

AEROSPACE RECOMMENDED PRACTICE

ARP1554™
REV. D

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Superseding ARP1554C

Vehicle Transport Unit Load Device (ULD)

RATIONALE

ARP1554D has been reaffirmed to comply with the SAE five-year review policy.

TABLE OF CONTENTS

1.	SCOPE.....	3
1.1	Purpose.....	3
1.2	Type A, B, C.....	3
1.3	Design Objectives.....	6
2.	APPLICABLE DOCUMENTS.....	6
2.1	SAE Publications.....	6
2.2	NAS Standards.....	6
2.3	IATA publications.....	7
2.4	ISO Publications.....	7
2.5	Other Publications.....	7
3.	DANGEROUS GOODS REGULATIONS.....	8
3.1	United States Department of Transportation.....	8
3.2	IATA Dangerous Goods Regulations.....	8
3.3	ICAO.....	8
4.	REQUIREMENTS.....	8
4.1	Dimensions.....	8
4.2	Airworthiness Approval.....	8
4.3	Construction.....	9
4.4	Base.....	9
4.5	Vehicle Support.....	10
4.6	Type A Units - Lower Deck.....	12
4.7	Type B Unit - Main Deck - Slanted Type.....	12
4.8	Type C Unit - Main Deck - Two Level Type.....	13
5.	CARGO LOADING.....	13
6.	ASSEMBLY AND DISASSEMBLY OF THE UNIT.....	14
6.1	Attachment Fittings.....	14
6.2	Loading and Preparation for Shipment.....	14
6.3	Disassembly and Return Haul Usage.....	14
7.	TARE WEIGHT LIMITS.....	15
8.	RESTRAINT PROVISIONS.....	15
8.1	Aircraft Restraint Provisions.....	15
8.2	Attachment Fittings.....	15
8.3	Vehicle Restraint Provisions.....	15
9.	ENVIRONMENTAL CRITERIA.....	16
9.1	Operating Conditions.....	16
9.2	Materials and Processes.....	16

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10.	LOADS	16
10.1	Vehicle Loads.....	16
10.2	Load Ratings	16
10.3	Ultimate Load Criteria – Aircraft.....	17
10.4	Operating Loads - Ground Transportation Minimum Requirements	17
11.	TESTING.....	17
11.1	Scope	17
11.2	Test Criteria.....	18
11.3	Recommended Test Equipment	18
11.4	Testing Requirements.....	18
12.	NOTES	19
FIGURE 1	GENERAL ILLUSTRATION OF UNIT TYPES.....	5
FIGURE 2	FORKLIFT TINEWAYS CONFIGURATION	11

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1. SCOPE

1.1 Purpose

This document provides functional, dimensional, structural, and environmental requirements for vehicle transport devices used to transport vehicles in wide-body aircraft. These devices are intended for use either in conjunction with NAS 3610 or AS36100 approved air cargo pallets or with specially designed and approved air cargo pallets. 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 and AS36100.

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 vehicle 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.

1.2 Type A, B, C

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

This SAE Aerospace Recommended Practice (ARP) establishes three types of transport units for carriage of vehicles in cargo compartments of certified civil transport aircraft. The term vehicle is used so as to encompass the possible transport of vehicles such as golf carts, light commercial vehicles, motorbikes etc. in addition to cars / automobiles. Type A (lower deck) and Type B (main deck) will be used for carriage of one vehicle in conjunction with an air cargo pallet secured within an aircraft restraint system designed to be compatible with NAS 3610 or AS36100 approved ULDs, 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 vehicles as either a full or part charter operation (see Figure 1).

The equipment covered by this ARP are units that interface with suitably approved / certified ULDs (typically air cargo pallets). It does not seek to bring into being any new type of ULD, although nothing prevents a potential new ULD being developed which uses this ARP as a guide to the design process.

a. Type A:

Will be used for carriage of one vehicle 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), a 88 in x 125 in (2235 mm x 3175 mm) or 96 in x 125 in (2438 mm x 3175 mm) air cargo pallets.

b. Type B:

Will be used for carriage of one vehicle in slanted configuration on the main deck of freighter wide-body aircraft, in conjunction with either 88 in x 125 in (2235 mm x 3175 mm) or 96 in x 125 in (2438 mm x 3175 mm) air cargo pallets.

