SAE Aerospace
An SAE International Group

AEROSPACE RECOMMENDED PRACTICE

SAE ARP1554 REV. C

Issued 1984-10
Revised 2002-03
Reaffirmed 2008-06

Superseding ARP1554B

Auto Transport Unit Load Device

TABLE OF CONTENTS

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

TABLE OF CONTENTS (Continued)

1. SCOPE:

1.1 Type A, B, C, and Drawings:

This SAE Aerospace Recommended Practice (ARP) establishes three types of transport units for carriage of autos. Types A (lower deck) and type B (main deck) will be used for carriage of one automobile in conjunction with an air cargo pallet compatible with NAS 3610 Class II restraint systems, primarily in a random intermix with general cargo pallets. Type C (main deck) will be used, in order to maximize volume utilization, for carriage of two or four automobiles as full or part charter operation (see Figure 1).

a. Type A: Will be used for carriage of one automobile on the lower deck of both freighter and/or passenger wide body aircraft, in conjunction with either a 60.4 in x 125 in (1534 mm x 3175 mm) or a 88 in x 125 in (2235 mm x 3175 mm) air cargo pallet compatible with NAS 3610 Class II restraint systems.

NOTE: 96 in x 125 in (2438 mm x 3175 mm) air cargo pallet may alternately be used, if designated aircraft compartments are designed for it.

b. Type B: Will be used for carriage of one automobile in slanted configuration on the main deck of freighter widebody aircraft, in conjunction with a 88 in x 125 in (2235 mm x 3175 mm) or 96 in x 125 in (2438 mm x 3175 mm) air cargo pallet compatible with NAS 3610 Class II restraint systems.

NOTE: Max allowed angle for slanted car position is 40°. When car is loaded in aircraft lengthwise, lower end must be forward to cover angle of attack at takeoff.

CAUTION: The angle of the car storage in the transport device is to be checked from car model to car model. Some cars are not permitted to be transported at a certain angle due to liquids (hydraulic/battery, etc.).

c. Type C: Will be used for carriage of two or four automobiles in a double level configuration on the main deck of freighter widebody aircraft, in conjunction with:

1. either an air cargo pallet(s) compatible with NAS 3610 Class II restraint systems,

2. or a specially designed air cargo pallet(s) matching the width of autos in order to ensure maximum use of aircraft volume.

1.1.1 Two kinds of Auto Transport ULD's are identified:

a. general purpose auto ULD's, useable as a single unit or in a car charter mode but with a variety of car-models fitting the geometry constraints

b. dedicated auto ULD's designed to optimize volume and handling effencies with a single defined car-model when used on regular charter programs.

