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DEPARTMENT OF DEFENSE
INTERFACE STANDARD

DESIGNING FOR INTERNAL AERIAL DELIVERY IN FIXED WING AIRCRAFT

AMSC N/A FSC 1510

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

FOREWORD

1. This standard is approved for use by the Department of the Air Force and is available for use by all Departments and Agencies of the Department of Defense.

2. This standard establishes general design and performance requirements for U.S. Government-developed or commercial-off-the-shelf cargo to be safely air transported in the cargo compartments of USAF fixed wing aircraft. Cargo is defined as any materiel such as munitions, machinery, food, fuel, and gases. Items used to support personnel or animals are also included. The standard covers the USAF prime mission cargo aircraft (e.g., C-130E/H/J, C-130J-30, C-17, C-5), cargo carrying systems of the tanker fleet (KC-10 and KC-135) as well as the cargo aircraft in the long-range, international segment of the Civil Reserve Air Fleet (CRAF) (e.g., B747, DC-10, B767). The structural and dimensional criteria for other cargo aircraft are documented in specific manuals for each aircraft.

3. The definition of an air transportability problem item and what does or does not need to be certified for air transport is provided in section 1.3.

4. General and detailed requirements with associated verification criteria are found in sections 4 and 5. Section 6 provides guidance for applying the requirements and includes rationale, guidance, and lessons learned.

5. Appendix A explains how the requirements may apply to three common types of cargo and how those types of cargo are air transported. Appendix B provides detailed data on specific aircraft limits to supplement the requirements stated in sections 4 and 5. Data on military aircraft can also be found in that aircraft's Technical Order (T.O.) 1C-XXX-9 cargo loading manual. For commercial aircraft, refer to the specific aircraft weight and balance manual. Appendix C describes operations common to the standard mission: load planning, loading, restraining cargo, flight, jettison, and combat offloading. Appendix C also gives an overview of the 463L air cargo system.

6. An interactive, electronic edition of this standard is also available. In addition to everything in this edition, it has a tool to aid the tailoring process and provides examples and case studies not suitable for this format. That edition may be obtained by contacting the offices listed below.

7. Comments, suggestions, or questions on this document should be emailed to Air Force Code 11 at engineering.standards@wpafb.af.mil or addressed to: AFLCMC/EZFC (ATTN: ATTLA), Building 28, 2145 Monahan Way, Wright-Patterson Air Force Base OH 45433-7017. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

CONTENTS

1. SCOPE

1.1 Purpose.

This standard provides design and performance requirements to assure the airworthiness of USAF fixed wing aircraft whose missions involve the safe and effective transport of cargo. It presents design requirements and operating limits from the basic aircraft loading manuals and technical publications and is supplemented by additional useful air transport data.

The process for approval or certification of cargo for air transport in USAF fixed wing aircraft is described in 6.4. This section presents the format for submitting a request for certification and provides examples of the type of data to submit.

The reinstatement of this document as a Department of Defense Standard (subsequent to its previous conversion to a MIL-HDBK) allows it to be cited in procurement packages.

1.2 General.

This standard covers general design and performance requirements of U.S. Government developed or purchased off-the-shelf cargo for internal air transport in military prime mission cargo aircraft and the long-range, international segment of the Civil Reserve Air Fleet (CRAF). The complete air transportability requirements for an item of equipment not specified herein will be specified in the individual equipment specification. This standard also describes the procedure to certify outsized or unusual cargo for air transport.

1.2.1 Appendices.

The appendices to this standard explain air transport concepts and detailed aircraft systems and limits. Common types of cargo and how the requirements apply are described in appendix A. Detailed aircraft information for C-130, C-130J (and C-130J-30), C-17, C-5, B747, KC-10 (DC-10), and KC-135 (B707) are shown in appendix B. C-27A data is provided as preliminary information for the C-27J. Basic air transport concepts are described in appendix C. Information on other aircraft, such as C-21 and C-40, are not shown in this document because ATTLA does not certify on these aircraft.

1.3 Applicability.

The requirements and tests contained in this standard apply to the internal air transportability aspects of all items intended for aerial delivery in CRAF or USAF aircraft. They represent the minimum acceptable transportability features. When it is known that the equipment requires features that are more restrictive than those stated herein, those features should be specified in the individual equipment specification.

1.3.1 Air transportability problem items.

An air transportability problem item is any item of equipment in its proposed shipping configuration which, because of its size, weight, fragile or hazardous characteristics, lack of adequate means for handling, or tie-down, or requirement for special support equipment, may be denied transport aboard US Air Force prime mission cargo aircraft or the cargo carrying segment of the Civil Reserve Air Fleet (CRAF). An item is considered a potential problem item when its design requirement includes transportability in such aircraft and the item exceeds any one of the general conditions imposed by E1.1.14.3, E1.1.14.4, and E1.1.14.5 in DODI 4540.07.

The potential problem item criteria requiring cargo to be evaluated are summarized and clarified as follows:

a. Length greater than 240 inches (20 feet)

b. Width greater than 96 inches (8 feet)

c. Height greater than 96 inches (8 feet)

d. Weight greater than 10,000 pounds

e. Weight distribution greater than aircraft limits, nominally based on the C-130:

   (1) 5,000 pound axle

   (2) 2,500 pound wheel

   (3) 1,600 pounds per linear foot running load

   (4) 50 pounds per square inch of floor contact pressure

f. Requires special handing for one or more of the following reasons:

   (1) Item characteristics are such that the aircraft or Air Force materials handling environment poses a problem.

   (2) Requires usage of aircraft electrical power or electronic system.

   (3) Cargo has electronic components that are powered on (electronically active) or are used while in the aircraft other than during onload/offload from/to the ground.

   (4) Susceptible to potential aircraft environment: high altitude, rapid decompression, electromagnetic environment, or extreme temperature.

   (5) Susceptibility to explosive atmosphere environment (aerial tanker aircraft only)

   (6) Cargo item requires maintenance of special in-flight conditions such as venting of hazardous materials, auxiliary power or controlled cargo compartment temperatures.

   (7) Inadequate ramp clearance for ramp inclines of 15 degrees.

g. Requires special loading/unloading procedures for any other reason.

1.3.2 Air transport certification.

Any item to be airlifted by USAF cargo transport aircraft that is categorized as an air transportability problem item must be reviewed by ATTLA. The federal sponsor (office, agency, or person that represents the U.S. Government and develops, procures, owns, or transports the item) must send a memo requesting that ATTLA approve the item for airlift aboard USAF cargo aircraft.

The air transport certification process is laid out with a detailed description in documents posted to the ATTLA website at https://afkm.wpafb.af.mil/ATTLA (direct) or https://wwwd.my.af.mil/afknprod/ATTLA (via AF Portal). Those unable to access the site may request them by contacting ATTLA.

A simplified description of the process is in 6.4.

1.3.3 Certification not required.

Cargo that is not an air transportability problem item (does not meet any of the criteria stated in 1.3.1 above will not require certification and can be transported with minimal risk at the discretion of the aircrew and their applicable MAJCOM.

2. APPLICABLE DOCUMENTS

2.1 General.

The documents listed in this section are specified in sections 3, 4, or 5 of this standard. This section does not include documents cited in other sections of this standard recommended for additional information or as examples. While every effort has been made ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks.

The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

Department of Defense Specifications

MIL-DTL-6458	Chain Assemblies, Single Leg, Aircraft Cargo Tie Down
MIL-DTL-25959	Tie Down, Tensioners, Cargo, Aircraft
MIL-PRF-27260	Tie Down, Cargo, Aircraft, CGU-1/B
MIL-DTL-27443	Pallets, Cargo, Aircraft, Type HCU-6/E, HCU-12/E, and HCU-10/C
MIL-DTL-27444	Net, Cargo Tiedown, Pallets HCU-7/E, HCU-15/C, HCU-11/C, and HCU-16/C

(Copies of these documents are available online at https://assist.dla.mil/quicksearch/ or http://www.assistdocs.com/search/search_basic.cfm or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

Joint Service Specification Guides:

JSSG 2000	Air System
JSSG–2001	Air Vehicle
JSSG-2006	Aircraft Structures
JSSG-2008	Vehicle Control and Management Systems (VCMS)
JSSG-2010	Crew Systems

(Copies of the JSSGs may be requested from engineering.standards@wpafb.af.mil or from ASC/ENRS Wright-Patterson AFB OH 45433-7101.)

Department of Defense Standards

MIL-STD-129	Military Marking for Shipment and Storage
MIL-STD-209	Lifting and Tiedown Provisions
MIL-STD-331	Fuze and Fuze Components, Environmental and Performance Tests for
MIL-STD-669	Loading Environment and Related Requirements for Platform Rigged Airdrop Material
MIL-STD-810	Environmental Engineering Considerations and Laboratory Tests
MIL-STD-814	Requirements for Tiedown, Suspension, and Extraction Provisions on Military Materiel for Airdrop
MIL-STD-1366	Transportability Criteria

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or http://www.assistdocs.com or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

Department of Defense Handbooks

MIL-HDBK-516	Airworthiness Certification Criteria
MIL-HDBK-514	Operational Safety, Suitability & Effectiveness for the Aeronautical Enterprise

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or http://www.assistdocs.com or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications.
The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

Air Force Instructions

AFI 11-202, Volume 3	Flying Operations, General Flight Rules
AFI 91-107	Design, Eval ion, Troubleshooting, and Maintenance Criteria for Nuclear Weapon Systems

Air Force Pamphlet

AFPAM 10-1403	Air Mobility Planning Factors

Air Mobility Command Pamphlet

AMCPAM 24-2	Civil Reserve Air Fleet Load Planning Guide, Vol 1-10

Joint Regulations

AFI 24-203	Preparation and Movement of Air Force Cargo
AFMAN 24-204(I)/ TM38-250/ NAVSUP PUB 505/ MCO P4030.19/ DLAM 4145.3	Preparation of Hazardous Materials for Military Air Shipment
DoDI 4540.07	Operation of DoD Engineering for Transportability and Deployability Program

Department of Defense publications can be obtained online via http://www.dtic.mil/whs/directives/; Air Force publications via http://www.e-publishing.af.mil/; other departments and agencies via http://www.dtic.mil/whs/directives/links.html.

Code of Federal Regulations

Title 14 CFR: Part 25 Aeronautics and Space: Federal Aviation Administration, Department of Transportation

Title 49 CFR: Parts 100-199: Transportation: Research and Special Programs Administration, Department of Transportation

(The above CFR parts are available online via http://www.access.gpo.gov/)

Field Manuals/Technical Orders

TO 1C-XXX-9	Cargo Loading Manual (XXX signifies a/c type number designation)

(For specific documents, search the Technical Order Catalog online at https://www.toindex-s.wpafb.af.mil/.)

(Copies of other Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.3 Order of precedence.

Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the 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.

3. DEFINITIONS.

463L Air cargo system	The designation for the USAF system of materials handling equipment. The 463L system consists of separate but interdependent equipment families: the terminal family, cargo preparation family (including the "463L pallet"), ground handling family, and aircraft systems family. A complete description can be found in appendix C.
Aerial delivery	The act or process of delivering cargo or personnel by air transport or airdrop.
Air cargo	Any goods or material shipped or consigned by air.
Air Mobility Command (AMC)	A unified command of the US Air Force which operates a fleet of transport aircraft for both strategic and tactical support of DOD. In addition to military aircraft, AMC operates civilian aircraft under charter, contract, or lease.
Air transport	Delivery of personnel or cargo from point to point in which the cargo is offloaded after landing the aircraft.
Air transportability problem item	An item of equipment in its proposed shipping configuration which, because of its size, weight, fragile or hazardous characteristics, lack of adequate means for handling or tiedown, or requirement for special support equipment, may be denied transport aboard US Air Force prime mission cargo aircraft or the long range international segment of the Civil Reserve Air Fleet (CRAF). An item is considered a potential problem item when its design requirement includes transportability in such aircraft and the item exceeds any one of the conditions imposed in 1.3.1.
Air Transportability Test Loading Activity (ATTLA)	USAF organization responsible for providing transportability engineering and design assistance and safety of flight airworthiness certification as related to transportability problem items to be airlifted onboard USAF prime mission cargo aircraft and Civil Reserve Air Fleet (CRAF) aircraft.
Air Transport Certificate	Documentation issued by ATTLA showing that the cargo is certified for air transport. Limitations and special procedures are included in the letter.
Air transportable	Denotes equipment and cargo items which are certified by ATTLA that they can be safely carried in an aircraft.
Airdrop	Delivery of personnel or cargo from point to point in which the cargo is offloaded prior to landing the aircraft.
Airdrop item	The equipment in its reduced configuration for airdrop, including external or internal loads such as fuel, ammunition, field gear, or rations.
Aeronautical Systems Center (ASC)	ASC is one of the product divisions under Air Force Materiel Command (AFMC). The prime mission of ASC is the initial development and acquisition of new weapons systems and supporting equipment.

Bulk cargo	General cargo capable of being stacked on the floor of an aircraft.
Buttock line (butt line, BL)	The distance from the longitudinal centerline of the aircraft measured in inches in an outboard direction. RBL or LBL is used to designate right and left hand side of aircraft when facing forward from aft end of the airplane.
Civil Reserve Air Fleet (CRAF)	A group of commercial transport aircraft with crews, which is allocated in time of emergency, under the emergency war plan, for exclusive use by DOD to augment the AMC fleet.
Clearance limits	The dimensions beyond which the size of, or projection of, a shipment may not extend in order to clear obstructions which restrict the handling or transportation of such shipment. Such limits may be actual or prescribed by law or regulation.
Compartment	The entire cargo carrying volume of the aircraft is commonly referred to as the cargo compartment. However, each airframe has designated sections with weight/size limitations specifically referred to as "compartments." These are named by letter (e.g. Compartment A).
Center Vertical Restraint Rail (CVR)	A hat-shaped channel used in conjunction with aircraft side rails to carry Container Delivery System (CDS) loads on C-130E/H. On the C-130J and C-130J-30, the CVR is an integral rail that retracts into the cargo floor.
Deployment	The movement of strategic or tactical aircraft and units to an overseas location. This includes emergency movements, scheduled rotations of aircraft from CONUS bases to overseas bases, and related exercises.
Dunnage	Shoring. See shoring definitions below.
Electromagnetic Compatibility (EMC)	(1) The capability of electrical and electronic systems, equipments, and devices to operate in their intended electromagnetic environment within a defined margin of safety, and at design levels of performance without suffering or causing unacceptable degradation as a result of electromagnetic interference. (NATO) (2) The ability of a device, equipment, or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment. (IEEE Std. 100-1996)
Electromagnetic Interference (EMI)	(1) Any electromagnetic disturbance, whether intentional or not, that interrupts, obstructs, or otherwise degrades or limits the effective performance of electronic or electrical equipment. (NATO) (2) Degradation of the performance of an equipment, transmission channel, or system caused by an electromagnetic disturbance. [IEC 60050-161 (1990-09)]
Field Manual (FM)	The Army version of the Air Force technical order.

Forward, aft, and lateral movement	Movement of cargo is defined relative to the aircraft. Thus when a vehicle is backed aboard the aircraft "forward movement" in terms of restraint in the aircraft is toward the vehicle's aft end.
Fuselage station (FUS STA, FS)	A longitudinal point in the aircraft designated in inches from a fixed reference point forward of the aircraft nose. For C-130J-30 see "Load Station".
G-force	The resultant force exerted on an object by gravity or by reaction to acceleration or deceleration. G is an acceleration ratio (a/g) of the item's acceleration (a) to the acceleration of gravity (g). When multiplied by an item's weight, the ratio gives the force experienced by the item due to acceleration/ deceleration. Also called G.
Hazardous material	Substance or materiel which has been determined and designated by the Secretary of Transportation or the services to be capable of posing an unreasonable risk to health, safety, and property when transported. Included are explosives, articles such as flammable liquids and solids, and other dangerous oxidizing materials, corrosive materials, compressed gases, poisons and irritating materials, etiologic agents and radioactive materials. (See provisions of Title 49 of the Code of Federal Regulations and AFMAN 24-204(I)/TM 38-250/NAVSUP PUB 505/MCO P4030.19(I)/DLAI 4145.3 for a complete listing of hazardous materials and certification requirements.)
K-loader	Operational term for cargo loading vehicles used by the DOD. These vehicles are part of the 463L materials handling system. The number designation in front of the K (kips) represents the usual approximate working capacity of the vehicle, in 1000 lb units. For example, a 25K loader would have a capacity of 25,000 lb.
Limit load	The maximum load which will not produce permanent deformation of the tiedown provision or cargo support system (frame, axles, suspension, etc.).
Loadmaster	Member of the air crew. Supervises cargo activities and related functions, including aircraft loading and off loading activities, cargo handling, and restraint. Performs pre-flight and post-flight of aircraft and aircraft systems. Computes weight and balance and performs other mission specific duties. Provides for safety and comfort of passengers and troops, and security of cargo, mail, and baggage during flight. Conducts cargo and personnel airdrops.
Load Station (LS)	A longitudinal point in the C-130J-30 (long fuselage C-130J) cargo compartment designated in inches from a fixed reference point forward of the aircraft nose. The C-130J-30 cargo compartment does not reference fuselage stations (FS) for loading cargo, Load Stations (LS) are used instead.

Medevac	Medical evacuation by airlift. Transporting patients by air.
Nonstandard pallet	Pallet that has not been certified for airlift by the Air Force.
Outsized cargo	Outsized cargo exceeds the capabilities of C-130 aircraft and requires use of C-17 or C-5.
Overhang	The distance, measured along the road surface between the centerline of the extreme end axles and the end of a vehicle. There can be a front and rear overhang.
Oversize cargo	Oversize cargo is a single item that exceeds the usable dimensions of a 463L pallet (104 in. length x 84 in. width x 96 in. height for military aircraft).
Pallet	A unit load device used for consolidation of cargo items for efficient handling. USAF standard pallets fall into two groups: a. Warehouse pallet. Generally a wood pallet 40 x 48 x 6 in., weighing 75 to 100 lb, with a capacity of 2000 lb. b. 463L pallet. A pallet designed as part of the 463L material handling system. They are compatible with military and commercial air cargo systems.
Platform	A unit load device similar to the pallet but specifically designed for airdrop. It is 108 inches wide with lengths ranging from 8 to 32 feet, in 4 foot increments.
PIW	Pounds per Inch of Width. This is a measure of lateral running load.
PLF	Pounds per Linear Foot. This is a measure of longitudinal running load.
PSI	Pounds per Square Inch. For air transport, this is a measure of floor contact pressure or tire inflation pressure.
Ramp crest	The crest of the ramp is the point where the inclined ramp joins the aircraft cargo floor at the hinge line. It is the critical point with respect to underside clearances of items being loaded from the ground up the aircraft ramp.
SAAM	Special Assignment Airlift Mission. Mechanism whereby government offices "rent" a USAF aircraft and crew for cargo transport or test purposes. Prepare and submit DOD Form 1249 in accordance with appendix Q of the Defense Travel Regulation.
SDDCTEA	Surface Deployment and Distribution Command, Transportation Engineering Agency. Army agency responsible for developing and evaluating cargo for all other modes of transport. Transportability Engineers work closely with requirements writers and equipment developers, including defense contractors, program managers and other government organizations, throughout the acquisition life cycle, to influence the design of systems in favor of efficient transportability.

Secondary Cargo	Systems or cargo attached to or carried internally or externally on the primary cargo item, and rely on it for restraint, shall be classified as secondary cargo. Examples are air conditioning units on an ISO container, bulk supplies on a trailer bed, computers on equipment shelves, and personal gear in a vehicle. Replaces the term “accompanying loads” used in the previous version of MIL-STD-1791 to eliminate confusion. Aircraft cargo loading manuals use the term “accompanying loads” for separate cargo items carried on the same aircraft at the same time, with individual restraint to the aircraft.
Shoring	Shoring is material used for a variety of purposes to facilitate cargo loading and to protect the aircraft. Plywood and dimensioned lumber are commonly used. a. Approach shoring (step up shoring). Approach shoring is used to reduce the ramp angle that a vehicle must traverse during aircraft on/offloading. b. Parking shoring. Shoring that is required during flight under the wheels or tracks of vehicular cargo to distribute loads or protect the cargo floor. c. Rolling shoring. Shoring that is required during on/off loading under the wheels or tracks of vehicular cargo to distribute loads or protect the cargo floor. d. Sleeper shoring. Shoring used to protect heavily loaded suspensions during hard landings. e. Bridge shoring. Shoring used to spread heavy loads to more than one cargo compartment.
Skid	A flat, weight bearing surface which is the primary means of ground contact for an item.
Skid board	Plywood boards used as base for airdrop bundles and container delivery systems.
Solid Wheel	Refers to solid steel wheels, solid hard rubber wheels, metal wheels with solid polymer “tires”, foam filled tires with minimal deflection characteristics, or any other wheel with line/ribbon ground contact.
Special Consideration Cargo	All cargo that may require special handling procedures, contains hazardous material, operates during flight, or interfaces with aircraft non-cargo systems shall be designated special consideration cargo. Non-standard cargo handling system interfaces and secondary cargo are also classified as special consideration cargo. Systems occupied by personnel and carried in the aircraft cargo compartment are listed here as well.
Strategic airlift	That airlift which can be applied to effect a strategic advantage and is characterized by the continuous or sustained air movement of units, personnel, and logistic support between the CONUS and overseas areas and between area commands.

	Strategic airlift forces will, when required for augmentation of tactical airlift forces, effect delivery of forces into objective areas employing airdrop or airland delivery as far forward as the tactical situation permits.
Tactical airlift	The means by which personnel, supplies, and equipment are delivered by air on a sustained, selective, or emergency basis to dispersed sites at any level of conflict throughout a wide spectrum of climate, terrain, and conditions of combat. Air Force tactical airlift forces enhance the battlefield mobility of the Army in ground combat operations by providing a capability to airland or airdrop combat elements and providing these forces with sustained logistical support.
Technical order (T.O., TO)	An AF publication that gives specific technical directives and information with respect to the inspection, storage, operation, modification, and maintenance on given AF items and equipment. Where this standard references “T.O. 1C-XXX-9” substitute the appropriate aircraft nomenclature for XXX, e.g. 1C-17A-9.
Test loading	A trial aircraft loading of an item(s) being evaluated for air transportability certification. Test loadings are limited to cases in which the characteristics of items prevent analytical means alone from determining an item's air transport eligibility. Because of the expense and manpower involved, test loadings are usually only performed based on ATTLA’s recommendation with the approval and support of AMC. Generally, test loadings require the development and documentation of special procedures for handling and restraint.
Tiedown device	Hook and tensioning mechanism used with chains or straps to restrain cargo by being connected between the item tiedown provisions and the aircraft floor or platform/pallet.
Tiedown provision (also referred to as tiedown fitting, ring, or shackle)	(1) An integral fitting or part of an item for restraining the item to the aircraft floor or an airdrop platform using tiedown devices. (2) A part of the aircraft cargo restraint system, O-ring or D-ring shaped, on the cargo floor.
US TRANSCOM (TRANSCOM)	United States Transportation Command. Unifying joint service command responsible for coordinating all types of transport for materiel and development of transportation systems.
Transportability report	A report submitted on a transportability problem item during development/acquisition with all information necessary for a comprehensive transportability review (all modes of transport). The report identifies transportability characteristics of proposed, newly designed, modified or off the shelf items and components thereof and will contain, to the extent available and pertinent, the information contained in DI-PACK 80880D.
Transportability review	An evaluation of the transportability characteristics of an equipment item and its components to assess its ability to be transported by the mode(s) of transportation specified in the

	materiel requirements documents.
Treadway	The high strength areas of the aircraft cargo floor specifically designed to support vehicle loads. Refer to appendix B for treadway location, strength, and applicable aircraft.
Ultimate strength	The maximum force which a provision must withstand before breaking failure occurs. Ultimate load should be at least 1.5 times limit load.
Unitary integrity	The ability of an item, in its shipping configuration, to remain in one piece without any components becoming detached, including secondary cargo and/or stowed equipment, during and after experiencing the conditions encountered in air transport.
Unitized load	Assembly into a single load of more than one package of one or more different line items of supply to allow the load to be moved in an unbroken state from source to distribution point or user as far forward in the supply system as practical. Thus, containerization and palletization facilitate transportability of supplies with compatible properties enabling transport using materials handling equipment.
Validation loading	A loading performed at the time of an item's first planned shipment to verify handling and tiedown procedures. Validation loadings are recommended when an item is judged by the ATTLA to be air transportable, but where circumstances exist which make close observation advisable during loading for first shipment. Validation loadings normally verify that standard handling and restraint procedures can be applied to the item.
Waterline (WL)	The vertical reference distance for an aircraft measured in inches from a fixed point below the aircraft.
Yield strength	The force at which a provision exhibits a permanent deformation or set of 0.002 inch per inch, in the direction of force application.

4. GENERAL REQUIREMENTS

4.1 Scope.

The requirements stated in this section represent those areas that shall be considered when designing items to be delivered by fixed-wing cargo aircraft. Because of differences in the physical characteristics of items to be shipped, the way they are configured or packaged during shipment, their concept of operations (ConOps) in relation to air transport, or the aircraft used to transport them, not all requirements apply in every case. While some overlap of requirements may exist, this standard categorizes the information presented by the type of requirement (see 6.3). Contact the Air Transportability Test Loading Activity (ATTLA@wpafb.af.mil) if there are questions on design criteria and guidance.

Compliance with the requirements of this standard constitutes a portion of the DoD Engineering for Transportability program. DoDI 4540.07, Operation of the DoD Engineering for Transportability and Deployability Program, designates the transportability agencies, promulgates policy, assigns responsibilities, and outlines procedures for conducting this program within the Army, Navy, Air Force, Marine Corps, and Defense Logistics Agency.

This section contains general requirements that identify overall critical parameters and methods of verification. Section 5 contains detailed requirements based on aircraft operating limits, current practices/policies and applicable standards. Further information on air transport is shown in appendices A and C. Specific aircraft limits referenced in section 5 are shown in appendix B.

The method for sorting and applying requirements is detailed in 6.3. The electronic version of MIL-STD-1791A has a tool which automates the process.

4.2 Verification methods.

Compliance with any requirements shall be shown by analysis, demonstration, test, or similarity. Additional sources of data for verification may be certification from other agencies or compliance with equivalent federal or commercial standards.

4.3 General requirements.

4.3.1 Size requirements.

Any required disassembly of cargo for transport shall not exceed the user's capability to reassemble the item within a specified time period under field conditions. Whenever possible, items intended for transport as cargo should be designed to be loaded/unloaded and flown aboard aircraft in their operational configuration. When necessary, removable sections or partial disassembly of items may be specified within the constraints of this requirement. The dimensional and structural limits of candidate transport aircraft are summarized in appendix B.

4.3.1.1 Loading/unloading.

Variations in aircraft cargo floor height shall be considered when evaluating an item for loading.

During the load/unload process, size and maneuverability of the item shall be such that it maintains no less than 6 inches of clearance with the walls and ceiling of the airframe. Wheeled vehicles shall maintain no less than 2 inches of clearance when cresting the ramp hinge.

Cargo that can be adjusted to facilitate loading and unloading is acceptable. (Examples are vehicles with adjustable suspension, an adjustable fifth wheel, or articulated axles.) Use of special equipment or material handling equipment is an acceptable practice. The weight and size of external equipment in combination with the cargo load must be within the aircraft loading/unloading limits and the limits of the special equipment. Use of special procedures or equipment is discouraged since such equipment and personnel may have to be transported with the load or may require additional aircraft.

4.3.1.2 Flight.

Cargo shall maintain a 6 inch clearance from the aircraft ceiling or overhanging conduit and aircraft interior sidewalls/insulation/equipment once parked/positioned for flight. Cargo shall not block passage of personnel for routine or emergency access. Cargo shall distribute weight to meet flight limits. Emergency access requirements for CRAF aircraft shall be satisfied in accordance with Federal Aviation Regulation, Part 25. Emergency access requirements for USAF aircraft (particularly C-130) shall also be met.

4.3.2 Weight limits.

In all possible shipping configurations, item gross weight and weight distribution shall meet loading and flight weight requirements shown in section 5 and applicable aircraft limits shown in appendix B.

Cargo items may meet flight limits by being able to redistribute weight (either internally or with additional support) after the item is parked.

The following are types of weight limits affecting the different methods of loading cargo (see table III) with references to the relevant detailed requirement paragraph:

Gross weight/center of gravity	5.3.2.1.1
Aircraft compartment limits	5.3.2.1.2
Aircraft roller conveyor limits (palletized cargo)	5.3.2.1.3
Concentrated loads/surface contact loads (bulk cargo)	5.3.2.1.4
Longitudinal loads, aka running loads (all cargo types)	5.3.2.1.5
Lateral floor loads (all cargo types)	5.3.2.1.6
Jackstand and tongue loads	5.3.2.1.7
Axle loads and axle spacing limits (rolling stock)	5.3.2.1.8
Pneumatic wheel/tire loads (rolling stock)	5.3.2.1.9
Solid wheel loads (rolling stock)	5.3.2.1.10
Tracked vehicles (rolling stock)	5.3.2.1.11
Vehicle suspension limits (rolling stock)	5.3.2.1.12
Ramp hinge limits (rolling stock and bulk cargo)	5.3.2.1.13
Palletized cargo	5.3.2.1.14

4.3.3 Restraint requirement.

Cargo items, in their shipping configuration(s), shall be capable of being restrained during all flight conditions and survivable crash landing conditions. After an encounter with such conditions the cargo item shall maintain its unitary integrity, not pose a hazard to the aircraft or crew, nor prevent egress or rescue from a crashed aircraft.

4.3.4 Markings.

Equipment shall be marked in accordance with the provisions of MIL-STD-129 and MIL-STD-209, as appropriate, to provide the information necessary to facilitate loading, restraining, or handling the item in the aircraft. Weight, size, and quantity limits for air transport shall also be identified. Unless otherwise specified, the marking shall be stenciled in an appropriate location or provided on the vehicle's data plate.

4.3.5 Air transport environment.

Cargo items shall be designed and configured or packaged for transport to withstand, without loss of performance or unitary integrity, the shock and vibration environment encountered in aircraft flight and ground maneuvering operations or during cargo on/off loading. Cargo shall be packaged for shipment to prevent loss of functionality if loss of functionality will result in a hazard to aircraft or personnel in the aircraft.

The cargo shall be packaged to withstand extreme temperatures, rapid decompression, and, as applicable: explosive vapor and the electromagnetic environment, without presenting a hazard to the aircraft or personnel. See section 5 for details.

Acceleration, Shock, and Vibration	5.3.5.1.1
Rapid Decompression	5.3.5.1.2
Explosive Atmosphere (Tanker Transport)	5.3.5.1.3
Extreme Temperature	5.3.5.1.4
EMI/EMC	5.3.5.1.5

4.3.6 Special consideration cargo.

Special consideration cargo shall meet the requirements pertinent to the deviation(s) from routine procedures. Some items may require a separate certification/approval from the applicable agency or organization. See section 5 for details, as listed below.

HAZMAT	5.3.6.1.1
Venting	5.3.6.1.2
Aircraft Electrical and Data Physical Interface	5.3.6.1.3
Bulk Fluid Tanks	5.3.6.1.4
Nuclear Cargo	5.3.6.1.5

4.3.6.1 Interfacing with aircraft systems other than cargo handling systems.

Where cargo items require maintenance of special in-flight conditions such as venting of hazardous materials, auxiliary power, sharing flight data, or controlled cargo compartment temperatures, their design shall incorporate the necessary hardware to interface properly with the aircraft installed facilities. The various aircraft have a number of different electrical outlets for power and venting ports for the release of hazardous vapor. Detailed interface data can be found in appendix B or obtained from the aircraft program office. See section 5.

4.3.6.2 Non-standard pallet or skid loads interfacing USAF 463L MHE.

If a custom-built container or other item is intended to be loaded, carried, and unloaded using the USAF 463L cargo handling system, the following shall apply. The item shall have sufficient surface area to distribute its weight to meet the roller and floor limits of both aircraft and Material Handling Equipment (MHE). If the item is to be restrained with chains, tiedown locations sufficient in number and capacity shall be supplied. If the item is to be restrained by the aircraft rail systems then: 1) the side rail profile shall be designed in accordance with the current USAF HCU-6/E specification/drawing (see figure 5 as a current example), 2) the side rail shall be large enough to distribute upward load to the aircraft restraint rails, 3) indents for engaging the aircraft locks shall be provided in the side rail, and 4) the side rail and supporting structure shall possess sufficient strength to hold the item in place alone, otherwise tiedown locations sufficient in number and capacity to restrain the entire weight of the item shall be provided.

4.3.6.3 Secondary cargo.

a. Size: The combined size of the cargo item(s), with secondary cargo mounted on the primary cargo item, shall not exceed the size constraints of the aircraft. For example, on a C-130, a 100 inch tall truck should not carry cargo that results in increasing the overall cargo height to more than 102 inches.

b. Restraint: Secondary cargo items shall be restrained or encased on the primary cargo to not less than the same levels of the acceleration, shock, and vibration levels of the primary cargo. The forces imposed on the secondary cargo may be greater at the attached location than the forces from the airplane to the primary cargo item due to dynamic characteristics of the primary cargo item. If the primary cargo item cannot meet the requirement to restrain the secondary cargo, secondary cargo shall have restraint provisions to allow it to be secured to the aircraft.

4.3.7 Special loading, unloading, and flight procedures.

a. Military equipment: New wheeled or tracked military equipment designs intended for routine transport shall be loadable without loading aids such as approach shoring or special loading equipment.

b. Commercial/non-routine: Commercial equipment purchases and non-routine cargo shall minimize or avoid the use of loading aids.

c. Tipoff: New equipment designs and commercial equipment purchases intended for use on pallets or platforms and with a combat offload or jettison requirement shall conform to the appropriate aircraft tipoff curve(s).

d. Special tools/equipment: Use of special tools and support equipment shall not degrade the user's mission capability, involve equipment not normally available at the deployment site (unless transported with the item), or compromise the safety of the aircraft or operating personnel.

5. DETAILED REQUIREMENTS

5.1 Scope.

This section contains detailed requirements as derived from current aircraft operating limits, historical data, and current practices.

This section is organized by type of requirement - size, weight, restraint, marking, air transport environment, special consideration cargo, and special loading and flight procedures. Verification methods and references to appendices are provided within each.

5.2 Air transport requirements and verification methods.

5.2.1 Requirements layout.

Detailed requirements for safe loading, handling, and flight in the following sections are in the same order as section 4. Each section contains subrequirements, as necessary, for specific types of cargo or for parameters relating to a particular feature within a type of cargo. Limitations specific to a type of aircraft are shown in appendix B and are summarized, where possible, on figures and in tables within each requirement. Further explanations of the requirements are provided in 6.4. Each subrequirement contains methods of verifying compliance with the stated requirement.

5.2.2 Verification methods.

Detailed instructions on how to verify compliance with a given requirement are shown with the associated requirement. Where applicable the verification methods are based on existing standards, and these standards are referenced within the verification method.

5.3 Detailed requirements.

5.3.1 Cargo size considerations.

The size limits are designed to ensure that the item can be loaded and shipped safely. Some refer to specific limits located in the aircraft appendix B.

5.3.1.1 Size requirements.

5.3.1.1.1 Loading/unloading.

Equipment and cargo, in all shipping configurations, shall be sized such that during on/offload it comes no closer than 6 inches from contact with the aircraft.

Critical parameters that affect the loading/unloading process are shown below.

5.3.1.1.1.1 Projection limits.

A vehicle's projected height shall not exceed aircraft height limitations. When a long, tall item is loaded at an angle (as when rolling or sliding up an inclined aircraft ramp) the effective height is increased. Maximum projection occurs in the situation illustrated on figure 1. Dimension "X" designates the projected height. Aircraft-specific projection limits are shown in appendix B.

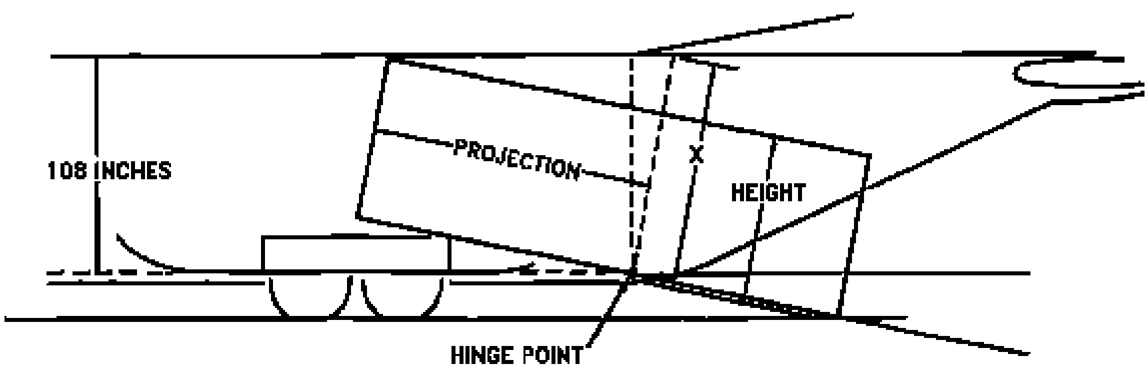


FIGURE 1. Maximum projected height.

5.3.1.1.1.2 Ground and ramp contact.

Front and rear overhang angle (approach/departure angle) shall be not less than 15 degrees to ensure that the item will not contact the ramp, ramp toe/extension, or the ground during loading. Aircraft limits apply when items are parked at the aft end of the cargo floor and overhang the closed aircraft ramp. Overhang distance and ground clearance (forward or aft of the axles) are the critical parameters for determining if the item exceeds aircraft overhang limits. Wheel base also affects overhang for rolling stock cargo. Aircraft-specific limits are shown in appendix B.

5.3.1.1.1.3 Ramp cresting.

Wheeled/tracked vehicles and other cargo, loaded from the ground, shall negotiate the crest of the inclined aircraft ramp without contact with the aircraft hinge when the cargo floor is at its highest position above ground level. Wheelbase and ground clearance (between axles) are the critical parameters. Aircraft-specific limits are shown in appendix B.

5.3.1.1.2 Cargo compartment clearances.

Equipment and cargo to be air transported shall be designed or purchased such that a clearance of not less than 6 inches between the top/sides of the equipment and aircraft interior is maintained. (This facilitates quick loading and unloading and takes into account item movement or deformation during flight.) Aircraft limits are shown in appendix B. Any existing cargo item exceeding these limits shall be evaluated by ATTLA.

TABLE I. Cargo compartment design box.

Dimension (in)	C-130 A-J	C-130J-30	C-17	C-5
Floor Length[1]	468	648	778[2] 818[2]	1459
Ramp Length[1]	125	125	257[3] 238[3]	116 (Fwd) 155 (Aft)
Width	107[4] 105 (at the floor)	107[4] 105 (at the floor)	204[5]	216[5]
Height[6]	102	102	142 156 (aft of wingbox)	108-156, see appendix B

[1]Floor and ramp lengths are available floor space.

[2]40 additional inches of centerline floor length are available at 150” wide.

[3]238 for cargo requiring ramp toes to load.

[4]Width dimension leaves the required 6 inch clearance on each side, but not the safety aisle(s).

[5]Width dimension leaves the required 6 inch clearance on each side.

[6]Height dimension is 6 inches from ceiling low point(s).

If the item is to be parked with a portion of the item overhanging the aircraft ramp, the item’s overhang ground clearance angle shall be sufficiently high to prevent contact with the aircraft ramp in the closed position. Overhang length and ground clearance are the critical parameters for determining if the item exceeds aircraft overhang limits as shown in appendix B.

5.3.1.1.2.1 Emergency access and safety aisle.

The item’s length, width, and height should allow a safe passageway for crew members and, in some cases, passengers, around the item. The passage is available on most cargo aircraft if the cargo is placed within the cargo envelope, except for C-130 in the wheel well area. The safe passageway for C-130 is defined in appendix B.

Emergency access requirements for CRAF aircraft should be satisfied in accordance with Federal Aviation Regulation, Part 25, paragraph 25.803.

5.3.1.2 Size verification methods.

Compliance with the requirements of 5.3.1.1. shall be met when it can be shown by measurement, engineering analysis, validation loading, or formal test loading.

5.3.2 Weight limits.

When in shipping configuration, item gross weight and weight distribution shall meet the requirements of the following subparagraphs as appropriate to the type of item under consideration.

The limits for the following parameters are shown in table III. More detailed limits are shown in appendix B.

5.3.2.1 Weight requirements.

5.3.2.1.1 Gross weight/center of gravity.

The gross weight of items in their shipping configurations shall not exceed the aircraft limits specified in appendix B for the mission/aircraft combination under consideration. The center of gravity of the total load may not cause the aircraft to be outside its flight stability limits when the load is positioned longitudinally or laterally inside the aircraft. The aircraft limits are shown in the aircraft's cargo weight loading envelope chart.

5.3.2.1.2 Aircraft compartment limits.

The weight distribution of the item(s) shall not exceed individual cargo compartment weight limits as shown for each aircraft in table III and appendix B for specific aircraft.

5.3.2.1.3 Aircraft roller conveyor limits.

The weight distribution of the item(s) shall not exceed individual aircraft roller conveyor limits for loading and during flight. The detailed limits are shown in table III and appendix B for specific aircraft. A.5.3.4 describes a method for computing roller loads.

5.3.2.1.4 Concentrated loads/surface contact loads.

Concentrated loads shall not exceed the rated values of the aircraft compartment where they are located. This requirement applies to non-rolling contact with the aircraft floor during loading or flight (treads/tracks have separate limits). The detailed limits are shown in table III and appendix B.

Cargo shall not have metal-to-metal contact with the aircraft floor. Padding (wood or plastic) may be built into the base or achieved by placing shoring between the base and cargo floor.

5.3.2.1.5 Longitudinal floor (running) loads.

Cargo shall not exceed aircraft longitudinal running load limits for loading or flight. The detailed limits are shown in table III and appendix B for specific aircraft.

5.3.2.1.6 Lateral floor loads.

Cargo shall not exceed aircraft lateral running load limits for loading or flight. The detailed limits are shown in table III and appendix B.

5.3.2.1.7 Jackstand and tongue loads.

Loads imposed on the aircraft floor/ramp by vehicle tongues shall not exceed their maximum rated capacity, when specified. Jackstands and other types of support structure shall withstand 4.5 times the intended carrying weight (to meet the 4.5 G download requirement in 5.3.3.1). The stand shall have a locking mechanism that prevents inadvertent collapse or "backing off" due to vibration.

Pneumatic and hydraulic stands shall not be used for flight without a mechanical lock because they can leak and lose pressure.

Different aircraft floor limits apply if the jackstand is fitted with a foot or a wheel. For a foot or plate, concentrated load limits, lateral load limits, and longitudinal load limits apply. For a wheel, axle load limits and wheel/tire limits or solid wheel limits apply. The detailed limits are shown in table III and appendix B for specific aircraft.

5.3.2.1.8 Axle loads and axle spacing limits.

Vehicle axle loads shall not exceed the aircraft compartment loading/flight load limits at the appropriate axle spacing shown in table III and appendix B. Axles spacing requirements vary by aircraft and two axles may be treated as a single axle whose weight is the combined weight of both axles when they are too close together. Axles, of any spacing, can be parked to straddle the boundary between compartments. Each axle is subjected to requirements defined for the aircraft compartment(s) in which it may be carried.

5.3.2.1.9 Pneumatic wheel/tire loads.

Vehicles and other wheeled cargo shall not impose pneumatic tire loads in excess of the aircraft compartment limitations for both flight and loading conditions. This is in addition to the requirements for axle loads and axle spacing.

Tires with a run flat core not based on reinforced sidewalls, or with internal pressure exceeding 100 psi, are restricted to the solid wheel floor limitations. However, on the C-5, tires up to 300 psi may use pneumatic wheel limits. The C-17 imposes contact-pressure requirements wherein high pressure tires may not be treated as pneumatic. (ATTLA reserves the right to examine run-flat tires on a case-by-case basis.)

Off-road, agricultural, or industrial tires with deep treads may necessitate rolling and parking shoring due to load concentration by the tread pattern. Foam-filled tires are nominally treated as hard rubber/steel but may be treated as pneumatic depending on individual tire/fill characteristics. Reducing tire pressure to meet limits is not an acceptable practice. Any such procedure shall be certified for air transport use by ATTLA. See B.3.2.3.

5.3.2.1.10 Solid wheel loads.

Vehicles and other wheeled cargo shall not impose steel/hard rubber wheel loads in excess of the aircraft compartment limitations for both flight and loading conditions. This is in addition to the requirements for axle loads and axle spacing. Tires with a run flat core not based on reinforced sidewalls, or with internal pressure exceeding 100 psi, are restricted to the solid wheel floor limitations. However, on the C-5 tires up to 300 psi may use pneumatic wheel limits. Foam-filled tires are nominally treated as solid wheels but may be treated as pneumatic depending on individual tire/fill characteristics. See B.3.2.3 for individual aircraft limits.

5.3.2.1.11 Tracked vehicles.

Vehicles and other tracked cargo shall not impose track loads in excess of the aircraft compartment limitations for both flight and loading conditions. Grousers or cleats, such as on bulldozers, require rolling shoring from the end of the ramp to the parking location to protect the cargo floor. The shoring shall be not less than 1 inch thick or the depth of the track pad or cleat if greater than 1 inch. Tracked vehicles with worn track pads shall also meet this requirement. Additional shoring may be required to distribute the weight within aircraft limits as shown in appendix B.

5.3.2.1.12 Vehicle suspension limits.

Military rated equipment may weigh up to the rated military tactical (cross-country) limits.

Commercially rated loads may carry up to the commercial equivalent of the military tactical (cross-country) limits. If the equivalent limits are unknown, the item may weigh up to 80 percent of the commercial axle rating without being supported. If 80 percent of the rated axle capacity is exceeded, the item may be supported by built-in auxiliary support stands, sleeper shoring, or equivalent systems. Alternatively, test or complete analysis is required to verify that the item can withstand the downward load factor. The support system shall not exceed the aircraft floor contact limits for flight and shall be able to withstand a 4.5 G download.

Special use vehicles weighing over 20,000 pounds, with wide base, off-road tires whose inflation pressure is not greater than 80 psi, and without a suspension system shall be sleeper shored for flight. (Examples are road graders, forklifts, and wheel loaders.)

Air ride suspension shall be fully retracted for flight. This is to prevent collapse of the suspension if a leak occurs. If the suspension collapses then tiedowns will loosen, compromising restraint.

Support system weight ratings such as for support (jack) stands shall not exceed the manufacturer's gross weight rating.

5.3.2.1.13 Ramp hinge limits.

In addition to the clearance requirements for ramp cresting, cargo items designed to be loaded from the ground up the inclined aircraft ramp shall not impose cresting loads in excess of the ramp hinge limits shown in appendix B.

5.3.2.1.14 Palletized cargo.

Where equipment can be delivered secured to a pallet that locks into an integral aircraft rail system, the entire unit load shall meet the requirements for restraint. Where such equipment can be secured to the pallet with approved nets and straps, the equipment need not meet the requirements for restraint. All other equipment shall be provided with tiedown provisions in accordance with applicable requirements. In all cases, palletized loads shall not exceed the limits shown in table II.

TABLE II. Pallet and platform limits.

Lengths: in Weights: lb	463L Pallet	Type V Platform	DRAS Platform	Plywood Skid Board	Warehouse Pallet Generally wood, 6-in. thick
Length Usable[1]	84	96 to 384	192	46	40
Width Usable	104	100	82	44	48
Cargo Height	45/96/100/>100[3]	See aircraft tip off curve	See aircraft tip off curve	88	90
Thickness	2.25	3.5	3.5	0.75-1.0	6
Material	Aluminum/Wood	Aluminum	Aluminum	Wood	Wood
Tare Weight	290 (355 w/ net)	See FM/TO	1,590 w/ outriggers 1,942 w/o outriggers	See FM/TO	75-100
Max Rigged Weight[2]	10,355/single pallet	See FM/TO	14,500	2,328	2000
Cargo Weight Limit	See rigged weight	See FM/TO	See FM/TO	See FM/TO	Max rigged minus tare & restraints
Contact PSI	250				

[1]463L Pallets can be linked in trains up to six long. In this case add 4 inches of usable length for space between each added pallet.

[2]Rigged weight includes the pallet/platform/skid board, cargo, cargo rigging equipment, parachutes, and parachute rigging equipment, to include drogue chutes, static lines, etc. For specific aircraft pallet height limitations see A.4.1.1.1.

[3]463L max cargo height depends on which cargo net(s) are used, cargo weight, and if special procedures are developed for air transport certification.

Aircraft roller load limits are specified in table III and appendix B for each aircraft.

5.3.2.2 Weight verification methods.

Verification shall be done by inspection. Manufacturer data may be used as an alternative to verify weight for certification. Standards cited in applicable sections of this document shall be used to validate the nonstandard pallet or skidded item.

TABLE III. Aircraft limits.

	Limit	Mode	C-130 A-H	C-130J	C-130J-30	C-17	C-5
Bulk Cargo and Rolling Stock, as applicable	Ramp Toes/Auxiliary Ground Loading Ramps (lb)	Loading	6,500/wheel 13,000/axle	6,500/wheel 13,000/axle	6,500/wheel 13,000/axle	Appendix B	Appendix B
	Ramp Toes/Auxiliary Ground Loading Ramps Size (inch)	Loading	66 Lx21 W	66 Lx21 W	66 Lx21 W	89"Lx41"W(Outbrd) 89"L x58"W (inbrd)	Appendix B
	Auxiliary Truck Loading Ramp (lb)	Loading	12,500/each	12,500/each	12,500/each	n/a	Appendix B
	Auxiliary Truck Loading Ramp Size (inch)	Loading	36 Lx26 W	36 Lx26 W	36 Lx26 W	n/a	Appendix B
	Bridge Plate	Loading	2,000 (ramp unsupported) 7,500 (ramp supported)	2,000 (ramp unsupported) 7,500 (ramp supported)	2,000 (ramp unsupported) 7,500 (ramp supported)	7,500, each (15,000 Total)	7,500, each, (locally manufactured)
	Compartment Loads (lb)	Loading	Appendix B	Appendix B	Appendix B	Appendix B	Appendix B
	Compartment Loads (lb)	Flight	Appendix B	Appendix B	Appendix B	Appendix B	Appendix B
	Concentrated loads (PSI)	Loading	50	50	50	Appendix B	Appendix B
	Concentrated loads (PSI)	Flight	50	50	50	Appendix B	Appendix B
	Non-Treadway Wheel (lb)	Loading/ Flight	Half the axle limit	Half the axle limit	Half the axle limit	n/a	n/a
	Non-Treadway Axle Load (lb)	Loading	5,000	5,000	5,000	n/a	n/a

TABLE III. Aircraft limits - Continued

	Limit	Mode	C-130 A-H	C-130J	C-130J-30	C-17	C-5
Bulk Cargo and Rolling Stock, as applicable	Non-Treadway Axle Load (lb)	Flight	5,000	5,000	5,000	n/a	n/a
	Non-Treadway Running Loads (lb/linear ft)	Loading	2,800	1,600	1,600	n/a	n/a
	Non-Treadway Running Loads (lb/linear ft)	Flight	Appendix B	1,600	1,600	n/a	n/a
	Non-Treadway Running Loads (PSI)	Loading	6.7	4.4	4.4	n/a	n/a
	Non-Treadway Running Loads (PSI)	Flight	3.1	4.4	4.4	n/a	n/a
	Lateral Running Loads (lb/in width or PIW)	Loading/ Flight	n/a	n/a	n/a	Appendix B	n/a
	Ramp Axle Weight (lb)	Loading	13,000	13,000	13,000	Appendix B	Appendix B
	Ramp Axle Weight (lb)	Flight	3,500 (limit to one axle)	3,500 (limit to one axle)	3,500 (limit to one axle)	Appendix B	Appendix B
	Ramp Load, Total (lb)	Flight	5,000	5,000	5,000	19,000 to 40,000, Appendix B	Appendix B
	Ramp Running Load (lb/linear in)	Flight	500	500	500	n/a	3,600 lb/l 20 in
	Tongue/Jackstand Load between treadways (lb)	Loading/ Flight	2,000	2,000	2,000	n/a	n/a
	Maximum Axle Load (lb) (C-130 Maximum Treadway Load)	Loading	13,000	13,000	13,000	36,000 (single) 40,000 (bogie, 42 inch min. spacing)	Appendix B

TABLE III. Aircraft limits - Continued

	Limit	Mode	C-130 A-H	C-130J	C-130J-30	C-17	C-5
	Maximum Axle Load (lb)	Flight	6,000 lb (FS 245-	6,000 lb (FS 245-	6,000 lb (LS 345-537,	36,000 (Compt. E)	20,000 (FS 517-
Bulk Cargo and Rolling Stock, as applicable	(C-130 Maximum Treadway Load)		336, 683-737) 13,000 lb (FS 337-682) 48 inch spacing, min	336, 683-737) 13,000 lb (FS 337-682) 48 inch spacing, min	882-1017) 13,000 lb (LS 537-882) 48 inch spacing, min	40,000 (bogie, 42 inch min. spacing, Compt. E) When parked side-by-side different min. spacing applies	724, 1884-1971) 36,000 (FS 724-1884) (40 inch spacing)
	Treadway Loads (PSI)	Loading	50	50	50	n/a	n/a
	Treadway Loads (PSI)	Flight	Appendix B	Appendix B	Appendix B	n/a	n/a
	Treadway Location (BL), left and right of center	Loading/ Flight	+/-29 (a/c -509 and below) to +/- 50 +/-15 to +/- 50	+/-15 to +/-50	+/-15 to +/-50	n/a	n/a
	Maximum Running Loads (lb/linear ft)	Loading	3,000 (Treadway)	3,000 (Treadway)	3,000 (Treadway)	Appendix B	Appendix B
	Treadway Running Loads (lb/linear ft)	Flight	Appendix B	Appendix B	Appendix B	n/a	n/a
	Treadway Running Loads (PSI)	Loading	7.2	7.2	7.2	n/a	n/a
	Treadway Running Loads (PSI)	Flight	Appendix B	Appendix B	Appendix B	n/a	n/a
	Treadway Wheel (lb)	Loading/ Flight	Half the axle limit	Half the axle limit	Half the axle limit	n/a	n/a

TABLE III. Aircraft limits - Continued

	Limit	Mode	C-130 A-H	C-130J	C-130J-30	C-17	C-5
Palletized Cargo	**Rollers**						
	Bi-directional Roller (lb/roller)	Loading	5,000/row	2,667/row	2,667/row	2,000	Appendix B
	Bi-directional Roller (lb/roller)	Flight	Appendix B	Appendix B	Appendix B	2,000	Appendix B
	Omni-Rollers (lb/roller)	Loading	n/a	n/a	n/a	1,940	Same as Bi-Directional
	Omni-Rollers (lb/roller)	Flight	n/a	n/a	n/a	1,000	Appendix B
	Teeter Roller (lb)	Loading/ Flight	n/a	n/a	n/a	3,000	Appendix B
	Palletized Loads, Running Roller Loads per Row (lb/lin ft)	Loading	6,000	3,200	3,200	n/a	Appendix B
	Palletized Loads, Running Roller Loads per Row (lb/lin ft)	Flight	Appendix B	Appendix B	Appendix B	n/a	Appendix B
	Locks						
	ADS Locks, Aft (lb)	Flight	0-4000 (RH)	0-3,350 / 6,750	0-3,350 / 6,750	0-7,500 (RH) 15,533 (LH & ramp)	n/a (portable kit)
	ADS Locks, Fwd (lb)	Flight	20,000 (RH, Adjustable)	26,900	26,900	14,800	n/a (portable kit)
	Logistic Locks, Aft (lb)	Flight	10,000 (LH)	Same locks as ADS	Same locks as ADS	10,000	7,500

TABLE III. Aircraft limits - Continued

	Limit	Mode	C-130 A-H	C-130J	C-130J-30	C-17	C-5
	Logistic Locks, Fwd (lb)	Flight	20,000 (LH)	Same locks as ADS	Same locks as ADS	20,000	15,000
Restraint	**Tiedowns**						
	CGU-1/B Tiedown Devices (5,000 lb)		40	40	40	50	50
	MB-1 Tiedown Devices (10,000 lb)		34	34	34	46	75
	MB-2 Tiedown Devices (25,000 lb)		6	6	6	46	75
	Ramp Tiedown Rings (pounds)		5,000	5,000	5,000	25,000	25,000
	Floor Tiedown Rings (pounds)		10,000 (Floor) 25,000 (3 fore, 2aft)	10,000 (Floor) 25,000 (2 aft)	10,000 (Floor) 25,000 (2 aft)	25,000	25,000
	Loading Aids						
	Snatch Block (pounds)		13,000	13,000	13,000	20,000	15,000
	Wheeled Pry Bar (pounds)		2,000 (MA-1 only)	2,000/Appendix B	2,000/Appendix B	1,000	1,000
	Winch Cable Load-Single Line pull (pounds)		4,000 (Bulldog & Hoover, Portable) 6,500 (HCU-9/A, Portable)	6,500 (Lucas, Internal) 4,000 (Bulldog & Hoover, Portable) 6,500 (HCU-9/A, Portable)	6,500 (Lucas, Internal) 4,000 (Bulldog & Hoover, Portable) 6,500 (HCU-9/A, Portable)	7,500 nominal 5,760 pneumatic tires 4,900 solid wheels	6,500 C-5A 7,500 C-5B/C

5.3.3 Restraint.

Cargo items, in their shipping configuration(s), shall be capable of being restrained under the conditions shown in table IV and in table V. After an encounter with such conditions the cargo item shall maintain its unitary integrity, not pose a hazard to the aircraft or crew, nor prevent egress or rescue from a crashed aircraft. Cargo items exclusively loaded on HCU-6/E pallets and restrained by MIL-N-27444 nets do not have to meet the requirements of 5.3.3.1, 5.3.3.2, or 5.3.3.3.

5.3.3.1 Restraint conditions.

The forces are considered to be applied independently. All directions are relative to the aircraft. If the item can be loaded facing either direction then the forward requirement applies to both forward and aft.

TABLE IV. Restraint: load factors.

Direction	G-Load
Up[1]	2.0 G 3.7 G (nuclear cargo)
Down[1 & 2]	4.5 G
Forward[3]	3.0 G 2.0 G (with forward cargo barrier on KC-135, KC-10) 1.5 G (with forward barrier on CRAF airplanes) 9 G (if cargo is to be carried aft of personnel on any aircraft)
Aft[3]	1.5 G
Lateral[3]	1.5 G

[1]These are limit loads and require at least a 1.5 factor of safety on ultimate strength. Item function should be maintained.

[2]Vehicles and other equipment shall be capable of withstanding the downward load factor without damage to their wheels, suspension systems, or support.

[3]These are ultimate loads. The item need not remain functional but shall maintain unitary integrity; tiedown provisions may yield but not break.

Cargo items shall be capable of withstanding the following changes in velocity (Δ V) within 0.1 second. Onset/decay rates are described in the guidance in section 6. The final velocity must be held long enough for an adequate cargo response to the input.

TABLE V. Restraint: velocity changes.

Direction	**Δ V**
Up[1]	10.0 ft/sec (15.2 ft/sec for nuclear cargo)
Down[1 & 2]	11.5 ft/sec
Forward[3]	10.0 ft/sec 7.5 ft/sec (with forward cargo barrier on KC-135, KC-10) 5.0 ft/sec (with forward barrier on CRAF airplanes) 30.0 ft/sec (if cargo is to be carried aft of personnel on any aircraft)
Aft[3]	5.0 ft/sec
Lateral[3]	5.0 ft/sec

[1]These are limit loads and require at least a 1.5 factor of safety on ultimate strength. Item function should be maintained.

[2]Vehicles and other equipment shall be capable of withstanding the downward load factor without damage to their wheels, suspension systems, or support.

[3]These are ultimate loads. The item need not remain functional but must maintain unitary integrity; tiedown provisions may yield but not break.

Internally carried equipment is not required to meet the load factors in tables IV and V. However, the primary cargo item is then additionally required to contain all loose objects produced by the loads to prevent them from becoming a hazard in the cargo compartment.

5.3.3.2 Tiedown provisions.

Equipment shall be provided with no less than four tiedown provisions or locations to adequately restrain the equipment subjected to the accelerations specified in restraint criteria. Provisions may consist of tiedown rings, structural cutouts, axles, frame members, or special equipment. Note that axles are allowed to provide up to half of the total required restraint in any direction (i.e., total restraint from all axles can only provide a maximum 1.5 G forward restraint). This prevents the item from separating from its axle. Tiedown provisions shall accommodate both ends of MIL-DTL-25959 and MIL-PRF-27260 tiedown devices and shall be marked in accordance with marking requirements (5.3.4). The tiedown provisions shall be capable of accepting the maximum number of tiedown devices as required by the tiedown pattern. These tiedown provisions shall be suitable for use in conjunction with the tiedown provisions on the aircraft floor. Aircraft floor tiedowns have a capacity of 10,000 pounds or 25,000 pounds, depending on the specific aircraft. See appendix B for specific aircraft tiedown pattern.

Ultimate strength for each tiedown provision shall be at least 1.5 times yield strength.

It is recommended that tiedown rings provide the same strength at all angles. See figure 2 for illustration. Any specific directional strength limits for tiedowns must be identified to prevent damage because it is nominally assumed that a tiedown has the same strength in all directions. See figure 3 for example tiedown provisions.

The provisions shall be located symmetrically about the equipment longitudinal centerline. Provisions shall be located to provide restraint in both the fore and aft direction of the equipment. The area of action for each provision is illustrated on figure 2. Longitudinal spacing between provisions shall be no less than 20 inches for 10,000 pound provisions, and 40 inches for 20,000 pound or stronger provisions. If a provision's location is suitable for use in only one direction, an additional provision must be provided for use in the opposite direction. Restraint devices should not contact any other part of the equipment. When a restraint device must contact a part of the equipment, testing must demonstrate that the affected part(s) has sufficient strength to withstand the force exerted to prevent permanent deformation of any part of the equipment, and that contact will not adversely affect the material of the tiedown device.

Provisions shall be located on the chassis of wheeled vehicles or the hull of tracked vehicles. Provisions shall be no higher than 6 feet on the equipment and no less than 2 feet above ground level. Provision placement should take into consideration vertical center of gravity of the equipment to prevent tipping.

Welded-on tiedown provisions not installed IAW applicable American Welding Society specifications, shall be de-rated by a factor of two (2) due to difficulty in verifying quality of the weld for the life of the item. This may be alleviated by performing Non-Destructive Evaluation to show that the weld is of adequate quality to maintain the rated capacity.

NOTE: See 6.5.3.2 VERIFICATION LESSONS LEARNED for information on vehicle weight growth.

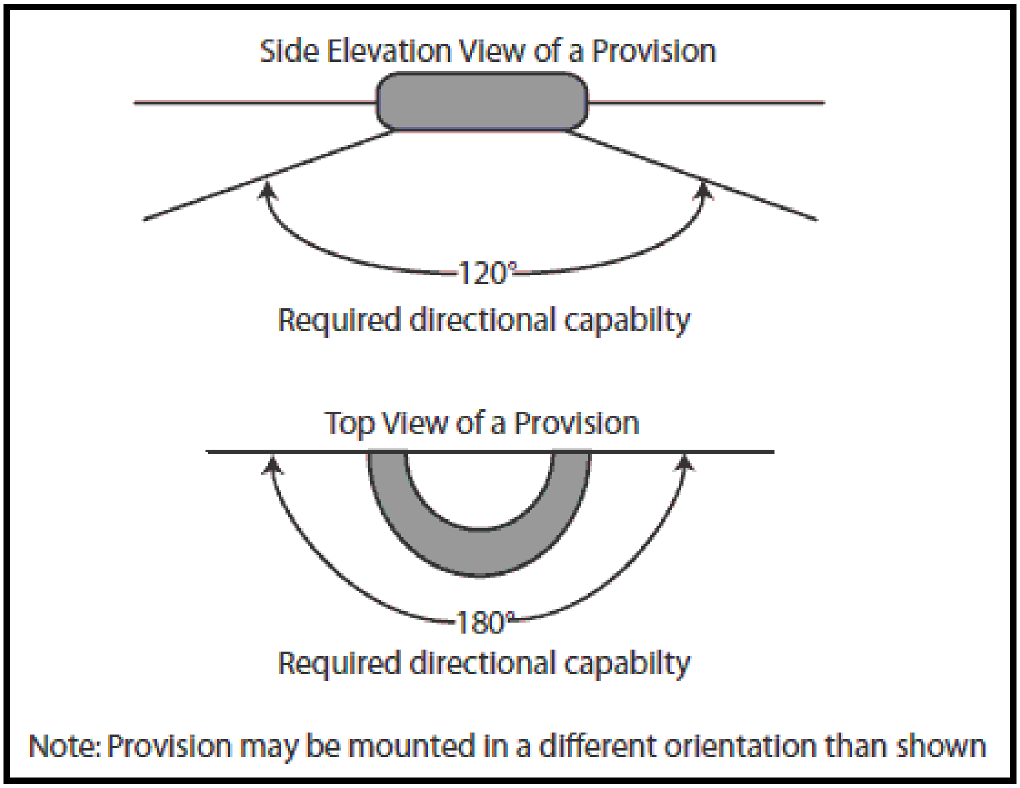


FIGURE 2. Tiedown rings.

Other Tiedown Provisions

Preferred Tiedown Provisions:
Example Configurations

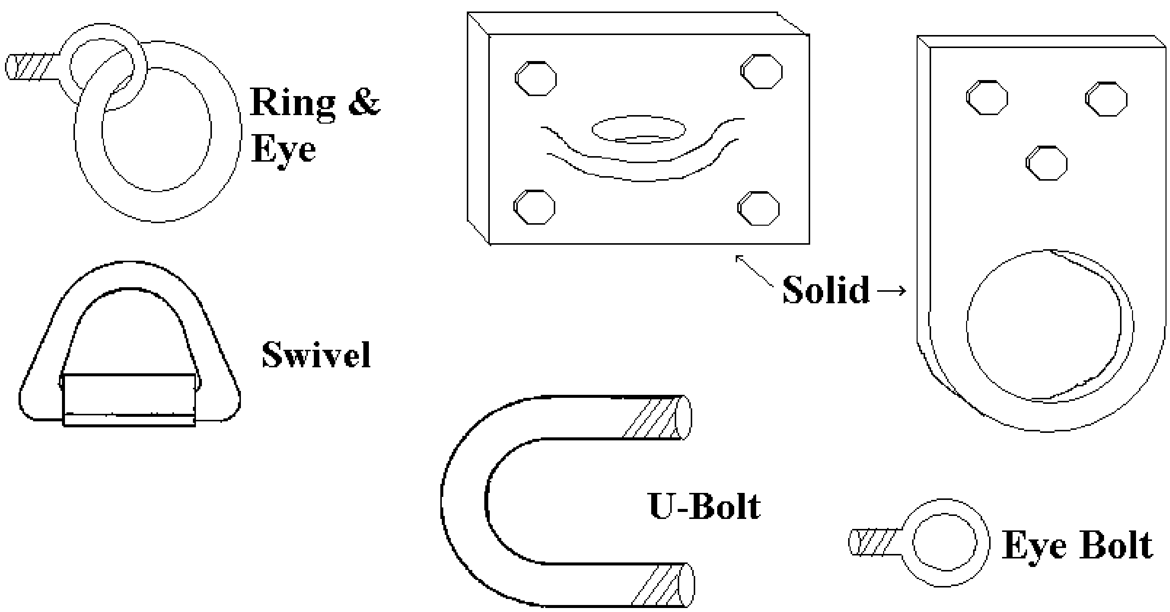


FIGURE 3. Example tiedown provisions.

5.3.3.3 Cargo without tiedown provisions.

Items without tie-down provisions shall be capable of being restrained against and withstanding the forces imposed by aircraft flight and maneuvering operations as shown and stated in section 5.3.3.1 for restraining loads. The requestor shall identify structural hard points where straps/chains may be wrapped around the item and pulled tight. The hard points shall be marked as tiedown points and marked with rated capacities, see 5.3.4.1.1.

5.3.3.4 Structure.

The item shall remain in one piece and be capable of being unloaded in the same manner in which it was loaded (maintain loadability), unless otherwise detailed in the loading plan. (e.g., a palletized item shall not crush or penetrate the pallet and render it immobile, thus requiring removal via forklift. A wheeled or tracked vehicle shall not crush its own suspension and render itself immobile. A self-propelled vehicle shall remain capable of driving off, if it was driven on. etc).

Military rolling stock gross weight shall not exceed the vehicle's tactical (cross-country) rating. If the tactical rating is exceeded, test or complete analysis shall be conducted to verify that the item can withstand the load factors and velocity changes.

Commerical rolling stock weight shall not exceed 80 percent of the manufacturer's gross vehicle weight rating. If 80 percent of the GVWR is exceeded, test or complete analysis is required to verify that the item can withstand the load factors and velocity changes.

5.3.3.5 Verification methods.

Compliance with the restraint requirements shall be assured when it can be demonstrated by engineering analysis or actual test that the item in its shipping configuration—and restrained in a manner representative of how it would be restrained for flight—can be subjected to the stated static and dynamic loads without loss of structural or unitary integrity of the item and without incurring damage to the aircraft.

Loss of structural or unitary integrity during analysis or test shall cause rejection of the load for airlift. Loss of loadability during verification of the vertical up or vertical down restraint criteria requirement, shall be sufficient to cause rejection of the load for airlift.

For palletized items in which the item is restrained to the pallet, the item is center of gravity location shall be verified by analysis or test.

If a vehicle does not have a cross-country weight rating and its weight or axle/suspension loading exceeds 80 percent of its highway gross vehicle rating, test or complete analysis is required to verify that the item can withstand the downward load factor.

The requirements of 5.3.3.2 shall be met when it can be shown by engineering analysis or actual test that the proposed tiedown provisions are adequate in strength, location, size, and number to accept the required MIL-DTL-25959 and MIL-PRF-27260 tiedown devices and provide the restraint required in 5.3.3.1. Cargo without tiedown provisions must be similarly verified using proposed tiedown locations instead of provisions.

5.3.4 Markings.

5.3.4.1 Marking requirements.

Equipment shall be marked in accordance with the provisions of MIL-STD-129 and MIL-STD-209, as appropriate, to provide the information necessary to facilitate loading and restraining the item in the aircraft. Unless otherwise specified, the marking shall be stenciled in an appropriate location or provided on the vehicle data plate. Markings shall include at least those defined below:

5.3.4.1.1 Tiedown provisions.

Tiedown provisions shall be identified, the allowable load shall be indicated, and a representative tiedown grid pattern shall be proposed as defined in the order or contract.

5.3.4.1.2 Shipping weight and center-of-gravity location.

The shipping weight of the equipment in an air transportable condition shall be marked in a conspicuous location. The center of gravity along each axis influencing the method of loading and tiedown shall be marked on the item. This information allows the loadmaster to place the cargo in the proper location on the aircraft.

5.3.4.1.3 Hoist fittings & forklift tines.

When equipment or cargo is to be hoisted onto an aircraft or onto a pallet or platform, the hoisting fittings shall be identified and the hoisting capacity shall be marked. Hoist fittings not suitable for use as tiedown provisions shall be marked accordingly. The locations where forklift tines may be applied shall be identified.

5.3.4.1.4 Other markings.

Other markings shall be provided to address the following, where applicable:

- a Instructions for retraction of wheels or casters to provide greater bearing surface or clearance.
- b Installation of special struts or braces to meet flight loads.
- c. Orientation(s) in aircraft when critical.
- d. Instructions for special servicing or other preparation for air shipment.
- e. Other precautions to be observed during on/offloading and flight.

5.3.4.2 Verification methods.

Verification shall be conducted by inspection or manufacturer’s data (e.g., drawings/photographs).

5.3.5 Air transport environment.

The air transport environment that the item in its shipping configuration shall withstand and applicable verification methods are defined below.

5.3.5.1 Air transport environment requirements.

5.3.5.1.1 Acceleration, shock, and vibration.

Cargo items shall be designed or configured for transport to withstand, without damage or loss of performance, the shock and vibration environment encountered in aircraft flight and ground maneuvering operations or during cargo on/offloading. The item, in shipping configuration, shall withstand acceleration and shock levels equivalent to the restraint requirements for each aircraft as shown in section 5.3.3. In addition, cargo with suspension frequency modes between zero and 20 Hz shall have sufficient damping to prevent resonance. Vibration environments for each aircraft can be obtained from an aircraft's Environmental Criteria Document (ECD). In case of unavailability of an ECD or measured data, aircraft general vibration environments described in MIL-STD-810, Environmental Test Methods shall be used.

5.3.5.1.1.1 Verification methods.

Tolerance to acceleration, shock, and vibration shall be provided by analysis, demonstration, or formal testing. The item, in its transport configuration, may be subjected to the actual environment or tested to methods described in MIL-STD-810, Environmental Test Methods, or equivalent. In addition, cargo with suspension frequency modes between zero and 20 Hz shall have sufficient damping as verified by test, analysis, or demonstration.

5.3.5.1.2 Rapid decompression.

The item, including critical subcomponents, shall withstand an internal pressure differential of 8.3 psi developed in 0.5 sec or less without any part of the item becoming a hazard. The aircraft system automatically maintains a maximum of 8.3 psi cabin pressure differential with the atmospheric air pressure.

5.3.5.1.2.1 Verification methods.

Compliance with this requirement shall be verified by analysis or formal testing which confirms that the test item can withstand an internal pressure differential of 8.3 psi developed in 0.5 sec or less without loss of unitary integrity (i.e., any part of the item becoming a missile). A sample calculation for analytical verification of venting area(s) is included in 6.5.5.1.2.

5.3.5.1.3 Explosive vapor.

Any cargo that is transported in tanker aircraft (e.g., KC-10, KC-135) that has the potential to cause a fire or explosion in an explosive fuel vapor environment if the item fails or operates in the aircraft shall be tested. (Cargo with electronic components, is metallic and carries explosives, or which carries material under high pressure should be tested or analyzed.)

5.3.5.1.3.1 Verification methods.

The item shall be tested to methods described in MIL-STD-810, Method 511.4 or equivalent.

5.3.5.1.4 Extreme temperature.

The cargo shall be packaged to withstand temperature extremes of -40 ºF to 120 ºF without posing a hazard to the aircraft and aircrew. Extreme low temperature may be caused by a prolonged cold soak in an arctic location or if a hatch blows (see rapid decompression) at high altitude. Extreme high temperatures can occur when the aircraft is heat soaked in a high-temperature location. Applicability of this requirement will be determined by the item's concept of operations.

5.3.5.1.4.1 Verification method.

If applicable, the users or manufacturer shall provide assurance that the item can withstand these conditions or the item shall undergo testing.

5.3.5.1.5 Electromagnetic environment.

This section shall apply to all munitions/explosives, electronic devices, and materials that are installed and transported on the aircraft to ensure safety of flight and mission capability, and to prevent hazards to aircrew and aircraft. Such items shall meet or exceed the criteria shown in table VI.

5.3.5.1.5.1 Electromagnetic interference and electromagnetic compatibility (EMI/EMC) requirements.

The item, in its air transport configuration, shall meet the requirements of MIL-STD-461 or an equivalent standard. See table VI.

Passive or electrical/electronic equipment/subsystems that will not be operated while on aircraft, including loading/unloading, do not need to be tested unless failure of the item or subsystem is hazardous to the aircraft and aircrew.

Safety Critical as used in table VI (and MIL-STD-461F) is defined as:
A category of subsystems and equipment whose degraded performance could result in loss of life or loss of vehicle or platform.

TABLE VI. EMI/EMC test requirements.

Type of equipment to be installed on aircraft	Is EMI laboratory testing required? (Yes/No and Type)	Is EMC aircraft-level testing required? (Yes/No and Type)
1. New or permanently changed/modified onboard electronic equipment.	Yes E & S	Yes R, O, G
2. Temporary non-transmitting electronic equipment meant to be used for a fixed period of time only.	Yes Safety Critical – E & S Non-safety-critical – E	Lab compliant – No Non-compliant* - Yes – O, G
3. Temporary transmitting electronic equipment meant to be used for a fixed period of time only.	Yes Safety Critical – E & S Non-safety-critical – E	Lab compliant –Yes – R, G Non-compliant* - Yes – R, O, G
4. Carry-on (rolled-on/rolled-off) non-transmitting electronic equipment.	Yes Safety Critical - E & S Non-safety-critical - E	Lab compliant – No Non-compliant* - Yes – O, G
5. Carry-on (rolled-on/rolled-off) transmitting electronic equipment.	Yes Safety Critical – E & S Non-safety-critical – E	Lab compliant – Yes – R, G Non-compliant* - Yes – R, O, G
6. Electrically initiated devices (EID) and electro-explosive devices (EED).	Yes H	No

*Minor non-compliance only. Minor "non-compliance" emissions can be classified as follows:

1) Radiated emissions: Emissions at frequencies not used by any of the host aircraft antenna connected receivers or emissions associated to host platform antenna connected receiver frequencies, but that are very narrow spikes (not visually broadband) and that do not exceed 7-10 dB in amplitude.

2) Conducted emissions: Narrow spikes not exceeding 7-10 dB in amplitude. All non-compliance emissions have to be evaluated on a case-by-case basis.

Types of tests:

E – Radiated & conducted emissions (Tests: RE102, CE102 only if connected to A/C power, CE106 only if it has antenna ports).
S – Radiated & conducted susceptibility (Tests: RS103, CS101, CS114, CS115, CS116).
H – Hazard of Electromagnetic Radiation to Ordnance (HERO) component testing. EED/EID shall be instrumented and show 16.5 dB safety margin from the determined no-fire current.
R – Intentional, harmonic, and spurious emissions must be evaluated for interference in the bandpass of aircraft-antenna-connected RF receivers via spectrum analyzer scans or other similar technique.
O – Non-compliant emissions may require an evaluation of the bandpass of aircraft-antenna-connected RF receivers via spectrum analyzer scans or other similar technique.

G – Source-victim testing

5.3.5.1.5.2 **Verification methods.**

Verification methods shall be based on test and analysis in accordance with MIL-STD-461 and MIL-STD-464. MIL-STD-461 shall be used for equipment/subsystem laboratory testing prior to system verification aircraft-level testing in accordance with MIL-STD-464.

5.3.6 Special consideration cargo.

All cargo that may require special handling procedures, contains hazardous material, operates during flight, or interfaces with aircraft non-cargo systems shall be designated special consideration cargo. Non-standard cargo handling system interfaces and secondary cargo are also classified as special consideration cargo.

5.3.6.1 Special consideration cargo requirements.

5.3.6.1.1 **Hazardous material.**

Where equipment is capable of carrying or having attached to itself hazardous materials, the containment or packaging of these materials shall meet the requirements of AFMAN 24-204(I)/TM 38-250/NAVSUP PUB 505/MCO P4030.19I/DLAI 4145.3/DCMAD1, CH3.4 (HM 24), or Title 49, Parts 100-199, Code of Federal Regulations. The containment, packaging, or other preparation of these materials shall be performed and certified such that they do not jeopardize the safety of cargo handlers, flight crews, or the aircraft. The item in its air transport configuration shall provide the aircrew with access to the material in case of emergency.

Any material not shown in AFMAN 24-204(I), carried in a nonstandard container, or shipped in nonstandard quantity requires approval from the proponent of AFMAN 24-204(I); currently the Air Force Logistic Support Office or 401 SCMS/GUMAA.

5.3.6.1.1.1 **Quantity of fuel/hazardous material.**

Container size is not restricted (within aircraft limits) but quantity can be restricted. The container shall not leak material into the aircraft. Requirements for quantity are found in AFMAN 24-204(I). Table VII below gives some guidelines derived from those requirements.

TABLE VII. Fuel in tank guidelines.

Fuel Tank Location	Floor loaded	Ramp loaded
Vehicles/self-propelled units—Tank must be closed to withstand flight loads.	1/2 tank	Drained[1]
Engine-powered support equipment[2]	Drained	
Aircraft and helicopters	Not to exceed 150 gallons or 3/4 full, whichever is less.	
Trailers	Drained	
Palletized units[3]	Drained	
Tactical, contingency, or emergency airlift	See AFMAN 24-204(I) Chapter 3	

[1]If fuel tank openings cannot be located on the high side of the ramp.

[2]If engine powered support equipment is fed from the same tank as the primary means of propulsion then this limit does not apply.

[3]Units palletized because of aircraft floor substructure may contain fuel. They are restricted by their characteristics instead of the fact that they are palletized.

5.3.6.1.1.2 Verification methods.

The hazardous item(s) shall be certified as meeting packaging requirements by the issuance of a DD Form 1387-2, Special Handling Data/Certification, by a qualified certifier. Department of Transportation Hazard Classification information must be coordinated with 401 SCMS/GUMAA.

5.3.6.1.2 Venting.

Cargo carrying cryogenic or hazardous material with potential for gaseous leaks into the cargo compartment may be vented out of the aircraft. A capture or filtering system such as an overflow or vapor container are acceptable alternatives. These containers must be designed to the same standards as the cargo and secondary cargo.

5.3.6.1.2.1 Interface.

The design shall incorporate the necessary hardware to interface properly with the aircraft-installed facilities. Design requirements for interfacing with the vents are in appendix B or can be obtained by contacting the applicable aircraft program office. C-130 has a single, dual purpose vent port. C-17 and C-5 aircraft are equipped with cryogenic vents on the left side and exhaust vents on the right side of the cargo compartment. KC-10 has a cryogenic vent.

5.3.6.1.2.2 Verification method.

Design specification or test data shall be sent to ATTLA for analysis. A form, fit, and function test may be required. The information may be distributed to the aircraft program offices and other applicable offices for evaluation.

5.3.6.1.3 Electrical and data transmission physical interface.

The design shall incorporate the necessary hardware to interface properly with the aircraft-installed facilities.

5.3.6.1.3.1 Aircraft electrical outlets and power supply.

Cargo aircraft are equipped with service receptacles for equipment that may use electrical power during flight. See appendix B for individual aircraft requirements.

5.3.6.1.3.2 Data transmission interface.

See 5.3.5.1.5 and appendix B for EMI/EMC and electrical interface requirements.

5.3.6.1.3.3 Verification.

A list and specification of applicable components shall be provided to ATTLA and the aircraft systems program office. An on-aircraft form, fit, and function test may be required to identify problems.

Also, see AFI 11-202, Volume 3, for guidelines on operating such systems in the aircraft.

5.3.6.1.4 Bulk fluid tanks.

Bulk fluid tanks shall not leak or rupture due to the air transport environment (5.3.5).

Bulk fluid tanks without baffles (or some other means of controlling slosh) shall be airlifted only when empty or totally filled. Totally filled is defined maximum capacity with 5% subtracted for expansion.

For bulk fluid tanks seeking approval to transport at fill levels other than empty or totally filled, an analysis shall to be performed to determine that the fluid dynamics (in-flight slosh) will not:

a, Cause flight control problems due to rapid CG shift.
b, Affect the restraint or structural integrity of the container.

5.3.6.1.4.1 Verification methods.

Conformance shall be verified by analysis and demonstration. The center of gravity shift for aircraft operability will be calculated by AFLCMC/EZFS Structures Branch.

Non-leaking verification: The tank in its airlift shipping configuration, full, shall not leak while the tank is tipped at a 60 degree angle in each flight orientation (port, starboard, aft, and forward with respect to the aircraft). Tipping of the tank may be accomplished using ramps or a crane. The tank shall be held in each tipped condition for a minimum of 15 minutes and shall be observed for leakage. Any sign of leakage, permanent deformation, or failure causing an unsafe condition as a result of this test shall constitute failure of the test.

5.3.6.1.5 Personnel occupied roll-on systems.

For systems to be loaded and transported in the aircraft cargo loading systems that will be occupied during any phase of flight see MIL-HDBK-516.

5.3.6.1.6 Nuclear cargo.

For cargo that contains nuclear munitions or radioactive material, this standard presents minimum requirements. Refer to AFI 91-107 for additional requirements.

5.3.6.2 Non-standard pallet or skid loads interfacing USAF MHE.

The following requirements shall be met when unique or nonstandard pallets are used to carry cargo. This includes cargo with a built-in pallet surface or skids and unique pallets for carrying general cargo.

a. Bottom surface or skids having less than full-width bases shall be capable of safely interfacing aircraft and material handling equipment. It shall be demonstrated that such loads can traverse the roller conveyors and applicable systems of the specified aircraft and appropriate ground handling equipment; see figure 4 (also 5.3.2 and applicable data for MHE). The bottom surface shall be as smooth as possible and the ends shall be beveled or rounded to prevent gouging of the rollers. Maximum bevel angle shall be not greater than 45-degrees from horizontal.

b. Pallets or skids shall be capable of withstanding flight loads as specified in this document at full weight with cargo (5.3.5.1). The force and pressure applied to the bottom surface by each roller or row of rollers must be considered, (see table III for roller capacity, appendix B for roller locations). For example, a 10,000 lb capacity unit would have to withstand a 4.5 G downward force (45,000 lb) without yield while resting on the aircraft rollers.

c. Aircraft roller loads shall not be exceeded. (To determine roller loads follow the procedure described in A.4.3.4. Aircraft roller limits are in table III and in appendix B in the aircraft roller system section. MHE roller limits must be obtained from the responsible program office.)

d. The base shall remain within the aircraft. Material handling equipment roller conveyor size limits and dimensions with cargo shall be within aircraft size limits (5.3.1.1.2, A.4, appendix B). Consider whether the cargo can be jettisoned in case of emergency and the overall shape and size of the item fall within the tip-off curve for each airplane (appendix B).

e. The pallet/base shall be capable of withstanding the forces created by the item teetering on a single set of rollers.

f. Non-standard pallets shall be capable of securing cargo to restraint limits as specified in this document (5.3.3.1.). Nonstandard pallets shall be compatible with the aircraft 463L cargo handling system. The side rail shall match the exterior profile and indent size/shape of the drawings referenced in MIL-DTL-27443. Figure 5 and figure A-11 show examples. Alternate indent/detent spacing that meets restraint requirements may be proposed. (See appendix B for specific data on aircraft rail and lock systems). See figure 5 for the simplified side rail profile. See figure A-13 for aircraft rail clearances.

g. Systems with skid bases that do not interface the aircraft rail and lock system shall provide adequate tiedown provisions for restraint.

h. Pallet or skidded surfaces shall be safe for aircrew or qualified personnel to handle when rigging and deploying.

i. Pallet or skidded surfaces shall have inspection criteria for aircrew to accept or reject the condition of the pallet and attaching equipment.

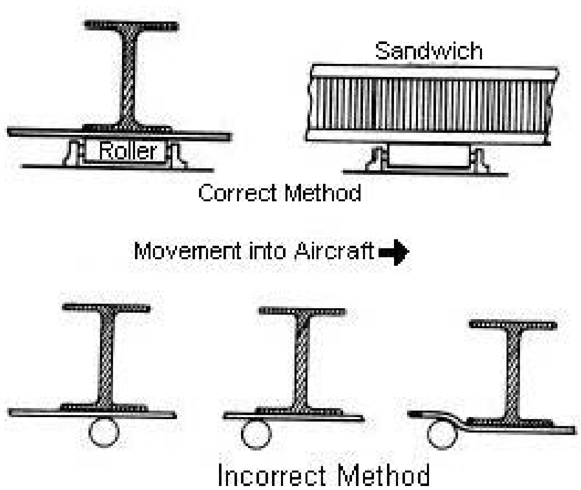


FIGURE 4 Pallet/roller interface.

Condensed from USAF
Drawing Number 7133042;
see MIL-DTL-27443F.

The 1.250 x 0.406 bevel does not need to be maintained if the rail in question cannot roll longitudinally across the aircraft rollers.

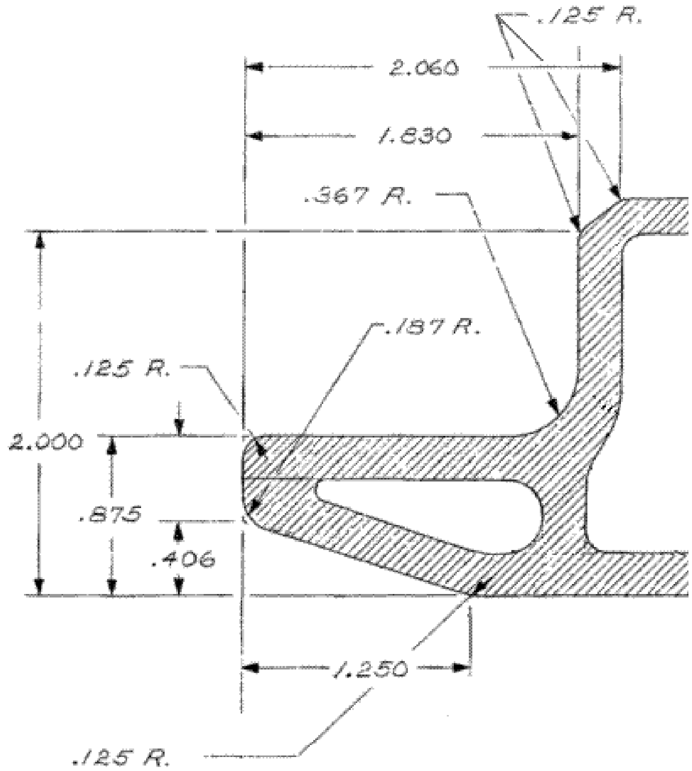


FIGURE 5. Pallet rail exterior profile.

5.3.6.2.1 Verification methods.

Compliance with the nonstandard pallet requirement shall be verified by methods appropriate to the particular design involved. Where such designs incorporate features of the 463L pallet, verification in accordance with other paragraphs in section 5 or MIL-DTL-27443 is required. All cargo items shall meet the verification criteria of 5.3.3.2. For skidded loads and loads having less than full width bases, it shall be shown that such loads can traverse the roller conveyors of the specified aircraft and appropriate ground handling equipment. For skidded loads and loads having less than full width bases, it shall be shown that such loads do not overload the rollers of the specified aircraft and appropriate ground handling equipment. Analytical proof based on roller conveyor capabilities and dimensions is the preferred method of verification for size and weight. Validation or test loading may be required depending on the specific design involved. The ATTLA will determine the need for such loadings.

Systems not utilizing the HCU-6/E rail profile will be evaluated on a case-by-case basis.

5.3.6.3 Secondary cargo.

5.3.6.3.1 Secondary cargo requirement.

Where a requirement exists for equipment to be air transported while carrying externally or having attached to itself, additional equipment or cargo, the entire unit load shall meet the requirements for restraint and size. Secondary cargo shall not exceed the cross-country payload capability of the vehicle or its equivalent (vehicle suspension limit requirement). Where the air delivered load capacity is different from the general load capacity of the vehicle, the allowable load shall be marked in accordance with MIL-STD-129. The additional equipment shall be independently tested to ensure restraint to the main item of equipment.

5.3.6.3.2 Verification methods.

Same as primary cargo item.

5.3.7 Special loading, unloading, and flight procedures.

To facilitate handling, the equipment should be as compact and lightweight as practical. However, reliability and maintainability shall not be substantially impaired in meeting this requirement. Any projected design compromise for the sake of air transportability shall be brought to the attention of the procuring activity. Using a minimum amount of handling equipment, it shall be possible to load the equipment into the aircraft and readily position the equipment without damage to the aircraft.

5.3.7.1 Shoring.

If a commercial vehicle has been procured not meeting certain loading/unloading size requirements (5.3.1.1.1) or certain weight requirements of this standard, loading aids, such as approach shoring, additional ramps or special loading equipment may be used to facilitate the load/offload.

If any type of shoring is necessary, the user shall provide all shoring material. Shoring shall be transported with the item. If all or part of the shoring is transported on the item, the weight of the shoring must not cause the item to exceed its weight limits or aircraft limits for flight. If all or part of the shoring is carried on the aircraft separate from the item, the shoring weight and location must not exceed aircraft flight limits. Shoring shall be able to withstand the forces imparted during loading and unloading. The material shall not cause damage to any aircraft part with which it interfaces. The shoring shall be stable during the load transfer process.

The minimum width of the top layer of approach shoring shall be 11 inches.

For more information on shoring and its applications see A.5.4.2.

5.3.7.1.1 Load spreading shoring limitations.

New equipment designs which impose unacceptable floor loadings under flight conditions shall incorporate integral devices to function as sleeper shoring. An example of an integral device is a jackstand. Normally, such devices do not relieve excess on/offload forces.

5.3.7.1.2 Load spreading shoring verification methods.

Weight such as gross weight, axle weights, and floor contact weights shall be within acceptable limits per data. Weights on critical areas during the onloading/offloading process and flight shall also be provided because weight distribution may differ from the loaded position sufficiently to exceed item and aircraft limits.

5.3.7.2 Winching.

If the item requires winching in and out of the aircraft, the item shall not cause the winch cable tension to exceed the value listed in the applicable technical order. Winching aboard may be accomplished using the aircraft winch or vehicle-installed winch from the ground or from a K-loader. Provisions for winching shall include attachment points which permit a straight ahead pulling force.

See appendix C.4.2 for details on winching operations. A tow bar, bridle, or load spreader may be utilized to prevent damage to the winch cable or cargo.

5.3.7.3 Combat offload.

New equipment designs and commercial equipment purchases intended for use on pallets or platforms with a combat offload requirement shall conform to the aircraft(s) tipoff curve(s).

5.3.7.4 Special tools and transport equipment.

Use of special tools and support equipment shall not degrade the user's mission capability, involve equipment not normally available at the deployment site, or compromise the safety of the aircraft or operating personnel.

5.3.7.4.1 Material handling equipment (MHE).

If the other requirements of this standard cannot be met, material handling equipment (MHE) shall be used to assist in loading/unloading the item. The item’s physical characteristics and loading/unloading procedures shall meet the requirements for the current MHE. Other equipment such as pallets and mobilizers may be used to facilitate movement in and out of the aircraft. Specialty built material handling equipment shall meet interface requirements of the standard MHE, pallets, or the aircraft depending on the transport procedures.