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

CAUTION: The angle of the vehicle storage in the transport device is to be checked as some vehicles are not permitted to be transported at a certain angle due to potential spillage or overflow of liquids (hydraulic / battery / lubricants, etc.).

c. Type C:

Will be used for carriage of two or four vehicles in a double level configuration on the main deck of freighter aircraft, in conjunction with:

1. either NAS 3610 or AS36100 approved air cargo pallet(s) ,
2. or specially designed and approved air cargo pallet(s) matching the width of vehicles in order to ensure maximum use of aircraft volume.

1.2.1 Two kinds of Vehicle Transport ULDs are identified:

- a. general purpose vehicle ULDs, useable as a single unit or in a vehicle charter mode but with a variety of models / types fitting the geometry constraints
- b. dedicated vehicle ULDs designed to optimize volume and handling efficiencies with a single defined vehicle model when used on regular charter programs.

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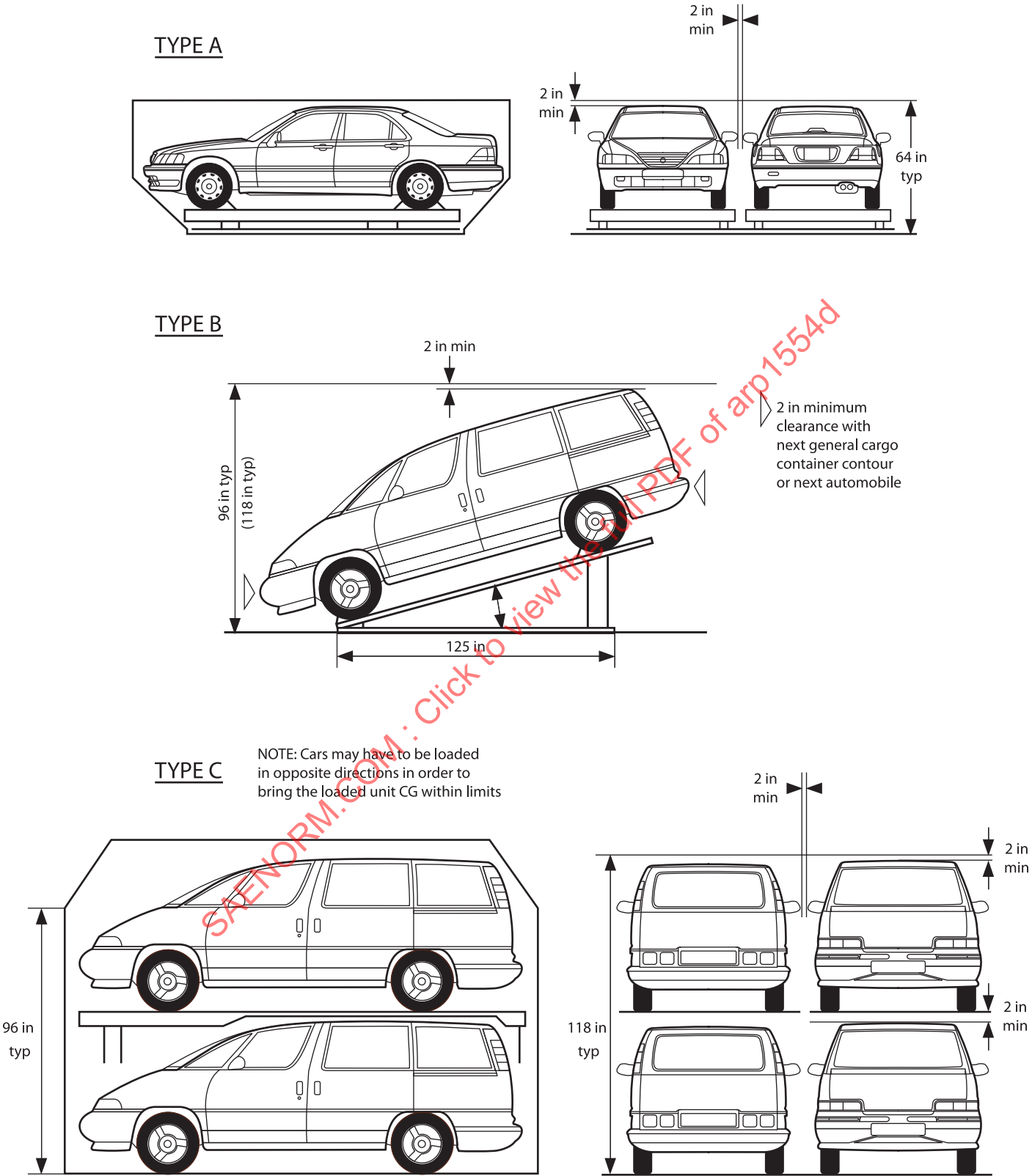