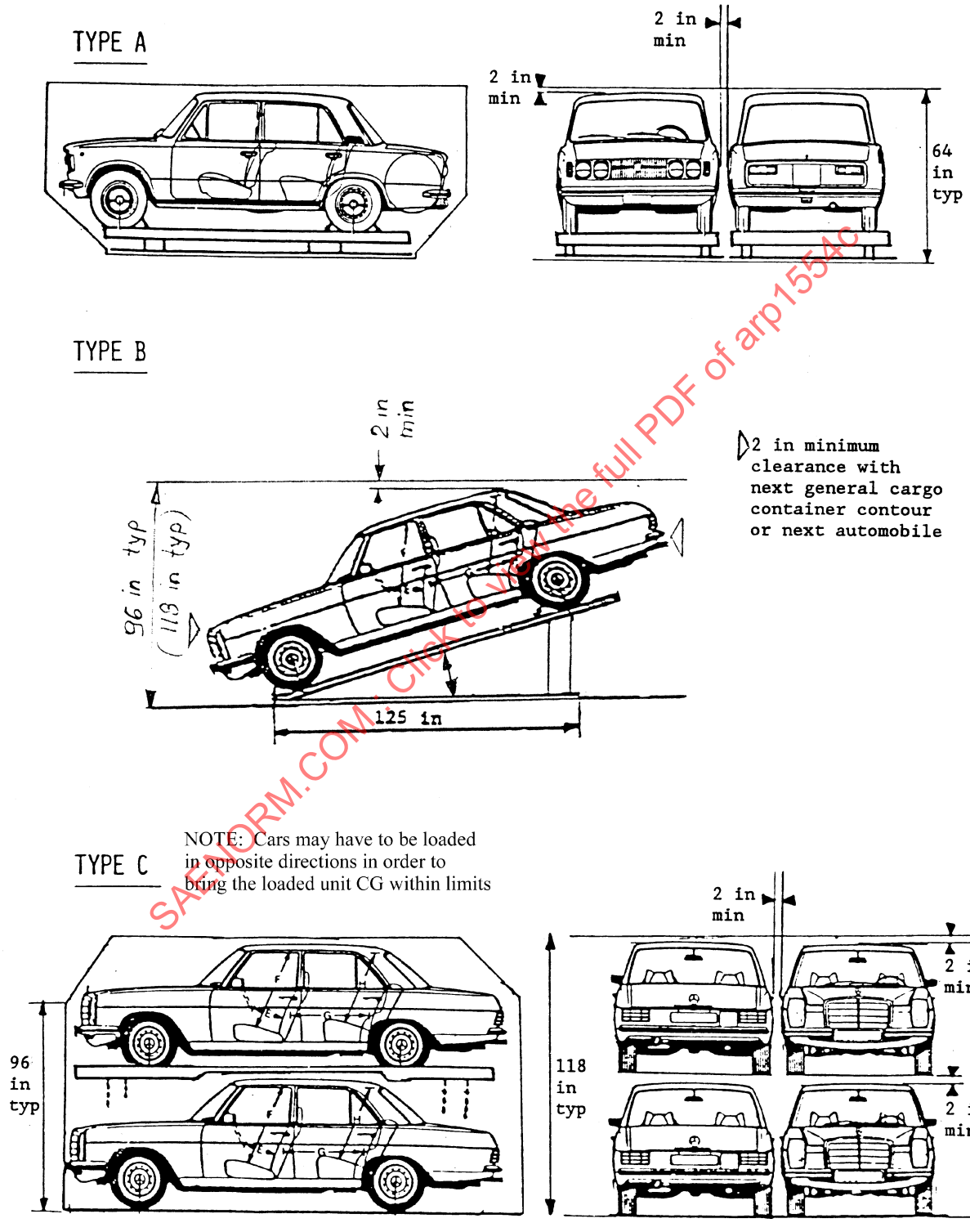

FIGURE 1 - General Illustration of Unit Types

1.2 Purpose:

This document provides functional, dimensional, structural, and environmental requirements for auto transport devices used to transport automobiles in wide body aircraft. These devices are intended to be used in conjunction with pallets compatible with NAS 3610 Class II restraint systems or pallets matching the width of autos to ensure maximum use of aircraft volume. The unit load device (ULD) shall facilitate alteration for carriage of general cargo during return haul. Pallet nets used in conjunction with existing pallets in order to restrain general cargo are also described in NAS 3610.

The minimum essential criteria are identified by use of the 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 dependable, economical, and practical auto transport devices. Deviation from recommended criteria should occur only after careful consideration, extensive testing, and thorough service evaluations have shown alternate methods to be satisfactory.

It is the intent of this document to specify minimum air and ground handling features and to ensure interchange capability and compatibility with present and future air transport and ground handling systems. It is not the intent of this document to specify equipment designs.

The unit load devices specified herein shall be designed primarily for the transport of automobiles and alternately for the transport of general air cargo in an acceptable and profitable manner.

1.3 Design Objectives:

1.3.1 Accommodate as many auto types and sizes as feasible within the aircraft envelope with emphasis on those most frequently shipped.

1.3.2 Ensure profitable return haul usage with general air cargo.

1.3.3 Ensure accessibility and compatibility to meet the minimum dangerous goods requirements for preparation of autos for shipment.