5.3.7.4.2 Reduced configuration.

To facilitate loading and unloading or to meet weight limitations, vehicles may be partially disassembled. Most commonly this involves removing cabs, counterweights, or tools (e.g. wide bulldozer blades). The reduced configuration shall not necessitate use of equipment not normally available at the deployment site; nor shall it compromise the safety of the aircraft or operating personnel.

5.3.7.4.3 Self-adjustment.

In order to meet weight and dimensional requirements, a cargo item's inherent adjustability may be employed to prevent contact with the aircraft during loading/unloading (e.g., raising bulldozer blades) or to redistribute weight during loading/unloading or flight.

5.3.7.5 Verification methods.

The item's critical dimensions, as identified above, shall be provided to ATTLA using the ATTLA data sheet, drawings, CAD files, or other acceptable means for analysis. ATTLA reserves the right to request a validation loading or a test loading if there is risk of contact with the aircraft, if additional data is required, or if the loading procedure is complex.

6. NOTES.

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use.

The information in this standard covers everything necessary to adequately design or modify a cargo item to be safely and successfully transported aboard USAF cargo aircraft from one location to another. The previous edition of this standard covered air drop of cargo as well. There are additional requirements pertaining to airdrop that were removed. Until such time as MIL-STD-1791A-1 is published the prior standard should be used. The air transport certification is military unique because there are not similarly configured commercial aircraft and no government or commercial group with adequate expertise.

6.2 Acquisition requirements.

Acquisition documents should specify the following:

a. Title, number, and date of this standard.

b. Use of the ATTLA data sheet for submission of data to ATTLA.

6.3 Tailoring instructions.

Some requirements, such as size limitations and vibration spectrum, apply to all cargo being transported by air. Other requirements, such as winching and axle limitations, apply only to cargo that cannot be loaded under its own power and which, for example, is wheeled. In order to identify the requirements pertinent to a given system, the following steps are recommended:

a. First, start with the requirements that apply to all cargo.

b. Second, sort size and weight requirements to match the method in which the cargo will be loaded.

c. Third, add requirements for special considerations based on the contents/intended use of the cargo.

d. Fourth, add requirements that apply to special loading or unloading procedures.

Requirements stemming from an item's concept of operations do occasionally impose additional restrictions on a cargo item. However, due to the wide variability in these situations, such CONOPs restrictions are best reviewed in consultation with an ATTLA agent.

6.3.1 Applicability of requirements.

6.3.1.1 Requirements that apply to all cargo.

The requirement areas that apply to all cargo are listed below:

Size
Weight
Restraint
Marking
Air Transport Environment

6.3.1.2 Loading method requirements.

Table VIII shows which size and weight limitations apply to the various loading methods. Also, some loading methods automatically qualify for special procedure requirements.

Table VIII. Loading methods.

Requirement	Loading Method	Wheels: Pneumatic	Wheels: Hi-Pressure Pneumatic (1)	Wheels: Steel/Hard Rubber	Wheels: Foam Fill (2)	Tracks: Pads	Tracks: Grousers	Tracks: Band	Roller System: HCU-6/E palletized	Roller System: Type V platform	Roller System: DRAS Platform	Roller System: Other(3)	Floor Load: Skids/ Flat Bottom	Landing Gear / Jackstands: Landing Gear/ Jackstands
Size	Projection	X	X	X	X	X	X	X					X	
	Ground and Ramp Contact	X	X	X	X	X	X	X					X	
	Ramp Cresting	X	X	X	X	X	X	X					X	X
	Palletized Cargo								X	X	X	X		
Weight	Axle Loads & Axle Spacing	X	X	X	X									
	Wheel/Tire Loads	X	X	X	X									
	Ramp Hinge Limits	X	X	X	X	X	X	X	X	X	X	X	X	
	Vehicle Suspension	X	X	X	X	X	X	X						
	Track Pads or Cleats/Grousers					X	X	X						
	Steel/Hard Rubber Wheel		X	X	X									(4)
	Concentrated Floor Contact Loads				X	X	X	X					X	(4)
	Jackstand/Tongue Loads													X
	Roller Conveyor								X	X	X	X		
	Restraint Rail								X	X	X	X		
Special Procedure	Floor Protection Shoring		X	X	X	X	X	X					X	X

(1) A pneumatic tire inflated to greater than 100 psi is generally considered a solid wheel, See 5.3.2.1.9 for details.

(2) Foam-filled tires are subject to different limits according to their characteristics, See 5.3.2.1.9 for details.

(3) Other includes container delivery system skid boards, commercial pallets, and custom built interfaces for the aircraft roller/rail systems, see 5.3.6.2 for details.

(4) Depending on the contact type between the jackstand/vehicle tongue and aircraft floor, concentrated floor contact loads or solid wheel limits may apply.

6.3.1.3 Special consideration requirements.

Nonroutine cargo that requires special handling procedures, quantity limits, or special packaging is classified as special consideration cargo. See 4.3.6 for the list of considerations.

Applicability of the requirements is determined by the intended use and contents of the cargo.

6.3.1.4 Special loading and flight procedures.

These requirements apply to certain loading methods under certain conditions.

Examples of special loading aids are approach shoring or special ramps, winching, use of forklift or K-loader, or special tools.

Examples of special flight procedures or aids are sleeper or parking shoring, added support stands, and manual adjustments during flight.

6.3.1.4.1 Shoring noncompliant vehicles.

Applies to wheeled or tracked loading method:

a. Approach shoring is used when a clearance limit in the loading methods table has been exceeded. Approach shoring is used to make the angle of the aircraft ramp lower to alleviate cargo contact with the ramp, ramp hinge, ground, or cargo compartment ceiling.

b. Approach shoring may also be used to reduce the load on the winch cable.

c. Sleeper shoring is used to protect overloaded vehicle suspensions in the event of a hard landing. For air transport purposes, military-rated (e.g., M-series) vehicles are considered overloaded when they exceed the suspension's rated capacity. Commercial suspensions are considered overloaded when they exceed 80 percent of their rated capacity.

d. Floor protection shoring is used to prevent damage from bulldozer-style track grousers or M-series tracks with worn pads.

e. Parking shoring is used to distribute concentrated loads from wheels, tracks, or jackpads.

6.3.1.4.2 Winching.

Applies to wheeled or tracked loading method:

Winching is used when a load either cannot be loaded under its own power or when loading cannot be accomplished safely. All military cargo aircraft and KC-10s either have an integral winch or carry one with them. It is also possible for vehicles with winches to load themselves. The aircraft have snatch blocks (pulleys) to create a "block and tackle" arrangement if sufficient winch line is available.

6.3.1.4.3 Jettison.

Applies to roller system loading method:

In the event of an in-flight emergency, the crew may opt to jettison any or all possible cargo. Arrangements for this should be made prior to take-off. This primarily applies to palletized cargo. For this reason, palletized loads are required to fit under the “tip-off curve” for the aircraft on which they will be flying.

6.3.1.4.4 Combat offload.

Applies to roller system loading method:

This is essentially cargo jettison while taxiing. Combat offload is used when appropriate material handling equipment is unavailable at the destination airfield or when conditions dictate leaving the cargo and taking off as rapidly as possible.

6.3.1.4.5 Special tools & support equipment.

Applies to any loading method:

If the other requirements of this standard cannot be met, material handling equipment (MHE) may be used to assist in loading/unloading the item. The item’s physical characteristics and loading/unloading procedures should meet the requirements for the current MHE. Other equipment such as pallets and mobilizers may be used to facilitate movement in and out of the aircraft. Special material handling equipment should meet interface requirements of the standard MHE, pallets or the aircraft depending on the transport procedures.

6.3.1.5 Concept of operations.

The proposed cargo item’s concept of operations should be reviewed to determine whether the item can be reconfigured or can be certified for airlift at all. Most cargo can be certified based on physical characteristics alone, but there are instances in which the item’s mission or mission concept may be limited by the aircraft’s capabilities.

Requirement Guidance:

Examples of operational restrictions due to cargo design:

(1) A large, heavy piece of cargo’s concept of operation dictates that it would be transported to a high altitude, short runway geographical location. The item’s size restricts it to being parked only in the aft cargo compartment. The cargo’s weight at the parked location puts the aircraft out of balance. The support equipment or loading equipment adds additional weight that exceeds the aircraft’s payload capability to land and take off from the desired location.

(2) The item may have other accompanying equipment that requires additional aircraft to transport the entire system.

(3) A vehicle too heavy to be airlifted fully assembled needs all the pieces to perform its mission. Some of the pieces may have to be transported on a pallet or even in a second aircraft to meet weight requirements.

(4) Vehicle packages are not certified as packages; each individual item is certified. Thus, a small, lightweight trailer towed behind a heavy prime mover may be certified with the trailer as C-130 transportable but operationally restricted to C-17 or C-5 with its dedicated prime mover.

6.3.2 Example.

An example of how design requirements are selected is shown in figure 6. The cargo item is a mobile command center with wheels and tracks. There is an antenna dish that can be folded up or down. It has jackstands that are deployed in the aircraft. The illustration shows how the various pieces of the item must meet the listed requirements.

Besides the elements described in the previous paragraph, the item has an air conditioning unit that must be mounted to withstand flight accelerations, shock loads and vibration, and restraint limits to prevent the unit from breaking loose from the item. The antenna dish and support structure must also meet accelerations, shock loads and vibration, and restraint limits. The trailer roof must be able to support the antenna if the aircraft experiences a 4.5 G download.

The following dimensions are verified to determine if the item can fit inside the aircraft and whether it can be loaded/unloaded: The location of axles and front and rear ends relative to each other, the ground clearances beneath the item and the item’s width and height.

These requirements are shown in sections 4 and 5 and in appendix B for each type of aircraft. Further explanations of the various types of cargo and how they are handled are given in appendix A and C.

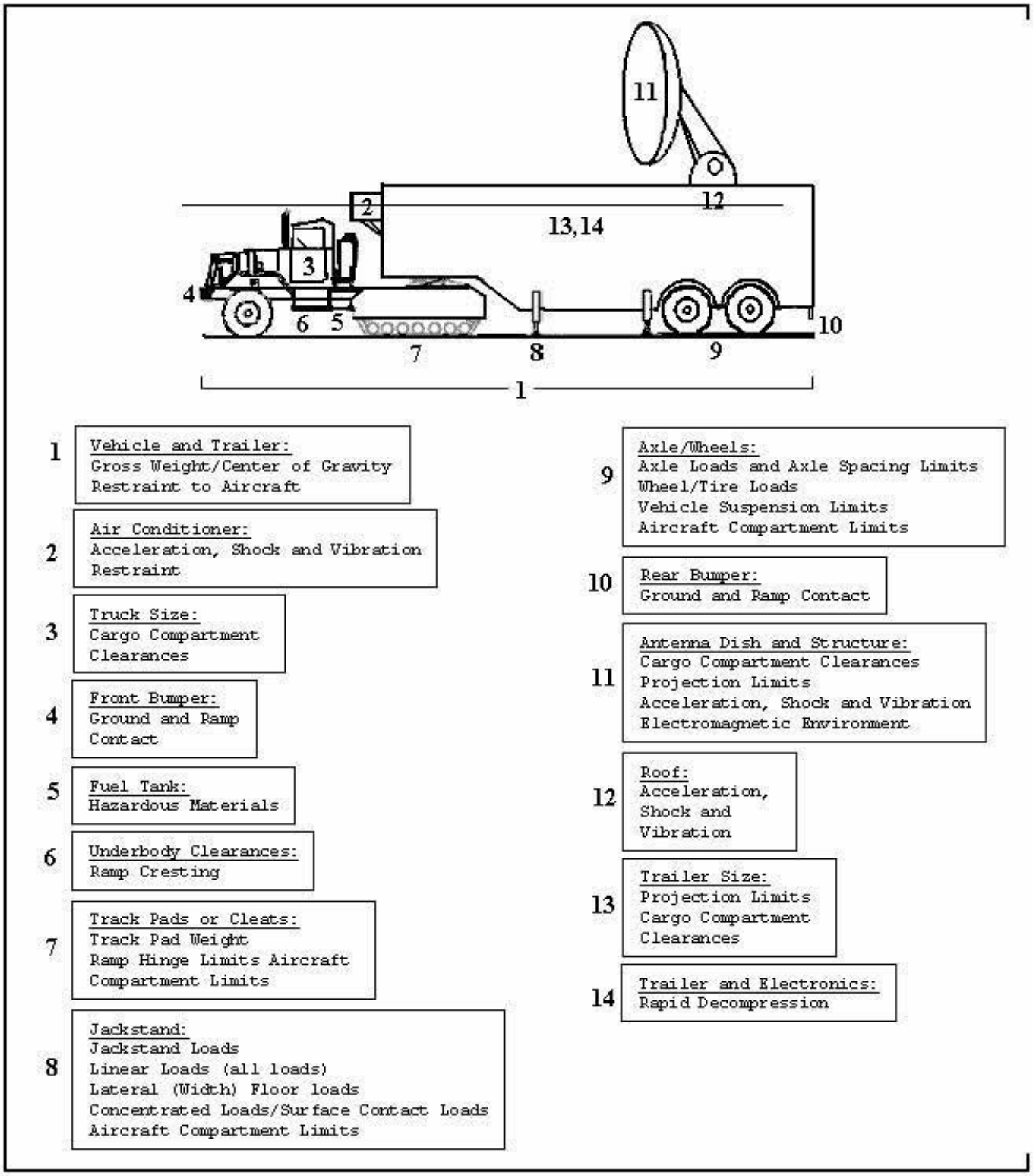


FIGURE 6. Example system.

6.4 Air transport certification process.

6.4.1 Air transport certification process.

A data package that details the physical characteristics of the equipment (including 3-view dimensioned drawings), proposed tiedown pattern, and the proposed on/off load plan will be required. After the request and data package are received, ATTLA will accomplish a technical analysis of the item with respect to internal air transportability and return an Air Transportability Certification memo for approved items or recommend changes to items which do not meet the requirements.

Data may be provided at a later date from the initial air transport certification request, provided that ATTLA has at least 45-60 days to review the data. The data package should include physical characteristics of the equipment, structural strength with substantiating information (for analysis of tiedown capability), proposed tiedown pattern, and the proposed on/off load plan. Dimensions may be submitted using drawings, certain CAD files, the ATTLA data sheet, or annotated photographs. The ATTLA data sheet is available in various electronic formats upon request to ATTLA@wpafb.af.mil. The structural analysis should list assumptions, material properties, and force diagrams in addition to calculations and conclusions. ATTLA reserves the right to request additional analysis or testing.

For items in development, ATTLA will provide design assistance through the applicable procurement office to ensure that the vendor produces an item that ultimately meets all airlift objectives. Because developmental items are subject to continual changes, ATTLA personnel can participate in design reviews and other technical interchanges during the evolution of a design. However, funding must be provided for ATTLA personnel to attend these activities; teleconference and video teleconference capability is also available; however, web-meetings are not.

ATTLA will conduct an analysis at no cost to the requesting federal office to assess the loading and transportability characteristics of a designated item. Some of the areas examined include fit and projection of the cargo, weight distribution of structural loads on the aircraft, aircrew in-flight access, aircraft weight and balance after loading, interface with material handling equipment, shoring requirements, and required loading methodology. Also considered in this analysis are the structural integrity of the cargo, the capability of sealed systems to survive rapid decompression, inclusion of any hazardous materials, in-flight operation of transported equipment, and the capability of identified restraint provisions, suspension systems, and axles to withstand the dynamics of takeoffs, landings, and flight.

If analysis alone cannot positively determine that the item can be safely loaded and airlifted, ATTLA will recommend that either a validation load (6.4.1.1) or a test load (6.4.1.2) be conducted.

ATTLA may certify the item as is or may require changes to the item in order to meet aircraft and operational limits prior to certification. Historically, only about five percent of cargo items presented to ATTLA could not be certified.

Upon certification, the owner, the developing agency, or the procuring agency (or all three) will receive a signed Air Transportability Certification memo from ATTLA for each item certified for airlift. In addition, a copy of the memo is forwarded to HQ AMC/A3V and another copy is maintained permanently in the item's project file at ATTLA. ATTLA maintains a database of items that have been certified since 1974.

A copy of the memo should accompany the item whenever it is presented for airlift.

For certified items, modifications that do not affect the item's exterior dimensions, weight, or ability to meet a requirement in this specification do not warrant a new certification. Examples include an upgraded radio, new paint scheme (without affecting markings), or a new engine (without weight increase). New tires of the same class will not require a new certification, but changing from highway to off-road or vice versa may affect floor contact pressure. Contact ATTLA for an evaluation if there is any question as to whether a modification will affect air transportability.

6.4.1.1 Validation loading.

Validation loadings are recommended in medium risk cargo situations to verify loading, unloading, and restraint in accordance with published procedures. The capability of the item itself to be transported usually is not in question; the problem is how to get the item safely on and off the aircraft. Validation loads may also be performed to determine whether multiple items can be loaded together. Validation loadings are often performed in conjunction with an item's first airlift. Whether the procedure requires the presence of ATTLA personnel is determined by assessing the anticipated risk. If ATTLA presence is required, the requestor must pay the ATTLA representative's travel cost.

6.4.1.2 Test loading.

Test loadings are conducted in cargo situations considered high risk. An analysis of the item indicates it cannot be transported without developing new procedures or equipment or that there is the possibility of exceeding aircraft limitation during loading, offloading, or transport. Test loadings are usually conducted as Special Assignment Airlift Mission (SAAM) requests and are managed by Headquarters Air Mobility Command, Test and Evaluation Directorate (HQ AMC/TEA), Scott AFB, IL in conjunction with the 33rd Flight Test Squadron at McGuire AFB, NJ, which is responsible for test execution.

The requesting office is responsible for making the arrangements with HQ AMC/TEA to conduct the test loading. A formal test load results in the generation of a test report that outlines the test criteria, results, and the details of any specific procedures or preparations that were needed to load the item. ATTLA will usually approve an item for airlift based upon a successful test load, but because of the test nature positive results are not always obtained.

Since test loadings usually involve very detailed instructions, items which have been successfully test loaded usually require publication in the "special procedures" section of the applicable aircraft loading manual. The cost of conducting a test loading is borne by the requesting agency.

6.4.2 Other certifications.

The following situations require an airworthiness approval from the aircraft program office for each type of aircraft on which the specified cargo is intended to be transported. ATTLA provides an airworthiness assessment to the aircraft program offices on the item shipped as cargo. Each aircraft office will perform an internal review of the request and ATTLA's recommendation and issue an airworthiness certificate for the aircraft.

a. Requires interface with aircraft electrical systems: electrical power or aircraft communications systems

b. Cargo is electronically active or is used while in the aircraft

c. Systems occupied by personnel

d. Susceptibility to explosive atmosphere environment (aerial tanker aircraft only)

6.4.2.1 Nuclear.

The certifying authority for air transport of nuclear material is the Air Force Nuclear Weapons and Counterproliferation Agency (AFNWCA) at Kirtland AFB NM.

The air transport environment for transporting nuclear cargo is the same as for other cargo and is addressed in this document. Contact AFNWCA for other transport requirements and special protection for stowage of radioactive material. ATTLA can provide technical assistance.

6.5 Rationale, guidance and lessons learned.

6.5.1 Size.

REQUIREMENT RATIONALE

The objective of the size requirement is to influence equipment design, consistent with operational needs, to enhance the item's aerial delivery characteristics. Because airlift resources are limited, using them most effectively is mandatory, particularly in contingency situations. Several design considerations impact the efficient use of both aircraft and personnel:

a. Equipment designed to be transported in its operational configuration eliminates the need for time-consuming operations such as breaking the item into sections (e.g. dismounting secondary cargo) or partial disassembly.

b. Operational equipment can generally be on/offloaded with fewer problems and less need for supporting equipment.

c. Items whose design satisfies the worst case or most restrictive combinations of criteria have the greatest chance of being transported in periods of airlift shortfall. This results from the item having physical characteristics compatible with the widest range of available aircraft.

REQUIREMENT GUIDANCE

All cargo aircraft have structural limitations which affect the size and configuration of cargo items which can be safely loaded and air delivered. Limitations common to these aircraft include axle loads, axle spacing, roller conveyor loads, bulk cargo linear loadings, cargo compartment zone weight limits, and ramp crest angles, among others. The magnitude of these limits can vary widely between aircraft due to both aircraft design and operational factors. By designing equipment to the most restrictive combination of criteria, the chances of air delivery of the item are greatly improved because the item will be eligible for movement in the widest range of available aircraft.

REQUIREMENT LESSONS LEARNED

Item sizing and configuration should be established with the following experience factors in mind:

a. Items specifically designed to be air delivered in their operational configuration often require no special support equipment for on/offloading. This is particularly important where these operations are carried out in austere locations where the availability of any support equipment is likely to be marginal.

b. Where item functional requirements prevent designing to the conditions of a. above, design alternatives should consider breaking the item into sections or use of reduction techniques. Exercise caution where breaking the item into sections or reduction is implemented to assure that tool and support equipment requirements are within the organic capability of the using organization or are built into the items to be air delivered.

c. Normally, only two auxiliary ramps are carried aboard C-130 aircraft. Where item design incorporates a tricycle wheel configuration, a fabricated auxiliary ramp is needed to accommodate the centerline wheels during on/offloading. Centerline axles should not exceed axle loads for nontreadway applications.

d. The use of shoring should be avoided whenever possible. Wood shoring is very often unavailable in remote locations and its use is time-consuming as well as labor-intensive. Most importantly each pound of shoring used reduces the aircraft payload by an equal amount. Support devices, designed as an integral part of the equipment can sometimes modify the need for shoring. Strategically positioned auxiliary landing gears, for instance, can eliminate the need for sleeper shoring.

e. Each aircraft has its unique structural limitations. Designing equipment for airlift in the smallest aircraft will not necessarily qualify the item for airlift in larger aircraft. Design should be based on the most restrictive combination of aircraft limits.

VERIFICATION RATIONALE

Verification of size requirements can usually be accomplished through analysis of equipment dimensional and weight data. Comparison of the equipment in its shipping configuration with the characteristic loading envelope of the aircraft involved is the least costly and quickest method of determining the aerial delivery eligibility. Where critical clearances exist, or special loading equipment/procedures are involved, a validation or test loading may be required to verify the acceptability of the item for aerial delivery. This method of verification should be a last option because of the high cost of manpower and airlift resources required.

VERIFICATION GUIDANCE

Though some latitude is permissible in the configuration of equipment in order to facilitate an item's air transport eligibility, extreme care must be exercised so that unacceptable limitations are not imposed by certain configurations. While every reasonable effort should be made to ensure the air transportability of an item, the capability of the using unit to make the item operationally ready in the field is often the limiting factor. Special tools and sophisticated support equipment necessary for handling and reassembling the item will probably not be available at most overseas sites. The manpower necessary to perform these operations is also a major factor which must be considered. A third element of major importance is the time required to achieve operational readiness of the item after aerial delivery.

The data shown in appendix B provides the necessary information to assist the designer to set acceptable limits on item configuration. A review of the limiting factors for the various aircraft reveals a variation in aircraft structural capability which must be recognized in the design process.

Such factors as linear loading limits and axle weights vary widely between aircraft. Good design practice is that which satisfies the most restrictive combination of requirements. This will assure that the item is eligible for aerial delivery in the maximum number of available aircraft and enhances the probability of the item being airlifted.

VERIFICATION LESSONS LEARNED

None available

6.5.1.1 Size requirements.

Use section 5 and the aircraft appendices to identify whether the item might have loading problems. Keep in mind that cargo may be loadable forward end first but not aft end first, or vice versa.

While not required by this standard, the emergency egress requirement is as follows: “The crew and passenger area shall have emergency means to allow complete abandonment in 90 seconds during ground egress or ditching of the air vehicle with half of the exits blocked, with the landing gear extended as well as retracted, considering the possibility of the air vehicle being on fire, and at maximum seating capacity.” See MIL-HDBK-516 paragraph 9.1.2.

6.5.1.1.1 Loading/unloading.

6.5.1.1.1.1 Projection limits.

REQUIREMENT RATIONALE

Mission requirements often necessitate loading general cargo and wheeled/tracked vehicles from the ground by winching or driving them directly into the aircraft cargo compartment. Any item loaded in this manner must be designed so that its height and length do not cause the item to contact the upper structural members of the aircraft or the undercarriage to contact the ramp crest area as shown in B.3.1.1 and B.3.1.3. In addition, the item should not contact the ground.

REQUIREMENT GUIDANCE

The allowable item projection is determined by three factors:

a. the height of the load

b. distance of the high point measured behind rear axle (when backed in).

c. the height of the cargo compartment floor at the hinge line of the ramp.

The allowable projection is measured from the centerline of the ramp hinge.

Charts are used in determining the acceptable dimensions of vehicles/wheeled cargo whose inclined ramp loading may approach a projection limit. The vehicle projection charts for each aircraft present height-projection limits for wheeled vehicles being on-loaded from the ground using the aircraft ramps. These charts give the critical vehicle height-projection values to determine the suitability of loading a given vehicle. Whenever possible, vehicles should be backed into the aircraft.

Projection Theory: projection length depends on where the item pivots at the ramp hinge to cause the longest projection length. If the item is two axle rolling stock, the pivot point occurs at the rear axle. If the item has multiple axles, the pivot point depends on whether the axles are tandem or independent. Tandem axles or bogies may articulate sufficiently (15-deg or greater) so that the pivot point is between the axles. If there are multiple axles with no articulation, the worst-case pivot point is at the rearmost (with respect to the aircraft) axle. For loads that are box shaped, refer to charts in the individual aircraft appendix.

REQUIREMENT LESSONS LEARNED

Loading vehicles in the aircraft with their aft end facing forward permits more rapid offload. This is particularly important when offloading occurs in combat areas.

VERIFICATION RATIONALE

Whenever possible, satisfaction of this requirement should be verified by comparing the item's critical dimensions with the limiting values shown on the appropriate charts for the aircraft involved. This is the fastest and least costly method of verification.

Alternate methods of establishing conformance with this requirement are:

a. a demonstration loading using a scale mock-up of the aircraft ramp and cargo compartment envelope

b. a validation loading to occur at the time of the first actual airlift of the item.

c. a formal test loading involving the actual aircraft

Experience has shown that the analysis method of verification can be applied in most cases. Formal test loadings are required only in extremely critical situations and must be recommended as necessary by the ATTLA before they will be approved. Validation loadings at the time of first shipment are commonly used to establish loading qualifications without incurring the cost involved in a formal test loading.

VERIFICATION GUIDANCE

Each chart has instructions to aid the designer in determining analytically if a proposed design or actual item qualifies for ground loading up the aircraft ramp. In some cases, the item's critical dimensions may so closely approach the limiting values that an analytical judgment may not be possible. In all cases, the final determination of an item's certification in this requirement area rests with the ATTLA, who will determine if any form of loading demonstration is required.

VERIFICATION LESSONS LEARNED

Because of the scale involved, graphical determination of an item's up-the-ramp loadability cannot be made with extreme precision.

Except for very critical items, formal test loading is seldom needed to determine an item's qualifications.

6.5.1.1.1.2 Ground and ramp contact.

REQUIREMENT RATIONALE

Vehicles which have structures extending long distances past the front or rear axles may have difficulty in loading up the inclined ramp from the ground. This is especially critical on vehicles which have low ground clearance. The potential problem involves interference between the overhanging portion of the vehicle and either the aircraft ramp or the ground (see B.3.1.2). The Loading Overhang Limit charts for each aircraft present the relationship between the design factors pertinent to this situation. Item design should be based on the assumption that the aircraft floor is at its maximum height.

A secondary overhang consideration involves the efficient use of the aircraft cargo compartment. By parking a vehicle near the aft end of the compartment, a portion of the vehicle overhang may project into the area above the ramp provided it does not extend so far aft that it contacts the ramp in its retracted position. The Parking Overhang Limit chart shows the relationship between vehicle overhang and vehicle floor clearance.

REQUIREMENT GUIDANCE

At present, roll-on/roll-off (RORO) cargo ships utilize a 16-degree approach angle. Capability to traverse this angle will help meet sea-based transportability requirements and provide margin for loading aboard aircraft.

For a quick check, figure 7 approximates 15 deg.

Also, see guidance in 6.5.1.1.1.1.

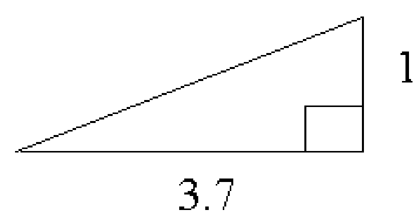


FIGURE 7. 15-degree angle.

REQUIREMENT LESSONS LEARNED

See lessons learned in 6.5.1.1.1.1.

VERIFICATION INFORMATION

See information in 6.5.1.1.1.1.

6.5.1.1.1.3 Ramp cresting.

REQUIREMENT RATIONALE

The most critical vehicle-to-structure clearance situation often occurs when the vehicle crests the ramp at the hinge line. This situation is more acute for vehicles having low ground clearances and long wheel bases. The Ramp Crest Limit charts in appendix B show the relationship between the vehicle wheelbase, vehicle ground clearance, and aircraft cargo floor height. Aircraft cargo floor height is only predictable within a given range because of the variable factors affecting it. Therefore, item design should always be based on worst-case conditions; i.e., with the cargo floor at its maximum height.

REQUIREMENT GUIDANCE

The Ramp Crest Limit charts are based on a vehicle having its maximum ground clearance at mid-wheelbase. While this is the case with many vehicles, it is becoming increasingly more common that vehicles such as vans are being designed with auxiliary equipment stowed beneath the structural framework. In these cases the critical ground clearance may not be at mid-wheelbase. In general, the closer the minimum ground clearance is located to the wheels, the less of a problem ramp cresting becomes.

For any aircraft figure 8 approximates the required cresting angle when the wheelbase is less than twice the ramp length.

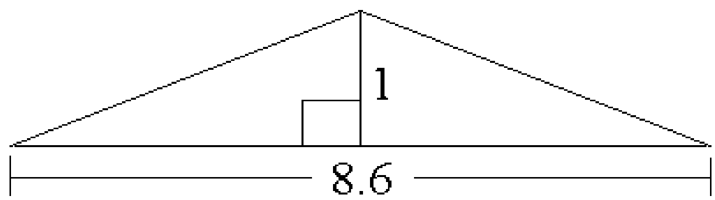


FIGURE 8. Cresting angle.

REQUIREMENT LESSONS LEARNED

None available

VERIFICATION RATIONALE

See rationale in 6.5.1.1.1.1.

VERIFICATION GUIDANCE

In addition to the guidance of 6.5.1.1.1.1., it should be remembered that the Ramp Cresting Limit charts are based on the vehicle maximum ground clearance occurring at mid-wheelbase. Where this location differs from the mid-point, this must be considered in analytically determining if the vehicle meets the ramp cresting requirements.

VERIFICATION LESSONS LEARNED

In addition to the lessons learned of 6.5.1.1.1.1, experience has shown the closer the minimum ground clearance point is to the wheels, the less of a problem ramp cresting becomes.

6.5.1.1.2 Cargo compartment clearances (flight).

REQUIREMENT RATIONALE

The purpose of this requirement is to prevent damage to the aircraft during item on/offloading and ground or flight operations of the aircraft. The size and lack of precise handling capability of many equipment items results in poor maneuverability characteristics. Loading items into an aircraft requires sufficient clearance to allow for the difficulty of accurately maneuvering the item into and within the aircraft. Items restrained on-board aircraft will be subjected to accelerations during both ground and flight operations. These accelerations will result in movement of the item relative to the aircraft. This movement can be caused by deflection of the aircraft, deflection of tiedown chains or straps, deflection of the item itself, or any combination of these conditions.

REQUIREMENT GUIDANCE

The clearance available during loading influences both the amount of time necessary to load an item and the skill level required of the loading crew. The minimum clearance between the item and the aircraft structure during ground maneuvering and flight operations is influenced by the loading on tiedown devices, cargo item, and aircraft structure. These loads cause deflections to varying degrees and in varying directions. Nylon webbing tiedowns, for example, can elongate up to 20 percent under full load conditions. Full loading occurs only rarely. However, large deflections coupled with minimal clearances could result in the movement of an item to impact the aircraft structure. The dimensions shown in appendix B represent the cargo design limits for items to be transported in the designated aircraft. These values are derived by reducing the basic rectangular box size of the aircraft cargo compartment to account for the required overhead and side clearances. The C-5 has an irregular cargo compartment cross section which can be described as a rectangle topped by a trapezoid whose base is common with the upper long side of the rectangle. Height dimensions are measured from the load surface of the aircraft floor and do not include any provision for 463L pallets, roller conveyors, or shoring.

Designing to these limits will insure that items will meet the aircraft dimensional criteria for straight-in loading. Other aspects of air transportability, such as ramp cresting, projection clearances, axle and wheel loads, and floor and roller loading must be addressed separately to assure compliance with all requirements. Existing equipment which exceeds these design limits may still be eligible for air transportability certification. However, a detailed review of the item's physical characteristics must be accomplished before this determination can be made. Special equipment or procedures may be required to permit air transport of certain equipment.

The dimensions of the Air Force prime mission cargo aircraft (C-130, C-17, and C-5) and the long range international segment of the Civil Reserve Air Fleet (CRAF) are contained in appendix B.

REQUIREMENT LESSONS LEARNED

Equipment on-board the aircraft can decrease the available clearance for loading cargo items. The following situations should be considered:

a. If equipment is to be loaded on the roller conveyor system, the value for the cargo compartment height should be reduced by the height of the rollers and pallet, if used.

b. The C-130 rail restraint system is not removable from the aircraft and limits available loading space.

VERIFICATION RATIONALE

The preferred method of verifying this requirement is by engineering analysis of the physical characteristics of the item. Experience has shown that this is the fastest, least costly procedure and can be used in the majority of cases. Where an item has such critical characteristics that analytical methods cannot positively determine if the item can be safely loaded and delivered, an actual test loading of the item may be necessary. Such loadings are the basis for the determination and formal documentation of loading and restraint procedures. Test loadings are expensive and are utilized only when absolutely necessary. Exceeding these limits does not necessarily prevent the item from being air delivered. However, such a situation does require a more critical analysis, often requires an expensive and time consuming test loading, and may require unusual loading procedures, the use of auxiliary support equipment, and highly skilled loading crews.

Cargo carried in an aircraft will be loaded by (1) straight-in loading over the horizontally positioned ramp from a truck or cargo loader, or (2) ramp loaded from the ground using the auxiliary loading ramps. Straight-in loading presents fewer cargo-aircraft interference problems, but requires ground support equipment which may not be readily available, particularly at austere off-load sites. Ramp loading, while less restrictive from a support equipment standpoint, is more critical with respect to cargo-aircraft interference.

Appendix B presents pictorial and graphic data on cargo compartment clearance and cargo-aircraft interference parameters. All load profiles must conform to dimensional envelope constraints. Additional limitations must be considered for ramp loaded items. These considerations include ramp cresting, parking overhang, loading overhang and projection limitations. Detailed knowledge of the dimensions and operational characteristics of equipment items is required to determine the acceptability of an item for aerial delivery by use of the appendix B data.

VERIFICATION GUIDANCE

The determination of an item's dimensional acceptability for aerial delivery is made by comparing the item in its shipping configuration with the aircraft dimensional data presented in the appendices to this document. The data presented in these appendices represent design limits which, if not exceeded, should assure that the item can be transported in the aircraft under consideration.

VERIFICATION LESSONS LEARNED

The dimensional acceptability of an item must be determined with the item in its shipping configuration. In addition to the dimensions of the item itself, consideration must be given to any cargo compartment space taken up by such ancillary items as shoring, pallets, or roller conveyors, if these are required.

Partial disassembly of equipment to meet the cargo compartment dimensional limits is an acceptable option only when the following conditions are met:

a. The item's reduced configuration must be such that it can be made operationally ready under field conditions within the specified mission ready response time using only the unit's organic capability.

b. The item in its reduced shipping configuration must not require the use of on/offloading support equipment which would not be available at the field site.

6.5.1.1.2.1 Emergency access and safety aisle.

REQUIREMENT RATIONALE

On military aircraft, a requirement exists for an aisle in the cargo compartment for crew transit from the flight station to the rear of the aircraft for fire fighting, checking and resecuring loads, and scanning engines or landing gear. When passengers are carried a similar requirement exists in order to provide safe egress. The C-17 and C-5 have walkways. While these walkways satisfy this requirement, they must be kept clear at all times of cargo or protrusions. On aircraft such as the C-130, a minimum clear space on the left-hand side (when facing forward) must exist at all times.

REQUIREMENT GUIDANCE

B.3.1.4 shows a cross-section of the C-130 fuselage and highlights two clear space options relative to the cargo compartment envelope.

Safety aisle "A" is 14 inches wide by 72 inches high, while safety aisle "B" is 30 inches wide by 48 inches high. Experience has shown that the "A" space will permit a crew member to walk with a slight crouch through the cargo compartment. Similarly, the "B" space is adequate to allow a crew member to crawl atop the cargo. The clear spaces are shown in the extreme upper left position of the cargo envelope. This utilizes the maximum cargo widths and heights in this area while still accommodating a walking or crawling man. Other locations of the clear spaces may be acceptable, as are combinations of walkways and crawlways, as long as a continuous passageway exists on the left side of the aircraft. In designing to meet these criteria, remember that the basic requirement is for a man wearing a parachute to be able to get from the forward end of the aircraft to the rear troop doors.

VERIFICATION RATIONALE

In the majority of cases, knowledge of the item's dimensions is adequate to make a determination of the acceptability of the clear space. This is the quickest and least costly method of verification. Where complex load configurations are involved, or where multiple units comprise the load, a demonstration of crew member access may be necessary. Because of the time and manpower involved, this verification method should be avoided whenever possible.

VERIFICATION GUIDANCE

The configuration of cargo loads seldom will present a uniform rectangular aisle way. Judgment must be used in many cases in evaluating the acceptability of a load where clear spaces vary from the requirement criteria. Many individual items must be evaluated in the absence of knowledge of the total aircraft load configuration. The overall load configuration can have an impact on clear space available at an individual item location. Experience has shown, however, that sufficient flexibility in load planning generally exists such that, if an individual item meets access criteria, it can be located in the overall load without adversely affecting the emergency access path. The ATTLA is available to provide advice in this area.

VERIFICATION LESSONS LEARNED

None Available

6.5.2 Weight limits.

REQUIREMENT RATIONALE

Aircraft loading/unloading weight limits are greater than flight limits because there are no additional vertical gust loads while the aircraft is on the ground.

REQUIREMENT GUIDANCE

Weight and weight distribution applies throughout the airlift process. The item should be able to load, park, and unload without exceeding aircraft structural limits and the cargo's structural limits. For example, a tractor/trailer should be able to traverse up the aircraft ramp with all axles in contact with the aircraft ramp and floor. If one axle lifts up, the increased weight on the other axles may exceed the axle capacity or aircraft limits.

6.5.2.1 Weight requirements.

REQUIREMENT RATIONALE

In general, the allowable cargo capacity is dependent on the aircraft floor strength, which varies from one location to another and is dependent on aircraft structural design. Variations in item design impose different types of loads on the aircraft structure. These aircraft structural limits are treated in detail in appendix B. In addition to unique aircraft structure loading, item weight and center-of-gravity affects aircraft weight and balance considerations as well as aircraft operational range.

REQUIREMENT LESSONS LEARNED

A trailer weighing 25,000 lbs, on two axles, with an axle separation of about 36 feet, had a C-130 transportability requirement. The ground loading limit for the C-130 floor is 13,000 lbs for the entire length but the flight limit of 13,000 lbs only encompasses about 28 feet in the middle of the cargo compartment. The solution was to roll the trailer on board, position eight stacks of shoring underneath the frame, then completely deflate the tires so that the shoring verifiably carried the entire weight of the trailer. Keep in mind that this trailer had no time restrictions on loading/unloading and was required to carry tire inflation/deflation equipment as part of the transportation package. Such a scheme, while a creative exploitation of aircraft limits, would not be appropriate for combat vehicles or others with time-sensitive deployment requirements.

6.5.2.1.1 Gross weight/center of gravity.

REQUIREMENT RATIONALE

Assuming all other load parameters are met, the maximum single item weight which can be carried in an aircraft is dependent on its payload-distance characteristics. Without considering the other factors which influence range, the heavier the payload, the shorter the range. In all cases there is a maximum payload which cannot be exceeded under any circumstances. The aircraft center of gravity (CG) is the point around which the aircraft will balance. The flight performance of the aircraft is dependent on the location of this point which can vary within limits. If the CG is outside this limit the aircraft cannot be flown. The aircraft CG is affected by the location of each individual item CG. In most cases the location of an item's CG is the natural result of its configuration. A preferred location is at or near the geometric center of the item.

REQUIREMENT GUIDANCE

Payload-distance information is presented in appendix B. CRAF payload-range data is published in AMCPAM 24-2. Contact the appropriate program office for more up-to date information. Center of gravity limit data are presented in the appendix for each aircraft. Use of these curves will determine if proposed loads will meet these requirements. The ability to tailor CG is, admittedly, limited. However, this factor should be recognized in item design. The areas which may provide the greatest potential for doing this are selective location of accompanying loads and CG shifts resulting from item reconfiguration to meet weight or dimensional restrictions.

REQUIREMENT LESSONS LEARNED

People tend to associate CG with the geometric center of items. For this reason it is important to assure adequate marking of CG location so that aircraft CG may be computed accurately. An advantage of a central CG location is that it offers more flexible loading options.

VERIFICATION RATIONALE

Comparison of the physical characteristics of candidate items with the established aircraft limit data is the most effective method of verifying this requirement. These data have been developed by the aircraft manufacturer and represent safe operating limits. Marking requirements are generally verified by inspection.

VERIFICATION GUIDANCE

The analysis by comparison of known physical characteristics with established criteria is a straight-forward matter. Determination of the total load CG may be made using C.3.2 for methodology.

VERIFICATION LESSONS LEARNED

Loads with high center of gravity may require additional restraint (tiedown) to overcome high overturning moment during G loading. An example is a boat in a cradle on a trailer. The craft's V-shape helps to prevent the boat from moving laterally. However, the boat may need some additional vertical tiedowns to prevent the boat from rolling over the cradle's edge when experiencing high G side loading. CG locations that are very high or near one end should be considered when designing the tiedown pattern and selection of locations for tiedown provisions. Axle weights and floor contact pressure may also be affected.

6.5.2.1.2 Aircraft compartment limits.

REQUIREMENT RATIONALE

The structural characteristics of the aircraft are such that multiple loading restrictions apply and must be simultaneously satisfied. These restrictions, though varying in specific nature, are imposed by aircraft design requirements to assure a specified aircraft capability over a given service life. The aircraft compartment limits and those requirements stated in the following subparagraphs are designed to assure maintenance of aircraft serviceability and safety of flight over the design life of the aircraft.

REQUIREMENT GUIDANCE

This requirement is concerned with the total load imposed on an aircraft compartment. The load limits apply regardless of the type of load, i.e., distributed, concentrated, linear, roller, etc. Meeting this requirement is a necessary, but not sufficient, condition for airlift acceptability. All appropriate weight limit requirements must be satisfied simultaneously. During on/offloading operations, all compartments have a strength equivalent to the strongest compartment under flight conditions. This permits moving items across lower strength areas to position them for flight.

REQUIREMENT LESSONS LEARNED

The lower flight load limits are designed to provide a margin of safety to allow for dynamic flight-induced loadings.

Frequently compartment load limits are not exceeded, but other types of loadings, such as plf loading, tire loads, and axle loads are outside limits. In many cases item design can be modified to satisfy these loading requirements. Shoring should be considered only after all other methods of solution have been investigated. Early contact with the ATTLA is recommended for advice and guidance.

VERIFICATION RATIONALE

Verification of this requirement by comparison of item load imposing characteristics with the compartment limits has been shown to be a cost effective method of determining compliance.

VERIFICATION GUIDANCE

Verification that this particular requirement has been met does not constitute complete satisfaction of all appropriate requirements for a particular item. All other applicable load limits must also be satisfied.

VERIFICATION LESSONS LEARNED

None Available

6.5.2.1.3 Aircraft roller conveyor limits.

REQUIREMENT RATIONALE

This requirement is established to ensure that the aircraft roller conveyor limits are not exceeded for the most severe flight or loading condition expected for that particular aircraft. The aircraft in-flight roller limits were established by rating the rollers based upon an ultimate in-flight load factor for the particular aircraft. The ultimate load factor for the C-141 was 6.6 g and for the C-5 aircraft is 6.15 g. Additional limits ensure that loads imposed on the roller do not exceed the cargo compartment floor limits. These limits are normally established by dividing the longitudinal floor loading limits by the longitudinal distance between the rollers. These requirements were established by the aircraft manufacturer.

REQUIREMENT GUIDANCE

Each aircraft has a specific procedure for determining limits on the rollers. In all cases, however, the determination of roller loading is accomplished by analysis using the item's contact with the rollers or pallet/platform, and the contact location with respect to the roller locations. HCU-6/E (463L) pallets, airdrop platforms, and energy dissipating material do not provide any load spreading. This premise generally applies to special bases, runners, and skids for items so equipped unless the design specifically provides for load spreading. Load contact patterns should be designed to provide the best load distribution; longitudinal load distribution is generally much preferred to lateral distribution. Note that for items rigged for airdrop, the energy dissipating material stacks are primarily arranged for impact survivability and that some stacks or section of stacks may not transfer loads to the rollers.

REQUIREMENT LESSONS LEARNED

Loads moving on/off the aircraft roller conveyor system must be kept coplanar with the roller surface to prevent excessive forces from being applied to individual rollers.

The load distribution between items bases, skids, or runners and the roller conveyor is critical in the design of these item-to-roller interfacing devices. These devices must have continuous strength in the areas that interface with the roller conveyor system to prevent damage to the rollers or the item base.

Because of the variable lateral roller conveyor spacing between the different aircraft and the cargo loaders (K-loaders), make sure item runners and skids are wide enough to operate on all intended aircraft and loader roller systems. In the C-5, the teeter rollers are a different width than the basic roller.

There are a number of vehicles certified for airdrop from the C-130 aircraft which were not certified from the C-141 because of the different roller limits in the aircraft.

A pallet stop on the C-130 A/A32H-4A rail prevents positioning the rigged item forward of FS 262. A pallet stop on the C-17 aircraft rail prevents positioning the rigged item forward of FS 337 in the ADS system or FS 379 in the logistics system.

VERIFICATION RATIONALE

Experience has shown that most air transport loads are adequately distributed so that the forces imposed on the roller systems are well within limits. Under these conditions, it is sufficient to satisfy this requirement to compare calculated load values against the limit values for the aircraft under consideration. Complex items often exhibit non-uniformly distributed load patterns. Analytical verification of compliance with this requirement is still the preferred method because of cost and time considerations involved in instrumented roller testing. However, such tests are acceptable in all cases and may, in fact, be necessary where loading/unloading involves possible non-coplanar orientation of the load with respect to the roller surface.

VERIFICATION GUIDANCE

Prior to 2007 there were no permanent C-130 or C-5 instrumented roller test beds constructed. A C-141 instrumented roller test bed was located at USA Natick Research and Development Center, Natick MA 01760. Data from the C-141 instrumented roller test bed had been used in evaluating airdrop rigged item loadings on lateral rows of rollers for the C-130 aircraft. The new instrumented roller test bed at Natick is adjustable and capable of simulating all present airdrop aircraft.

VERIFICATION LESSONS LEARNED

Excessive roller loads and possible damage to both rollers and the item base can result from the impact of the edge of skids, runners, and special bases on the roller as the base device rides up and over the roller. A beveled edge similar to that on the 463L pallet should overcome this potential problem.

Testing conducted on an instrumented roller test bed, with an apparent uniformly loaded test weight, concluded that the loads transmitted to the aircraft rollers were not uniformly distributed.

Reference Report on the Testing of the C-141 Roller Conveyor System, Report No 379 and 386, by Brooks & Perkins, Incorporated, Contract No F33657-69-0927.

6.5.2.1.4 Concentrated loads/surface contact loads.

REQUIREMENT RATIONALE

This requirement is imposed to assure that the puncture/crushing limits of the aircraft floor are not exceeded by the imposition of concentrated loads (see section 3 definitions).

REQUIREMENT GUIDANCE

To determine if the concentrated loading exceeds the limit value for an aircraft, it is necessary to determine the weight of the item and the area of contact of the load with the floor. If the limiting value is exceeded, check shoring requirements to see if the spreading effect will bring the loading within an acceptable level.

REQUIREMENT LESSONS LEARNED

If shoring is used to spread a load, the weight of the shoring must be considered as a part of the weight when computing psi loading values.

In general, it is better to overcome excessive concentrated loadings through item design than to use shoring. The use of shoring aggravates the weight problem (see above paragraph) and imposes the requirement for shoring to be available at all loading sites.

VERIFICATION RATIONALE

This method is the most cost-effective procedure for verifying compliance with this requirement.

VERIFICATION GUIDANCE

See requirement guidance in 6.5.2.1.4.

VERIFICATION LESSONS LEARNED

When using shoring, the weight added will increase by approximately 2 pounds per board foot for construction grade lumber. The weight will be higher for hardwood lumber.

6.5.2.1.5 Longitudinal floor load.

REQUIREMENT RATIONALE

Linear loading imposes bending forces on the aircraft fuselage structure. Limits on these forces have been established by the aircraft manufacturers consistent with mission requirements and aircraft service life. Linear loading forces must be restricted simultaneously with other forces.

REQUIREMENT GUIDANCE

Determine linear loading by dividing the weight (in pounds) of the item by its projected length (in feet) which results in a pounds per linear foot value. Comparison of this value with the limit value for a given aircraft determines if this criterion has been met. While the bending force is independent of the length of contact between the item and the floor, contact length is a factor in psi/psf loadings which must be simultaneously satisfied.

REQUIREMENT LESSONS LEARNED

It is possible to satisfy linear loading requirements and at the same time exceed psi/psf loading limits. These puncture/crushing loads are determined by the item's contact area while linear loading is dependent on projected length.

VERIFICATION GUIDANCE

See VERIFICATION INFORMATION in 6.5.2.1.4

6.5.2.1.6 Lateral floor loads.

None available

6.5.2.1.7 Jackstand and tongue loads.

REQUIREMENT RATIONALE

Towed wheeled vehicles impose a tongue load on the aircraft floor when in position for flight. This load must be limited to prevent crushing or puncturing the aircraft floor, particularly under the influence of gust and flight maneuver loads.

REQUIREMENT GUIDANCE

Depending on aircraft design, either a psi loading limit or a combination psi/maximum load limit is imposed. Knowledge of the tongue load and bearing area are sufficient data to calculate psi values. Comparison with aircraft limit values will determine compliance with this requirement.

REQUIREMENT LESSONS LEARNED

See lessons learned for 6.5.2.1.4.

VERIFICATION GUIDANCE

See VERIFICATION INFORMATION in 6.5.2.1.4

6.5.2.1.8 Axle loads and axle spacing limits.

REQUIREMENT RATIONALE

Vehicle axle loads impose bending forces on the aircraft fuselage. Axle spacing requirements are set to assure that forces are distributed so that major fuselage structural members do not experience overload conditions. Both limits are set by the airframe manufacturer based on design utilization of the aircraft over a specified service life. Item loading limits are equal to or higher than flight limits because no gust or flight maneuver forces are secondarily imposed during the loading/unloading process. Thus, in some instances it may be possible to load an out-of-limit axle if provision can be made through the use of shoring or other means to bring the axle within flight limits once the vehicle is on-board the aircraft.

REQUIREMENT GUIDANCE

Appendix B specifies the axle load and axle spacing limits. Knowledge of the axle configuration (number of wheels per axle), axle weight and spacing will permit determination of the acceptability of the vehicle for loading and flight.

REQUIREMENT LESSONS LEARNED

Axle loads and wheel loads must be satisfied simultaneously. Often axle/wheel configuration will be such that the wheel load becomes the more restrictive criteria (see 5.3.2.1.9/10/11).

It is important to ensure that, where the axle/wheel configuration permits a given load, the tires are of the appropriate load-bearing range so that tire failure will not occur under either loading or flight conditions. Use of a better grade tire than required for operational purposes may prove to be cost effective if extensive precautions need otherwise be taken in order to airlift the vehicle.

VERIFICATION RATIONALE

Experience has shown that this requirement can generally be verified by comparison of axle/wheel configurations, axle loads, and axle spacing with aircraft limit data. Analysis may be required for loading procedures which involve ramp cresting where axle loads may be instantaneously transferred with possible overloads resulting.

VERIFICATION GUIDANCE

Comparison of the vehicle physical characteristics with the limit data presented in the appendix B is the initial step in the verification process. This establishes if the vehicle can be loaded straight in across the horizontally positioned ramp. Loading from the ground up the inclined ramp involves cresting at the hinge line. Without sufficient axle articulation, axle loads can shift at the crest point and cause an overloaded condition to exist until all axles are supported by the aircraft floor. If this condition exists the ATTLA should be contacted immediately for advice.

VERIFICATION LESSONS LEARNED

None Available

6.5.2.1.9 Pneumatic wheel/tire loads.

REQUIREMENT RATIONALE

Pneumatic tires impose a crushing load on the aircraft floor. Steel wheels, in theory, provide only line contact with the supporting area. Slight flexibility of both floor and wheel makes the contact a ribbon rather than a line, but the weight on a steel wheel is still concentrated. Solid rubber wheels also often concentrate the load on a small area. Because steel and solid rubber wheels are essentially unyielding, high concentrated loads can easily be developed. A second consideration applies to pneumatic tires. Tires loaded beyond their rated capacity are subject to failure. Tires filled with a core material no longer spread the load under flight conditions as well as pneumatic tires due to smaller tire deflections.

REQUIREMENT GUIDANCE

Appendix B presents data for pneumatic tires as well as charts for steel and hard rubber wheels. Direct comparison of the loads and physical dimensions of the steel/hard rubber wheels with the appropriate limit data from the charts will indicate acceptability of the wheels at shipment load values. Tire loads should not only fall within limits imposed by the aircraft manufacturer and shown in tables for each aircraft, but should also adhere to tire manufacturers' load limits as well. If it can be verified that the core filled tires adequately distribute the load for the load factors in 5.3.3.1, relief from this requirement is possible.

REQUIREMENT LESSONS LEARNED

Tires have tread which effectively reduces contact area. In cases of construction and rough terrain vehicles this reduction can be significant. To insure full floor contact, shoring equal in thickness to at least one-half of the tire groove width will be used. For example, if the tire has a groove between tread of two inches, any shoring used must have a thickness of at least one inch.

Tire pressure will be maintained within the manufacturer's operating pressure range. At pressures lower than this, a danger exists that the tire-to-rim seal may be broken with the possibility of sudden tire failure and damage to the aircraft.

VERIFICATION RATIONALE

The method of verifying compliance with this requirement by direct comparison of loads and tire/wheel characteristics with published limit data is both adequate and cost effective.

VERIFICATION GUIDANCE

See rationale

VERIFICATION LESSONS LEARNED

For the C-130 aircraft explicitly and as a guideline for other aircraft, pneumatic tires having an air pressure in excess of 100 psi must be considered solid wheels and verification of acceptability must be based on these criteria.

6.5.2.1.10 Solid wheel loads.

See 6.5.2.1.9

6.5.2.1.11 Tracked pads or cleats.

See 6.5.2.1.4

LESSONS LEARNED

Rolling shoring is specified for tracks with grousers to the depth of the cleat plus at least ¼ inch. It is possible for the vehicle to damage the shoring during loading to the point that it is unusable for offload and a second set may be required. The minimum recommended width is 1.5 times the width of the track to account for minor steering adjustments during the onload/offload. This may be required for tracks with pads if the pads are worn and present a danger to the aircraft floor.

6.5.2.1.12 Vehicle suspension limits.

REQUIREMENT RATIONALE

Military vehicles previously had two gross vehicle weight ratings. One rating was for highway service and the second was for cross-country (off highway) operation. The highway rating was essentially an overload condition which was permitted for operations on improved roads under mild shock and vibration conditions. The cross-country rating provided load carrying capability based on vehicle design for rough terrain operation where severe shock and vibration environments are encountered. Experience showed that operating vehicles at the highway rated capacity resulted in excessive maintenance costs and reduced vehicle life. Consequently, the Army now has a single vehicle load rating (tactical rating) at which the cross-country rating is equal to the highway rating; however, the vehicle speed is limited.

The cross-country scenario most closely approximates the environment a vehicle experiences in an aircraft under gust and flight maneuver loads. Experience has shown that military vehicles can be safely airlifted at gross weights not exceeding the cross-country rating.

Commercial vehicles do not have a similar rating. Because their gross vehicle weight rating is essentially an improved road rating, it is not satisfactory as an airlift criteria. Consult with the ATTLA for guidance on the weight carrying capacity of commercial vehicles.

REQUIREMENT GUIDANCE

A military vehicle which has an established tactical/cross-country rating can be carried safely in all aircraft at gross vehicle weights (GVWs) not exceeding this value provided all other aircraft limitations are met. The ATTLA will determine the acceptable GVW of all other vehicles including all commercial vehicles.

REQUIREMENT LESSONS LEARNED

Commercial vehicles generally have lighter duty suspension systems than military vehicles which are designed for more rugged service environments. This not only means that they are more subject to failure under flight load conditions with a high potential for aircraft damage, but they are also more prone to uncontrolled random movement which places greater stresses on tiedown devices.

Commercial vehicles are increasingly being used for military applications. Because these vehicles are not designed to have the inherent ruggedness the military environment requires, it would be prudent to procure these vehicles with as rugged a suspension package as possible. The initial cost can be recovered many times over through the increased capability of the vehicle and reduced problems associated with aerial delivery. An option is to include load bearing stabilizing devices which function as sleeper shoring (see 5.3.7.1.2).

The earliest possible contact with the ATTLA is advised when commercial vehicles are being considered for use. This can often result in problem avoidance.

VERIFICATION RATIONALE

Assurance that the actual GVW does not exceed the published value or that determined by cognizant authority is sufficient verification for this requirement. Maximum GVW values are set at levels which will assure safe loading and flight for the vehicles.

VERIFICATION GUIDANCE

Cross-country/tactical ratings are shown in the field manual or technical order for each military vehicle. Where no cross-country/ tactical rating for a vehicle has been established, 80 percent of the manufacturer's GVW rating should be used to determine the maximum airlift weight of a vehicle. In addition, the C.G. of the vehicle should be so located that no axle weight exceeds 80 percent of its maximum rated capacity.

VERIFICATION LESSONS LEARNED

None Available

6.5.2.1.13 Ramp hinge limits.

REQUIREMENT RATIONALE

The design characteristics of the various aircraft limit the ability of the ramp hinge to withstand loads imposed as items crest the ramp-hinge line entering or exiting the aircraft. This varies by aircraft and applies only to crest loads.

REQUIREMENT GUIDANCE

This requirement limits the maximum load the ramp hinge can withstand at the moment the item crests the hinge line. This limit applies to axle loads as well as linear loads and refers to the instantaneous loading that occurs at the moment of cresting.

Take note of this for tracked vehicles fitted with non-articulating suspension. The entire weight of the vehicle may balance on the ramp crest when it transitions from climbing the ramp to traversing the cargo floor.

REQUIREMENT LESSONS LEARNED

Where the action angle of bogie axles is less than the crest angle there will be a point during loading when the bogie axle load will shift to a single axle. Under these conditions a hinge overload can easily occur.

The C-130 hinge can withstand any total load as long as linear loading criteria are not exceeded. This does not apply to axle loads.

VERIFICATION RATIONALE

Experience has shown that this requirement can be verified by analysis with the knowledge of the applicable load and the action angle of articulating members. Measurements and formal testing may be necessary if complex loading patterns are known or suspected.

VERIFICATION GUIDANCE

Verification can be accomplished by determining that the cresting loads do not exceed the aircraft limit levels. Simple comparison of loads with limit values is sufficient in most cases. Where bogie axles are involved and the possibility exists that load shifting at the crest point may occur, analysis must be performed to assure that the resultant loading does not overstress the hinge. If more complex loading situations are involved, consult the ATTLA as soon as possible for guidance.

VERIFICATION LESSONS LEARNED

None Available

6.5.2.1.14 Palletized cargo.

REQUIREMENT RATIONALE

The standard 463L pallet can be used as a base on which to position and restrain a unitized load of general cargo as well as larger cargo items such as vehicles. The 463L pallet is described in A.4.1.1.1.

When locked into an integral military aircraft rail system, the 463L pallet, and its companion MIL-N-27444 nets and straps, constitutes a system capable of restraining a uniformly distributed 10,000-pound load of general cargo against the acceleration forces of 5.3.3.1. General cargo conforming to the load configuration of MIL-N-27444 and restrained by the 463L pallet/net system meets all air transportability restraint criteria.

Where the nature of the load is such that it cannot be restrained to the 463L pallet with MIL-N-27444 nets, specifically tailored tiedown procedures using adequate attachment points and MIL-T-25959 or MIL-T-27260 tiedown devices must be used.

463L pallets are load-limited in two respects. First, concentrated loads on the surface of these devices can cause puncturing of the pallet skin. Secondly, loads carried by these devices are transmitted to and reacted by the aircraft rollers which also have structural limits. Thus, the cargo must not impose loads which exceed either the roller limits shown in table III or the pallet puncture load limits of 250 pounds per square inch (psi).

REQUIREMENT GUIDANCE

To determine if a palletized object is suitable for air transport, it is necessary to compute the loads which will be imposed on the rollers of the aircraft under consideration. This loading is a function of the object's contact length on the pallet which determines the number of roller stations contacted. A.4.3.4 provides guidance in this area.

Two important considerations must be kept in mind when determining the acceptability of pallet loads. First, no load spreading capability is assumed to exist with the 463L pallet. Therefore, to determine the longitudinal roller loads for palletized cargo, use only the object's actual contact length per longitudinal contact station on the pallet. If load spreading is necessary to meet roller load limits, wood shoring may be used employing the principle of geometric weight distribution. Refer to A.5.4.2 for details on the use of shoring. The second factor is the number of roller conveyors (longitudinal trays of rollers) contacted. Differing roller load limits apply depending on the number of conveyors under load.

REQUIREMENT LESSONS LEARNED

None Available

VERIFICATION RATIONALE

Except where complex weight distributions are involved, analytical means have proved adequate to verify the acceptability of palletized loads. In those cases where complex loading exists, instrumented tests may be necessary to assure that the forces imposed on the roller system or the pallets themselves do not exceed established limits.

VERIFICATION GUIDANCE

The basic data required to compute the loads on the aircraft roller system are the dimensions of the base of the cargo item and the item's weight distribution. Both footprint pressure and load placement on the pallet must be considered. Footprint pressure must not exceed 250 psi. Load placement directly affects the loading imposed on the rollers. Analysis will permit determination of the number of roller conveyors under load as well as the number of roller stations contacted.

VERIFICATION LESSONS LEARNED

Design of palletized loads must take into account the weight of the pallet, required restraint hardware, and any additional equipment. An airdrop program lost cargo capability when the upgraded airdrop recovery system increased in weight over the old one. The rated capacity of a unitized load system (pallet, airdrop platform, skidboard, etc) cannot be increased to accommodate the same cargo capacity just because the support equipment increases in weight.

6.5.3 Restraint.

6.5.3.1 Restraint requirement.

REQUIREMENT RATIONALE

The restraint criteria in current use have resulted from a structured evolution. During this process, safety of flight considerations have been carefully balanced against operational considerations. The result is a set of criteria which provide a high probability of safety under expected flight conditions and, at the same time, impose reasonable operational requirements. The restraint levels specified are based on a statistical analysis of cargo aircraft accident data coupled with years of successful cargo flight experience at reduced restraint levels.

Both static and dynamic conditions are required due to the nature of the actual air transport environment (i.e., the factors are derived from maneuver, gust, and crash loads). The change in velocity within a specified time is designed to give latitude for verification of the dynamic conditions by testing.

REQUIREMENT GUIDANCE

The following factors should be considered when designing equipment to meet the specific restraint criteria:

a. When equipment is of such size or configuration that it can be loaded into cargo aircraft with either end facing forward (i.e., a truck that can be driven forward or backed into the aircraft), the highest load factor applies, both fore and aft. When the loading direction is fixed or specified, the 3 g requirement applies in the forward direction and the aft load factor requirement applies in the rearward direction.

b. Vehicles and other equipment should be capable of withstanding, without loss of unitary integrity or loadability, the vertical downward load factor imposed on the wheels, suspension systems, or support.

c. MIL-STD-209 and 5.3.3.2 provide criteria for tiedown provisions on the item which can interface with aircraft tiedowns' strength and physical dimensions.

d. The procuring agency may wish to levy load requirements in excess of those stated herein due to other mission requirements.

Chains and straps cannot be used together when restraining cargo to the aircraft. Straps stretch further than chains under the same load and can produce uneven tension of the tiedowns. Likewise, tiedown attachment points on the item cannot be made of material that may stretch more than other attachment points on the item. For example, a nylon loop should not be used as a tiedown on one part of the item while other parts are made of metal, unless the nylon is of the same stiffness and has the same elongation properties as the metal.

REQUIREMENT LESSONS LEARNED

The amount of restraint afforded by a tiedown (strap, chains, etc.) in a specific direction will be less than the capacity of the tiedown due to the angle at which the tiedown is attached.

Wheeled vehicles are usually self-limiting in their ability to withstand vertical downward forces. The limiting factor is the ability of the suspension system and wheels to resist down loads without failure that would cause aircraft damage. For this reason, suspension loads are limited to the vehicle's cross-country rated load or its equivalent commercial rating. Where this rating is exceeded for flight, but not for loading, devices should be incorporated in the design of the vehicle to limit the load experienced by the suspension system to safe levels.

Vehicles with only a commercial highway gross vehicle weight rating are generally limited to 80 percent of the highway gross vehicle rating and 80 percent of the individual highway axle/suspension rating. Analysis or test would be required to upgrade the vehicle weight above 80 percent of the highway rating.

The M-149 water trailer was not designed to withstand the air transport load factors with a full complement of water in the tank. Evaluations are now required to attempt to qualify the trailer in this configuration.

The forward restraint criteria was lowered from 4 g to 3 g in July 1974. Refer to ASTR-73-17, Final Report - Air Cargo Restraint Criteria, April 1973, and ASTR-76-30, Cargo Aircraft and Spacecraft Forward Restraint Criteria.

An item that might not receive attention with regard to restraint is the wood-frame trailer. Camping, travel, and mobile home sized trailers modified to hold test or command and control equipment have become common. (ATTLA even saw one modified as a mobile kitchen.) With the addition of heavy equipment racks the original design parameters of the trailer will be quickly exceeded. If analysis of the modified frame and equipment installation is not provided, structural reinforcements will be required. Tiedown rings mounted in wood are unacceptable without analysis.

6.5.3.2 Tiedown provisions.

REQUIREMENT RATIONALE

Any item of equipment must have a suitable number of tiedown provisions to allow restraint to the aircraft, using available, on-board tiedown devices. Three such devices--Type CGU-1/B for nylon straps and Types MB-1 and MB-2 for chains--are currently in use. These devices are described in C.5.2.2. Any tiedown provision should be designed to allow either end of the tiedown device to be used. The other end of the device is secured to a tiedown filling in the aircraft floor. In general, the aircraft has a tiedown point grid pattern on 20 inch (0.51 m) centers. C-130 tiedown provisions have a rated strength of 10,000 pounds (4,536 kg.). A few have a capacity of 25,000 pounds (11,340 kg). The C-17 has 25,000 pound attachment points on 25 inch centers; and the C-5 has 25,000 pound attachment points on 40 inch centers.

Because all loads are reacted at the tiedown provisions, these must be of sufficient size and strength to accept the number and type of tiedown devices necessary to meet fore, aft, lateral, and vertical upward restraint criteria of 5.3.3.1. For most items, at least four tiedown provisions are necessary to restrain an item along its three principal geometric axes. The tiedown provisions must be sized to accept at least two tiedown devices oriented at 90 degrees to each other or a single device of sufficient strength and properly positioned to accept the equivalent resultant load of the dual chain configuration.

REQUIREMENT GUIDANCE

Tiedown provisions are usually considered to be specifically designed for the purpose. Such items as lifting and tiedown rings and clevises are commonly used as tiedown provisions. However, tiedown provisions which naturally result from item configuration are acceptable for use provided their strength is adequate to provide the required restraint. Examples of such tiedown provisions are vehicle frames, axles and cross members, pintle hooks, and cut-outs or other openings in structural members.

All vehicles must be restrained by using tiedown provisions on the frame. However, up to one-half of the tiedown devices may be attached to the vehicle axles. The designer must insure that the through structure to the axles can withstand the loads when the vehicle is secured in this manner.

Since a load can move in any direction, at least four tiedowns 90 degrees (1.57 radians) apart must be secured to an item. The total number is determined by the weight of the item. However, all tiedown provisions should, whenever possible, be symmetrical to allow even loading. The tiedown provisions may be designed to accommodate as many tiedown devices as necessary to achieve the required restraint. MIL-STD-209 provides design information on tiedown provisions.

REQUIREMENT LESSONS LEARNED

The following items must be taken into consideration when determining tiedown provisions type and quantity:

a. When computing the number of tiedown provisions, consider restraint capability degradation incurred when applying tiedown devices at an angle.

b. If possible, position tiedown provisions around the horizontal periphery of the equipment. Also, locate these points so that they are accessible to the equipment on the aircraft. (Installation of a tiedown ring on the vehicle frame and subsequently hanging a fuel tank outboard of that tiedown ring will severely limit or prevent application of restraining devices.) If the equipment needs servicing during flight, the tiedown provisions should be located so as not to block these areas.

The following items must be taken into consideration when determining the number and type of tiedown devices:

a. Do not intermix chain and webbing tiedowns. Use either all chains or all webbing. The difference in elongation between the two types of tiedowns creates unsymmetrical loading and increases the potential for restraint device overload and failure.

b. Selection of tiedown devices should be based on the appropriate strength rating to provide adequate restraint with the minimum number of devices.

c. Tiedown device strength rating must not exceed the strength rating of available tiedown provisions or points of attachment to the cargo.

d. Use steel tiedown devices on heavy objects which have attachment lugs or a hard surface for the chains to go around.

e. Attach tiedowns in a symmetrical pattern by using corresponding provisions on each side of the cargo floor centerline.

For additional information see C.5.

VERIFICATION RATIONALE

The complete restraint system consists of tiedown provisions on the item, CGU-1/B, MB-1, and MB-2 tiedown devices and cargo floor tiedown provisions and receptacles. All components except the tiedown provisions on the items have previously been qualified at their rated capacities. The number and strength of the tiedown provisions is the only remaining unknown requiring verification.

Verification of these requirements can be accomplished in two ways. Proof of capability can be determined through engineering analysis with the knowledge of tiedown pattern geometry and materials characteristics. Because tiedown patterns may change due to aircraft differences, equipment availability, and aircraft load characteristics, proof of capability must be predicated on worst-case conditions. The second method of proof is actual testing of the tiedown provisions by subjecting them to appropriate worst-case loads and angles of application.

The analytical method of verification is preferred because it is generally less costly and time consuming.

VERIFICATION GUIDANCE

Tiedown provisions on items should be located such that the lines of action of the attached tiedown devices intersect, if possible, above the cargo center of gravity as shown in figure C-15. Such an arrangement reduces the tendency of an item to overturn when subjected to combined upward and side loads.

The point of attachment of a tiedown device to a cargo unit must be substantial enough to withstand the loads for which the cargo unit is being restrained. A tiedown device must not be attached to just any convenient protrusion on a cargo unit without due consideration of the protrusion's strength.

The angle of application of tiedown devices affects the restraint capability of that device. The rated capacity of a tiedown device applies only in pure tension. Most cargo units are restrained by tiedown devices angled from the attachment points to the floor tiedown provisions. This has the advantage of having one tiedown device provide restraint in more than one plane, but at a reduced restraint level dependent on the angle of the line of action. Thus, the resultant forces applied concurrently in each principal plane must not exceed the rated capacity of the tiedown device or the tiedown provisions, whichever is less.

VERIFICATION LESSONS LEARNED

Meeting the requirements of MIL-STD-209, while valuable, allows zero weight growth. MIL-STD-209 procedures specify designing and testing tiedowns at the current design weight of the vehicle. However, military vehicles have a historic weight growth of 25 percent over their service lives (SDDCTEA report entitled “Historic Weight Growth of U.S. Army Combat Vehicle Systems” at http://www.tea.army.mil/pubs/nr/deploy/paperspubs/WeightGrowthPaper082702.pdf). It is strongly recommended that new vehicle designs incorporate tiedown capability for at least 125 percent of the design weight. Existing vehicles modified with tiedown provisions should include as much of this margin as possible.

6.5.3.3 Cargo without tiedown provisions.

None available

6.5.3.4 Vehicle structure.

REQUIREMENT GUIDANCE

Attention should be paid to modified commercial trailers. With the addition of heavy equipment racks the original design parameters of the trailer may be quickly exceeded. If analysis of the modified frame and equipment installation is not provided, structural reinforcements will be required. Tiedown rings mounted in wood are unacceptable without analysis.

6.5.3.5 Verification methods.

VERIFICATION RATIONALE

Items are restrained to the aircraft either by tiedown to the aircraft floor or restrained to a pallet which in turn is locked in the aircraft rail system.

Standard aircraft and airdrop tiedowns, and aircraft rail locks and tiedown provisions, do not require verification. Therefore, only restraint criteria verification of the item in its aerial delivery configuration and its attaching (tiedown) provisions is required. The pallet center of gravity is restricted to insure that palletized loads can be restrained to the load factors described by the requirement. Verification of the rigged item center of gravity location is required. Analysis or test will suffice for determining the location.

VERIFICATION GUIDANCE

a. Analysis normally will suffice in verification of the item to withstand the load factors in all directions. When fluids are carried, the analysis should include the effects of the fluid. Testing is the preferred method of verification of a vehicular item's capability to withstand the downward load factors when the weight is above the 80 percent of the gross highway weight rating. However, a complete analysis of the axle/suspension and vehicle is an acceptable substitute.

b. For the dynamic vertical up and down load conditions, the vehicle must be oriented as in the aircraft since the velocity change accounts for 3.0 G (up) and 3.5 G (down) respectively. The intent of this requirement is to have the cargo under a 1 G static condition, then subjected to the dynamic loadings.

c. If testing is used for the dynamic verification, an acceptable rate of onset prior to the beginning of the 0.1 second measurement is 20 A/sec or greater, where A is the appropriate load factor of 5.3.3.1. Similar rates for decay are also acceptable.

If a drop test is accomplished to verify the dynamic down load requirement, the change in velocity is changed from 11.50 ft/sec to 14.50 ft/sec. This is because a 1 G static load was not present on the suspension during the drop test.

d. The change in velocity during a test can be measured directly or can be derived from an acceleration trace. The change in velocity requirement opens up additional methods of complying with the dynamic aspect of the restraint requirement.

VERIFICATION LESSONS LEARNED

Not only must the basic item be restrained to the criteria specified, but all components of the basic item must be as well.

The Commercial Utility Cargo Vehicle (CUCV) exceeded the 80 percent commercial highway gross weight criteria. The vehicle was successfully tested at its commercial highway gross weight by placing each wheel of the vehicle on four individual instrumented hydraulic rams which, in being activated simultaneously, applied the required load factors to the vehicle. Most variants also passed rail impact testing with no modifications.

6.5.4 Markings.

6.5.4.1 Marking requirements.

None available

6.5.4.1.1 Tiedown provisions.

None available

6.5.4.1.2 Shipping weight and center-of-gravity location.

None available

6.5.4.1.3 Hoisting fittings and forklift tines.

None available

6.5.4.1.4 Other markings.

REQUIREMENT RATIONALE

Adequate marking of items to be airlifted is necessary to provide information on loading techniques, weight, and balance data for positioning the item within the aircraft and tiedown provision data for determining restraint device requirements. Special preparation or servicing instructions may be included in the marking, as appropriate. By marking these data and instructions permanently on the item, they are readily available at the time of loading and will provide the necessary information to loading personnel to enable them to safely load and restrain items with which they have no previous experience. Such data also eliminates questions regarding the capability of equipment components because ratings are established by knowledgeable design personnel.

REQUIREMENT GUIDANCE

Visual inspection of the item will verify compliance with the marking requirements. Determination of the accuracy of the data displayed on the item may be made by engineering analysis or actual test for such items as centers of gravity and strength of tiedown and hoisting provisions. Instructional markings can be verified by attempting the procedure and comparing actual results with predicted results.

REQUIREMENT LESSONS LEARNED

Where special instructions are required to prepare an item for air transport, such instructions should be coordinated with the ATTLA to assure that the proposed procedures are acceptable in all appropriate air transport situations.

Tiedown provisions and other attachment points must meet the strength, number, and location criteria of 5.3.3.

VERIFICATION RATIONALE

In general, verification can be performed through visual inspection of the item markings. This alone does not insure the validity of the information presented. However, verification of the hardware characteristics of the item is required by other sections of this standard. Comparison of the markings with these results will assure the accuracy of the markings. Where special servicing or preparation is necessary to make the item ready for airlift, certification of procedure acceptability based on analysis or actual demonstration is usually accomplished prior to final acceptance of the item. Comparison of the validated procedure with the instructional markings will serve as verification.

VERIFICATION GUIDANCE

The most difficult requirements to verify involve the special servicing and preparation instructions. This is basically associated with the quality and completeness of the instructions.

The directions are usually written by persons thoroughly familiar with the item, but must be used by persons who may never have seen the item before. In these situations it is all too easy for the writer to assume a higher level of user knowledge than actually exists. This often results in directions which are incomplete or confusing to follow. Use of the proposed instructions by unfamiliar personnel to accomplish the procedure should determine the adequacy of the instructions. In many cases this step is a contractual requirement tied to a maximum time permitted to accomplish this.

VERIFICATION LESSONS LEARNED

None Available

6.5.5 Air transport environment.

6.5.5.1 Air transport environment requirements.

6.5.5.1.1 Acceleration, shock and vibration.

REQUIREMENT RATIONALE

This requirement is imposed to assure that functional damage to the item due to the flight environment is avoided to the maximum extent. Only the designer has knowledge of the structural ruggedness of the item and what shock and vibration levels the unprotected item can tolerate and still function satisfactorily. The purpose of this requirement is to make the designer aware of the airlift operations shock and vibration environment so that necessary protective measures can be applied to the item.

REQUIREMENT GUIDANCE

This requirement is intended to define the shock and vibration environment an item may experience during on/offloading and flight. Failure to provide item protection against these potential conditions could cause safety of flight problems. Another adverse effect expected would be failure of the item to function properly. With knowledge of the shock and vibration environment, the item designer would work with packaging personnel to assure item protection.

REQUIREMENT LESSONS LEARNED

Air Force Flight Dynamics Laboratory Technical Report 74-144 (AD B003792), C-5A Cargo Deck Low-Frequency Vibration Environment, February 1975 (limited access) provides data on levels of vibration - induced accelerations experienced on the flight deck during all phases of C-5A aircraft operations.

VERIFICATION RATIONALE

This standard establishes uniform environmental test methods for determining the resistance of equipment to the effects of natural and induced environments peculiar to military operations. It provides environmental test methods in order to obtain, as much as possible, reproducible test results.

VERIFICATION GUIDANCE

MIL-STD-810 Method No 514 for Vibration and Method No 516 for Shock are the appropriate test methods to determine compliance with the serviceability/performance portion of this requirement.

VERIFICATION LESSONS LEARNED

None Available

6.5.5.1.2 Rapid decompression.

REQUIREMENT RATIONALE

The shipment of cargo by air presents a special potential problem not encountered during surface transport. That is the problem of rapid decompression of the cargo compartment. The three USAF prime mission cargo aircraft have automatically controlled cargo compartment pressurization systems which maintain compartment pressure at approximately 8.3 psi differential above outside air pressure when at flight altitude. If extremely rapid pressure loss should occur due to aircraft structural failure, it is possible that sealed items could explode under the influence of reduced external pressure. Parts of these items could become projectiles endangering crew members as well as the aircraft.

REQUIREMENT GUIDANCE

This problem is associated principally with well sealed containers which enclose large volumes of air such as vans, ISO containers, and shelters configured as shops, repair, and test facilities, etc. The effects of rapid decompression on the item can be mitigated by providing for controlled breathing to accommodate air flow due to pressure changes or the use of devices to permit safe relief of an 8.3 psi pressure build-up within 0.5 sec. The intent of this requirement is to assure that this potential problem is considered in item design and provisions made to accommodate rapid decompression if the item will be adversely affected by it.

There are two distinct methods of meeting this requirement. The item can be strong enough that the pressure differential can be survived with no effect, such as with the on-board fire extinguisher. Alternately, vent areas of sufficient size to equalize the air pressure fast enough to prevent structural failure (or other hazard) may be used. The venting need not be accomplished in 0.5 sec, but fast enough for the structure to survive. Commercially available “burst panels” are available to assist in meeting this requirement.

REQUIREMENT LESSONS LEARNED

Most commercial vans, containers, and shelters are designed for surface move movement where rapid decompression is not a factor. When such containers are used for military purposes where airlift is anticipated, provisions for attenuation of the potential damage due to decompression must be made.

Some commercial containers are designed to permit air to enter/exit the interior due to pressure changes. In general these passages are not designed to accommodate rapid decompression.

Small food packets have been known to expand and damage larger containers that carry multiple packets, and each other, as the aircraft ascends to higher altitude. One solution is to not fill a container to maximum capacity to allow the small packets to expand safely. Flexible containers are to be evaluated on a case-by-case basis.

VERIFICATION RATIONALE

The inherent design features and ruggedness of some items may be sufficient to withstand the effects of rapid decompression without modification. Where it can be shown by engineering analysis that this is the case, such analytical proof should be adequate to verify compliance with this requirement. The alternative is dynamic testing of the item in its shipping configuration under the worst-case conditions stated above and inspection of the item to determine no parts have become a missile.

VERIFICATION GUIDANCE

Where it can be shown analytically, using accepted engineering practices, that the subject item can withstand rapid decompression under the conditions of 5.3.5.1.2.1, this constitutes compliance with the requirements of 5.3.5.1.2. In all other cases formal testing should be accomplished to verify compliance.

The formula $A = \left(\frac{3.504}{1280}\right)2V$ may be used to determine if a system that cannot withstand the pressure differential has sufficient vent area. V is the container volume and A is the minimum area required to provide venting.

The full derivation (based on analysis done at Natick Soldier Center) is as follows:

This analysis assumes the following:

1) One dimensional flow through a slowing converging, diverging duct
2) Ideal gas specifically air
3) Isentropic flow

The referenced analysis looked at the decompression issue on a standard ISO container using the door seals as the air exit port. During a sudden decompression the door seals would blow out providing an 1/8" gap for which to equalize the pressure.

The cargo item uses open panel areas to provide for pressure equalization. The following analysis uses the same equation in calculating the venting time as the referenced analysis. Since the cargo item uses large open panel areas vs. just the door perimeter seal gap, it is felt that this analysis is conservative and will easily meet the pressure equalization time requirement.

In the referenced analysis, estimates for compartment decompression, the outflow time for air was shown to be

$$\Delta t = \left(\frac{V}{A}\right)\frac{1}{\sqrt{\gamma R T_0}}\left[3.575\sqrt{\frac{\gamma-1}{2}} - \sqrt{\left(\frac{2}{\gamma+1}\right)^{-\left(\frac{\gamma+1}{\gamma-1}\right)}}\ln\left(\frac{1.894P_f}{P_0}\right)\right]$$

where Δt is the time in seconds for the pressure in the compartment volume V to drop from P_0 to P_f thru the decompression port area A.

In this estimate for isentropic flow of an ideal gas thru a converging-diverging geometry

γ = 1.40 ≈ 7/5, ratio of specific heats for air

R = 1717.61 $\frac{ft-lb}{slug-{}^0R} = \frac{ft^2}{\sec^2-{}^0R}$, individual gas constant for air (R_u/mol.wt)

$\sqrt{\gamma R T_0}$ = c, speed of sound in air at temperature T_0

1.894 = $\frac{P_{stagnation}}{P_0}$, for Mach M=1 and γ = 1.40

Δt = time required for the pressure to fall from P_0 to P_f [sec]
V = volume of compartment at initial pressure P_0 [ft^3]
A = decompression port area [ft^2]
P_0 = initial compartment pressure [psia]
T_0 = constant compartment temperature [^oR]
P_f = external pressure against which compartment air empties [psia]

For initial conditions, we use the standard atmosphere pressure and temperature at 8000 ft

P_0 = 10.92 psia at 8000 ft
T_0 = 490.16 ^oR = 30.5 ^oF at 8000 ft.

The temperature of the air in only the emptying volume determines its flow characteristics.

For the standard 8ftx8ftx20ft ISO container with nominal volume V = 1280 ft^3, substituting the indicated air constants gave the following simplified formula for the estimated outflow time

$$\Delta t = \frac{1}{A\sqrt{T_0}}\left[41.738 - 45.105\ln\left(\frac{1.894P_f}{P_0}\right)\right]$$

For external, final pressure, we use a desired pressure drop of 8.3 psid per MIL-STD-1791 (5.2.5.2), which corresponds to a standard atmosphere altitude of a little over 40,000 ft

Pf = 2.62 psia at a little over 40,000 ft

So, finally, substituting these Po, Pf, and To, gives for the 1280 ft^3 standard ISO container

$$\Delta t = \left(\frac{3.504}{A}\right)$$

Then the requirement that the pressure falls 8.3 psid within Δt = 0.5 sec, gives a required port area for the standard ISO container of at least 7.008 ft^2.

For the same initial and final conditions, we can ratio the last equation for any free volume V and port area A to get the corresponding depressurization time.

$$\Delta t = \left(\frac{3.504}{1280}\right)\frac{V}{A}$$

Sample Results: A cargo item consists of three containers:

1. cargo item
2. cargo item
3. cargo item

The following tabulates the estimated time for the compartment pressure to fall the required 8.3 psi using the above formula and constants and shows that the provided port area is adequate.

	Fixed volume [ft3]	Port area [ft2]	Time [sec]
cargo item 1	126	7.4	0.05
cargo item 2	101	3.4	0.08
cargo item 3	84	15	0.02

VERIFICATION LESSONS LEARNED

None Available

6.5.5.1.3 Explosive vapor.

None available.

6.5.5.1.4 Extreme temperature.

None available

6.5.5.1.5 Electromagnetic environment.

REQUIREMENT GUIDANCE

This includes laptop computers, PDAs, cell phones, and other personal portable electronic devices that may be utilized during tests.

This section does not include information about magnetic materials. Magnetic materials are considered HAZMAT and requirements may be found in AFMAN 24-204(I).

6.5.5.1.5.1 Electromagnetic interference and electromagnetic compatibility (EMI/EMC) requirements.

None available

6.5.6 Special consideration cargo.

6.5.6.1 Special consideration cargo requirements.

6.5.6.1.1 Hazardous material.

REQUIREMENT RATIONALE

Certain materials which make up components of equipment items, are used in support of equipment operations, or can be carried aboard equipment as secondary cargo represent potential safety hazards to flight personnel and aircraft. In order to reduce the risk of air transporting these materials to an acceptable level, consistent with operational needs, specific preparation procedures have been developed. These required procedures and the conditions governing their application are detailed in Joint Service Publication AFMAN 24-204(I)/TM 38-250/NAVSUP PUB 505/MCO P4030.19H/DLAI 4145.3/DCMA1, CH3.4.

REQUIREMENT GUIDANCE

All pertinent requirements of AFMAN 24-204(I) must be met in air transportability situations. Detailed information regarding procedures to be followed for each hazard is provided in this publication. No deviations from these procedures are acceptable unless specifically authorized by official waiver.

REQUIREMENT LESSONS LEARNED

None Available

VERIFICATION RATIONALE

Because of the complex nature of, and potential danger in hazardous materials, verification of their proper preparation for air shipment must be accomplished by personnel qualified under the provisions of AFMAN 24-204(I). Normally, specialists familiar with specific items will prepare them for shipment and certify that they meet the requirements for air transport. The advantage of this is that such specialists are more knowledgeable about the characteristics of the item and its potentially hazardous elements. Of primary importance are the qualifications of the certifying personnel to assure that the required air transport safety standards have been met. Air terminal personnel, also qualified under AFMAN 24-204(I) standards, will inspect the load prior to its acceptance for air transport, thus providing a secondary check on the unit's proper preparation for shipment.

VERIFICATION GUIDANCE

This requirement has been met when a qualified certifier attests to the adequacy of hazardous materials preparation by executing DD Form 1387-2, Special Handling Data/Certification. The provisions of AFMAN 24-204(I) pertinent to the hazard must be complied with unless an official deviation/waiver is obtained.

VERIFICATION LESSONS LEARNED

None available

6.5.6.1.1.1 Quantity of fuel/hazardous material.

None available

6.5.6.1.2 Venting.

None available

6.5.6.1.2.1 Interface.

None available

6.5.6.1.3 Aircraft electrical and data interface.

REQUIREMENT GUIDANCE

It is recommended that the users meet with the aircraft program office early in the design process to define interface requirements that may be unique to each type of aircraft.

Unless equipment has been specifically electrically isolated, static discharge is not ordinarily encountered. Vehicles and equipment are normally grounded through contact with the aircraft floor, tiedown chains, or the pallet.

6.5.6.1.3.1 Aircraft electrical outlets and power supply.

None available

6.5.6.1.3.2 Data transmission interface.

None available

6.5.6.1.4 Bulk fluid tanks.

REQUIREMENT RATIONALE

Movement of large quantities liquids can severely shift the aircraft's center of gravity, putting the aircraft out of limits.

6.5.6.1.5 Personnel occupied roll-on systems.

REQUIREMENT RATIONALE

Despite being classified as "Special Consideration Cargo," by definition cargo does not carry personnel. Nonetheless, these are systems carried in the aircraft cargo compartment and are required to meet the same interface requirements as cargo.

REQUIREMENT GUIDANCE

In recent years there have been efforts to produce a variety of these systems. Airline-style seats mounted to pallets, VIP seats mounted to pallets, and in-flight test equipment with operator seats are a few examples. All efforts to date revolve around pallet-mounted equipment, thus the information in 5.3.6.2, 6.5.6.2, A.4, C.4, C.6, and C.9 is recommended as a starting point for interface requirements.

6.5.6.1.6 Nuclear cargo.

None available

6.5.6.2 Non-standard pallet or skid loads interfacing USAF MHE.

REQUIREMENT RATIONALE

Often it is advantageous and, in some cases, necessary to design equipment for air transport with an integral base or pallet. The interface with the aircraft system requires special design considerations. The integral base/pallet design must be designed to be compatible with the aircraft and materials handling equipment roller conveyor systems, but depending upon the specific equipment design, it may or may not be compatible with the aircraft guide rails and restraint lock systems. A design which incorporates 463L system compatibility offers increased potential for aerial delivery. At the same time it imposes different requirements which must be satisfied.

REQUIREMENT GUIDANCE

A flat bottom is highly desirable, but is only required in the areas and directions where the pallet will contact the rollers or ball casters of the aircraft and material handling equipment. Skids may be used on pallet or equipment bottoms if they are located and sized to mate with the roller conveyor systems and are strong enough to withstand the flight load requirements. The pallet/base must also be capable of withstanding the forces created by the item teetering on a single set of rollers.

Equipment with an integral base/pallet that must mate with the aircraft guide rail and restraint lock system must have a lip along the side that interfaces with the aircraft systems. Refer to figure A-13 for illustration of aircraft rail/pallet interface. Equipment/pallets that do not mate with the aircraft restraint lock system must have tiedown provisions in accordance with 5.3.3.1 so that it can be secured in the aircraft to the required restraint levels by means of approved tiedown devices.

REQUIREMENT LESSONS LEARNED

For efficient use of the aircraft, the base/pallet should lock into the aircraft rail system. This will permit the equipment to be secured to the pallet for the required restraint and then the pallet/equipment assembly can be locked into the aircraft to the required restraint level. However, long (exceeding 30 feet) or heavy (exceeding 30,000 pounds) equipment items are difficult to align with the aircraft guide rail system.

Load distribution between the pallet and the roller conveyor systems is critical in the design of specialized pallets or integral base designs. Skids and flat bottom pallets must have continuous strength in the areas that interface with the roller conveyor systems. Sometimes, due to misalignment between cargo loaders and the aircraft, the roller conveyor systems are not coplanar; therefore, a pallet/base can contact only a single set of rollers during the transition or cresting process.

The underside of the pallet or skid base must be as flat as possible and supported adequately to avoid a "washboard" or "wavy" shape while traversing the roller system. In addition, there should be no sharp edges, discontinuities, or projections which could damage the rollers. The leading and trailing edges of the pallet or skids should be beveled at a 45 degree angle or be rounded to ease the transition as the edge moves onto the rollers.

One HCU-6/E size design was able to meet roller limit and restraint rail requirements with two longitudinal skids along the outboard edges of the container. However, the container bottom was then raised above the pallet end stops on K-loaders and indoor aerial port cargo handling systems, which are on centerline. This forced a system redesign to meet MHE requirements, by putting a bar across the gap at each end. Lowering the container was not possible.

It is strongly recommended to have a full-length side rail/pallet lip when interfacing the aircraft rails for restraint. The aircraft rails are designed to provide vertical restraint to running loads, not point loads. For example, a 100” pallet with four 10” lip sections will be limited in weight to what 40” of aircraft rail can restrain. If the rail weight limit is exceeded the item must accommodate supplemental restraint to the aircraft floor.

VERIFICATION RATIONALE

The method of requirements verification depends to a large extent on the final item configuration. For instance, with a full pallet base, compliance with the appropriate MIL-DTL-27443 requirements is adequate verification for this requirement. In other designs, analysis of the item from both dimensional and structural standpoints may be all that is required to prove acceptability. Where large or heavy items or otherwise complex loading situations are involved, formal test loadings or other demonstration techniques may be required.

VERIFICATION GUIDANCE

As in all verification procedures, the method chosen should be the simplest one which will provide assurance that the requirements have been met. Judgment as to the proper procedure must be made on a case-by-case basis. The assistance of the ATTLA is available to both the program office and the designer to determine the feasibility of proposed designs and appropriate verification procedures. In many cases, the experience the ATTLA has had with similar designs may prove valuable in avoiding problem areas and may improve item characteristics. The earliest possible contact with the ATTLA is advised.