FIGURE 1 - GENERAL ILLUSTRATION OF UNIT TYPES

1.3 Design Objectives

- 1.3.1 Accommodate as many vehicle types and sizes as is 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 vehicles for shipment.
- 1.3.4 Protect vehicles 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 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. Note: No revision number is indicated. Check the latest published revision on the SAE website

AS1130	Air and Air/Surface (Platform) Cargo Pallets
AS1491	Interline Air Cargo Pallet
AS36100	Air Cargo Unit Load Devices – Performance Requirements and Test Parameters
AS33601	Track and Stud Fitting for Cargo Transport Aircraft, Standard Dimensions for
AS5385	Cargo Restraint Straps – Design Criteria and Testing Methods
ARP1334	Ground Equipment Requirements for Compatibility with Aircraft Unit Load Devices (IATA AHM 911 is equivalent)
ARP5595	Cargo Restraint Straps - Utilization Guidelines
ARP5486	Air Cargo Pallets – Utilization Guidelines
ARP36103	Air Cargo Unit Load Devices – Center of Gravity Control Methods

2.2 NAS Standards

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, www.aia-aerospace.org.

NAS 3610	Minimum Requirements and Test Conditions for Cargo Unit Load Devices U.S. Government Publications
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2.3 IATA publications

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

IATA 50/0 Requirements for Interlining Unit Load Devices (ULDs)

IATA 50/1 NAS 3610 Class II Aircraft Pallets

IATA 50/9 ISO Size Cargo Pallets

IATA 90/3 Aircraft ULD for Automobile Transport

2.4 ISO Publications

Available from either

American National Standards Institute (ANSI), 25W 43rd St., 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.

ISO 4116 Air cargo equipment - Ground equipment requirements for compatibility with aircraft ULDs

ISO 4117 Air and Air/Land cargo pallets - Specification and testing

ISO 4171 Air cargo equipment Interline Pallet

ISO 8097 Aircraft - Minimum Airworthiness Requirements and Test Conditions for Certified Air Cargo Unit Load Devices

ISO 8268 Air cargo equipment - Automobile transport devices - Basic requirements

ISO 9788 Air Cargo Equipment - Cast Components of Double Stud Fitting Assembly with a load capacity of 22 250N (5 000lbf) for aircraft cargo restraint

ISO 16049-1 Air-Cargo – Restraint straps – Part 1: Design criteria and testing methods

ISO 16049-2 Air-Cargo – Restraint straps – Part 2: Utilisation guidelines

ISO 16412 Pallet Utilization Guidelines

PAS 21100 Air Cargo Unit Load Devices – Performance Requirements and Test Parameters

2.5 Other Publications

Available from U.S. Government Printing Office, 732 N Capitol St. NW, Washington DC 20401, Tel 202-512-0000, www.gpoaccess.gov

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 vehicles 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

United States Department of Transportation Pipeline and Hazardous Materials Safety Administration Regulations, Parts 173.120, 173.250, 173.257, 173.306, 175.305, and 176.905.

3.2 IATA Dangerous Goods Regulations

IATA Dangerous Goods Regulations, Packing Instructions 900 and 901.

3.3 ICAO

ICAO Document Number 9284, Technical Instructions 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 Airworthiness Approval

4.2.1 The unit together with its base pallet shall be approved for installation in the aircraft type(s) for which it is intended

4.2.2 The unit together with its base pallet shall meet all the applicable requirements of the approved Weight and Balance Manual(s) of this (these) aircraft type(s)

4.2.3 Airworthiness requirements compliance can be achieved in one of two ways:

a. Where possible, through the base pallet being approved under TSO C90 in reference to AS36100 or NAS 3610, with the unit's structure being considered as a palletisation accessory (see ARP5486 para 8.4.1 and 8.4.3), subject to all the following conditions being met:

- no modification of the base pallet as approved
- The loads imposed on the pallet edge rails by securing the loaded unit shall not exceed the capability of the pallet edge rail. These loads shall be applied to the edge rail at positions either the same as those defined for net attachment in the pallet's TSO C90 airworthiness approval, or as close as possible to such defined points.