1.3.4 Protect autos from damage.

1.3.5 Ensure maintainability using standard high quality aerospace practices.

2. 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 SAE Publications:

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

ARP1395	Minimum Requirements for Future Wide-Body Aircraft Cargo Systems and Compartments (Intermodal)
ARP1372	Minimum Requirements for Air Cargo Unit Load Devices,Ground Handling and Transporting Systems
ARP1334	Ground Equipment Requirements for Compatibility with Aircraft Unit Load Devices (IATA AHM 911 is equivalent)
AS1130	Air and Air/Surface (Platform) Cargo Pallets

2.2 NAS Standards:

Available from Aerospace Industries Association, 1250 Eye Street NW, Washington, DC 20005.

NAS 3610	Minimum Requirements and Test Conditions for Cargo Unit Load Devices and Equipment to be installed in certified aircraft

2.3 Other Documents:

IATA Documents: Available from International Air Transport Assoc., 800 Place Victoria, P.O. Box 113, Montreal, Quebec, Canada H4Z 1M1.

IATA 50/0	General Technical Requirements and Serviceability Limits
IATA 50/1	Pallet for NAS 3610 Class II Restraint Systems
IATA 50/9	ISO Size Cargo Pallets (equivalent to AS1130)
IATA 90/3	Aircarft ULD for Automobilr Transport

ISO Documents: Available from International Organization for Standardization, Case Postale 56, CH-1211 Geneve 20, Switzerland.

ISO 7715	Minimum requirements for air cargo ULD Ground Handling and Transport systems
ISO 4116	Air cargo equipment - Ground equipment requirements for compatibility with aircraft ULD's
ISO 4117	Air and Air/Land cargo pallets - Specification and testing
ISO 8268	Air cargo equipment - Automobile transport devices - Basic requirements

United States Department of Transportation Motor Carriers Safety Regulations
Part 393.100, Subpart I, "Protection Against Falling or Shifting Cargo"

3. DANGEROUS GOODS REGULATIONS:

It is not the intent of this document to provide criteria applicable to the safe air transport of automobiles as far as hazardous materials/dangerous goods regulations are concerned. Details of applicable regulations can be found in the following:

3.1 United States Department of Transportation Materials Transportation Bureau Regulations, Parts 173.120, 173.250, 173.257, 173.306, 175.305, and 176.905.

3.2 IATA Dangerous Goods Regulations, Packing Instructions 900 and 901.

3.3 ICAO Document Number 9284, Technical Instruction for the Safe Transport of Dangerous Goods by Air.

4. REQUIREMENTS:

4.1 Dimensions:

4.1.1 Type A: Shall adapt to a pallet length of 125 in (3175 mm) and should have an adjustable width range of 58 in (1473 mm) to 88 in (2235 mm) and/or 96 in (2438 mm).

4.1.2 Type B: Shall adapt to a pallet length of 125 in (3175 mm) and should have an adjustable width of 88 in (2235 mm) or 96 in (2438 mm).

4.1.3 Type C: Shall adapt to a pallet length of 196 in (4978 mm) or 238.5 in (6058 mm) and should have an adjustable width range with, at least, 62.5 in (1588 mm), 88 in (2235 mm), and 96 in (2438 mm) fixed positions.

4.2 Construction:

4.2.1 Units shall be rugged, weatherproof, and lightweight.

4.2.2 Components shall not permit liquids, sand, or debris to accumulate within.

4.2.3 Unit construction shall provide sufficient structural strength to withstand, without permanent deformation, the static and dynamic loads and the impact shock and racking stresses resulting from over-the-road carriage at highway speeds, forklift handling, and in-flight ultimate loads associated with the appropriate NAS 3610 Class II restraint condition (see 10.3 hereafter for applicable ultimate load factors)

4.3 Base:

4.3.1 The unit design shall ensure that, when fully loaded, the unit base foot imprint area loading on the pallet does not exceed 400 psf (1.9 kPa) for types B and C (main deck) and 200 psf (0.95 kPa) for type A (lower deck).