VERIFICATION LESSONS LEARNED

The increasing emphasis on on/offloading items with minimal MHE has made this requirement more generally applicable. Where the base/pallet is fully compatible with the 463L roller conveyor system (including restraint provisions), the entire unit load should be structurally capable of being restrained by the rail restraint devices.

Unless the base of the item can be maintained coplanar with the surface of the aircraft and MHE rollers during on/offloading, roller overloading and possible failure may result. Intensive consideration of the method of handling the item during on/offloading should be a part of any decision process relative to 463L system compatibility.

On/offloading conditions at remote sites should always be considered to be the limiting factor in judging the acceptability of items in terms of 463L compatibility.

Aircraft and MHE roller crowns are not perfectly co-planar. At transport weights the aluminum and balsa HCU-6/E is a flexible structure. The net result is that the calculated roller contact (based on the load, see A.4.3.4) is achieved. One proposed skid was so stiff that although it had sufficient calculated roller contact, in practice the entire weight of the skid was carried by the highest roller.

6.5.6.3 Secondary cargo.

REQUIREMENT RATIONALE

In many cargo aircraft the available cargo compartment volume is effectively filled before the weight carrying capability of the aircraft is reached. This is particularly true where high volume-to-weight ratio items such as vehicles are involved. In an effort to more effectively utilize the aircraft payload capability, it is often practical to use the load compartment of vehicles to carry additional cargo. This would be an obvious example of an item with secondary cargo.

More subtle examples of secondary cargo are situations involving certain vehicles whose design incorporates components which can become disengaged under flight load conditions. An example is the truck-mounted crane. The crane is mounted on the truck chassis using a large diameter kingpin with no provisions to prevent the kingpin from becoming disengaged during vertical accelerations.

Because secondary cargo is subjected to all the same acceleration forces as the basic item, it must be independently restrained to the same levels. The restraint criteria to be met are shown in 5.3.3.1.

Because it is impractical to tie down individual components of items such as trucks or helicopters, these components should be designed with sufficient inherent strength to withstand the acceleration forces of 5.3.3.1. The entire vehicle, including any additional cargo, must be fully restrained at its gross transported weight. Loose items such as those listed below should have provisions to be secured to the frame of the vehicle:

a. Spare wheels, tools and tool boxes, towing chains, pinch bars, etc.

b. Bulldozer blades and push arms.

c. Cranes or booms on wrecking trucks, etc.

d. Dump truck bodies and other hydraulic or mechanical lift mechanisms.

e. Machines and tools in shop trucks, shelters, and containers.

REQUIREMENT GUIDANCE

Where secondary cargo is involved in the shipping configuration of an item, the following factors must be considered. First, where equipment can carry additional load or is moved in a configuration where its weight is increased, the restraint system must be developed at the highest possible gross weight. Second, all loose loads or equipment components which are not inherently restrained to withstand the acceleration loads of 5.3.3.1 must be separately restrained to these levels. Third, the additional loads placed on vehicles must not cause the vehicle to exceed its cross-country weight rating, axle load limits, or other air transportability criteria.

The common method of restraining secondary cargo is to tie it down to a structurally sound member of the principal item such as a vehicle frame. If this mode is used, restraint design can be based on the weight of the secondary cargo. The principal item must be restrained to the maximum weight of the item plus the secondary cargo. If the principal item and the secondary cargo are each restrained to the aircraft floor, restraint design can be based on the highest weight of each load. All requirements of 5.3.3.1 must be complied with.

REQUIREMENT LESSONS LEARNED

None Available.

VERIFICATION RATIONALE

The restraint criteria in current use have resulted from a structured evolution. During this process, safety of flight considerations have been carefully balanced against operational considerations. The result is a set of criteria which provide a high probability of safety under expected flight conditions and, at the same time, impose reasonable operational requirements. The restraint levels specified are based on a statistical analysis of cargo aircraft accident data coupled with years of successful cargo flight experience at reduced restraint levels.

VERIFICATION GUIDANCE

Because secondary cargo is generally secured to the basic vehicle or item rather than the aircraft floor, it will be necessary to determine that the attachment points on both the load and the carrying structure are adequate in accordance with the provisions of 5.3.3.1. Where the secondary cargo is restrained to the aircraft floor, only the load attachment points need be verified for compliance.

VERIFICATION LESSONS LEARNED

None Available.

6.5.7 Special loading and flight procedures.

6.5.7.1 Shoring.

REQUIREMENT RATIONALE

The use of wood shoring is disadvantageous for a number of reasons. Each pound of shoring reduces aircraft payload by a similar amount. Shoring use is time consuming, which increases loading time and decreases loading clearance, which in turn restricts the dimensions of the item to be airlifted. Often, suitable shoring may not be available at the loading site, particularly at remote sites.

REQUIREMENT GUIDANCE

Shoring should be considered an expedient to be used only when all other practical methods of meeting handling requirements have been exhausted. It should never be considered a substitute for prudent planning or adequate design. Approach shoring is most frequently required because of problems involving projection (see 5.3.1.1.1.1), ground contact (see 5.3.1.1.1.2), or ramp cresting (see 5.3.1.1.1.3). Addressing these potential problems early in the design phase and consulting with the ATTLA for advice often results in practical solutions to these problems. Floor protective shoring is used principally to protect the aircraft floor from damage due to steel wheels, lugs, cleats and studs, etc. In many cases there is no practical way to avoid certain of these features in item design. Floor protective shoring becomes a necessity in these situations. Rolling shoring is used to provide a means of accommodating unit floor or ramp overloads during the loading process only. This is an expedient to be used only when all practical methods of designing around a problem have been exhausted. It is important to recognize that, although shoring decreases psi and plf loading, it does not permit these load limits to be exceeded. Axle load allowables are not affected.

Examples of routine items are: M-series vehicles, other federal department/agency vehicles, presidential transport.

Examples of non-routine items are: humanitarian cargo, space cargo, animal transporters.

REQUIREMENT LESSONS LEARNED

The weight of the shoring used becomes, in effect, a part of the weight of the item because it must be considered a part of the load imposed on the aircraft. For example, a typical piece of shoring material (scotch pine lumber) 12”L x 12” W x 1” thick piece (144 cubic inches, one board foot) weights 2.04 pounds. A 57” L x 24” W x 8” H wedge for a 10 degree angle on a C-130 weighs about 184 lb per stack or 368 lb total since shoring is usually required in pairs. The same approach angle on a C-17 requires a wedge 72”L x 24”W x 11”H weighing 310 lbs, 620 lbs for the pair.

Shoring also takes up space when carried in the aircraft or on the primary cargo item. When floor loaded, a large shoring kit can reduce space by a full pallet position.

Tires have tread which effectively reduces contact area. In case of construction and rough terrain vehicles, this reduction can be significant. The shoring thickness must be at least one-half of the tire groove width.

Approach shoring may be reduced or eliminated with adjustable height features. While adjusting the height and ground clearance of an item while it traverses the ramp necessitates a very slow load and unload, this can be preferable to carrying additional equipment. Adjustable height fifth-wheel trucks are a popular application of this principle.

Rolling and Parking Shoring reduces the usable cargo compartment height. Care must be taken that its use does not create a clearance problem.

The C-130 aircraft has only two ramp toes. Where an item has a centerline wheel, approach shoring will be required to function also as a third ramp toe.

VERIFICATION RATIONALE

In almost all cases analysis can be used to verify the adequacy of shoring. This determination is made from knowledge of the physical characteristics of the item and the shoring combined with geometric considerations. Certain situations, generally involving heavy, complex items and the need for approach shoring, may require a demonstration or test loading to verify that all factors have been met.

VERIFICATION GUIDANCE

Figure A-22 shows the load spreading effect of shoring. It is important to note that, although shoring reduces the cargo psi and plf loading, it does not allow these aircraft limits to be exceeded. Axle load allowables are not affected. Using the geometric weight distribution estimation technique, knowledge of the amount of the load and its contact area is all that is necessary to compute the load distribution effect of the shoring. Comparison of the calculated load value with the limit load for the particular aircraft will determine acceptability of the shoring. Approach or "step-up" shoring primarily serves to decrease the ramp angle making it possible to load certain items which would otherwise have cresting, projection, or overhang problems. Acceptability of approach shoring can be shown by analysis in many cases. In more complex loading situations it may be necessary to perform a demonstration or test loading during which the exact configuration of the shoring is established and documented.

VERIFICATION LESSONS LEARNED

None Available.

6.5.7.1.1 Approach shoring.

None available, see 6.5.7.1

6.5.7.1.2 Load spreading shoring limitations.

None available, see 6.5.7.1

6.5.7.2 Winching.

REQUIREMENT GUIDANCE

A straight-ahead winch pulling force is important because it keeps the vehicle tracking straight during on/offloading, minimizing steering corrections and the potential for item or aircraft damage.

6.5.7.3 Combat offload.

None available.

6.5.7.4 Special tools and transport equipment.

SPECIAL TOOLS REQUIREMENT RATIONALE

In most cases, items requiring aerial delivery capabilities are destined for rapid deployment in austere environments. Under these conditions little, if any, support equipment is likely to be available to assist in offloading reassembly operations. Additionally, mission readiness requirements may not allow time for any but minor item reassembly operations. Special tools, even those which are small and easily carried with the item, represent a major problem in remote areas if replacement is needed because of loss or damage. While total avoidance of special tools may not be possible, requiring their use must be minimized.

SPECIAL TOOLS REQUIREMENT GUIDANCE

Item design should be tailored to permit loading and air movement of the item in its operational configuration whenever possible. This not only eliminates the time and effort to prepare the item for transport at the origin and restore it to operational readiness at the destination, but also eliminates the need for supporting equipment and special tools at both locations. The designer should keep in mind that field conditions are vastly different than shop conditions both in terms of manpower and facilities availability. Design should be predicated on the worst-case situation which is the combat field environment. While air transport of items in their operational configuration is a desired goal, many situations exist where this cannot be accomplished. In these cases every effort should be made to eliminate the need for extensive item modification to make it ready for aerial delivery. In many cases program requirements may limit the amount of time and resources available to prepare the item for operation once it is delivered to the user.

SPECIAL TOOLS REQUIREMENT LESSONS LEARNED

The more special tools and equipment necessary to support an item, the greater the potential for malfunction and loss of use of that item.

Mission requirements often severely limit the allowable time to make equipment operationally ready from its air transport configuration. A factor which is easily overlooked is that combat field conditions can considerably extend the time required to perform a given operation.

SPECIAL TOOLS VERIFICATION RATIONALE

Verification of the acceptability of proposed procedures is seldom entirely objective. However, because mission-ready status can be defined in terms of elapsed time from aircraft offload, these criteria are reasonable to establish if make-ready procedures are satisfactory. The acceptability of special tools and equipment is often a matter of subjective judgment. Guidelines must be established by the program office on a case by case basis. Comparison of the characteristics of the special tools/equipment with the established criteria should be the determinant of whether these items are acceptable.

SPECIAL TOOLS VERIFICATION GUIDANCE

Where this requirement applies, the program office responsible for the equipment development will specify acceptance criteria. Planning factors for various operational scenarios will determine the allowable time and other conditions for making the equipment ready for use once it is air delivered to the user. The skill level of the personnel readying the equipment must be considered in verifying the satisfaction of this requirement. In most cases these personnel will be unskilled and unfamiliar with the items requiring assembly/disassembly.

SPECIAL TOOLS VERIFICATION LESSONS LEARNED

Demonstrations to prove the acceptability of proposed special tools and procedures may not be representative of actual user circumstances. Care should be taken to make demonstrations as realistic as possible. Factors which must be considered include the user's skill level, training, familiarity with both equipment and procedures, and the physical and environmental conditions under which the operations must take place.

MHE REQUIREMENT RATIONALE

The less reliance on supporting MHE, the greater the ability to load/offload items even in the austere environments in which many operations must take place. In many cases, the required MHE will not be available at the destination unless it also is air transported to the offload site. This not only delays the offloading of the item, but denies valuable aircraft space to other airlift cargo.

MHE REQUIREMENT GUIDANCE

With the trend to procurement of commercial, off-the-shelf equipment, less latitude is available in the area of wheeled and tracked vehicles to exercise design judgment to implement this requirement. However, these factors should be recognized in the source selection process and every effort should be made to avoid items with inherent transportability problems. More design freedom exists in the area of initial item design. This is a particularly important time for consideration of this and all air transportability requirements for two reasons. First, within item functional limits, the design has not been frozen and may still accommodate features which enhance the item's handling characteristics. Second, initial item design is often perpetuated through extended use of the item or with the basic item modified to function in other mission roles. This means that designed-in problems are perpetuated if they are permitted in the initial design.

MHE REQUIREMENT LESSONS LEARNED

Most standard containers and shelters can be loaded with the aircraft cargo winch from the ground if they have mobilizers attached. This also has the advantage of providing ground mobility. One disadvantage is that the mobilizer sets require approximately 10 additional feet of cargo floor for storage. In this mode, containers/shelters need not be placed on pallet trains and loaded into the aircraft from K-loaders.

Many instances can be cited where vehicles fully qualified for air transport have been progressively modified to the point where they no longer can be handled without supporting MHE. While these modifications may not prevent the vehicles from being air transported, they severely restrict the on/offloading options.

One of the greatest problems in designing handling provisions of items is the failure to recognize the degree to which an item's maneuverability is limited by narrow aircraft ramps and small interior clearances. Generally only small directional corrections can be made because of these restrictions.

MHE VERIFICATION RATIONALE

Experience has shown that analytical methods of verifying this requirement can be effectively used in many cases. However, where sophisticated handling features are employed, actual demonstration of the item's capabilities is the preferred method of verification. This not only verifies the acceptability of the item's features, but also identifies the procedures necessary for successful handling.

MHE VERIFICATION GUIDANCE

To the extent possible, analytical verification should be used because it is faster and the least costly. The ATTLA, as final approval authority, has the expertise to provide assistance in this area. Handling demonstrations, using a mock-up of the aircraft ramps and cargo compartment envelope, are the next desirable option. Test loading using an actual aircraft should be resorted to only after all other options have been thoroughly investigated. Test loadings, while providing an absolute check of an item's handling characteristics, are very expensive and require ATTLA approval before being performed.

MHE VERIFICATION LESSONS LEARNED

Historically, early consideration of air transport, supported by accurate technical data for on/offloading analysis, has eliminated the requirement for actual test loading in all but a few special cases.

6.6 Subject terms (key words).

Air Transport
Airdrop Systems
ATTLA
Cargo
Compartment
Configuration
Electrical outlets
Envelope
Limits
Load
Palletized cargo
Parking
Pneumatic tire loads
Ramp
Ramp crest
Ramp toe loading
Restraint
Roller systems
Shoring
Tie down
Tire loads
Vehicular cargo
Vents
Weight Limits
Wheel
Winch

6.7 International standardization agreement implementation.
This standard implements (1) AIR-STD-25/59, Criteria for the Design of Equipment required to be Air Transported or Airdropped from Fixed Wing and Rotary Wing Transport Aircraft, (2) AIR-STD-44/3, Lashings for Fixed Wing Aircraft, (3) AIR-STD-44/17, Fixed Wing Cargo Aircraft Tie-Down Fittings. When changes to, revision, or cancellation of this standard are proposed, the preparing activity must coordinate the action with the U.S. National Point of Contact for the international standardization agreement, as identified in the ASSIST database at https://assist.dla.mil.

6.8 Changes from previous issue.
Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

COMMON CARGO EXAMPLES

A.1 SCOPE

A.1.1 Purpose.

The purpose of this appendix is to give some generic examples of the three most common cargo configurations presented for shipment. The examples show how the requirements in paragraphs 4 and 5 can apply to specific situations. This appendix is not a mandatory part of the DoD standard. The information contained herein is intended for guidance only.

A.1.2 Applicability.

The examples given in this appendix should not be considered exhaustive or definitive. However, addressing the requirements presented here will cover most cargo of the given type.

A.2 DEFINITIONS

Bulk Cargo: Cargo that does not have any equipment to facilitate its movement such as wheels or pallets. (Cargo that utilizes the roller conveyor system is considered palletized cargo even if it is not carried on a standard pallet.) Bulk cargo can be loaded from the ground, or hand carried, and/or it can utilize special handling equipment. An instrumentation crate is an example of bulk cargo (figure A-1).

Palletized Cargo: These are loads that are rigged on standard 463L cargo pallets, Type V or Type VI (aka DRAS) airdrop platforms, container delivery system (CDS) skid board, or nonstandard pallets. Pallet examples on figure A-7. Figure A-8 and figure A-9 show loads palletized on a single 463L pallet or multiple pallets.

Loads with flat surfaces or skids that interface with the roller conveyor system are also considered palletized cargo because the same requirements for interfacing with the aircraft and MHE roller and rail systems apply.

Rolling Stock: Cargo that is loaded on any type of wheel or tread whether self-propelled, towed, or winched aboard. Aircraft loaded on landing gear also fall under this category.

A.3 BULK CARGO

FIGURE A-1. Examples of bulk cargo.

A.3.1 Aircraft systems.

The applicable aircraft systems for handling bulk cargo are the cargo floor, ramp, and tiedowns.

A.3.2 Bulk cargo parameters.

The critical parameters are overall dimension, floor contact surface dimensions, weight distribution, and ability to be restrained. The internal and external components must be able to withstand the air transport environment.

A.3.2.1 Projection.

Some bulk cargo may be loaded up the ramp from the ground. The maximum projection usually occurs when the cargo CG reaches the ramp hinge. When the cargo moves forward of the hinge, the cargo has a tendency to rotate down, lowering the projection height. (figure A-2)

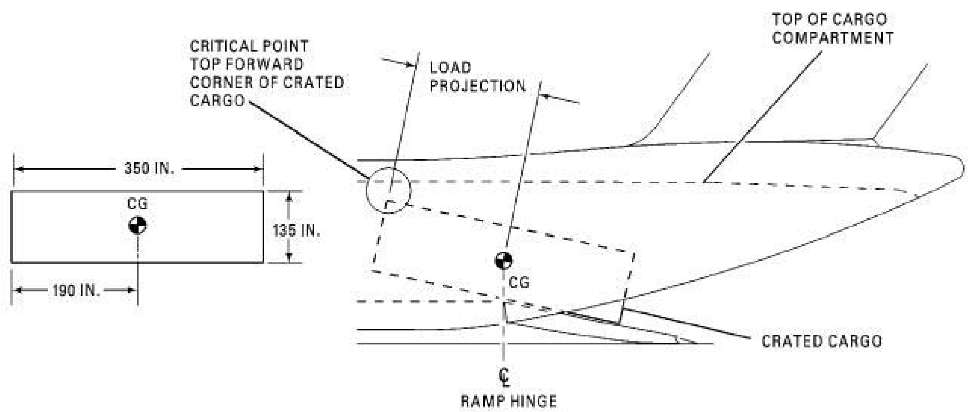


FIGURE A-2. Projection of bulk cargo.

A.3.2.2 Height.

If cargo is loaded straight in, the height limit is the shape and height of the cargo compartment opening. C-17 and C-5 have ceilings that narrow towards the top. See appendix B for details on opening sizes and projection limits for each airplane.

A.3.2.3 Weight.

As cargo traverses the ramp to the cargo floor, weight may be concentrated on the ramp hinge as shown in the projection diagram on figure A-2. Ramp hinge limits are shown in appendix B.

Cargo weight on the floor should be distributed to meet floor pressure limits, running load, and lateral weight distribution limits for each aircraft. See figure A-3 for an example.

Floor Pressure: Divide the weight for each floor contact area by that contact area to get floor pressure in PSI.

Running Load: Divide the weight for ALL contact areas in a given length by the length of contact area to get pounds per linear foot (not inch).

Lateral Load: Pounds per inch of width (PIW) is computed by dividing the weight of each contact area by the width of the contact area.

All aircraft consider running load. PIW is used on C-17. The C-5 also uses contact length plus width (L+W) to evaluate floor contact loads; see C-5 concentrated load guidance in appendix B for this calculation. The applicable limits are shown in appendix B.

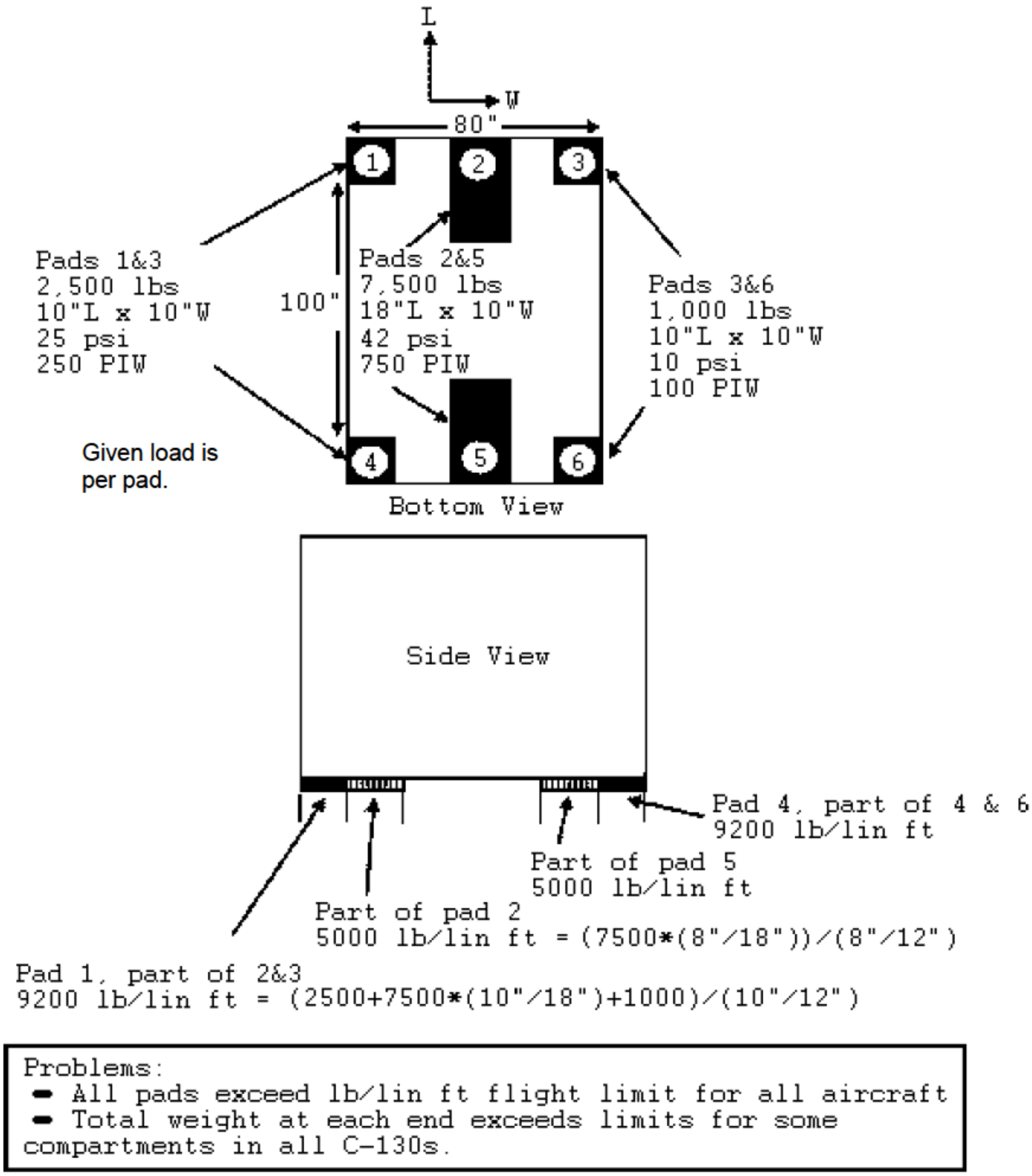


FIGURE A-3. Floor loading calculation.

There are various methods that can be employed to lower the weight distributions shown on figure A-3. The contact areas can be redesigned to increase contact length and spread the load over more of the aircraft floor. Contact areas can be added to reduce weight per contact area. The item could be placed on pallets or a trailer so that applicable weight limits become roller or axle limits, respectively. Pallet placement or bridge shoring may also be used to spread the load between two compartments.

A.3.3 Special loading procedures.

Small bulk cargo can be hand carried into the aircraft. If the item is too massive to hand carry, it can be loaded using MHE (figure A-4).

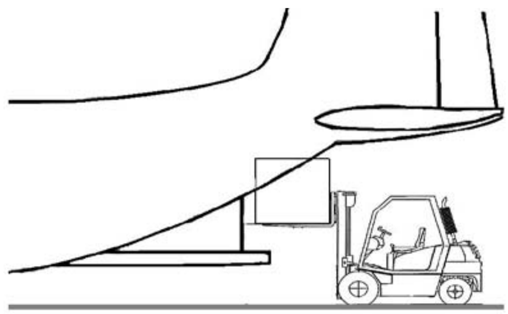


FIGURE A-4. Forklift loading bulk cargo.

A.4. Palletized cargo.

Palletized cargo is loaded into the airplane using special handling equipment such as K-loaders and forklifts. The pallet will utilize the aircraft roller conveyor system for movement and support. Pallets also usually utilize the rail system for guidance and restraint.

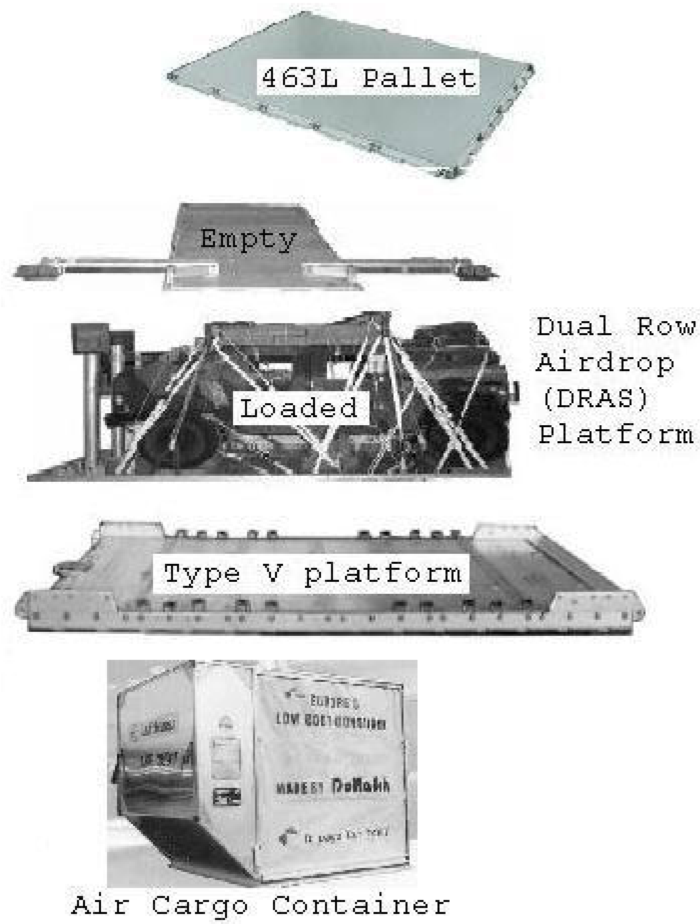


FIGURE A-5. Types of pallets.

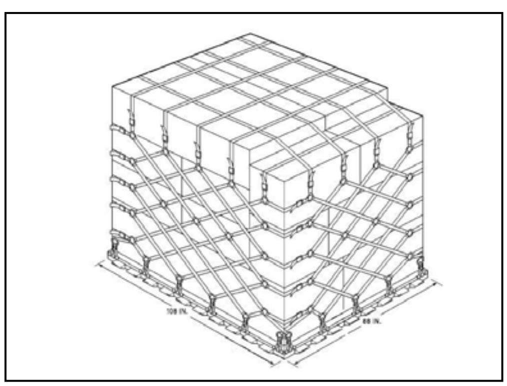


FIGURE A-6. Single pallet load.

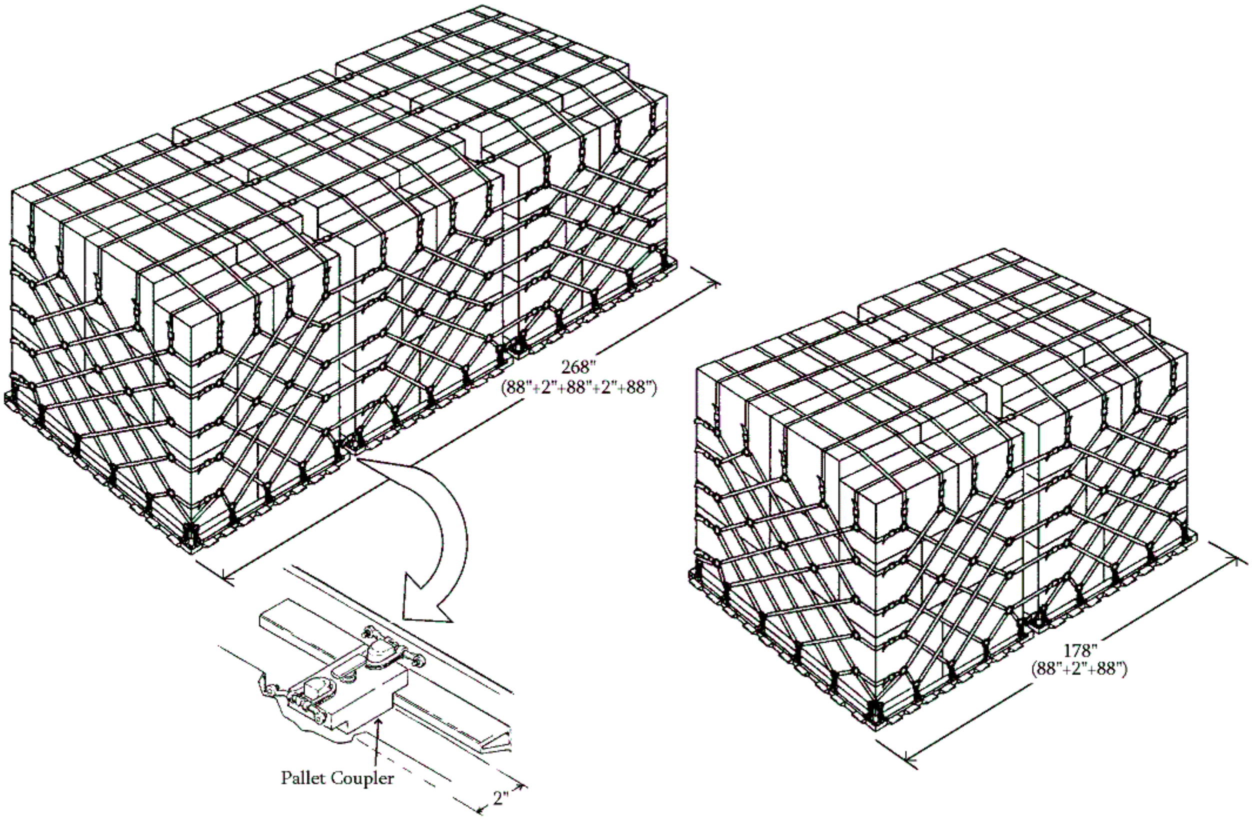


FIGURE A-7. Double and Triple married pallet loads with detail of pallet coupler.

A.4.1 Pallets and skids.

Most pallets and platforms have restraint provisions to restrain the item to the pallet. On some occasions, the pallet serves only as a surface on which to carry the item over the rollers while restraint is provided from the item directly to the cargo floor.

The standard pallets compatible with USAF cargo planes are the 463L pallets (HCU-6/E and HCU-12/E), Type V Airdrop Pallet, DRAS platform, and CDS skidboards.

Loads can also be carried on nonstandard pallets or flat surfaces (skids) may be built into the cargo to provide load carrying contact with aircraft or MHE rollers.

A.4.1.1 Standard pallet/platforms.

A.4.1.1.1 463L pallet.

463L pallets are built in accordance with MIL-DTL-27443. Two pallet sizes are covered in MIL-DTL-27443, but only the HCU-6/E [108 x 88 in. (2.74 x 2.24 m.)] is used on the C-130, C-17, and C-5 aircraft and is the size to be considered in designing for these aircraft. The HCU-6/E pallet is illustrated on figure A-6 showing miscellaneous cargo or troop baggage tiedown using HCU-15/C and HCU-7/E cargo nets. In this appendix, generic references to "pallets" apply to the HCU-6/E.

The pallet is constructed of a corrosion-resistant aluminum surface with a balsa wood core. An outside frame holds the top and bottom surfaces and the core while supporting a lip. The lip has indents to catch the aircraft rail system locks and is shaped to ride under the aircraft rail. It is shown on figure A-11. This lip holds 22 tiedown rings for securing the cargo nets. The tiedown rings are capable of 240 degrees of free movement in a vertical place that intersects the pallet edge at a right angle. The tiedown ring capacity is 7,500 lb in any direction. Pallet dimensions are 108 x 88 in. and the weight is approximately 290 lb with a usable area of 104 x 84 in. and a loaded height of 96 in. The maximum allowable puncture load for the pallet is 250 psi up to the 10,000-lb maximum capacity. Loads that exceed the 250 psi limit must be shored to reduce the load per square surface unit to the maximum allowable.

Loads must be positioned symmetrically so that the center of gravity (CG) of the cargo falls within 12 in. of the lateral centerline and 14 in. of the longitudinal centerline of the pallet. If the cargo is concentrated on one side of the pallet, an equal weight must be placed on the opposite side so that the common CG of both items falls within the 24 x 28 in. rectangle in the pallet center.

The contact area of all wheeled items must be measured to ensure that wheel loads do not exceed the 250 psi limit. Shoring may be used to increase contact-bearing surface and thereby reduce wheel pressure per square inch. Shoring affects only loads positioned on the pallet surface and provides a load spreading effect as illustrated on figure A-22. (The pallet itself should never be considered as shoring. The construction within the pallet does not permit load spread.) Caution must be exercised in air transporting solid wheel vehicles. Due to the thin ribbon line contact, it is recommended that protective shoring be used for all solid wheel loads. The maximum contact area of a single solid wheel on the pallet will not normally exceed one square inch and direct contact may damage the pallet in flight.

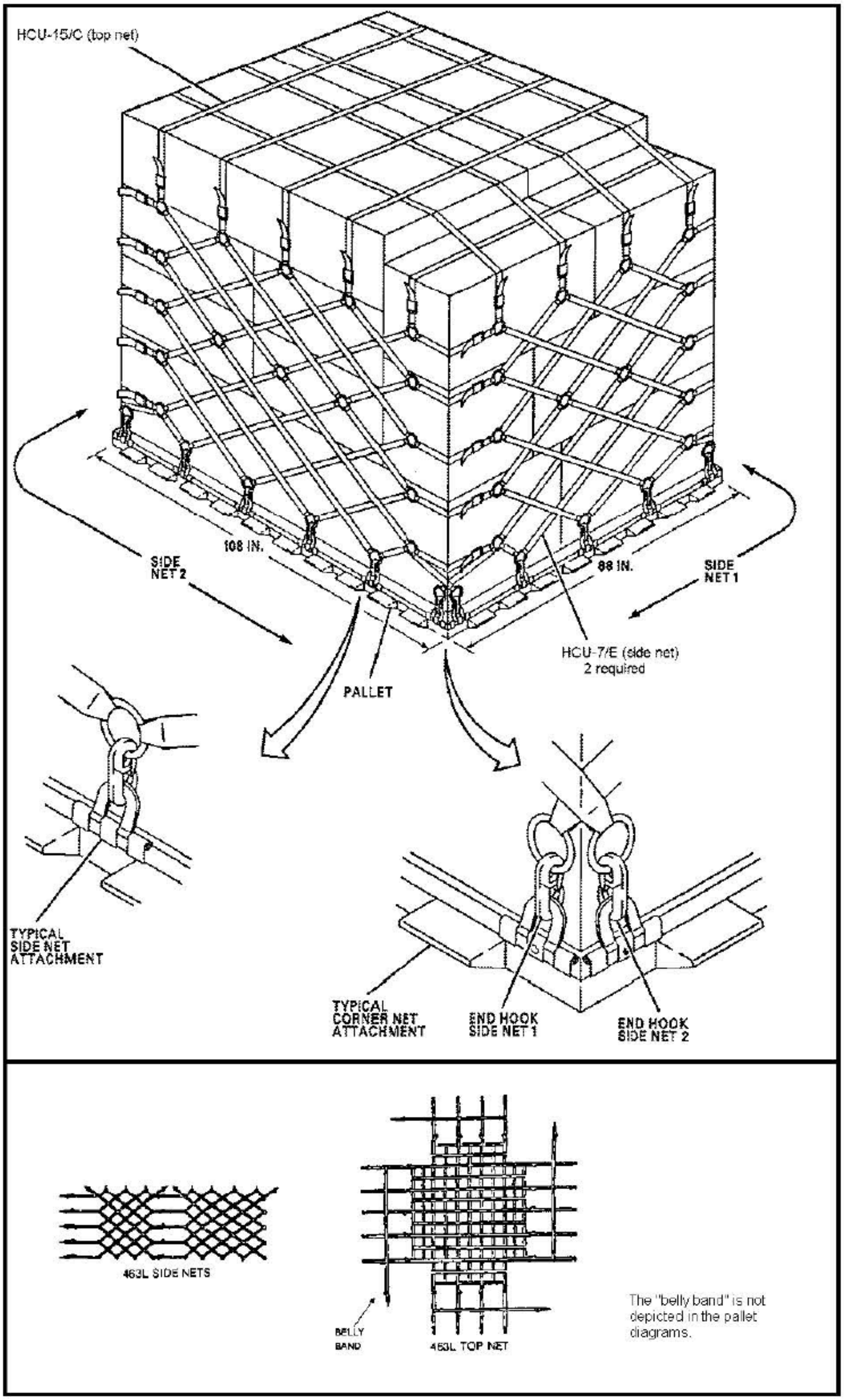


FIGURE A-8. Side netting.

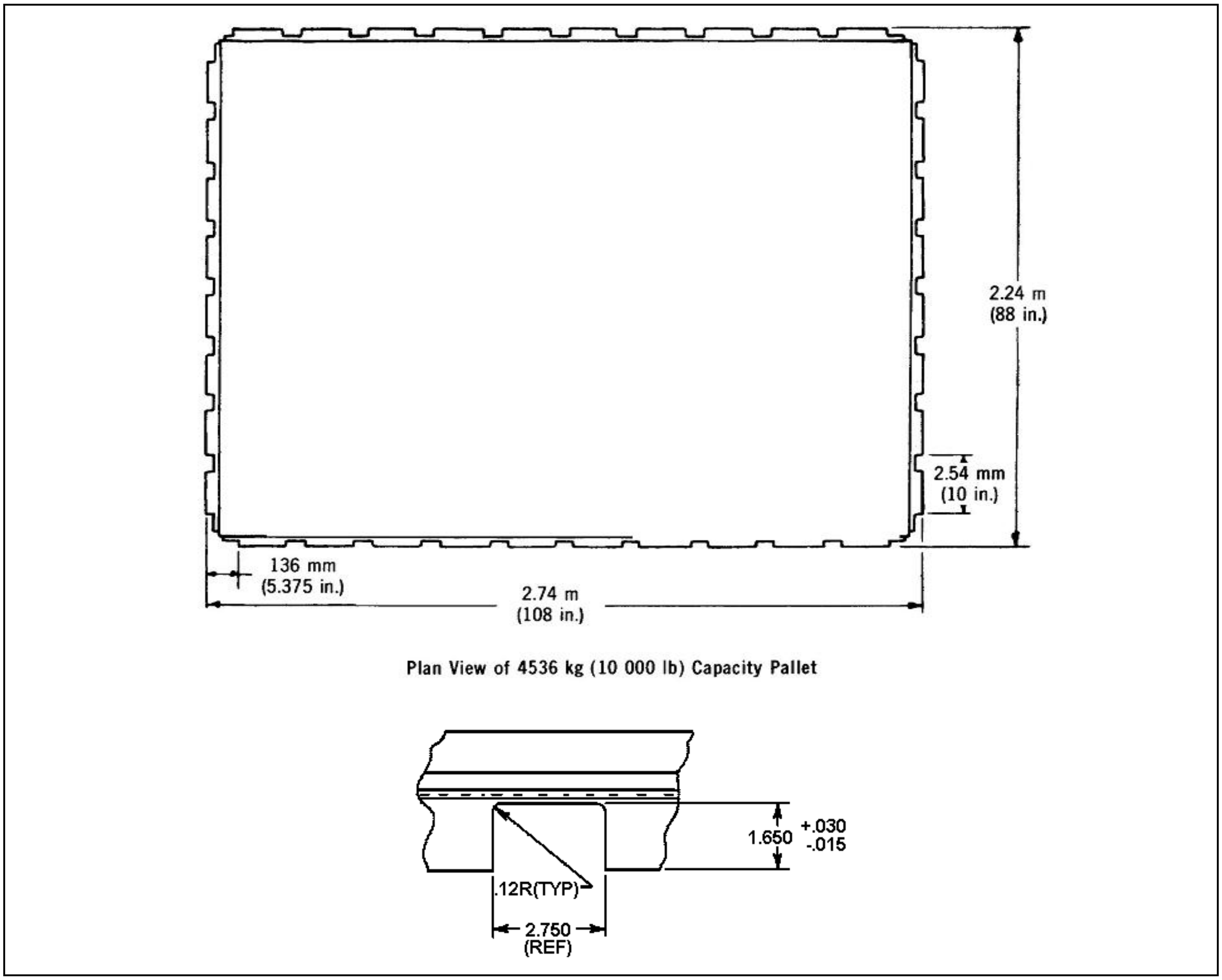


FIGURE A-9. Pallet and side rail.

The 10,000-lb limit for a single pallet is due to the restraint rail system. Additional restraint to aircraft floor rings may be able to raise this limit for certain cases. The maximum weight may be limited by other factors such as the aircraft roller limits, load distribution limits, or floor weight limits.

FM 55-9 provides detailed guidance on pallet building and documentation.

The normal stacking height of cargo for palletized cargo is 96 inches. This can be exceeded by 4 inches (to 100 inches) when the maximum pallet cargo weight does not exceed 8000 pounds. For oversize single unit items to be secured to the cargo floor, the C-130 height limitation is 102 inches above the floor. For the C-17 and C-5 aft loading, a single item can exceed the 96-inch limit to 108 inches, and up to 156 inches for forward loading on the C-5. Restraint cannot be achieved using standard nets.

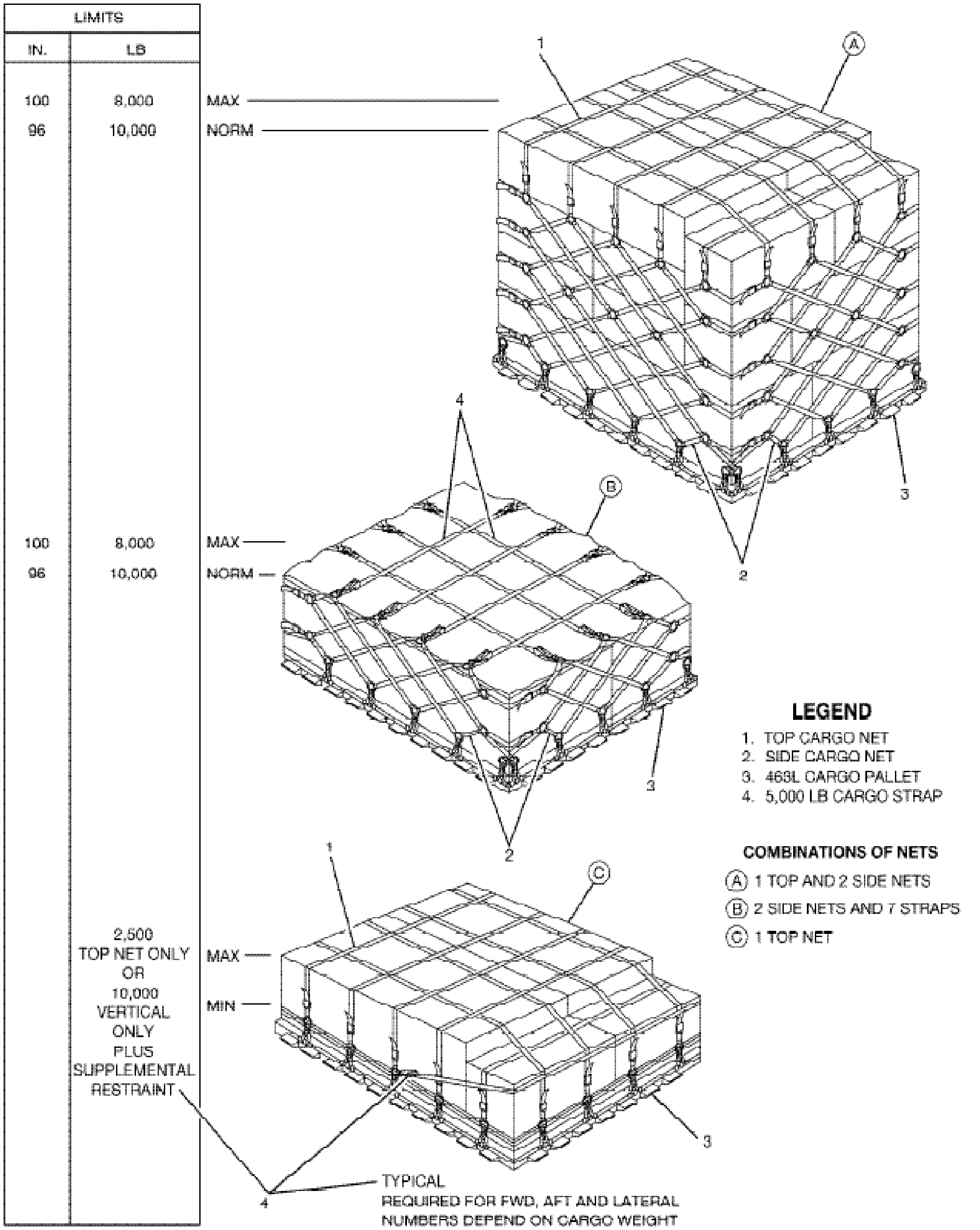


FIGURE A-10. Pallet size and weight limits with net restraint.

A.4.1.1.2 Type V airdrop platform.

The Type V Platform ranges in size from 8 feet to a maximum length of 32 feet in increments of 4 feet. The platform is assembled using components consisting of panels, side rails, roller pads, extraction bracket, suspension brackets, extraction force transfer assembly bracket and spacer clevis. Weight limits and additional information for this type of platform may be found in T.O. 13C7-1-5/FM 4.20-102.

A.4.1.1.3 Type VI airdrop platform (DRAS platform).

The Type VI airdrop platform is a modular component assembly constructed similarly to the Type V airdrop platform, but having a different Side Rail cross section and an 88 inch overall width instead of the 108 inch width. It is 463L cargo system compatible and is designed specifically for the C-17 aircraft's logistic system. It is intended to be gravity extracted and has no rear panel incorporating an airdrop extraction provision. Weight limits and additional information for this type of platform may be found in TO 13C7-1-51/FM 4-20.105.

A.4.1.1.4 CDS skidboard.

Skidboards are constructed of aircraft quality plywood, 48 inches by 48 inches by 3/4 to 1 inch thick. A skidboard can carry up to 2200 lb of cargo. The base is designed to fit into the aircraft rail system. The C-130 uses a center vertical rail (CVR) in between the primary 108 in wide rail system to carry two rows of CDS loads. On the C-130J and C-130J-30, the CVR is an integral rail folded into the cargo floor. On the C-17, the skidboards fit in between the ADS rail and the inboard logistic rails to form two rows of CDS cargo. Weight limits and additional information for this type of platform may be found in TO 13C7-1-11/FM 4-20.103. At the time of this publication, additional capability is being investigated for double and quad CDS configurations; no information is currently available.

A.4.1.1.5 Warehouse pallets.

These pallets are 6 inch thick, plywood constructed pallets. They are rated to carry up to 2,000 pounds.

A.4.1.1.6 Commercial containers.

Commercial containers are shown on figure A-5 They are used to carry small packages. They are the primary cargo carrying platform on tanker aircraft and CRAF aircraft.

A.4.1.2 Nonstandard pallets.

These are pallets that have not been approved by ATTLA. See sections 4 and 5.3.6.2 for design requirements.

A.4.2 Aircraft systems.

The primary aircraft systems used by palletized loads are the rollers and rail system.

A.4.2.1 Side loading aircraft.

When designing equipment for movement on side loading aircraft, consider the 90 degrees change of direction of that equipment to allow loading. These aircraft are primarily loaded with pallets. Vehicles and other equipment are usually palletized. The basic loading method is to move the pallet into an aircraft and then change direction by 90 degrees on a transfer pad. This pad is a grid of 1 inch diameter steel balls on 5 inch centers. Any item with its own base that can be carried on these aircraft must be designed to move over these transfer pads without any deformation or damage to the base (MIL-DTL-27443). If a vehicle is to be driven on the aircraft, it must have sufficient turning radius to maneuver into the aircraft. The available turning space is further reduced by curvature of the aircraft fuselage, as shown in appendix B, and the need for a pallet sub-floor. Side loading cargo aircraft are originally designed primarily for passenger service and do not provide the most suitable cargo handling system. Commercial freight aircraft generally fall into this category; however, the door size and aircraft system will vary on the same type of aircraft owned by different airlines. Refer to appendix B for additional details.

A.4.2.2 Aft loading aircraft.

An ancillary mission of Air Force cargo aircraft is an airdrop of supplies under combat conditions. This mission has resulted in the need for an aft door to allow extraction of the load during flight. This has resulted in special design of the roller/rail system to perform this mission. The combination of the logistics and airdrop needs in designing the aircraft has resulted in a system allowing the designer leeway in placing loads into the aircraft. It also results in a more rugged system due to more severe conditions that are incurred during airdrop. Some aircraft, such as the C-5, also have the capability to accept loads through a forward door. The same basic system is used in the primary USAF cargo aircraft.

Some difficulties with the system are listed below.

a) Non-uniform distribution of the load on the top surface of the platform results in unequal loading of the rollers. In general, the inboard rollers support most of the load. However, the platform undersides and the aircraft floor are not perfectly flat and the rollers are not perfectly round, directly contributing to the loading problem.

b) Individually, the detent locks are very precise and perform satisfactorily. However, when more than one lock is engaged, unequal loading of the locks occurs due to the tolerance buildup in the pallet detent spacing. The systems between aircraft are extremely similar. The main difference is the strength of detents.

A.4.2.3 Rollers.

Aircraft and MHE rollers are laid out on 10 inch centers longitudinally, except the C-17's omnidirectional rollers which are every 5 inches on center. Laterally, each aircraft and K-loader has a different spacing due to different structural considerations. See B.3.2.4 for a drawing of lateral roller spacings.

The function and characteristics of each type of roller and the rail system are described below.

A.4.2.3.1 Teeter roller.

Teeter rollers are a row of bidirectional rollers located at the last row of the ramp. They are designed to support the entire weight of the pallet as it rolls on and off the end of the ramp. Teetering occurs during transfer from the loader to the aircraft and vice versa. It also occurs during jettison or airdrop.

A.4.2.3.2 Omnidirectional roller.

Omnidirectional rollers allow the pallet to roll forward and back, spin, and move sideways. They are on KC-135, KC-10, C-17, C-5 aircraft, and on some K-loaders, in specific areas.

A.4.2.3.3 Bidirectional rollers.

Bidirectional rollers allow the pallet to only move forward and backward. The majority of rollers on the aircraft and K-loaders are bidirectional rollers.

A.4.2.3.4 Roller limits.

The pallet/platform loaded item must engage a sufficient number of rollers to prevent damage to the rollers. These limits are shown in several parameters such as weight (lbs) per foot, pounds per roller row, or pounds per roller. Each aircraft dictates its own critical roller parameters and method for computing these parameters. See 5.3.2.1.3 or appendix B for details.

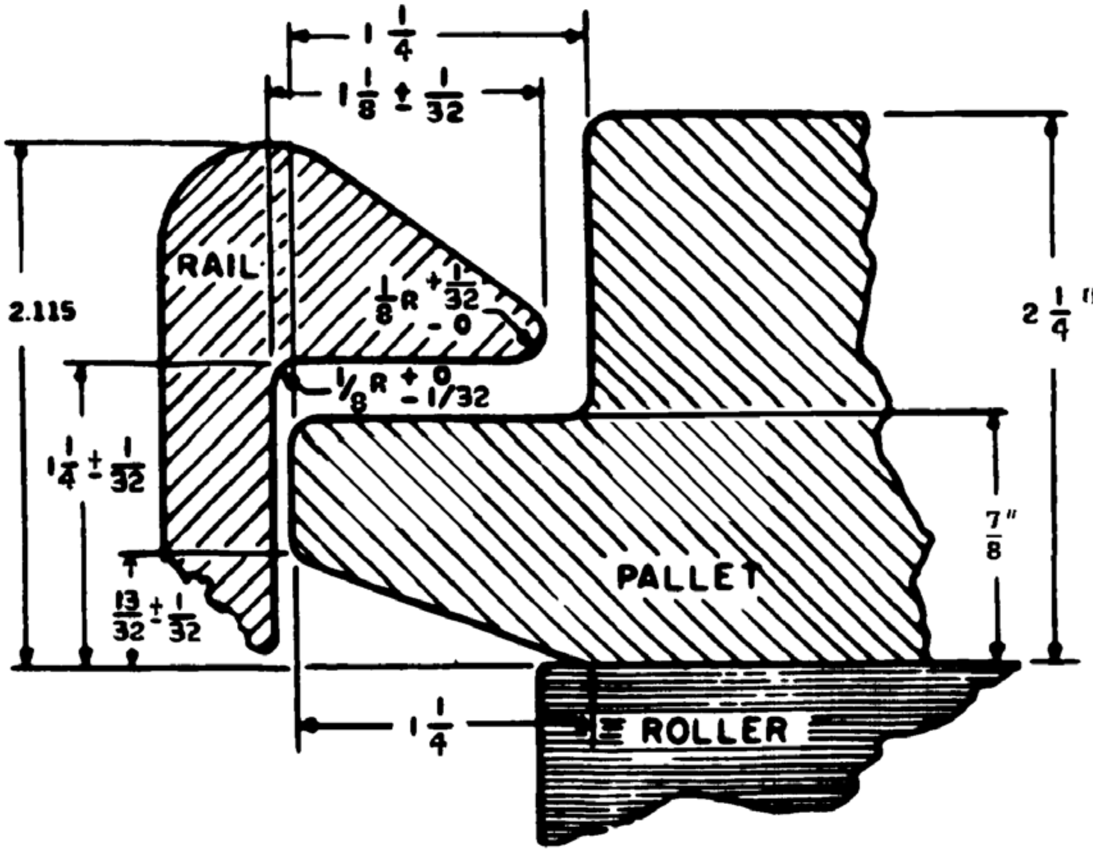
A.4.2.4 Rail systems.

Pallets and platforms have side rails with an "L" shaped cross section. The pallet rails slide into slots in restraint rails along each side of the roller system. The restraint rails' sidewalls and horizontal lips provide lateral and vertical restraint to the pallet. Locks built into the rails extend into the pallet side rail notches, or indents, to provide forward and aft restraint. There are two types of rails and locks on C-17 and C-5: Aerial Delivery System (ADS) and Logistics. On C-130s one system serves both purposes.

ADS rails and locks carry pallets and Type V airdrop platforms. The ADS rails are 108 inches wide. The ADS variable restraint locks are mounted in the right-hand restraint rail. The aft restraint values of the ADS locks can be adjusted to release at various force levels. When the lock(s) senses that the extraction force is at a desired level, the lock(s) releases to airdrop cargo out of the aircraft. On the opposite side are the ADS logistic locks. The ADS rail logistic locks are not adjustable. During transport, both sets of locks are engaged into the platform. Prior to airdrop the logistic locks are retracted.

Logistic rails are used primarily to carry pallets. The logistic rails are 108 inches wide on C-5, and 88 inches wide on the C-17 (and are also used with the Type VI airdrop platforms). The locks are not adjustable.

The ADS and logistic locks are 40 inches apart longitudinally; on C-5 the spacing varies at certain locations along the cargo floor. These locks are designed specifically to engage the 463L type side rail. The same side rail dimensions are used on the Type V and Type VI airdrop platforms, and other pallets that utilize the USAF cargo rail system. The locks are sized to provide sufficient contact area with the side rail indents to restrain the pallet.



Note: See USAF Drawing Number 7133042 for detailed pallet dimensions.

FIGURE A-11. Aircraft rail and pallet side rail interface.

The C-130 A-H have ADS variable locks on the right-hand side and logistic locks on the left. The C-130J and C-130J-30 aircraft have ADS variable locks on both sides for airdrop and air transport. C-17 and C-5 have side-by-side roller systems for logistic cargo purposes. The C-17 has a center-line roller system for airdrop cargo. (The C-5 airdrop system is not integral to the aircraft and is only installed for special missions. It is not currently available for use.) Airdrop and logistic systems are not available at the same time on C-17/C-5. The location of these rail systems is shown in appendix B. The locks' forward and aft restraint values are shown in table III.

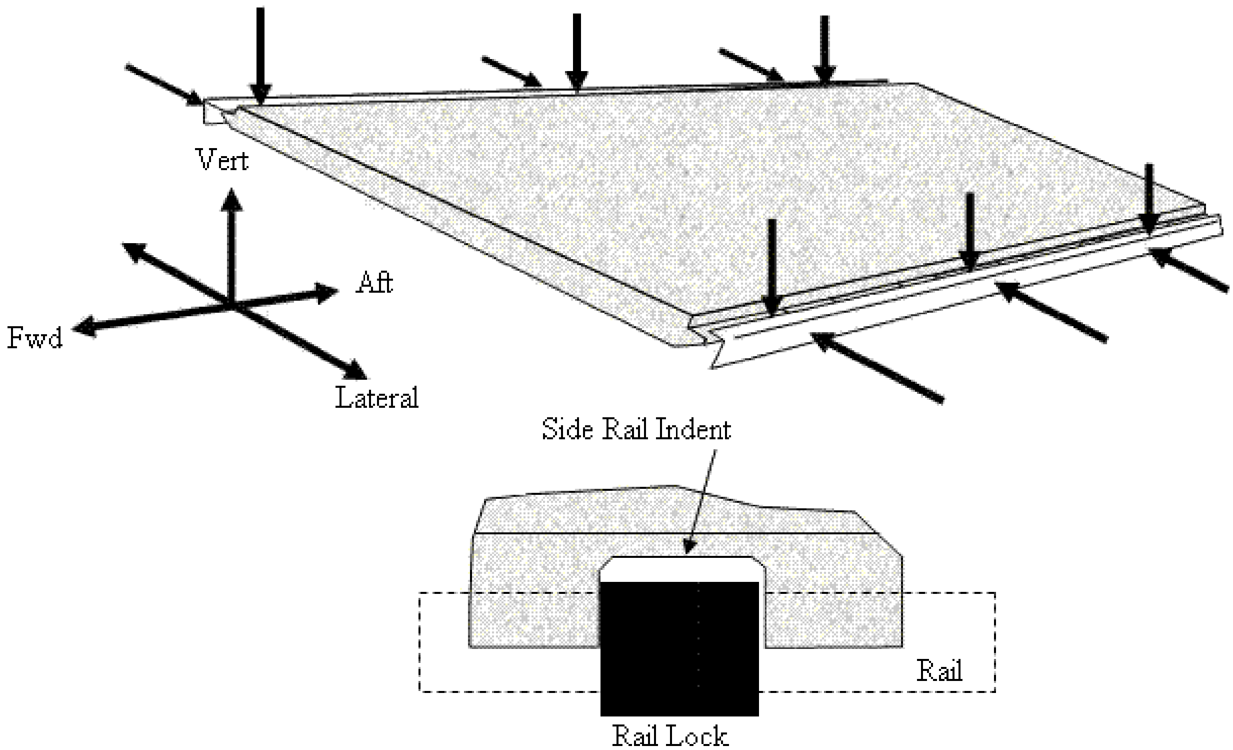


FIGURE A-12. Pallet locked into aircraft rails.

A.4.3 Cargo limitations.

A.4.3.1 Cargo size.

The total size of the cargo and pallet must be loadable through the cargo door opening. Some cargo requires dunnage to distribute the weight of the cargo to meet aircraft, MHE, or pallet weight requirements. Dunnage may add additional height to the rigged cargo (figure A-13). Also, cargo should be shaped so that it can be jettisoned in case of emergency. Ability to jettison is NOT a requirement. The loadmaster will try to place loads that can be jettisoned aft. To determine if an item can be jettisoned, use the tip-off curve shown in B.3.5.1.

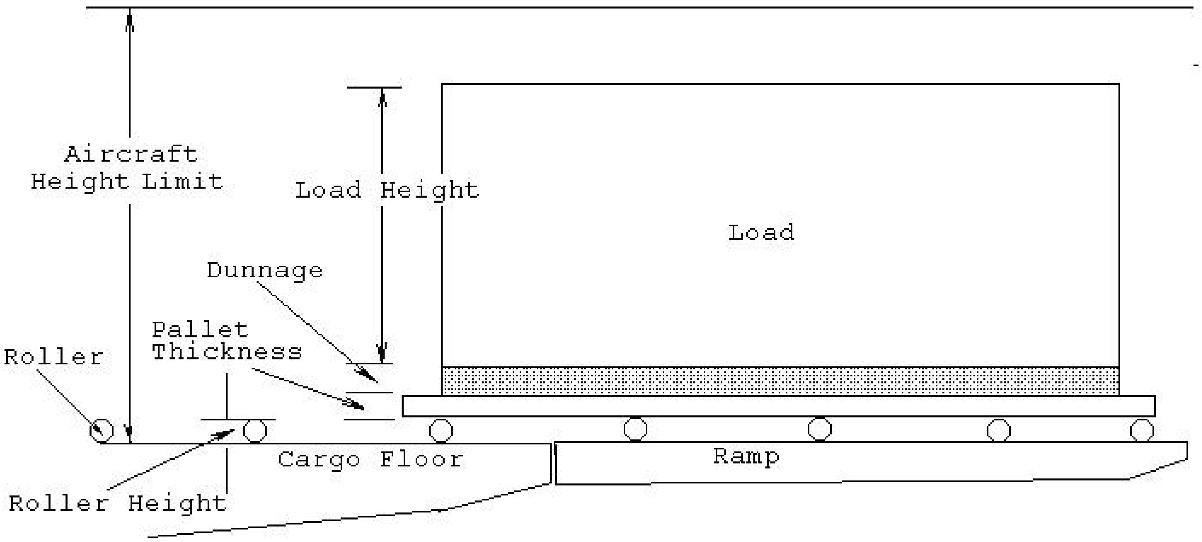


FIGURE A-13. Palletized cargo height.

A.4.3.2 Weight.

The load must be distributed on the pallet in such a manner as to not exceed the pallet limit, MHE limit, aircraft roller limits, and aircraft rail system limits.

A.4.3.3 Pallet surface contact pressure.

Cargo must not exceed the pallet surface pressure limit and total weight capacity. To determine the pressure on the pallet surface, calculate the area that is in contact with the pallet and divide the weight at each point by its corresponding contact area. The pressure at each point must not exceed the limits of the pallet. For example, the surface pressure limit for 463L pallets is 250 psi. The weight at the contact point also translates through the pallet onto the aircraft roller system and the weight at that point must not exceed the aircraft's roller limit.

A.4.3.4 Computing roller loads.

Caution: The pallet does not act like shoring. Cargo weight does not evenly distribute over the entire surface of the pallet.

The procedure for calculating the number of rows of rollers contacted by any skid is to take the length and divide by 10, discarding any remainder.

Figure A-14 below illustrates how cargo weight can be distributed unevenly over rollers covered by the pallet. Roller loads can be computed by determining the weight at each contact area and the number of rollers or roller rows under the contact area. If shoring is placed between the cargo and the pallet, the shored up area and weight on the shoring should be included in the roller loading computation.

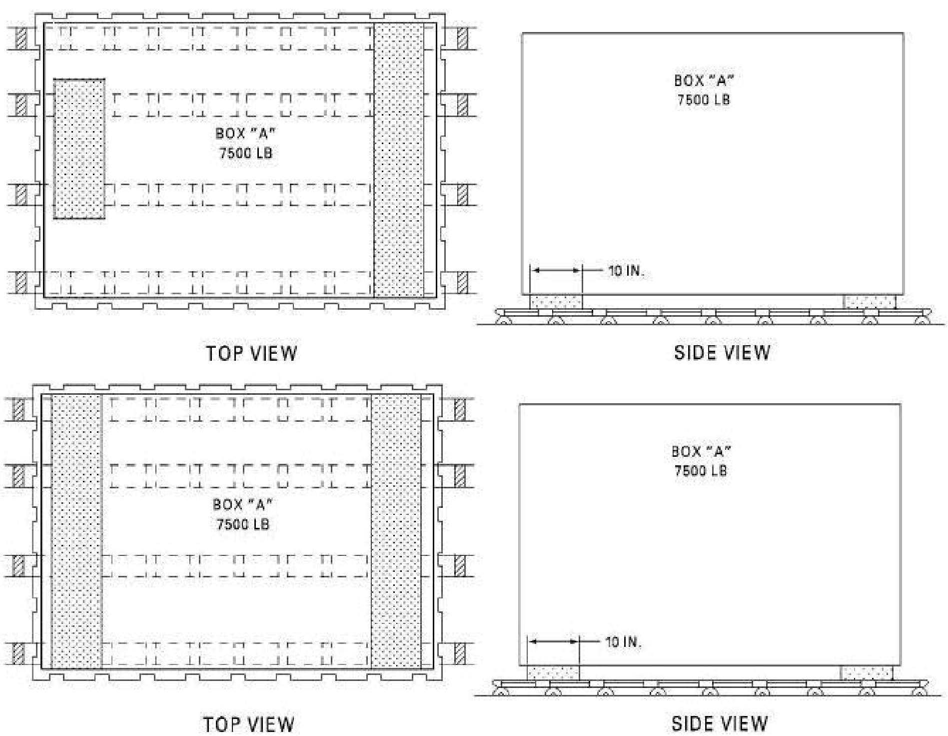


FIGURE A-14. Non-uniform pallet loading.

Figure A-15(A) shows that the cargo weight is concentrated over a row of rollers on the right side (4 rollers) and a row of rollers on the left side (4 rollers) for a total of 8 rollers. The weight is NOT distributed over the entire surface of the pallet. In the example shown below on figure A-15(B), the cargo weight is concentrated over 2 rows of rollers on the right side (8 rollers) and 2 rows of rollers on the left side (8 rollers) for a total of 16 rollers. The 2,500 lb per roller weight exceeds the C-17 single roller limit. By shoring up the item to contact the middle column of rollers, the single roller weight is reduced to 1,250 lbs.

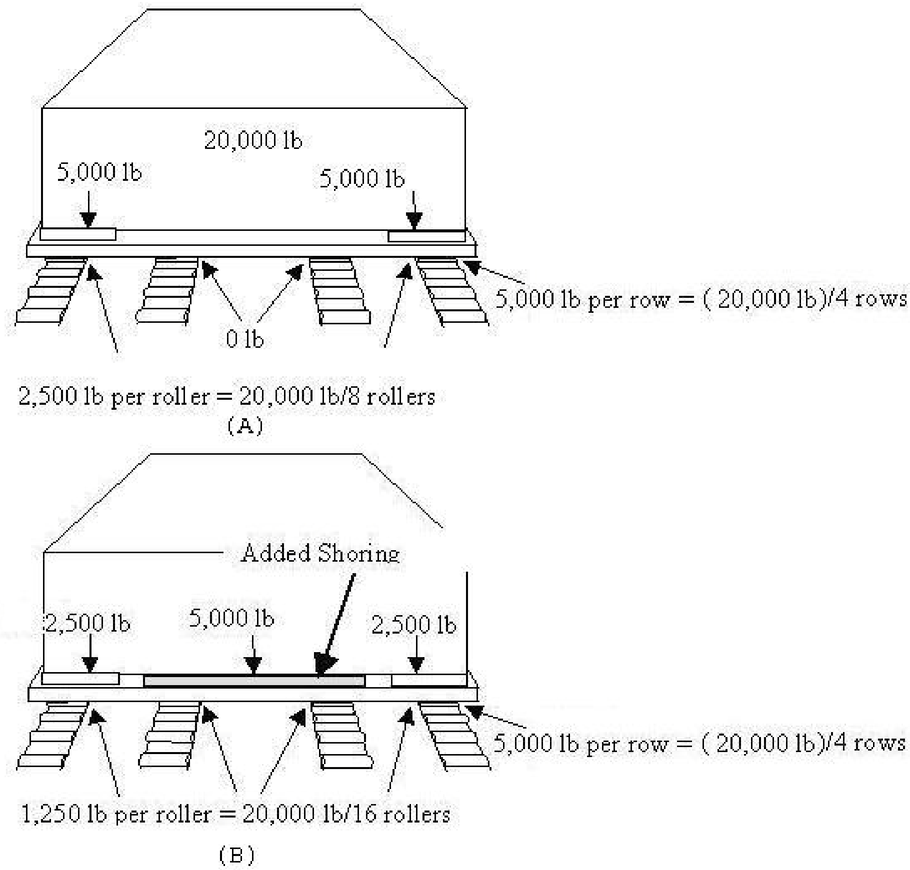


FIGURE A-15. Pallet/roller weight distribution.

A.5 Rolling stock.

A.5.1 Aircraft systems.

The primary aircraft systems used for rolling stock loads are the ramp toes, ramp, cargo floor, tiedown rings and winch. The floor on the C-27 and C-130 have reinforced areas called treadways in which heavy weight loads are carried. The cargo floors on the C-17 and C-5 have uniform loading limits for each compartment.

When designing for the C-130 or C-27, make all efforts to keep the tires of the vehicles on the treadway. If a tire is only partially on the treadway, you must consider the full weight as being off the treadway. Maximum allowable treadway limits are provided in axle and individual wheel loads. Where only an axle limit is provided, the wheel limit is one-half. If a vehicle has two single-wheel axles on the same lateral line, they are considered a single axle.

A.5.2 Critical parameters.

The critical parameters for rolling stock cargo are overall dimensions, undercarriage clearances, and weight.

Figure A-16 illustrates the effect of the problems that can occur, depending on the aircraft approach ramp, size of opening, height of cargo floor to the ground, and ceiling height inside the cargo compartment. Appendix B and the T.O. 1C-XXX-9 cargo loading manual show the size limits of loads that can be carried without using special loading procedures.

For ramp and ground contact, cresting, and projection requirements, see 5.3.1.1.1.

The critical weight parameters are weight per wheel (limits depend on type of wheel or tire), axle limits, cleat/pad area for track vehicles, cleat or grouser depth and gross weight. Weight limits dictate whether the item needs to be restricted from loading or parking in certain areas of the aircraft or require special procedures to redistribute the weight. These limits are listed in the text below, in appendix B and in the applicable aircraft T.O. 1C-XXX-9 cargo loading manual.

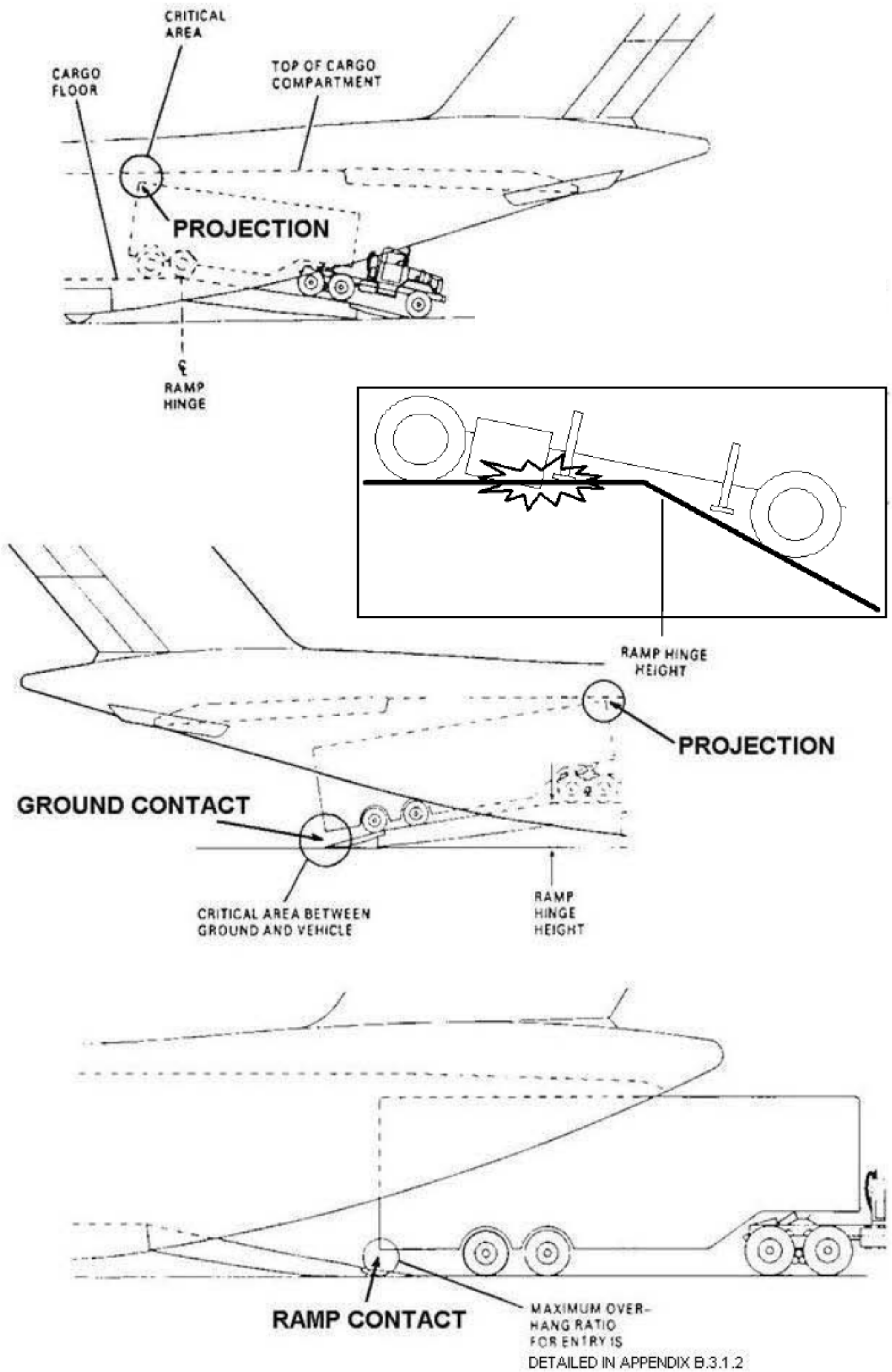


FIGURE A-16. Loading issues.

A.5.2.1 Width.

The item must be able to pass through the aircraft opening and through the cargo compartment. The limiting factor is the cargo door opening as it is usually smaller than the aircraft interior dimensions. As the item moves into the cargo compartment, the available floor spacing, sidewall clearance or width at various heights should be considered. Aircraft lateral clearances and lateral center of gravity limits should also be observed. For C-130 aircraft, there is a requirement to maintain a safety aisle for the aircrew member to pass through for inspection and emergency movement. If passengers are onboard, the C-130 also has a different aisle way requirement (see 5.3.1.1.2.1 and B.3.1.4). Depending on its location, the item may be wider than the floor width due to fuselage curvature, if the item does not block any potential exits.

A.5.2.2 Height.

Height is critical for projection, straight-in loading and movement inside the cargo compartment. For straight-in loading, the cargo door opening in the limiting factor. For movement inside the cargo compartment, the combination of height and width may restrict the load's location inside the aircraft. For example, the C-17 wing box limits the height to 148 inches underneath it. Taller loads have to be stationed aft of the wing box. For C-5 and C-17 aft end, the cargo compartment gets narrower with increasing height. (See appendix B.)

A.5.3 Weight distribution.

A.5.3.1 Wheels, tires and axles.

The critical weight parameters are axle weights, wheels/tire weights, wheel/tire contact length, width and diameter, tire type and contact surface pattern.

NOTE: Special use vehicles weighing over 20,000 pounds, with off-road tires, and without a suspension system should be sleeper shored for flight. Examples are road graders, forklifts, and scoop loaders.

A.5.3.2 Axle weight.

The aircraft has axle limits for loading and for flight as shown in appendix B. The longitudinal spacing between support beams under the aircraft ramp and cargo floor dictate that the distance between axles must be at least 48 inches to be considered as individual axles. Any axles less than 48 inches will be considered as a single axle with the combined weight of both axles.

A.5.3.3 Tires

A.5.3.3.1 Pneumatic tires.

Road tires or highway tires have an internal pressure of no more than 100 psi. The tires' pads are spaced close together so the tire contact area is mostly covered within the contact length and width.

A.5.3.3.2 Off-road tires.

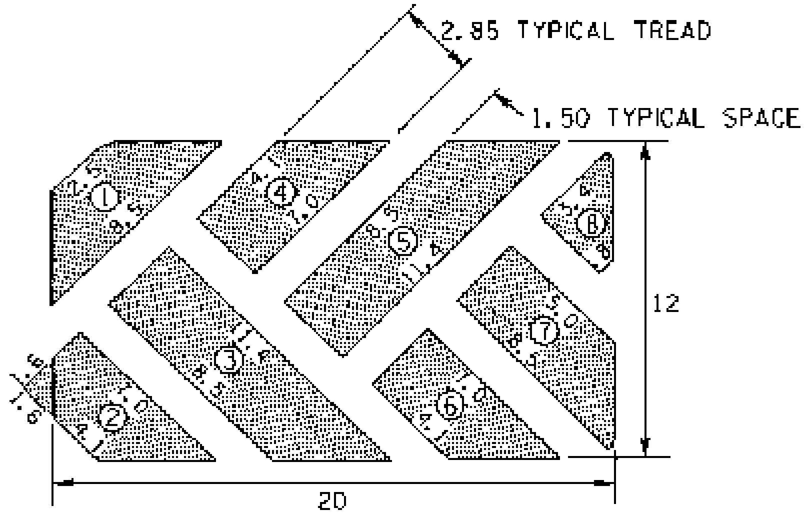
Off-road tires, such as those found on construction or farm equipment, have deep grooves and large gaps between tire pads. The gaps increase floor pressure and may require rolling and parking shoring to meet aircraft limits. A guideline for shoring dimensions is to have the thickness at half the distance between the gaps and at least one gap distance more than the overall floor contact length and width of the tire. For example, if the floor contact length is 12 inches and the width is 10 inches but the gap between pads is 2 inches, the shoring size will be 14 inches long by 12 inches wide by 1 inch thick. Additional shoring is required depending on the aircraft limits and actual tire pad contact area.

A.5.3.3.3 Solid wheels.

These types of tire include hard rubber tires, single piece wheels (rubber, wooden, plastic or metal), and casters. These wheels do not flex during flight. High pressure pneumatic and run-flat tires may be treated as solid wheels. (See 5.3.2.1.9 for details.)

A.5.3.3.4 Computing tire contact area.

Tire contact area is computed by adding the areas of individual contact surfaces inside the length and width of the tire. For road or highway tire, the area is simply the length and width (L x W) of the tire. For off-road tires with large gaps between the contact pads, contact surfaces are individually computed, then added together (figure A-17).



DETERMINE A_{NET} (SHADED AREA) FOR THE TIRE FOOTPRINT.

A_1	=	1/2 (8.5 + 2.5) x 2.85	=	15.7
A_2	=	1/2 (4.1 + 7.0) x 2.85 - 1/2 (1.6) (1.6)	=	14.5
A_3	=	1/2 (8.5 + 11.4) x 2.85	=	28.4
A_4	=	1/2 (4.1 + 7.0) x 2.85	=	15.8
A_5	=	1/2 (8.5 + 11.4) x 2.85	=	28.4
A_6	=	1/2 (4.1 + 7.0) x 2.85	=	15.8
A_7	=	1/2 (5.0 + 8.5) x 2.85	=	19.2
A_8	=	1/2 (3.4 + 0.8) x 2.85	=	6.0
			A_{NET}	143.8

FIGURE A-17. Tire contact area.

A.5.3.4 Tracks.

Tracked vehicles are governed by the same axle limits as wheeled cargo. There are additional limitations for tracked vehicles with non-articulated suspension. Non-articulated tracks teeter at the ramp crest, balancing their entire weight at the top and then crashing down once the CG moves forward. When non-articulated tracks transition to and from the ramp toes the entire weight of the track is supported at the ends, changing the distributed load to a concentrated load.

Tracks with pads (usually military) are treated similarly to calculating tire contact area. Tracks with grousers (bulldozers) always require shoring. To prevent damage to the aircraft, a layer of rolling and parking shoring must be used. The shoring must be at least 1 inch thick and should be as thick as the cleat or grouser depth plus 1/2 inch. Shoring thickness and width are also predicated on the weight of each track pad.

A.5.3.5 Pads or stands.

The pressure per pad should not exceed the aircraft floor pressure limits. Supports such as jackstands must have a locking mechanism to prevent the stand from collapsing. Hydraulic stands are not acceptable as support inside the aircraft because hydraulic fluid can leak and reduce the stand's carrying capability. The bottom of the pad must be padded or shored to prevent metal-to-metal contact with the cargo floor (figure A-18).

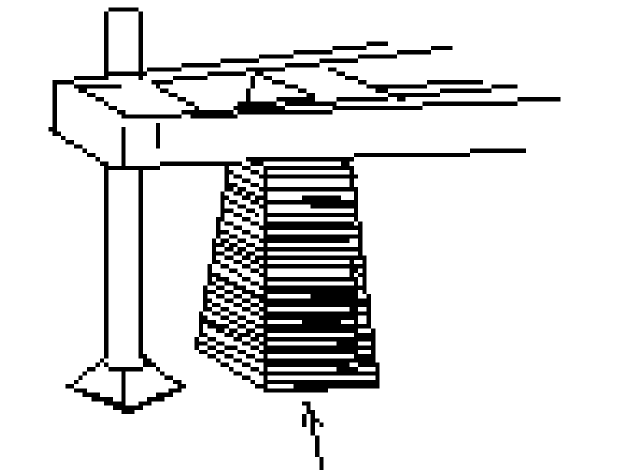


FIGURE A-18. Jackstand support.

A.5.4 Special loading and flight procedures.

When vehicles in their operational configuration are incapable of meeting certain size and/or weight requirements there are a variety of nonstandard procedures that may be applicable. These do not excuse poor design. Except for limiting weight, each of these procedures adds time, materiel, and/or manpower in order to successfully transport the item. These procedures are categorized as special loading and flight procedures.

A.5.4.1 Limiting weight.

Air transport weight limits are placed on items to prevent damage. These limits are in accordance with the item's manufacturer's design limits. Such an item is restricted further because it has a lower margin of safety than the loads due to acceleration it will see in flight. For example, an item can carry 1,000 pounds, maximum. If it cannot withstand the 4.5G download while carrying 1,000 lbs, the maximum weight it can carry for flight is derated to 222 lbs (1,000 lbs divided by 4.5).

NOTE: “Cross country” rating for commercial axles/suspensions.

The cross-country rating is calculated as 80% of the item’s axle limit. It is used to prevent damage to commercial items, or loads not reinforced for military applications, during a 4.5-G download or severe flight turbulence. The percent value is based on studies on commercial vehicles. It can be used when manufacturer’s data on suspension system performance for air transport conditions is not available. A good guide is to brace the item (sleeper shoring) to prevent compressing its suspension systems when the axle weights exceed 80% of rated capacity (or cross country rating).

A.5.4.2 Shoring.

The shipper should supply all required shoring material. The Air Force does not maintain stockpiles of shoring or shoring material.

A.5.4.2.1 Approach shoring.

Approach shoring changes the approach angle into the aircraft to prevent contact with the ground, aircraft ramp, or aircraft ceiling in keeping with the requirements for ground contact, cresting, and projection (5.3.1.1.1.1-3). Usually approach shoring reduces the approach angle for a segment of the ramp, the entire ramp or in an area along the loading path.

Approach shoring can be constructed from any material compatible with aircraft aluminum, able to withstand the forces associated with the onloading/unloading operation and able to withstand all operational environments (flight and ground). Approach shoring should be provided as assembled kits. Ease of handling, assembly, and storage space and weight should be considered. Typical shoring material is lumber. If metal is used, it must be padded to prevent metal-to-metal contact with the aircraft surface.

Approach shoring may also be used to keep all axles in contact with the aircraft ramp. Particularly for trailers with more than two axles, the suspension frequently does not have enough travel to keep all axles in contact with the aircraft ramp. Two conditions may result: either an axle may become overloaded or aircraft limits may be exceeded.

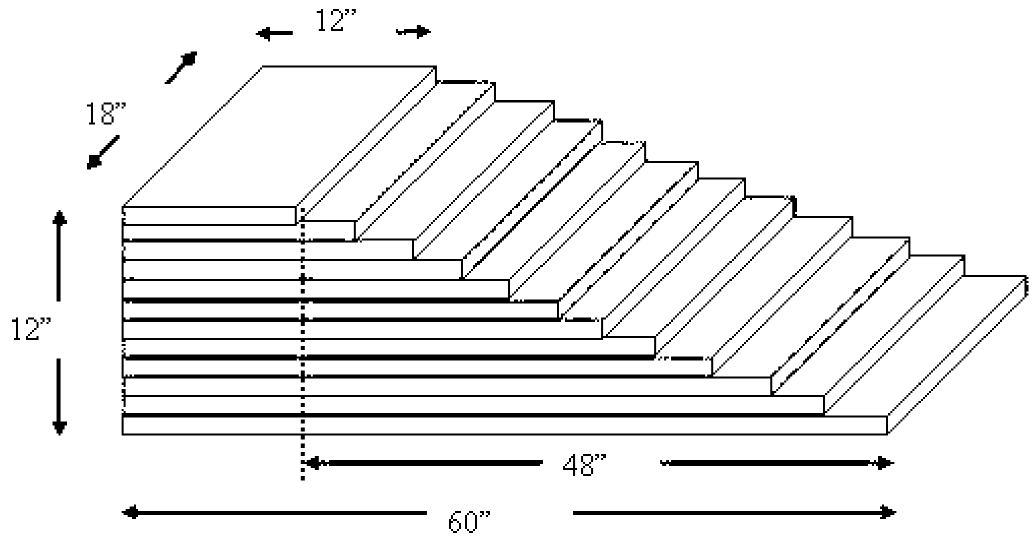


FIGURE A-19. Sample approach shoring stack.

C-17 has weight-based requirements for approach shoring width under the ramp toes. See B.3.5.3.

C-5 approach shoring must be wide enough to completely support the intended ramp toe. The required width under the toe is either 36 inches if an outboard toe is traversed or 28 inches if one of the inboard toes is traversed. See B.3.5.3.

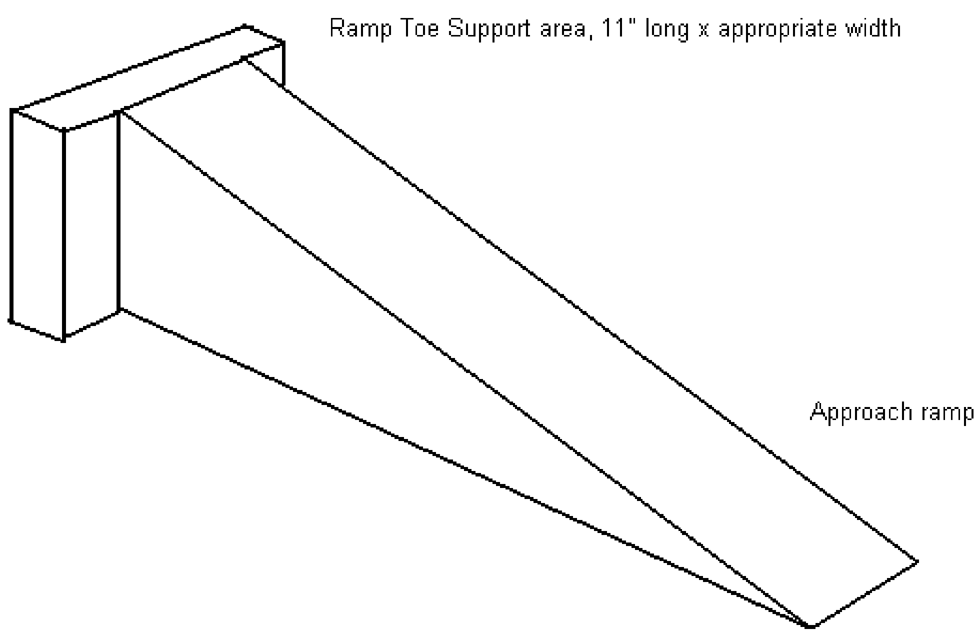


FIGURE A-20. C-5 approach shoring ramp toe support.

Guidance:

The weight and size of shoring must be added to the total cargo weight and volume when transporting the shoring kits in the same aircraft. If shoring is carried in the item, shoring is considered as secondary cargo and must be restrained to the same levels as the primary cargo item and the added weight must not exceed the cargo's weight limits. If shoring is carried outside the item, there must be adequate spacing available in the aircraft and the weight must not exceed aircraft limits.

Shoring should give the item's problem area more than 1 inch of clearance with the aircraft.

Shoring should be at least 2 inches wider than the widest rolling contact surface. Use of additional ramp toes, placed laterally together, may also be required. Shoring width must also present a stable platform. Shoring that is too narrow may wobble during the loading/unloading process.

Shoring kits that are not lumber should have a ground contact area large enough to prevent the shoring from sinking into the surface during loading. The total surface area should be at least equivalent to the contact area of the tires or track pad. ATTLA reserves the right to review such shoring kits for interface requirements and strength.

A.5.4.2.2 Pedestal shoring.

Approach shoring can be placed over or under the ramp and ramp toes. When it is placed underneath the ramp toes to decrease angle, pedestal shoring may be required to support the ramp and maintain the approach angle. Table A-I shows the minimum shoring footprint dimensions for current Air Force inventory cargo aircraft. Figure A-21 shows the definitions for table A-I.

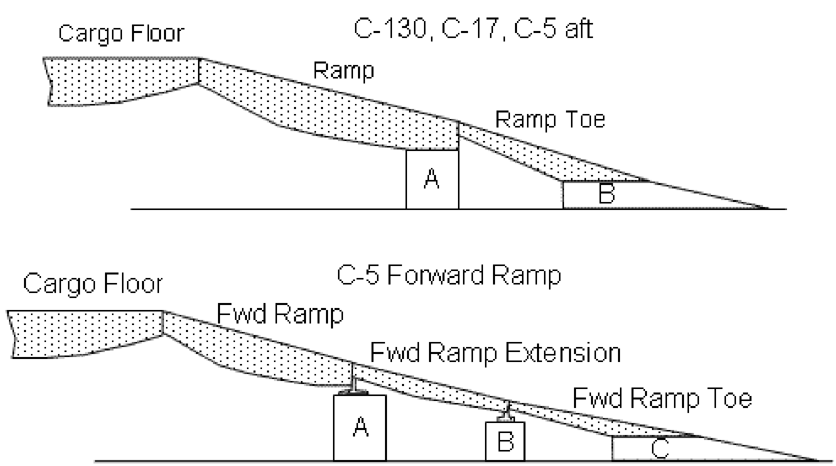


FIGURE A-21. Pedestal shoring.

TABLE A-I. Shoring minimum size.

Top Layer	all C-130's	C-17	C-5 aft	C-5 Fwd
(A) Ramp	18 in. L x 18 in. W	18 in. L x 30 in. W	Two: 26 in. L x 18 in. W	n/a
(B) Ramp Toe	11 in. L	11 in L x See Chart appendix B	11 in. L	n/a
(A) Forward Ramp	n/a	n/a	n/a	Two: 13 in. L x 16 in. W Two: 15 in. L x 18 in. W
(B) Forward Ramp Extension	n/a	n/a	n/a	Four: 15 in. L x 15 in. W
(C) Forward Ramp Toe	n/a	n/a	n/a	11 in L x See Chart appendix B

A.5.4.2.3 Shoring for weight distribution.

Shoring can be used to distribute the weight by increasing contact area to meet loading or flight limits. The basic principle is shown on figure A-22. The following explains the different types of weight-distributing shoring: rolling, parking, and sleeper.

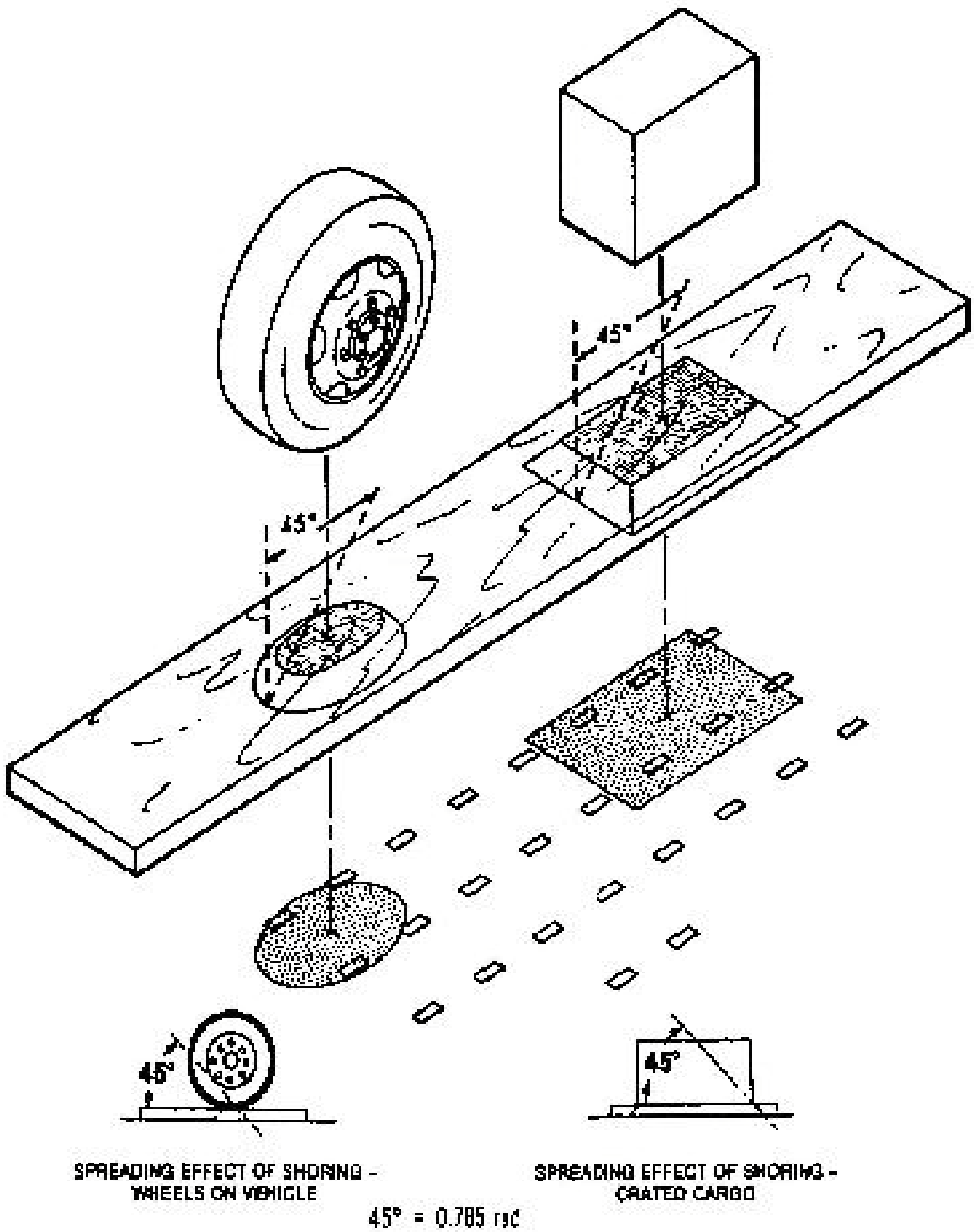


FIGURE A-22. Shoring to spread weight.