Note – aircraft pallet nets are not generally recommended for restraining vehicles, and any tie-down straps (general purpose or purpose built) used as primary restraints shall meet the requirements of AS5385C (ISO 16049-1).

- compliance with the intended aircraft(s) maximum area load, running load, and ULD C-of-G range at the intended aircraft positions. NOTE: This usually requires stiffening / load spreading members to be part of the device's structure.

b. Where the pallet cannot be, or remain, TSO approved (e.g. due to its being a special size, the pallet's approval becoming invalid due to modification of the pallet, or the device being permanently attached to the base pallet such that the whole constitutes an integral unit). Under these circumstances, the whole unit must be approved under a STC or alternative approval procedure (see ARP5486 para 8.4.2)

4.3 Construction

4.3.1 Units shall be rugged, weatherproof, and lightweight.

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

4.3.3 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 ULD restraint condition (see 10.3 hereafter for applicable ultimate load factors).

4.4 Base

4.4.1 In general, the unit design shall ensure that, when fully loaded, the unit base foot imprint area loading on the pallet does not exceed 418 lb/ft² (20 kPa) for types B and C (main deck) and 209 lb/ft² (10 kPa) for type A (lower deck). Consideration must however be given during the design process of which aircraft are to be used, and any applicable floor loading limitations incorporated in the design. Dependant on the design of the unit and the air cargo pallet to be used, it might also be necessary to provide additional means of spreading the load imposed on the pallet to prevent local deformation or excessive point-load.

4.4.2 The unit shall be equipped with a flat and continuous drip pan that could also form a base. The bottom surface of the drip pan shall not apply a point-load or have sharp edges in contact with the pallet. Closeable 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 vehicle loaded above, or additional absorption material may be used.

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

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

4.4.5 Attachment of the unit base to the pallet shall be accomplished using universal seat track fitting complying with AS33601 standard, and which can be installed or removed without modification or the use of tools. Attachment fittings shall meet or exceed the ultimate load requirements of the Weight & Balance Manual(s) for the intended aircraft type(s).

4.4.6 Attachment fittings 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.

4.4.7 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.

4.4.8 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.

4.5 Vehicle Support

- 4.5.1 The vehicle shall be supported on its tires. Wheel trays shall provide full support for each tire imprint area.
- 4.5.2 Overall dimensions of wheel support trays shall be kept to a minimum. Vehicles and/or supporting structures which overhang the pallet will be acceptable if it can be demonstrated that no damage to the aircraft and/or the vehicle/s / equipment will occur if normal pallet handling practices are employed.
- 4.5.3 Vehicle support structures that 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 the pallet edge rail shall be fully accessible for net attachment and aircraft restraint.
- 4.5.4 support wheel trays shall permit placement / rolling of the vehicle on the wheel tray without the use of the forklifts and / or other lifting devices which may damage the vehicle. It is recognized that accessory loading ramps may be part of this device.
- 4.5.5 The lower horizontal structural members of the unit, which may, or may not, incorporate wheel trays shall be equipped with fork tineways suitable for moving and / or assembling the fixture with a maximum allowable weight vehicle on board. Tineways shall be fully enclosed or equivalent, to provide tipping restraint and prevent damage to the vehicle.
- 4.5.6 Tineway dimensions shall be per Figure 2.
- 4.5.7 Each wheel tray shall be equipped with a minimum of two wheel chocks and / or equivalent to control wheel rolling. Chock locking positions shall permit placement of the vehicle on center of unit regardless of wheel base designs or axle locations.
- 4.5.8 In order to accommodate the maximum possible range of vehicle wheelbases 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.
- 4.5.9 If continuous wheel channels are used to support the vehicle, channel end stops shall be provided to prevent the vehicle from rolling off one end during loading.
- 4.5.10 Wheel tray loading ramps shall permit manual loading on the ground before loading the pallets into the aircraft.
- 4.5.11 Wheel curb rails and / or restraints shall be provided to control the lateral movement of the vehicle.