4.3.2 The unit shall be equipped with a flat and continuous drip pan that would also form a base. The bottom surface of the drip pan shall not point load or have sharp edges in contact with the pallet. Clean out openings should be provided and sized so that waste material may be flushed out of the pan. Drip pan capacity shall be designed to accumulate all liquids contained in the car loaded above, or additional absorption material may be used.

4.3.3 No structure, fittings, or other objects shall protrude below the bottom surface of the base.

4.3.4 The unit base shall structurally adapt to any pallet equipped with continuous seat track along the edge rail and having the designed minimal length appropriate to the unit type.

4.3.5 Attachment of the unit base to the pallet shall be accomplished using universal seat track fitting complying with MS 33601a standard, and which can be installed or removed without modification or the use of tools. Attach fittings shall meet or exceed minimum NAS 3610 - Class II restraint requirements.

4.3.6 Attach devices shall be designed so as to provide a means to prevent all vertical and horizontal movements beyond ±0.125 in (3.2 mm) which may occur between the unit and pallet.

4.3.7 When attached to a pallet, the unit base design shall provide for support and ease of movement at the not to be exceeded distributed load specified in 4.3.1 and 11.3.1 and on a minimum conveyor system as outlined in ARP1334.

4.3.8 Base design shall take into account in-plane conveyor power drive systems and their inability to move a ULD when the pallet flexes away from the conveyor friction drive devices.

4.4 Auto Support:

4.4.1 The auto shall be supported by its tires. Wheel trays shall provide full support for each tire imprint area.

4.4.2 Overall dimensions of wheel support trays shall be kept to a minimum. Automobiles and/or supporting structures which overhang the pallet will be acceptable if it can be demonstrated that no damage to the aircraft and/or shipment will occur if normal pallet handling practices are employed.

4.4.3 Auto support structures which cannot be disassembled, fully collapsed, and bundled for return haul shall collapse within the overall dimensions of the pallet the fixture rests on. When collapsed, the base shall facilitate cargo loading and pallet edge rail shall be fully accessible for net attachment and aircraft restraint.

4.4.4 Auto support wheel trays shall permit placement/rolling of the auto on the wheel tray without the use of the forklifts and/or other lifting devices which may damage the auto. It is recognized that accessory loading ramps may be part of this device.

4.4.5 Each wheel tray shall be equipped with fork tineways suitable for moving and/or assembling the fixture with a maximum allowable weight auto on board. Tineways shall be fully enclosed or equivalent, so as to ensure against damage to the auto and provide tipping restraint.

4.4.6 Tineway dimensions shall be per Figure 2.

4.4.7 Each wheel tray shall be equipped with a minimum of two wheel chocks and/or equivalent to control forward and reverse wheel movement. Chock locking positions shall permit placement of auto on center of unit regardless of wheel base designs or axle locations.

4.4.8 In order to accommodate the maximum possible range of auto wheel bases and at the same time keep the length of the wheel tray to a minimum, wheel chocks shall be located on the inboard side of the wheels.

4.4.9 If continuous wheel channels are used to support the auto, channel end stops shall be provided to prevent the auto from rolling off one far end during loading.

4.4.10 Wheel tray loading ramps shall permit manual loading on the ground before loading the pallets into the aircraft.

4.4.11 Wheel curb rails and/or restraints shall be provided to control the lateral movement of the auto.

4.5 Type A Units - Lower Deck:

4.5.1 Type A units shall include compatibility with small cargo door aircraft and be adaptable to 60.4 in x 125 in (1534 mm x 3175 mm) pallet to facilitate transportation of subcompact autos occupying only 2 LD-3 positions in lower deck or an 88 in x 125 in (2235 mm x 3175 mm) pallet to facilitate carriage of wider autos on aircraft with full-size pallet cargo doors.