A.5.4.2.4 Rolling shoring.

Rolling shoring is used to distribute weight from wheels and tracks to meet aircraft loading limits.

The shoring width and thickness are computed by the same methods used to compute area and floor pressure for the type of wheel or track pad. For example, if a track pad footprint exceeds aircraft limitations, a proportionately larger footprint is calculated that meets the requirement. The thickness is then the height of the 45-degree triangle required to "match up" the footprints.

The width is the total width of the original footprint plus the base of the 45 degree triangle, as on figure A-22. The length starts from the area in which aircraft limits are exceeded, such as at the end of the ramp toes/extensions or the cargo floor, to where the item is parked for flight. Additional shoring, parking shoring, may be placed on top of rolling shoring to meet flight loads.

Rolling shoring may also be used for floor protection. It is used to protect the aircraft ramp(s) and/or cargo compartment floor from damage during on/ offloading of tracked vehicles or vehicles with wheels that have lugs, cleats, studs, metal rolling surfaces, or small diameters.

NOTE: Rolling shoring will increase the effective height of the vehicle.

A.5.4.2.5 Parking shoring.

Parking shoring is used to distribute weight from wheels and tracks to meet aircraft flight limits. Sleeper shoring may also be used in place of parking shoring because the vertical flight loads are carried by sleeper shoring stacks rather than by the wheels or tracks (figure A-23 and figure A-24).

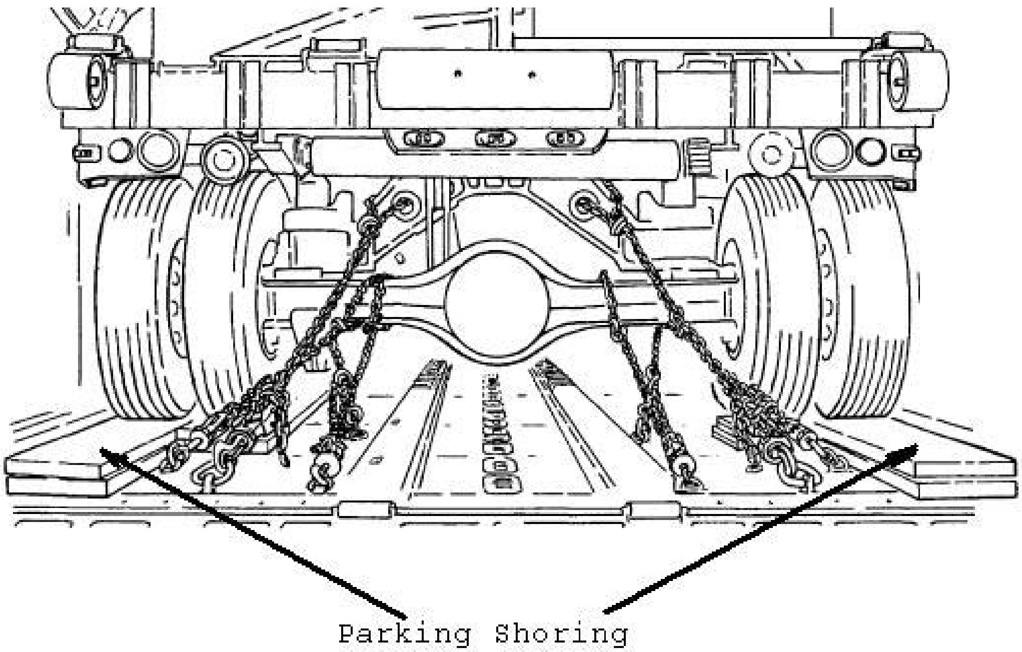


FIGURE A-23. Parking shoring.

MARK LENGTH HERE

MARK WIDTH HERE

STEP 1

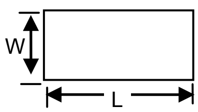
PARK THE VEHICLE ON A FLAT SURFACE.

STEP 2

PLACE MARKS ON THE SURFACE AS ILLUSTRATED.

STEP 3

MOVE THE VEHICLE. THE MARKS SHOULD APPEAR LIKE THIS:



STEP 4

SINCE THE ACTUAL PAD PATTERN IS ELLIPTICAL IN SHAPE, USE THE FOLLOWING FORMULA TO DETERMINE PAD AREA:

A = .785 LW

A - AREA
L - LENGTH
W - WIDTH

EXAMPLE PROBLEM:

ASSUME THE VEHICLE WHEEL PAD IS 12 INCHES LONG AND 6 INCHES WIDE.

A = .785 X 12 X 6

A = 56.5 SQUARE INCHES

STEP 5

THE WHEEL LOAD MUST BE KNOWN TO DETERMINE THE PSI EXERTED BY THE TIRE ON THE PAD AREA. THE FORMULA FOR WHEEL LOAD IS:

$$\frac{\text{AXLE WEIGHT}}{\text{NUMBER OF WHEELS}} = \text{WHEEL LOADS}$$

EXAMPLE PROBLEM:

ASSUME THE AXLE WEIGHT IS 2,000 POUNDS AND THAT THERE ARE TWO WHEELS.

$$\frac{2{,}000}{2} = \text{1,000 POUNDS WHEEL LOAD}$$

USING THE PAD AREA DETERMINED IN STEP 4 AND THE WHEEL LOAD ABOVE, USE THE FOLLOWING FORMULA TO DETERMINE THE PSI FLOOR LOADING:

$$\frac{\text{WHEEL LOAD}}{\text{PAD AREA}} = \text{FLOOR LOAD (PSI)}$$

$$\frac{1{,}000}{\text{56.5 SQUARE INCHES}} = \text{17.7 PSI}$$

METRIC EQUIVALENTS

6 in. = 152 mm

12 in. = 305 mm

56 in^2 = 0.0361 m^2

1000 lbs = 454 kg

2000 lbs = 907 kg

17.7 psi = 124 kPa

FIGURE A-24. Computing tire contact pressure.

Parking shoring may also be used for floor protection. It is used to protect the aircraft ramp(s) and/or cargo compartment floor from damage during flight for tracked vehicles or vehicles with wheels that have lugs, cleats, studs, metal rolling surfaces, or small diameters.

For weight distribution, shoring length, width, and thickness are computed by the same methods used to compute area and floor pressure for the type of wheel or track pad or jackstand. For some aircraft the load distribution must meet linear and lateral weight distribution limits.

NOTE: Parking shoring will increase the effective height of the vehicle.

Any tire having an internal pressure greater than 100 psi is considered to be a solid tire for analysis. These tires may need to have shoring to reduce the floor contact pressure when rolling in and out of the airplane. Tires with deep grooves may have to be shored to at least ¼ inch thicker (min 1 inch thick) than the groove or cleat depth.

The general rule for shoring tires with deep pads or large gaps between pads is shown on figure A-24. Basically, measure the distance between contact pad on the tire. The minimum shoring thickness should be half (1/2) the length of the gaps. Since shoring spreads the weight or contact surface area at 45 degrees in all directions, the shoring thickness will allow the weight to be distributed across the gaps at the bottom of the shoring stack. For example, if the gap between an excavator tire is 3 inches, the shoring thickness should be at least 1 ½ inch thick and 1 1/2 inches larger than the contact length and width of the tire (figure A-25).

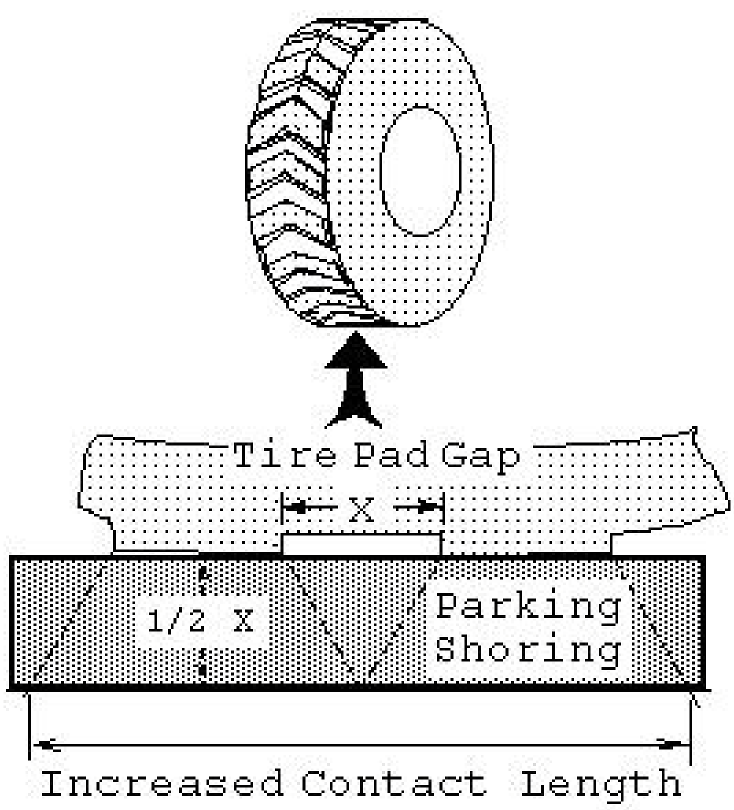


FIGURE A-25. Shoring for large gapped tires.

A.5.4.2.6 Bridge shoring.

Each aircraft specifies axle weight limits for various floor compartments. Heavy axles and/or axle spacing limit the places the item can be parked. If an axle or tandem axles exceed compartment limits, spreading or sharing the axle loads with other compartments is an acceptable method of bringing the axle load within compartment limits. One of these methods is called bridge shoring as shown on figure A-26.

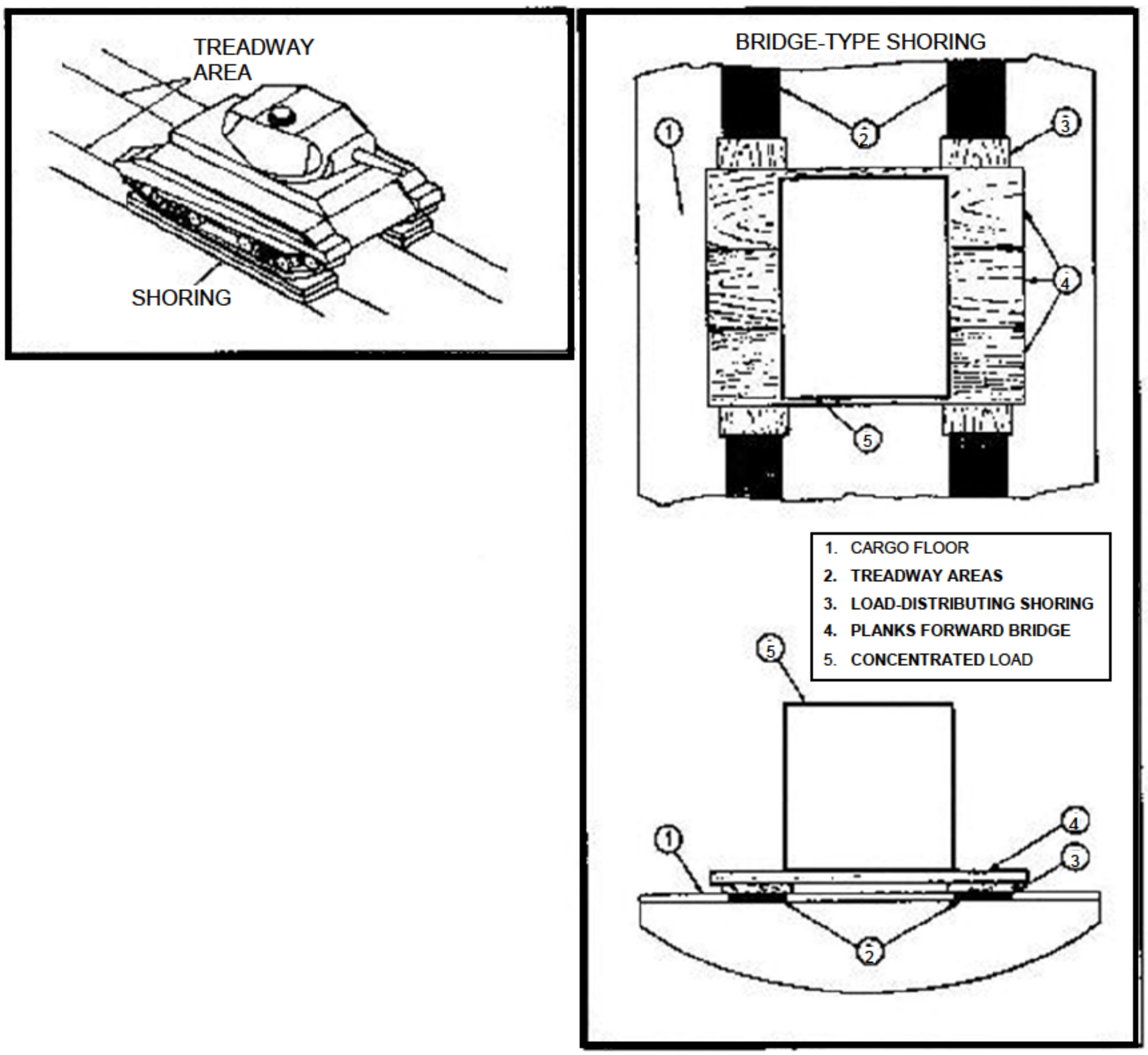


FIGURE A-26. Bridge shoring.

A.5.4.2.7 Sleeper shoring.

Sleeper shoring is intended to prevent the vertical 4.5G download from damaging the suspension, axle, and/or frame of the item. It is placed under frame members to support the item. Sleeper shoring can sometimes be used in lieu of parking shoring. To calculate sleeper shoring size, divide the weight of the vehicle by the number of stacks to be used (two per axle, one per jackstand). The stack's footprint should then be large enough to meet the concentrated load limit on the applicable aircraft. Shoring weight is not included in the calculation. Sleeper shoring can be pyramid shaped or a rectangular prism (figure A-27).

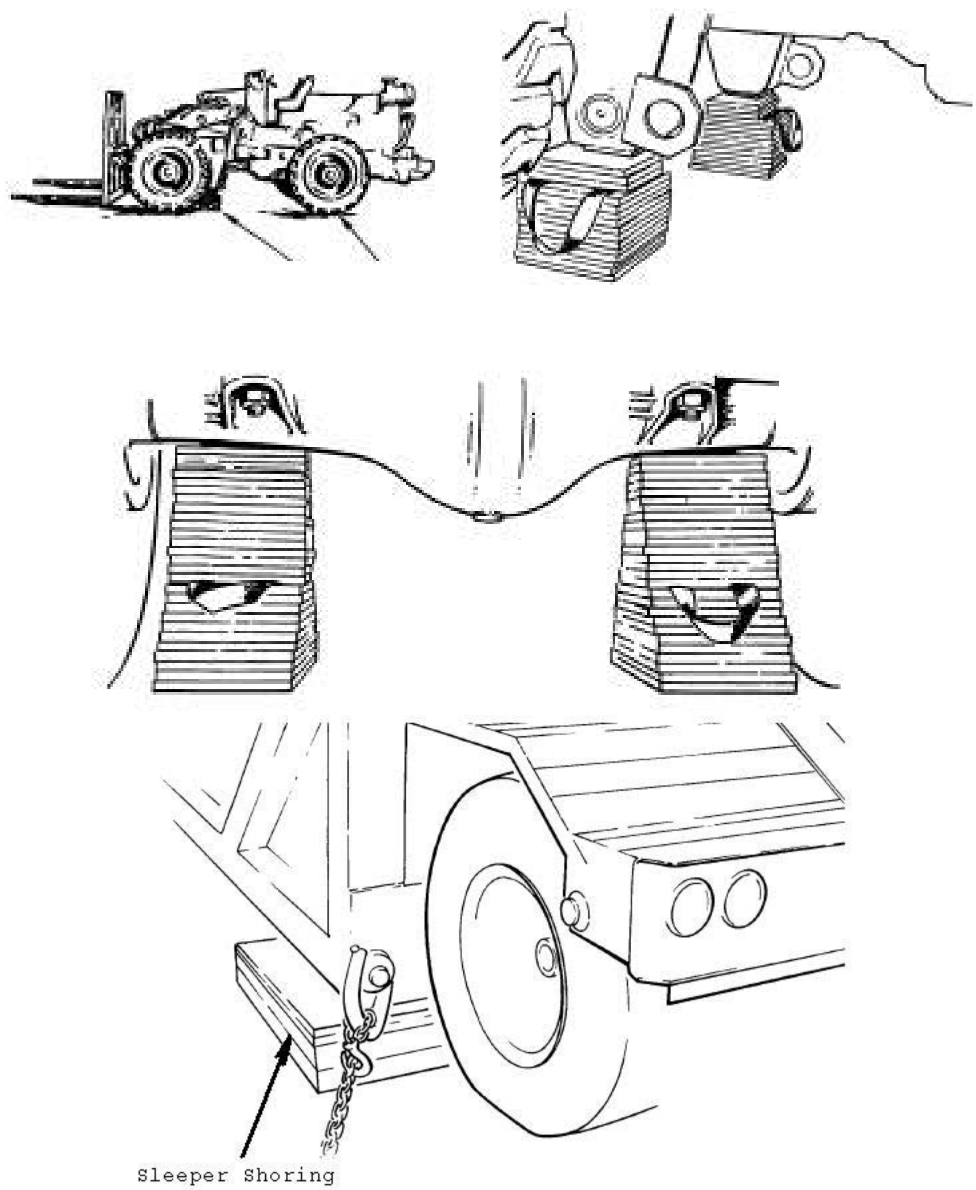


FIGURE A-27. Sleeper shoring.

A.5.4.3 Special tools and transport equipment.

A.5.4.3.1 MHE as loading aid.

MHE can be utilized to help with loading. K-loaders allow cargo to be brought straight in. This is limited by the carrying capability of the K-loader, availability of equipment to place the item on the K-loader, the straight-in loading limits of the aircraft, and the opening size of the aircraft. A forklift can be used put a light item directly onto the cargo floor or ramp. Dollies and mobilizers can be attached to the item to help it negotiate the ramp.

If the item is carried into the aircraft on MHE, the entire system of cargo and MHE should be considered as rolling stock. For example, if a forklift is used to pick up the item, the combined weight of the item and forklift weight should be considered. The added weight on the forklift axles or tires should not exceed aircraft limits and the forklift's ratings. The added dimension(s) of the item on the forklift must also be considered.

A.5.4.3.2 Self adjustment.

Cargo may also have the capability to adjust its clearances to avoid the problems areas. Examples are 1) a pintle that can vary height can be used to avoid ramp cresting; 2) an axle that rises to clear the ramp hinge; and 3) an excavator with the capability to move its scoop to avoid aircraft ramp and ceiling.

Cargo may lack the power to climb the ramp or roll into the aircraft. Each cargo plane has a winch to help with pulling the item into the aircraft. The winch limits are shown in table III. Winch procedures and calculations may be found in A.5.4.4.

A.5.4.3.3 Lowering tire pressure.

Lowering tire pressure to reduce item height is not an acceptable practice. The loadmaster is prohibited from using this technique because a reduction in tire pressure reduces tire capability and may also cause the item to ride on the tire rims. Having the rim roll on the aircraft floor or impact the floor during turbulence may damage the floor and the item's wheel and/or axle. A few items which have undergone a thorough analysis for this procedure are allowed to reduce tire pressure to reduce height for loading or to avoid having the tire categorized in the hard rubber or solid wheel. It is a means of last resort. The lower pressure must be within the range in which the tire capability is not degraded beyond usable limits such as weight carrying capacity. Approval to lower the tire pressure must be obtained from ATTLA.

A.5.4.4 Winching.

The aircraft cargo winch may be required to assist the loading process. The item may need special equipment such as a tow bar to provide proper orientation of the winch or towing cable. Item steering may occur during the movement. It is the requestor's responsibility to ensure that weight distribution during movement does not exceed any limits (figure A-28). For a detailed discussion of winching operations see C.4.2.

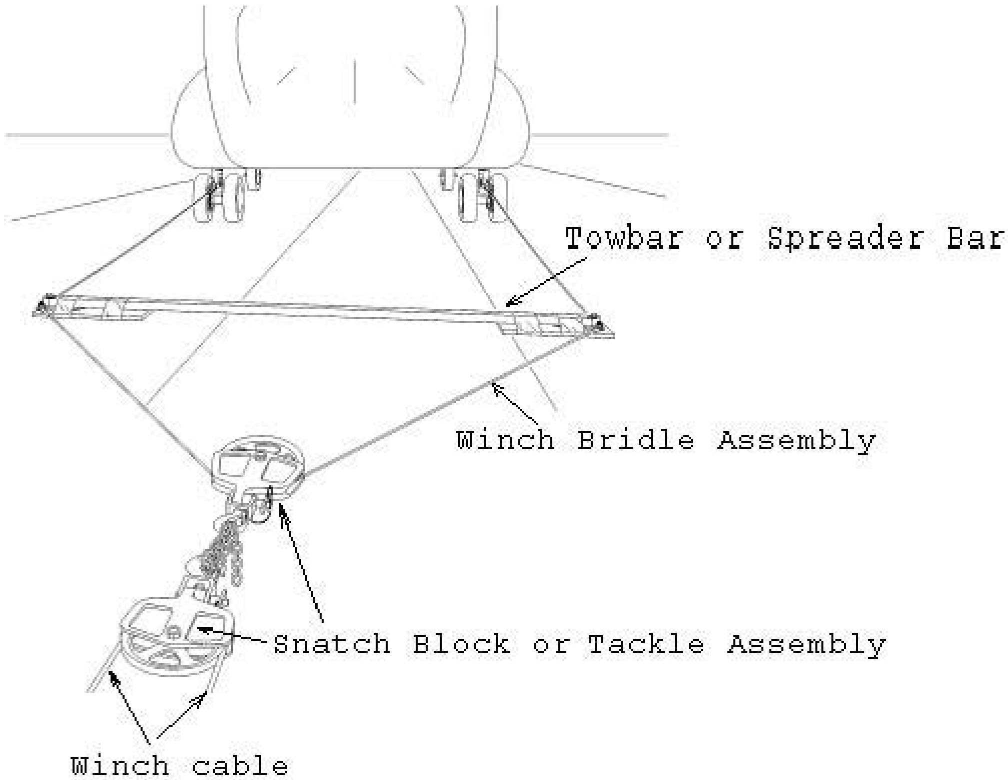


FIGURE A-28. Winching cargo.

B.1 SCOPE

B.1.1 Purpose.

This appendix provides data on specific aircraft limitations and procedures to determine whether an item exceeds those limits. It is derived from the basic aircraft loading manuals and technical publications. This appendix is a mandatory part of this standard.

B.1.2 Applicablilty.

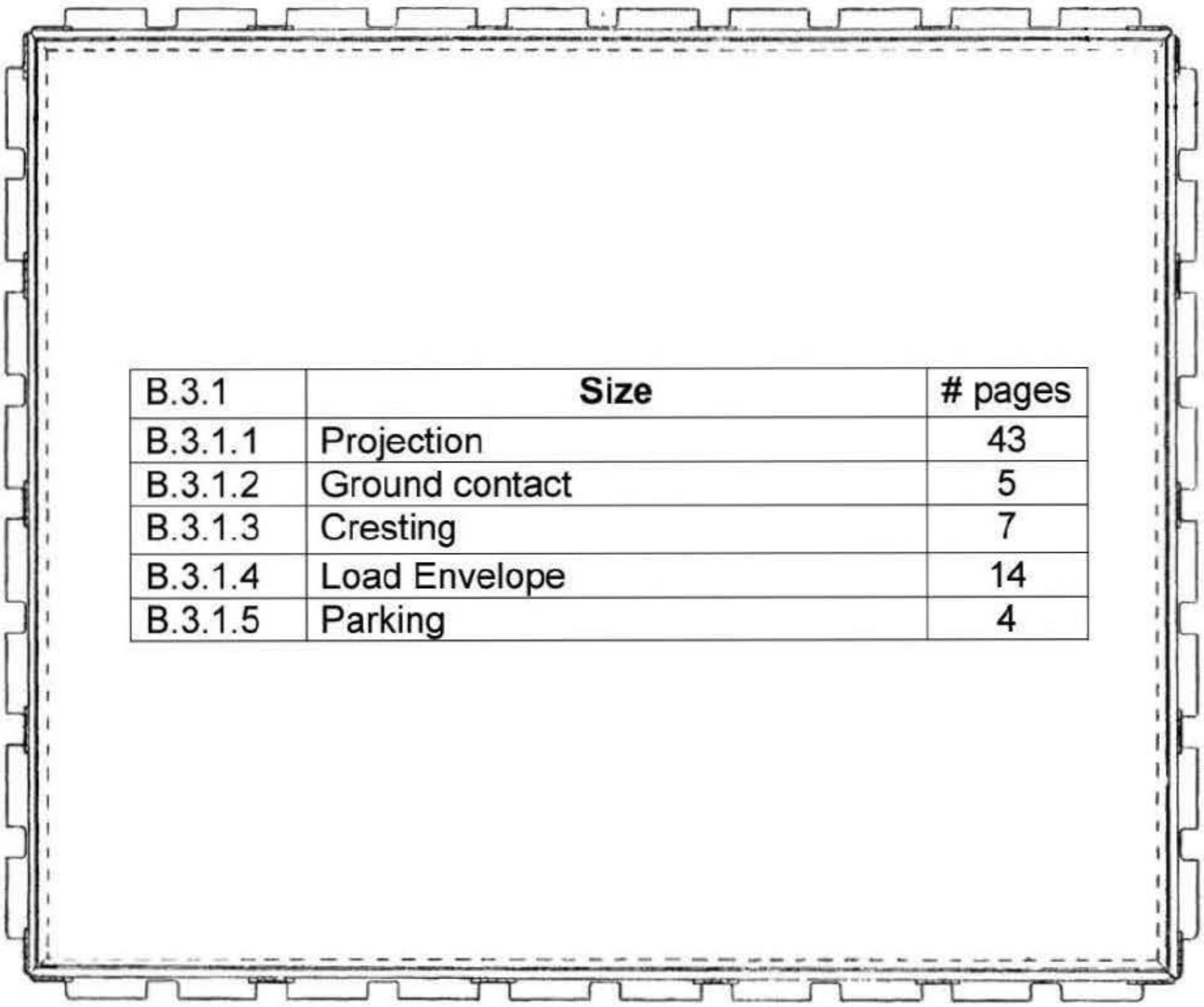
The limitations contained in this appendix are specific to individual aircraft. The applicability of a given limit to a specific cargo item is determined according to the guidelines in 6.1.

B.2 Definitions.

The names of some of the vehicle measurements called out in the different aircraft loading manuals are not consistent. The measurement locations indicated and referred to as "Critical Dimension," "Wheelbase," "Projection," and "Overhang" are not consistent between aircraft, or even between different graph/table sets for each aircraft, particularly the "Critical Dimension." In the weight limits charts, take note that “steel wheel,” “hard rubber wheel,” and “solid tire” are interchangeable with “solid wheel” as defined in paragraph 3.

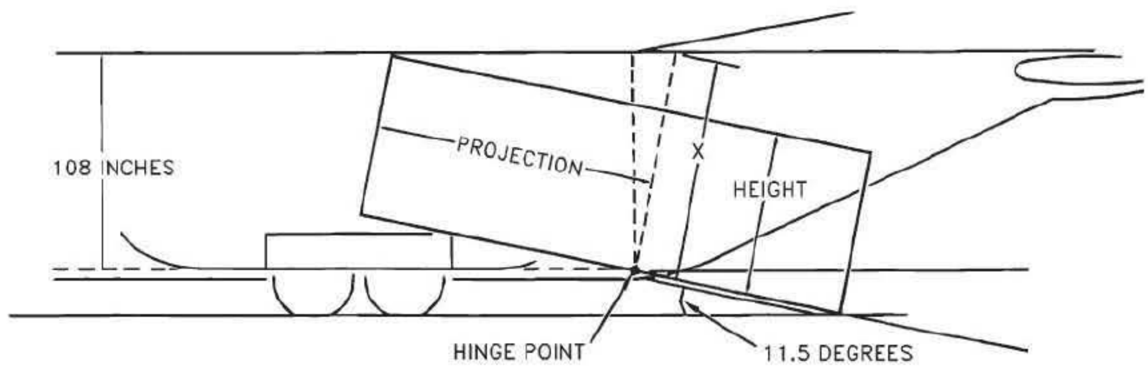
The loading manuals have been written by different companies over the last fifty years (the YC-130 first flight was in 1954) and are unique to their specific aircraft, both in dimensions and nomenclature.

B.3 C-130, C-17, and C-5 characteristics.



B.3.1	Size	# pages
B.3.1.1	Projection	43
B.3.1.2	Ground contact	5
B.3.1.3	Cresting	7
B.3.1.4	Load Envelope	14
B.3.1.5	Parking	4

Caution: The measurements indicated for each aircraft and referred to as "Critical Dimension", "Wheelbase", "Projection", and "Overhang" are not consistent between aircraft, nor even between different graph/table sets for each aircraft, particularly the "Critical Dimension"



TO CALCULATE THE MAXIMUM CARGO PROJECTION INTO THE AIRPLANE, USE CHART A. EXTEND A LINE TO THE LEFT SCALE FROM A POINT ON THE CHART CURVE DIRECTLY ABOVE THE CARGO HEIGHT ON THE BOTTOM SCALE. READ THE ALLOWABLE PROJECTION.
EXAMPLE: CARGO HEIGHT IS 90 INCHES. MAXIMUM PROJECTION IS 99 INCHES.

CHART A: EXAMPLE

FIGURE B-1. Overhang and projection limits (cargo) (sheet 1 of 2)

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C-130 Crated Cargo Projection Limits

F

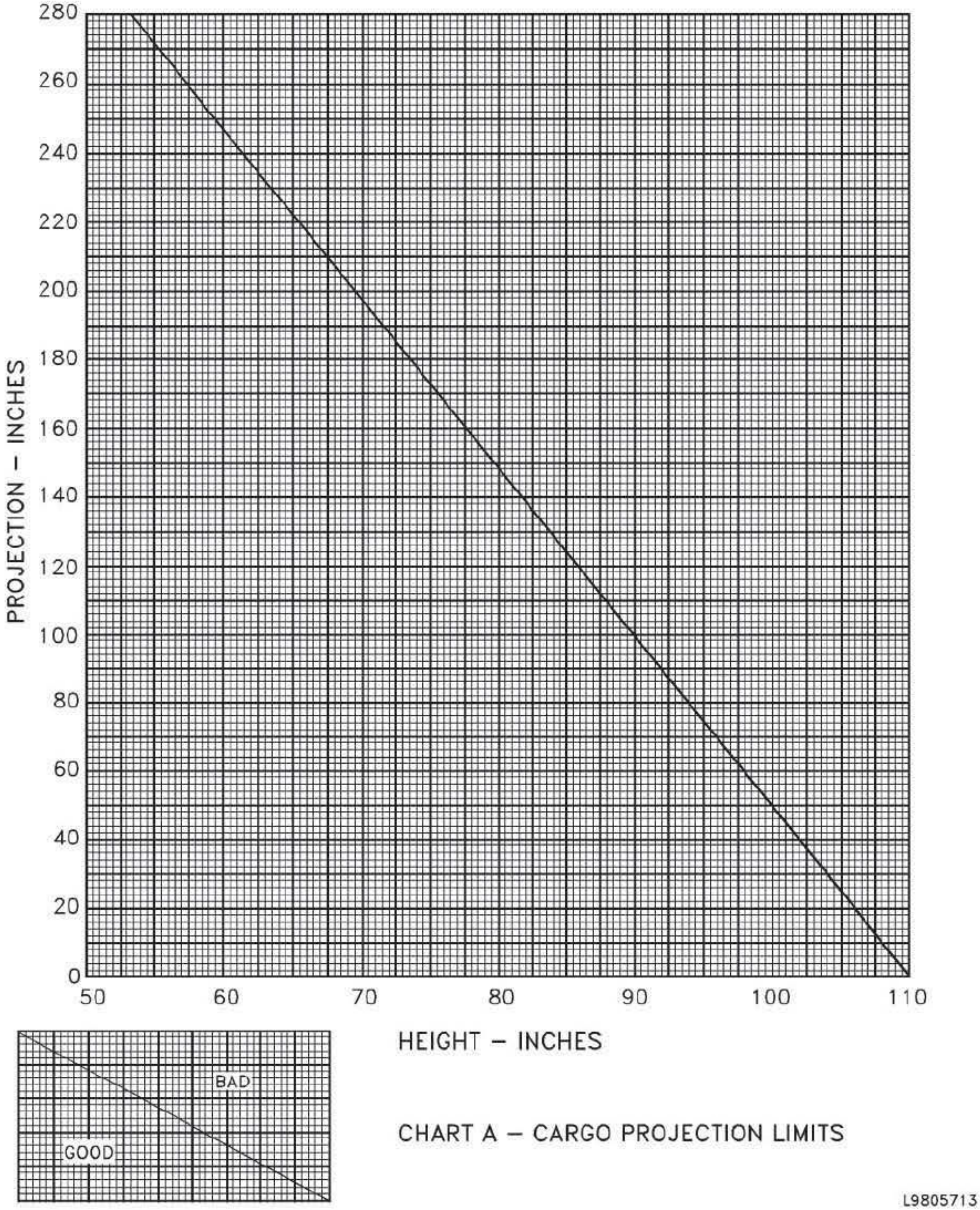
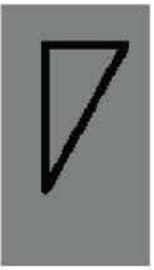


FIGURE B-2. Overhang and projection limits (cargo) (sheet 2 of 2)

C-130 Crated Cargo Projection Limits



Caution: The measurements indicated for each aircraft and referred to as "Critical Dimension", "Wheelbase", "Projection", and "Overhang" are not consistent between aircraft, nor even between different graph/table sets for each aircraft, particularly the "Critical Dimension"

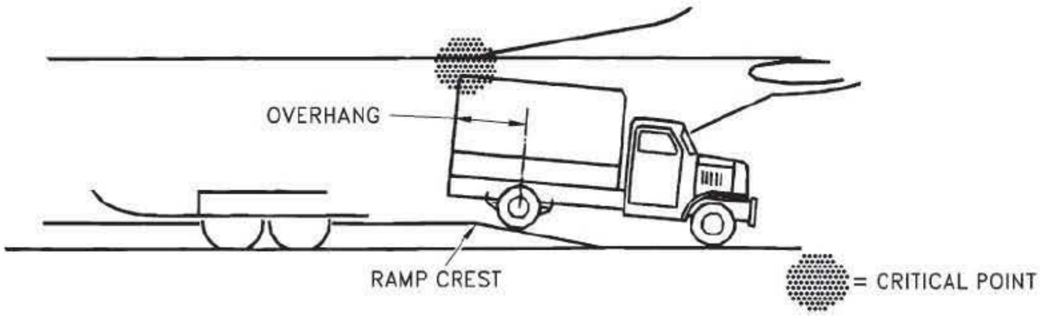


CHART D: EXAMPLE

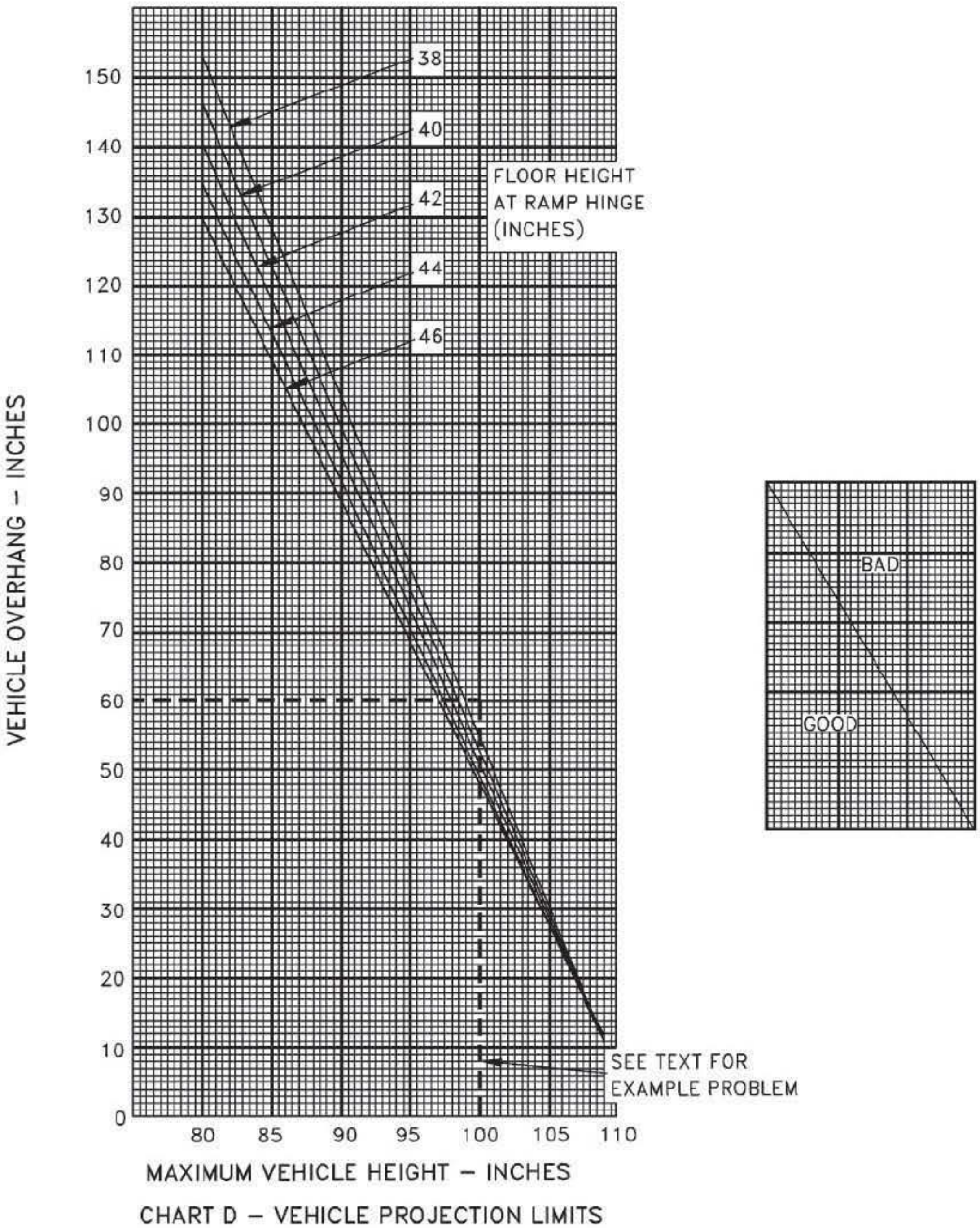
EXAMPLE – VEHICLE PROJECTION LIMIT

TO DETERMINE WHETHER A VEHICLE WHICH IS 100 INCHES HIGH AT ITS ENDS AND HAS 60 INCHES OF OVERHANG CAN BE LOADED UP THE INCLINED RAMP, PROCEED AS FOLLOWS:

a. ENTER THE HEIGHT SCALE OF CHART D AT 100 INCHES, AND ENTER THE OVERHANG SCALE AT 60 INCHES. THE INTERSECTION OF THE TWO LINES LIES ABOVE ALL OF THE RAMP HEIGHT CURVES. THIS INDICATES THAT THE VEHICLE WILL NOT HAVE CLEARANCE AT THE TOP OF THE COMPARTMENT. IT CAN BE SEEN THAT THE MAXIMUM PERMISSIBLE OVERHANG FOR A VEHICLE 100 INCHES HIGH IS FROM 49 INCHES TO 56 INCHES, DEPENDING ON THE HEIGHT OF THE RAMP CREST.

C-130 Vehicle Projection Limits

FIGURE B-3. Overhang and projection limits (vehicle) (sheet 1 of 2)



NOTE

OVERHANG MEASUREMENT FOR TANDEM AXLE WILL BE THE DISTANCE MIDWAY BETWEEN REAR AXLES

C-130 Vehicle Projection Limits

FIGURE B-4. Overhang and projection limits (vehicle) (sheet 2 of 2)

Caution: The measurements indicated for each aircraft and referred to as "Critical Dimension", "Wheelbase", "Projection", and "Overhang" are not consistent between aircraft, nor even between different graph/table sets for each aircraft, particularly the "Critical Dimension"

NOTE

- THE CARGO PROJECTION IS MEASURED FROM THE CG OF THE CARGO TO THE END OF THE CARGO THAT WILL ENTER THE AIRCRAFT FIRST AS IT IS LOADED. THE HEIGHT OF THE CARGO IS THE TOTAL HEIGHT INCLUDING SKIDS.
- TABULAR DATA ON SHEETS 2 THRU 5 PROVIDE A QUICK MEANS OF DETERMINING IF THE CRATED CARGO CAN BE SAFELY ON/OFFLOADED.

TO USE THE TABULAR DATA TO DETERMINE IF THE CRATED CARGO CAN BE SAFELY ON/OFFLOADED, PROCEED AS FOLLOWS:

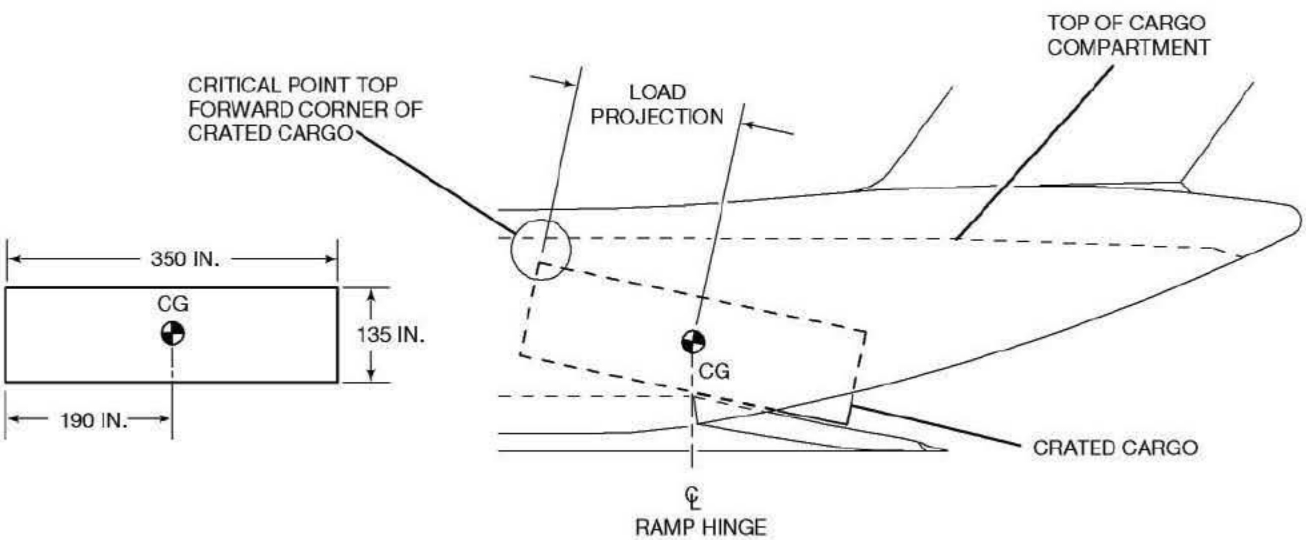
A. LOCATE THE CARGO HEIGHT IN THE LEFT COLUMN.

B. MOVE RIGHT AND LOCATE THE LOAD PROJECTION FIGURE THAT IS CLOSEST TO, BUT NOT LESS THAN THE ACTUAL LOAD PROJECTION.

C. MOVE UP TO THE TOP ROW TO DETERMINE ALLOWABLE RAMP HINGE HEIGHT.

EXAMPLE:

DETERMINE IF A CRATED ITEM OF CARGO 135 IN. HIGH AND 350 IN. LONG, WITH ITS CENTER OF GRAVITY LOCATED 190 IN. FROM THE END THAT WILL BE LOADED FIRST (LOAD PROJECTION) CAN BE SAFELY ON/OFFLOADED INBOARD OF X = ±82.



CARGO PROJECTION LIMIT

TO DETERMINE IF THE EXAMPLE CRATED CARGO CAN BE SAFELY ON/OFFLOADED INBOARD OF X = ± 82 PROCEED AS FOLLOWS:

A. USE TABULAR DATA ON SHEETS 2 AND 3.

B. LOCATE THE CARGO HEIGHT IN THE LEFT COLUMN THAT IS CLOSEST TO (136 IN.), BUT NOT LESS THAN THE ACTUAL HEIGHT (135 IN.).

C. MOVE RIGHT AND LOCATE THE LOAD PROJECTION FIGURE THAT IS CLOSEST TO (195 IN.), BUT NOT LESS THAN THE ACTUAL LOAD PROJECTION (190 IN.).

D. MOVE UP TO THE TOP ROW TO DETERMINE THE ALLOWABLE RAMP HINGE HEIGHT (72 IN.).

C-17

FIGURE B-5. Cargo projection limits

TABLE B-I. Cargo projection limits inboard ox X=±82

Cargo Height	Ramp Hinge Height					
	64 Inches	66 Inches	68 Inches	70 Inches	72 Inches	74 Inches
	Maximum Load Projection					
50	823	781	744	709	678	650
52	809	768	731	698	667	639
54	796	755	719	686	656	628
56	782	742	707	674	645	618
58	768	729	694	662	633	607
60	755	716	682	651	622	596
62	741	703	669	639	611	585
64	727	690	657	627	600	575
66	713	677	645	615	588	564
68	700	664	632	603	577	553
70	686	651	620	592	566	542
72	672	638	608	580	555	532
74	658	625	595	568	543	521
76	645	612	583	556	532	510
78	631	599	570	544	521	499
80	617	586	558	533	510	489
82	603	573	546	521	498	478
84	590	560	533	509	487	467
86	576	547	521	497	476	456
88	562	534	509	486	465	446
90	548	521	496	474	453	435
92	535	508	484	462	442	424
94	521	495	471	450	431	413
96	507	482	459	438	420	403
98	493	469	447	427	408	392
100	480	456	434	415	397	381
102	466	443	422	403	386	370
104	452	430	410	391	375	360
106	438	417	397	379	363	349
108	425	404	385	368	352	338
110	411	391	372	356	341	327
112	397	378	360	344	330	317
114	383	365	348	332	318	306

C-17 Crated Cargo

TABLE B-I. Cargo projection limits inboard ox X=±82 - continued

Cargo Height	Ramp Hinge Height					
	64 Inches	66 Inches	68 Inches	70 Inches	72 Inches	74 Inches
	Maximum Load Projection					
116	370	352	335	321	307	295
118	356	338	323	309	296	284
120	342	325	311	297	285	274
122	328	312	298	285	273	263
124	315	299	286	273	262	252
126	301	286	273	262	251	241
128	287	273	261	250	240	231
130	273	260	249	238	228	220
132	260	247	236	226	217	209
134	246	234	224	215	206	198
136	232	221	212	203	195	188
138	218	208	199	191	184	177
140	205	195	187	179	172	166
142	191	182	174	167	161	155
144	177	169	162	156	150	145
146	163	156	150	144	139	134
148	150	143	137	132	127	123
150	136	130	125	120	116	112
152	122	117	113	108	105	102
154	108	104	100	97	94	91
156	95	91	88	85	82	80
158	81	78	75	73	71	69
160	67	65	63	61	60	59
162	53	52	51	50	49	48
164	40	39	38	38	37	37
166	26	26	26	26	26	26
168	12	13	13	14	15	15

Table is to be used when loading items between X =±82.

C-17 Crated Cargo

TABLE B-I. Cargo projection limits inboard ox X=±82 - continued

Cargo Height	Ramp Hinge Height					
	64 Inches	66 Inches	68 Inches	70 Inches	72 Inches	74 Inches
	Maximum Load Projection					
50	782	742	706	674	644	617
52	768	729	694	662	633	606
54	754	716	681	650	622	596
56	740	703	669	638	610	585
58	727	690	657	626	599	574
60	713	677	644	615	588	563
62	699	664	632	603	577	553
64	685	651	619	591	565	542
66	672	638	607	579	554	531
68	658	625	595	568	543	520
70	644	612	582	556	532	510
72	630	599	570	544	520	499
74	617	586	558	532	509	488
76	603	573	545	520	498	477
78	589	559	533	509	487	467
80	575	546	520	497	475	456
82	562	533	508	485	464	445
84	548	520	496	473	453	434
86	534	507	483	461	442	424
88	520	494	471	450	430	413
90	507	481	459	438	419	402
92	493	468	446	426	408	391
94	479	455	434	414	397	381
96	465	442	421	403	385	370
98	452	429	409	391	374	359
100	438	416	397	379	363	348
102	424	403	384	367	352	337
104	410	390	372	355	340	327
106	397	377	360	344	329	316
108	383	364	347	332	318	305
110	369	351	335	320	307	294
112	355	338	322	308	295	284
114	342	325	310	296	284	273

C-17 Crated Cargo

TABLE B-I. Cargo projection limits inboard ox X=±82 - continued

Cargo Height	Ramp Hinge Height					
	64 Inches	66 Inches	68 Inches	70 Inches	72 Inches	74 Inches
	Maximum Load Projection					
116	328	312	298	285	273	262
118	314	299	285	273	262	251
120	300	286	273	261	250	241
122	287	273	261	249	239	230
124	273	260	248	238	228	219
126	259	247	236	226	217	208
128	245	234	223	214	205	198
130	232	221	211	202	194	187
132	218	208	199	190	183	176
134	204	195	186	179	172	165
136	190	182	174	167	160	155
138	177	169	162	155	149	144
140	163	156	149	143	138	133
142	149	143	137	132	127	122
144	135	130	124	120	116	112
146	122	117	112	108	104	101
148	108	104	100	96	93	90
150	94	87	87	84	82	79
152	80	75	75	73	71	69
154	67	63	63	61	59	58
156	53	50	50	49	48	47
158	39	38	38	37	37	36
160	25	25	25	25	26	26
162	12	13	13	14	14	15

Table is to be used when loading items which will extend outboard of X =±82.

C-17 Crated Cargo

Caution: The measurements indicated for each aircraft and referred to as "Critical Dimension", "Wheelbase", "Projection", and "Overhang" are not consistent between aircraft, nor even between different graph/table sets for each aircraft, particularly the "Critical Dimension"

NOTE

THE AXLE FROM WHICH REAR OVERHANG IS MEASURED WILL DEPEND UPON THE TYPE OF AXLES, i.e., TRIPLE ARTICULATING, DUAL TANDEM OR BOGEY.

C-17 Vehicular Cargo

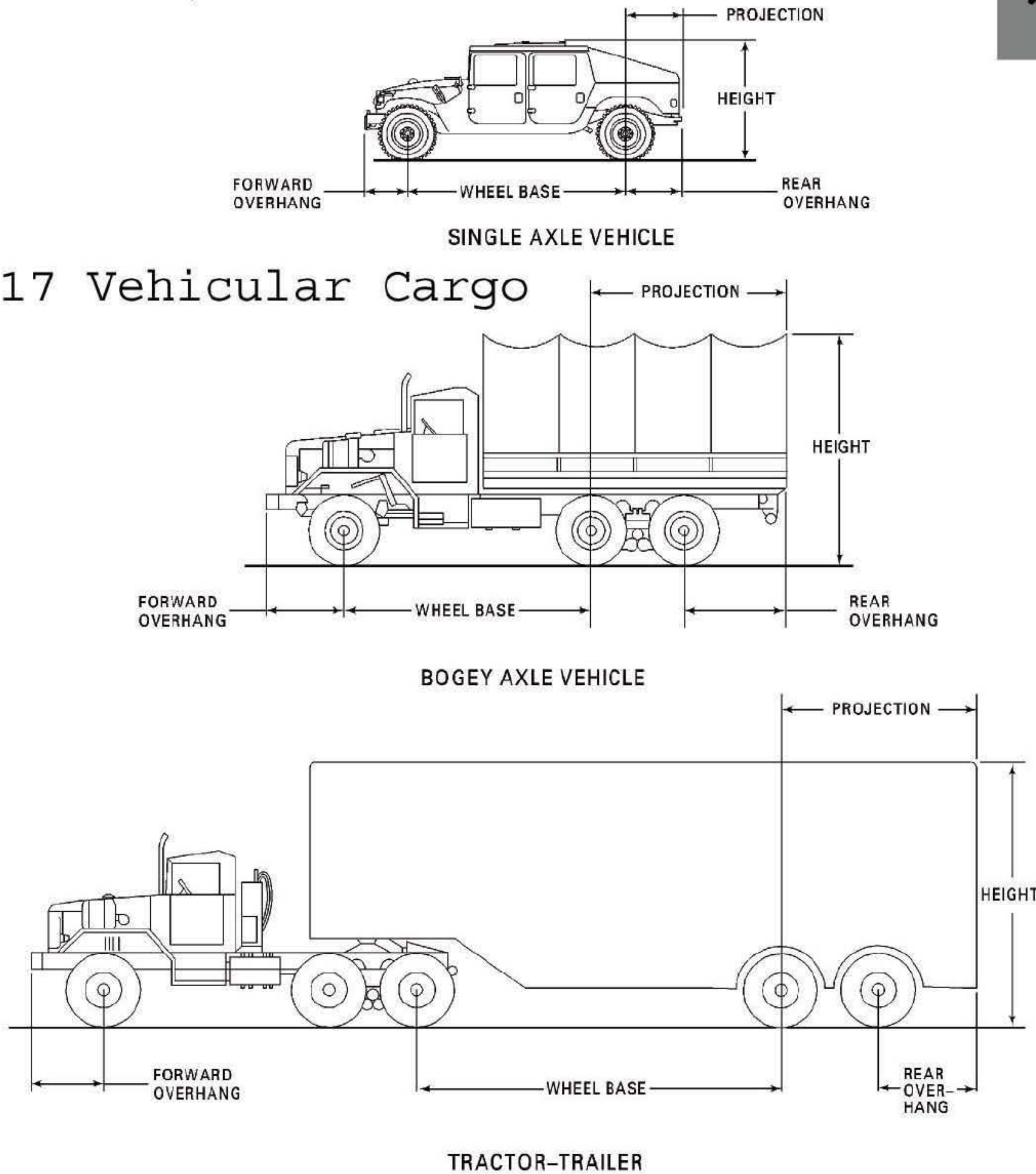


FIGURE B-6. Vehicle dimensional limits (sheet 1 of 2)

WHEN DETERMINING THE DIMENSIONAL LOADABILITY OF LARGE VEHICLES/ROLLING STOCK, OBSERVE THE FOLLOWING FIVE STEPS.

NOTE

MEASURE THE CARGO FLOOR HEIGHT NEAR THE RAMP HINGE AREA PRIOR TO DETERMINING STEP 1. ALTERNATE LOADING METHODS SHOULD BE CONSIDERED IF ANY OF THE FOLLOWING LIMITS ARE EXCEEDED.

STEP 1

VEHICLE PROJECTION LIMIT

A. USE ACTUAL WHEELBASE AND DETERMINE IF ITEM IS TO BE LOADED INBOARD OF X = ±82 OR IF IT WILL EXTEND OUTBOARD OF X = ±82. THIS WILL DETERMINE WHICH TABULAR DATA IN FIGURE 4D-3 TO BE USED ON SHEETS 2 THRU 13.

B. LOCATE THE VEHICLE HEIGHT IN THE LEFT COLUMN THAT IS CLOSEST TO, BUT NOT LESS THAN THE ACTUAL HEIGHT.

C. MOVE RIGHT AND LOCATE THE MAXIMUM VEHICLE PROJECTION FIGURE THAT IS CLOSEST TO BUT NOT LESS THAN THE ACTUAL LOAD PROJECTION.

D. MOVE UP TO THE TOP OF THE TABLE TO DETERMINE MAXIMUM RAMP HINGE HEIGHT.

STEP 2

RAMP TOES CONTACT LIMIT

A. MEASURE THE OVERHANG AT THE END OF THE VEHICLE ENTERING THE AIRCRAFT FIRST.

B. MEASURE THE GROUND CLEARANCE AT THE SAME END.

C. DIVIDE THE GROUND CLEARANCE INTO THE OVERHANG.

D. RESULT: A RATIO WHICH WILL DETERMINE WHETHER OR NOT THE LEADING EDGE WILL STRIKE THE RAMP PRIOR TO THE WHEELS RAISING THE VEHICLE. THIS RATIO SHALL NOT EXCEED 3.5.

STEP 3

GROUND CONTACT LIMIT

A. MEASURE THE OVERHANG AT THE TRAILING END OF THE VEHICLE.

B. MEASURE THE GROUND CLEARANCE AT THE SAME END.

C. REDETERMINE THE WHEELBASE.

D. DIVIDE THE GROUND CLEARANCE INTO THE OVERHANG.

E. RESULT: A RATIO WHICH IS USED IN CONJUNCTION WITH THE WHEELBASE AND APPLIED TO THE GROUND CONTACT LIMIT TABLE TO DETERMINE WHETHER OR NOT THE VEHICLE WILL DRAG ACROSS THE GROUND.

STEP 4

RAMP CREST LIMIT

A. MEASURE THE WHEELBASE OF THE VEHICLE.

B. MEASURE THE GROUND CLEARANCE AT THE MID-WHEELBASE.

C. APPLY THESE FIGURES TO THE RAMP CREST LIMIT TABLE.

D. RESULT: WHETHER OR NOT THE VEHICLE WILL DRAG ACROSS THE RAMP CREST (HINGE) AREA.

STEP 5

PARKING OVERHANG LIMIT

A. MEASURE THE OVERHANG AT THE END PROJECTING OVER THE RAMP.

B. MEASURE THE GROUND CLEARANCE AT THE SAME END.

C. APPLY THESE FIGURES TO THE PARKING OVERHANG CHART.

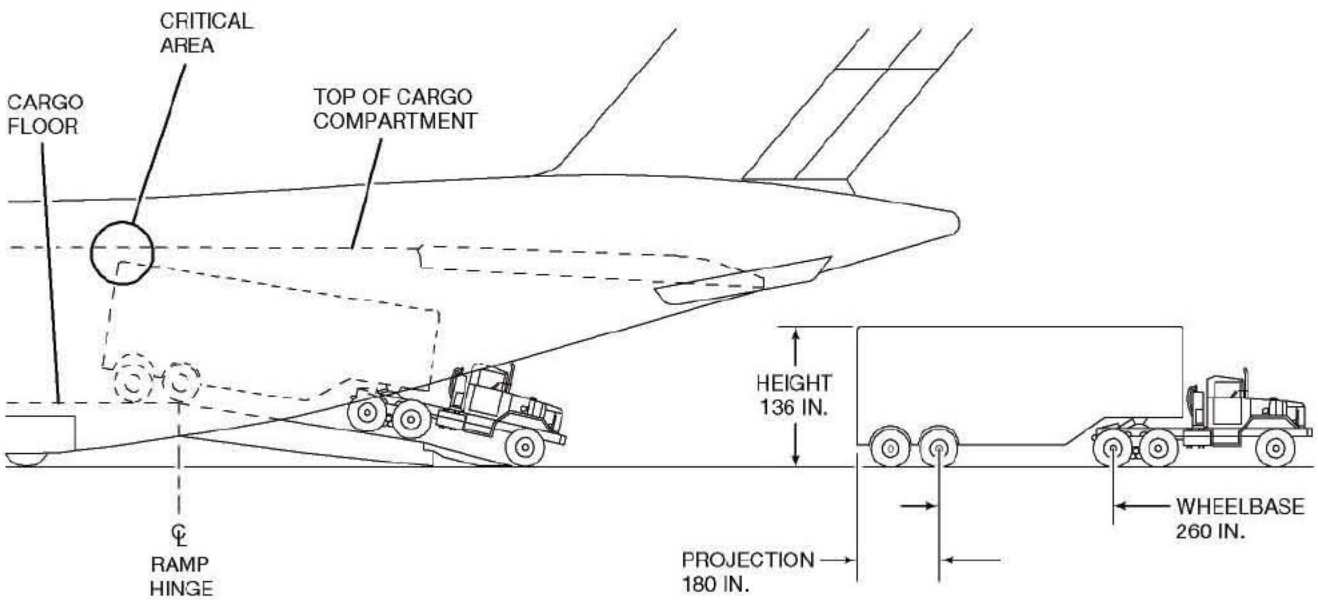
D. RESULT: WHETHER OR NOT THE VEHICLE WILL CONTACT THE RAMP WHEN IT IS CLOSED.

C-17

FIGURE B-7. Vehicle dimensional limits (sheet 2)

EXAMPLE:

DETERMINE IF A VEHICLE WITH A KNOWN PROJECTION OF 180 IN., AND A KNOWN HEIGHT OF 136 IN. WITH A WHEELBASE OF 260 IN. CAN BE SAFELY ON/OFFLOADED INBOARD OF X = ±82.



C-17 Vehicular Cargo

VEHICLE PROJECTION LIMIT

TO DETERMINE IF THE EXAMPLE VEHICLE CAN BE SAFELY ON/OFFLOADED PROCEED AS FOLLOWS:

A. USE ACTUAL WHEELBASE AND DETERMINE IF ITEM IS TO BE LOADED INBOARD OF X = ±82 OR IF IT WILL EXTEND OUTBOARD OF X = ±82. THIS WILL DETERMINE WHICH TABULAR DATA ON SHEETS 2 THRU 13 IS TO BE USED. THIS VEHICLE WILLBE LOADED INBOARD OF X = ±82 (TABULAR DATA ON SHEETS 2 THRU 7).

B. LOCATE THE VECHICLE HEIGHT IN THE LEFT COLUMN (136 IN.).

C. MOVE RIGHT AND LOCATE THE MAXIMUM VEHICLE PROJECTION FIGURE THAT IS CLOSEST TO (181 IN.) BUT NOT LESS THAN THE ACTUAL LOAD PROJECTION (180).

D. MOVE UP TO THE TOP OF THE TABLE TO DETERMINE MAXIMUM RAMP HINGE HEIGHT (68 IN. OR LESS).

Figure B-8. Vehicle projection limits

TABLE B-II. Vehicle projection limits inboard of X =±82 - wheelbase less than 257 inches

Vehicle Height	Wheelbase Less Than 257 Inches					
	Ramp Hinge Height					
	64 Inches	66 Inches	68 Inches	70 Inches	72 Inches	74 Inches
	Maximum Load Projection					
50	823	781	744	709	678	650
52	809	768	731	698	667	639
54	796	755	719	686	656	628
56	782	742	707	674	645	618
58	768	729	694	662	633	607
60	755	716	682	651	622	596
62	741	703	669	639	611	585
64	727	690	657	627	600	575
66	713	677	645	615	588	564
68	700	664	632	603	577	553
70	686	651	620	592	566	542
72	672	638	608	580	555	532
74	658	625	595	568	543	521
76	645	612	583	556	532	510
78	631	599	570	544	521	499
80	617	586	558	533	510	489
82	603	573	546	521	498	478
84	590	560	533	509	487	467
86	576	547	521	497	476	456
88	562	534	509	486	465	446
90	548	521	496	474	453	435
92	535	508	484	462	442	424
94	521	495	471	450	431	413
96	507	482	459	438	420	403
98	493	469	447	427	408	392
100	480	456	434	415	397	381
102	466	443	422	403	386	370
104	452	430	410	391	375	360
106	438	417	397	379	363	349
108	425	404	385	368	352	338
110	411	391	372	356	341	327
112	397	378	360	344	330	317

C-17 Vehicular Cargo

TABLE B-II. Vehicle projection limits inboard of X =±82 - wheelbase less than 257 inches - continued

Vehicle Height	Wheelbase Less Than 257 Inches					
	Ramp Hinge Height					
	64 Inches	66 Inches	68 Inches	70 Inches	72 Inches	74 Inches
	Maximum Load Projection					
114	383	365	348	332	318	306
116	370	352	335	321	307	295
118	356	338	323	309	296	284
120	342	325	311	297	285	274
122	328	312	298	285	273	263
124	315	299	286	273	262	252
126	301	286	273	262	251	241
128	287	273	261	250	240	231
130	273	260	249	238	228	220
132	260	247	236	226	217	209
134	246	234	224	214	206	198
136	232	221	212	203	195	188
138	218	208	199	191	184	177
140	205	195	187	179	172	166
142	191	182	174	167	161	155
144	177	169	162	156	150	145
146	163	156	150	144	139	134
148	150	143	137	132	127	123
150	136	130	125	120	116	112
152	122	117	112	108	105	102
154	108	104	100	97	94	91
156	95	91	88	85	82	80
158	81	78	75	73	71	69
160	67	65	63	61	60	58
162	53	52	51	50	49	48
164	40	39	38	38	37	37
166	26	26	26	26	26	26
168	12	13	13	14	15	15

C-17 Vehicular Cargo

TABLE B-II. Vehicle projection limits inboard of X =±82 - wheelbase 257 to 339 inches - continued

Vehicle Height	Wheelbase 257 to 339 Inches					
	Ramp Hinge Height					
	64 Inches	66 Inches	68 Inches	70 Inches	72 Inches	74 Inches
	Maximum Load Projection					
50	662	641	622	578	563	548
52	651	631	612	569	553	539
54	640	620	602	559	544	530
56	629	610	591	550	535	521
58	618	599	581	540	526	512
60	607	588	571	531	516	503
62	596	578	561	521	507	494
64	585	567	550	512	498	485
66	574	557	540	502	489	476
68	563	546	530	493	480	467
70	552	535	520	483	470	458
72	541	525	509	474	461	449
74	530	514	499	464	452	440
76	519	504	489	455	443	431
78	508	493	478	445	433	422
80	497	482	468	436	424	413
82	487	472	458	426	415	404
84	476	461	448	417	406	395
86	465	451	437	407	396	386
88	454	440	427	398	387	377
90	443	429	417	388	378	368
92	432	419	407	379	369	359
94	421	408	396	369	360	350
96	410	398	386	360	350	341
98	399	387	376	350	341	332
100	388	376	365	341	332	323
102	377	366	355	331	323	314
104	366	355	345	322	313	306
106	355	344	335	312	304	297
108	344	334	324	303	295	288
110	333	323	314	293	286	279
112	322	313	304	284	276	270

C-17 Vehicular Cargo

TABLE B-II. Vehicle projection limits inboard of X =±82 - wheelbase 257 to 339 inches - continued

Vehicle Height	Wheelbase 257 to 339 Inches					
	Ramp Hinge Height					
	64 Inches	66 Inches	68 Inches	70 Inches	72 Inches	74 Inches
	Maximum Load Projection					
114	311	302	294	274	267	261
116	300	291	283	265	258	252
118	289	281	273	255	249	243
120	278	270	263	246	240	234
122	267	260	252	236	230	225
124	256	249	242	227	221	216
126	245	238	232	217	212	207
128	234	228	222	208	203	198
130	223	217	211	198	193	189
132	212	207	201	189	184	180
134	202	196	191	179	175	171
136	191	185	181	170	166	162
138	180	175	170	160	156	153
140	169	164	160	151	147	144
142	158	154	150	141	138	135
144	147	143	139	132	129	126
146	136	132	129	122	120	117
148	125	122	119	113	110	108
150	114	111	109	103	101	99
152	103	101	98	94	92	90
154	92	90	88	84	83	81
156	81	79	78	75	73	72
158	70	69	68	65	64	63
160	59	58	57	56	55	54
162	48	48	47	46	46	45
164	37	37	37	36	36	36
166	26	26	26	27	27	27
168	15	16	16	17	18	19

TABLE B-II. Vehicle projection limits inboard of X =±82 - wheelbase 340 inches + - continued

Vehicle Height	Wheelbase 340 Inches +					
	Ramp Hinge Height					
	64 Inches	66 Inches	68 Inches	70 Inches	72 Inches	74 Inches
	Maximum Load Projection					
50	650	631	612	595	579	563
52	639	620	602	585	569	554
54	628	610	592	575	560	545
56	618	599	582	566	550	536
58	607	589	572	556	541	526
60	596	578	562	546	531	517
62	585	568	552	536	522	508
64	575	558	542	526	512	499
66	564	547	531	517	503	489
68	553	537	521	507	493	480
70	542	526	511	497	484	471
72	532	516	501	487	474	462
74	521	506	491	477	465	453
76	510	495	481	468	455	443
78	499	485	471	458	446	434
80	489	474	461	448	436	425
82	478	464	451	438	427	416
84	467	453	441	428	417	406
86	456	443	430	419	408	397
88	446	433	420	409	398	388
90	435	422	410	399	389	379
92	424	412	400	389	379	369
94	413	401	390	379	369	360
96	403	391	380	370	360	351
98	392	381	370	360	350	342
100	381	370	360	350	341	332
102	370	360	350	340	331	323
104	360	349	340	331	322	314
106	349	339	330	321	312	305
108	338	328	319	311	303	295
110	327	318	309	301	293	286
112	317	308	299	291	284	277

C-17 Vehicular Cargo

TABLE B-II. Vehicle projection limits inboard of X =±82 - wheelbase 340 inches + - continued

Vehicle Height	Wheelbase 340 Inches +					
	Ramp Hinge Height					
	64 Inches	66 Inches	68 Inches	70 Inches	72 Inches	74 Inches
	Maximum Load Projection					
114	306	297	289	282	274	268
116	295	287	279	272	265	258
118	284	276	269	262	255	249
120	274	266	259	252	246	240
122	263	256	249	242	236	231
124	252	245	239	233	227	221
126	241	235	229	223	217	212
128	231	224	218	213	208	203
130	220	214	208	203	198	194
132	209	203	198	193	189	184
134	198	193	188	184	179	175
136	188	183	178	174	170	166
138	177	172	168	164	160	157
140	166	162	158	154	151	147
142	155	151	148	144	141	138
144	145	141	138	135	132	129
146	134	131	128	125	122	120
148	123	120	117	115	113	110
150	112	110	107	105	103	101
152	102	99	97	95	94	92
154	91	89	87	86	84	83
156	80	78	77	76	75	73
158	69	68	67	66	65	64
160	59	58	57	56	56	55
162	48	47	47	46	46	46
164	37	37	37	37	36	36
166	26	26	27	27	27	27
168	15	16	16	17	17	18

TABLE B-II. Vehicle projection limits outboard of X =±82 - wheelbase less than 257 inches - continued

Vehicle Height	Wheelbase Less Than 257 Inches					
	Ramp Hinge Height					
	64 Inches	66 Inches	68 Inches	70 Inches	72 Inches	74 Inches
	Maximum Load Projection					
50	782	742	706	674	644	617
52	768	729	694	662	633	606
54	754	716	681	650	622	596
56	740	703	669	638	610	585
58	727	690	657	626	599	574
60	713	677	644	615	588	563
62	699	664	632	603	577	553
64	685	651	619	591	565	542
66	672	638	607	579	554	531
68	658	625	595	568	543	520
70	644	612	582	556	532	510
72	630	599	570	544	520	499
74	617	586	558	532	509	488
76	603	573	545	520	498	477
78	589	559	533	509	487	467
80	575	546	520	497	475	456
82	562	533	508	485	464	445
84	548	520	496	473	453	434
86	534	507	483	461	442	424
88	520	494	471	450	430	413
90	507	481	459	438	419	402
92	493	468	446	426	408	391
94	479	455	434	414	397	380
96	465	442	421	403	385	370
98	452	429	409	391	374	359
100	438	416	397	379	363	348
102	424	403	384	367	352	337
104	410	390	372	355	340	327
106	397	377	360	344	329	316
108	383	364	347	332	318	305
110	369	351	335	320	307	294
112	355	338	322	308	295	284

TABLE B-II. Vehicle projection limits outboard of X =±82 - wheelbase less than 257 inches - continued

Vehicle Height	Wheelbase Less Than 257 Inches					
	Ramp Hinge Height					
	64 Inches	66 Inches	68 Inches	70 Inches	72 Inches	74 Inches
	Maximum Load Projection					
114	342	325	310	296	284	273
116	328	312	298	285	273	262
118	314	299	285	273	262	251
120	300	286	273	261	250	241
122	287	273	261	249	239	230
124	273	260	248	238	228	219
126	259	247	236	226	217	208
128	245	234	223	214	205	198
130	232	221	211	202	194	187
132	218	208	199	190	183	176
134	204	195	186	179	172	165
136	190	182	174	167	160	155
138	177	169	162	155	149	144
140	163	156	149	143	138	133
142	149	143	137	131	127	122
144	135	130	124	120	116	112
146	122	117	112	108	104	101
148	108	104	100	96	93	90
150	94	91	87	84	82	79
152	80	77	75	73	71	69
154	67	64	63	61	59	58
156	53	51	50	49	48	47
158	39	38	38	37	37	36
160	25	25	25	25	26	26
162	12	12	13	14	14	15

C-17 Vehicular Cargo

TABLE B-II. Vehicle projection limits outboard of X =±82 - wheelbase 257 to 339 inches - continued

Vehicle Height	Wheelbase 257 to 339 Inches					
	Ramp Hinge Height					
	64 Inches	66 Inches	68 Inches	70 Inches	72 Inches	74 Inches
	Maximum Load Projection					
50	529	512	497	483	470	457
52	519	504	489	475	462	449
54	510	495	480	467	454	442
56	501	486	472	458	446	434
58	492	477	463	450	438	426
60	483	468	455	442	430	418
62	474	460	446	433	422	410
64	465	451	438	425	414	403
66	456	442	429	417	405	395
68	446	433	420	409	397	387
70	437	424	412	400	389	379
72	428	415	403	392	381	371
74	419	407	395	384	373	364
76	410	398	386	375	365	356
78	401	389	378	367	357	348
80	392	380	369	359	349	340
82	383	371	361	351	341	332
84	373	362	352	342	333	325
86	364	354	344	334	325	317
88	355	345	335	326	317	309
90	346	336	326	317	309	301
92	337	327	318	309	301	293
94	328	318	309	301	293	286
96	319	309	301	293	285	278
98	310	301	292	284	277	270
100	300	292	284	276	269	262
102	291	283	275	268	261	254
104	282	274	267	260	253	247
106	273	265	258	251	245	239
108	264	256	249	243	237	231
110	255	248	241	235	229	223
112	246	239	232	226	221	215

Table B-II **Vehicle Projection Limits Outboard of X =±82 -Wheelbase 257 to 339 Inches**

C-17 Vehicular Cargo

TABLE B-II. Vehicle projection limits outboard of X =±82 - wheelbase 257 to 339 inches - continued

Vehicle Height	Wheelbase 257 to 339 Inches					
	Ramp Hinge Height					
	64 Inches	66 Inches	68 Inches	70 Inches	72 Inches	74 Inches
	Maximum Load Projection					
114	237	230	224	218	213	208
116	227	221	215	210	205	200
118	218	212	207	202	197	192
120	209	204	198	193	189	184
122	200	195	190	185	181	176
124	191	186	181	177	173	169
126	182	177	173	168	164	161
128	173	168	164	160	156	153
130	164	159	155	152	148	145
132	154	151	147	144	140	137
134	145	142	138	135	132	130
136	136	133	130	127	124	122
138	127	124	121	119	116	114
140	118	115	113	110	108	106
142	109	106	104	102	100	98
144	100	98	96	94	92	91
146	91	89	87	86	84	83
148	81	80	79	77	76	75
150	72	71	70	69	68	67
152	63	62	61	61	60	59
154	54	53	53	52	52	52
156	45	45	44	44	44	44
158	36	36	36	36	36	36
160	27	27	27	28	28	28
162	18	18	19	19	20	20

TABLE B-II. Vehicle projection limits outboard of X =±82 - wheelbase 340 inches + - continued

Vehicle Height	Wheelbase 340 Inches +					
	Ramp Hinge Height					
	64 Inches	66 Inches	68 Inches	70 Inches	72 Inches	74 Inches
	Maximum Load Projection					
50	617	599	581	565	550	535
52	606	588	571	555	540	526
54	596	578	561	545	531	517
56	585	567	551	536	521	507
58	574	557	541	526	512	498
60	563	547	531	516	502	489
62	553	536	521	506	493	480
64	542	526	511	496	483	470
66	531	515	501	487	474	461
68	520	505	490	477	464	452
70	510	495	480	467	455	443
72	499	484	470	457	445	433
74	488	474	460	447	435	424
76	477	463	450	438	426	415
78	467	453	440	428	416	406
80	456	442	430	418	407	396
82	445	432	420	408	397	387
84	434	422	410	398	388	378
86	424	411	400	389	378	369
88	413	401	390	379	369	359
90	402	390	379	369	359	350
92	391	380	369	359	350	341
94	381	370	359	349	340	332
96	370	359	349	340	331	322
98	359	349	339	330	321	313
100	348	338	329	320	312	304
102	338	328	319	310	302	295
104	327	317	309	301	293	285
106	316	307	299	291	283	276
108	305	297	289	281	274	267
110	295	286	278	271	264	258
112	284	276	268	261	255	248

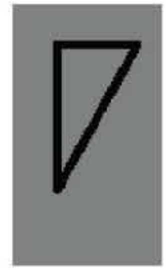


TABLE B-II. Vehicle projection limits outboard of X =±82 - wheelbase 340 inches + - continued

Vehicle Height	Wheelbase 340 Inches +					
	Ramp Hinge Height					
	64 Inches	66 Inches	68 Inches	70 Inches	72 Inches	74 Inches
	Maximum Load Projection					
114	273	265	258	252	245	239
116	262	255	248	242	236	230
118	252	245	238	232	226	221
120	241	234	228	222	217	211
122	230	224	218	212	207	202
124	219	213	208	203	198	193
126	208	203	198	193	188	184
128	198	192	188	183	179	174
130	187	182	177	173	169	165
132	176	172	167	163	160	156
134	165	161	157	154	150	147
136	155	151	147	144	141	138
138	144	140	137	134	131	128
140	133	130	127	124	122	119
142	122	120	117	114	112	110
144	112	109	107	105	102	101
146	101	99	97	95	93	91
148	90	88	87	85	83	82
150	79	78	76	75	74	73
152	69	67	66	65	64	64
154	58	57	56	56	55	54
156	47	47	46	46	45	45
158	36	36	36	36	36	36
160	26	26	26	26	26	27
162	15	15	16	16	17	17

C-17 Vehicular Cargo

Caution: The measurements indicated for each aircraft and referred to as "Critical Dimension", "Wheelbase", "Projection", and "Overhang" are not consistent between aircraft, nor even between different graph/table sets for each aircraft, particularly the "Critical Dimension"

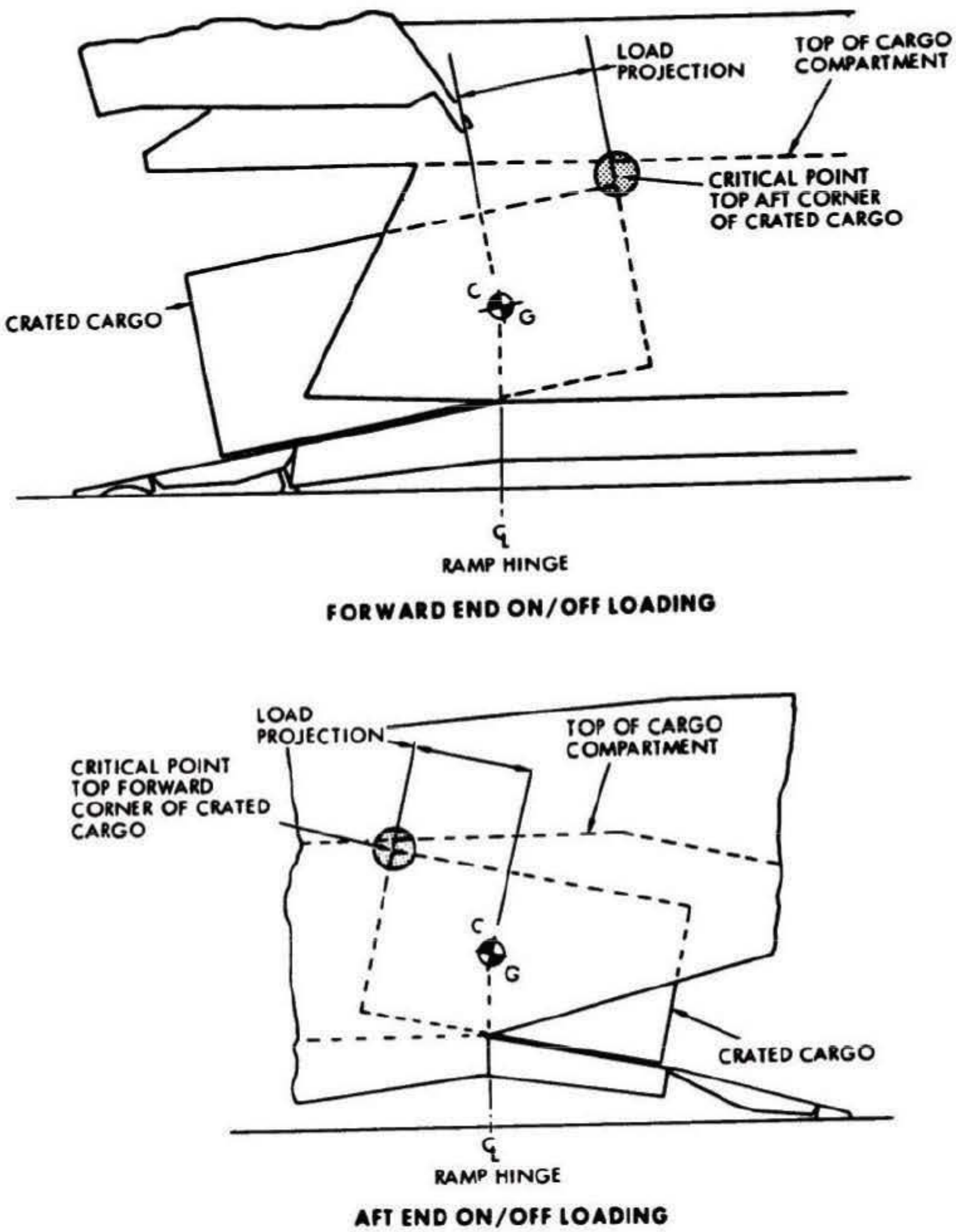
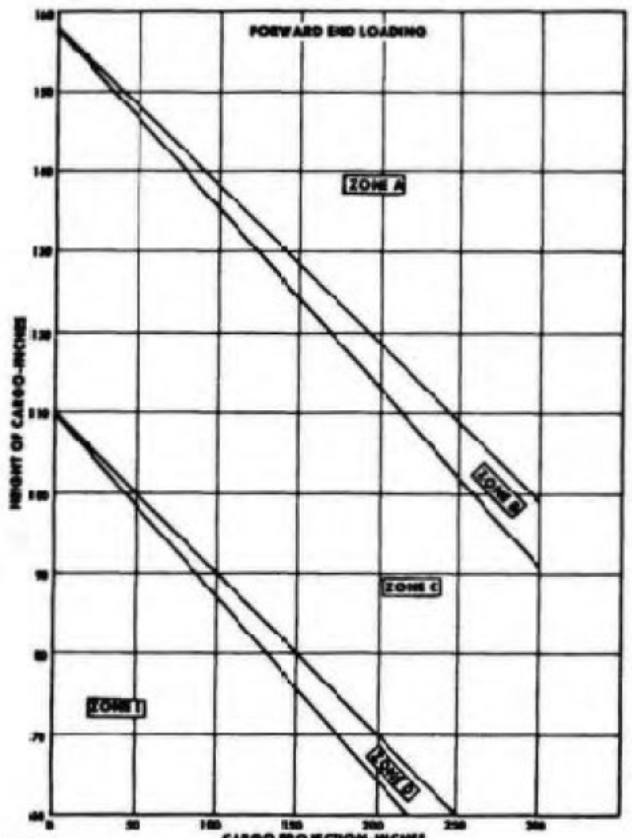


FIGURE B-9. Crated cargo projection limits (forward and aft end loading-palletized)

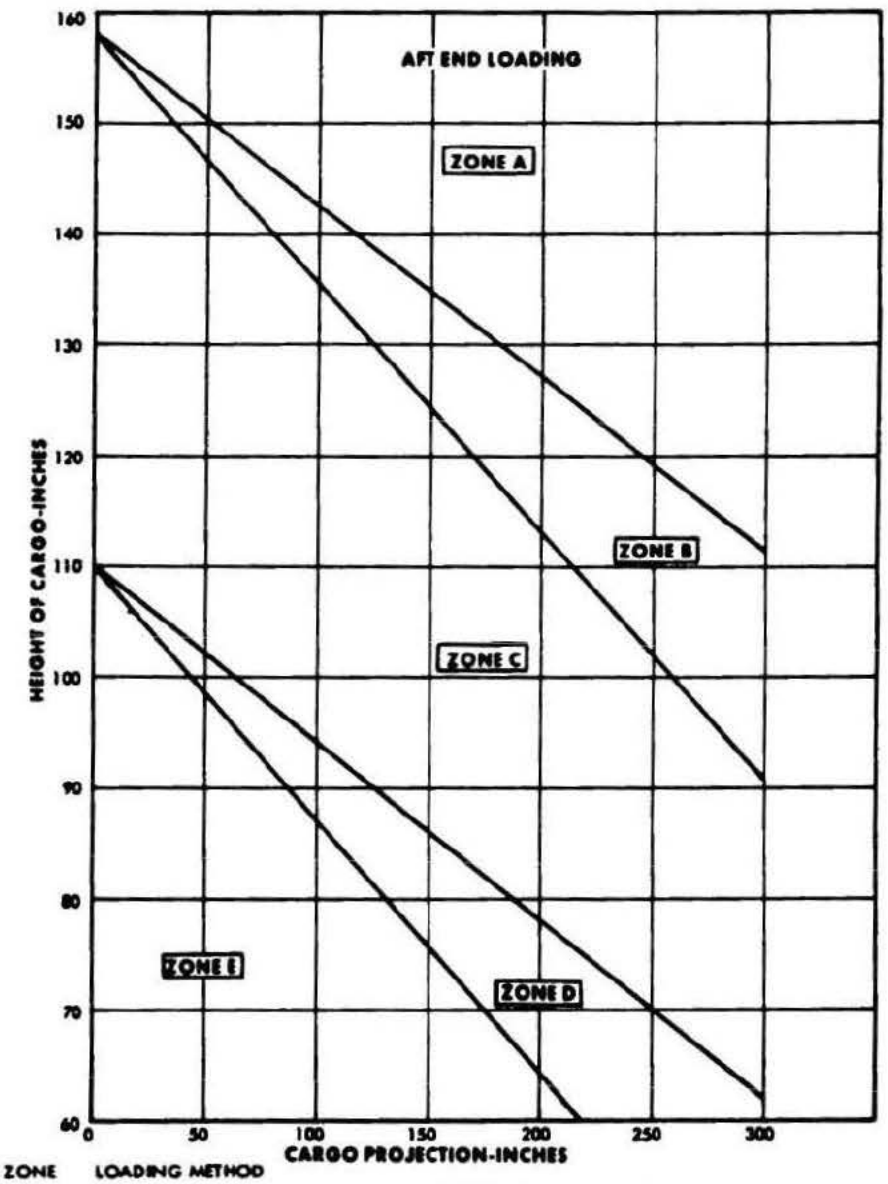
APPENDIX B



GRAPH ZONE	LOADING METHOD
ZONE A	LOAD WITH RAMP AND EXTENSION IN TRUCK LOADING POSITION OR, USING SPECIAL HANDLING PROCEDURES.
ZONE B	LOAD BETWEEN BL70 LEFT AND BL70 RIGHT WITH AIRPLANE FWD KNEELED.
ZONE C	LOAD BETWEEN BL70 LEFT AND BL70 RIGHT WITH AIRPLANE IN FWD OR LEVEL KNEELED POSITIC
ZONE D	LOAD AT ANY POINT ACROSS CARGO FLOOR BETWEEN BL114 LEFT AND BL114 RIGHT WITH AIRPLANE FWD KNEELED, OR BETWEEN BL 70 LEFT AND BL 70 RIGHT WITH AIRPLANE IN ANY KNEELED POSITION.
ZONE E	LOAD AT ANY POINT ACROSS CARGO FLOOR BETWEEN BL114 LEFT AND BL114 RIGHT WITH AIRPLANE IN FWD OR LEVEL KNEELED POSITION.

FIGURE B-10. Crated cargo projection limits (forward and aft end loading-palletized) - Continued

C-5



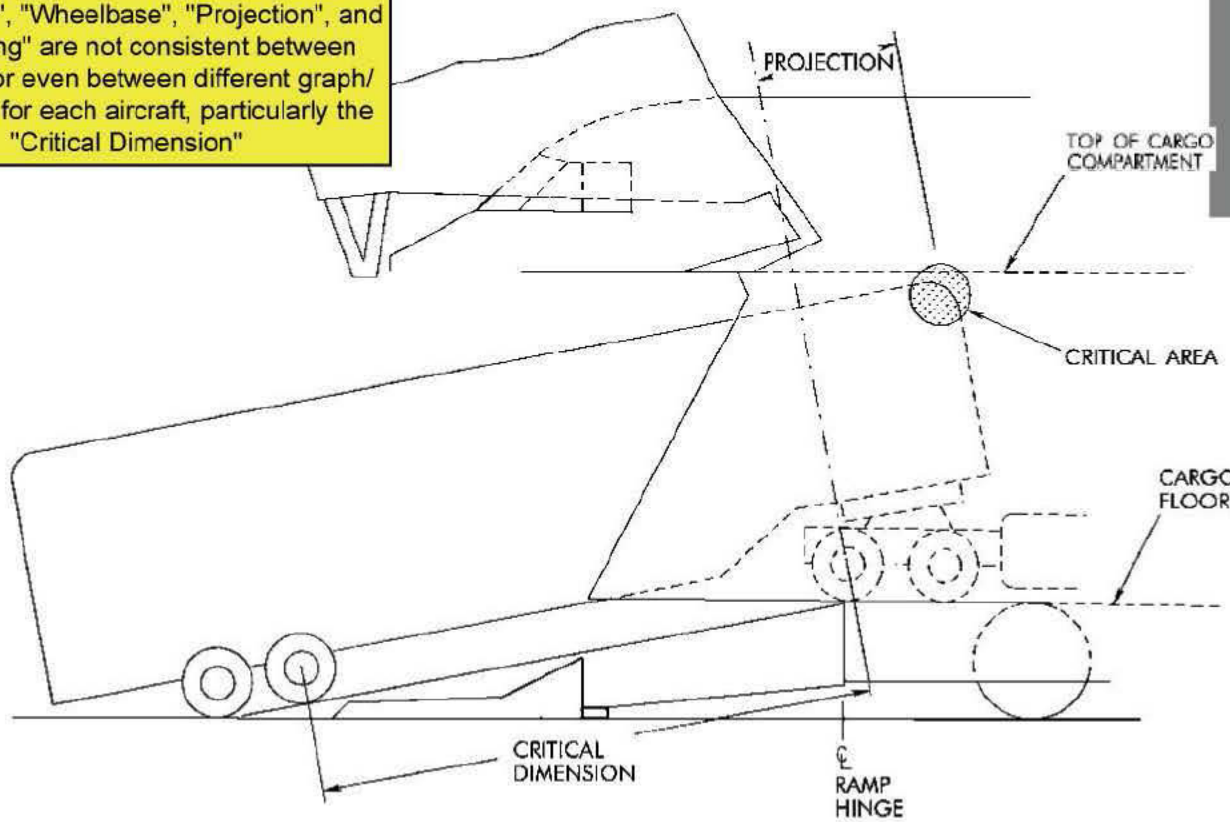
GRAPH ZONE	LOADING METHOD
ZONE A	LOADING WITH RAMP AND PRESSURE DOOR IN TRUCK LOADING POSITION, OR USING SPECIAL HANDLING PROCEDURES.
ZONE B	LOAD BETWEEN BL78 LEFT AND BL78 RIGHT WITH AIRPLANE AFT KNEELED.
ZONE C	LOAD BETWEEN BL78 LEFT AND BL78 RIGHT WITH AIRPLANE IN ANY KNEELED POSITION.
ZONE D	LOAD AT ANY POINT ACROSS CARGO FLOOR BETWEEN BL114 LEFT AND BL114 RIGHT WITH AIRPLANE AFT KNEELED, OR BETWEEN BL78 LEFT AND BL78 RIGHT WITH AIRPLANE IN ANY KNEELED POSITION.
ZONE E	LOAD AT ANY POINT ACROSS CARGO FLOOR BETWEEN BL114 LEFT AND BL114 RIGHT WITH AIRPLANE IN ANY KNEELED POSITION.