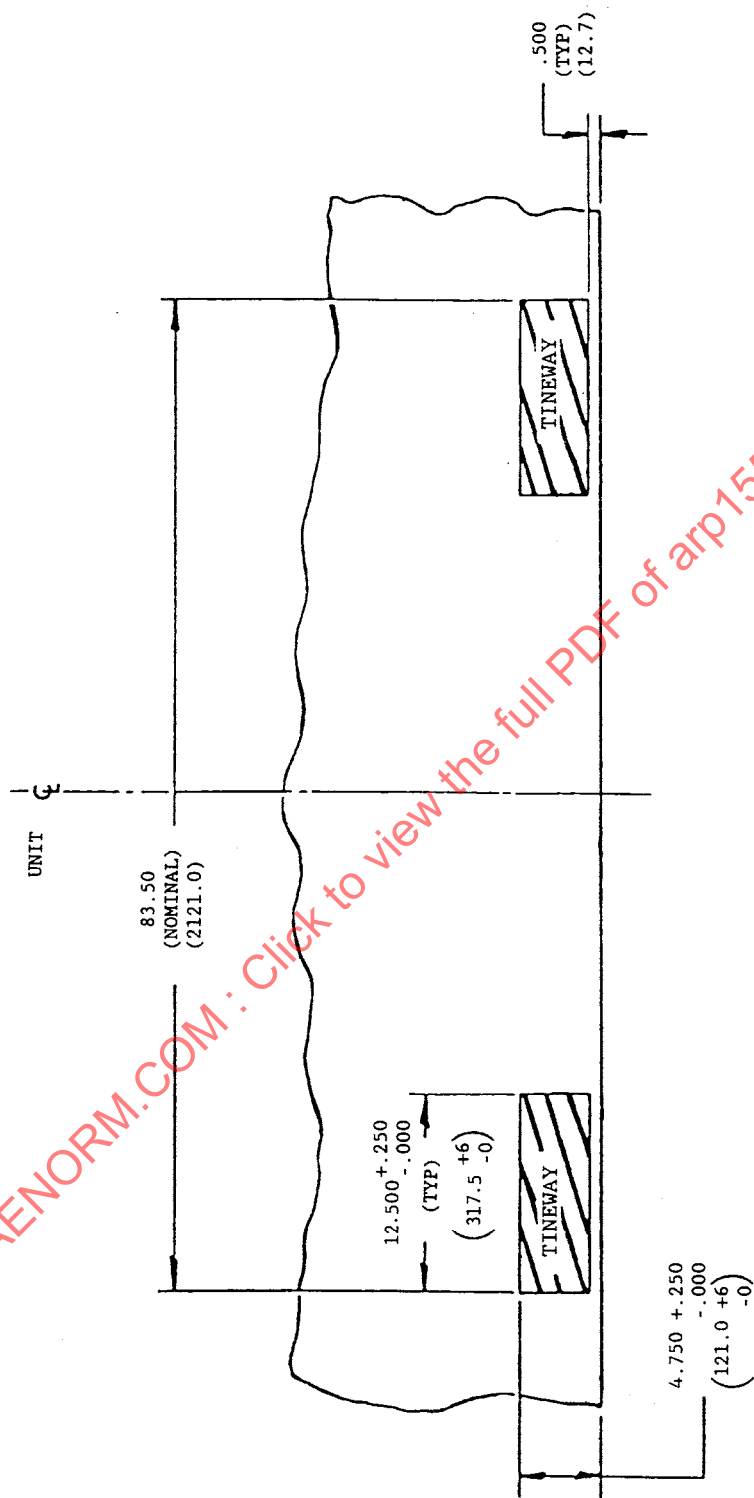


FIGURE 2 - FORKLIFT TINEWAYS CONFIGURATION

4.6 Type A Units - Lower Deck

- 4.6.1 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 vehicles occupying only 2 LD-3 positions in lower deck or an 88 in x 125 in (2235 mm x 3175 mm) pallet or 96 in x 125 in (2438 mm x 3175 mm) air cargo pallet to facilitate carriage of wider vehicles on aircraft with full-size pallet cargo doors.
- 4.6.2 The wheel support trays shall provide a simple means of adjusting the height of a vehicle 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 vertically from the conveyor roll plane.
- 4.6.3 To permit the carriage of vehicles 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 vehicle and carrier shall be at least 1 in (25 mm) inboard of the pallet edge rail on the other side.
- 4.6.4 The overall length of the wheel tray for lower deck application should not exceed 125 in (3175 mm).
- 4.6.5 Either longitudinal end of the unit shall function facing forward or aft in the aircraft and shall not interfere with other ULDs or vehicle transport units in adjoining aircraft positions. This requirement shall apply on one side only when vehicles exceeding the pallet width are carried as per 4.6.3 above.
- 4.6.6 Where applicable, the design objective for spacing between cars in adjoining positions shall be 2 in (51 mm).

4.7 Type B Unit - Main Deck - Slanted Type

- 4.7.1 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.
- 4.7.2 Wheel support trays shall include simple mechanical or hydraulic means by which to be raised into a slanted position up to a 40 degrees angle from the horizontal position.
- 4.7.3 The operation of the raising device shall be possible inside or outside of the aircraft, by one person without an external power source, using a crank, lever or hand tool with a manual effort not exceeding 70 lb (31 daN) at maximum vehicle weight capacity.
- 4.7.4 It is recognized that longer types of vehicles, 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 positions, if loaded with general cargo. However, the design shall provide capability for end-to-end location of the base pallets, regardless of vehicle length, whenever two or more type B units are adjacent to each other.
- 4.7.5 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 operational horizontal position, part of the raising end of the wheel trays will overhang from the pallet.
- 4.7.6 Either longitudinal end of the unit shall function facing forward or aft in the aircraft and shall not interfere with restraint of other ULDs or vehicle transport units in adjoining aircraft positions.
- 4.7.7 The liftable 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 vehicle, once raised, to either 96 in (2438 mm) or 118 in (2997 mm) height clearance.
- 4.7.8 Wheel chocks shall be provided and so designed as to prevent vehicle movement in the maximum slanted position.

4.7.9 Where applicable, the design objective for spacing between vehicles in adjoining positions, or a vehicle and a structural member, shall be a minimum of 2 in (51 mm).

4.8 Type C Unit - Main Deck - Two Level Type

4.8.1 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).

4.8.2 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 vehicles(s) possible.