NOTE: 96 in x 125 in (2438 mm x 3175 mm) air cargo pallet may alternately be used, if designated aircaft compartments are designed for it.

4.5.2 Wheel support tray shall provide simple means of adjusting the height of an automobile and supporting it at maximum allowable weight while in transit. The range of height adjustment shall be from 4 in (102 mm) to 12 in (305 mm) as measured from the conveyor roll plane.

4.5.3 To permit the carriage of autos wider than 60.4 in (1534 mm) but less than 70 in (1778 mm) in the lower deck of aircraft with base occupying only 2 LD-3 positions of the aircraft, the wheel support tray shall be designed so as to extend over the edge rail of the pallet on one side only. The range of adjustment of the wheel tray shall extend from the 60.4 in (1534 mm) pallet edge rail dimension to 67.5 in (1715 mm). The auto and carrier shall be at least 1 in (25 mm) inboard of the pallet edge rail on the other side.

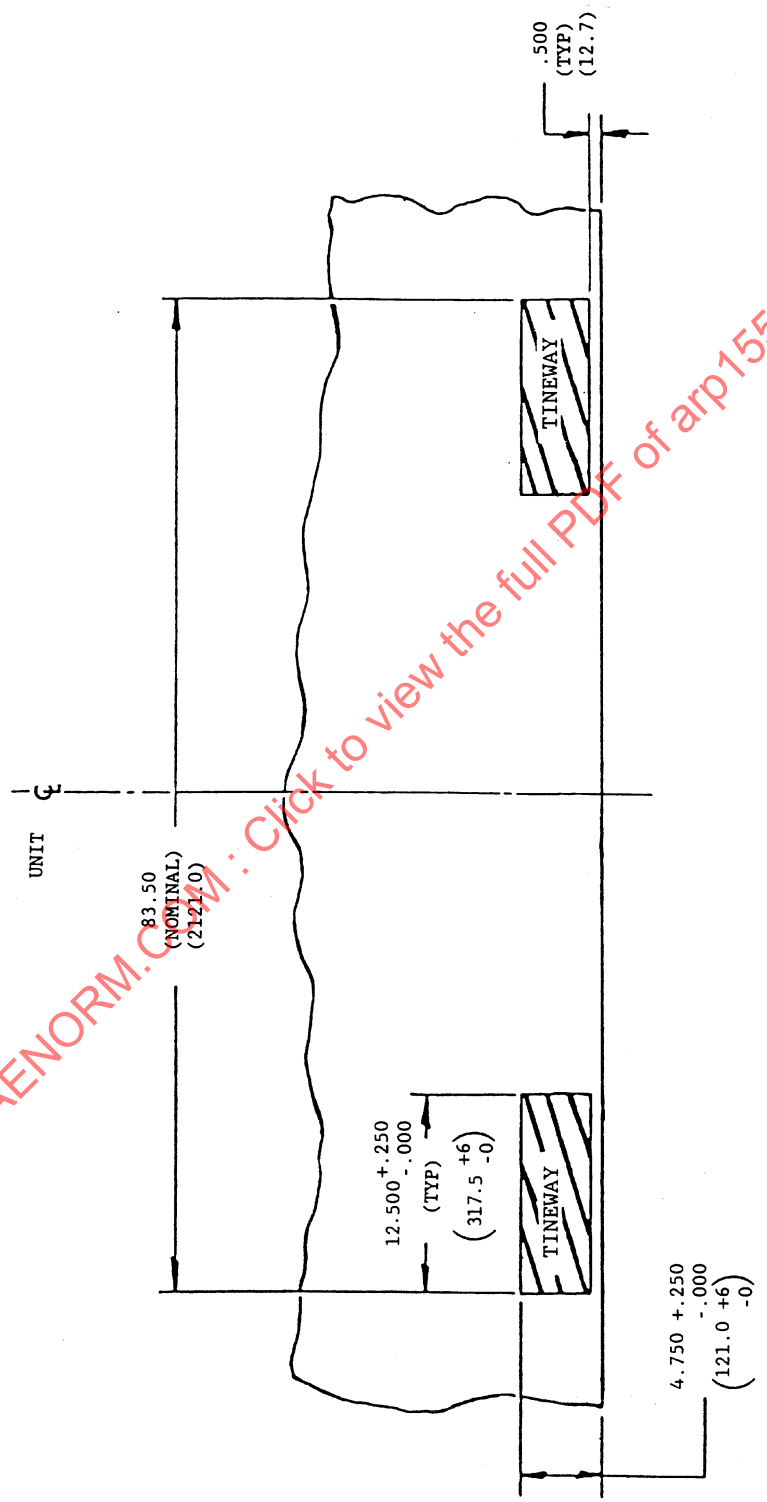

FIGURE 2 - Forklift Tineways Configuration

4.5.4 The overall length of the wheel tray for lower deck application should not exceed 125 in (3175 mm).

4.5.5 Either longitudinal end of the unit shall function facing forward or aft in the aircraft and shall not interfere with other ULD's or auto transport units in adjoining aircraft positions. This requirement shall apply on one side only when autos exceeding pallet width are carried as per 4.5.3 above.

4.5.6 Where applicable, design objective for spacing between cars in adjoining positions shall be 2 in (51 mm).

4.6 Type B Unit - Main Deck - Slanted Type:

4.6.1 Type B units shall adapt to an 88 in x 125 in (2235 mm x 3175 mm) or 96 in x 125 in (2438 mm x 3175 mm) pallet. The overall height of the units in the lowered (horizontal) or erected (fully slanted) position shall be less than 96 in (2438 mm) measured over the conveyor plane, not including the height of the car.

4.6.2 Wheel support trays shall include simple mechanical or hydraulic means to be raised into a slanted position up to a 40° angle from the horizontal position.