NOTE

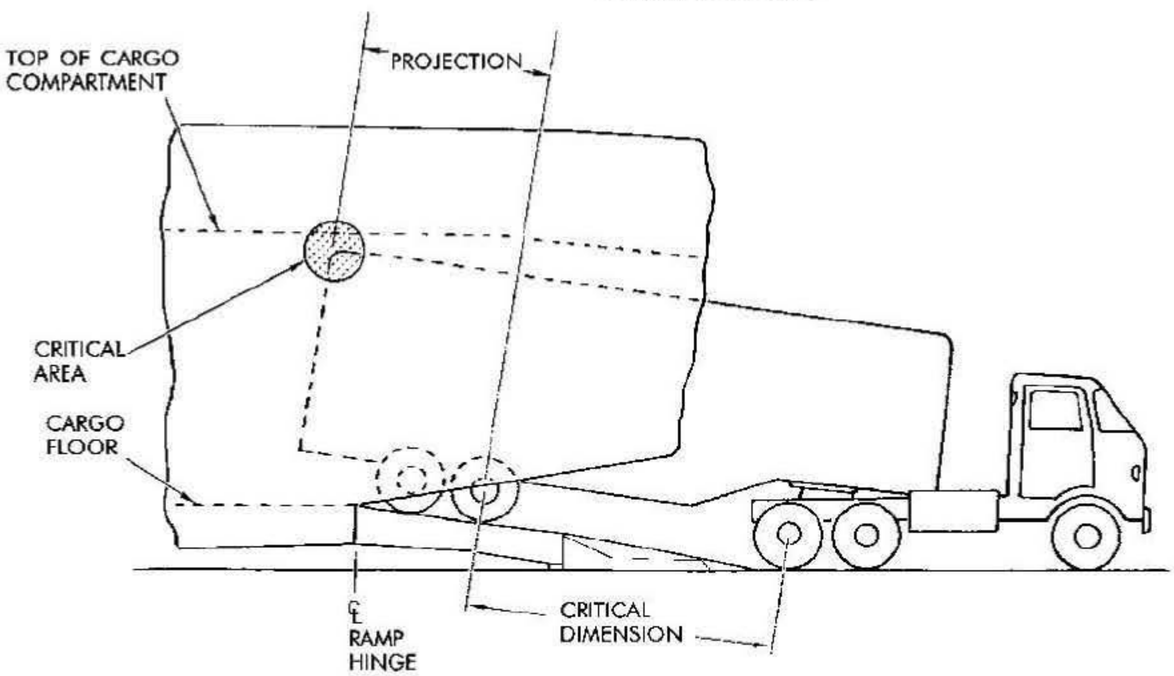
PRESSURE DOOR LIMITATIONS WHEN PRESSURE DOOR IS IN OVERHEAD POSITION.

FIGURE B-11. Crated cargo projection limits (forward and aft end loading-palletized) - Continued

Caution: The measurements indicated for each aircraft and referred to as "Critical Dimension", "Wheelbase", "Projection", and "Overhang" are not consistent between aircraft, nor even between different graph/ table sets for each aircraft, particularly the "Critical Dimension"



FORWARD LOADING



AFT LOADING

C5-9-4D-1-011-1

FIGURE B-12. Forward and aft end loading - vehicle projection limits (sheet 1 of 25)

CALCULATION PROCEDURE FOR ON/OFF LOADING OF VEHICLES

NOTE

1. SEE FIGURE 4-18 FOR VEHICLE DIMENSIONS AND CARGO FLOOR LOADING HEIGHTS THAT CAN AFFECT VEHICLE LOADING.
2. THE CALCULATION PROCEDURES ARE THE SAME REGARDLESS OF THE TYPE OF VEHICLE (SINGLE AXLE, BOGIE AXLE, OR TRACTOR TRAILER) THAT IS TO BE LOADED.
3. USE GRAPHS NO. 1 THROUGH NO. 4 AND NO. 11 FOR FORWARD END LOADING CALCULATIONS.
4. USE GRAPHS NO. 5 THROUGH NO. 10 AND NO. 12 FOR AFT END LOADING CALCULATIONS.

TO DETERMINE IF A VEHICLE CAN BE SAFELY ON/OFF LOADED, PROCEED AS FOLLOWS:

1. LOCATE VEHICLE KNOWN PROJECTION (P) ON LEFT SCALE OF GRAPH.
2. LOCATE VEHICLE KNOWN CRITICAL DIMENSION (C) ON BOTTOM SCALE OF GRAPH.
3. SIMULTANEOUSLY MOVE RIGHT ACROSS GRAPH FROM LEFT SCALE AND UP VERTICALLY ON GRAPH FROM BOTTOM SCALE TO THE INTERSECTION POINT FOR BOTH THESE KNOWN VALUES.
4. IF THE VEHICLE KNOWN HEIGHT (H) IS THE SAME AS OR LESS THAN THE CURVE (VEHICLE HEIGHT - INCHES) ON OR ABOVE THE INTERSECTION POINT (OBTAINED IN STEP 3), THE VEHICLE CAN BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY THE GRAPH.
5. IF THE VEHICLE KNOWN HEIGHT (H) IS GREATER THAN THE CURVE (VEHICLE HEIGHT - INCHES) ON OR ABOVE THE INTERSECTION POINT (OBTAINED IN STEP 3), THE VEHICLE CANNOT BE SAFELY LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED IN THE GRAPH AND MUST BE ON/OFF LOADED WITH THE VEHICLE IN THE TRUCK BED LOADING POSITION, IF POSSIBLE, OR USING SPECIAL ON/OFF LOADING PROCEDURES.

EXAMPLE PROBLEM NO. 1

DETERMINE IF A VEHICLE WITH A KNOWN PROJECTION OF 115 INCHES, A KNOWN CRITICAL DIMENSION OF 370 INCHES, AND A KNOWN HEIGHT OF 136 INCHES CAN BE SAFELY ON/OFF LOADED.

1. LOCATE THE VEHICLE KNOWN PROJECTION OF 115 INCHES ON THE LEFT SCALE OF GRAPH.
2. LOCATE THE VEHICLE KNOWN CRITICAL DIMENSION OF 370 INCHES ON THE BOTTOM SCALE OF GRAPH.
3. SIMULTANEOUSLY MOVE RIGHT ACROSS GRAPH FROM LEFT SCALE AND UPWARD ON GRAPH FROM BOTTOM SCALE TO THE INTERSECTION POINT FOR BOTH THESE VALUES.
4. THE INTERSECTION POINT (OBTAINED IN STEP3) INDICATES THAT THE EXAMPLE VEHICLE CAN BE SAFELY ON/OFF LOADED AS FOLLOWS:

GRAPH NO. 1 THE KNOWN VEHICLE HEIGHT OF 136 INCHES IS LESS THAN THE MAXIMUM ALLOWABLE VEHICLE HEGHT OF 146 INCHES AS INDICATED BY THE 146-INCH CURVE LOCATED ABOVE THE INTERSECTION POINT (OBTAINED IN STEP 3). THE VHEICLE CAN BE SAFELY ON/OFF LOADED IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 1.

GRAPH NO. 2 THE KNOWN VEHICLE HEIGHT OF 136 INCHES IS LESS THAN THE MAXIMUM ALLOWABLE VEHICLE HEGHT OF 142 INCHES AS INDICATED BY THE 142-INCH CURVE LOCATED ABOVE THE INTERSECTION POINT (OBTINED IN STEP 3). THE VEHICLE CAN BE SAFELY ON/OFF LOADED IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 2.

GRAPH NO. 3 THE KNOWN VEHICLE HEIGHT OF 136 INCHES IS GREATER THAN THE MAXIMUM ALLOWABLE VEHICLE HEGHT OF 98 INCHES AS INDICATED BY THE 98-INCH CURVE LOCATED ABOVE THE INTERSECTION POINT (OBTAINED IN STEP 3). THE VEHICLE CANNOT BE SAFELY ON/OFF LOADED IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 3.

FIGURE B-13. Forward and aft end loading - vehicle projection limits (sheet 2)

GRAPH NO. 4 THE KNOWN VEHICLE HEIGHT OF 136 INCHES IS GREATER THAN THE MAXIMUM ALLOWABLE VEHICLE HEIGHT OF 94 INCHES AS INDICATED BY THE 94-INCH CURVE LOCATED ON THE INTERSECTION POINT (OBTAINRD IN STEP 3). THE VEHICLE CANNOT BE SAFELY ON/OFF LOADED IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 4.

GRAPH NO. 5 THE KNOWN VEHICLE HEIGHT OF 136 INCHES IS EQUAL TO THE MAXIMUM ALLOWABLE VEHICLE HEIGHT OF 136 INCHES AS INDICATED BY THE 136-INCH CURVE LOCATED ON THE INTERSECTION POINT (OBTAINRD IN STEP 3). THE VEHICLE CAN BE SAFELY ON/OFF LOADED IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 5.

GRAPH NO. 6 THE KNOWN VEHICLE HEIGHT OF 136 INCHES IS LESS THAN THE MAXIMUM ALLOWABLE VEHICLE HEIGHT OF 140 INCHES AS INDICATED BY THE 140-INCH CURVE LOCATED ABOVE THE INTERSECTION POINT (OBTAINRD IN STEP 3). THE VEHICLE CAN BE SAFELY ON/OFF LOADED IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 6.

GRAPH NO. 7 THE KNOWN VEHICLE HEIGHT OF 136 INCHES IS LESS THAN THE MAXIMUM ALLOWABLE VEHICLE HEIGHT OF 140 INCHES AS INDICATED BY THE 140-INCH CURVE LOCATED ABOVE THE INTERSECTION POINT (OBTAINRD IN STEP 3). THE VEHICLE CAN BE SAFELY ON/OFF LOADED IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 7.

GRAPH NO. 8 THE KNOWN VEHICLE HEIGHT OF 136 INCHES IS GREATER THAN THE MAXIMUM ALLOWABLE VEHICLE HEIGHT OF 86 INCHES AS INDICATED BY THE 86-INCH CURVE LOCATED ON THE INTERSECTION POINT (OBTAINRD IN STEP 3). THE VEHICLE CANNOT BE SAFELY ON/OFF LOADED IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 8.

GRAPH NO. 9 THE KNOWN VEHICLE HEIGHT OF 136 INCHES IS GREATER THAN THE MAXIMUM ALLOWABLE VEHICLE HEIGHT OF 90 INCHES AS INDICATED BY THE 90-INCH CURVE LOCATED ABOVE THE INTERSECTION POINT (OBTAINRD IN STEP 3). THE VEHICLE CANNOT BE SAFELY ON/OFF LOADED IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 9.

GRAPH NO. 10 THE KNOWN VEHICLE HEIGHT OF 136 INCHES IS GREATER THAN THE MAXIMUM ALLOWABLE VEHICLE HEIGHT OF 98 INCHES AS INDICATED BY THE 98-INCH CURVE LOCATED ABOVE THE INTERSECTION POINT (OBTAINRD IN STEP 3). THE VEHICLE CANNOT BE SAFELY ON/OFF LOADED IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 10.

EXAMPLE PROBLEM NO. 2

DETERMINE IF A VEHICLE WITH A KNOWN PROJECTION OF 152 INCHES, A KNOWN CRITICAL DIMENSION OF 490 INCHES, AND A KNOWN HEIGHT OF 132 INCHES CAN BE SAFELY ON/OFF LOADED.

1. LOCATE VEHICLE KNOWN PROJECTION OF 152 INCHES ON THE LEFT SCALE OF GRAPH.
2. LOCATE THE VEHICLE KNOWN CRITICAL DIMENSION OF 490 INCHES ON BOTTOM SCALE OF GRAPH.
3. SIMULTANEOUSLY MOVE RIGHT ACROSS GRAPH FROM LEFT SCALE AND UPWARD ON GRAPH FROM BOTTOM SCALE TO THE INTERSECTION POINT FOR BOTH THESE KNOWN VALUES.
4. THE INTERSECTION POINT (OBTAINED IN STEP 3) INDICATES THAT THE EXAMPLE VEHICLE CAN BE SAFELY ON/OFF LOADED IN THE CONFIGURATIONS REPRESENTED BY THE FOLLOWING GRAPHS:

   GRAPH NO. 1, GRAPH NO. 2, GRAPH NO. 5, GRAPH NO. 6, AND GRAPH NO. 7.
5. THE INTERSECTION POINT (OBTAINED IN STEP 3) INDICATES THAT THE EXAMPLE VEHICLE CANNOT BE SAFELY ON/OFF LOADED IN THE CONFIGURATIONS REPRESENTED BY THE FOLLOWING GRAPHS:

   GRAPH NO. 3, GRAPH NO. 4, GRAPH NO. 8, GRAPH NO. 9, AND GRAPH NO. 10.

FIGURE B-13. Forward and Aft End Loading -- Vehicle Projection Limits (sheet 3) - Continued

VEHICLE PROJECTION LIMITS - CRITICAL DIMENSION LESS THAN 275 INCHES

NOTE

IF THE VEHICLE KNOWN HEIGHT IS GREATER THAN 112 INCHES AND THE CRITICAL DIMENSION IS GREATER THAN 275 INCHES, SEE GRAPHS 1 THROUGH 4.

GRAPH ZONE

- A LOAD WITH RAMP AND EXTENSION IN TRUCK LOADING POSITION OR, USE SPECIAL HANDLING PROCEDURES.
- B LOAD BETWEEN BL 78 LEFT AND BL 78 RIGHT WITH AIRPLANE FORWARD KNEELED.
- C LOAD BETWEEN BL 78 LEFT AND BL 78 RIGHT WITH AIRPLANE FORWARD OR LEVEL KNEELED.
- D LOAD AT ANY POINT ACROSS CARGO FLOOR BETWEEN BL 114 LEFT AND BL 114 RIGHT WITH AIRPLANE FORWARD KNEELED, OR BETWEEN BL 78 LEFT AND BL 78 RIGHT WITH AIRPLANE IN ANY KNEELED POSITION.
- E LOAD AT ANY POINT ACROSS CARGO FLOOR BETWEEN BL 114 LEFT AND BL 114 RIGHT WITH AIRPLANE FORWARD OR LEVEL KNEELED.

GRAPH NO.11 FORWARD RAMP

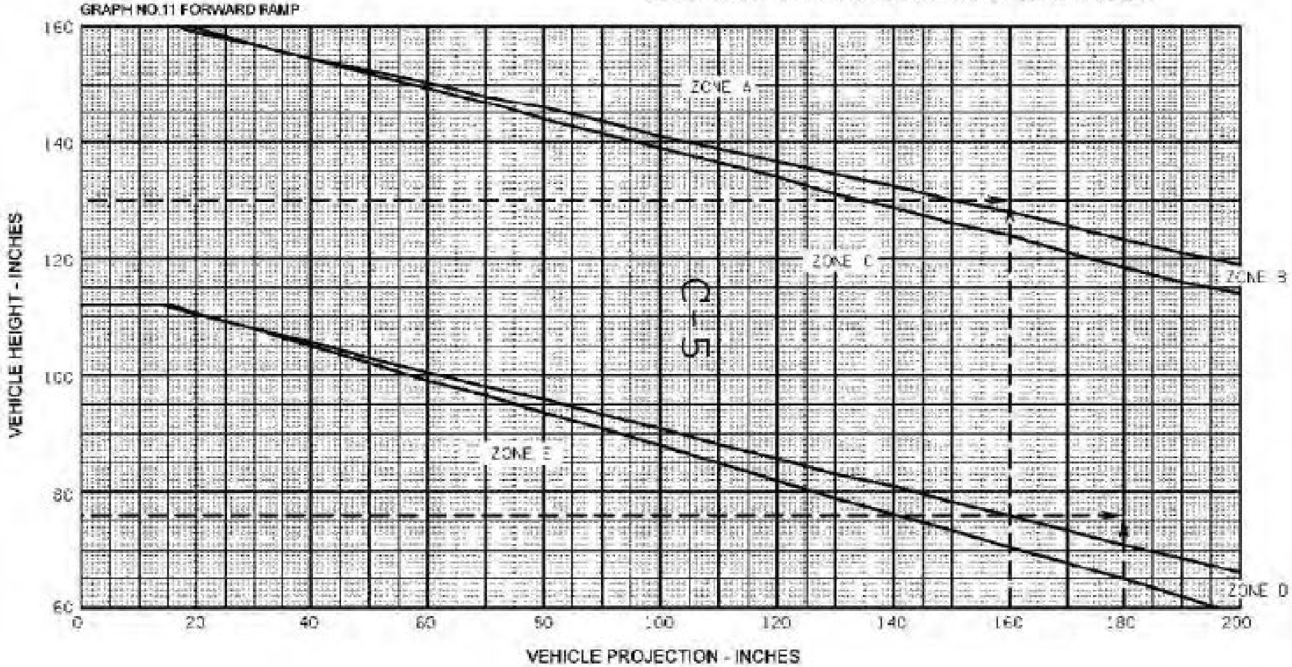


FIGURE 14. Forward and aft end loading - vehicle projection limits (sheet 4)

C-5

VEHICLE PROJECTION LIMITS - CRITICAL DIMENSION LESS THAN 320 INCHES

NOTE

IF THE VEHICLE KNOWN HEIGHT IS GREATER THAN 112 INCHES AND THE CRITICAL DIMENSION IS GREATER THAN 320 INCHES, SEE GRAPHS 5 THROUGH 10.

GRAPH ZONE

- A LOAD USING SPECIAL HANDLING PROCEDURES.
- B LOAD BETWEEN BL 78 LEFT AND BL 78 RIGHT WITH AIRPLANE AFT KNEELED.
- C LOAD BETWEEN BL 78 LEFT AND BL 78 RIGHT WITH AIRPLANE FORWARD OR LEVEL KNEELED.
- D LOAD BETWEEN BL 78 LEFT AND BL 78 RIGHT WITH AIRPLANE IN ANY KNEELED POSITION.
- E LOAD AT ANY POINT ACROSS CARGO FLOOR BETWEEN BL 114 LEFT AND BL 114 RIGHT WITH AIRPLANE AFT KNEELED, OR BETWEEN BL 78 LEFT AND BL 78 RIGHT WITH AIRPLANE IN ANY KNEELED POSITION.
- F LOAD ANY POINT ACROSS CARGO FLOOR BETWEEN BL 114 LEFT AND BL 114 RIGHT WITH AIRPLANE IN ANY KNEELED POSITION.

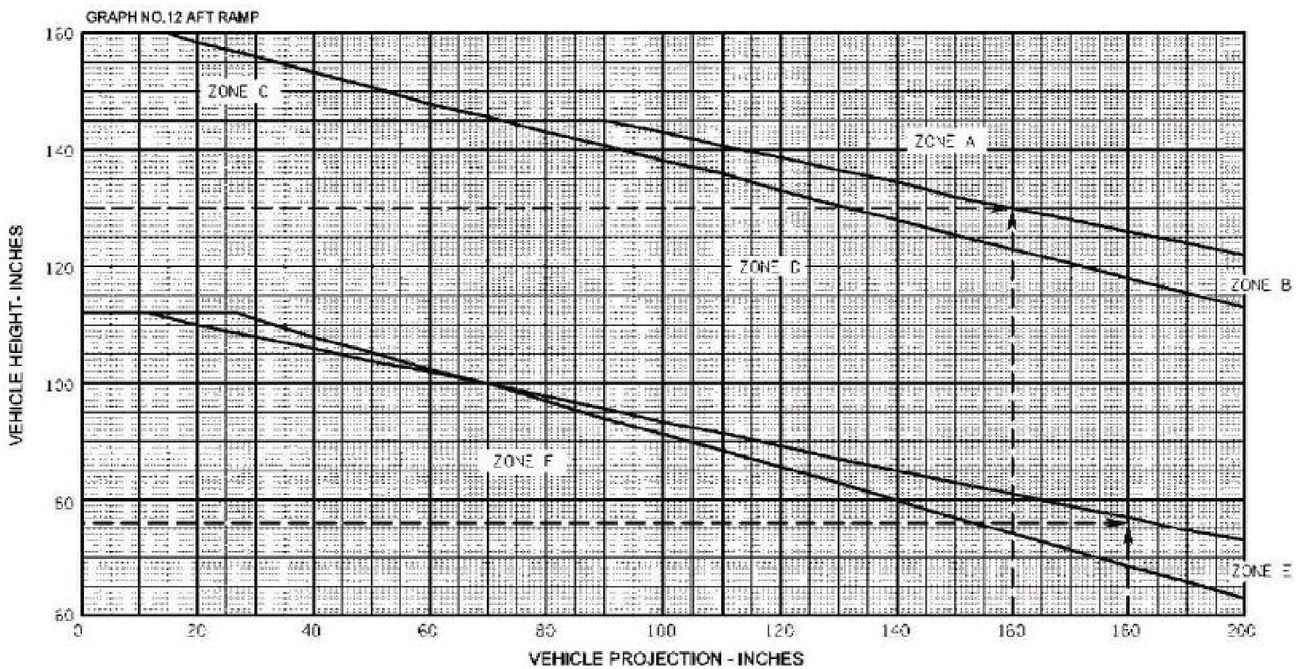


FIGURE B-15. Forward and aft end loading - vehicle projection limits (sheet 5)

Caution: The measurements indicated for each aircraft and referred to as "Critical Dimension", "Wheelbase", "Projection", and "Overhang" are not consistent between aircraft, nor even between different graph/table sets for each aircraft, particularly the "Critical Dimension"

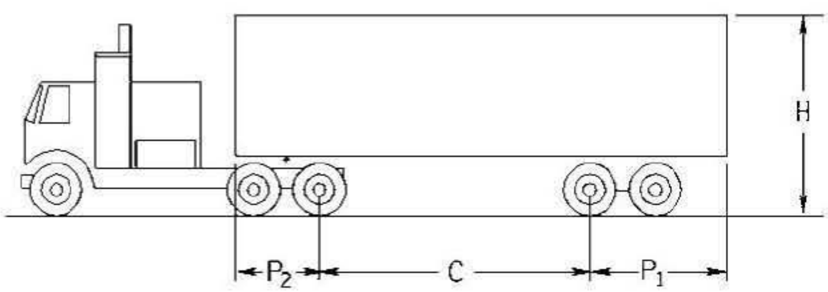
VEHICLE MEASUREMENTS PERTINENT TO THE C-5 PROJECTION LIMIT CHARTS

CAUTION

DO NOT LOAD THE VEHICLE THROUGH THE AIRPLANE FORWARD END WITH THE AIRPLANE FORWARD KNEELED IF THE LIMITS IN THE GRAPH ARE EXCEEDED.

NOTE

1. IF THE VEHICLE KNOWN HEIGHT IS GREATER THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE VEHICLE CANNOT BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY THE GRAPH
2. IF THE VEHICLE KNOWN HEIGHT IS THE SAME OR LESS THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE VEHICLE CAN BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY THE GRAPH
3. SEE THE CALCULATION PROCEDURES AND EXAMPLE PROBLEMS IN THIS FIGURE FOR EXPLANATION ON THE USE OF THE GRAPH



C = CRITICAL DIMENSION
H = HEIGHT
P = PROJECTION

FIGURE B-16. Forward and aft end loading - vehicle projectio

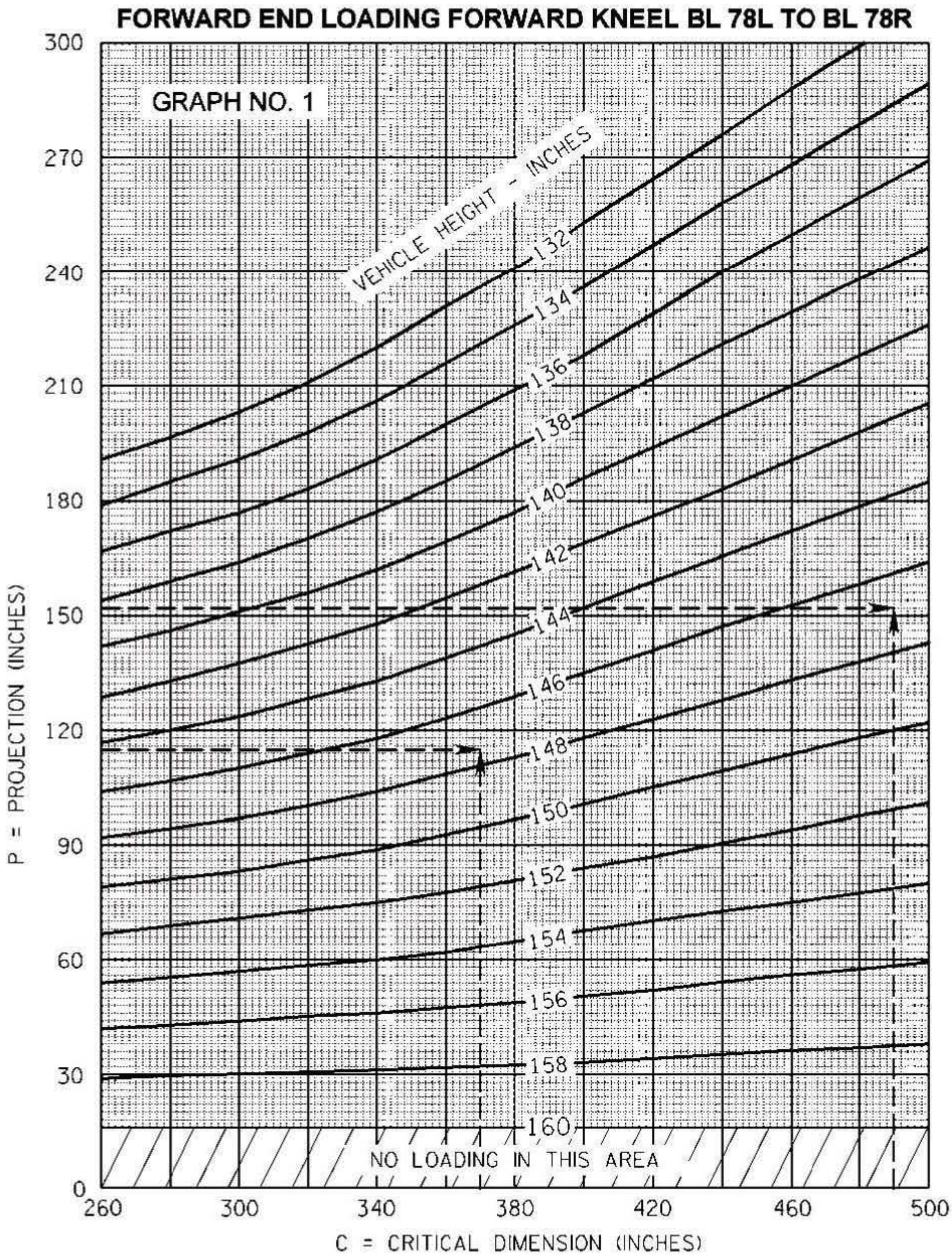


FIGURE B-17. Forward and aft end loading - vehicle projection limits

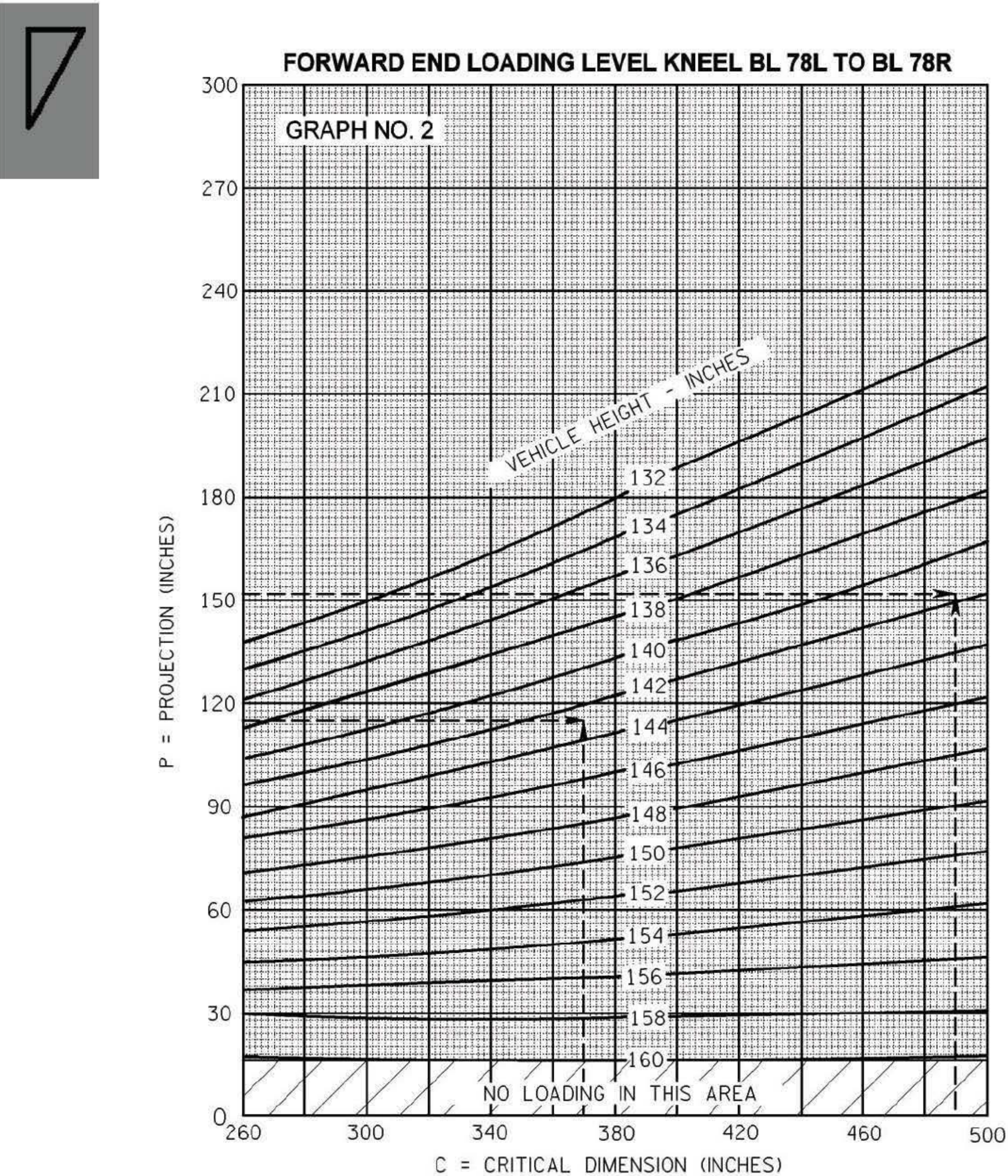


FIGURE B-18. Forward and aft end loading - vehicle projection limits . C-5

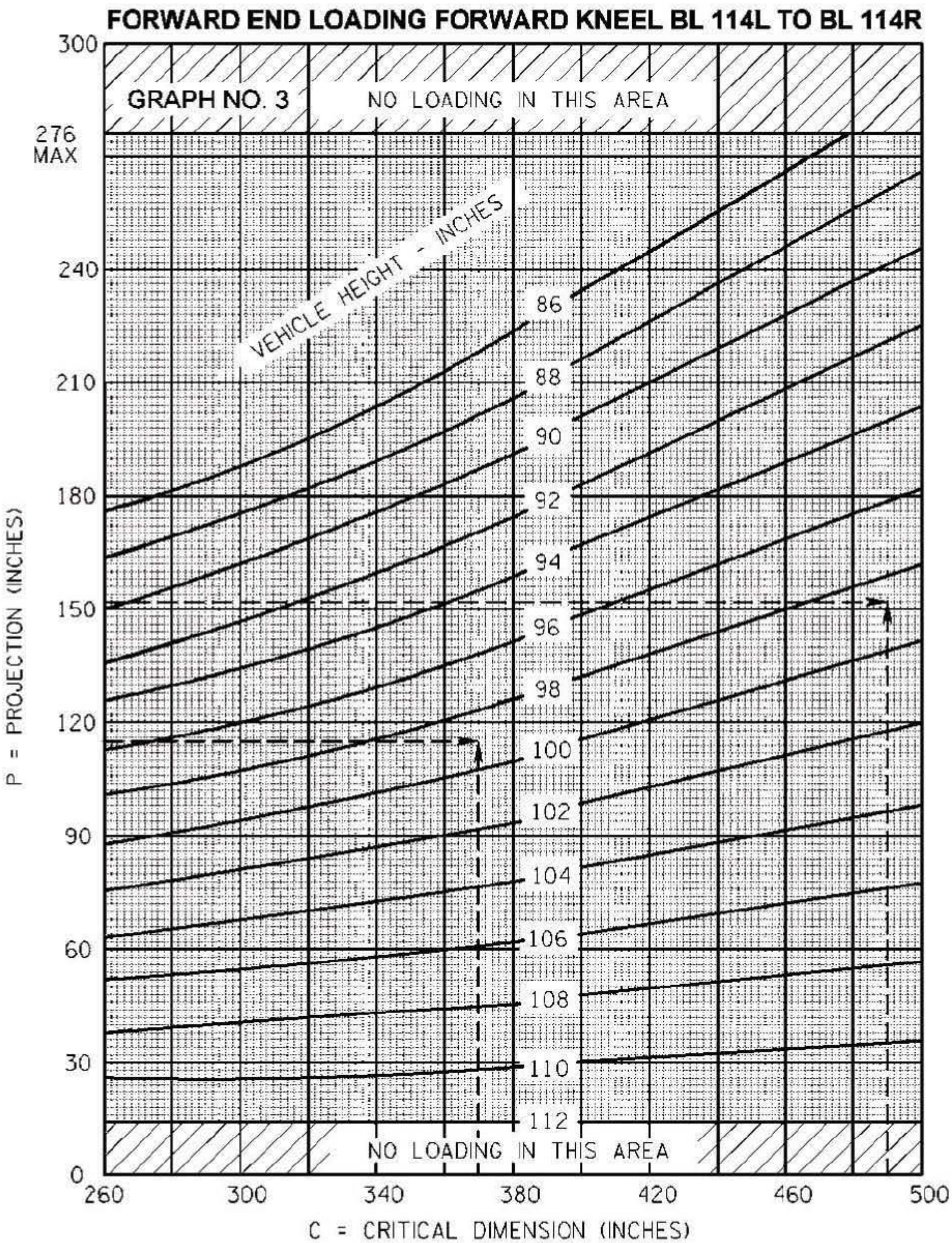


FIGURE B-19. Forward and aft end loading - vehicle projection limits C-5

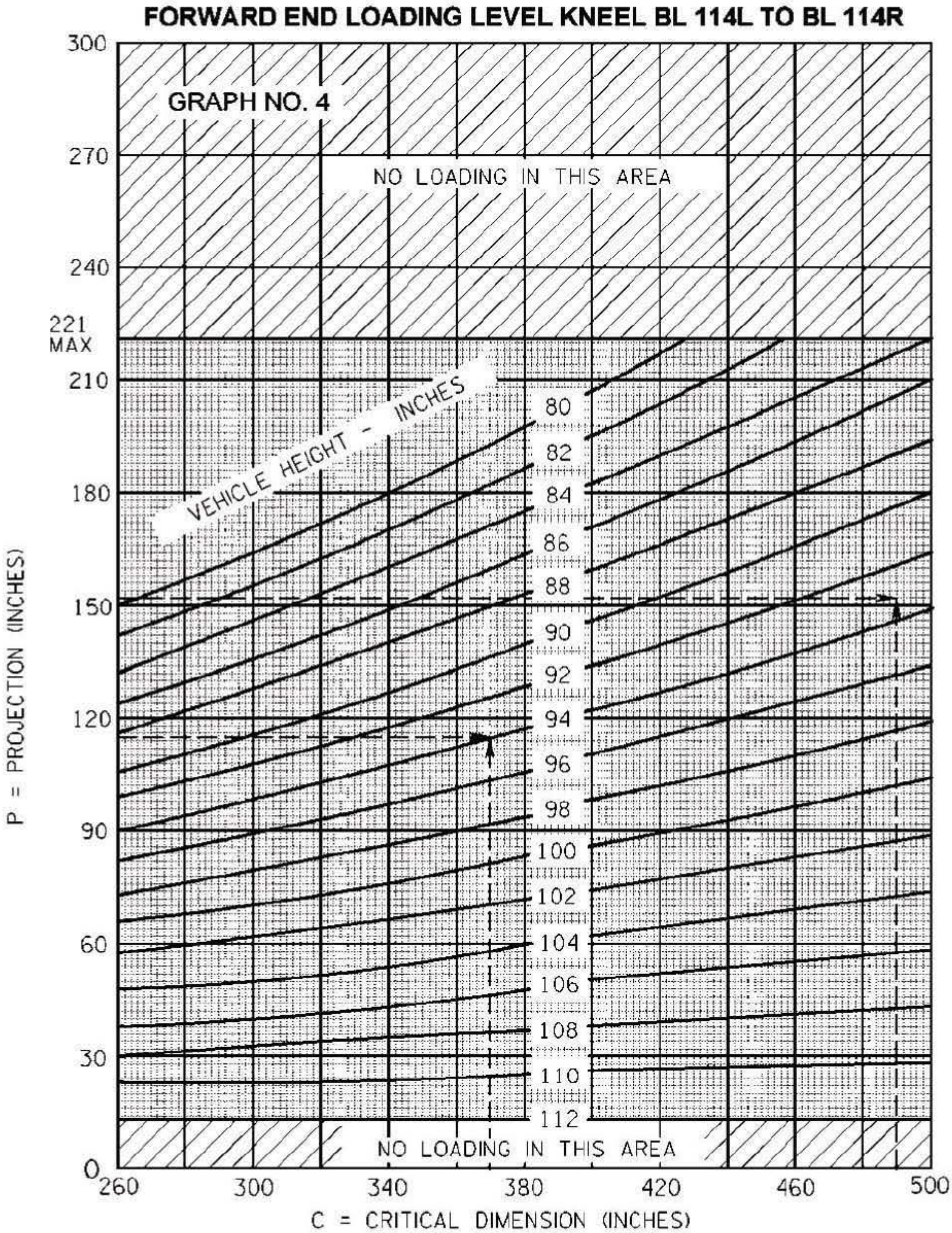


FIGURE B-20. Forward and aft end loading - vehicle projection limits C-5

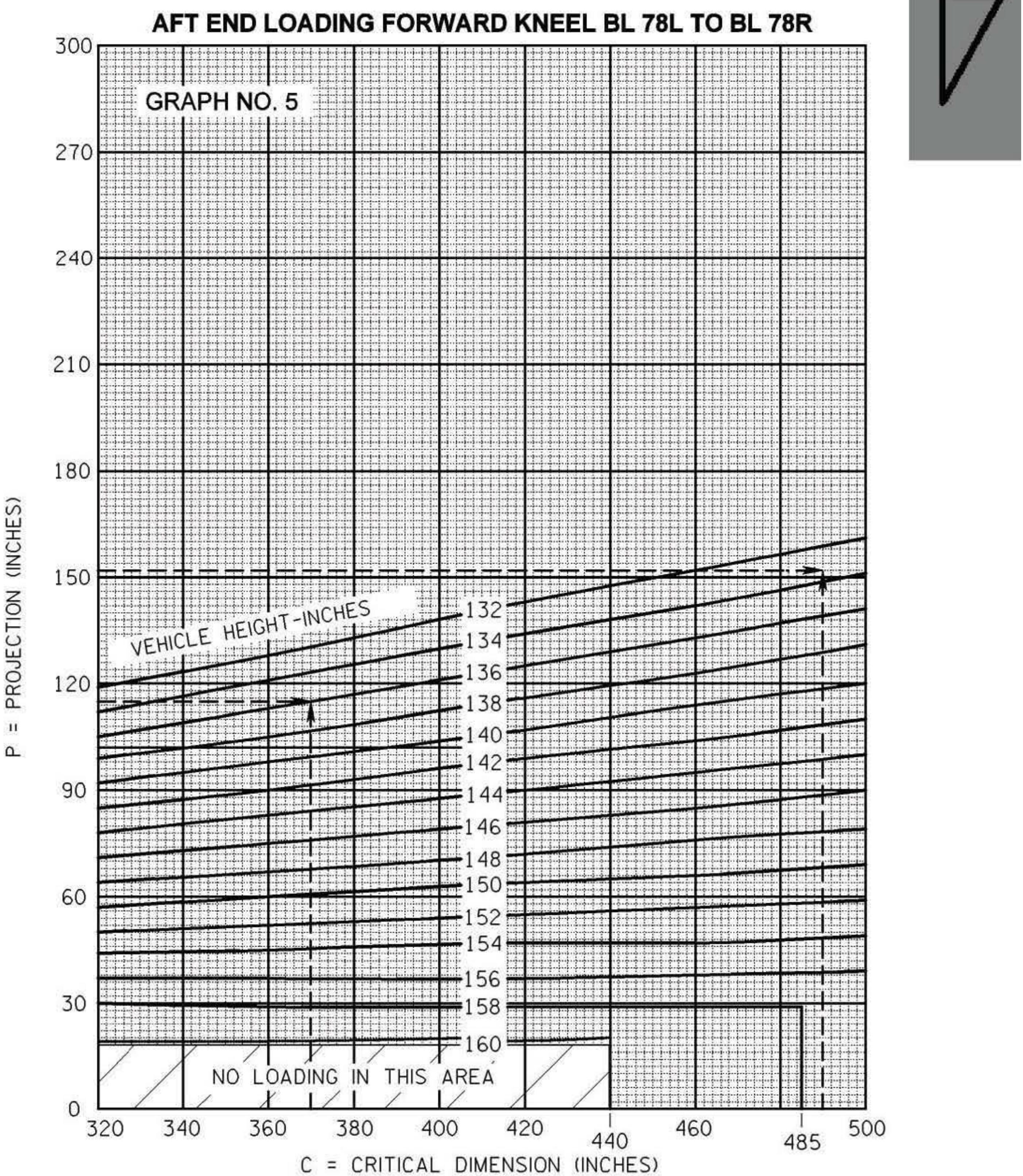


FIGURE B-21. Forward and aft end loading - vehicle projection limits C-5

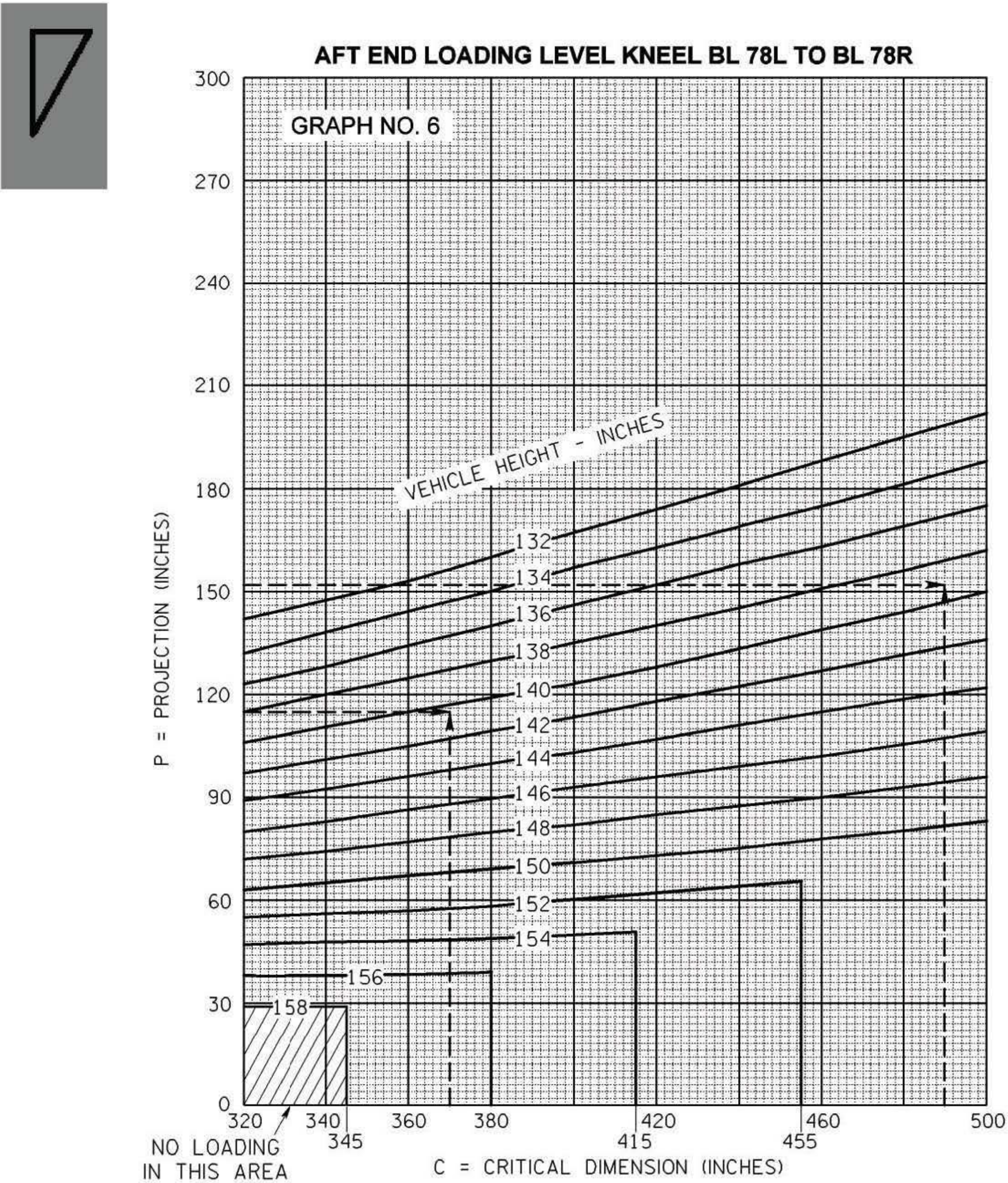


FIGURE B-22. Forward and aft end loading - vehicle projection limits

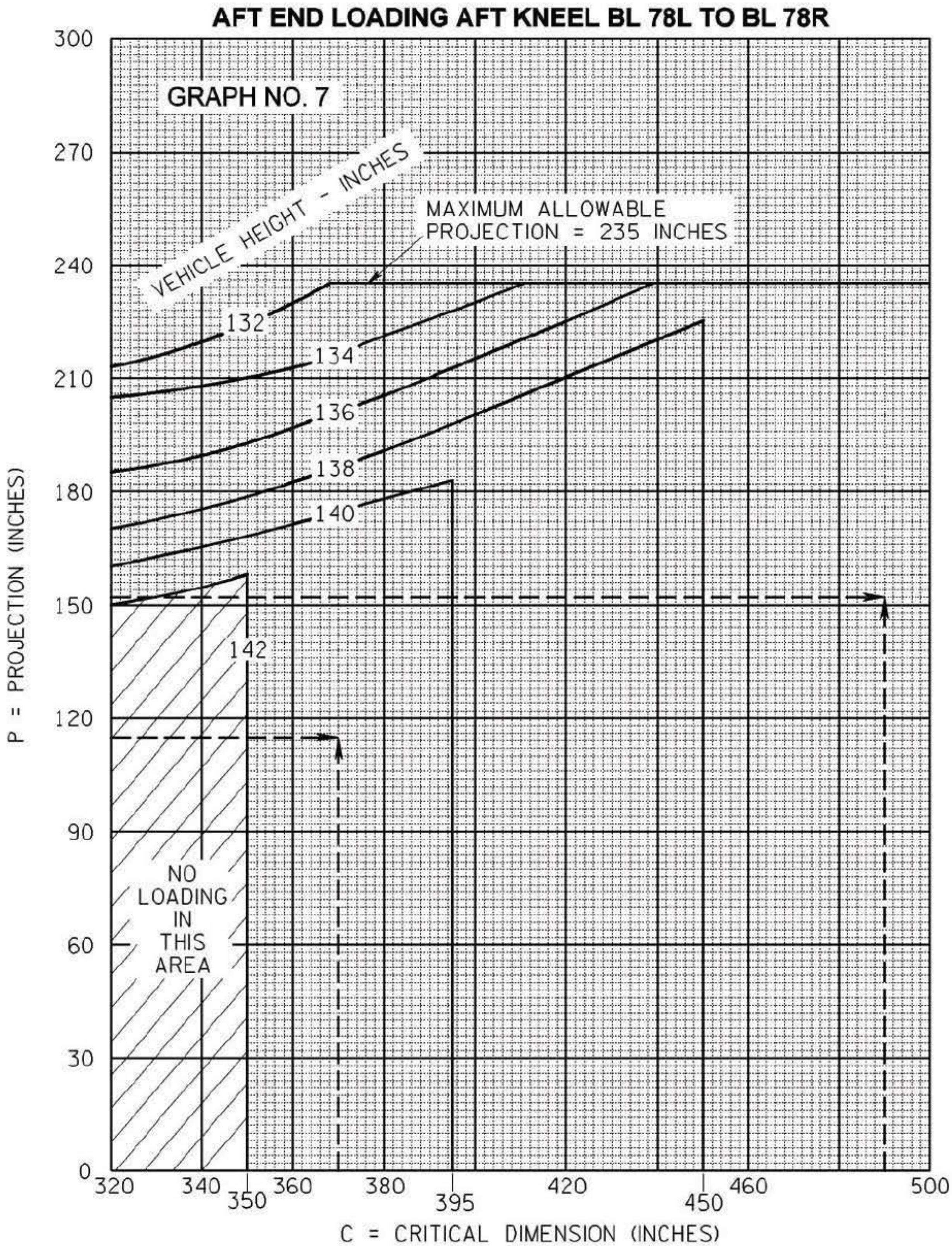


FIGURE B-23. Forward and aft end loading - vehicle projection limits

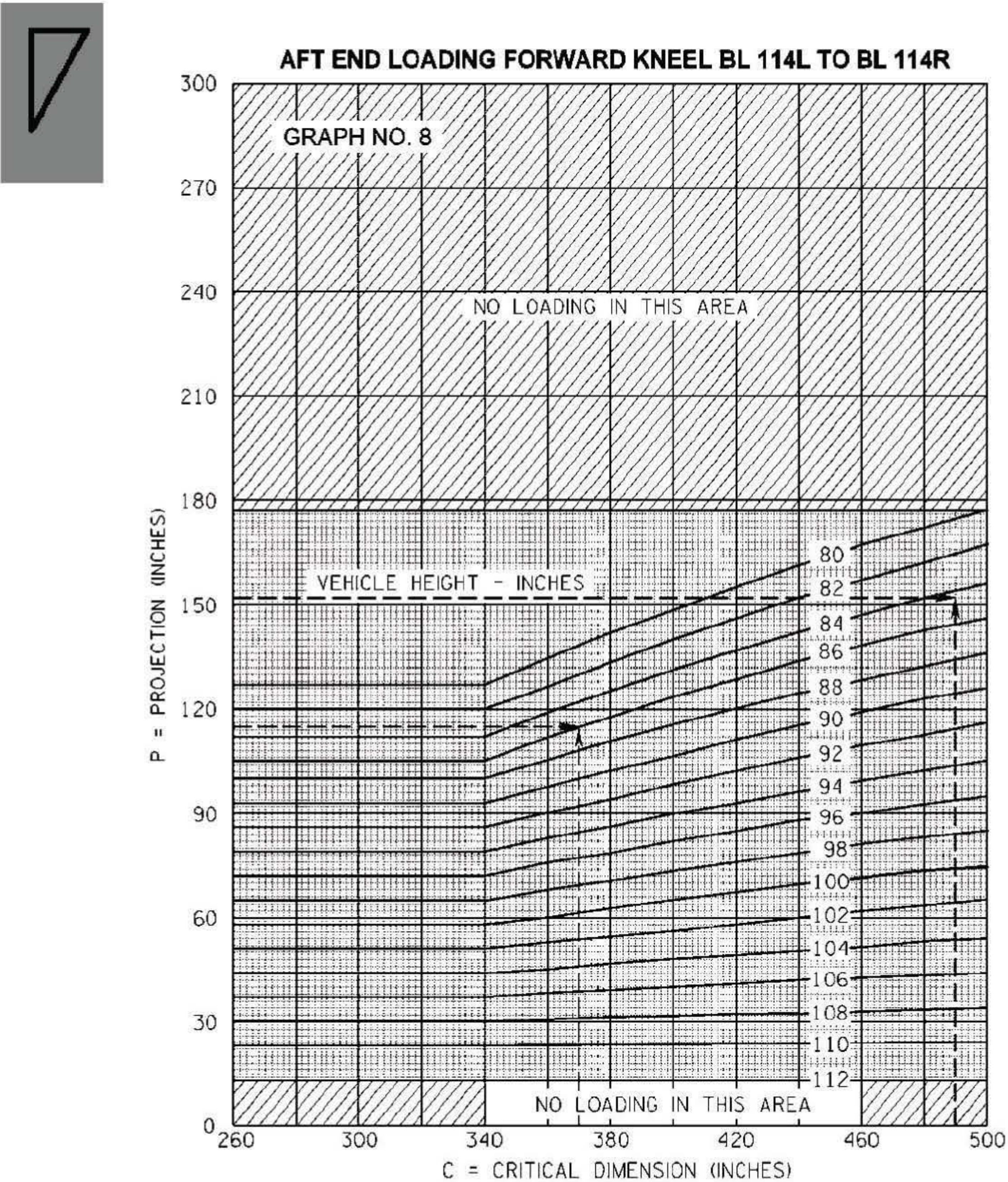


FIGURE B-24. Forward and aft end loading - vehicle projection limits

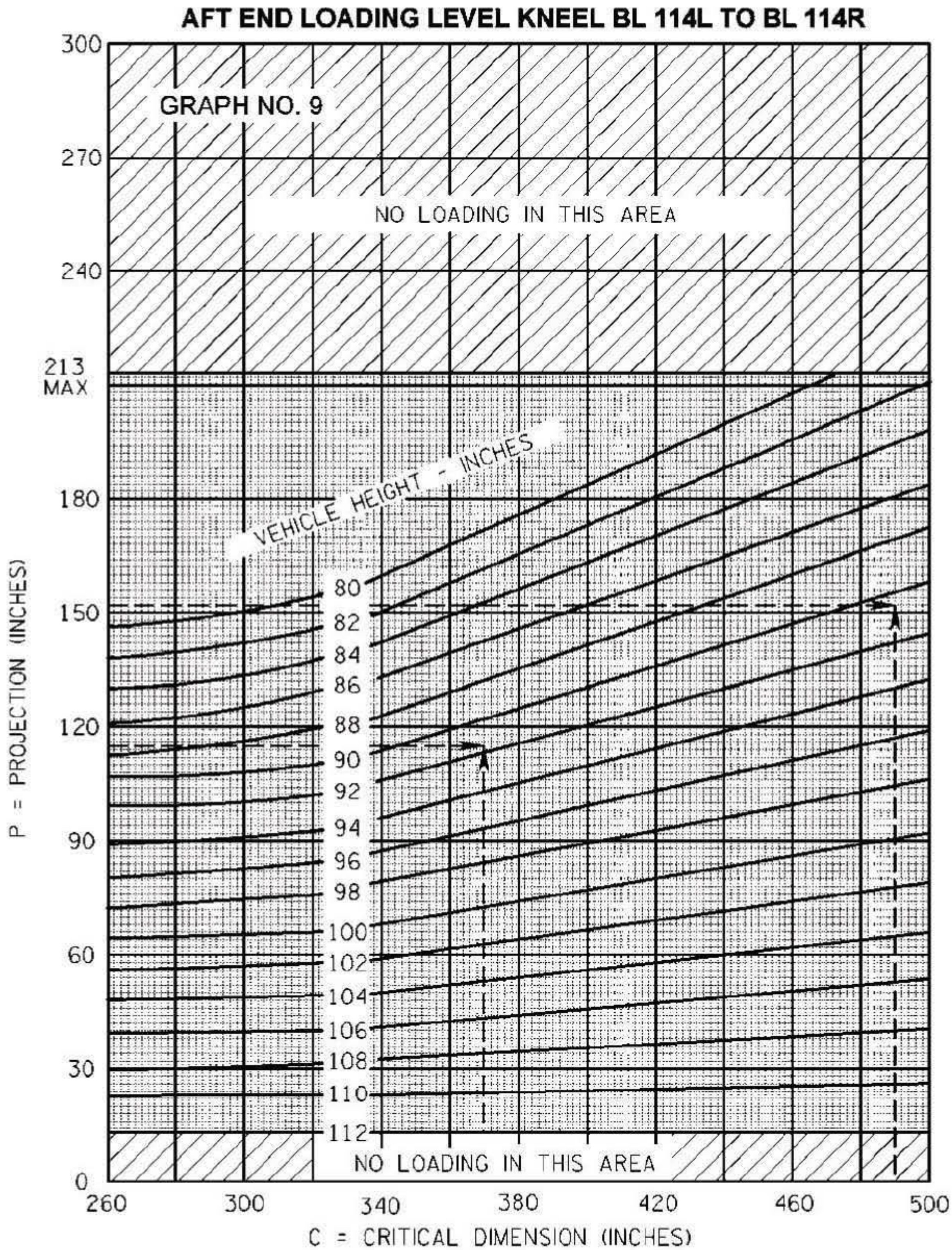


FIGURE B-25. Forward and aft End loading - vehicle projection limits C-5

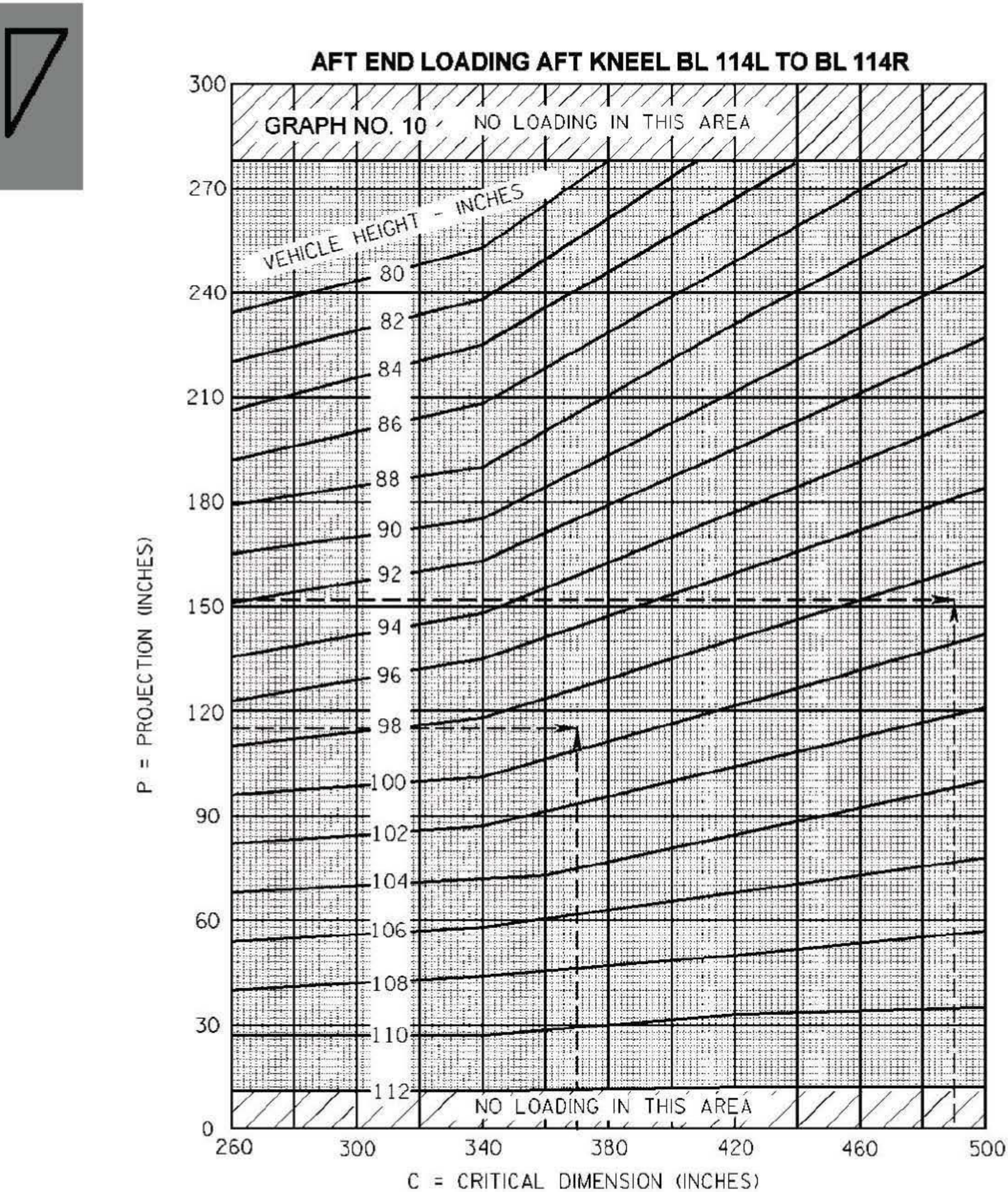


FIGURE B-26. Forward and aft end loading - vehicle projection limits C-5

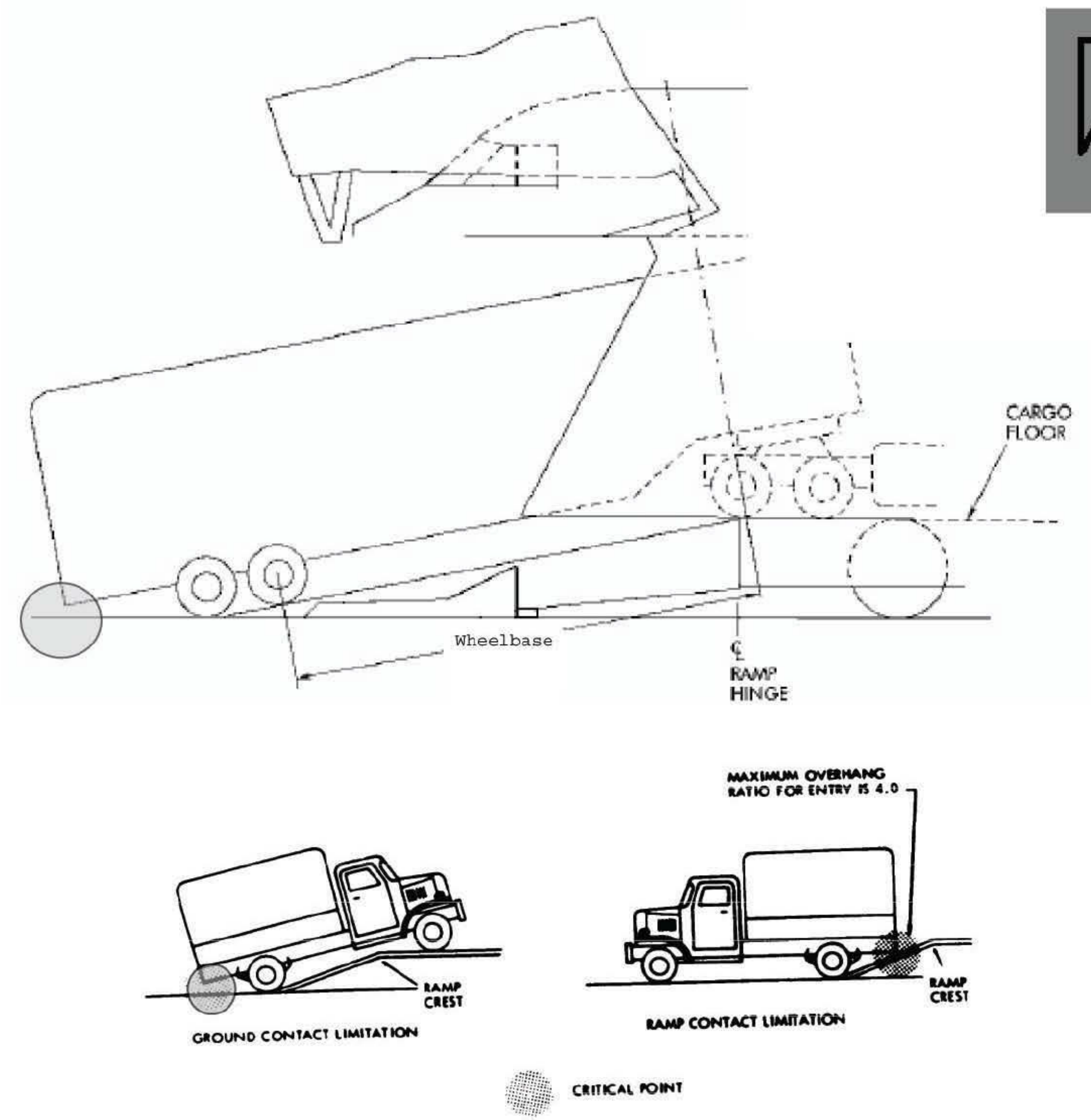
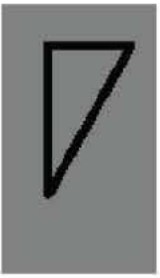
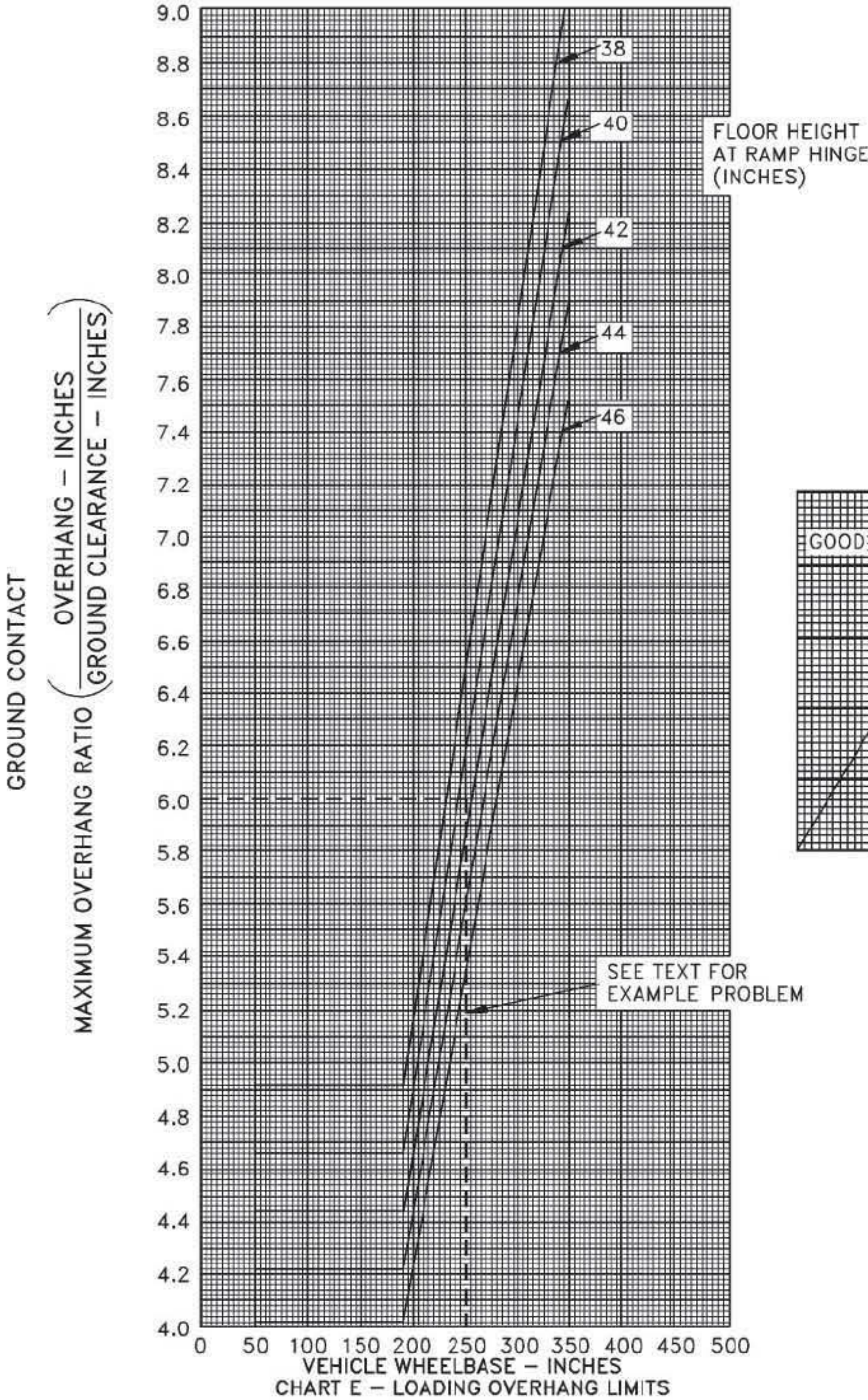


FIGURE B-27. Ground and ramp contact





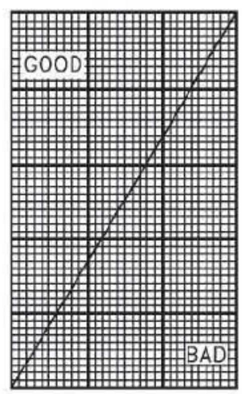


FIGURE B-28. Overhang and projection limits (vehicle)

C-130 Ground Contact

TABLE B-III. Vehicle ground contact limits

Wheelbase	Ramp Hinge Height					
	64 Inches	66 Inches	68 Inches	70 Inches	72 Inches	74 Inches
	Ratio					
50	2.62	2.62	2.62	2.62	2.62	2.62
75	2.89	2.89	2.89	2.89	2.89	2.89
100	3.37	3.36	3.35	3.34	3.33	3.32
125	3.77	3.74	3.70	3.67	3.64	3.61
150	4.08	4.03	3.97	3.92	3.87	3.82
175	4.34	4.27	4.19	4.12	4.05	3.99
200	4.55	4.46	4.37	4.29	4.20	4.12
225	4.73	4.62	4.52	4.42	4.33	4.23
250	4.89	4.76	4.65	4.54	4.43	4.33
275	5.02	4.89	4.76	4.63	4.52	4.41
300	5.14	4.99	4.85	4.72	4.59	4.47
325	5.24	5.08	4.93	4.79	4.66	4.53
350	5.38	5.21	5.05	4.90	4.76	4.62
375	5.77	5.59	5.42	5.26	5.11	4.97
400	6.17	5.98	5.80	5.63	5.46	5.31
425	6.56	6.36	6.17	5.99	5.82	5.66
450	6.96	6.74	6.54	6.35	6.17	6.00
475	7.35	7.13	6.91	6.71	6.52	6.34
500	7.75	7.51	7.28	7.07	6.87	6.68

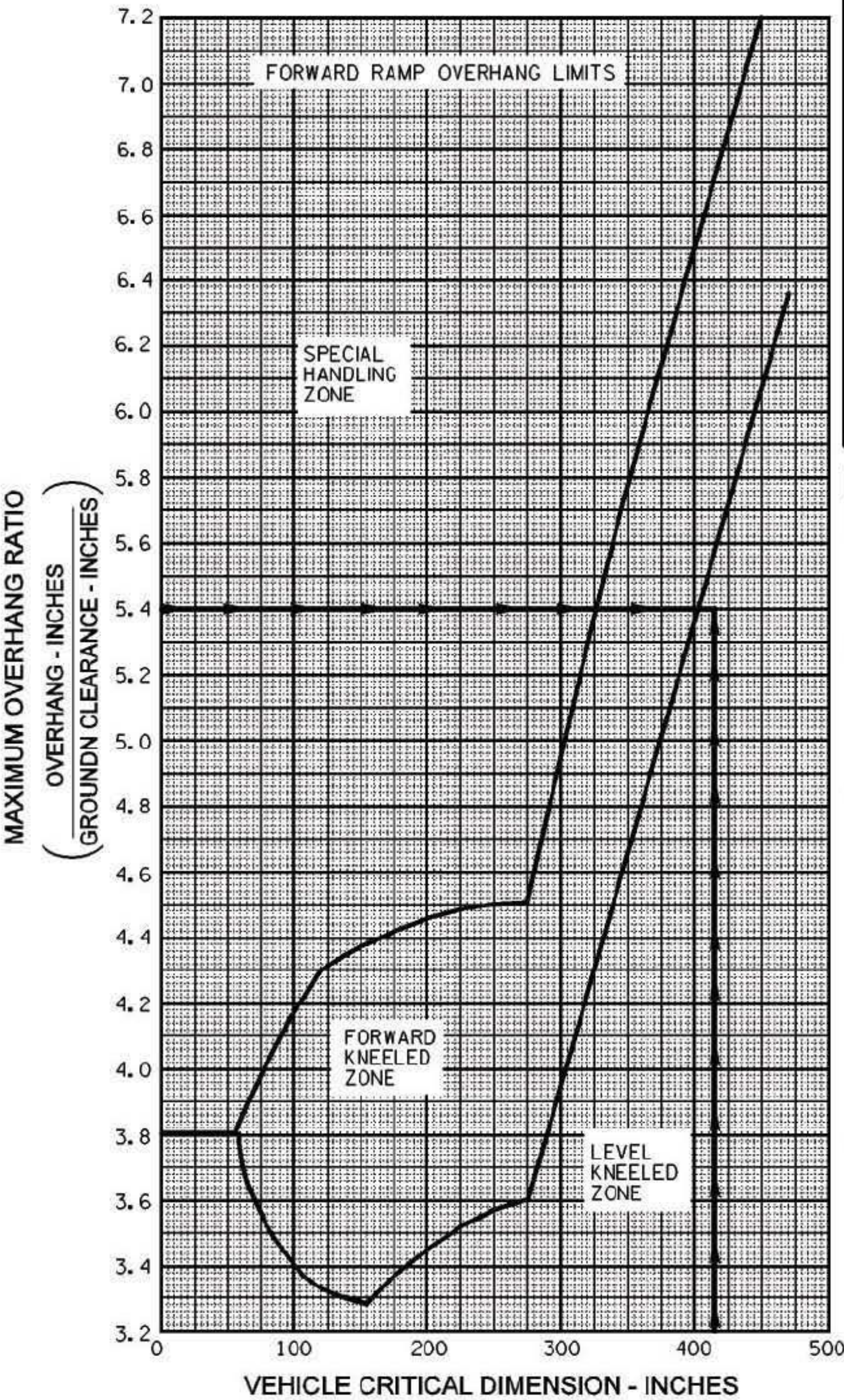
Example Problem:

1. Enter the table at wheelbase closest to but not to exceed actual wheelbase. Use example wheelbase of 325-in.

2. Determine ground contact ration by dividing overhang by ground clearance. For the example load, use ration of 5.08. Move laterally to table ratio that is closest to but not less than ratio for the onload item.

4. Move up to ramp hinge height. The table indicates that if the ramp hinge height is 66 inches or less, the item may be safely loaded without approach shoring.

C-17 Ground Contact



FORWARD RAMP CONTACT LIMITS

CONFIGURATION	MAXIMUM OVERHANG RATIO
FWD KNEELED	4.59
FWD KNEELED (K-LOADER KIT)	6.00
LVL KNEELED	3.54

CAUTION

IF MAXIMUM OVERHANG RATIO IS EXCEEDED WHEN EITHER BACKING OR DRIVING A VEHICLE IN, IT MUST BE ON/OFF LOADED USING SPECIAL HANDLING PROCEDURES. THIS ONLY APPLIES TO RAMP CONTACT, NOT GROUND CONTACT.

NOTE

1. THE VEHICLE CAN BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY ANY ZONE, IF THE INTERSECTION POINT FALLS WITHIN THAT ZONE OR BELOW.
2. IF THE INTERSECTION POINT FALLS ABOVE THE FORWARD KNEELED ZONE, THE VEHICLE MUST BE ON/OFF LOADED WITH THE RAMP AND EXTENSION IN THE TRUCK LOADING POSITION, OR USING SPECIAL HANDLING PROCEDURES.
3. TO DETERMINE THE REQUIRED THICKNESS OF APPROACH SHORING FOR SPECIAL HANDLING, PROCEED AS FOLLOWS:

   REQUIRED GROUND CLEARANCE = OVERHANG / MAXIMUM OVERHANG RATIO

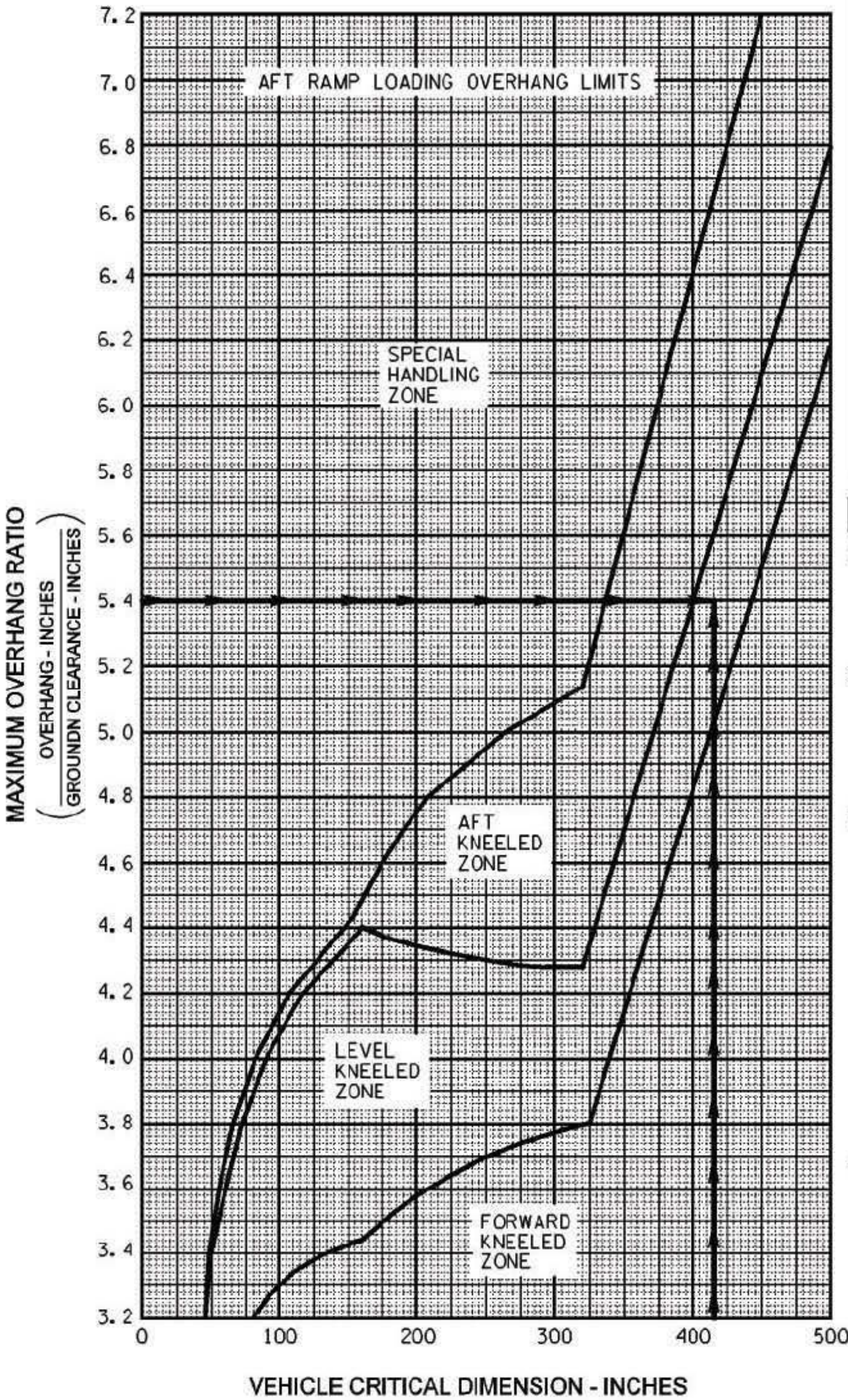
   APPROACH SHORING THICKNESS = REQUIRED GROUND CLEARANCE - ACTUAL GROUND CLEARANCE

4. TO DETERMINE THE REQUIRED LENGTH OF APPROACH SHORING, PROCEED AS FOLLOWS:

   APPROACH SHORING LENGTH = 1/2 X CRITICAL DIMENSION OR OVERHANG + SHORING THICKNESS (WHICHEVER IS GREATER)

FIGURE B-29. Forward and aft cargo ramp vehicle overhang limits

C-5 Ground Contact



AFT RAMP CONTACT LIMITS

CONFIGURATION	MAXIMUM OVERHANG RATIO
AFT KNEELED	5.26
FWD KNEELED	2.76
LVL KNEELED	4.00

CAUTION

IF MAXIMUM OVERHANG RATIO IS EXCEEDED WHEN EITHER BACKING OR DRIVING A VEHICLE IN, IT MUST BE ON/OFF LOADED USING SPECIAL HANDLING PROCEDURES. THIS ONLY APPLIES TO RAMP CONTACT, NOT GROUND CONTACT.

NOTE

1. THE VEHICLE CAN BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY ANY ZONE, IF THE INTERSECTION POINT FALLS WITHIN THAT ZONE OR BELOW.
2. IF THE INTERSECTION POINT FALLS ABOVE THE FORWARD KNEELED ZONE, THE VEHICLE MUST BE ON/OFF LOADED WITH THE RAMP AND EXTENSION IN THE TRUCK LOADING POSITION, OR USING SPECIAL HANDLING PROCEDURES.
3. TO DETERMINE THE REQUIRED THICKNESS OF APPROACH SHORING FOR SPECIAL HANDLING, PROCEED AS FOLLOWS:

   REQUIRED GROUND CLEARANCE = OVERHANG / MAXIMUM OVERHANG RATIO

   APPROACH SHORING THICKNESS = REQUIRED GROUND CLEARANCE - ACTUAL GROUND CLEARANCE

4. TO DETERMINE THE REQUIRED LENGTH OF APPROACH SHORING, PROCEED AS FOLLOWS:

   APPROACH SHORING LENGTH = 1/2 X CRITICAL DIMENSION OR OVERHANG + SHORING THICKNESS (WHICHEVER IS GREATER)

FIGURE B-30. Forward and aft cargo ramp vehicle overhang limits

C-5 Ground Contact

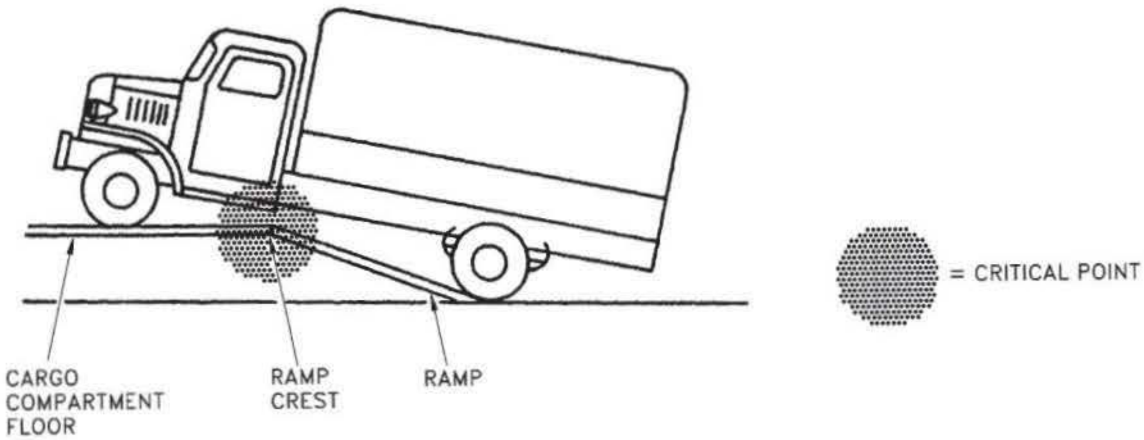
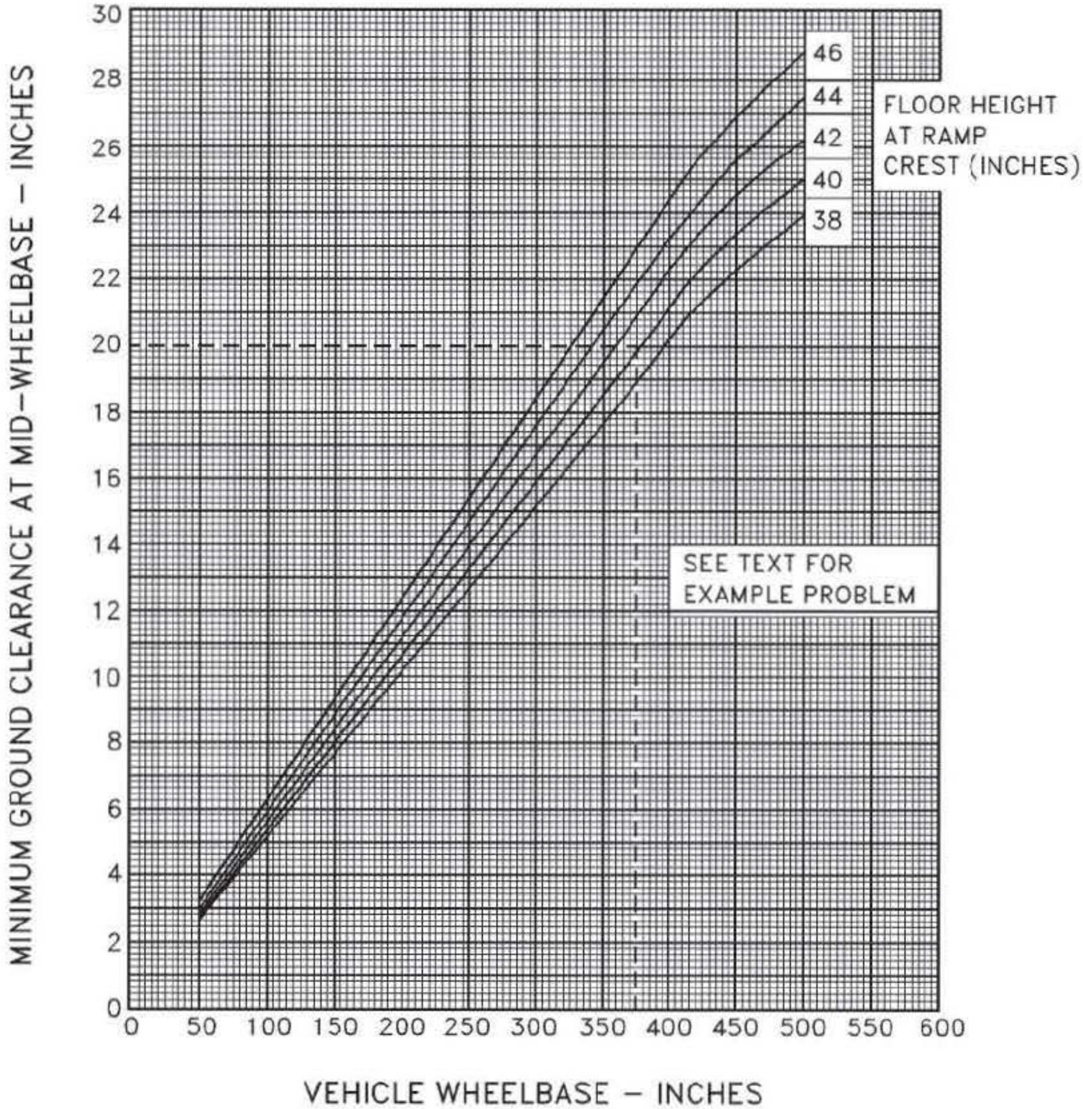
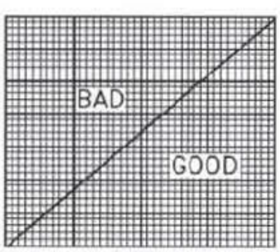


FIGURE B-31. Ramp cresting, all aircraft





C-130 – RAMP CREST LIMITS

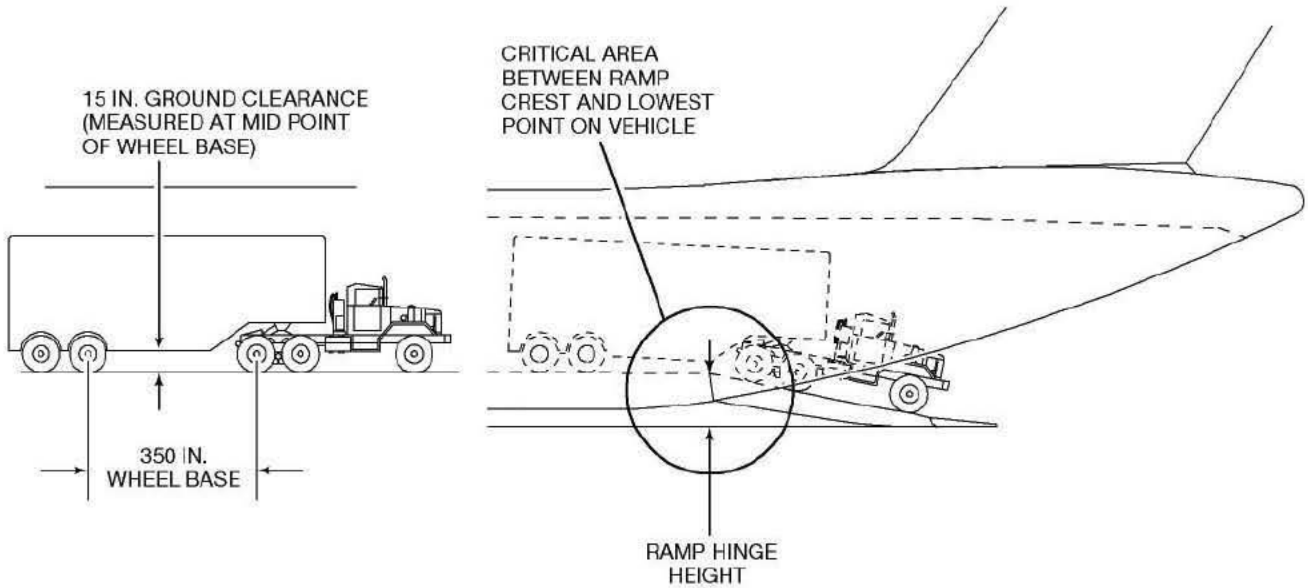
FIGURE B-32. Overhang and projection limits (vehicle)

CALCULATION PROCEDURES - VEHICLE RAMP CREST LIMIT

TABULAR DATA ON SHEET 2 PROVIDES A QUICK MEANS OF DETERMINING THE PERMISSIBLE GROUND CLEARANCE FOR SAFE VEHICLE ON/OFFLOAD.

EXAMPLE:

DETERMINE IF A VEHICLE WITH A WHEEL BASE OF 350 IN., AND A GROUND CLEARANCE OF 15 IN. CAN BE SAFELY ON/OFFLOADED.



RAMP CREST LIMIT

TO DETERMINE IF THE EXAMPLE VEHICLE CAN BE SAFELY ON/OFFLOADED PROCEED AS FOLLOWS:

A. LOCATE THE VEHICLE WHEEL BASE IN THE LEFT COLUMN (350 IN.).

B. MOVE RIGHT AND LOCATE THE GROUND CLEARANCE HEIGHT OF 15 IN. OR LESS.

C. MOVE UP TO THE TOP ROW TO DETERMINE THE ALLOWABLE RAMP HINGE HEIGHT (70 IN. OR LESS).

C-17

FIGURE B-33. Vehicle ramp crest limit

TO DETERMINE THE REQUIRED THICKNESS OF STEP-UP SHORING FOR LOADING VEHICLES, PROCEED AS FOLLOWS:

A. LOCATE THE VEHICLE WHEELBASE IN THE VEHICLE CRITICAL DIMENSION.

B. MOVE HORIZONTALLY TO THE RAMP HEIGHT LINE AND DOWN TO THE MINIMUM GROUND CLEARANCE TO DETERMINE THE REQUIRED GROUND CLEARANCE HEIGHT.

C. SUBTRACT THE ACTUAL GROUND CLEARANCE FROM THE REQUIRED GROUND CLEARANCE TO OBTAIN SHORING THICKNESS. SHORING MAY BE PLACED A DISTANCE EQUAL TO ONE HALF VEHICLE CRITICAL DIMENSION ON EACH SIDE OF THE RAMP CREST.

NOTE

THE VEHICLE CAN BE SAFELY ON/OFFLOADED, IF THE REQUIRED GROUND CLEARANCE IS EQUAL TO OR GREATER THAN THE ACTUAL GROUND CLEARANCE.