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

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

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

4.8.6 Structural supports for the upper level shall be narrow in profile so as to result in maximum clearance for the lower level vehicles(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 to minimize volume loss. Either longitudinal end of the unit shall function facing forward or aft in the aircraft and shall not interfere with other ULDs or vehicle transport units in adjoining aircraft position.

4.8.7 Where applicable, the design objectives for spacing between vehicles in adjoining positions or a vehicle 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.

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

4.8.9 The second level vehicle tray wheel support surface shall be located 60 in (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.

4.8.10 The lower level shall provide a clear envelope for a vehicle 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

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

- Types of cargo will be general, both unitized and non-unitized.
- 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 NAS 3610 class II for the Pallet-size concerned.

6. ASSEMBLY AND DISASSEMBLY OF THE UNIT

6.1 Attachment 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 that can easily be lost. Small assembly components and parts shall be attached by chain or lanyard.

6.2 Loading and Preparation for Shipment

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

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, jacking handle / crank
- 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, jacking handle / crank
- 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.

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

Type A - 250 lb (113 kg)

Type B - 350 lb (159 kg)

Type C - 500 lb (227 kg) for a two vehicle unit, or 700 lb (317 kg) for a four vehicle 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 attachment 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 securing of the vehicle and transport unit directly to the pallet and/or aircraft should the operator deem it necessary.

8.1.3 The unit, combined with the appropriate air cargo pallet, shall not impose loads on the aircraft restraint system that exceed that system's stated load parameters. Load paths should be as direct as possible.

8.1.4 The unit design shall be such that the fully loaded unit, when adequately attached to the appropriate air cargo pallet will not impose any loads exceeding those for which the air cargo pallet is designed.

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

8.2 Attachment 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 that can easily be lost. Small assembly components and parts shall be attached by chain or lanyard.

8.3 Vehicle Restraint Provisions

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

8.3.2 Provisions shall be made to secure the vehicle via its wheels to the unit and / or pallet using specially designed strap arrangements where attachment points have not been provided by the vehicle manufacturer(s).

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