4.6.3 The operation of the raising device shall be possible within or out of the aircraft, by one man without external power source, using a crank, lever or hand tool with a manual effort not exceeding 70 lb (31 daN) at minimum car weight capacity.

4.6.4 It is recognized that longer types of automobiles, when installed on the unit in the slanted position, will exceed the 125 in (3175 mm) pallet length and require contour limitations on the adjoining pallet postions, if loaded with general cargo. However, design shall provide capability of end to end location of the base pallets, regardless of auto length, whenever two or more type B units are adjacent to each other.

4.6.5 The overall length of the wheel trays should not exceed 125 in (3175 mm) in order to facilitate return haul usage. It is recognized that, in the operative horizontal position, part of the raising end of the wheel trays will overhang from the pallet.

4.6.6 Either longitudinal end of the unit shall function facing forward or aft in the aircraft and shall not interfere with restraint of other ULD's or auto transport units in adjoining aircraft positions.

4.6.7 The raising end of each wheel tray shall be equipped with stops, adjustable by 2 in (51 mm) increments, in order to limit the position of the automobile, once raised, to either 96 in (2438 mm) or 118 in (2997 mm) height clearance.

4.6.8 Wheel chocks offering a minimum of 80° ramp angle against the wheels shall be provided in order to ensure protection against car movement in the maximum slanted position.

4.6.9 Where applicable, design objective for spacing between cars in adjoining positions, or a car and a structural member, shall be a minimum of 2 in (51 mm).

4.7 Type C Unit - Main Deck - Two Level Type:

4.7.1 Type C units shall adapt to any pallet or combination of pallets having an overall length of 196 in (4978 mm) and having an overall width range between 62.5 in (1588 mm) and 125 in (3175 mm).

4.7.2 The upper level of this device shall be designed to maximize the use of the aircraft internal cross-section available so as to accommodate the maximum height, length, and width of the auto(s) possible.