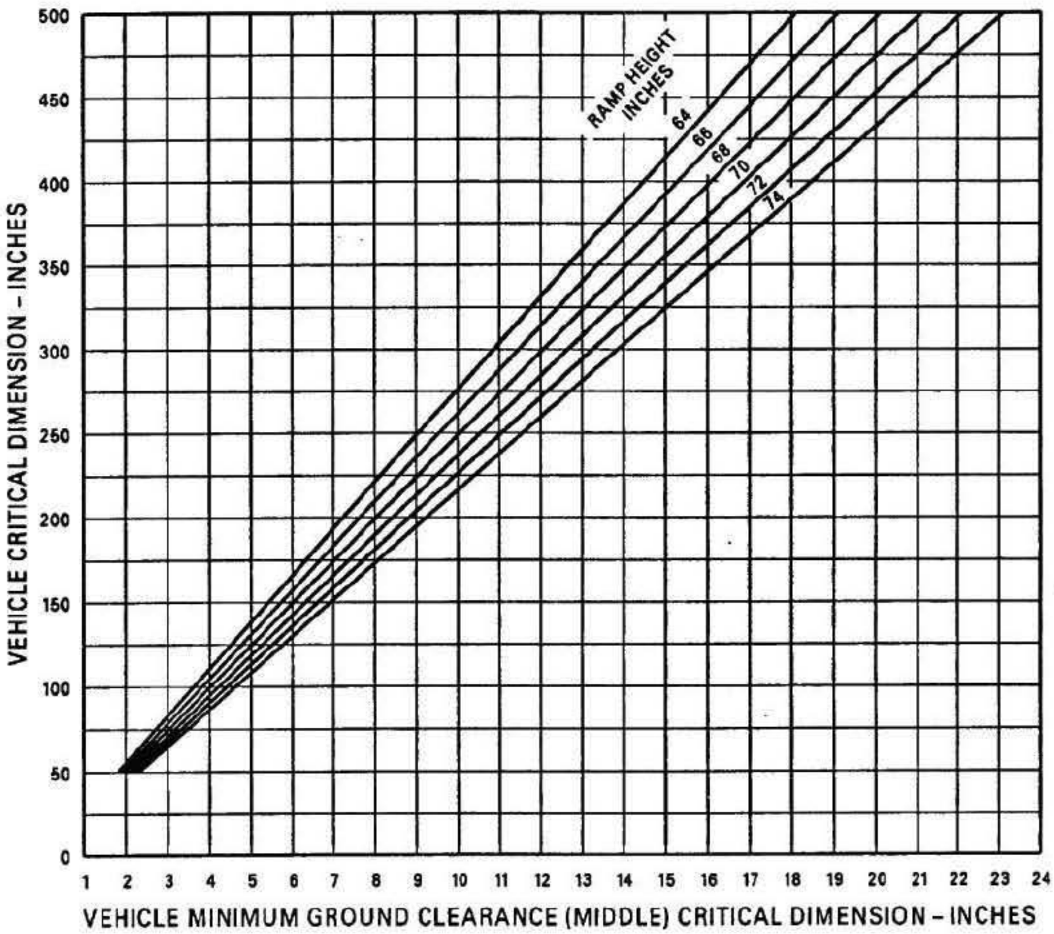


FIGURE B-34. Vehicle ramp crest clearance limit

C-17 Ramp Crest Limits

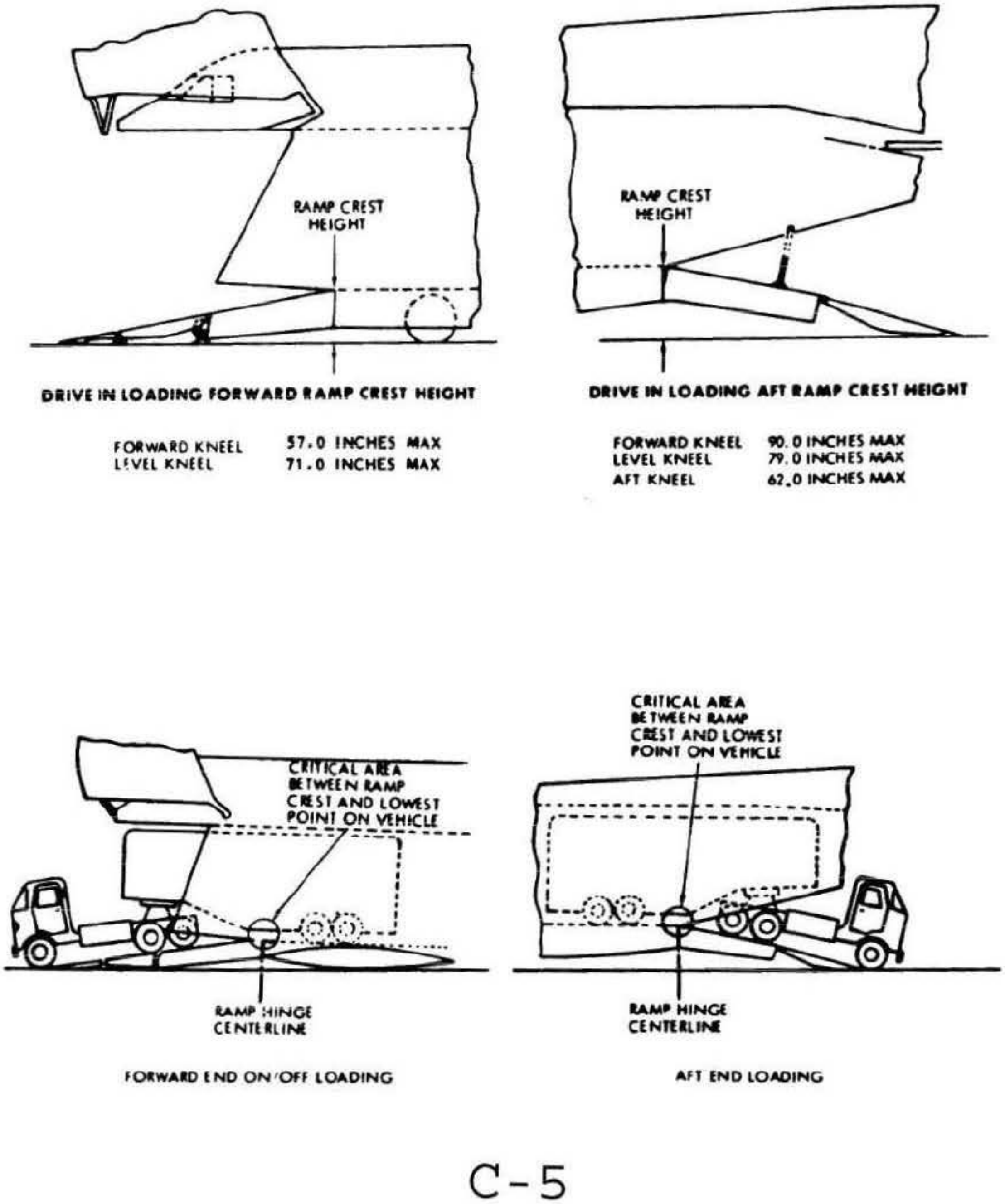
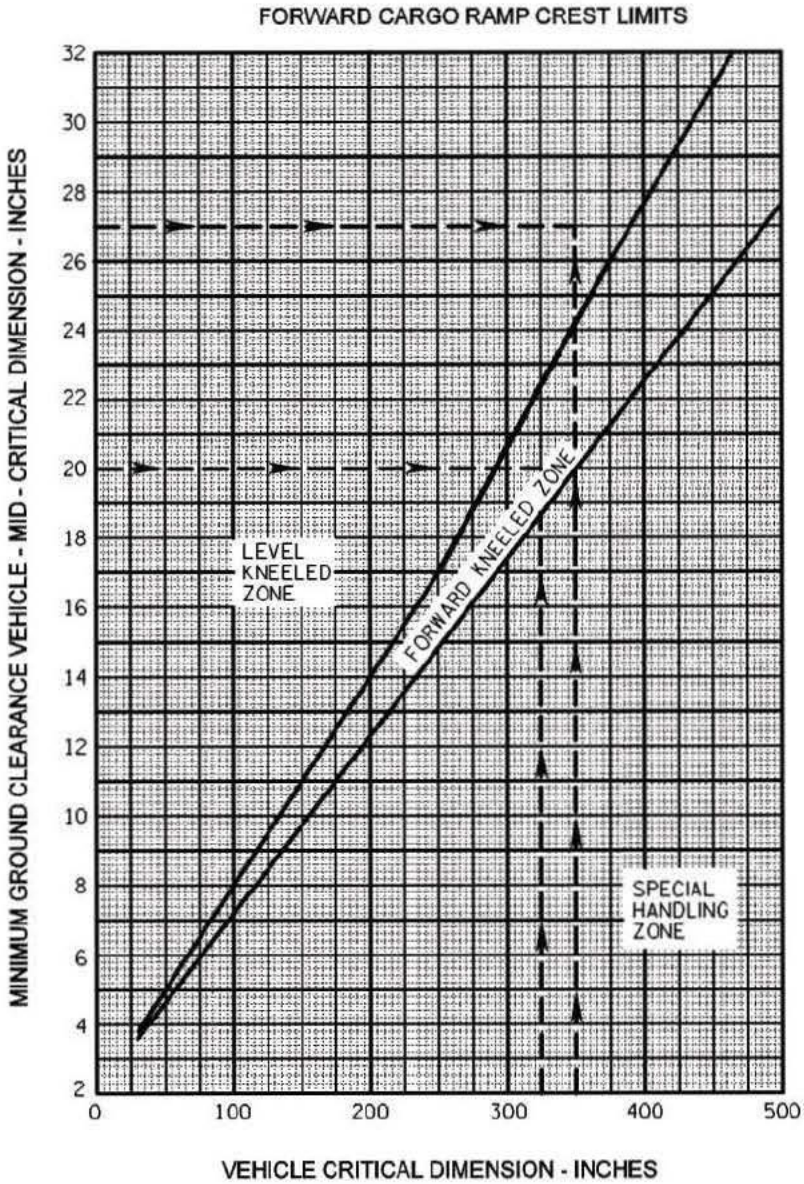


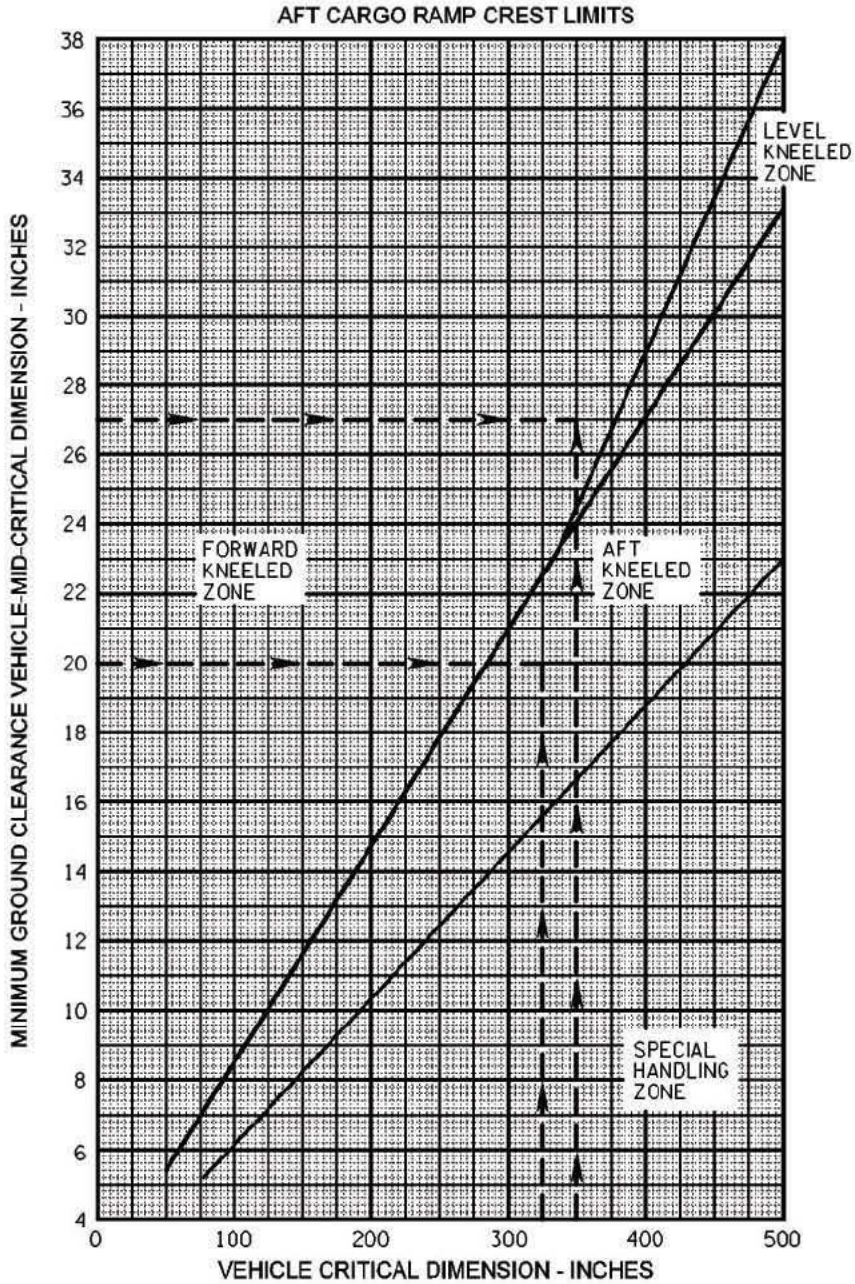
FIGURE B-35. Forward and aft ramp crest limits



NOTE

1. THE VEHICLE CAN BE SAFELY ON/OFF LOADED, IF THE INTERSECTION POINT FALLS WITHIN OR ABOVE THE AIRPLANE CONFIGURATION ZONE.
2. IF THE INTERSECTION POINT FALLS BELOW THE FORWARD KNEELED ZONE, THE VEHICLE MUST BE ON/OFF LOADED WITH THE RAMP AND EXTENSION IN THE TRUCK LOADING POSITION OR, USING SPECIAL HANDLING PROCEDURES.
3. TO DETERMINE THE REQUIRED THICKNESS OF STEP-UP SHORING FOR SPECIAL HANDLING, PROCEED AS FOLLOWS:
   a. USING THE VEHICLE CRITICAL DIMENSION MOVE UP TO THE APPROPRIATE KNEELED ZONE.
   b. MOVE HORIZONTALLY TO READ THE REQUIRED GROUND CLEARANCE.
   c. SUBTRACT THE ACTUAL GROUND CLEARANCE FROM THE REQUIRED GROUND CLEARANCE TO OBTAIN SHORING THICKNESS. SHORING MAY BE PLACED A DISTANCE EQUAL TO 1/2 VEHICLE CRITICAL DIMENSION ON EACH SIDE OF THE RAMP CREST.

FIGURE B-36. Forward and aft ramp crest limits C-5



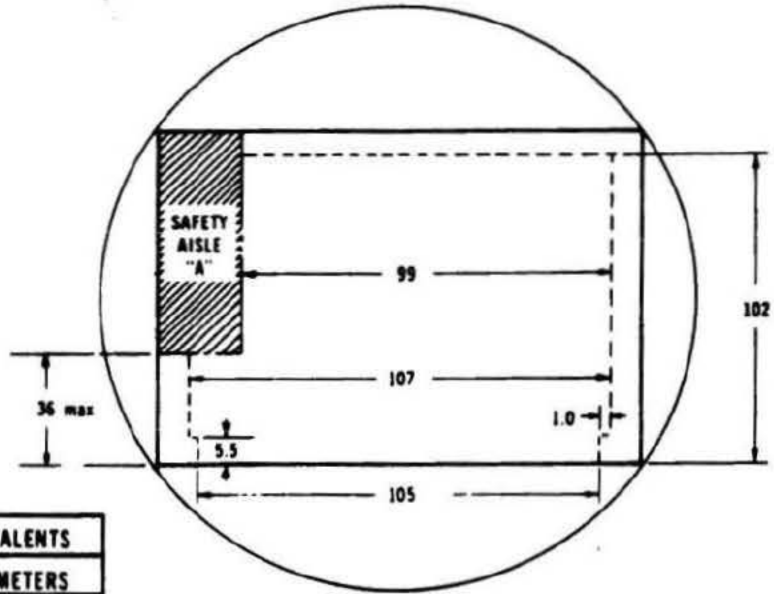
NOTE

1. THE VEHICLE CAN BE SAFELY ON/OFF LOADED, IF THE INTERSECTION POINT FALLS IN OR ABOVE THE AIRPLANE CONFIGURATION ZONE.
2. IF THE INTERSECTION POINT FALLS BELOW THE AFT KNEELED ZONE, THE VEHICLE MUST BE ON/OFF LOADED WITH THE RAMP AND PRESSURE DOOR IN THE TRUCK LOADING POSITION OR, USING SPECIAL HANDLING PROCEDURES.
3. TO DETERMINE THE REQUIRED THICKNESS OF STEP-UP SHORING FOR SPECIAL HANDLING, PROCEED AS FOLLOWS:

   a. USING THE VEHICLE CRITICAL DIMENSION MOVE UP TO THE APPROPRIATE KNEELED ZONE.
   b. MOVE HORIZONTALLY TO READ THE REQUIRED GROUND CLEARANCE.
   c. SUBTRACT THE ACTUAL GROUND CLEARANCE FROM THE REQUIRED GROUND CLEARANCE TO OBTAIN SHORING THICKNESS. SHORING MAY BE PLACED A DISTANCE EQUAL TO 1/2 VEHICLE CRITICAL DIMENSION ON EACH SIDE OF THE RAMP CREST.

FIGURE B-37. Forward and aft ramp crest limits

C-130



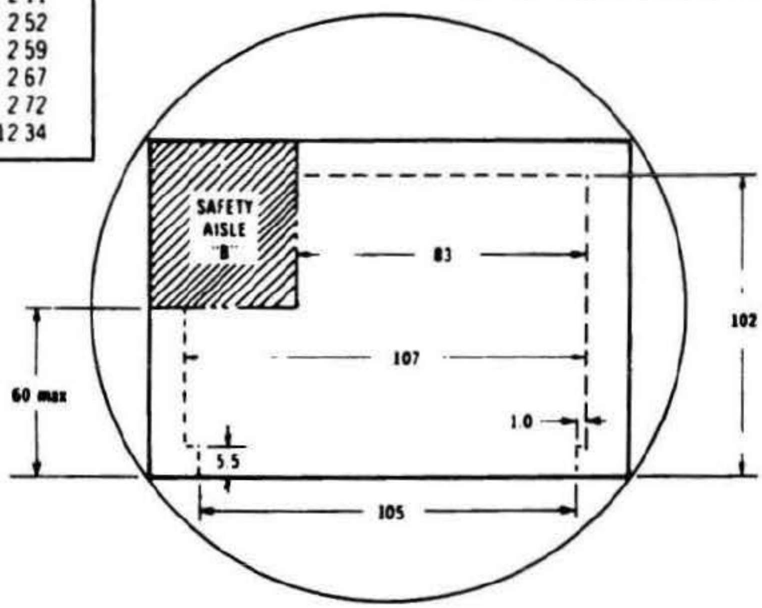
METRIC EQUIVALENTS	
INCHES	METERS
1 0	0 025
5 5	0 140
36.0	0 914
83 0	2 11
99 0	2 52
102 0	2 59
105 0	2 67
107 0	2 72
486 0	12 34

LOADMASTER SAFETY AISLE OPTIONS

DIMENSIONS GIVEN IN INCHES

A SIDE AISLE 0.355 by 1.83 m (14 by 72 in.) min
B TOP AISLE 0.762 by 1.22 m (30 by 48 in.) min

When passengers are carried a safety aisle the same width as "A" and extending from floor to ceiling is required.



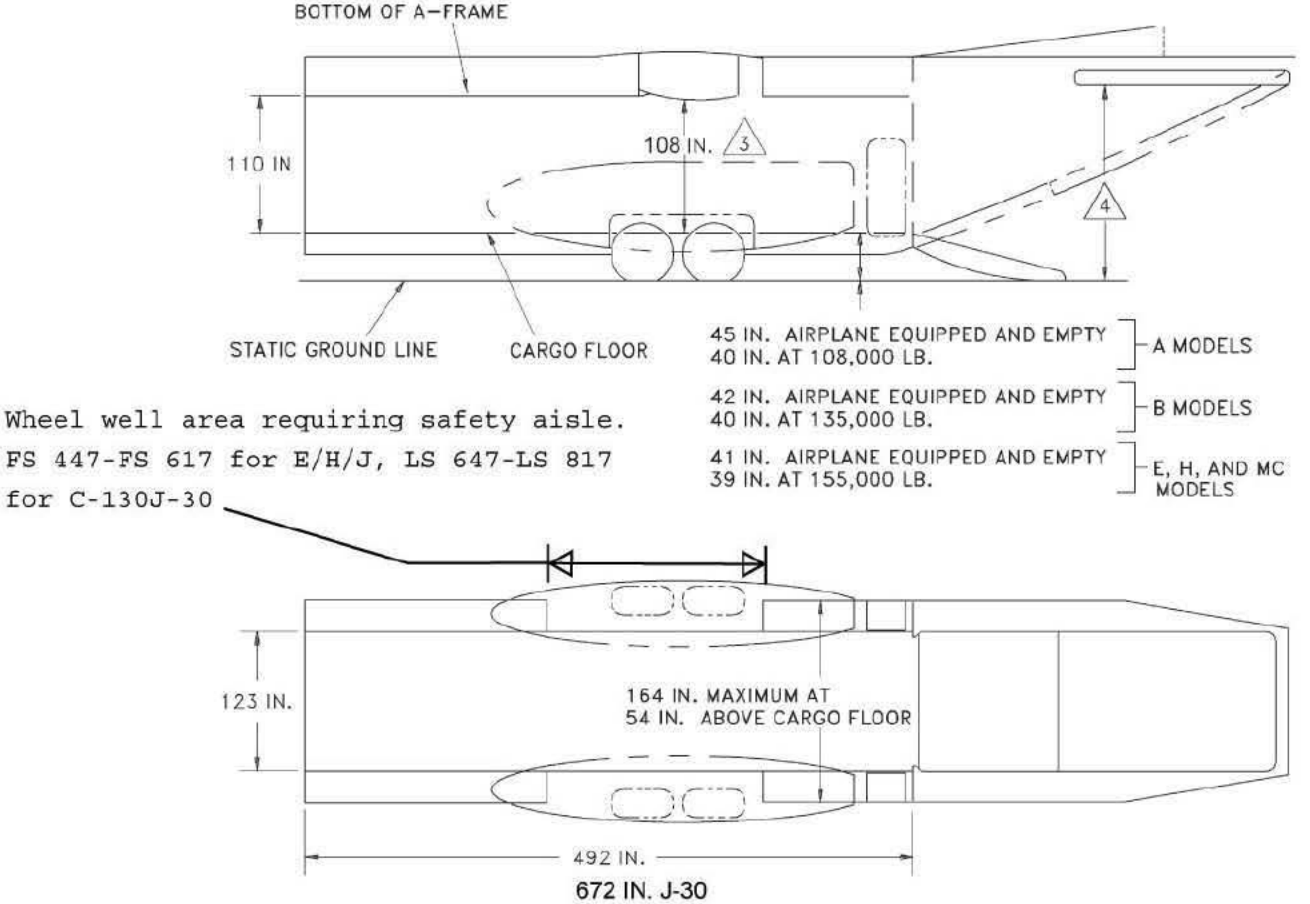
Design length 468 inches

VIEWS LOOKING FORWARD INTO AIRCRAFT

NOTE: For vehicles with tracks or non-sensitive steering, 6 inches of rolling shoring is required when the clearances between the side rails and the vehicle is critical. Vehicles with clearances to the side rail of less than 2.5 inches on each side require ATTLA review and approval.

C-130

FIGURE B-38. Dimensional design limits



NOTE

1. DIMENSIONS SHOWN ARE DISTANCES BETWEEN STRUCTURAL OR EQUIPMENT SURFACES. DIMENSIONS MAY VARY DEPENDING ON EQUIPMENT INSTALLED OR AIRPLANE MODIFICATION.
2. SEE SHEET 2 FOR DETAILED DIMENSIONS.
3. (△) 9 FEET WITH LITTER BRACKET INSTALLED.
4. (△) AIRPLANE ON HARD SURFACE, LANDING GEAR STRUTS AT STANDARD INFLATION, NOMINAL DIAMETER TIRES AT 35 PERCENT DEFLECTION, THIS DISTANCE IS:

   C-130A: 12 FT. 2 IN. AT 108,000 LBS, CG AT 24.1% MAC.
   C-130B: 12 FT. 3 IN. AT 135,000 LBS, CG AT 24% MAC.
   C-130E, C-130H, MC-130H, AND MC-130P: 11 FT. 11 IN. AT 155,000 LBS, CG AT 28.2% MAC.
5. WITH A/A32H-4A CARGO HANDLING SYSTEM INSTALLED, SUBTRACT 2-5/8 IN. FROM CARGO COMPARTMENT HEIGHT.

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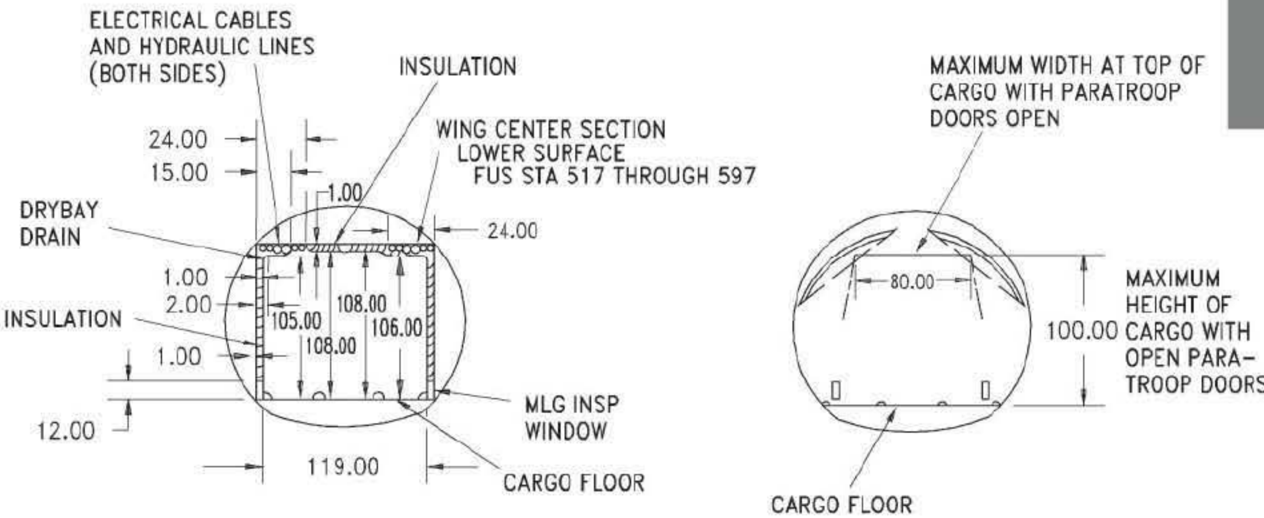
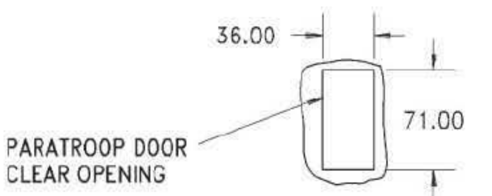
FIGURE B-39. Cargo compartment dimensions (sheet 1 of 2)

C-130



AIRPLANES AF61-2358 THROUGH AF61-2373



NOTE

6. ALL DIMENSIONS ARE IN INCHES.
7. WHEN A/A32H-4A CARGO HANDLING SYSTEM IS INSTALLED, THE MAXIMUM DISTANCE BETWEEN THE DUAL RAILS IS 105-5/8 INCHES.

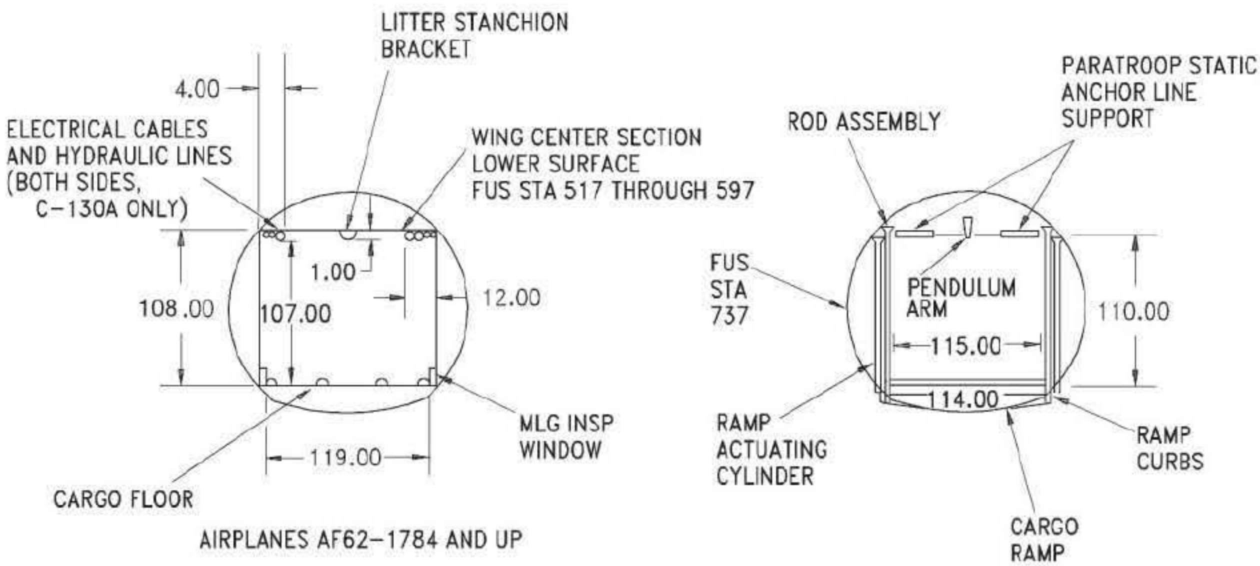


FIGURE B-40. Cargo compartment dimensions (sheet 2)

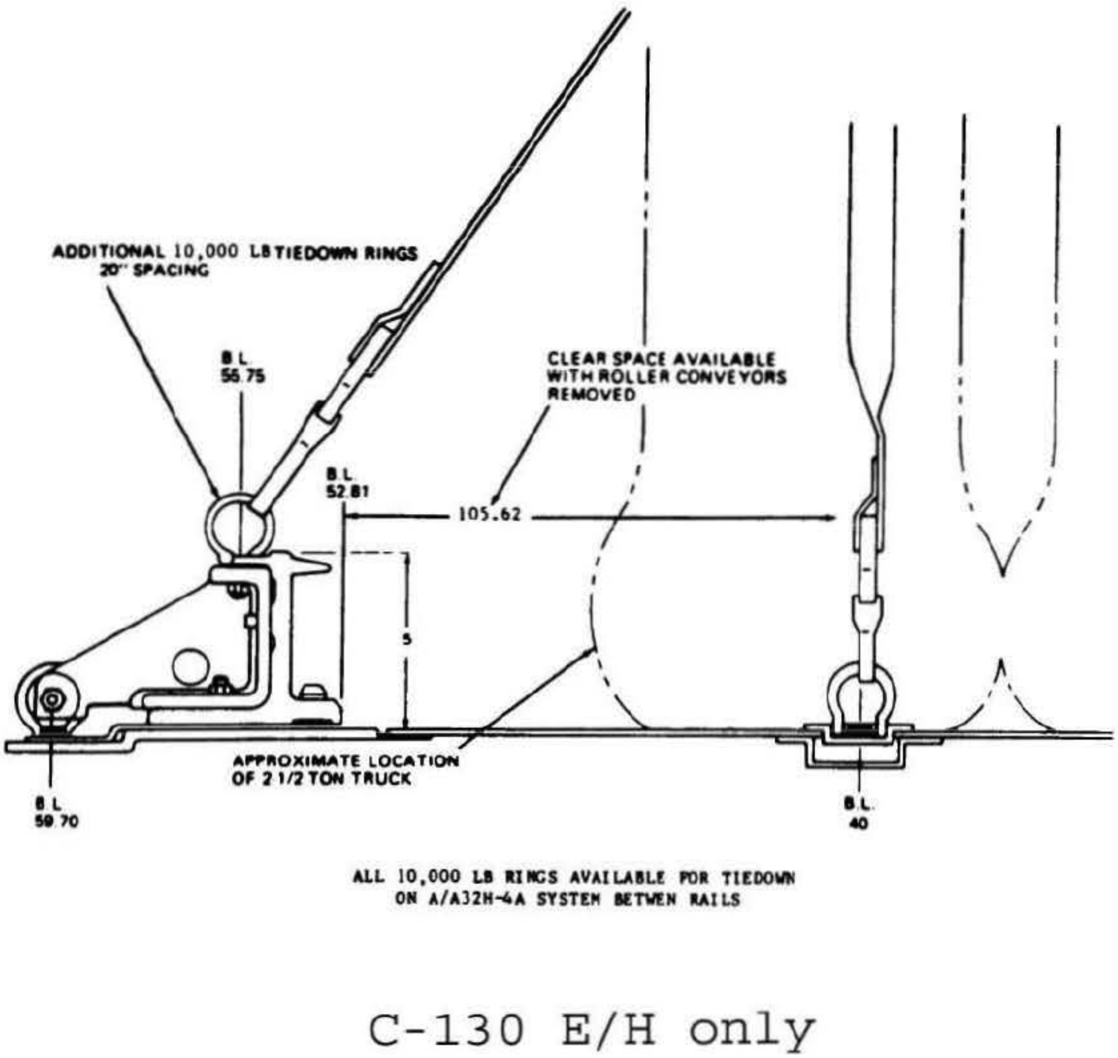
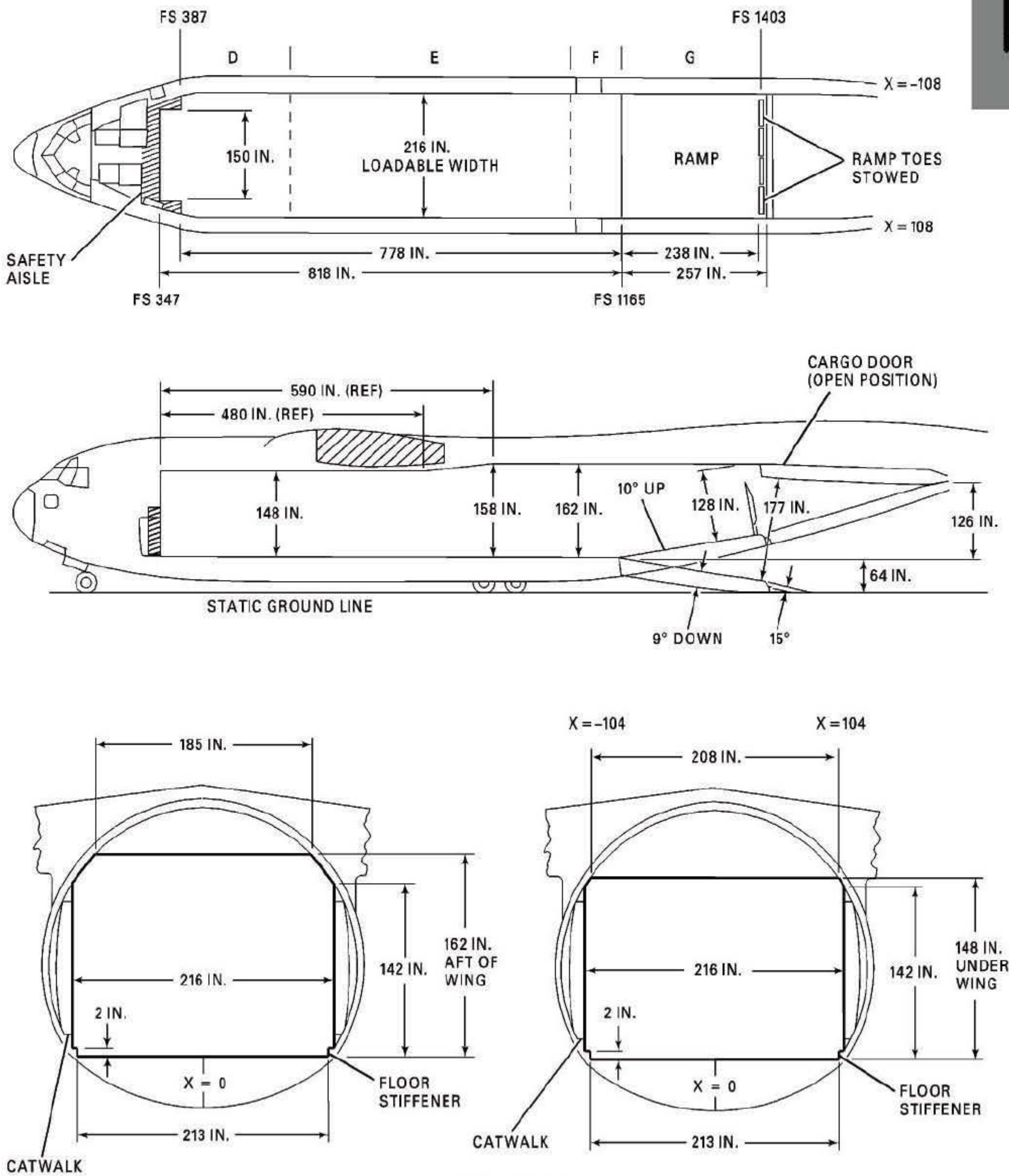


FIGURE B-41. Rail mounted cargo rings (-4A)



C-17

FIGURE B-42. Cargo compartment loading envelope

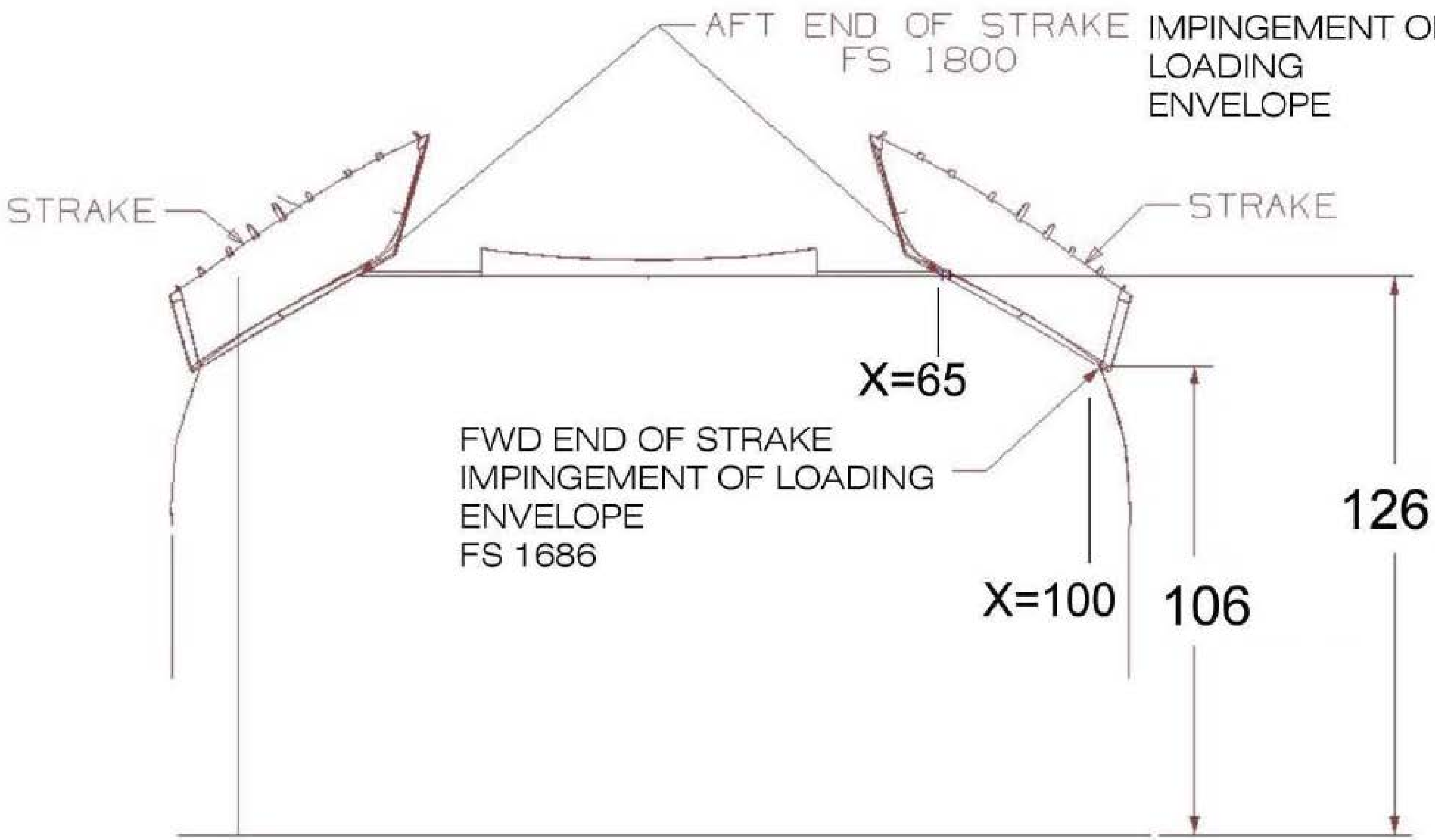


FIGURE B-43. C-17 straight-in loading envelope, end view

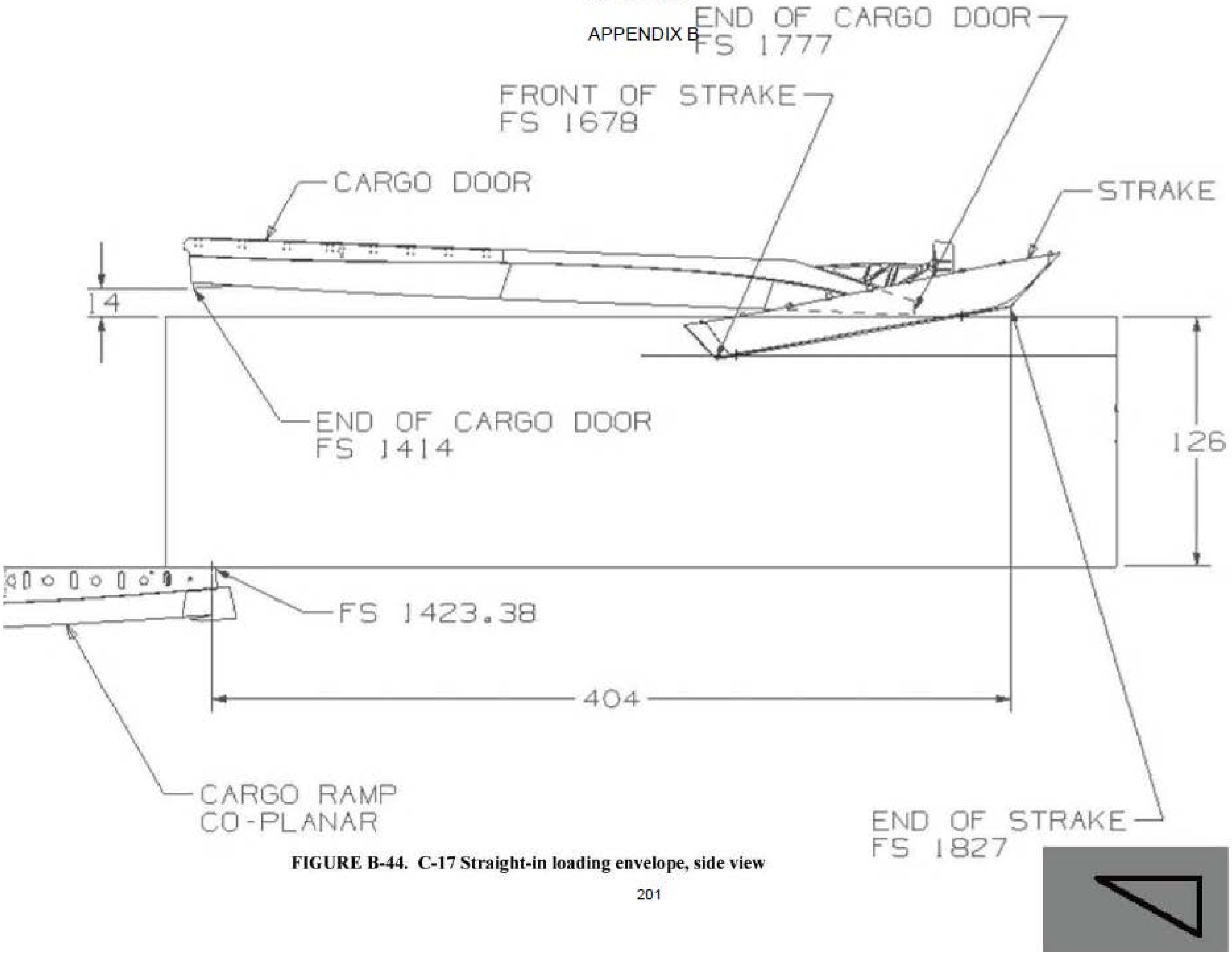
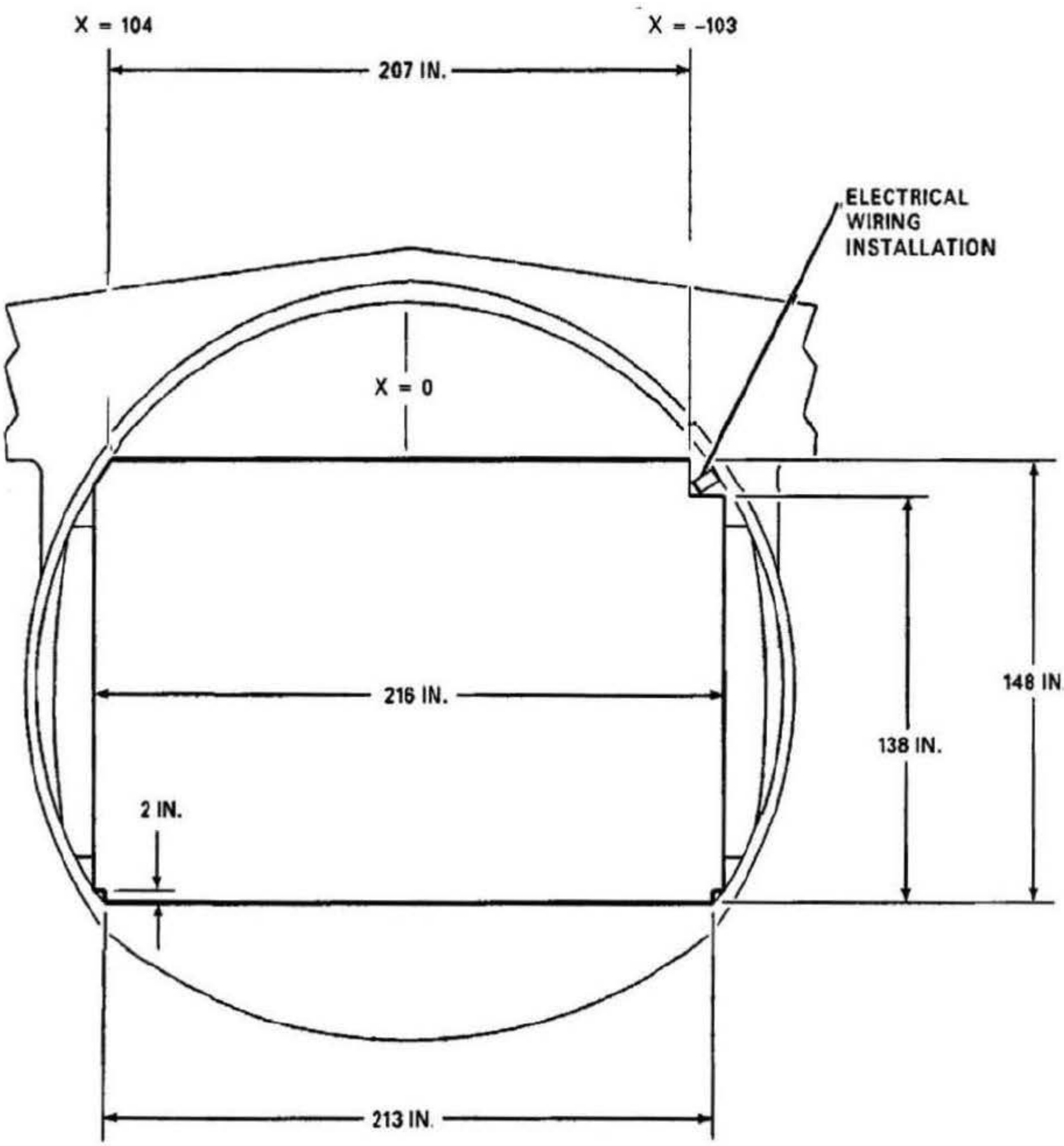


FIGURE B-44. C-17 Straight-in loading envelope, side view



FS 884 & FS 911

FIGURE B-45. Electrical bracket

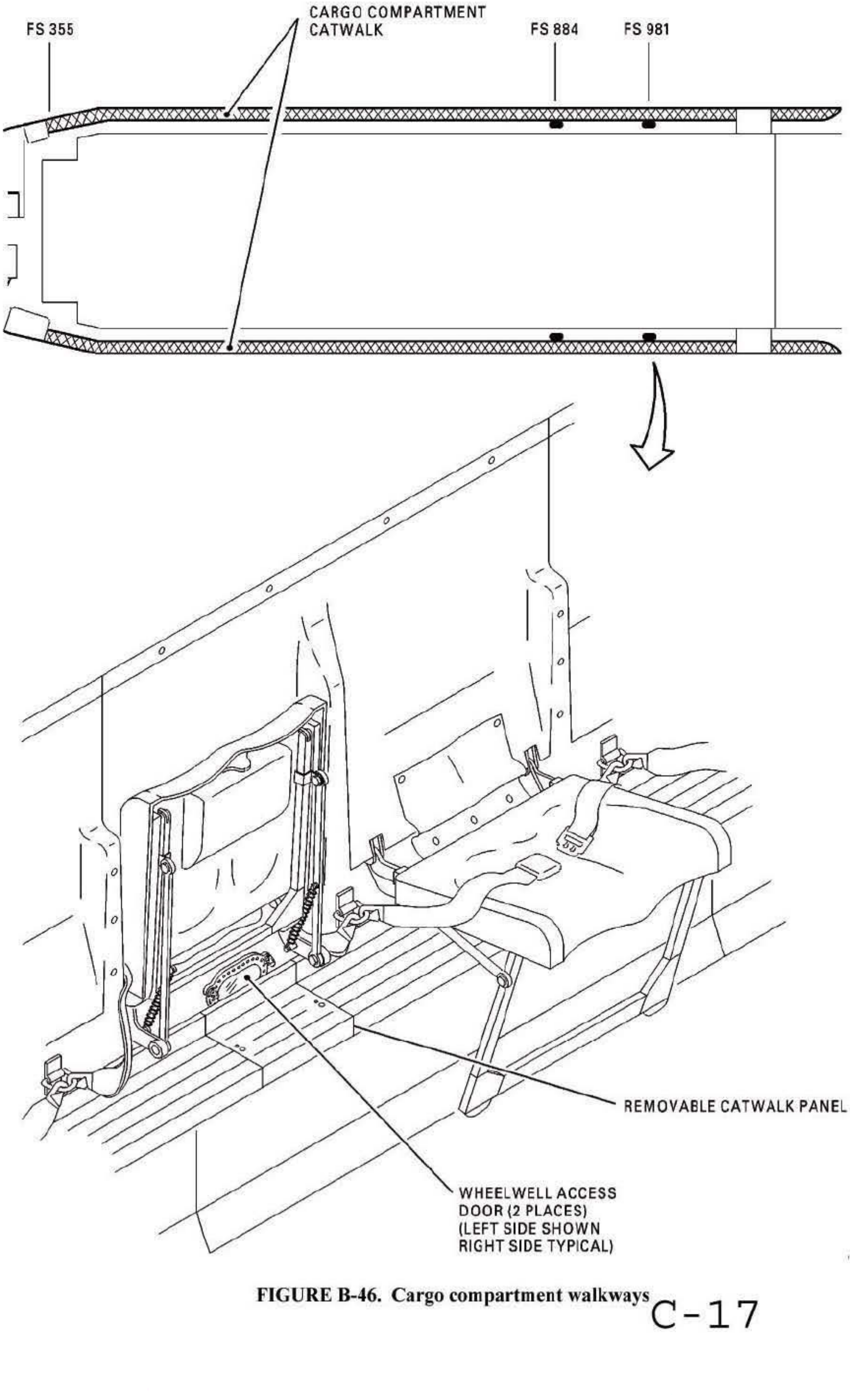
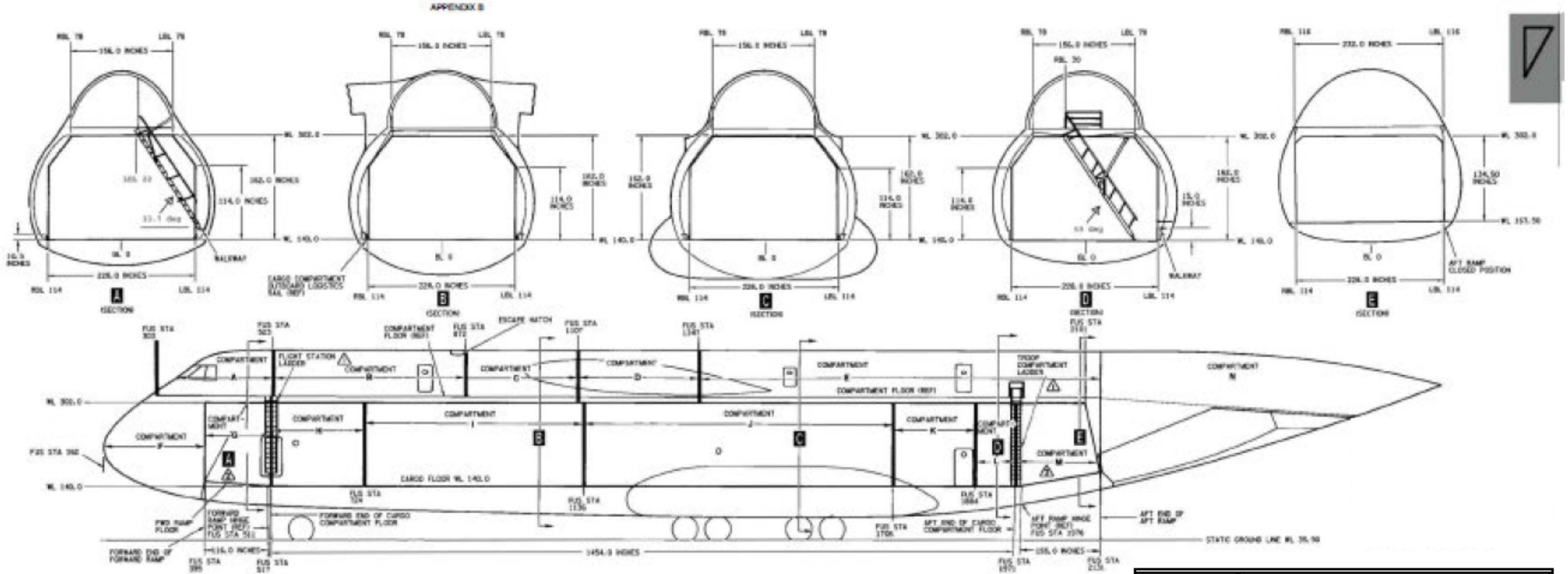


FIGURE B-46. Cargo compartment walkways C-17



C-5

NOTE	
1	FLIGHT STATION AND TROOP COMPARTMENT LADDERS DO NOT INFRINGE ON CARGO COMPARTMENT WHEN STOWED IN POSITION.
2	CLOSED ANGLE OF FORWARD RAMP IS 3 DEGREES.
3	CLOSED ANGLE OF AFT RAMP IS 10 DEGREES.
4	CARGO COMPARTMENT BOUNDARIES ARE MARKED ON SIDEWALLS OF COMPARTMENT WITH BLACK VERTICAL STRIPES.

FIGURE B-47. Cargo compartment envelope

THIS FIGURE PROVIDES A MEANS OF DETERMINING THE MAXIMUM ALLOWABLE HEIGHT OF CARGO OVER 114 INCHES HIGH FOR ANY GIVEN WIDTH. WIDTHS AND HEIGHTS ARE APPLICABLE TO BOTH THE FORWARD DOOR OPENING WITH RAMP AND RAMP EXTENSION IN THE TRUCK LOADING POSITION AND TO THE CARGO COMPARTMENT.

PROCEDURE:

1. ENTER GRAPH AT THE ACTUAL WIDTH OF CARGO AND MOVE UP VERTICALLY TO THE CLEARANCE CURVE.
2. MOVE HORIZONTALLY ACROSS AND READ MAXIMUM ALLOWABLE CARGO HEIGHT.

EXAMPLE PROBLEM:

DETERMINE IF A VEHICLE 96 INCHES WIDE AND 120 INCHES HIGH CAN BE LOADED ON THE RIGHT SIDE OF THE AIRPLANE.

1. ENTER GRAPH AT ACTUAL WIDTH OF 96 INCHES AND MOVE UP VERTICALLY TO THE INTERSECTION POINT ON THE CURVE.
2. MOVE HORIZONTALLY ACROSS AND READ CARGO ALLOWABLE HEIGHT OF 129 INCHES. THE ALLOWABLE HEIGHT OF 129 INCHES IS GREATER THAN ACTUAL HEIGHT OF 120 INCHES, THEREFORE THE VEHICLE CAN BE LOADED ON THE RIGHT SIDE OF THE CARGO COMPARTMENT.

NOTE

THE GRAPH AND PROCEDURE IS TO BE USED FOR EITHER SIDE OF AIRPLANE.

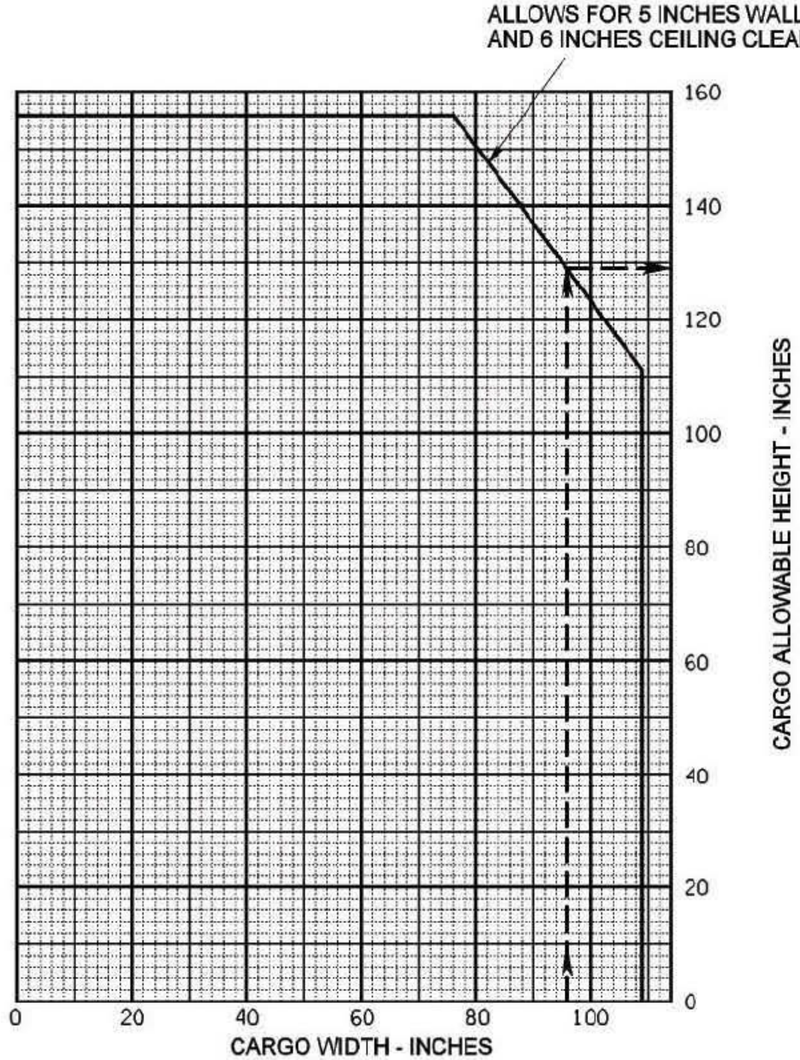


FIGURE B-48. Allowable cargo height

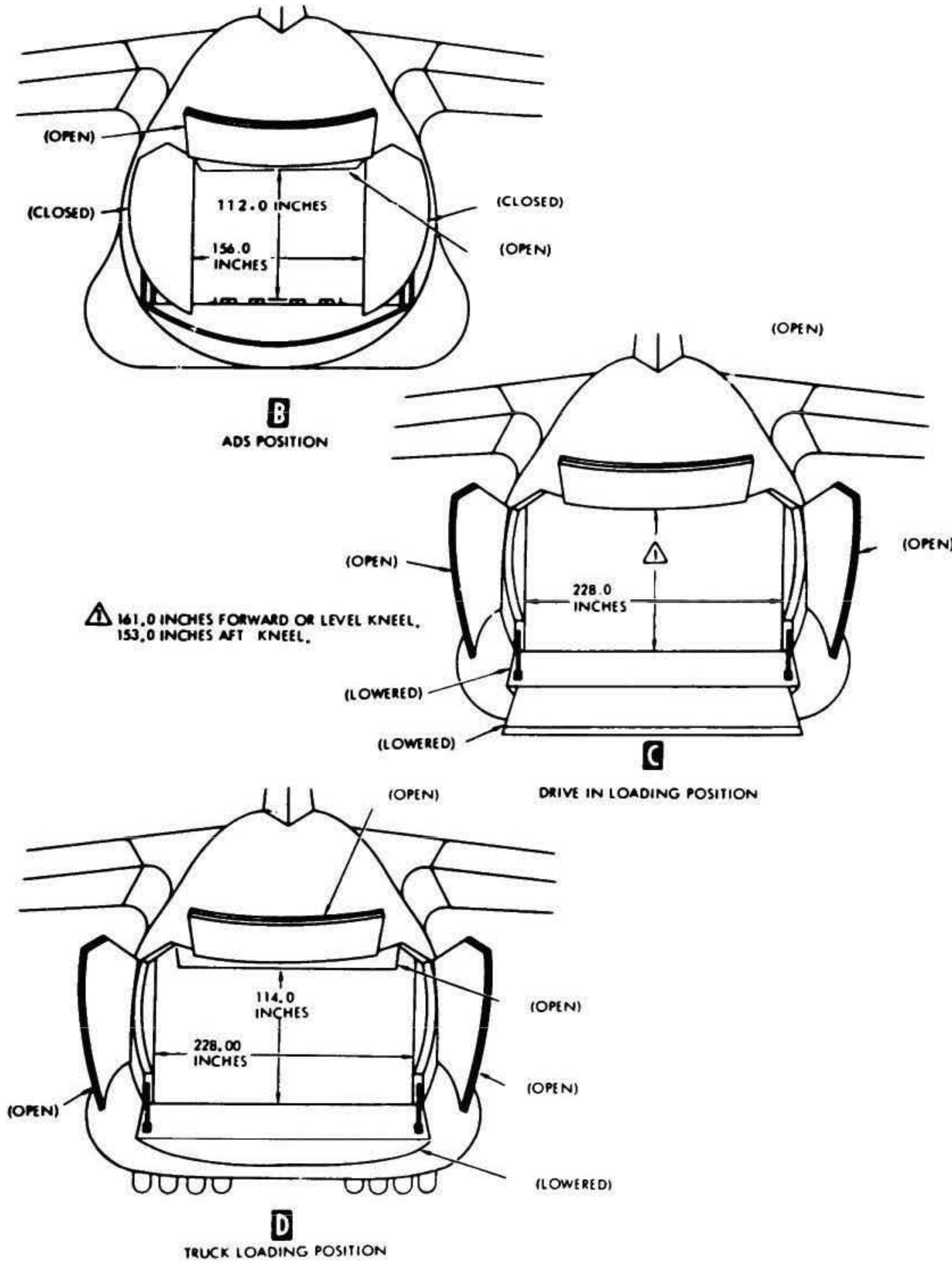


FIGURE B-49. Aft cargo opening dimensions

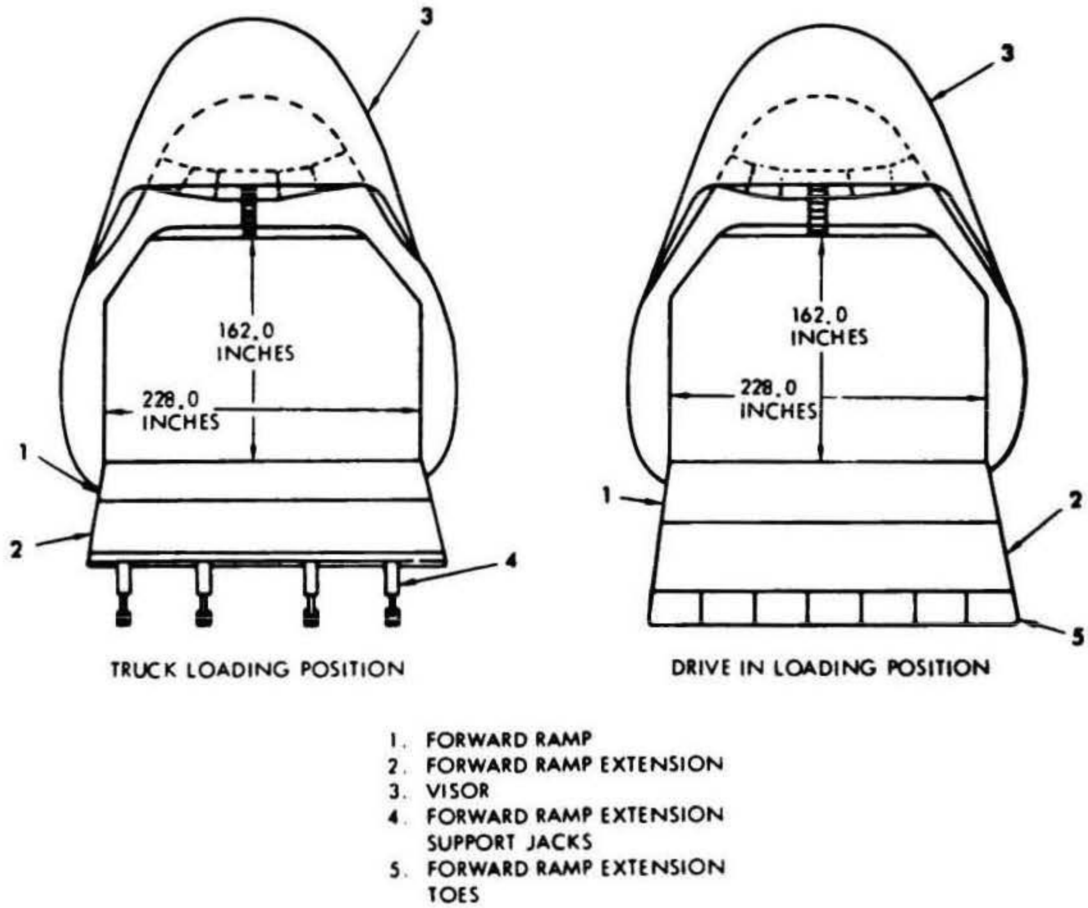
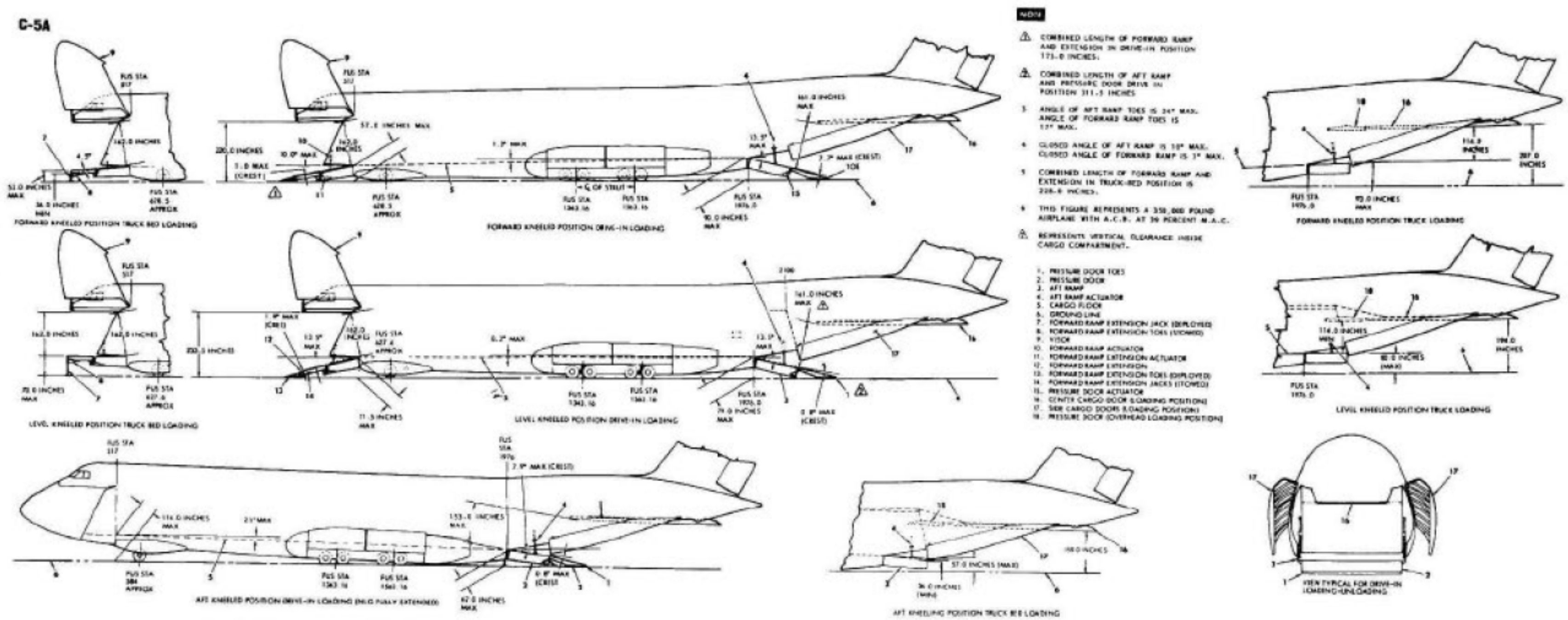


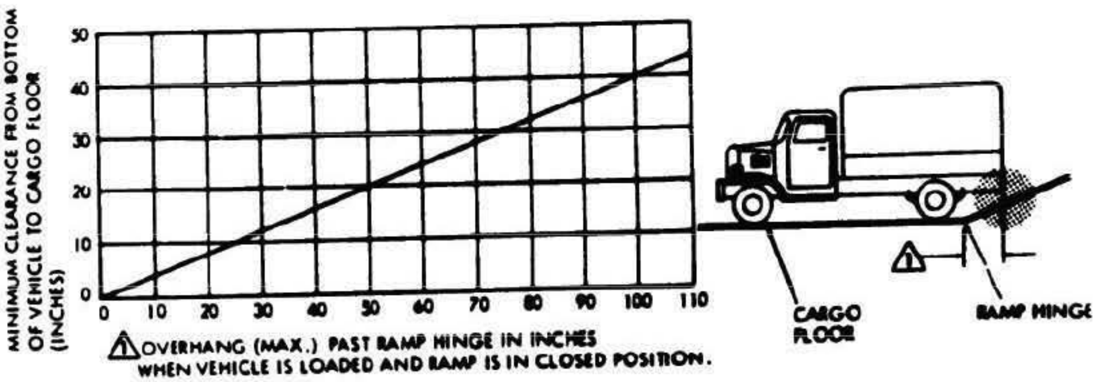
FIGURE B-50. Forward cargo opening dimensions

C-5

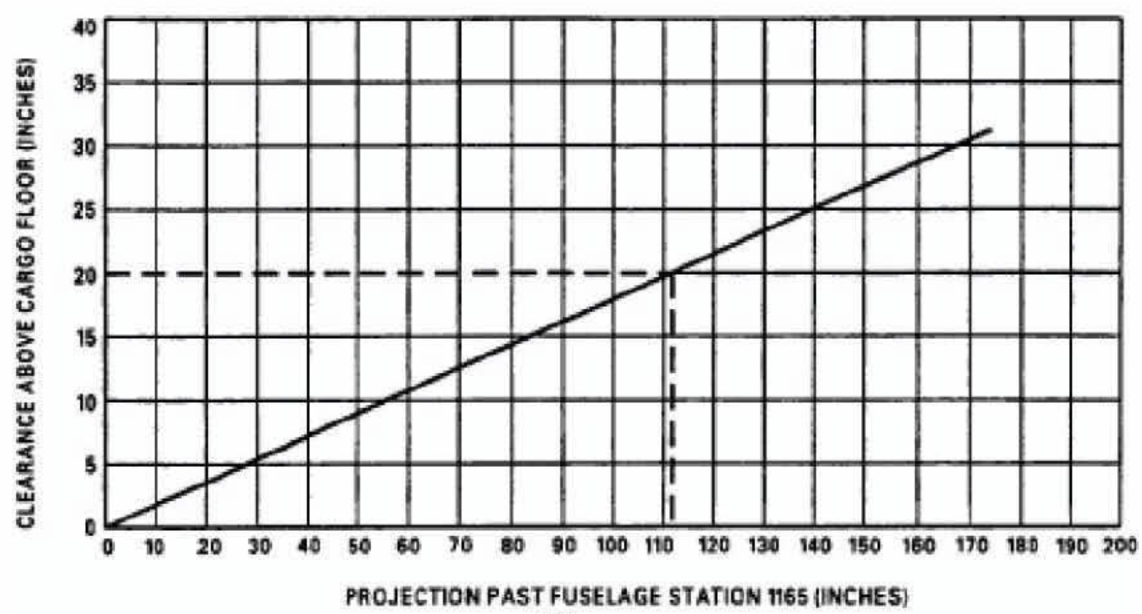


C-5

FIGURE B-51. Airplane kneeling loading position (on/off loading).

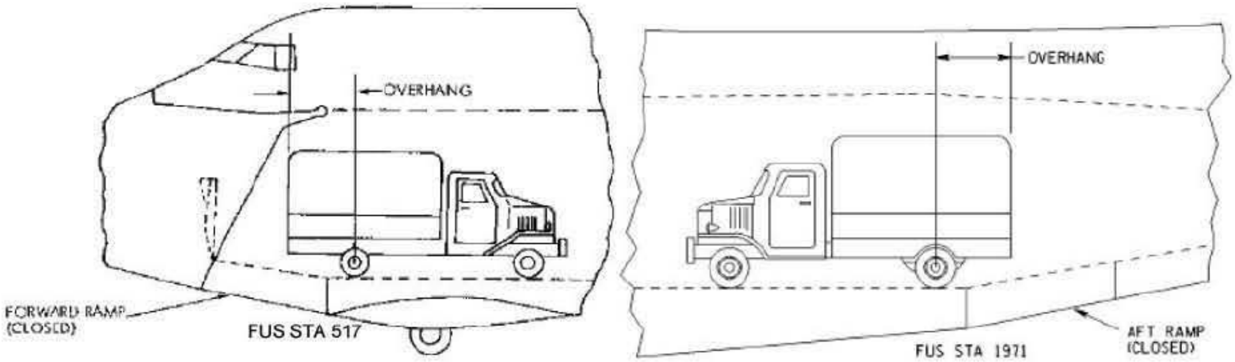


C-130 PARKING OVERHANG LIMITS



C-17 - PARKING OVERHANG LIMITS

FIGURE B-52. Parking overhang limits



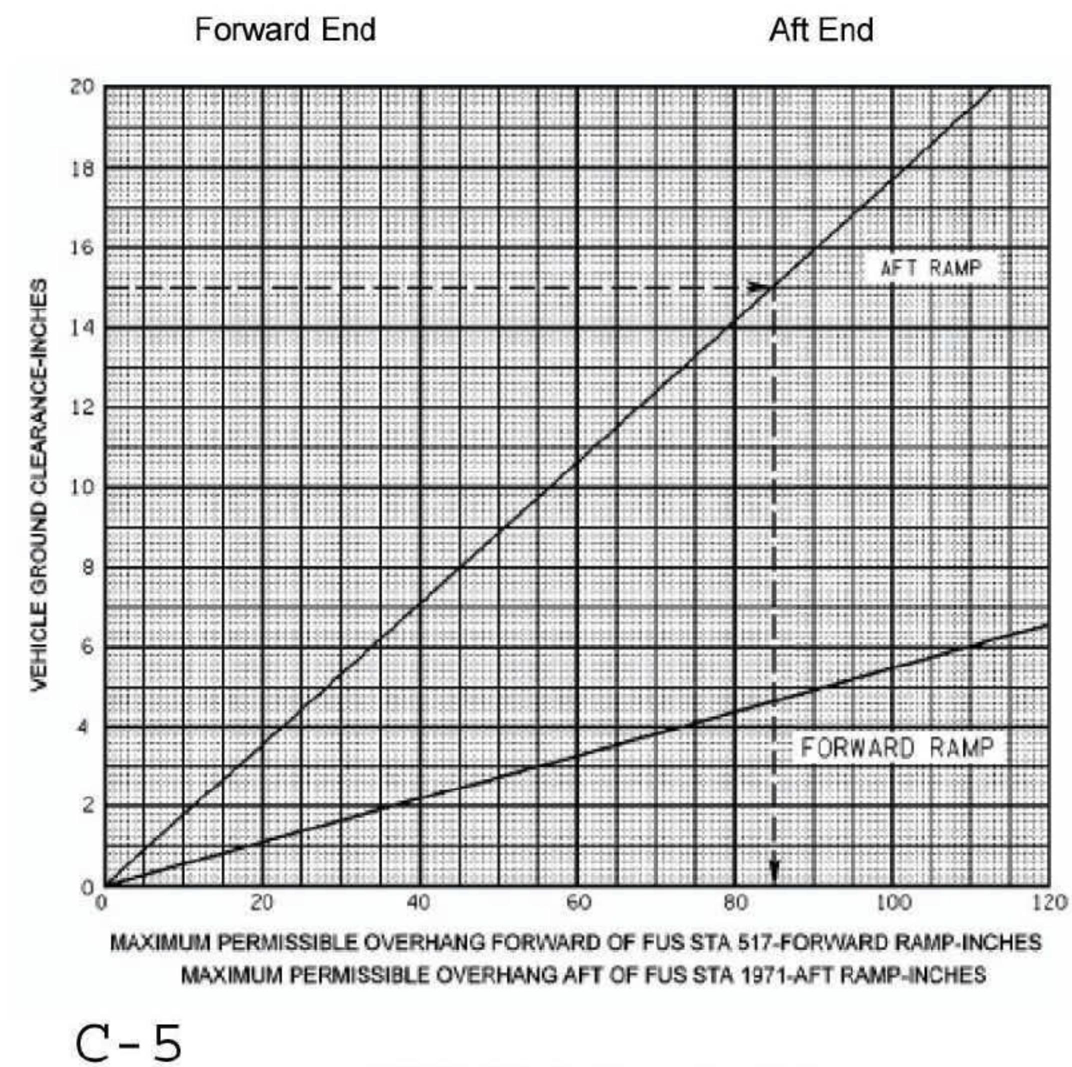
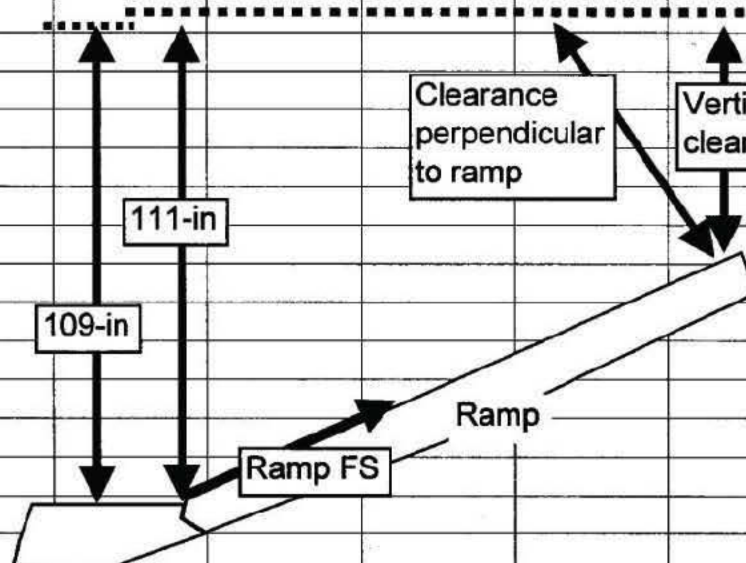


FIGURE B-53. Parking overhang limits

C-130
Ramp Length =123-in
Ramp angle = 21.48-deg

*Clearance Ramp FS 0 to 40 protrudes into cargo compartment with height limit of 109-in

	Ramp FS (in)	Ht above cargo floor (in)	Vertical clearance w/ ramp closed (in)	Clearance perpendicular to ramp w/ ramp closed (in)*
Ramp Hinge	0	111	111.0	117.1
	5	111	109.2	115.2
	10	111	107.3	113.2
	15	111	105.5	111.2
	20	111	103.7	109.3
	25	111	101.8	107.3
	30	111	100.0	105.3
	35	111	98.2	103.4
	40	111	96.4	101.4
	45	111	94.5	101.6
	50	111	92.7	99.6
	55	111	90.9	97.6
	60	111	89.0	95.7
	65	111	87.2	93.7
	70	111	85.4	91.7
	75	111	83.5	89.8
	80	111	81.7	87.8
	85	111	79.9	85.8
	90	111	78.0	83.9
	95	111	76.2	81.9
	100	111	74.4	79.9
	105	111	72.6	78.0
	110	111	70.7	76.0
	115	111	68.9	74.0
	120	111	67.1	72.1
End of ramp	123	111	66.0	70.9



C-130

FIGURE B-54. C-130 ramp loadable height

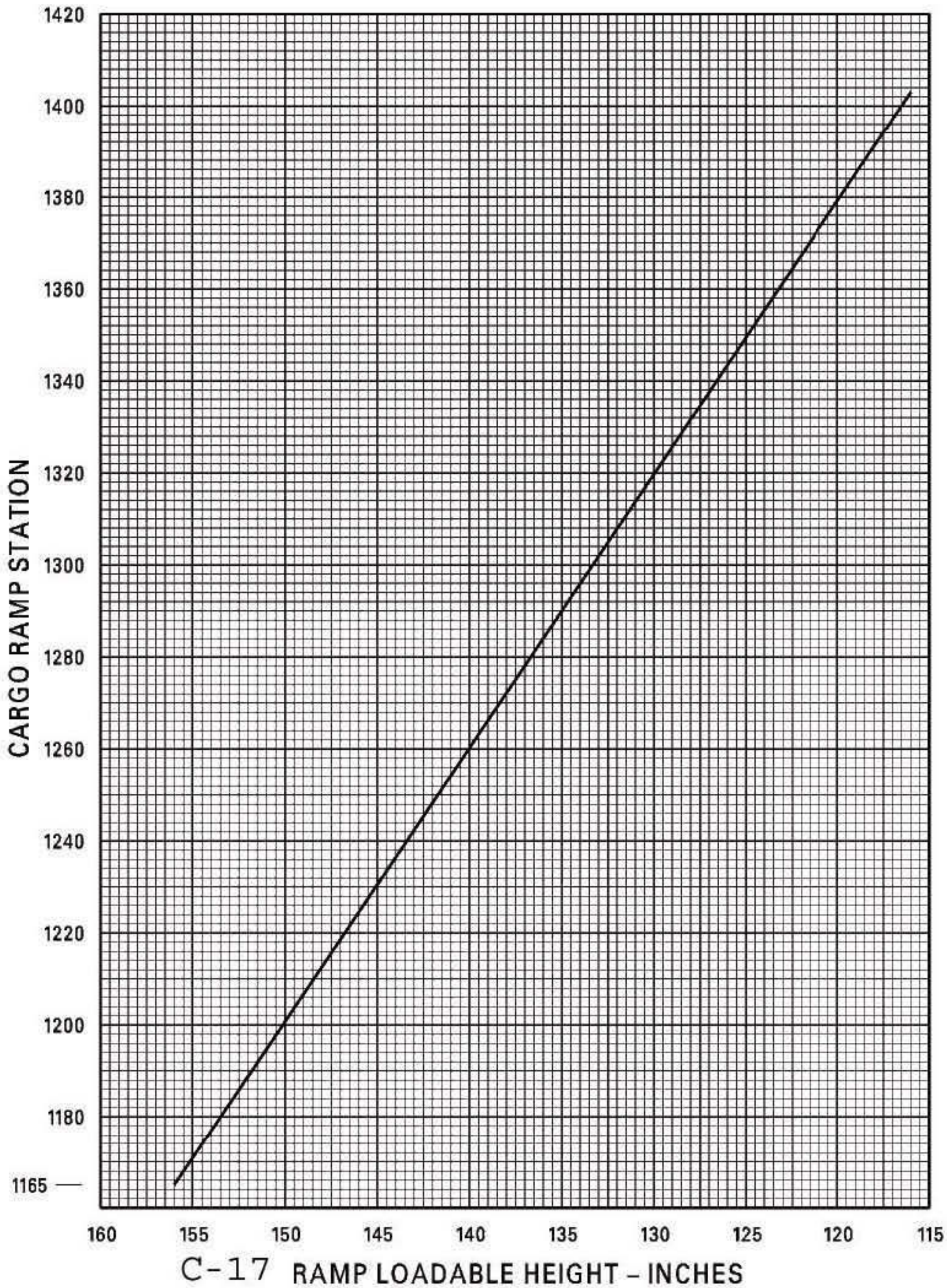
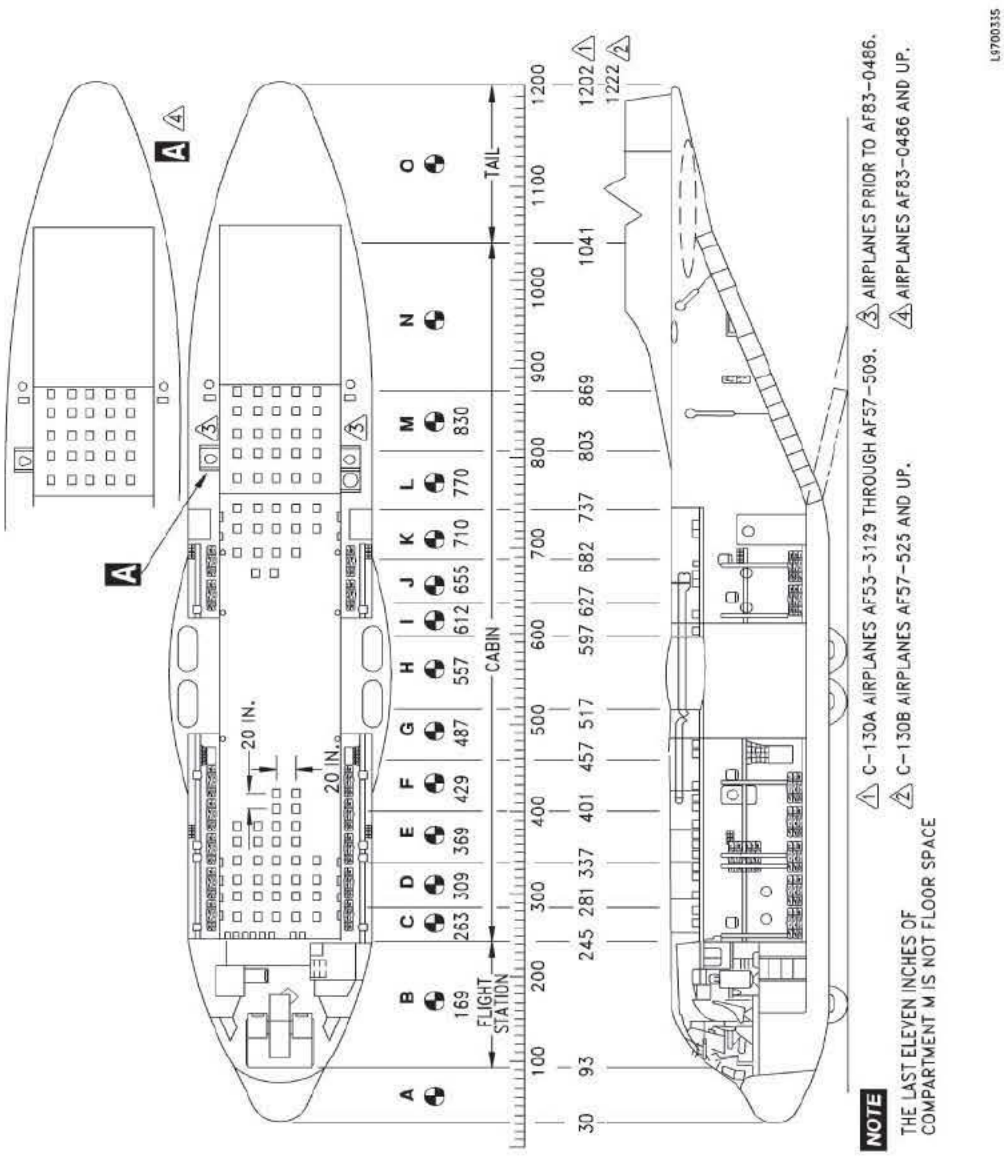


FIGURE B-55. Allowable in-flight ramp loadable height

B.3.2	**Weight**	# pages
B.3.2.1	Floor Capacity	26
B.3.2.2	Ramp capacity	12
B.3.2.3	Hard wheel limits	4
B.3.2.4	463L	13

C-130E/H Cargo Compartments



(Aircraft 53-3129 Through 57-509 and 57-525 and Up)

FIGURE B-56.

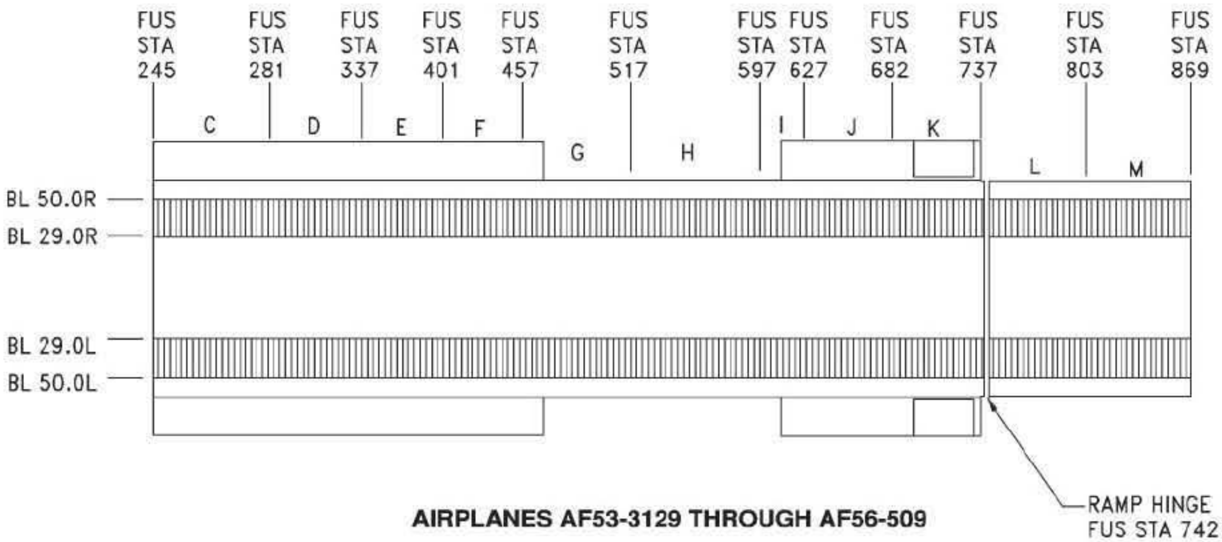


FIGURE 57.

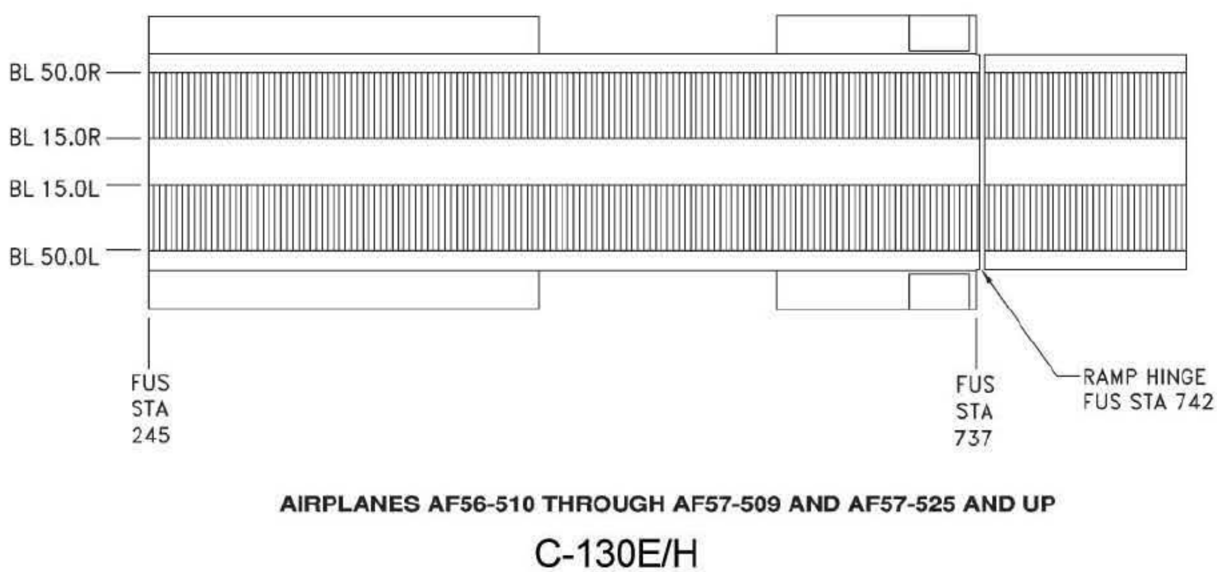


FIGURE B-58. Treadways

C-130E/H Floor Loading Capacity, Ground

GROUND LIMITS

GENERAL

1	FUSELAGE STATION		245	281	337	401	457	517	597	627	682	737	803	869
2	COMPARTMENTS		C	D	E	F	G	H	I	J	K	L	M	
3	FLOOR AREA (APPROX)	SQ FT	31	48	55	48	51	68	26	47	47	56	56	
4	USABLE VOLUME	CU FT	280	430	495	430	460	610	235	420	420	450	280	

LOADING AND UNLOADING LIMITS

				C	D	E	F	G	H	I	J	K	L	M
1		MAXIMUM INDIVIDUAL COMPARTMENT CAPACITY	LB	20,000	30,000	40,000	40,000	40,000	40,000	37,000	40,000	30,000	26,000	26,000
2	BULK CARGO	CONCENTRATED LOADS—ALL AREAS ⚠3	PSI	50	50	50	50	50	50	50	50	50	50	50
	BULK CARGO	RUNNING LOAD PER TREADWAY ⚠1	PSI	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
			LB/LIN FT	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
	BULK CARGO	RUNNING LOAD BETWEEN TREADWAY ⚠1	PSI	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
			LB/LIN FT	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800
3 ⚠6	WHEELED CARGO	PNEUMATIC TIRES — 100 PSI MAX. TIRE PRESSURE — FOUR FEET MINIMUM DISTANCE BETWEEN AXLES ⚠9												
	WHEELED CARGO	AXLE LOAD: TREADWAYS	LB	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000
	WHEELED CARGO	AXLE LOAD: BETWEEN TREADWAY	LB	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
	WHEELED CARGO	TONGUE LOAD BETWEEN TREADWAYS	LB ⚠2	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
4		PALLETIZED CARGO—DUAL RAIL (ONE OR MORE LATERAL CONVEYORS)	LB/LIN FT	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
5		PALLETIZED CARGO—DUAL RAIL (ONE OR MORE LATERAL CONVEYORS)	LB/ ROLLER	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000

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FIGURE B-59.

