO 9788, the geometry of which ensures a higher ultimate strength in the same track.

4.3.5 The minimum base area load requirements [10 kPa (209 lb/ft^2) for most sizes or 20 kPa (418 lb/ft^2) for sizes G and R] are shown on the UC. See AS36101. They shall be considered acting on any area representing at least 10% of the total base area, assuming the base is supported by a typical aircraft roller system (ARP1334/ISO 4116 can be considered equivalent for this purpose).

NOTE: In practice, this refers to two types of bases, "thin" ones (mostly aluminium plate) or "stiff" ones, characterised by different minimum base core EI values. See applicable ULD design specifications and IATA ULD Technical Manual's applicable Standard Specification (SS) for industry agreed minimum base core EI values, related to operational experience rather than airworthiness.

4.3.6 The ultimate loads in either direction which the ULD shall withstand without rupture in order to be approved are shown on the UC's "Ultimate load criteria" Table. Note that in most cases the horizontal ultimate loads shall be applied for testing in combination with a specified download, consistent with the corresponding NAS 3610 UC.

NOTE: For definition of ultimate load vs limit load, see 14CFR (FAR) 25.301 and 25.303: the ultimate load is the maximum expected limit load multiplied by a factor of safety of 1.5. Conversely, since a ULD is tested only to ultimate load, the maximum limit load it is approved for in a given direction is the UC Table's ultimate load divided by 1.5.

4.3.7 The specified ultimate loads shall be applied with the maximum specified Centre of Gravity (CG) height and horizontal eccentricities. Note the specified CG height was determined in accordance with the worst case for a given base size, i.e. 864 mm (34 in) for base sizes capable of lower deck carriage [1625 mm (64 in) contour height] only and 1218 mm (48 in) for base sizes capable of main deck carriage [2438 mm (96 in) or more height]. Where a container's contour or a net's size allows only a lower load height, the testing CG height may be reduced to 55% of the maximum height of the container or net contour.

NOTE: For means used for ensuring maximum CG height and eccentricity are not exceeded in operation, see ARP36103.

4.3.8 The applicable restraint condition(s) (RC) for testing the ULD size is (are) shown at the bottom of the UC sheet. A single testing restraint condition (RC) sheet is shown in AS36100 for any given base size, except size R which has different restraint philosophies in both directions of loading aboard the aircraft. See paragraph 4.4 hereafter.

4.3.9 Pallet and net compatibility is not shown on AS36100 UC sheets, since it is straightforward between the units specified by the document (same classification code).

NOTE: However, see ARP36104 for guidance as to compatibility with existing NAS 3610 pallets and nets. Also, it may be possible, subject to Authority approval, to obtain dual UC approval for certain nets (e.g., 2A7N/2B7N, or 2A7N/2M2N) to extend compatibility. But it is not possible to obtain dual AS36100/NAS 3610 designations (different TSOs).

4.4 ULD Testing Restraint

4.4.1 Check the list of ULD restraint conditions (RC) sheets provided in Table 2. It also indicates the ULD base sizes (UCs) they can be used for, the corresponding orientation aboard the aircraft, and whether the case considered applies to lower, main or upper deck of aircraft.

4.4.2 Each testing condition defines the plan-view location of restraints for the ULD base size (UC) considered, their detail dimensions, and a number of other conditions to be applied at testing.

4.4.3 The dimensional tolerances for fabrication of a test facility are the general tolerances of AS36100 § 4.9, as a function of the number of decimals in the indicated nominal dimension in either mm or inches.

4.4.4 Any facility to be used for ULD approval tests shall be checked for precise compliance with the indicated dimensions and tolerance intervals. All other testing conditions shown shall be implemented during the test. See AS36102 for detailed guidance as to the types of facility and the test methods to be used. Analysis or numeric simulation, where used in total or in part to replace testing (see 6.6 hereafter), shall use the same assumptions.

5. USE OF NAS 3610

NOTE: Since NAS 3610, originally a quite ancient document, is an AIA publication on which no additional explanations or instructions for use exist, the following was compiled to represent the commonly practiced method of using it as the reference document for ULD airworthiness, and the prevailing interpretations. SAE and its AGE-2A Sub-Committee are not responsible for the information in this section, provided only to assist the users in highlighting the differences with AS36100.

5.1 Sequence

The following sequence should be used when referring to NAS 3610:

Step 1: Determine the base size, ULD type and ULD form (Container, Net, Pallet) desired.

Step 2: Go to Table I, Load and restraint conditions: it shows the allowable options classified by ULD classification identifier (first digit for type 1 or 2, second digit for base size, third digit for ULD configuration used), independently from the ULD forms which are shown on the listed ULD configuration (UC) sheets.

Step 3: From the ULD type and base size, identify in Table I the possible ULD configurations. In most cases there are several.

Step 4: Go to the indicated ULD configuration (UC) sheets to identify which are applicable to the desired ULD form (Container, Net, Pallet) and geometrically correspond to the design of the ULD being considered. This will rule out a number of possible configurations, but may still leave several.

Step 5: Return to Table I with the remaining possible ULD configurations. For each of them, there are usually several load conditions defined, each in one of several restraint conditions. It is intended that a ULD approved to a given configuration code must satisfy the requirements of each of the listed load/restraint conditions combinations.

Example: SIZE M (96 x 125)

TABLE 1

Unit Load Device	Load Condition Ref. Table II	Restraint Condition Ref. Table III
2M1	- - - -	- - - -
2M2	- - - -	- - - -
2M3	18 9 14 14	7 9 11 12