4.7.3 The lower level of this device should permit flow through capability of the lower auto(s) and allow the frame of the auto(s) to extend over the pallet edge rails in both longitudinal directions during transit. To permit carriage of auto(s) greater than 196 in (4978 mm) in length, it is recognized that auto(s) may extend into aircraft walkways.

4.7.4 The second level auto tray shall provide lightweight liquid spill/drip protection to protect the lower auto. The protective shield used shall be impervious to all types of liquids, lubricants, and/or acids normally used on automobiles.

4.7.5 Horizontal movements and/or racking of the unit when fully loaded shall not result in permanent deformation.

4.7.6 Structural supports for the upper level shall be narrow in profile so as to result in maximum clearance for the lower level auto(s) and minimize loss in aircraft volume. Supports shall be offset on opposite sides and designed so as to integrate with auto transport units in adjoining aircraft positions preventing redundant volume loss. Either longitudinal end of the unit shall function facing forward or aft in the aircraft and shall not interfere with other ULD's or auto transport units in adjoining aircraft position.

4.7.7 Where applicable, design objectives for spacing between cars in adjoining position or a car and a structural member shall be a minimum of 2 in (51 mm). Structural members are to be incorporated in the allowable spacing in order to prevent loss of useable space.

4.7.8 The overall height of the unit fully assembled and loaded shall not exceed 118 in (2997 mm) as measured from the conveyor plane (pallet included).

4.7.9 The second level auto tray wheel support surface shall be located 60 inches (1524 mm) above conveyor plane with pallet base included. As an option, this elevation shall provide a vertical adjustment of ±4 in (102 mm) in 1 in (25 mm) increments.

4.7.10 The lower level shall provide a clear envelope for an auto measuring 57 in (1448 mm) in height. This envelope shall allow vertical clearance for deflections and racking while in transit and freedom of movement during assembly and disassembly/loading and offloading.

5. CARGO LOADING:

5.1 Type A, B, and C units will alternately be used for the carriage of cargo during return haul.

5.1.1 Types of cargo will be general, both unitized and nonunitized.

5.2 When disassembled and/or collapsed as per 6.3 hereafter, units shall fit over base pallets and leave the seat track area on the periphery thereof available for attachment of a general cargo restraint pallet net meeting the requirements of NAS3610 class II for the Pallet-size concerned.

6. ASSEMBLY AND DISASSEMBLY OF THE UNIT:

6.1 Attach Fittings:

6.1.1 Fittings shall be located so that they cannot damage or be damaged by aircraft hardware and/or adjacent units should they inadvertently be left open or become open in transit.

6.1.2 No tools or equipment shall be required to secure fittings.

6.1.3 Means should be provided to give visual and mechanical indication that fittings are positively secured.

6.1.4 Where possible, fittings and assembly components should be interchangeable.

6.1.5 Handles, straps, fittings, etc., shall withstand a minimum of 5000 lb (2225 daN) pull in any direction.

6.1.6 When assembled or disassembled there shall be no loose parts which can easily be lost. Small assembly components and parts shall be chain attached.

6.2 Loading and Preparation for Shipment:

Assembly/disassembly manning, equipment, and time required should be held to a minimum. The following shall be minimum ojectives:

6.2.1 Type A (1 car, lower deck):

a. Maximum manning - one man
b. Maximum equipment - one 3000 lb (1335 daN) forklift, or equivalent
c. Maximum assembly/disassembly time - 5 min

6.2.2 Type B (1 car, main deck, slanted):

a. Maximum manning - one man
b. Maximum equipment - one 3000 lb (1335 daN) forklift, or equivalent
c. Maximum assembly/disassembly time including erection to required angle - 10 min

6.2.3 Type C (2 or 4 cars, main deck, double level):

a. Maximum manning - two men
b. Maximum equipment - one 3000 lb (1335 daN) forklift, or equivalent
c. Maximum assembly/disassembly time - 15 min

6.3 Disassembly and Return Haul Usage:

6.3.1 When disassembled and/or collapsed, units shall occupy minimal space so as to optimize cargo loading of the aircraft.