Concentrated or Pneumatic Tire Loads (Aircraft 53-3129 through 57-509 and 57-525 and Up)

C-130E/H Floor Loading Capacity, Flight

FLIGHT LIMITS

GENERAL

1	FUSELAGE STATION		245 281 337 401 457 517 597 627 682 737 803 869										
2	COMPARTMENTS		C	D	E	F	G	H	I	J	K	L	M
3	FLOOR AREA (APPROX)	SQ FT	31	48	55	48	51	68	26	47	47	56	56
4	USABLE VOLUME	CU FT	280	430	495	430	460	610	235	420	420	450	280

FLIGHT LIMITS

				C	D	E	F	G	H	I	J	K	L	M
1	MAXIMUM INDIVIDUAL COMPARTMENT CAPACITY		LB	8,400	12,900	19,500	28,000	30,000	30,000	15,000	24,400	12,700	2,500	2,500
2 ⚠5	BULK CARGO	CONCENTRATED LOADS–ALL AREAS ⚠3	PSI	50	50	50	50	50	50	50	50	50	50	50
		RUNNING LOAD PER TREADWAY ⚠1	PSI	3.4	3.4	7.2	7.2	7.2	7.2	7.2	7.2	3.4	1.2	1.2
			LB/LIN FT	1,400	1,400	3,000	3,000	3,000	3,000	3,000	3,000	1,400	500	500
		RUNNING LOAD BETWEEN TREADWAY ⚠1	PSI	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	1.3	1.3
			LB/LIN FT	1,400	1,400	1,600	1,600	1,600	1,600	1,600	1,600	1,400	500	500
3 ⚠6	WHEELED CARGO	PNEUMATIC TIRES – 100 PSI MAX. TIRE PRESSURE – FOUR FEET MINIMUM DISTANCE BETWEEN AXLES ⚠9												
		AXLE LOAD – TREADWAYS	LB	6,000	6,000	13,000	13,000	13,000	13,000	13,000	13,000	6,000	2,500 ⚠8	2,500 ⚠8
		AXLE LOAD – BETWEEN TREADWAYS	LB	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	1,200	1,200
		TONGUE LOAD BETWEEN TREADWAYS	LB ⚠2	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	450	450
4	PALLETIZED CARGO–DUAL RAIL (ONE OR MORE LATERAL CONVEYORS)		LB/LIN FT	2,800	2,800	3,200	3,200	3,200	3,200	3,200	3,200	2,800	1,000	1,000
5 ⚠7	PALLETIZED CARGO–DUAL RAIL (ONE OR MORE LATERAL CONVEYORS)		LB/ROLLER	2,333	2,333	2,667	2,667	2,667	2,667	2,667	2,667	2,333	833	833

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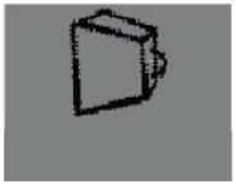

FIGURE B-60

Concentrated or Pneumatic Tire Loads (Aircraft 53-3129 through 57-509 and 57-525 and Up)

C-130E/H Floor Loading Capacity, Notes

NOTE

1. TREADWAY LOAD MUST BE SYMMETRICAL ABOUT THE AIRPLANE CENTERLINE. TREADWAY AND NON–TREADWAY AREAS MUST NOT BE LOADED SIMULTANEOUSLY TO MAXIMUM VALUES SHOWN. LOAD LIMITS BETWEEN TREADWAYS MAY EXTEND OVER ENTIRE CARGO FLOOR WIDTH. SHORING MAY BE REQUIRED FOR ROLLING LOADS OUTSIDE TREADWAYS.

2. NOT TO EXCEED 50 PSI.

3. CONCENTRATED LOAD IS DEFINED AS A LOAD IN WHICH THE WEIGHT IS CONCENTRATED AT A POINT ON THE CARGO AREA FLOOR AND THE CONTACT SURFACE BETWEEN THE LOAD AND THE FLOOR IS VERY SMALL WHEN COMPARED TO THE SIZE AND WEIGHT OF THE TOTAL PACKAGE.

4. THIS CHART IS USED AS A REFERENCE TO DETERMINE THE AVAILABLE AREA AND VOLUME OF CARGO AREA COMPARTMENTS. THE CHART IS ALSO USED AS A REFERENCE TO DETERMINE THE STRUCTURAL LIMITS (FLIGHT AND GROUND OPERATIONS) OF EACH COMPARTMENT FOR VARIOUS TYPES OF CARGO. LOADING OF CARGO MUST TAKE INTO CONSIDERATION AIRPLANE GROSS WEIGHT AND CENTER OF GRAVITY CALCULATED FOR FLIGHT PURPOSES. FOR ANY TYPE OF LOAD, DO NOT EXCEED THE MAXIMUM COMPARTMENT CAPACITY LIMIT, POUNDS LIMIT PSI LIMIT, OR THE POUNDS PER LINEAR FEET LIMIT.

   AN EXAMPLE FOR USE OF THE CHART FOR FLIGHT LOADING IS AS FOLLOWS:

   A. DETERMINE DIMENSIONS OF CARGO.
   B. DETERMINE WEIGHT OF CARGO.
      (1) GROSS WEIGHT
      (2) AXLE AND TONGUE LOADS (IF WHEELED CARGO)
      (3) PSI AND POUNDS/LINEAR FOOT IF BULK CARGO.
   C. DETERMINE DESIRED LOADING POSITION IN AIRPLANE (WEIGHT AND BALANCE DATA MUST BE CONSIDERED).
   D. CHECK CHART TO DETERMINE IF FLOOR LOADING CAPACITY IS ADEQUATE FOR SELECTED LOADING AREA. IF ANY LIMIT IS EXCEEDED, CHECK SHORING REQUIREMENTS TO SPREAD LOAD OVER GREATER FLOOR AREA OR SELECT AREA HAVING GREATER CAPACITY.

5. LOAD LIMITS FOR UNIFORM LOADING OVER ENTIRE CARGO FLOOR (COMPARTMENTS C–K ONLY) ARE 3.0 PSI AND 4,300 LBS/LIN FT.

6. MEASURE THE DISTANCE BETWEEN THE EXTREME POINTS THROUGH WHICH THE LOAD IS APPLIED. IN THE CASE OF MOST VEHICLES, THIS WILL BE THE WHEELBASE. IF THE VEHICLE HAS ONE AXLE AND ONE RESTING POINT, MEASURE THE DISTANCE FROM THE CENTER OF THE AXLE TO THE CENTER OF THE RESTING POINT. DIVIDE THE GROSS WEIGHT OF THE LOAD BY THE DISTANCE EXPRESSED IN FEET. IF THE RESULT (IN POUNDS PER LINEAR FOOT) IS MORE THAN 2,800 BUT LESS THAN 6,000 THE VEHICLE MUST BE PLACED SO THAT ITS AXLES OR RESTING POINTS WILL NOT BE FORWARD OF FUSELAGE STATION 337 OR AFT OF FUSELAGE STATION 682.

7. A. SOME LOADS MAY REQUIRE THE COMPUTING OF ROLLER LOAD LIMITS TO DETERMINE IF THE OBJECT IS SUITABLE FOR LOADING.

   THE POUND/ROLLER LIMITS IN THE CHART ARE BASED ON A ROLLER STATION. A ROLLER STATION IS DEFINED AS THE LATERAL ALIGNMENT OF 4 ROLLERS ON A FUSELAGE STATION. THE CHART LIMITS APPLY WHETHER ONE ROLLER OR ALL FOUR ROLLERS AT A ROLLER STATION ARE CONTACTED.

   COMPUTE THE ROLLER LOADS BY USING LONGITUDINAL CONTACT LENGTH ON THE PALLET. A CONTACT LENGTH OF 1 INCH TO 19 INCHES WILL ONLY GUARANTEE ONE ROLLER STATION CONTACTED (SEE EXAMPLE 1A).

   FOR EACH ADDITIONAL 1 TO 10 INCHES OF LONGITUDINAL CONTACT LENGTH, ONE ADDITIONAL ROLLER STATION WILL BE CONTACTED (SEE EXAMPLE 1B). IN ALL CASES, THE FIRST DIGIT OF THE ACTUAL CONTACT LENGTH (IN INCHES) DETERMINES THE NUMBER OF LONGITUDINAL ROLLER STATIONS CONTACTED, I.E., A SKID LENGTH OF 56 INCHES RESULTS IN CONTACT AT 5 ROLLER STATIONS, ETC. A MAXIMUM OF 8 ROLLER STATIONS MAY BE CONTACTED ON A 463L PALLET (SEE EXAMPLE 1C).

   SKIDS PLACED LATERALLY ON A PALLET WILL USUALLY ONLY CONTACT ONE ROLLER STATION (SEE EXAMPLE 2) AND MAY REQUIRE SHORING TO CONTACT ADDITIONAL ROLLER STATIONS (SEE EXAMPLE 3).

   B. THE ROLLER STATION LOAD CAN BE COMPUTED BY DIVIDING THE WEIGHT OF THE CARGO BY THE NUMBER OF ROLLER STATIONS CONTACTED.

   FOR EXAMPLE, AN 8,000–LB OBJECT IS UNIFORMLY DISTRIBUTED IN TWO CONTACT STATIONS OF 25 INCHES EACH (4 ROLLER STATIONS CONTACTED). THE ROLLER STATION LOAD IS FOUND BY DIVIDING 8,000 BY 4. IF THE RESULTING FIGURE (ROLLER LOAD) IS EQUAL TO OR LESS THAN THAT GIVEN IN THE ROLLER LOADS COLUMN (LOADING OR UNLOADING LIMITS), THE OBJECT MAY BE LOADED. THE RESULTING FIGURE (ROLLER LOAD) MUST BE EQUAL TO OR LESS THAN THAT GIVEN IN THE ROLLER LOADS COLUMN (FLIGHT LIMITS) FOR FLIGHT REQUIREMENTS. IF THE CALCULATED FIGURE IS GREATER THAN THAT IN THE ROLLER LOAD COLUMN, THE OBJECT MAY NOT BE LOADED WITHOUT SHORING. EITHER BRIDGE TYPE OR SIMPLE SHORING MAY BE USED TO SATISFY ROLLER LOAD CRITERIA. IF BRIDGE TYPE SHORING IS USED (REFER TO SECTION 4), IT SHOULD BE PLACED LONGITUDINALLY ON THE PALLET AND THE MINIMUM DISTANCE SHOULD BE 20 INCHES. IF SIMPLE SHORING IS USED, THE CONTACT LENGTH BEARING

L9700329

Concentrated or Pneumatic Tire Loads (Aircraft 53-3129 through 57-509 and 57-525 and Up)

FIGURE B-61. Sheet 1 or 2

C-130E/H Floor Loading Capacity, Notes

SURFACE OF THE PALLET AT EACH CONTACT POINT MUST BE A MINIMUM OF 20 INCHES UTILIZING THE PRINCIPLE OF SHORING EFFECT.

8 A SINGLE AXLE WEIGHT UP TO 3,500 LB MAY BE TRANSPORTED ON THE AIRPLANE RAMP PROVIDED IT IS THE ONLY ITEM ON THE RAMP.

NOTE

THIS CHART IS PROVIDED FOR INSERTION IN THE ALLOWABLE LOAD INSTRUCTION PLATE HOLDER (PLASTIC ENVELOPE) AT R/H FUSELAGE STATION 490 ON AIRPLANES AF64-517 AND UP.

NOTE

THIS CHART MAY BE REPRODUCED AND PLACED IN THE CHART HOLDER ON THE AIRPLANE.

NOTE

50 PSI RESTRICTION FOR ON TREADWAY DOES NOT APPLY TO PNEUMATIC TIRES THAT HAVE 100 PSI OR LESS INTERNAL TIRE PRESSURE. IF INTERNAL TIRE PRESSURE EXCEEDS 100 PSI, REFER TO SPECIFIC PROCEDURES IN Chapter 6, ASC CERTIFICATION PROCEDURES, OR REFER TO TABLE 4-I-2

NOTE

LARGE VEHICLES WITH HEAVY AXLE LOADS OF MORE THAN 7,000 POUNDS (I.E., FRONT END LOADER, FORK LIFTS, TRUCKS, ETC.) SHALL BE TIED DOWN SO THAT THE AXLE LOAD IS NOT BETWEEN STATIONS 577 AND 617. THIS RESTRICTION APPLIES TO ALL AIRPLANES EXCEPT C-130A/H, AIRPLANES WITH LESS THAN 6,000 FLIGHT HOURS, AND AIRPLANES INSPECTED IN ACCORDANCE WITH TO 1C-130A-6WC-15, WORK CARDS 2-003 AND 2-004, ON WHICH NO CRACKS WERE FOUND.

NOTE

USE BULK CARGO LOAD LIMITS WHEN BRIDGE SHORING IS USED.

9 IF UNIT AXLES ARE LESS THAN 4 FEET APART, THE SUM OF THE AXLE WEIGHTS MUST NOT EXCEED COMPARTMENT LOAD LIMITS.

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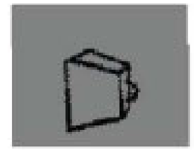
Concentrated or Pneumatic Tire Loads (Aircraft 53-3129 through 57-509 and 57-525 and Up)

FIGURE B-61. Sheet 2 - Continue



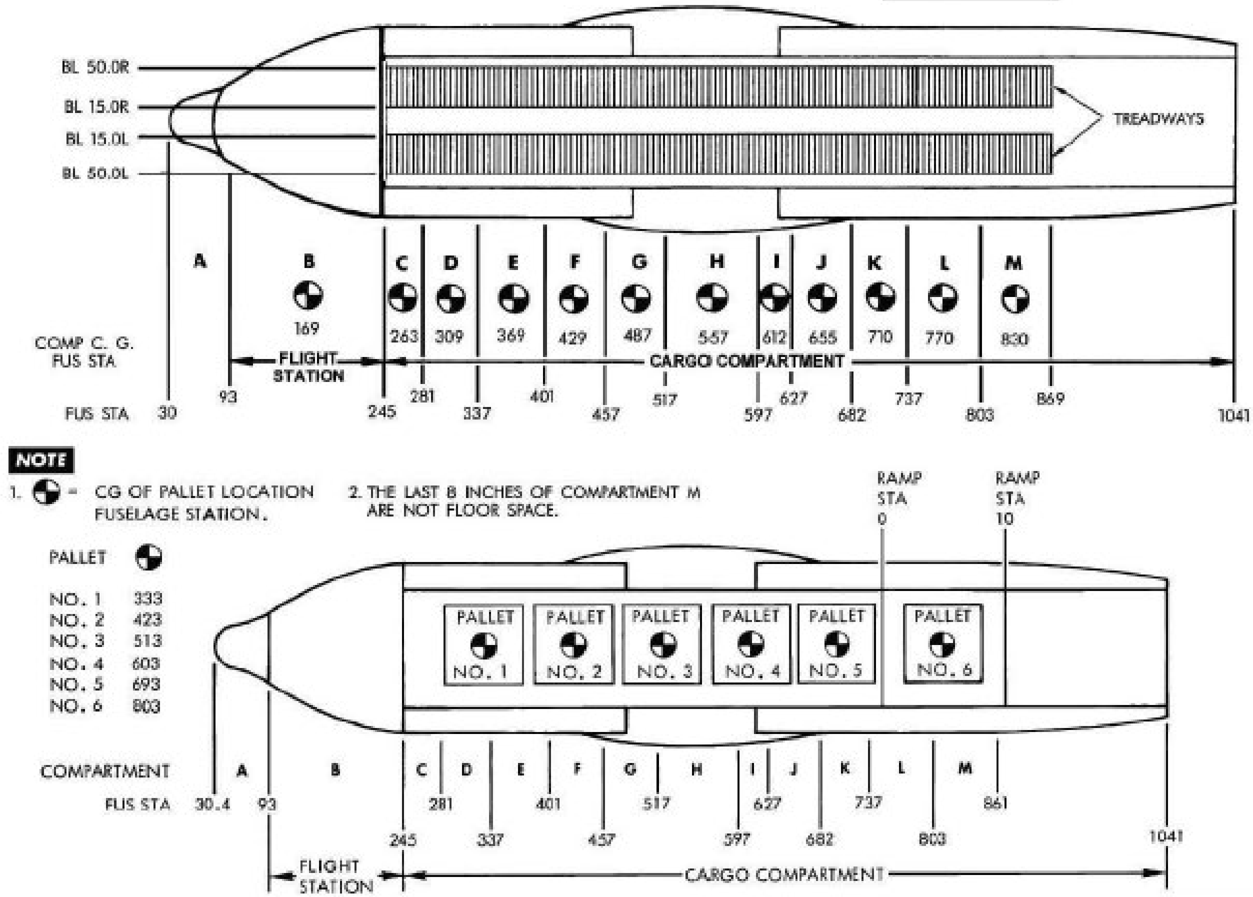


FIGURE B-62. Compartments, treadways and pallet centriods

C-130J

GROUND LIMITS

GENERAL (5)

			C	D	E	F	G	H	I	J	K	L	M	
1	FUSELAGE STATION	245	281	337	401	457	517	597	627	682	737	803	869	
2	COMPARTMENTS		C	D	E	F	G	H	I	J	K	L	M	
3	FLOOR AREA (APPROX)	SQ FT	31	48	55	48	51	68	26	47	47	56	56	
4	USABLE VOLUME	CU FT	280	430	495	430	460	610	235	420	420	450	280	

LOADING AND UNLOADING LIMITS

				C	D	E	F	G	H	I	J	K	L	M
1	MAXIMUM INDIVIDUAL COMPARTMENT CAPACITY		LB	9,000	14,000	16,000	14,000	15,000	20,000	7,500	13,750	13,750	16,500	16,500
2	BULK CARGO	CONCENTRATED LOADS–ALL AREAS (3)	PSI	50	50	50	50	50	50	50	50	50	50	50
		RUNNING LOAD PER TREADWAYS (1)	PSI	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
			LB/LIN FT	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
		RUNNING LOAD BETWEEN TREADWAYS (1)	PSI	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
			LB/LIN FT	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600

COMPARTMENTS						C	D	E	F	G	H	I	J	K	L	M
3	WHEELED CARGO	AXLE LOAD (5)	PNEUMATIC TIRES, 100 PSI MAXIMUM PRESSURE (8)	TREADWAYS	LBS	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000
				BETWEEN TREADWAYS	LBS	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
		TONGUE LOADS BETWEEN TREADWAYS (2)			LBS	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
4	PALLETIZED CARGO-DUAL RAIL (ONE OR MORE LATERAL CONVEYORS)				LB/LIN FT	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200
5	PALLETIZED CARGO-DUAL RAIL (ONE OR MORE LATERAL CONVEYORS) (16)				LB/ROLLER	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2667

FIGURE B-63. Floor loading capacity - concentrated or pneumatic tire loads

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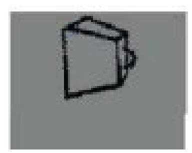

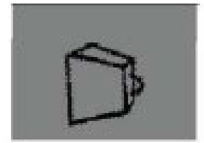

FLIGHT LIMITS (CONT)

COMPARTMENTS					C	D	E	F	G	H	I	J	K	L	M
3	WHEELED CARGO	AXLE LOAD △5 — PNEUMATIC TIRES, 100 PSI MAXIMUM PRESSURE △8	TREADWAYS	LBS	6,000	6,000	13,000	13,000	13,000	13,000	13,000	13,000	6,000	2,500 △17	2,500 △17
			BETWEEN TREADWAYS	LBS	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	1,200	1,200
		TONGUE LOADS BETWEEN TREADWAYS △2		LBS	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	450	450
4	PALLETIZED CARGO-DUAL RAIL (ONE OR MORE LATERAL CONVEYORS)			LB/LIN FT	2,800	2,800	3,200	3,200	3,200	3,200	3,200	3,200 △6	2,800 △6	1,000	1,000
5	PALLETIZED CARGO-DUAL RAIL (ONE OR MORE LATERAL CONVEYORS) △6			LB/ROLLER	2,333	2,333	2,667	2,667	2,667	2,667	2,667	2,667 △6	2,333 △6	833	833

NOTE

△1 TREADWAY LOAD MUST BE SYMMETRICAL ABOUT THE AIRPLANE CENTERLINE. TREADWAY AND NON-TREADWAY AREAS MUST NOT BE LOADED SIMULTANEOUSLY TO MAXIMUM VALUES SHOWN. LOAD LIMITS BETWEEN TREADWAYS MAY EXTEND OVER ENTIRE CARGO FLOOR WIDTH. SHORING MAY BE REQUIRED FOR ROLLING LOADS OUTSIDE TREADWAYS.

△2 NOT TO EXCEED 50 PSI.

△3 CONCENTRATED LOAD IS DEFINED AS A LOAD IN WHICH THE WEIGHT IS CONCENTRATED AT A POINT ON THE CARGO AREA FLOOR AND THE CONTACT SURFACE BETWEEN THE LOAD AND THE FLOOR IS VERY SMALL WHEN COMPARED TO THE SIZE AND WEIGHT OF THE TOTAL PACKAGE.

4. MAXIMUM CARGO HEIGHT IN THE CARGO COMPARTMENT IS 108 IN. WHEN ROLLER CONVEYORS ARE INSTALLED, MAXIMUM CARGO HEIGHT IS REDUCED 1.5 INCHES.

△5 IF AXLES ARE LESS THAN 4 FEET APART, THE SUM OF THE AXLE WEIGHTS MUST NOT EXCEED AXLE LOAD LIMITS.

△6 THE CARGO LOADING SYSTEM RESTRAINT RAIL SECTIONS BETWEEN FUSELAGE STATIONS 649 AND 737 ARE LIMITED TO 8,500 LBS TOTAL WEIGHT RESTRAINT.

7. SEE TABLE 4-4 FOR HARD RUBBER TIRE AND STEEL WHEEL LIMITATIONS.

△8 MAXIMUM WHEEL LOAD PER TREADWAY IS EQUAL TO HALF THE ALLOWABLE AXLE LOAD.

9. MAXIMUM HEIGHT OF PALLETIZED CARGO ON THE RAMP IS 76 IN. AS MEASURED FROM THE TOP SURFACE OF THE PALLET, WHEN THE PALLET CENTROID IS AT F.S. 803.

△10 LOAD LIMITS FOR UNIFORM LOADING OVER ENTIRE CARGO FLOOR (COMPARTMENTS C-K ONLY) ARE 3.0 PSI AND 1,600 LBS/LIN FT.

△11 CENTER OF GRAVITY OF THE CUMULATIVE LOAD SHOWN IN ALL COMBINED COMPARTMENTS C THROUGH H MUST FALL AFT OF THE CENTER OF THE LOADED COMPARTMENTS (GIVEN IN PARENTHESIS).

△12 CENTER OF GRAVITY OF THE CUMULATIVE LOAD SHOWN IN ALL COMBINED COMPARTMENTS H THROUGH M MUST FALL FORWARD OF THE LOADED COMPARTMENTS (GIVEN IN PARENTHESIS).

△13 THE VALUES IN BRACKETS, { }, DENOTE MAXIMUM CUMULATIVE COMPARTMENT CAPACITIES IF MORE THAN 3 CREW MEMBERS ARE LOCATED IN THE FLIGHT STATION.

FIGURE B-64. Floor loading capacity - concentrated or pneumatic tire loads (sheet 1 of 2)

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NOTE

14 IN ADDITION TO FLOOR LIMITATIONS AND COMPARTMENT CAPACITIES, A WEIGHT AND CG RESTRICTION FOR CARGO PLACED ON THE RAMP IS IMPOSED. THE CG OF THE GIVEN LOAD MUST FALL AT OR FORWARD OF THE FOLLOWING FUSELAGE STATIONS.

(FS)	(WEIGHT OF CARGO)
803	5000
810	4835
820	4620
830	4420
840	4240
850	4070

THE RAMP CENTROID IS FS 803 AND THE LOCATION OF THE RAMP LOCK DETENT. LINEAR INTERPOLATION BETWEEN THE LOADS IS ACCEPTABLE.

15 THIS CHART IS USED AS A REFERENCE TO DETERMINE THE AVAILABLE AREA AND VOLUME OF CARGO AREA COMPARTMENTS. THE CHART IS ALSO USED AS A REFERENCE TO DETERMINE THE STRUCTURAL LIMITS (FLIGHT AND GROUND OPERATIONS) OF EACH COMPARTMENT FOR VARIOUS TYPES OF CARGO. LOADING OF CARGO MUST TAKE INTO CONSIDERATION AIRPLANE GROSS WEIGHT AND CENTER OF GRAVITY CALCULATED FOR FLIGHT PURPOSES. FOR ANY TYPE OF LOAD, DO NOT EXCEED OVERALL AIRPLANE RESTRICTIONS.

AN EXAMPLE FOR USE OF THE CHART FOR FLIGHT LOADING IS AS FOLLOWS:

A. DETERMINE DIMENSIONS OF CARGO.
B. DETERMINE WEIGHT OF CARGO.
   (1) GROSS WEIGHT
   (2) AXLE AND TONGUE LOADS (IF WHEELED CARGO)
   (3) PSI AND POUNDS/LINEAR FOOT IF BULK CARGO.
C. DETERMINE DESIRED LOADING POSITION IN AIRPLANE (WEIGHT AND BALANCE DATA MUST BE CONSIDERED).
D. CHECK CHART TO DETERMINE IF FLOOR LOADING CAPACITY IS ADEQUATE FOR SELECTED LOADING AREA. IF ANY LIMIT IS EXCEEDED, CHECK SHORING REQUIREMENTS TO SPREAD LOAD OVER GREATER FLOOR AREA OR SELECT AREA HAVING GREATER CAPACITY.

16 A. SOME LOADS MAY REQUIRE THE COMPUTING OF ROLLER LOAD LIMITS TO DETERMINE IF THE OBJECT IS SUITABLE FOR LOADING.

THE POUND/ROLLER LIMITS IN THE CHART ARE BASED ON A ROLLER STATION. A ROLLER STATION IS DEFINED AS THE LATERAL ALIGNMENT OF 4 ROLLERS ON A FUSELAGE STATION. THE CHART LIMITS APPLY WHETHER ONE ROLLER OR ALL FOUR ROLLERS AT A ROLLER STATION ARE CONTACTED.

COMPUTE THE ROLLER LOADS BY USING LONGITUDINAL CONTACT LENGTH ON THE PALLET. A CONTACT LENGTH OF 1 INCH TO 19 INCHES WILL ONLY GUARANTEE ONE ROLLER STATION CONTACTED (SEE EXAMPLE 1A).

FOR EACH ADDITIONAL 1 TO 10 INCHES OF LONGITUDINAL CONTACT LENGTH, ONE ADDITIONAL ROLLER STATION WILL BE CONTACTED (SEE EXAMPLE 1B). IN ALL CASES, THE FIRST DIGIT OF THE ACTUAL CONTACT LENGTH (IN INCHES) DETERMINES THE NUMBER OF LONGITUDINAL ROLLER STATIONS CONTACTED, I.E., A SKID LENGTH OF 56 INCHES RESULTS IN CONTACT AT 5 ROLLER STATIONS, ETC. A MAXIMUM OF 8 ROLLER STATIONS MAY BE CONTACTED ON A 463L PALLET (SEE EXAMPLE 1C).

SKIDS PLACED LATERALLY ON A PALLET WILL USUALLY ONLY CONTACT ONE ROLLER STATION (SEE EXAMPLE 2) AND MAY REQUIRE SHORING TO CONTACT ADDITIONAL ROLLER STATIONS (SEE EXAMPLE 3).

B. THE ROLLER STATION LOAD CAN BE COMPUTED BY DIVIDING THE WEIGHT OF THE CARGO BY THE NUMBER OF ROLLER STATIONS CONTACTED.

FOR EXAMPLE, AN 8,000-LB OBJECT IS UNIFORMLY DISTRIBUTED IN TWO CONTACT STATIONS OF 25 INCHES EACH (4 ROLLER STATIONS CONTACTED). THE ROLLER STATION LOAD IS FOUND BY DIVIDING 8,000 BY 4. IF THE RESULTING FIGURE (ROLLER LOAD) IS EQUAL TO OR LESS THAN THAT GIVEN IN THE ROLLER LOADS COLUMN (LOADING OR UNLOADING LIMITS), THE OBJECT MAY BE LOADED. THE RESULTING FIGURE (ROLLER LOAD) MUST BE EQUAL TO OR LESS THAN THAT GIVEN IN THE ROLLER LOADS COLUMN (FLIGHT LIMITS) FOR FLIGHT REQUIREMENTS. IF THE CALCULATED FIGURE IS GREATER THAN THAT IN THE ROLLER LOAD COLUMN, THE OBJECT MAY NOT BE LOADED WITHOUT SHORING. EITHER BRIDGE TYPE OR SIMPLE SHORING MAY BE USED TO SATISFY ROLLER LOAD CRITERIA. IF BRIDGE TYPE SHORING IS USED (REFER TO SECTION 4), IT SHOULD BE PLACED LONGITUDINALLY ON THE PALLET AND THE MINIMUM DISTANCE SHOULD BE 20 INCHES. IF SIMPLE SHORING IS USED, THE CONTACT LENGTH BEARING

17 A SINGLE AXLE LOAD UP TO 3,500 POUNDS MAY BE CARRIED ON THE RAMP PROVIDED IT IS THE ONLY ITEM ON THE RAMP AND IS POSITIONED BETWEEN TIEDOWN RING ROWS.

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FIGURE B-65. Floor loading capacity - concentrated or pneumatic tire loads (sheet 2)

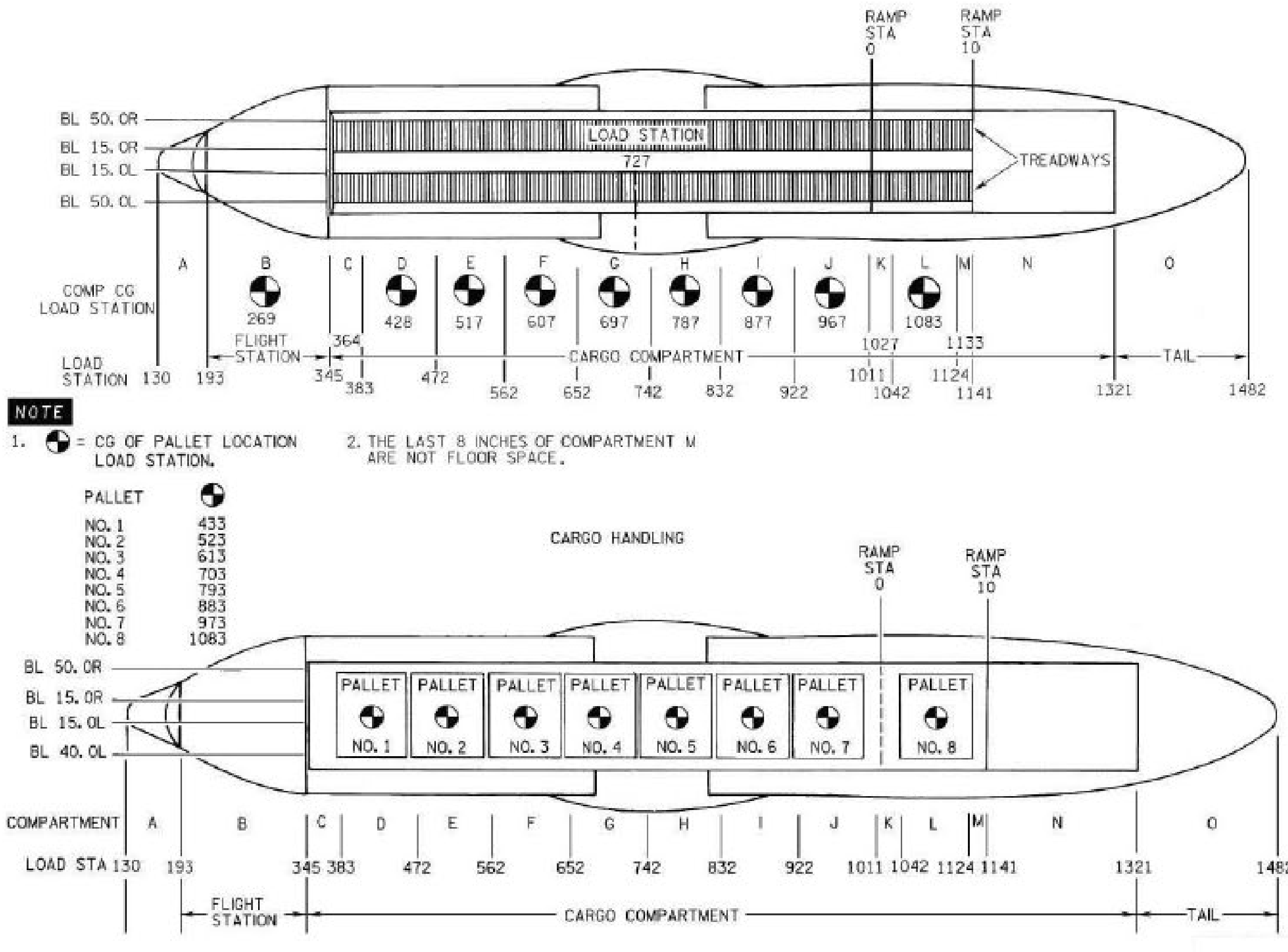

FIGURE B-66. Compartments, treadways and pallet centroids

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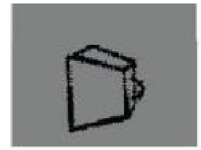

GROUND LIMITS

GENERAL △15

			C	D	E	F	G	H	I	J	K	L	M
1	LOAD STATION	345	383	472	562	652	742	832	922	1011	1042	1124	1141
2	COMPARTMENTS		C	D	E	F	G	H	I	J	K	L	M
3	FLOOR AREA (APPROX)	SQ FT	32	76	77	77	77	75	77	76	27	71	15
4	USABLE VOLUME	CU FT	292	684	692	692	678	676	692	684	219	454	73

LOADING AND UNLOADING LIMITS

				C	D	E	F	G	H	I	J	K	L	M
1		MAXIMUM INDIVIDUAL COMPARTMENT CAPACITY	LB	9,500	22,250	22,500	22,500	22,500	22,500	22,500	22,250	7,750	20,500	4,250
2	BULK CARGO	CONCENTRATED LOADS– ALL AREAS △3	PSI	50	50	50	50	50	50	50	50	50	50	50
		RUNNING LOAD PER TREADWAYS △1	PSI	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
			LB/LIN FT	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
		RUNNING LOAD BETWEEN TREADWAYS △1	PSI	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
			LB/LIN FT	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600

COMPARTMENTS						C	D	E	F	G	H	I	J	K	L	M
3	WHEELED CARGO	AXLE LOAD △5	PNEUMATIC TIRES, 100 PSI MAXIMUM PRESSURE △8	TREADWAYS	LBS	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000
				BETWEEN TREADWAYS	LBS	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
		TONGUE LOADS BETWEEN TREADWAYS △2			LBS	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
4	PALLETIZED CARGO-DUAL RAIL (ONE OR MORE LATERAL CONVEYORS)				LB/LIN FT	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200
5	PALLETIZED CARGO-DUAL RAIL (ONE OR MORE LATERAL CONVEYORS) △6				LB/ROLLER	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667

FIGURE B-67. Floor loading capacity - concentrated or pneumatic tire loads

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FLIGHT LIMITS (CONT)

COMPARTMENTS					C	D	E	F	G	H	I	J	K [Δ14]	L [Δ14]	M [Δ14]
3	WHEELED CARGO	AXLE LOAD [Δ5] PNEUMATIC TIRES, 100 PSI MAXIMUM PRESSURE [Δ8]	TREADWAYS	LBS	6,000	6,000	6,000 [Δ19]	13,000	13,000	13,000	6,000 [Δ19]	6,000	2,500 [Δ17]	2,500 [Δ17]	2,500 [Δ17]
			BETWEEN TREADWAYS	LBS	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	1,200	1,200	1,200
		TONGUE LOADS BETWEEN TREADWAYS [Δ2]		LBS	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	450	450	450
4	PALLETIZED CARGO-DUAL RAIL (ONE OR MORE LATERAL CONVEYORS)			LB/LIN FT	2,800	2,800	2,800 [Δ20]	3,200	3,200	3,200	2,800 [Δ20]	2,800 [Δ6]	1,000 [Δ6]	1,000	1,000
5	PALLETIZED CARGO-DUAL RAIL (ONE OR MORE LATERAL CONVEYORS) [Δ6]			LB/ROLLER	2,333	2,333	2,333 [Δ21]	2,667	2,667	2,667	2,333 [Δ21]	2,333 [Δ6]	833 [Δ6]	833	833

NOTE

[Δ1] TREADWAY LOAD MUST BE SYMMETRICAL ABOUT THE AIRPLANE CENTERLINE. TREADWAY AND NON-TREADWAY AREAS MUST NOT BE LOADED SIMULTANEOUSLY TO MAXIMUM VALUES SHOWN. LOAD LIMITS BETWEEN TREADWAYS MAY EXTEND OVER ENTIRE CARGO FLOOR WIDTH. SHORING MAY BE REQUIRED FOR ROLLING LOADS OUTSIDE TREADWAYS.

[Δ2] NOT TO EXCEED 50 PSI.

[Δ3] CONCENTRATED LOAD IS DEFINED AS A LOAD IN WHICH THE WEIGHT IS CONCENTRATED AT A POINT ON THE CARGO AREA FLOOR AND THE CONTACT SURFACE BETWEEN THE LOAD AND THE FLOOR IS VERY SMALL WHEN COMPARED TO THE SIZE AND WEIGHT OF THE TOTAL PACKAGE.

4. MAXIMUM CARGO HEIGHT IN THE CARGO COMPARTMENT IS 108 IN. WHEN ROLLER CONVEYORS ARE INSTALLED, MAXIMUM CARGO HEIGHT IS REDUCED 1.5 INCHES .

[Δ5] IF AXLES ARE LESS THAN 4 FEET APART, THE SUM OF THE AXLE WEIGHTS MUST NOT EXCEED AXLE LOAD LIMITS.

[Δ6] THE CARGO LOADING SYSTEM RESTRAINT RAIL SECTIONS BETWEEN LOAD STATIONS 929 AND 1017 ARE LIMITED TO 8,500 LBS TOTAL WEIGHT RESTRAINT.

7. SEE TABLE 4-4 FOR HARD RUBBER TIRE AND STEEL WHEEL LIMITATIONS.

[Δ8] MAXIMUM WHEEL LOAD PER TREADWAY IS EQUAL TO HALF THE ALLOWABLE AXLE LOAD.

9. MAXIMUM HEIGHT OF PALLETIZED CARGO ON THE RAMP IS 76 IN. AS MEASURED FROM THE TOP SURFACE OF THE PALLET, WHEN THE PALLET CENTROID IS AT LS 1083.

[Δ10] LOAD LIMITS FOR UNIFORM LOADING OVER ENTIRE CARGO FLOOR (LS 345 TO LS 1017) ARE 3.0 PSI AND 1,600 LBS/LIN FT.

[Δ11] CENTER OF GRAVITY OF THE CUMULATIVE LOAD SHOWN IN ALL COMBINED COMPARTMENTS C THROUGH H MUST FALL AFT OF THE CENTER OF THE LOADED COMPARTMENTS (GIVEN IN PARENTHESIS).

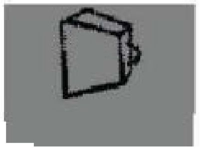
[Δ12] CENTER OF GRAVITY OF THE CUMULATIVE LOAD SHOWN IN ALL COMBINED COMPARTMENTS H THROUGH M MUST FALL FORWARD OF THE LOADED COMPARTMENTS (GIVEN IN PARENTHESIS).

[Δ13] THE VALUES IN BRACKETS, { }, DENOTE MAXIMUM CUMULATIVE COMPARTMENT CAPACITIES IF 3 PEOPLE, IN ADDITION TO THE 3 REGULAR CREW MEMBERS, ARE LOCATED IN THE FLIGHT STATION.

NOTE: Compartment limits vary with aircraft gross weight and other flight considerations and affect locations of the item in the aircraft. Consult T.O. 1C-130J-9 or ATTLA to determine if these limits affect the load design.

FIGURE B-68. Floor loading capacity - concentrated or pneumatic tire loads (Sheet 1 of 2)

C-130J-30



NOTE

14 THE RAMP (LS 1017 THROUGH LS 1141) IS CONTAINED WITHIN COMPARTMENTS K, L AND M. THE MAXIMUM ALLOWABLE FLIGHT LOAD PERMITTED ON THE RAMP IS 5,000 POUNDS. IN ADDITION TO FLOOR LIMITATIONS AND COMPARTMENT CAPACITIES, A WEIGHT AND CG RESTRICTION FOR CARGO PLACED ON THE RAMP IS IMPOSED. THE CG OF THE GIVEN LOAD MUST FALL AT OR FORWARD OF THE FOLLOWING FUSELAGE STATIONS:

(LS)	(WEIGHT OF CARGO)
1083	5,000
1090	4,835
1100	4,620
1110	4,420
1120	4,240
1130	4,070

THE RAMP CENTROID IS LS 1083 AND THE LOCATION OF THE RAMP LOCK DETENT. LINEAR INTERPOLATION BETWEEN THE LOADS IS ACCEPTABLE.

15 THIS CHART IS USED AS A REFERENCE TO DETERMINE THE AVAILABLE AREA AND VOLUME OF CARGO AREA COMPARTMENTS. THE CHART IS ALSO USED AS A REFERENCE TO DETERMINE THE STRUCTURAL LIMITS (FLIGHT AND GROUND OPERATIONS) OF EACH COMPARTMENT FOR VARIOUS TYPES OF CARGO. LOADING OF CARGO MUST TAKE INTO CONSIDERATION AIRPLANE GROSS WEIGHT AND CENTER OF GRAVITY CALCULATED FOR FLIGHT PURPOSES. FOR ANY TYPE OF LOAD, DO NOT EXCEED OVERALL AIRPLANE RESTRICTIONS.

AN EXAMPLE FOR USE OF THE CHART FOR FLIGHT LOADING IS AS FOLLOWS:

A. DETERMINE DIMENSIONS OF CARGO.
B. DETERMINE WEIGHT OF CARGO.
   (1) GROSS WEIGHT
   (2) AXLE AND TONGUE LOADS (IF WHEELED CARGO)
   (3) PSI AND POUNDS/LINEAR FOOT IF BULK CARGO.
C. DETERMINE DESIRED LOADING POSITION IN AIRPLANE (WEIGHT AND BALANCE DATA MUST BE CONSIDERED).
D. CHECK CHART TO DETERMINE IF FLOOR LOADING CAPACITY IS ADEQUATE FOR SELECTED LOADING AREA. IF ANY LIMIT IS EXCEEDED, CHECK SHORING REQUIREMENTS TO SPREAD LOAD OVER GREATER FLOOR AREA OR SELECT AREA HAVING GREATER CAPACITY.

16 A. SOME LOADS MAY REQUIRE THE COMPUTING OF ROLLER LOAD LIMITS TO DETERMINE IF THE OBJECT IS SUITABLE FOR LOADING.

THE POUND/ROLLER LIMITS IN THE CHART ARE BASED ON A ROLLER STATION. A ROLLER STATION IS DEFINED AS THE LATERAL ALIGNMENT OF 4 ROLLERS ON A FUSELAGE STATION. THE CHART LIMITS APPLY WHETHER ONE ROLLER OR ALL FOUR ROLLERS AT A ROLLER STATION ARE CONTACTED.

COMPUTE THE ROLLER LOADS BY USING LONGITUDINAL CONTACT LENGTH ON THE PALLET. A CONTACT LENGTH OF 1 INCH TO 19 INCHES WILL ONLY GUARANTEE ONE ROLLER STATION CONTACTED (SEE EXAMPLE 1A).

FOR EACH ADDITIONAL 1 TO 10 INCHES OF LONGITUDINAL CONTACT LENGTH, ONE ADDITIONAL ROLLER STATION WILL BE CONTACTED (SEE EXAMPLE 1B). IN ALL CASES, THE FIRST DIGIT OF THE ACTUAL CONTACT LENGTH (IN INCHES) DETERMINES THE NUMBER OF LONGITUDINAL ROLLER STATIONS CONTACTED, I.E., A SKID LENGTH OF 56 INCHES RESULTS IN CONTACT AT 5 ROLLER STATIONS, ETC. A MAXIMUM OF 8 ROLLER STATIONS MAY BE CONTACTED ON A 463L PALLET (SEE EXAMPLE 1C).

SKIDS PLACED LATERALLY ON A PALLET WILL USUALLY ONLY CONTACT ONE ROLLER STATION (SEE EXAMPLE 2) AND MAY REQUIRE SHORING TO CONTACT ADDITIONAL ROLLER STATIONS (SEE EXAMPLE 3).

THE ROLLER STATION LOAD CAN BE COMPUTED BY DIVIDING THE WEIGHT OF THE CARGO BY THE NUMBER OF ROLLER STATIONS CONTACTED.

B. FOR EXAMPLE, AN 8,000-LB OBJECT IS UNIFORMLY DISTRIBUTED IN TWO CONTACT STATIONS OF 25 INCHES EACH (4 ROLLER STATIONS CONTACTED). THE ROLLER STATION LOAD IS FOUND BY DIVIDING 8,000 BY 4. IF THE RESULTING FIGURE (ROLLER LOAD) IS EQUAL TO OR LESS THAN THAT GIVEN IN THE ROLLER LOADS COLUMN (LOADING OR UNLOADING LIMITS), THE OBJECT MAY BE LOADED. THE RESULTING FIGURE (ROLLER LOAD) MUST BE EQUAL TO OR LESS THAN THAT GIVEN IN THE ROLLER LOADS COLUMN (FLIGHT LIMITS) FOR FLIGHT REQUIREMENTS. IF THE CALCULATED FIGURE IS GREATER THAN THAT IN THE ROLLER LOAD COLUMN, THE OBJECT MAY NOT BE LOADED WITHOUT SHORING. EITHER BRIDGE TYPE OR SIMPLE SHORING MAY BE USED TO SATISFY ROLLER LOAD CRITERIA. IF BRIDGE TYPE SHORING IS USED (REFER TO SECTION 4), IT SHOULD BE PLACED LONGITUDINALLY ON THE PALLET AND THE MINIMUM DISTANCE SHOULD BE 20 INCHES. IF SIMPLE SHORING IS USED, THE CONTACT LENGTH BEARING

17 A SINGLE AXLE LOAD UP TO 3,500 POUNDS MAY BE CARRIED ON THE RAMP PROVIDED IT IS THE ONLY ITEM ON THE RAMP AND IS POSITIONED BETWEEN TIEDOWN RING ROWS.

18 7.2 PSI AND 3,000 POUNDS BETWEEN LS 537 AND LS 882.

19 13,000 POUNDS BETWEEN LS 537 AND LS 882.

20 3,200 POUNDS BETWEEN LS 537 AND LS 882.

21 2,667 POUNDS BETWEEN LS 537 AND LS 882.

22 NO MORE THAN 2 PEOPLE, IN ADDITION TO THE 3 REGULAR CREW MEMBERS ON THE FLIGHT STATION BUNK.

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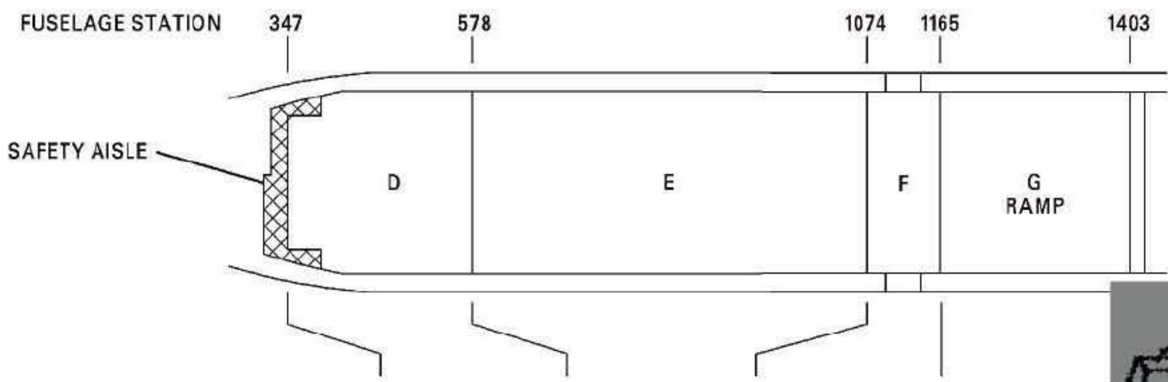
FIGURE B-68. Floor Loading Capacity - Concentrated or Pneumatic Tire Loads (Sheet 2 of 2) - Continued

C-130J-30



MAXIMUM ALLOWABLE WEIGHT IN EACH COMPARTMENT (LB) (TOTAL WEIGHT NOT TO EXCEED 170,900 LB)	72,000	170,900	35,000	40,000
MAXIMUM ALLOWABLE PNEUMATIC TIRE INFLATABLE PRESSURE (PSI)	100	100	100	100
AXLES SIDE BY SIDE	SEE SHEET 2 AND 4	SEE SHEET 3 AND 4	SEE SHEET 2 AND 4	SEE SHEET 2 AND 4
SIDE BY SIDE BOGIES (TANDEM) 42 IN. MIN AXLE SPACING	23,000/PER BOGIE 42 IN. AXLE SPACING	40,000/PER BOGIE 42 IN. AXLE SPACING	23,000/PER BOGIE 42 IN. AXLE SPACING	23,000/PER BOGIE 42 IN. AXLE SPACING
VEHICLE CENTERLINE MUST BE WITHIN 8 IN. OF AIRCRAFT CENTERLINE. VEHICLE SINGLE AXLE WEIGHTS, SINGLE ROW	22,001 TO 27,000	27,001 TO 36,000	22,001 TO 27,000	22,001 TO 27,000

NOTE

- THERE ARE NO PLACEMENT RESTRICTIONS ON BOGIES PROVIDED AXLE SPACING AND COMPARTMENT LIMITS ARE COMPLIED WITH.
- COMPARTMENT LIMITS WILL NOT BE EXCEEDED.
- WHEN BOGIES ARE LOADED ALONG SIDE OF OR IN LINE WITH SINGLE AXLES AND BOGIE AXLE SPACING IS 48 INCHES OR MORE, SINGLE AXLE LIMITATIONS MAY BE USED PROVIDED COMPARTMENT LIMITS ARE NOT EXCEEDED.
- BOGIES LOADED SIDE–BY–SIDE WHERE ALL AXLE CENTROIDS ARE WITHIN AN AREA OF 8 FEET WILL CONSTITUTE SIDE–BY–SIDE BOGIES.
- DO NOT PLACE FLOOR LOADED CARGO/WHEELS/TRACKS IN SAFETY AISLE AREA DEPICTED ABOVE.

There are additional restrictions on side-by-side loads (axle-axle, axle-track). If data for planning entire aircraft loads is required please contact ATTLA.

FIGURE B-69. Floor limitations

CB9AA00116L

MAXIMUM FLOOR LIMITATIONS				
COMPARTMENTS	D	E	F	G
MAX VEHICLE WEIGHT	65,000	130,000	* 65,000	40,000
MAX PLF	6200	8670	6200	6200
MAX PAD PSI	180	180	180	170
MAX PIW	230	NOTE	230	220

USE CHART

VEHICLE WEIGHT	MAX PIW
20,000	417
25,000	421
30,000	425
35,000	429
40,000	434
45,000	438
50,000	442
55,000	446
60,000	451
65,000	455
70,000	459
75,000	464
80,000	468
85,000	472
90,000	476
95,000	480
100,000	485
105,000	489
110,000	493
115,000	497
120,000	502
125,000	506
130,000	510

NOTE PIW REMAINS CONSTANT ABOVE 130,000 POUNDS

* MAXIMUM VEHICLE WEIGHT THAT MAY BE POSITIONED IN E AND F, OR F AND G COMPARTMENTS. EXAMPLE: THE C.G. OF A VEHICLE WEIGHING 64,000 POUNDS IS POSITIONED AT FS 1074. THIS IS PERMISSIBLE SINCE THE LIMITS OF F COMPARTMENT ARE NOT EXCEEDED.

FIGURE B-70. Tracked vehicle articulated suspension

DISCUSSION:

LOADABILITY OF CONCENTRATED LOADS IS DETERMINED BY FOUR FACTORS: POUNDS PER SQUARE INCH (PSI), POUNDS PER INCH OF WIDTH (PIW), POUNDS PER LINEAR FOOTS (PLF), AND LONGITUDINAL DISTANCE BETWEEN SKIDS.

CONCENTRATED LOAD LIMITS:

1. MINIMUM SKID LENGTH OR WIDTH IS 1.5 INCHES.
2. WHEN SKID WIDTH IS LESS THAN 4.0 INCHES THE SKID CONTACT PRESSURE SHALL NOT EXCEED 22 PSI.
3. WHEN SKID CONTACT PRESSURE IS LESS THAN 22 PSI, PIW DOES NOT APPLY.
4. WHEN THE LONGITUDINAL DISTANCE BETWEEN SKIDS IS LESS THAN 12 INCHES, THEY WILL BE TREATED AS ONE LOAD (VALUE) IN COMPUTING PIW.
5. LATERAL SPACING BETWEEN SKIDS IS NOT A DETERMINING FACTOR IN COMPUTING PIW.

FORMULAS:

A. DETERMINE WEIGHT ON EACH SKID: $\frac{\text{WEIGHT}}{\text{NO. OF SKIDS}} = \text{POUNDS ON EACH SKID}$

B. DETERMINE TOTAL CONTACT AREA: (L X W) X NO. OF SKIDS = TOTAL CONTACT AREA

C. DETERMINE POUNDS PER SQUARE INCH (PSI). $\frac{\text{SKID WEIGHT}}{\text{AREA}} = \text{PSI}$

D. DETERMINE POUNDS PER INCH OF WIDTH (PIW): $\frac{\text{WEIGHT (OF EACH SKID)}}{\text{WIDTH (OF EACH SKID)}} = \text{PIW}$

E. DETERMINE POUNDS PER LINEAR FOOT (PLF):

1. FOR SINGLE CONCENTRATED LOAD THE INDIVIDUAL ITEM WEIGHT SHALL NOT EXCEED 23,000 POUNDS IN COMPARTMENT D, F & G OR 27,000 POUNDS IN COMPARTMENT E.
2. MULTIPLE CONCENTRATED LOADS, WHEN THE DISTANCE BETWEEN LONGITUDINAL CONTACT POINTS ARE LESS THAN 24 INCHES: THE CONCENTRATED LOADS MUST BE ADDED TOGETHER TO DETERMINE IF LOAD COMBINATION IS WITHIN PLF LOADING LIMITS.
3. MULTIPLE CONCENTRATED LOADS, WHEN THE DISTANCE BETWEEN LONGITUDINAL CONTACT POINTS ARE 24 INCHES OR MORE: THE CONCENTRATED LOADS ARE EACH CONSIDERED A SINGLE CONCENTRATED LOAD.

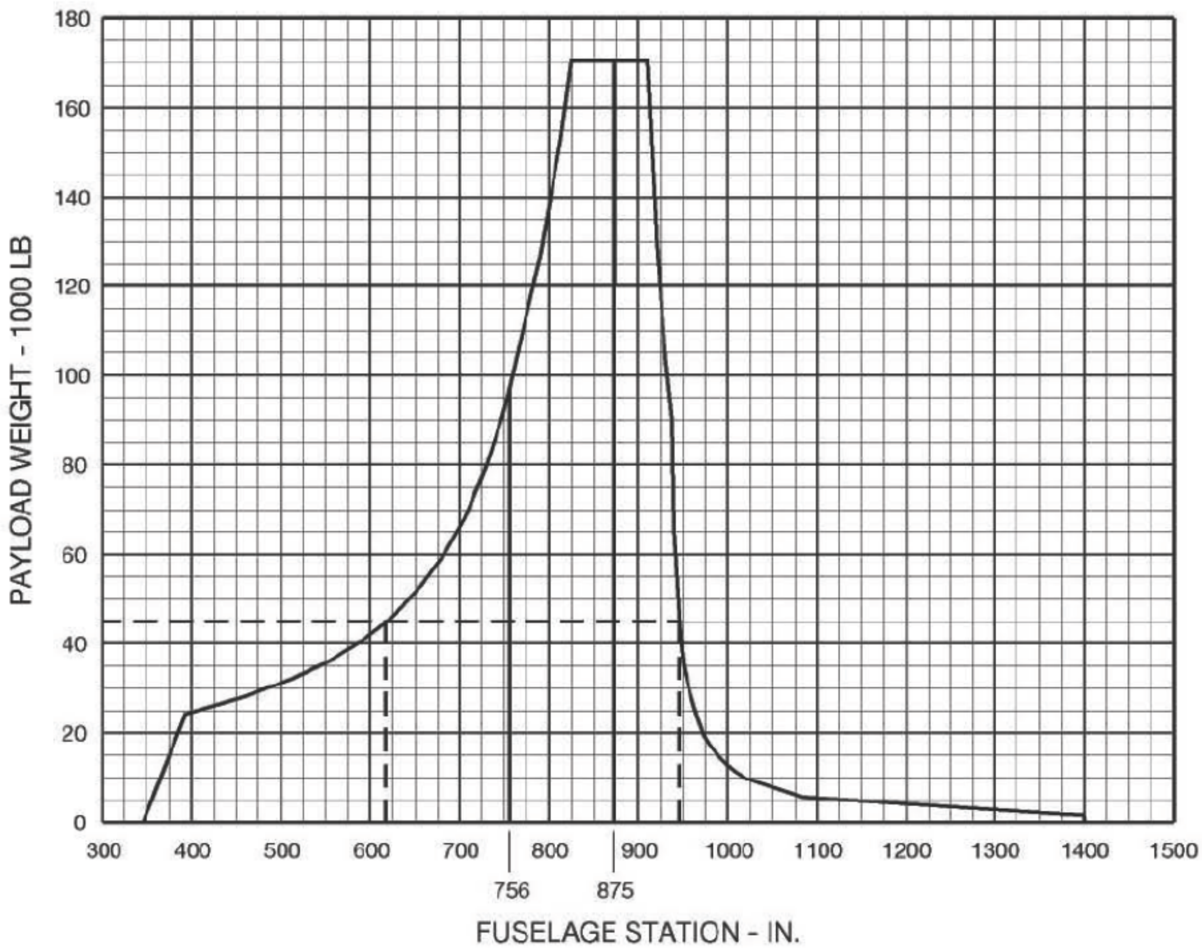
FLOOR LOADED/CONCENTRATED CARGO LOAD PLACED WITHIN THE 8 FOOT ZONE OF A MAXIMUM WEIGHT AXLE: UP TO 4,000 LBS OF FLOOR LOADED/CONCENTRATED CARGO CAN BE PLACED WITHIN THE 8 FOOT ZONE OF A MAXIMUM WEIGHT AXLE WITHOUT EXCEEDING PLF LIMITS. FOR CONCENTRATED LOADS IN EXCESS OF 4,000 POUNDS, THE FLOOR LOADED CARGO AND AXLE(S) WEIGHT MUST BE ADDED TOGETHER TO DETERMINE IF THE COMBINATION IS WITHIN PLF LOADING LIMIT.

NOTE

WHEN PLF LIMITATIONS ARE EXCEEDED AND THE ITEMS CAN NOT BE REPOSITIONED ON THE CARGO FLOOR OR RAMP, CONTACT THE OPERATIONAL MAJCOM FOR GUIDANCE.

MAXIMUM PSI	MAXIMUM PIW	MAXIMUM PSI	MAXIMUM PIW	MAXIMUM PSI	MAXIMUM PIW
0–22	NO LIMIT	38	595	70	479
23	897	40	575	75	473
24	864	42	559	80	469
26	858	44	547	90	462
28	840	46	536	100	456
30	840	48	527	110	452
32	832	50	520	120	448
33	708	55	505	140	443
34	670	60	494	160	439
36	624	65	486	180	436

FIGURE B-71. Concentrated floor loads - calculations



NOTE

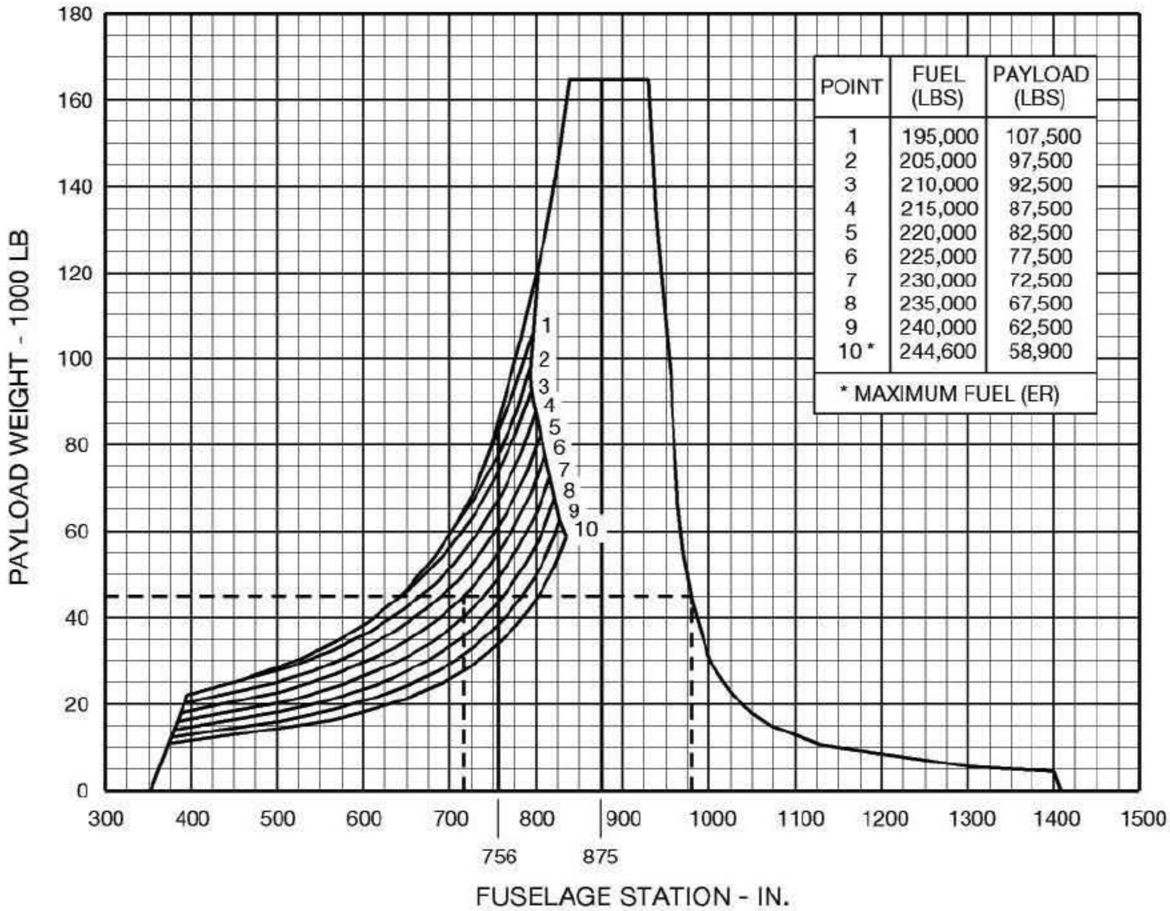
- THIS GRAPH DEPICTS THE CG RANGE IN WHICH THE PAYLOAD MAY BE LOADED.
- THESE DATA ARE FOR PLANNING PURPOSES ONLY. THE RESULTS ARE APPROXIMATE. FINAL LOADING OPERATIONS MUST BE CHECKED FOR INDIVIDUAL AIRCRAFT.
- THIS GRAPH IS BASED ON AN OPERATING WEIGHT OF 276,500 LB AND OPERATING CG AT FS 918.
- 50 % OF FLAT FLOOR IS FS 756.0.
- 50 % OF FLAT FLOOR AND RAMP IS FS 875.0.

EXAMPLE:

DETERMINE THE CG LIMITS FOR A PAYLOAD OF 45,000 LB.

1. ENTER THE GRAPH ON THE VERTICAL SCALE AT THE 45,000 LB PAYLOAD WEIGHT.
2. FROM THIS POINT, EXTEND A LINE HORIZONTALLY UNTIL IT INTERSECTS THE FORWARD LIMIT, THEN MOVE DOWN THE GRAPH VERTICALLY TO READ THE FORWARD FUSELAGE STATION. THIS IS FS 616.
3. USING THE SAME HORIZONTAL LINE, EXTEND THE LINE UNTIL IT INTERSECTS THE AFT FUSELAGE STATION LIMITS THEN MOVE DOWN THE GRAPH VERTICALLY TO READ THE AFT FUSELAGE STATION. THIS IS FS 945.
4. THE HORIZONTAL LINE DRAWN AT 45,000 LB INDICATES THE CG LIMITS FOR THAT PAYLOAD MUST BE BETWEEN FS 616 AND FS 945.

FIGURE –B-72. Cargo weight loading envelope (non-E/R)



NOTE

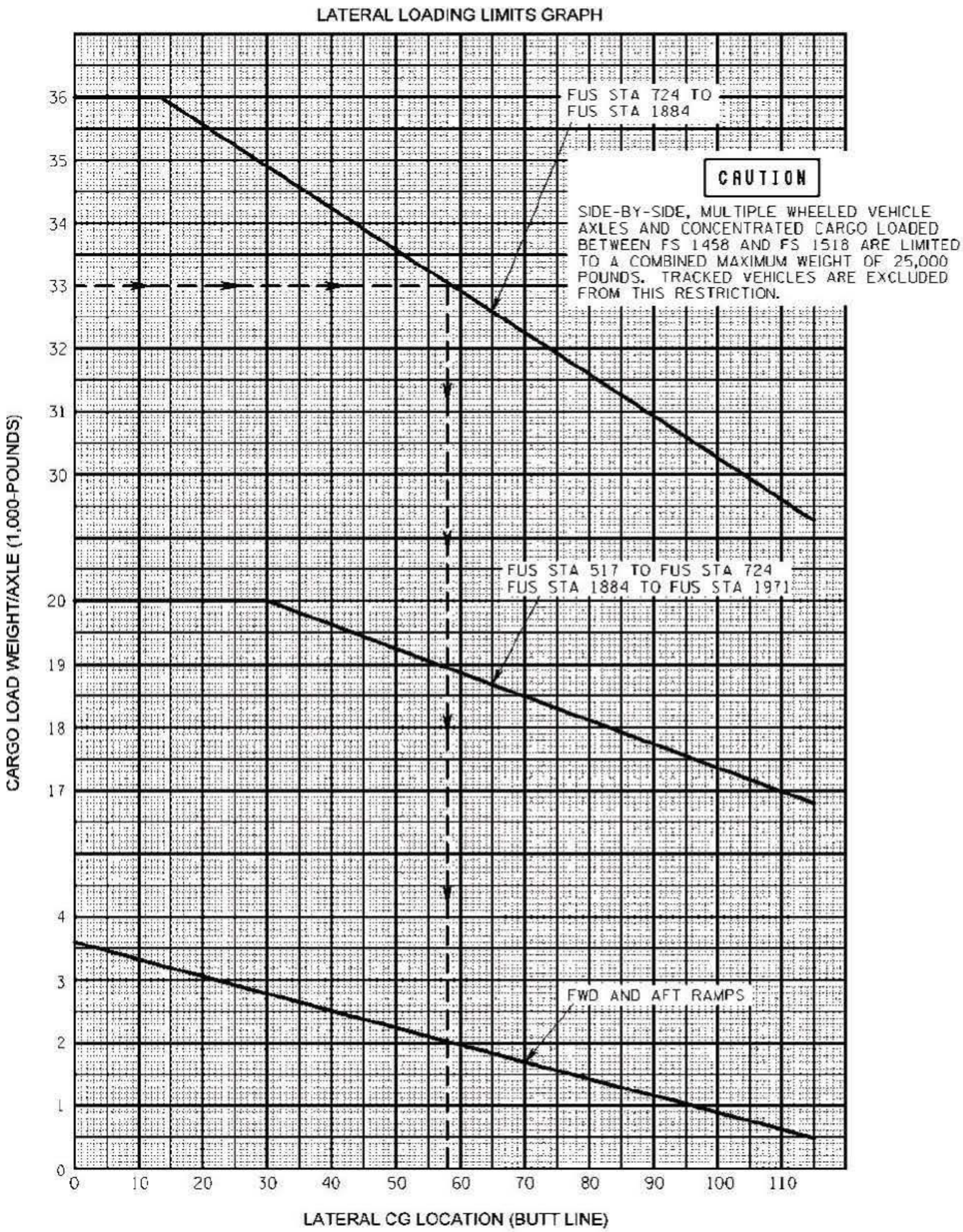
- THIS GRAPH DEPICTS THE CG RANGE IN WHICH THE PAYLOAD MAY BE LOADED.
- THESE DATA ARE FOR PLANNING PURPOSES ONLY. THE RESULTS ARE APPROXIMATE. FINAL LOADING OPERATIONS MUST BE CHECKED FOR INDIVIDUAL AIRCRAFT.
- THIS GRAPH IS BASED ON AN OPERATING WEIGHT OF 276,500 LB AND OPERATING CG AT FS 918.
- 50 % OF FLAT FLOOR IS FS 756.0.
- 50 % OF FLAT FLOOR AND RAMP IS FS 875.0.

EXAMPLE:

DETERMINE THE CG LIMITS FOR A PAYLOAD OF 45,000 LB WITH 225,000 LB OF FUEL.

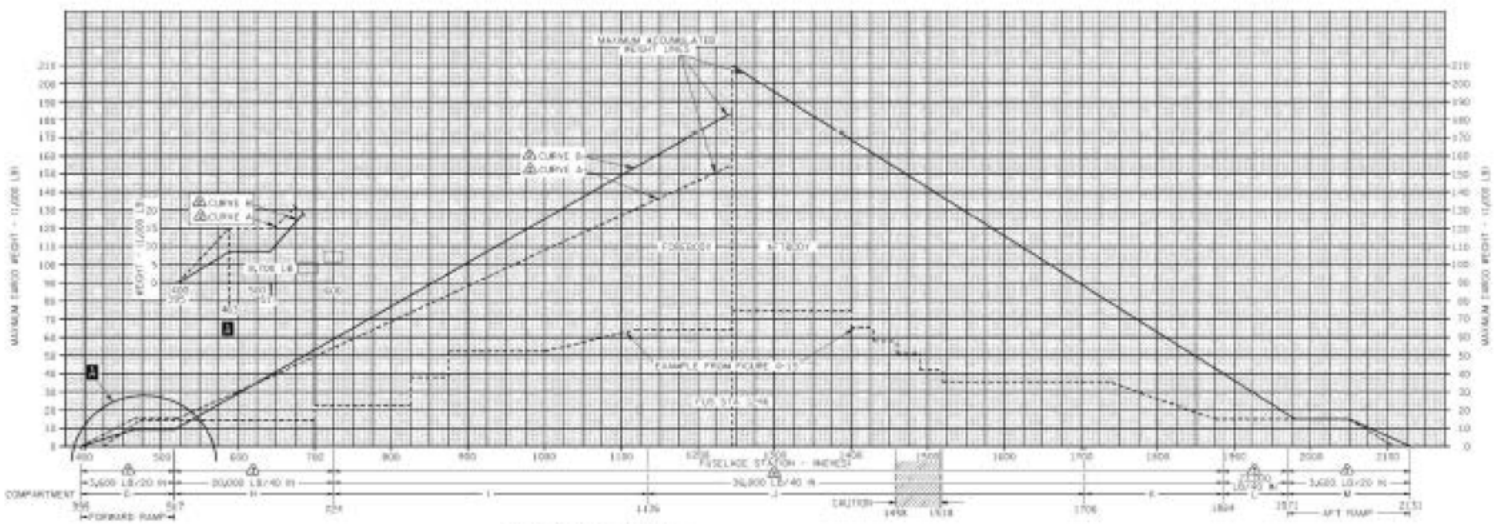
1. ENTER THE GRAPH ON THE VERTICAL SCALE AT THE 45,000 LB PAYLOAD WEIGHT.
2. FROM THIS POINT, EXTEND A LINE HORIZONTALLY UNTIL IT INTERSECTS THE 225,000 LB FUEL CURVED LINE (POINT 6), THEN MOVE DOWN THE GRAPH VERTICALLY TO READ THE FORWARD FUSELAGE STATION. THIS IS FS 708.
3. USING THE SAME HORIZONTAL LINE, EXTEND THE LINE UNTIL IT INTERSECTS THE AFT FUSELAGE STATION LIMITS, THEN MOVE DOWN THE GRAPH VERTICALLY TO READ THE AFT FUSELAGE STATION. THIS IS FS 972.
4. THE HORIZONTAL LINE DRAWN AT 45,000 LB INDICATES THE CG LIMITS FOR THAT PAYLOAD MUST BE BETWEEN FS 708 AND 972.

FIGURE 73. Cargo weight loading envelope (E/R)



C-5 Lateral CG LImits

FIGURE B-74. Cargo maximum allowable lateral CG location



C-5

FIGURE B-75. Cargo floor loading limitations

CAUTION

Side-by-side, multiple wheeled vehicle axles and concentrated cargo loaded between FS 1458 and FS 1518 are limited to a combined maximum weight of 25,000 pounds. Traced vehicles are excluded from this restriction.

NOTE

Read all the notes in this figure and comply with, as applicable, before attempting any loading.

1. The maximum cargo weight curved define the maximum cargo that can be loaded forward of any fuselage station in the fore body or that can be loaded AFT of any fuselage station in the AFT body provided the center of gravity limits of the airplane are not exceeded. Maximum single pallet weight on ramps is 7,500 pounds when loaded in the logistics rail system.

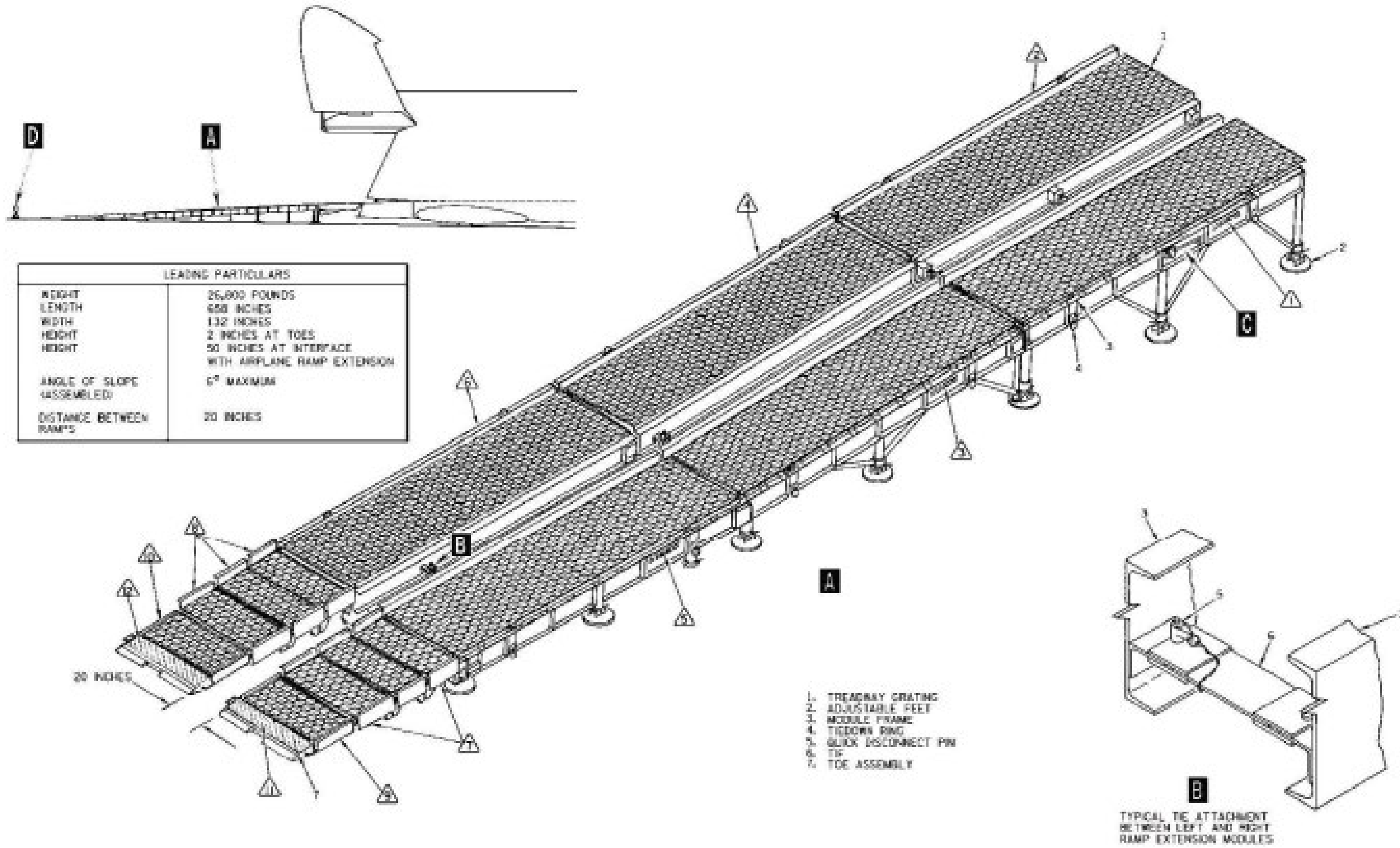
△2 Maximum allowable load 3,600 pounds in any 20-inch length of the ramp, or 15,000 pounds total weight (use curve A), Maximum allowable load 3,600 pounds in any 20-inch length of the ramp, or 8,700 pounds total load (use curve B).

△3 Maximum allowable load 20,000 pounds in any 40-inch length of cargo floor.

△4 Maximum allowable load 36,000 pounds in any 40-inch length of cargo floor.

△5 Maximum allowable load 3,600 pounds in any 20-inch length of the ramp, or 15,000 pounds total weight.

6. Load may be made up of a single axle, two or more axles, a combination of axles and cargo or all cargo.
7. The floor contact loading must meet the requirements of figures 4-12, 4-14, 4-24, through 4-29.
8. The lateral location of the load shall meet the requirements of figure 4-17.



LEADING PARTICULARS	
WEIGHT	26,800 POUNDS
LENGTH	658 INCHES
WIDTH	132 INCHES
HEIGHT	2 INCHES AT TOES
HEIGHT	50 INCHES AT INTERFACE WITH AIRPLANE RAMP EXTENSION
ANGLE OF SLOPE (ASSEMBLED)	6° MAXIMUM
DISTANCE BETWEEN RAMPS	20 INCHES

FIGURE B-76. Portable loading ramp extension (sheet 1 of 2)

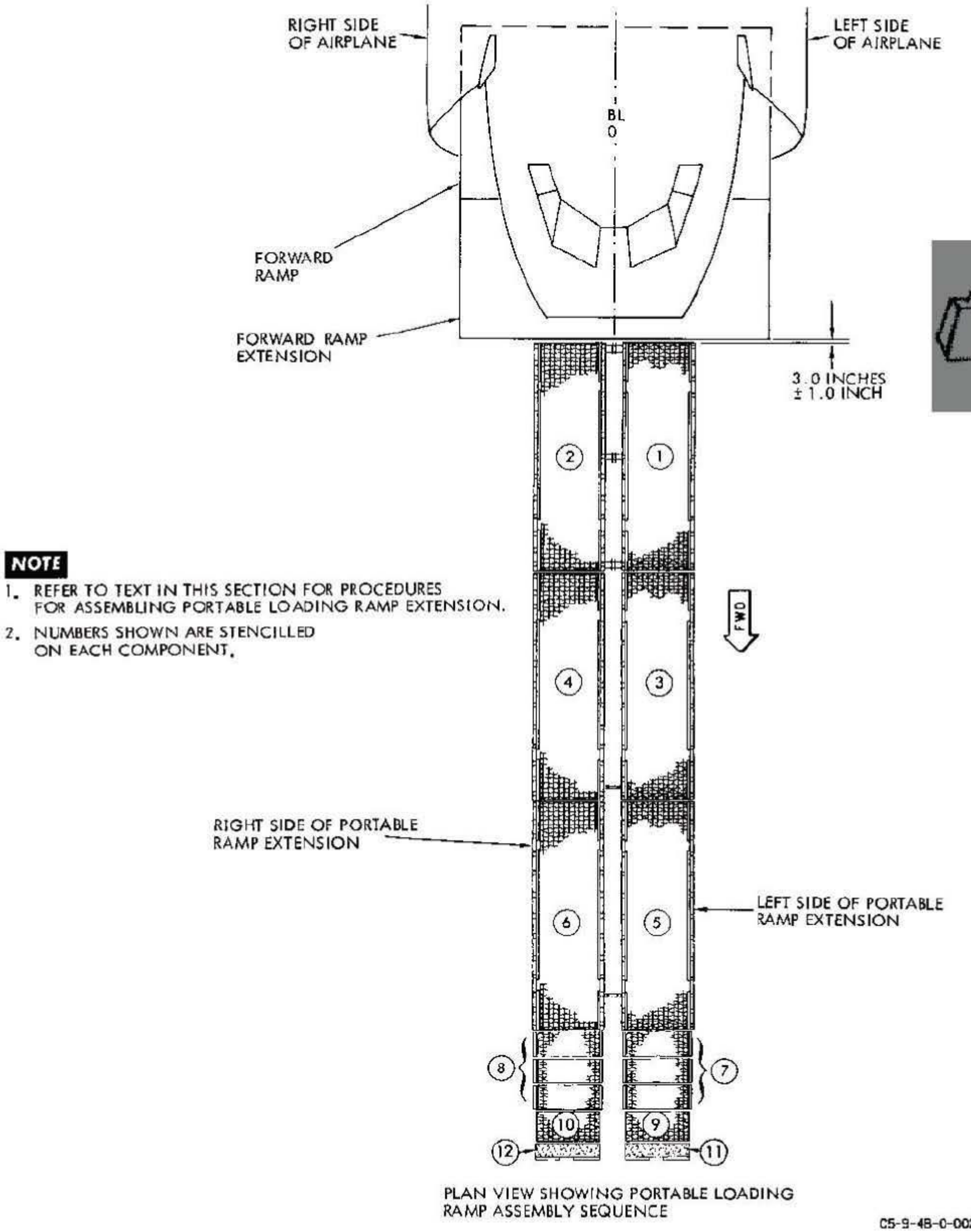


FIGURE B-77. Portable loading ramp extension assembly sequence

PROCEDURES FOR DETERMINING CONCENTRATED CARGO MAXIMUM ALLOWABLE FLOOR LOADS AND CALCULATION OF SHORING WHEN REQUIRED.

CAUTION

IF A CONCENTRATED CARGO LOAD IS TO BE PARTIALLY SUPPORTED BY FLOOR DISCONTINUITIES SUCH AS STOWED INBOARD LOGISTICS RAILS, ROLLER CONVEYORS, AND TIEDOWN RING PANS, CONTACT ATTLA

NOTE

FOR LOADS LESS THAN 2 INCHES IN LENGTH PLUS WIDTH, USE 1-INCH THICK PLYWOOD UNDER THE LOAD AND ASSUME A 2-INCH LENGTH PLUS WIDTH TO DETERMINE THE REQUIRED SHORING.

USE OF FORMULAS:

1. IF ALLOWABLE LOAD IS EQUAL TO OR GREATER THAN CARGO LOAD, NO SHORING IS REQUIRED.
2. IF ALLOWABLE LOAD IS LESS THAN CARGO LOAD, SHORING IS REQUIRED.
3. IF THE CARGO LENGTH PLUS WIDTH IS EQUAL TO OR GREATER THAN THE REQUIRED LENGTH PLUS WIDTH, NO SHORING IS REQUIRED.
4. IF THE CARGO LENGTH PLUS WIDTH IS LESS THAN THE REQUIRED LENGTH PLUS WIDTH, SHORING MUST BE CALCULATED.

NOTE

THE SHORING SHALL PROJECT BEYOND THE CARGO FOOTPRINT ON ALL SIDES A MINIMUM DISTANCE EQUAL TO THE SHORING THICKNESS.

SHORING:

SHORING THICKNESS ≥ MINIMUM SHORING THICKNESS

SHORING WIDTH ≥ CARGO WIDTH + (2 × THICKNESS)

SHORING LENGTH ≥ CARGO LENGTH + (2 × THICKNESS)

CALCULATION FORMULAS

NON-RUBBER CONTACT SURFACE (CARGO FLOOR)

1. ALLOWABLE LOAD = 404.7 (LENGTH + WIDTH)
2. REQUIRED LENGTH + WIDTH = CARGO LOAD ÷ 404.7
3. SHORING THICKNESS = $\dfrac{\text{REQUIRED (LENGTH + WIDTH)} - \text{ACTUAL (LENGTH + WIDTH)}}{4}$
4. MINIMUM SHORING THICKNESS = 1/2 INCH

FIGURE B-78. Concentrated cargo maximum allowable floor loads (sheet 1 of 3)

NON-RUBBER CONTACT SURFACE (RAMP FLOOR)

1. ALLOWABLE LOAD = 231.8 (LENGTH + WIDTH)
2. REQUIRED LENGTH + WIDTH = CARGO LOAD ÷ 231.8
3. SHORING THICKNESS = $\frac{\text{REQUIRED (LENGTH + WIDTH) - ACTUAL (LENGTH + WIDTH)}}{4}$
4. MINIMUM SHORING THICKNESS = 1/2 INCH

EXAMPLE: DETERMINE IF SHORING IS REQUIRED AND, IF REQUIRED, DETERMINE THE SHORING REQUIREMENTS FOR A CONCENTRATED CARGO LOAD (WITH A NON-RUBBER CONTACT SURFACE), TO BE LOADED ON THE CARGO COMPARTMENT FLOOR. THE CARGO LOAD HAS CONTACT LENGTH OF 10 INCHES AND A CONTACT WIDTH OF 15 INCHES (10 × 15 INCHES) AND WEIGHS 11,900 POUNDS.

1. DETERMINE ALLOWABLE LOAD USING APPROPRIATE ALLOWABLE LOAD FORMULA.

   404.7 (10 + 15) = 10117.50

2. DETERMINE REQUIRED LENGTH + WIDTH.

   11900 ÷ 404.7 = 29.4044

3. THE ACTUAL LENGTH PLUS WIDTH IS LESS THAN THE REQUIRED LENGTH PLUS WIDTH; THEREFORE, SHORING IS REQUIRED AND IS CALCULATED AS FOLLOWS:

   A. DETERMINE THE SHORING THICKNESS BY FIRST SUBSTRACTING THE ACTUAL LENGTH PLUS WIDTH FROM THE REQUIRED LENGTH PLUS WIDTH.

REQUIRED LENGTH + WIDTH	29.4044 INCHES
ACTUAL LENGTH + WIDTH	25.0 INCHES
	4.4044 INCHES MINIMUM ADDITIONAL LENGTH PLUS WIDTH

   B. THE MINIMUM SHORING THICKNESS IS DETERMINED BY DIVIDING THE ADDITIONAL LENGTH PLUS WIDTH BY 4.

   THICKNESS = 4.5 ÷ 4 = 1.125 INCHES

   C. THE SHORING SHALL PROJECT BEYOND THE FOOTPRINT ON ALL SIDES BY A MINIMUM AMOUNT EQUAL TO THE SHORING THICKNESS.

   MINIMUM SHORING WIDTH = 15.0 + 1.125 + 1.125 = 17.250 INCHES

   MINIMUM SHORING LENGTH = 10.0 + 1.125 + 1.125 = 12.250 INCHES

FIGURE B-78. Concentrated cargo maximum allowable floor loads (sheet 2 of 3) - continued

D. THE SHORING REQUIRED IS AS FOLLOWS:

THICKNESS ≥ 1.2 INCHES

WIDTH ≥ 17.3 INCHES

LENGTH ≥ 12.3 INCHES

NOTE

THE CARGO SHALL BE CENTERED ON THE SHORING SUCH THAT THE SHORING EXTENDS BEYOND THE CARGO ON ALL SIDES BY AN AMOUNT GREATER THAN OR EQUAL TO THE SHORING THICKNESS.

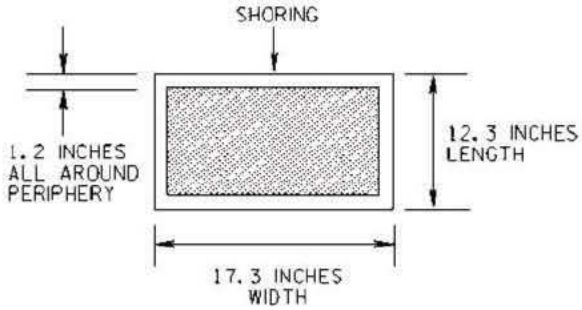
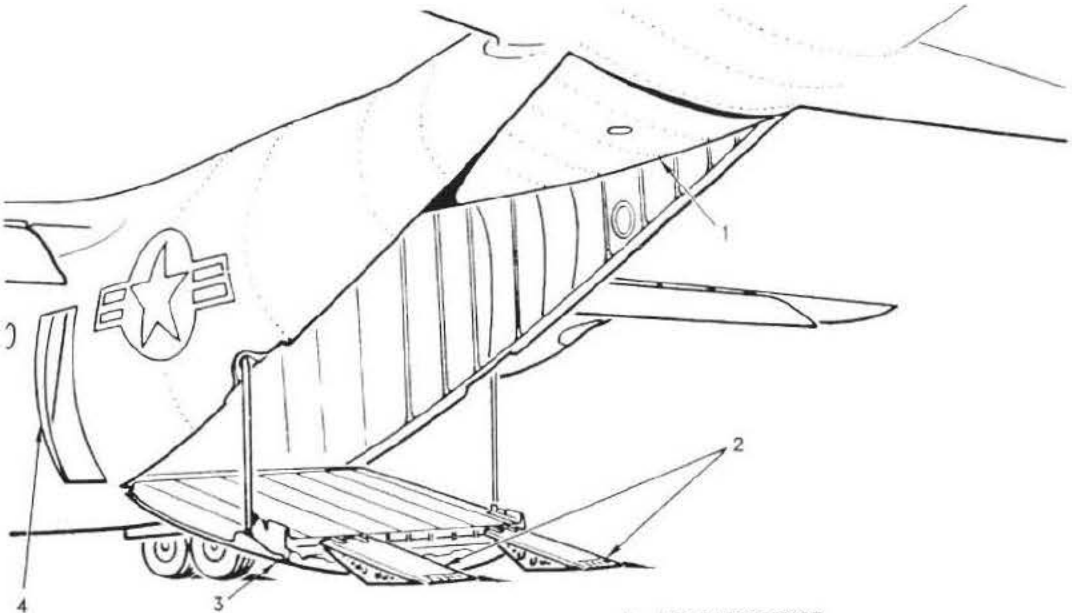


FIGURE B-78. Concentrated cargo maximum allowable floor loads (sheet 3) - continued

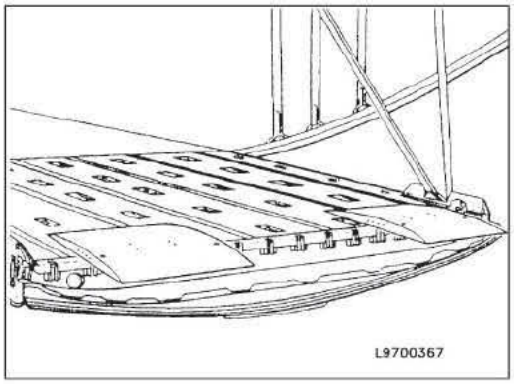


1. AFT CARGO DOOR
2. AUXILIARY GROUND LOADING RAMP
3. RAMP
4. PARATROOP DOOR

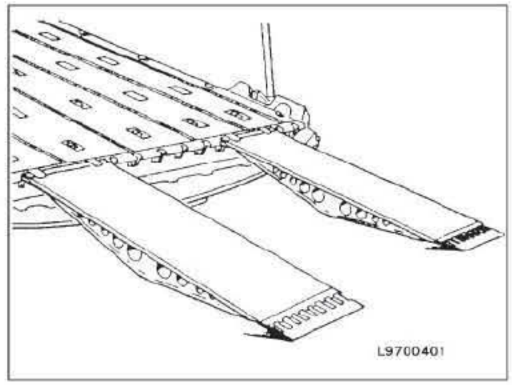
AIRCRAFT					
RAMP HEIGHT	C-130A	C-130B	C-130D SKIS UP	C-130D SKIS DOWN	C-130E C-130H
Minimum	40	40	40	44	39
Maximum	45	42	42	49	41
Add $2\frac{5}{16}$ in. to all dimensions for aircraft to be loaded with rollers installed.					

C-130 Ramp Payload Capacity is integral to the floor capacity charts in B.3.2.1. The E/H/J ramp starts at FS737. The J-30 ramp starts at LS1017.