6.3.2 The optimum designs should permit complete disassembly and bundling of one or more units together during return haul. It is intended that pallets used to support the base of the units may be disconnected and used for carriage of cargo.

7. TARE WEIGHT LIMITS:

The tare weight shall be kept to a minimum consistent with the requirements and within limits of good design practices.

7.1 The tare weight objectives (excluding pallet) are as follows:

7.1.1 Type A: 250 lb (113 kg)

7.1.2 Type B: 350 lb (159 kg)

7.1.3 Type C: 500 lb (227 kg) for two cars unit, or 700 lb (317 kg) for four cars unit

8. RESTRAINT PROVISIONS:

8.1 Aircraft Restraint Provisions:

8.1.1 Aircraft restraint provisions normally used for the size pallet being used shall be employed. Wheel trays and attach fittings shall not negate access required by aircraft restraints and/or the ability for one man, without the use of tools, to set the required aircraft restraints.

8.1.2 Provisions shall be made to permit tiedown of the automobile and transport unit directly to the pallet and/or aircraft should the operator deem it necessary.

8.1.3 The unit restraint system shall conform to the NAS 3610 Class II restraint system. Load paths should be as direct as possible.

8.1.4 The unit design shall be such that the fully loaded unit, when adequately restrained in the aircraft system, conforms to appropriate NAS 3610 Class II restraint parameters.

8.1.5 Where possible, restraint devices/fittings should be designed to accomplish multiple functions.

8.2 Attach Fittings:

8.2.1 Fittings shall be located so that they cannot damage or be damaged by aircraft hardware and/or adjacent units should they inadvertently be left open or become open in transit.

8.2.2 No tools or equipment shall be required to secure fittings.

8.2.3 Means should be provided to give visual and mechanical indication that fittings are positively secured.

8.2.4 Where possible, fittings and assembly components should be interchangeable.

8.2.5 Handles, straps, fittings, etc., shall withstand a minimum of 5000 lb (2225 daN) pull in any direction.

8.2.6 When assembled or disassembled there shall be no loose parts which can easily be lost. Small assembly components and parts shall be chain attached.

8.3 Auto Restraint Provisions:

8.3.1 Provision shall be made to secure the auto to the unit using designated attach points and fittings as provided and/or specified by each automobile manufacturer.

8.3.2 Provisions shall be made to secure the auto via its wheels to the unit and/or pallet using special design strap arrangements when attach fitting devices have not been provided by the automobile manufacturers.

8.3.3 Restraint attach fittings shall permit the use of take-up devices to collapse the automobile suspension system as necessary to stabilize the auto while in transit.

8.3.4 Restraint attach fitting shall provide adequate design limits to accept repeated rhythmic loads incurred when an automobile is not stabilized during transit.

9. ENVIRONMENTAL CRITERIA:

9.1 Operating Conditions:

Equipment should be capable of operating under the following conditions:

9.1.1 Temperature range of -25 to +140 °F (-32 to +60 °C).

9.1.2 Relative humidity of 100%.

9.1.3 Exposure to salt-sea atmosphere.

9.1.4 Vibration incidental to service use.

9.1.5 Sand and dust particles, wind velocity of 60 mph (97 km/h)

9.1.6 Exposure to rain, snow, and sleet.

9.1.7 All fluids normally contained on automobiles and on aircraft.

9.1.8 Conveyor support criteria per ARP1334.

9.2 Materials and Processes:

9.2.1 Materials and process selected should give consideration to extremely hard usage to which the unit will be subjected to provide for a maximum service life.

9.2.2 All metal parts should be protected against corrosion.

9.2.3 All nonmetallic parts and/or joints which are liquid absorbent should be sealed and/or treated.

9.2.4 All materials shall be flame-resistant in accordance with regulatory requirements.

9.2.5 All materials and/or components shall be protected against deterioration or loss of strength in service due to exposure, weathering, corrosion, or other causes where the type of material used requires such protection.