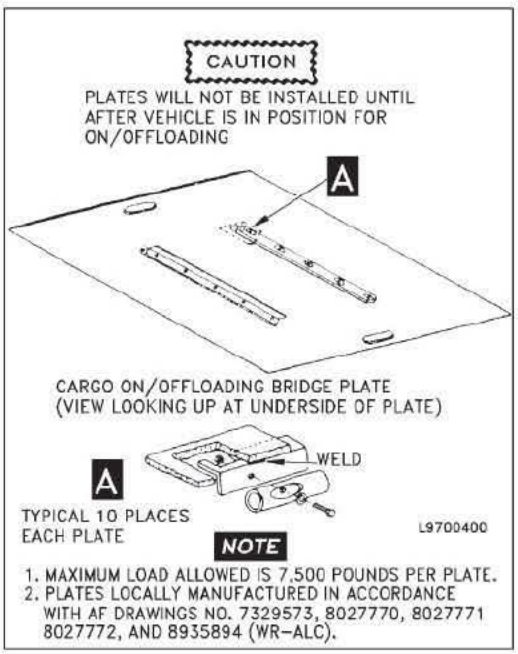
FIGURE B-79. Cargo door and ramp (sheet 1 of 2)



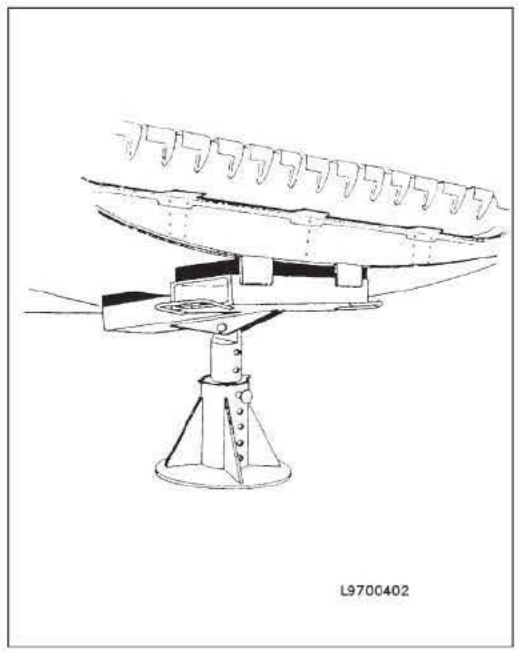
Auxiliary Truck Loading Ramps Installed



Auxiliary Ground Loading Ramps Installed



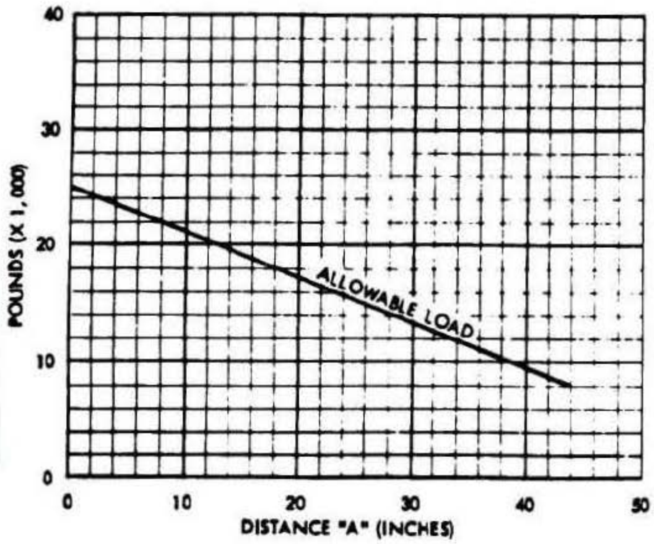
Bridge Plates

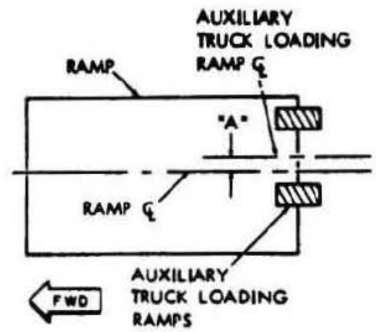


Ramp Support

FIGURE B-79. Cargo door and ramp (sheet 2) - continued

C-130





To determine distance "A", measure from the ramp centerline to a point midway between the installed ramps. Find distance "A" on the horizontal scale. Extend a line vertically from this point to the allowable load line. Extend a line horizontally until it intersects the vertical scale. Read the allowable load.

EXAMPLE: Distance "A" is 0.965 m (38 in.). Allowable load on the ramps is 4536 kg (10 000 lb).

Auxiliary truck loading ramp loads.

AIRCRAFT					
RAMP HEIGHT	C-130A	C-130B	C-130D SKIS UP	C-130D SKIS DOWN	C-130E C-130H
Minimum	40	40	40	44	39
Maximum	45	42	42	49	41
Add 2⅝ in. to all dimensions for aircraft to be loaded with rollers installed.					

METRIC EQUIVALENTS					
lb	kg	in.	m	in.	m
10	4.54	2⅝	0.067	41	1.04
20	9.07	10	0.254	42	1.07
30	13.61	20	0.508	44	1.12
40	18.14	30	0.762	45	1.14
10 000	4536.0	38	0.965	49	1.24
		39	0.991		
		40	1.02		

FIGURE B-80. Ramp height

C-130E/H

The aft end of the toes shall not be supported when in the low position. During normal operations the toes are hydraulically sequenced with the ramp and door.

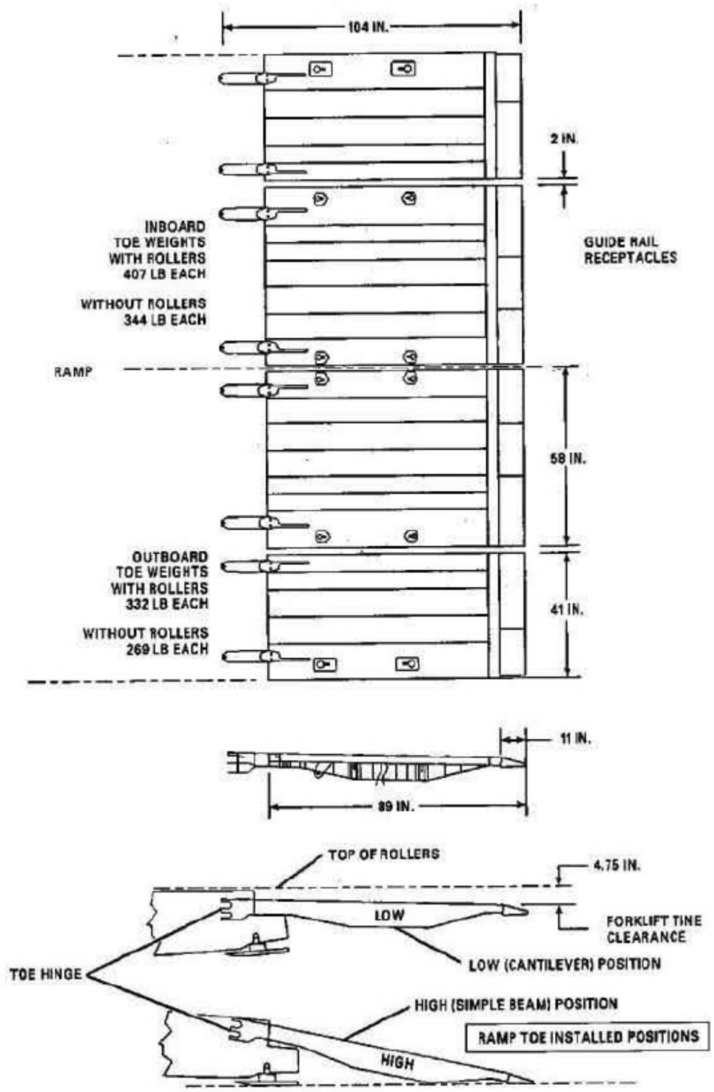


FIGURE B-81. Ramp toes

TABLE B-IV. Ramp toe loading limitation chart

Toe Configuration	Strut Configuration (1)	ADS Link Configuration (3)	Maximum Weight (LB)
Low (6)	Stowed	Stowed/Connected	8,400
Low (6) (7)	Deployed	Stowed	9,100
Low (6) (7)	Deployed	Connected (2)	10,355 (5)
High	Stowed	Stowed/Connected	10,355
High	Deployed	Stowed	16,000 Axle 20,000 Bogie
High	Deployed	Connected (2)	72,000 (4)
None	Stowed	Stowed/Connected	10,355
None	Deployed	Stowed	16,000
None	Deployed	Connected (2)	72,000 (4)
Low (Ramp on Ground)	Stowed/Deployed	Stowed	10,355
High (Ramp on Ground)	Stowed	Stowed	65,000 (8)
High (Ramp on Ground)	Deployed	Stowed	135,000 (4) (8)

WARNING

When bare tine forklift loading, ramp toe rollers shall not be removed while a pallet is positioned over the toes. Ramp toe inner roller channels may only be removed prior to marshalling the forklift into position.

CAUTION

- In the low position the aft end of toes must not be supported. Upper tang of ramp toe beam will be fractured.
- In the low position rolling stock shall not be on/offloaded to the ground. End of toes may be fractured.
- In the high position the aft end of toes must be supported. Lower tang of ramp toe beam will be fractured.
- In the high position the required overlap between ramp toe contact pads and floor of loader is 11 inches.
- In the high position the bottom of toes must not come in contact with the ramp step edge or floor on loader.

TABLE B-IV. Ramp toe loading limitation chart - continued

- In the high position the toe must not be at an angle which causes the aft end of the toe to be above a coplanar position with the ramp floor.

(1) When using the ramp as a lifting aid the stab struts should be deployed for weights above 10,355 lb.

(2) Ramp shall be supported by the ADS links when connected.

(3) Short or long links do not increase or decrease the weight limitations.

(4) Wheeled and tracked vehicles over 65,000 lb must be on/offloaded within 8 in. of aircraft centerline.

(5) For two axles on the toes, total axle weights shall not exceed 10,355 lb. For 18-foot type VI platforms, this may be increased to 14,500 lb.

(6) When loading rolling stock, bridge plates shall be used to bridge the gap between the ramp toes and the K-loader or flatbed truck. Shoring may be required to transition the 4 3/4-in. step-up from the ramp toes to the ramp during on/offloading.

(7) When loading pallets with a bare tine forklift, one set of inner roller channels may be removed from the ramp toes if the pallet weight does not exceed 8,500 pounds.

(8) The same capability exists when ramp pedestal shoring is used.

C-17 Ramp Payload

EXAMPLE PROBLEM:

DETERMINE THE AFT CG LIMIT FOR A TOTAL RAMP CARGO WEIGHT OF 33,500 POUNDS.

A. ENTER THE GRAPH ON THE HORIZONTAL SCALE FOR CARGO WEIGHT OF 33,500 POUNDS.
B. FROM THIS POINT EXTEND A LINE VERTICALLY UNTIL IT INTERSECTS THE CURVED LINE, THEN EXTEND THE LINE LEFT TO DETERMINE THE CG STATION.

CONCLUSION:

BY ENTERING THE GRAPH ON THE HORIZONTAL SCALE AND EXTENDING A LINE VERTICALLY TO THE CURVED LINE AND THEN TO THE LEFT WE DETERMINE THAT THE CG FOR THE TOTAL RAMP LOAD MUST BE AT OR FORWARD OF FUSELAGE STATION 1320.

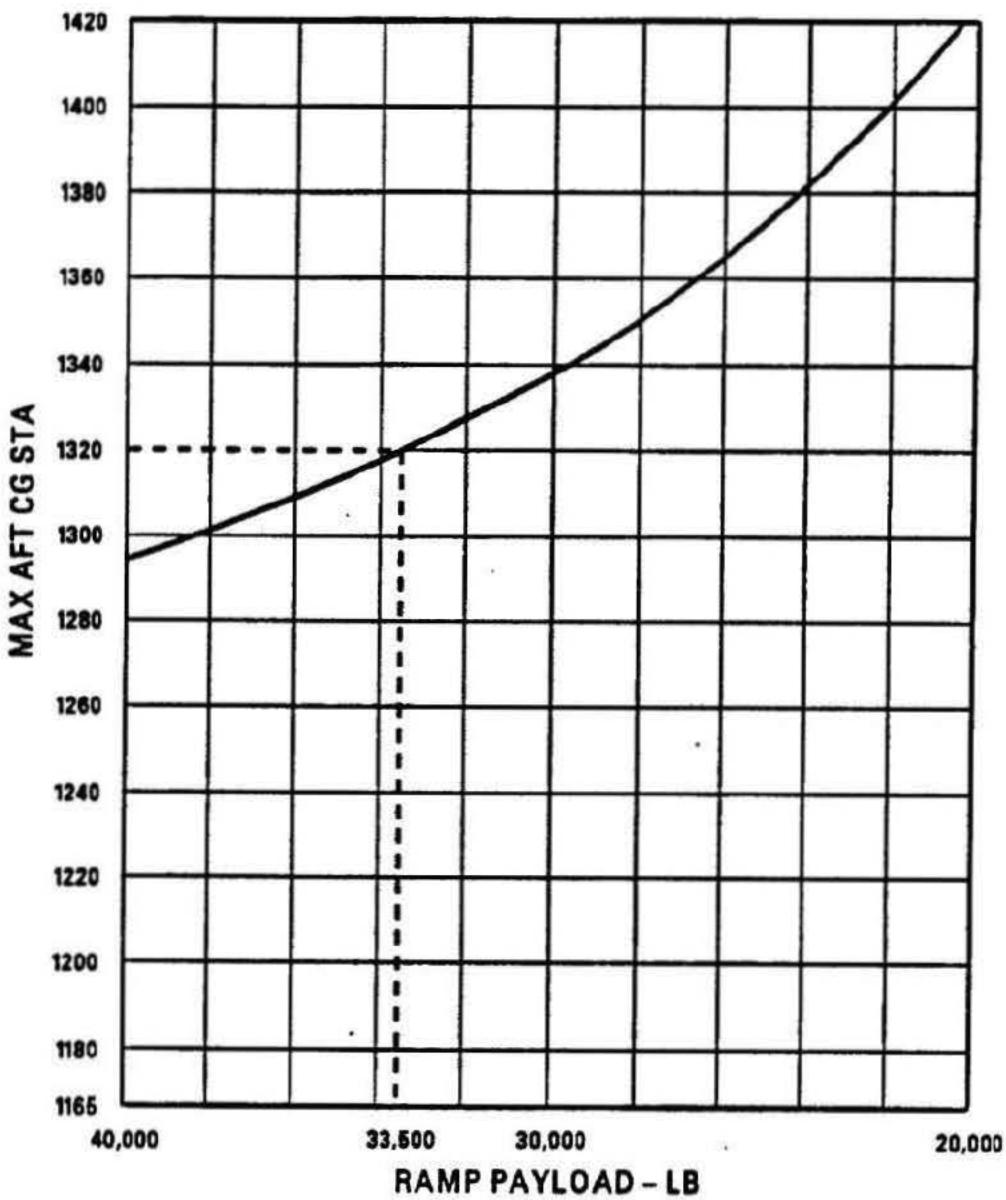
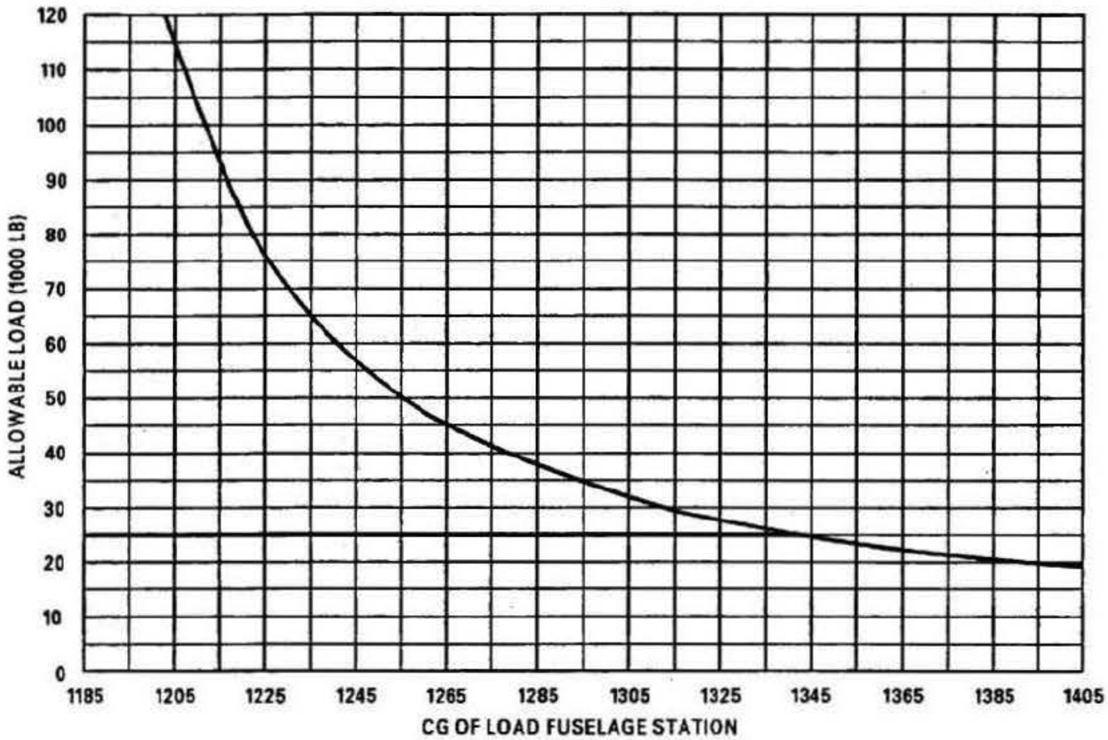


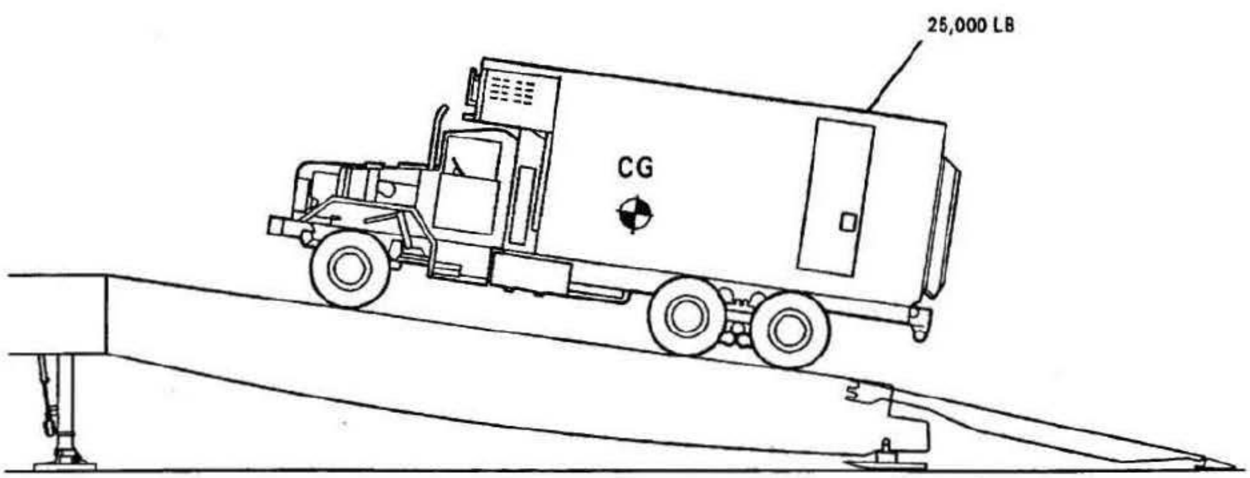
FIGURE B-82. Allowable in-flight ramp payload

C-17



EXAMPLE:

THE RAMP CAN LIFT 40,000 LB WT/CG LOCATED AT FS 1279
THE RAMP CAN LIFT 80,000 LB WT/CG LOCATED AT FS 1222
THE RAMP CAN LIFT 27,000 LB WT/CG LOCATED AT FS 1333



THE CG OF A VEHICLE WEIGHING 25,000 POUNDS MUST BE AT OR FORWARD OF FS 1345. THIS WILL ENSURE RAMP LIFTING CAPABILITY IS NOT EXCEEDED. BASED ON VEHICLES LOADED WITHIN 8 INCHES OF CENTERLINE.

FIGURE B-83. Ramp Lifting Limits

1. Vehicles weighing over 65,000 lbs shall be loaded within 8 inches of aircraft centerline.
2. Vehicles less than or equal to 86,420 lbs shall be loaded over area A. If in contact with both areas, the lower limit applies.
3. Vehicles 86,421 to 97,000 lbs:
   a. Raise cargo ramp to prevent teetering (see ramp lifting limits).
   b. Minimum track width is 24"
   c. Minimum track ground contact length is 137".
   d. Grouser spacing shall be less than 12".
   e. Minimum shoring thickness is 3".

PIW (CRESTING) LIMITATIONS FOR VEHICLES WEIGHING LESS THAN OR EQUAL TO 86,420 POUNDS		
CRESTING AREA	A	B
MAX PIW (CRESTING)	1964	1139

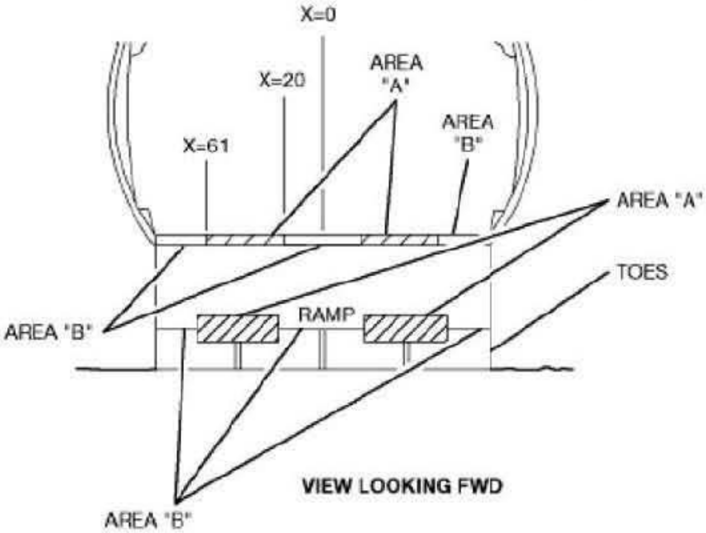


FIGURE B-84. C-17 ramp crest teeter limitations

TABLE B-V. ADS ramp platform weight limitations

CENTER OF PLATFORM (FUS STA)	LENGTH (FEET)	MAXIMUM PLATFORM WEIGHT (POUNDS)
1294	20	24541
1269	16	23126
1279	16	21774
1289	16	20422
1299	16	19069
1244	12	15029
1254	12	14248
1264	12	12975
1274	12	11703
1284	12	10431
1294	12	15520
1304	12	14248
1314	12	12975
1324	12	11703
1334	12	10431
1219	8	8766
1229	8	7565
1239	8	6364
1249	8	5163
1259	8	3963
1269	8	5230
1279	8	7565
1289	8	5230
1299	8	5163
1309	8	3963
1319	8	8766
1329	8	7565
1339	8	6364
1349	8	5163
1359	8	3963
1369	8	2762

Do not exceed maximum roller loads of 2,630 pounds per roller. This limitation applies only to this table.

Do not load on omni-directional rollers.

Center of platform locations include the following longitudinal center of gravity (CG) tolerances.

20 FT = ± 22.5 inches
16 FT = ± 21.0 inches
12 FT = ± 19.5 inches
8 FT = ± 18.0 inches

Use the platform actual CG to compute aircraft weight and balance.
The CG of the platform must fall within the above ± tolerances.

TABLE VI. ADS pallet weight limitations

CTR of PALLET (FUS STA)	MAX PALLET WEIGHT (POUNDS)
1101	*9500
1111	*7000
1209	5434
1219	10355
1239	8678
1249	7056
1259	5434
1269	5230
1279	5230
1289	5230
1299	5230
1309	5434
1329	10355
1339	8678
1349	7056
1359	5434

This table identifies maximum pallet weights when pallets are loaded out of pallet positions 9, 10 and 11.

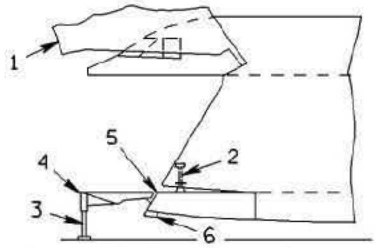
If the pallet can be restrained for 2G's vertical using aircraft tiedown equipment, no limitations apply.

For pallet position 9 all other fuselage stations are IAW Section IVB.

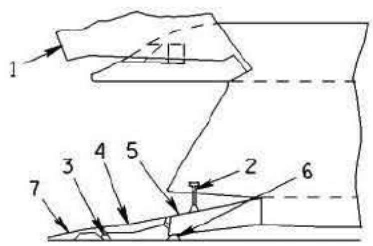
These restrictions also apply to 8 foot airdrop platforms.

CAUTION

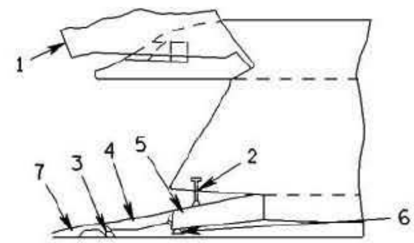
SHORING SHALL BE USED UNDER ALL THE RAMP EXTENSION SUPPORT JACKS AND RAMP SUPPORT PADS WHEN NECESSARY TO ENSURE PROPER CONTACT WITH THE GROUND DURING ON/OFF LOADING OPERATIONS. FAILURE TO COMPLY COULD RESULT IN DAMAGE TO THE RAMP EXTENSION ACTUATORS AND RAMP EXTENSION AND/OR RAMP STRUCTURE.



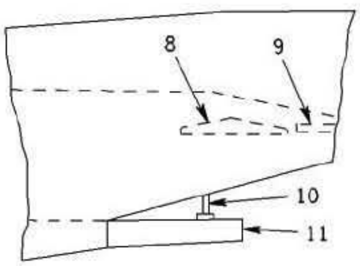
TRUCK LOADING POSITION RAMP ACTUATOR SUPPORTED (1)



DRIVE-IN LOADING POSITION RAMP GROUND SUPPORTED (2)

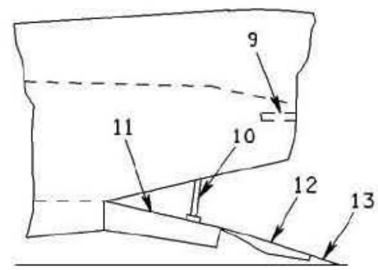


DRIVE-IN LOADING POSITION RAMP ACTUATOR SUPPORTED (2)

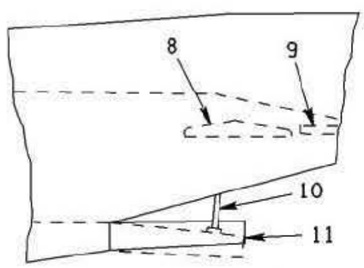


TRUCK LOADING POSITION RAMP ACTUATOR SUPPORTED (3)

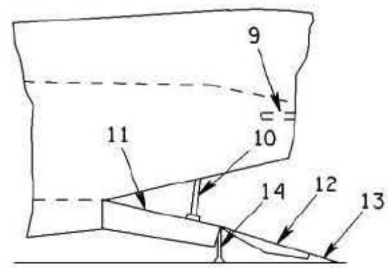
1. VISOR
2. RAMP ACTUATOR
3. FORWARD RAMP EXTENSION JACKS
4. FORWARD RAMP EXTENSION
5. FORWARD RAMP
6. FORWARD RAMP GROUND SUPPORT PADS
7. FORWARD RAMP EXTENSION TOES
8. PRESSURE DOOR (OVERHEAD POSITION)
9. CENTER CARGO DOOR (OVERHEAD POSITION)
10. RAMP ACTUATOR
11. AFT RAMP
12. PRESSURE DOOR (RAMP EXTENSION POSITION)
13. PRESSURE DOOR TOES
14. AFT RAMP SUPPORT PADS



DRIVE-IN LOADING POSITION RAMP ACTUATOR SUPPORTED (4)



TRUCK LOADING POSITION RAMP ACTUATOR SUPPORTED (4)



DRIVE-IN LOADING POSITION RAMP GROUND SUPPORTED (5) (6)

NOTE

(1) THE LIMITS IN THIS FIGURE ARE BASED ON LOADS MOVING ACROSS THE RAMP AND RAMP EXTENSION DURING ON/OFF LOADING OPERATIONS IN TRUCK LOADING POSITION.

(2) THE LIMITS IN THIS FIGURE ARE BASED ON LOADS MOVING ACROSS THE RAMP AND RAMP EXTENSION DURING ON/OFF LOADING OPERATIONS IN DRIVE-IN LOADING POSITION.

(3) THE LIMITS IN THIS FIGURE ARE BASED ON LOADS MOVING ACROSS THE RAMP DURING ON/OFF LOADING OPERATIONS IN THE TRUCK LOADING POSITION WITH THE RAMP LEVEL WITH CARGO COMPARTMENT FLOOR.

(4) THE LIMITS IN THIS FIGURE ARE BASED ON LOADS MOVING ACROSS THE RAMP DURING ON/OFF LOADING OPERATIONS IN THE TRUCK (WITH RAMP ADJUSTED BELOW LEVEL OF CARGO FLOOR) AND DRIVE-IN LOADING POSITIONS.

(5) AFT RAMP SUPPORT PADS MUST BE DEPLOYED CONTACTING GROUND AND SUPPORTING RAMP. SHORING MAY BE USED UNDER PADS TO ACHIEVE THIS REQUIREMENT.

(6) THE LIMITS IN THIS FIGURE ARE BASED ON LOADS MOVING ACROSS THE RAMP DURING ON/OFF LOADING OPERATIONS IN THE DRIVE-IN LOADING POSITION.

C-5

C5-9-4D-4-001-1

FIGURE B-85. Forward and aft cargo ramp on/off loading limitations (sheet 1 of 2)

CAUTION

NO LOADING PERMITTED ACROSS THE FORWARD RAMP AND OR RAMP EXTENSION IN AFT KNEEL. FAILURE TO COMPLY COULD RESULT IN DAMAGE TO THE AIRCRAFT.

RAMP	CONFIGURATION		RAMP GROUND SUPPORTED	RAMP ACTUATOR SUPPORTED
FORWARD	TRUCK BED	ALL RAMP EXTENSION JACKS	1 A E	
		2 OUTBOARD and 1 INBOARD	2 3	
		CAUTION		
		3 ADJ RAMP EXT JACKS	2 4 5 D	
	DRIVE-IN	ALL RAMP EXTENSION JACKS	6 E	A E
		2 OUTBOARD and 1 INBOARD	PROHIBITED	
		3 ADJ RAMP EXT JACKS	4 D	
		CAUTION		
		3 ADJACENT SUPPORT PADS	4 B F	A E
AFT	TRUCK BED	NORMAL	1 A E	
	DRIVE-IN	NORMAL	C E	A E

NOTE

ALL LIMITS BASED ON LOADS MOVING ACROSS THE RAMP DURING ON/OFF LOADING OPERATIONS.

LIMITATIONS:

1. ONE 50,000-POUND PLATFORM. TWO 40,000 POUND PLATFORMS SIDE-BY-SIDE.
2. 10,000-POUND PALLETS IN THE LOGISTICS RAIL SYSTEM.
3. 10,000-POUND PLATFORMS IN THE ADS RAIL SYSTEM.
4. ON/OFF LOAD ON SUPPORTED SIDE ONLY.
5. ADS LOADING PROHIBITED.
6. MAXIMUM TRACKED VEHICLE WEIGHT IS 129,000 POUNDS. TRACKED VEHICLES OVER 112,000 POUNDS SHALL BE LOADED WITH CG AT BL 0 (+- 7 INCHES).

A. MAXIMUM TRACKED VEHICLE WEIGHT IS 85,000 POUNDS. TRACKED VEHICLES OVER 62,000 POUNDS SHALL BE LOADED WITH CG AT BL 0 (+- 7 INCHES).
B. CENTERLINE ON/OFF LOADING PROHIBITED.
C. MAXIMUM TRACKED VEHICLE WEIGHT IS 112,000 POUNDS.
D. VEHICLE AXLES OVER 25,000 POUNDS ARE PROHIBITED. 25,000-POUNDS AXLE VEHICLES AND TRACKED VEHICLES UP TO 62,000 POUNDS SHALL BE ON/OFF LOADED BETWEEN BL 30 ON THE SIDE WITH ONE SUPPORT JACK TO BL 114 ON THE SIDE WITH TWO SUPPORT JACKS.
E. VEHICLE AXLES OVER 25,000 POUNDS SHALL BE LOADED WITH CG AT BL 0 (+- 7 INCHES). TWO 25,000-POUNDS AXLES IN TANDEM. ONE 36,000-POUNDS AXLE.
F. 25,000-POUND AXLE VEHICLES AND TRACK VEHICLES UP TO 112,000 POUNDS SHALL BE ON/OFF LOADED BETWEEN BL 30 ON THE SIDE WITH ONE SUPPORT JACK TO BL 114 ON THE SIDE WITH TWO SUPPORT JACKS.

C-5 ramp flight capacity limits are integral with the floor capacity chart, see B.3.2.1

C5-9-4D-5-001-2

FIGURE B-85. Forward and aft cargo ramp on/off loading limitations (sheet 2 of w) - continued

TABLE B-VII. Floor loading capacity (solid tires)

C-130 All

	ALLOWABLE LOAD (POUNDS PER INCH OF TIRE WIDTH)				
	GROUND LOADING CAPACITY - ROLLING SOLID TIRES				
TIRE DIAMETER (INCHES)	WITHOUT SHORING	3/4-INCH SHORING	1-INCH SHORING	1-1/2-INCH SHORING	2-INCH SHORING
1	28	69.5	77		
2	56	139	154		
4	111	278	308		
6	167	417	461	NOTE: On airplanes AF53-3129 through AF55-509, multiply table values by 0.75.	
8	222	556	615		
10	278	695	769		
12	334	834	923		
14	389	973	1,077		
16	445	1,112	1,230		
18	500	1,250	1,384		
	INFLIGHT CAPACITY - STOWED SOLID TIRES				
1	15.5	38.5	46	61.5	77
2	31	77	92	123	154
4	62	154	185	246	308
6	92	231	277	369	461
8	123	308	370	492	615
10	154	385	462	615	762
12	185	462	555	738	923
14	216	539	648	861	1,077
16	247	616	741	984	1,230
18	278	693	834	1,107	1,384

CAUTION

Do not exceed 500 pounds per inch of tire width for unshored vehicles.

CAUTION

Maximum load on non-treadway area, compartments C through K, is 2,000 pounds per tire. For compartments L and M, maximum load on non-treadway area is 1,000 pounds per tire.

NOTE

To obtain steel-wheel values, multiply values shown by 0.60.

NOTE

To calculate the allowable load for odd-sized tires, add the allowable load for the next-smallest tire size to the allowable load for a 1-inch tire. For example, the allowable load for a 13-inch tire is the sum of the allowable loads for a 12-inch tire and a 1-inch tire. For rolling solid tires (without shoring), the allowable load for a 12-inch tire is 334 pounds per inch of tire width and the allowable load for a 1-inch tire is 28 pounds per inch of tire width. The allowable load for a 13-inch tire is therefore 334 + 28 = 362 pounds per inch of tire width.

TABLE B-VIII. Steel and hard rubber wheel - allowable floor load limitations

Wheel Width (in)	On/Off Allowable Loading (Pounds)						
	Without Shoring	3/4 Inch Shoring	1 Inch Shoring	1-1/2 Inch Shoring	2 Inch Shoring	2-1/4 Inch Shoring	3 Inch Shoring
	On/Offloading (Rolling)						
1	632	982	2532	3027	3506	3765	4619
2	682	2626	2871	3347	3857	4115	5094
3	2330	2955	3198	3705	4213	4518	5639
4	2680	3325	3565	4049	4651	5017	12209
6	3388	4022	4308	5004	10852	11530	13565
8	4102	8136	10852	12209	13565	14243	16278
10	10852	12887	13565	14922	16278	16956	18000
12	13565	15600	16278	17635	18000	18000	18000
16	16278	18000	18000	18000	18000	18000	18000
18	18000	18000	18000	18000	18000	18000	18000
20	18000	18000	18000	18000	18000	18000	18000
On/Offloading Roller Tray and Logistic Rail Cover							
1	632	982	1328	1871			
2	682	1424	1712				
3	1167						
4	1505						
In–Flight Loading (Parking)							
1	321	499	1305	1560	1807	1941	2381
2	347	1354	1480	1725	1988	2121	2626
3	1201	1523	1649	1910	2171	2329	2907
4	1381	1714	1838	2087	2397	2586	6262
6	1747	2073	2221	2580	5867	6236	7344
8	2114	4095	5410	6193	6919	7305	8268
10	5165	6157	6488	7211	7971	8492	9223
12	6296	7129	7475	8414	9083	9496	10357
16	8265	9121	9504	10327	11295	11687	12879
18	9222	10161	10592	11336	12067	12575	13999
20	10278	10964	11316	12279	13444	13924	15133
In Flight Loading (Parking) Roller Tray and Logistic Rail Cover							
1	321	499	665	938			
2	347	714	858				
3	585						
4	754						

CAUTION

- Do not use steel wheels without shoring. Failure to comply could cause damage to the floor.
- Do not roll or park a 1.0 inch or 2.0 inch wide wheel over the Logistic Rail Cover latch hole without shoring. Failure to comply could cause damage to the Logistic Rail Cover.

NOTE

- For wheel widths not given use an allowable for a smaller wheel, or interpolate between given allowables.
- All wheels must be oriented in the forward and aft direction.

- The 1.67 Criteria shown in T.O. 1C-17A-9 (paragraph 4D-29, Change 5) shall not be utilized to determine loadability of pneumatic tires with inflation pressures greater than 100 psi

- Flight – Utilize Concentrated Floor Loads to determine if parking shoring is required. Use the tire's actual floor contact pressure and PIW for the evaluation.

- Loading – Utilize the following chart to determine if rolling shoring is required for the loading of the tire. Use the tire's actual floor contact pressure and PIW for the evaluation. If the tire does not exceed the PIW limit for a given psi then shoring is not required.

- For psi values not given use an allowable for a lower pressure or interpolate between given values.

MAXIMUM PSI	MAXIMUM PIW
39	No Limit
40	1570
42	1512
46	1502
49	1470
53	1470
56	1456
58	1239
60	1173
63	1092
67	1041
70	1006
74	978
77	957
81	938
84	922
88	910
96	884
105	865
114	851
123	838
131	828
140	821
158	809
175	798
193	791
210	784
245	775
280	768
315	763

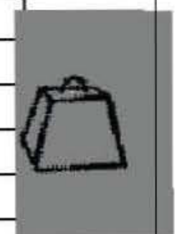


FIGURE B-86. C-17 high pressure pneumatic tire limitations

PROCEDURE FOR DETERMINING HARD RUBBER OR STEEL WHEEL (NO MEASURABLE LENGTH) MAXIMUM ALLOWABLE FLOOR LOADS AND CALCULATION OF SHORING WHEN REQUIRED.

NOTE

USE THE PROCEDURES IN FIGURE 4-26 FOR WHEELS WITH A MEASURABLE LENGTH THAT WILL BE PARKED OVER DISCONTINUITIES.

WHEEL MUST BE PLACED IN CENTER OF SHORING.

1. ANY HARD RUBBER WHEEL OR STEEL WHEEL THAT CAN BE TRANSPORTED ON THE CARGO FLOOR WITHOUT SHORING, CAN BE ON/OFF LOADED WITHOUT SHORING ACROSS ALL THE CARGO FLOOR.
2. HARD RUBBER WHEELS ARE DEFINED AS SOLID RUBBER TIRES AND RUBBER WHEELS.

FORMULA STEPS

1. CALCULATE EFFECTIVE WIDTH (PARKED OVER DISCONTINUITY)

EFFECTIVE WIDTH = ACTUAL WIDTH - DISCONTINUITY WIDTH

2. CALCULATE ALLOWABLE LOAD

CARGO FLOOR (HARD RUBBER OR STEEL WHEEL)

ALLOWABLE LOAD = (ACTUAL OR EFFECTIVE WIDTH) X 468.5

RAMP FLOOR (HARD RUBBER WHEELS)

ALLOWABLE LOAD = (ACTUAL OR EFFECTIVE WIDTH) X 408

RAMP FLOOR (STEEL WHEELS)

ALLOWABLE LOAD = (ACTUAL OR EFFECTIVE WIDTH) X 342

3. CALCULATE SHORING (HARD RUBBER OR STEEL WHEEL - RAMP OR CARGO FLOOR)

A. REQUIRED (L+W)

CARGO FLOOR (HARD RUBBER OR STEEL WHEEL)

$$\text{REQUIRED WIDTH} = \frac{\text{WHEEL LOAD}}{468.5}$$

RAMP FLOOR (HARD RUBBER WHEELS)

$$\text{REQUIRED WIDTH} = \frac{\text{WHEEL LOAD}}{408}$$

RAMP FLOOR (STEEL WHEELS)

$$\text{REQUIRED WIDTH} = \frac{\text{WHEEL LOAD}}{342}$$

B. THICKNESS, LENGTH, AND WIDTH

$$\text{THICKNESS} = \frac{\text{REQUIRED WIDTH} - (\text{ACTUAL OR EFFECTIVE WIDTH})}{2}$$

LENGTH = 2 X THICKNESS

WIDTH = 2 X THICKNESS + ACTUAL WIDTH

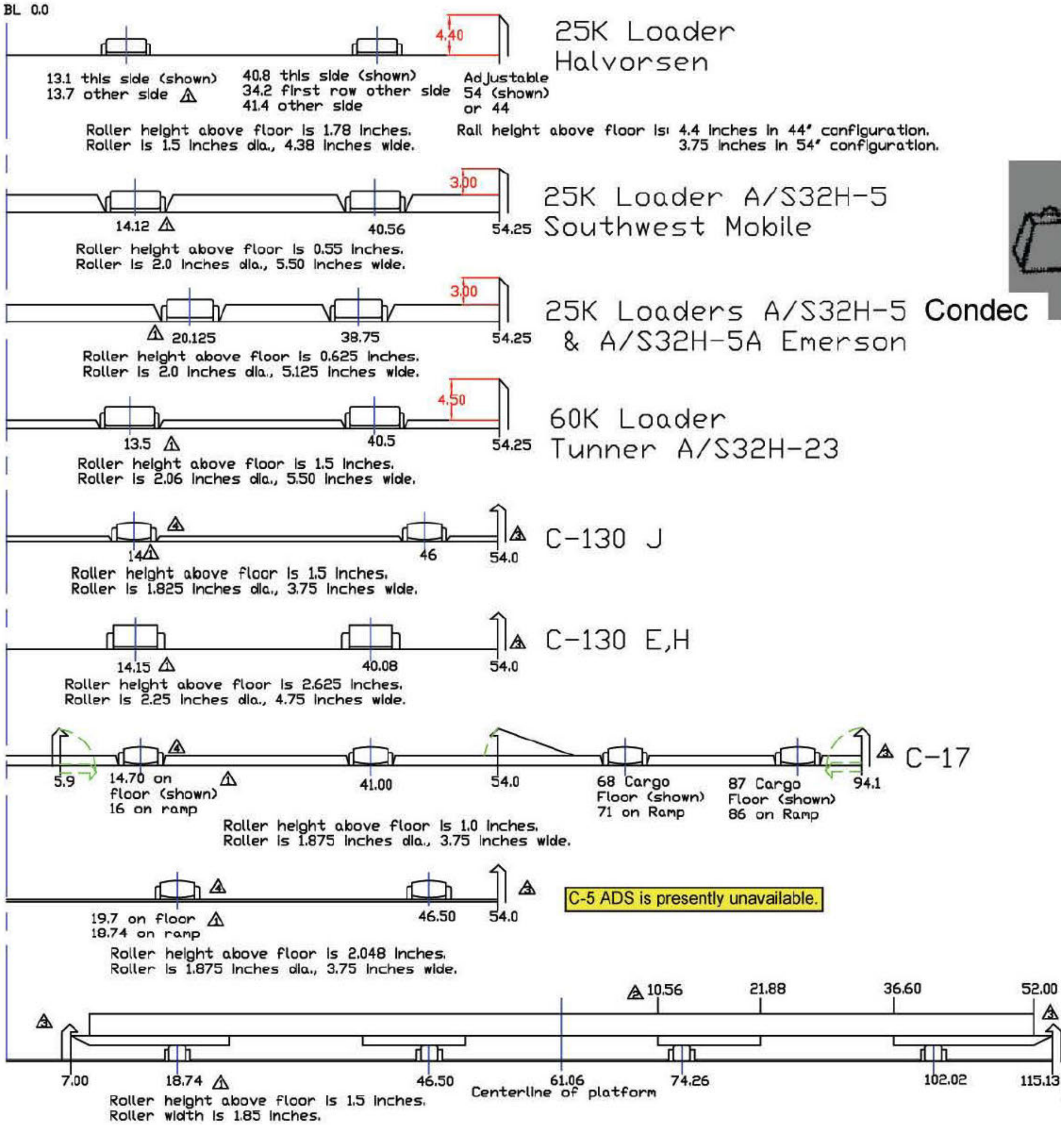
MINIMUM LENGTH OF SHORING IS ONE INCH.

C5-9-4D-3-016

FIGURE B-87. Hard rubber or steel wheel maximum allowable floor loads

C-5

Comparison of lateral roller spacings, roller widths, and rolling surface height for existing K-Loaders and aircraft.



C-5 Logistics rail/roller interface with Type V airdrop platform

Notes:
1 - Lower numbers are BL distances from aircraft centerline.
2 - Upper numbers are Left/Right of Platform centerline (BL 61.06)
3 - Aircraft Rail Height is approximate.
4 - Roller crown is approximate.
5 - Only dimensioned items are to scale

FIGURE B-88.

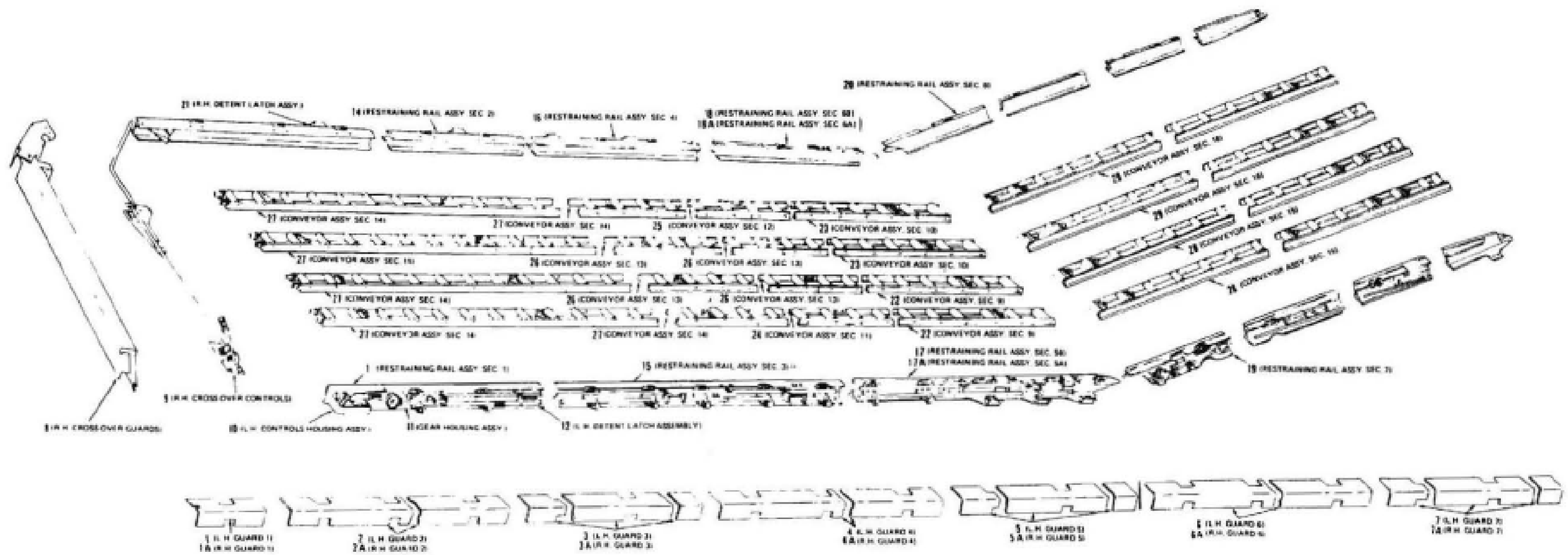


FIGURE B-89. A/A32H-4A cargo handling system

C-130 E/H

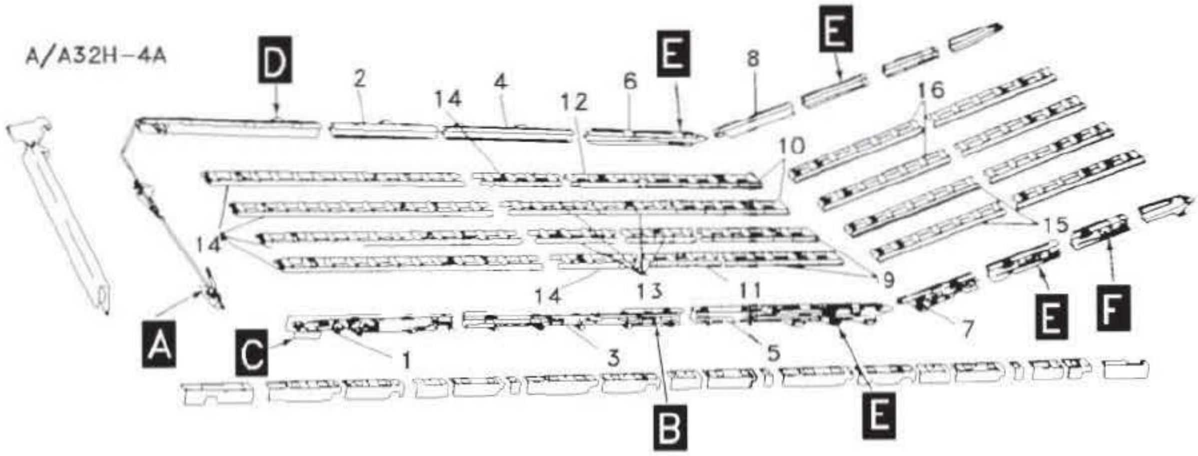
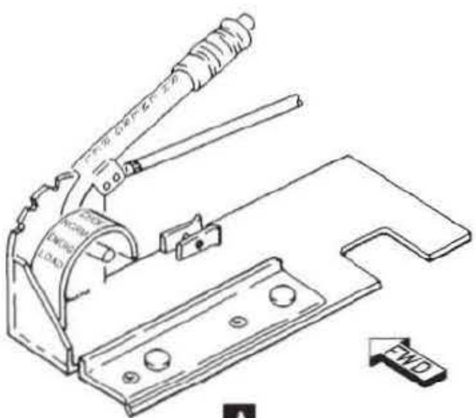


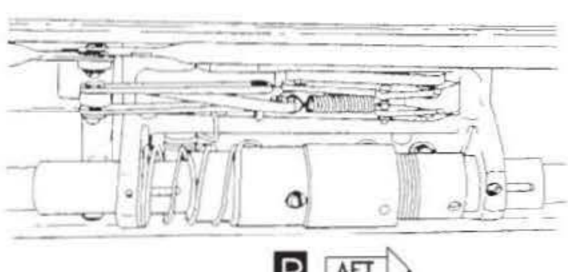
FIGURE B-89. A/A32H-4A cargo handling system annotated - continued

CONVEYOR SECTION WEIGHTS (POUNDS)							
LEFT SECTIONS		RIGHT SECTIONS		AUXILIARY SECTIONS			
SECTION	WEIGHT TOTAL	SECTION	WEIGHT TOTAL	SECTION	WEIGHT TOTAL	SECTION	WEIGHT TOTAL
1	228	2	226	9 (2 EA)	70	13 (4 EA)	112
3	196	4	206	10 (2 EA)	70	14 (6 EA)	141
5	66	6	68	11	34	15 (2 EA)	80
7	88	8	88	12	34	16 (2 EA)	80

RH CONTROL AND GUARD WEIGHT IS 25 POUNDS. REMOVABLE SECTIONS 9 THROUGH 16 TOTAL 621 POUNDS. INSTALLED TOTAL WEIGHT IS 1,812 POUNDS.



RIGHT-HAND MASTER CONTROL



LEFT-HAND DETENT LATCH ASSEMBLY

L9700390

FIGURE B-89. A/A32H-4A cargo handling system (A & B) - continued

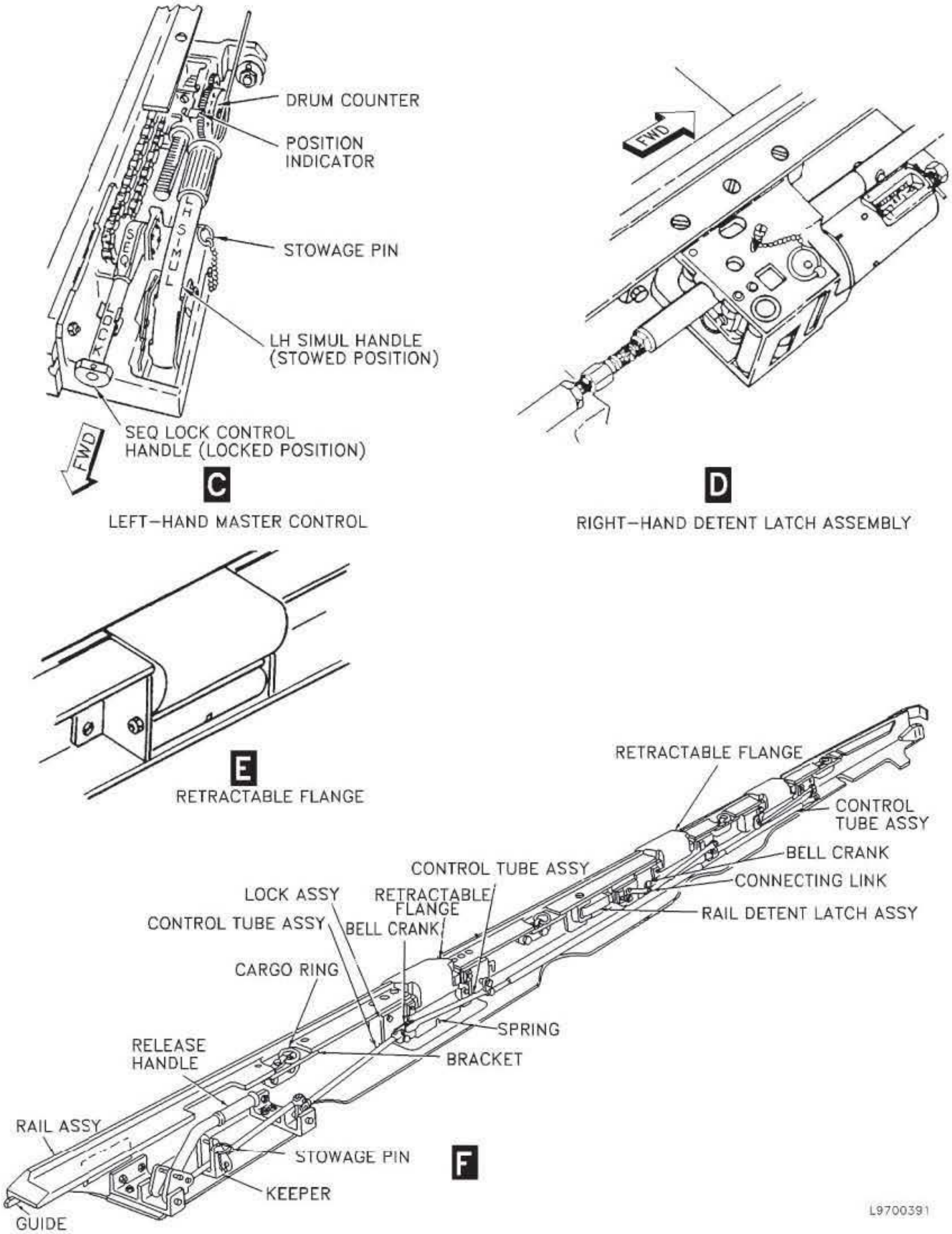
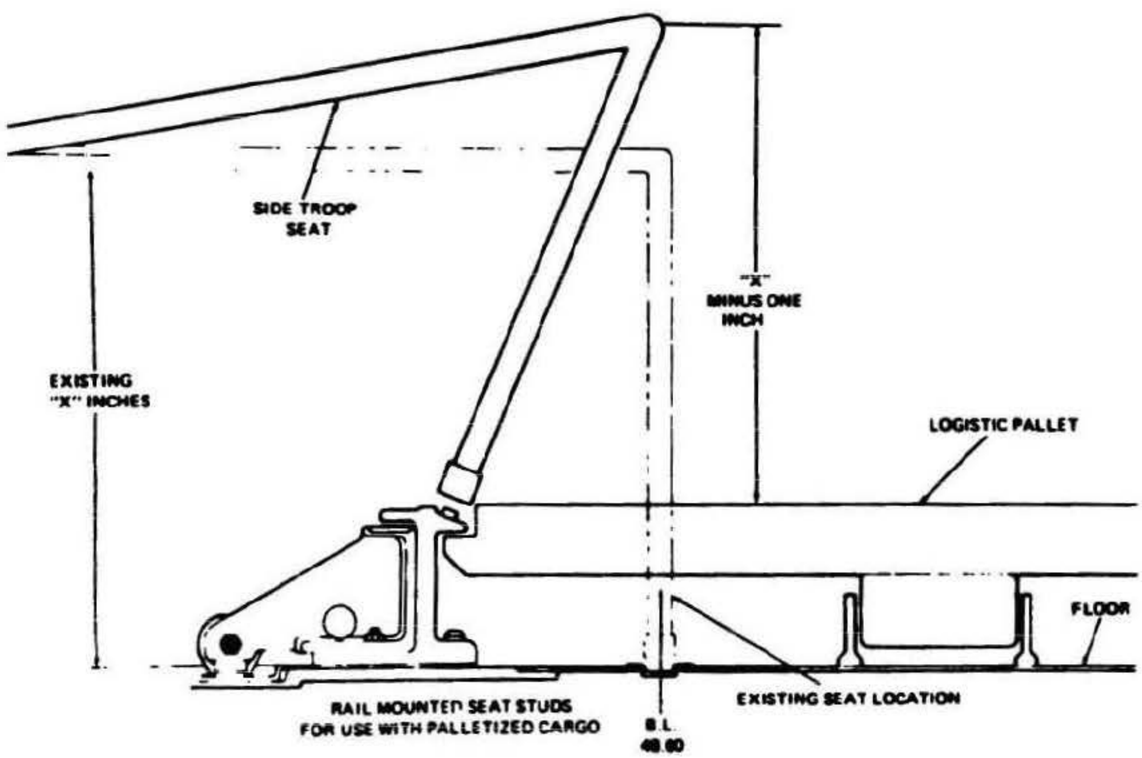


FIGURE B-89. A/A32H-4A cargo handling system (C-F) - continued



C-130 E/H

FIGURE B-90. Rail mounted seat stude (-4A)

TABLE B-1. Palletized cargo weight limitation for all C-130s

Ground Limits for Palletized Cargo – C-130F/H

FS	245	281	337	401	457	517	597	627	682	737	803	869
Compartment	C	D	E	F	G	H	I	J	K	L	M	
LB/LIN FT	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	
LB/ROLLER*	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	

*LB/ROLLER is based on roller stations; one or more rollers in a lateral row constitute a roller station.

To determine number of roller stations contacted, divide skid length by 10 and discard remainder.

Flight Limits for palletized cargo —C-130E/H

FS	245	281	337	401	457	517	597	627	682	737	803	869
Compartment	C	D	E	F	G	H	I	J	K	L	M	
LB/LIN FT	2,800	2,800	3,200	3,200	3,200	3,200	3,200	3,200	2,800	1,000	1,000	
LB/ROLLER*	2,333	2,333	2,667	2,667	2,667	2,667	2,667	2,667	2,333	833	833	

Ground Limits for palletized cargo — C-130J (Short Fuselage)

FS	245	281	337	401	457	517	597	627	682	737	803	869
Compartment	C	D	E	F	G	H	I	J	K	L	M	
LB/LIN FT	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	
LB/ROLLER*	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	

Flight Limits for palletized cargo — C-130J (Short Fuselage)

FS	245	281	337	401	457	517	597	627	682	737	803	869
Compartment	C	D	E	F	G	H	I	J	K	L	M	
LB/LIN FT	2,800	2,800	3,200	3,200	3,200	3,200	3,200	3,200	2,800	1,000	1,000	
LB/ROLLER*	2,333	2,333	2,667	2,667	2,667	2,667	2,667	2,667	2,333	833	833	

FS 649-737
Max 8,500

Ground Limits for palletized cargo —C-130J-30 (Long Fuselage)

LS	345	383	472	562	652	742	832	922	1011	1042	1124	1141
Compartment	C	D	E	F	G	H	I	J	K	L	M	
LB/LIN FT	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	
LB/ROLLER*	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	

Flight Limits for palletized cargo — C-130J-30 (Long Fuselage)

LS	345	383	472	537	562	652	742	832	882	922	1011	1042	1124	1141
Compartment	C	D	E†		F	G	H	I†		J	K	L	M	
LB/LIN FT	2,800	2,800	2,800	3,200	3,200	3,200	3,200	3,200	2,800	2,800	2,800	1,000	1,000	
LB/ROLLER*	2,333	2,333	2,333	2,667	2,667	2,667	2,667	2,667	2,333	2,333	2,333	833	833	

†Compartments E and I have loading limits that change in the middle.
Reference the Load Station number for exact location.

FS 929-1017
Max 8,500

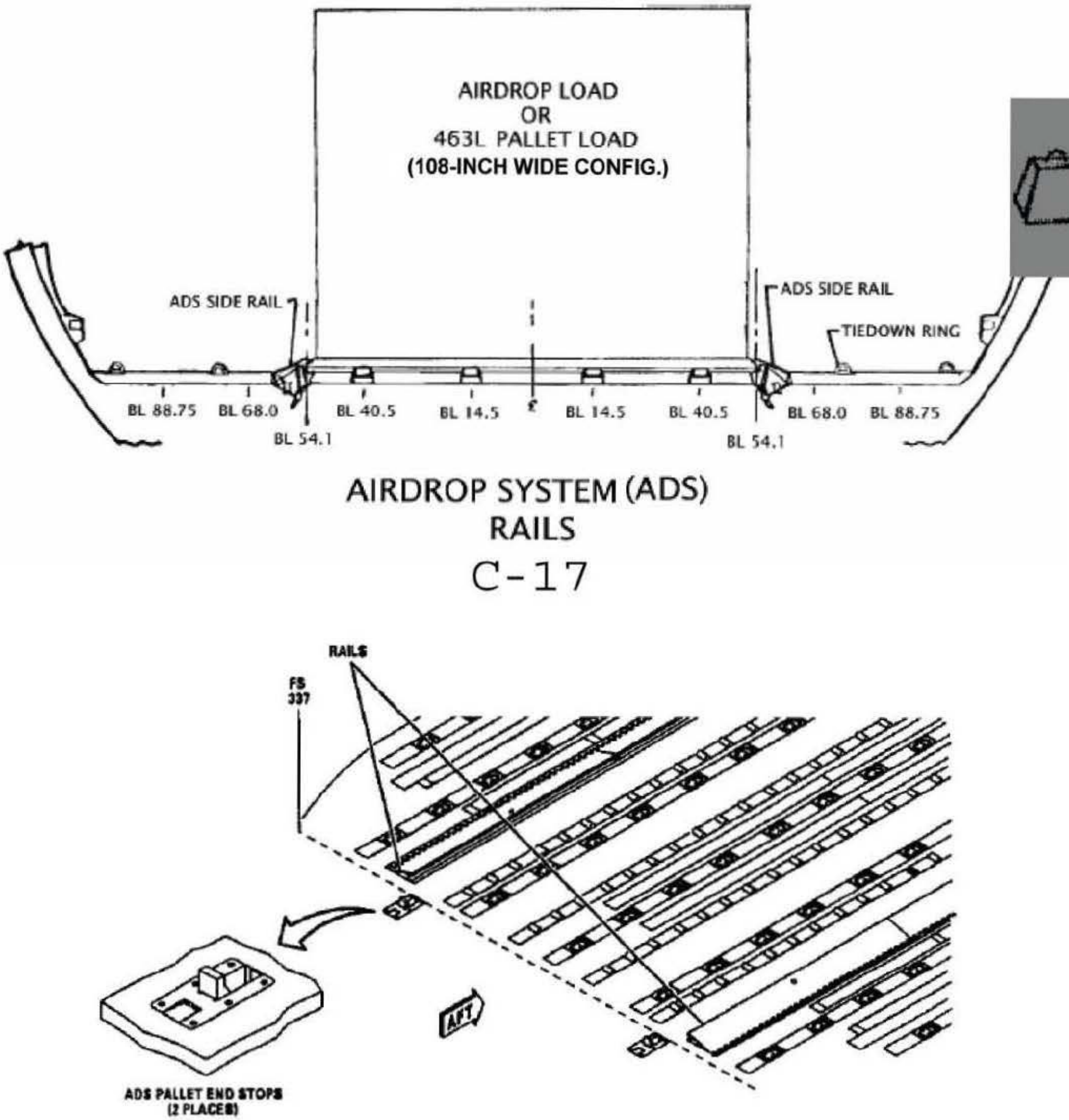
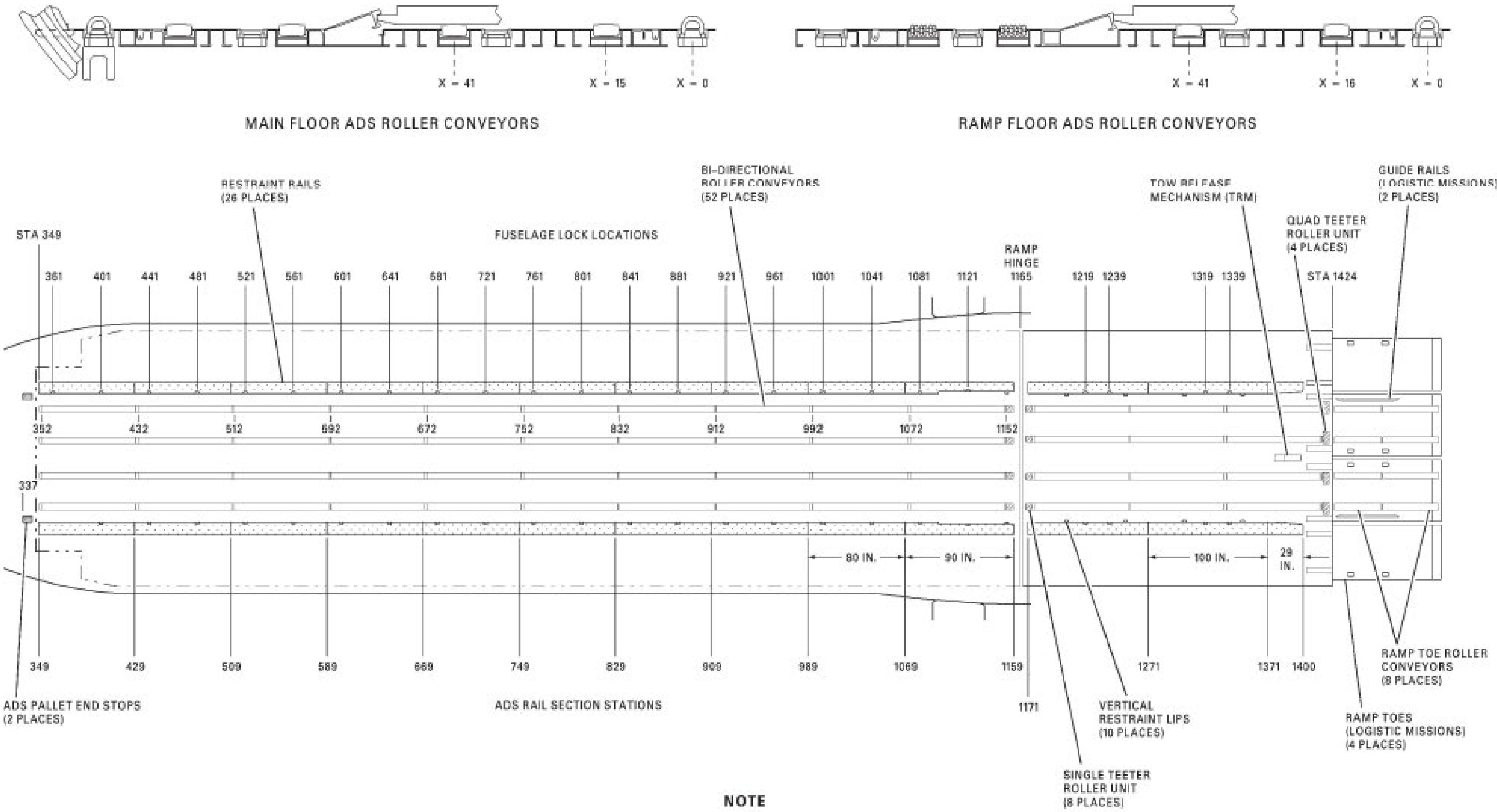


FIGURE B-91. C-17 ADS system



NOTE

- ADS RAILS MAIN FLOOR, 80 INCH SECTIONS (18 PLACES)
- ADS RAILS MAIN FLOOR, 90 INCH SECTIONS (2 PLACES)
- ADS RAILS RAMP, 100 INCH SECTIONS (4 PLACES)
- ADS RAILS RAMP, 29 INCH SECTIONS (2 PLACES)
- X = COORDINATES PLUS AND MINUS

FIGURE B-91. AD restraint rails – cargo floor and ramp (sheet 2 of 2) – cont.

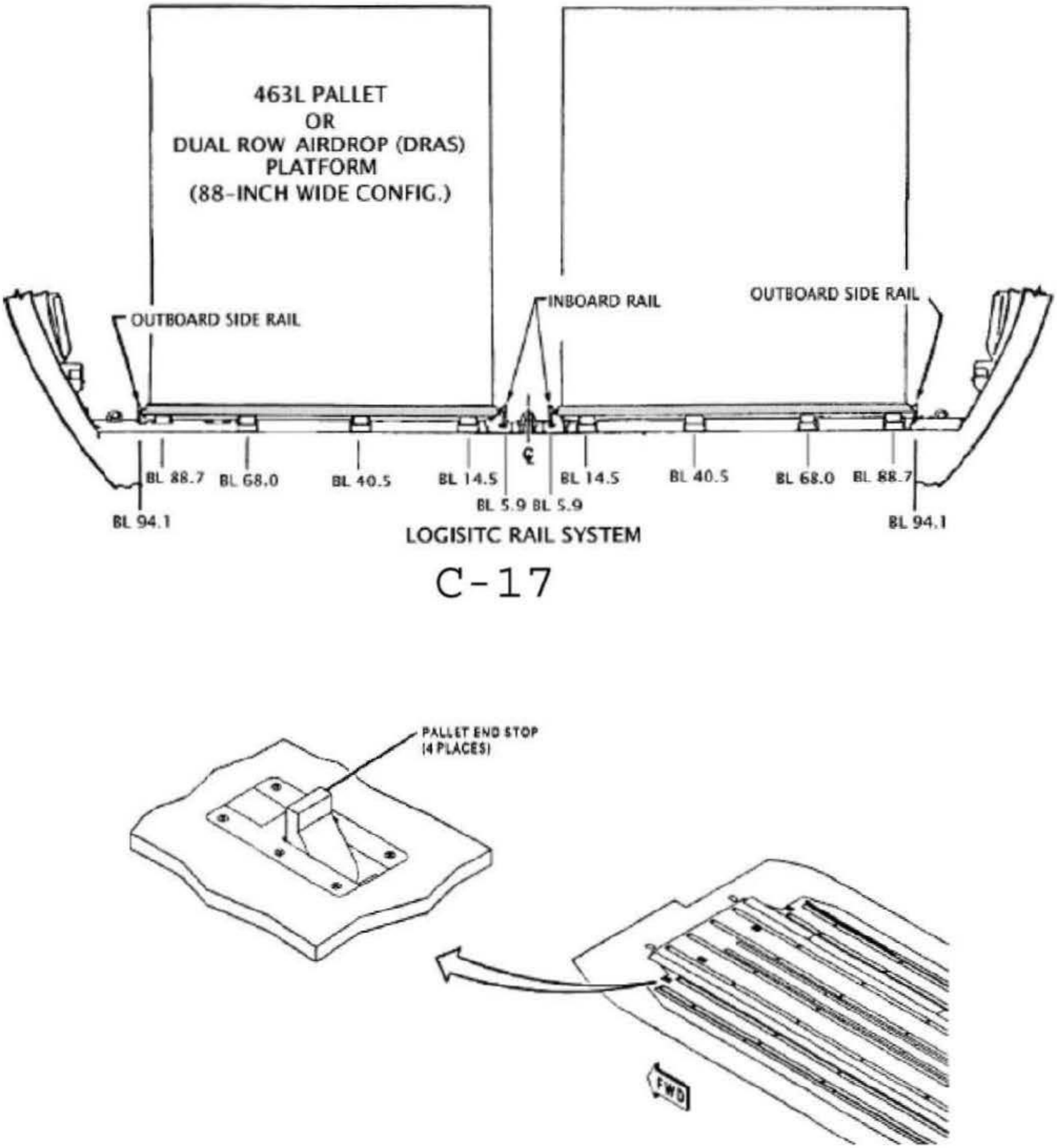
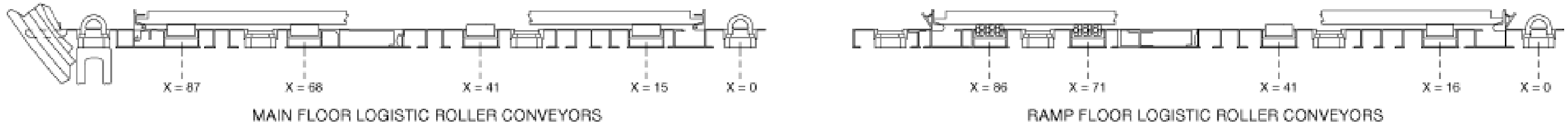
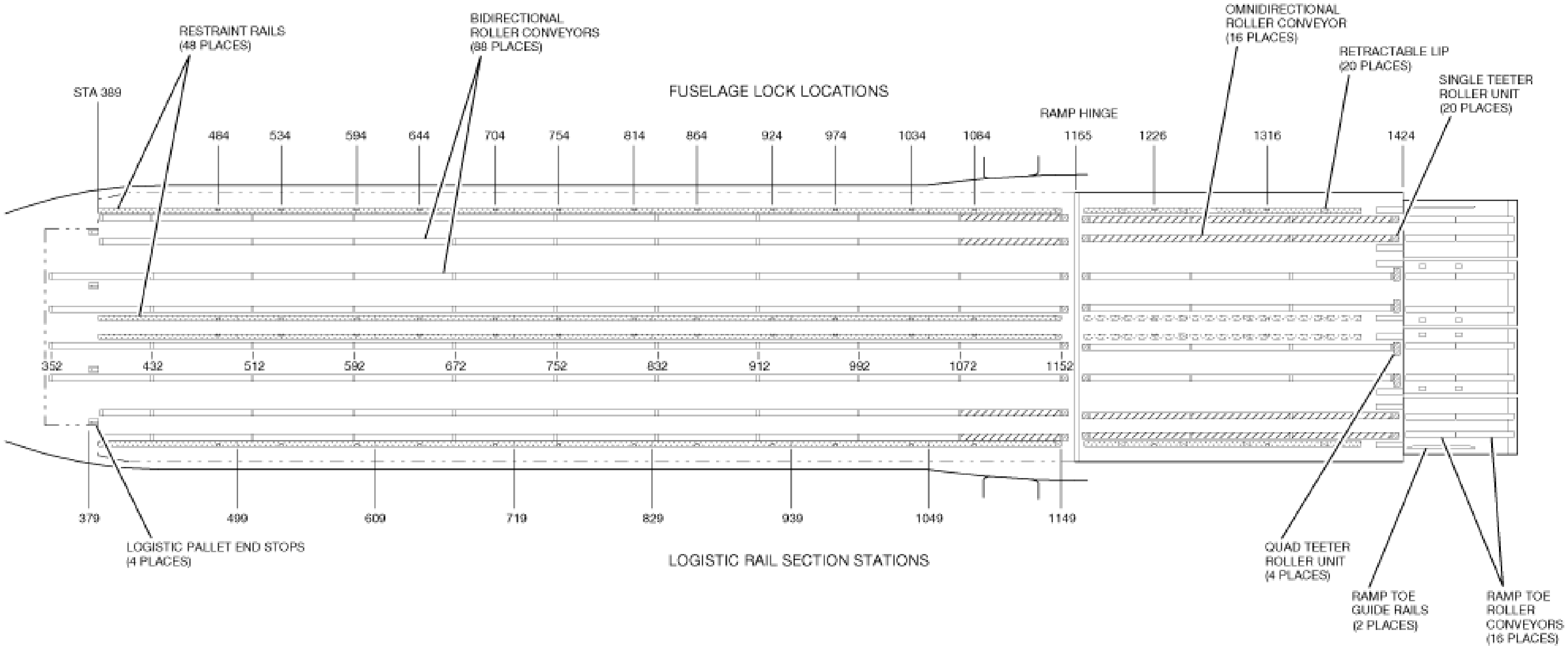


FIGURE B-92. C-17 logistic rail system





NOTE

- ROLLER STATIONS ARE TO CENTROID OF LATCH ASSEMBLIES
- 78 INCH ROLLER CONVEYORS FLOOR AND RAMP (100 PLACES)
- 38 INCH ROLLER CONVEYORS FLOOR (4 PLACES)
- 10 INCHES BETWEEN SINGLE TEETERS AT RAMP HINGE
- X = COORDINATES PLUS AND MINUS

FIGURE B-92. Logistic restraint rail system – cargo floor and ramp (sheet 2 of 2) – cont.

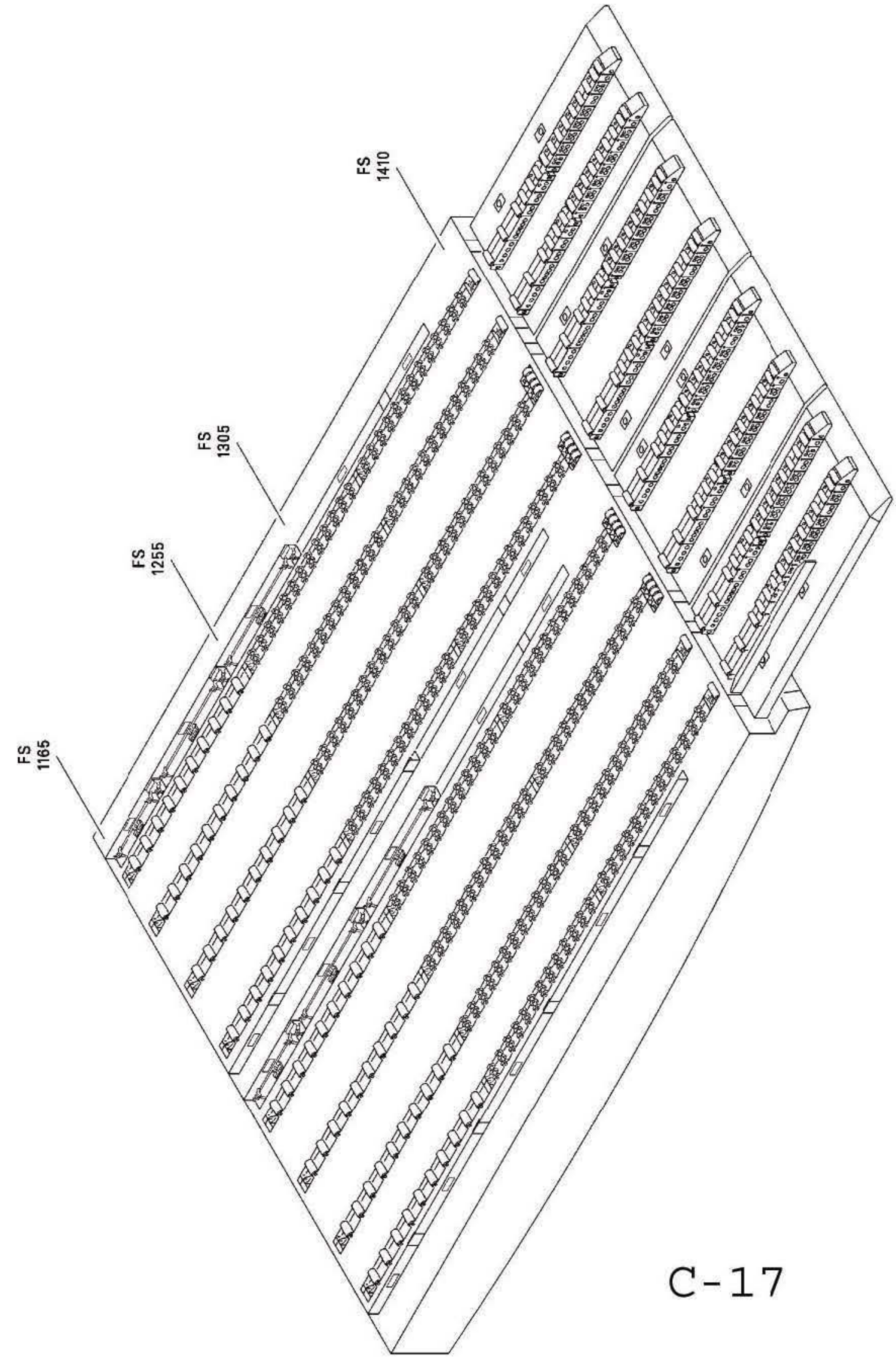


FIGURE B-93. C-17 ramp and ramp toes configured for dual row logistics system loading

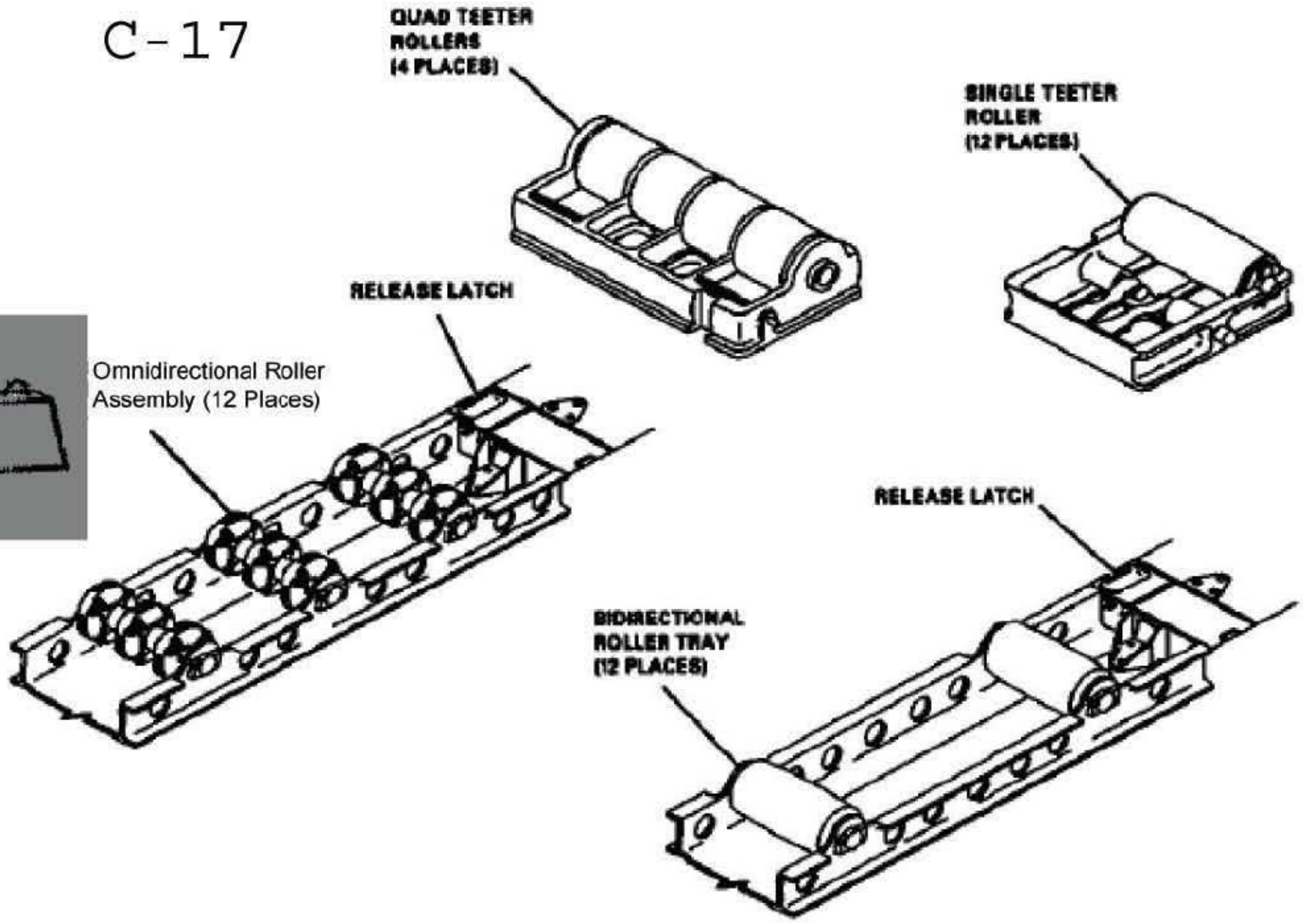
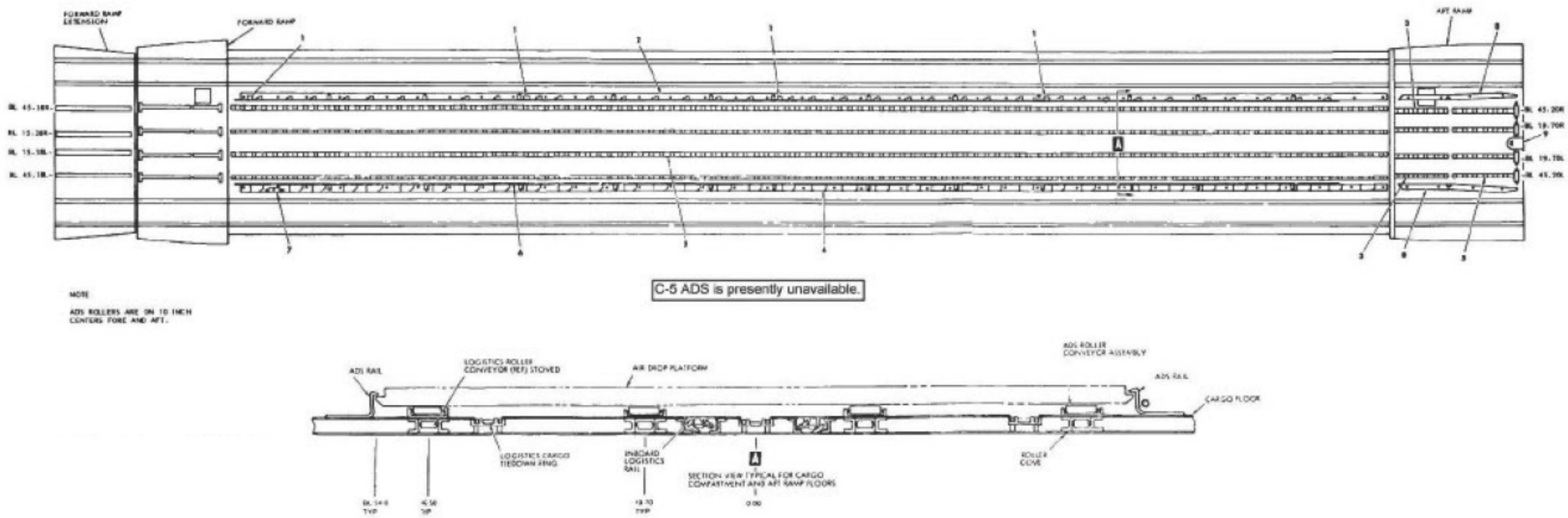


FIGURE B-94. C-17 rollers and limitations

Omnidirectional Rollers are on 5-inch centers fore and aft.
Bidirectional Rollers are on 10-inch centers fore and aft.
The removable Ramp Toe bidirectional roller trays have rollers on 5-inch centers at the end of the toe, to facilitate safe loading from MHE.
Ramp Toe guide rails are available to facilitate pallet alignment with ADS or logistics rails.

Roller	Capacity
Bidirectional* & Single Teeter	2,000 lbs
Omnidirectional	1,940 lbs loading/1,000 lbs flight
Quad Teeter	3,000 lbs

*When requirements exist to increase the load on a single bidirectional roller to 3,000 LB, the conveyor roller immediately forward and aft of that roller will be limited to 1,500 LB.



1. Control Handles and Actuators RH Rails (4)
2. ADS Restraint Rail (TYP)
3. Teeter Roller Conveyor Assembly
4. Restraint and Release Mechanisms (TYP)
5. ADS Roller Conveyor and Roller Fairing Assemblies
6. Quick Disconnect Coupling (TYP)
7. Master Control LH Rails
8. AFT Ramp ADS Guide Rail
9. Extraction Line Guard

FIGURE B-95. Cargo floor configuration (ADS cargo)

C-5

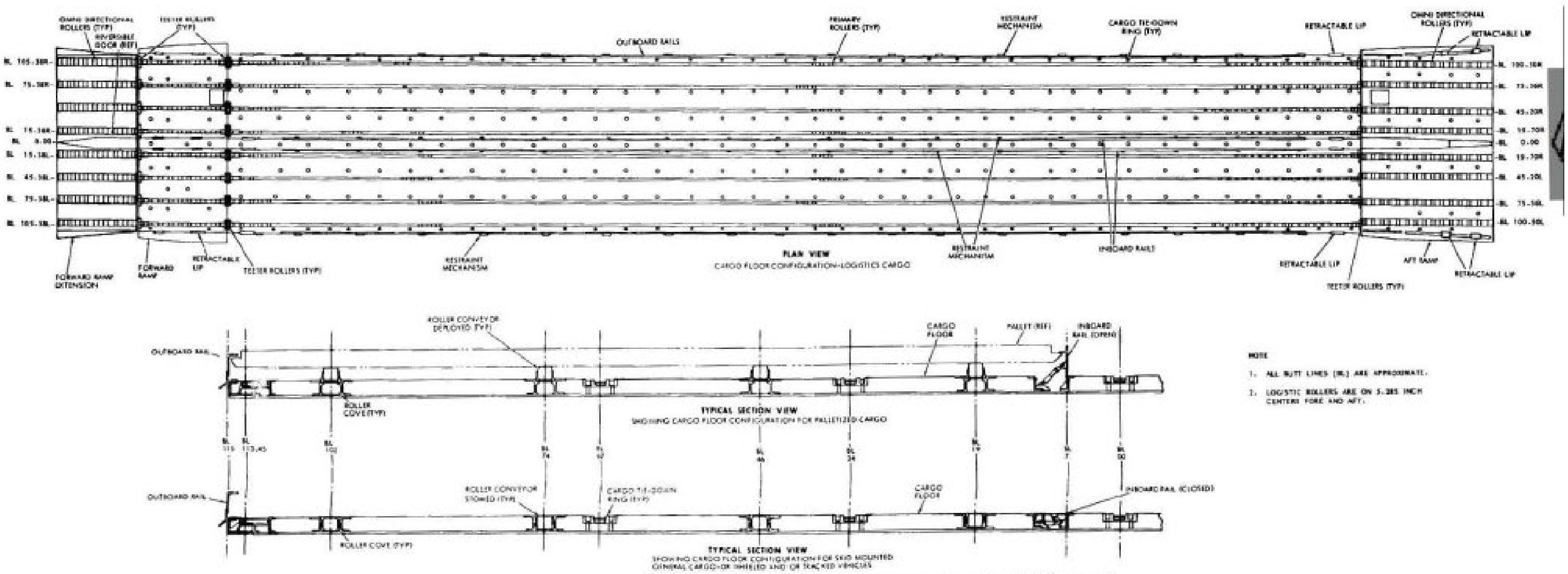
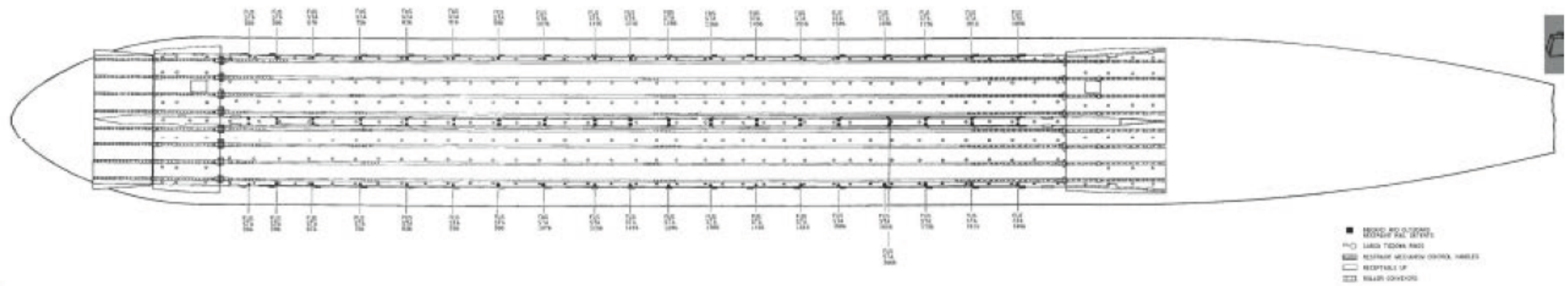


FIGURE B-96. Cargo floor configuration (logistics cargo)

C-5



PLAN VIEW SHOWING INBOARD AND OUTBOARD
LOGISTICS RESTRAINT RAIL MECHANISM DETENT LOCATIONS

C-5

FIGURE B-97. Inboard and outboard restraint rail mechanism detent locations

PROCEDURE FOR DETERMINING MAXIMUM ALLOWABLE ROLLER CONVEYOR SYSTEM FLIGHT LOADS AND CALCULATION OF SHORING WHEN REQUIRED

	MAXIMUM ALLOWABLE ROLLER CONVEYOR FLIGHT LOADS			
COLUMN	1	2	3	4
	EACH CONTACT POINT SUPPORTED BY ONE LONGITUDINAL ROLLER AND USES ONLY ONE ROLLER CONVEYOR FOR SUPPORT.	EACH CONTACT POINT SUPPORTED BY ONE LONGITUDINAL ROLLER AND USES 2 TO 4 ROLLER CONVEYORS FOR SUPPORT.	EACH CONTACT POINT SUPPORTED BY MORE THAN ONE LONGITUDINAL ROLLER AND USES 1 OR 2 ROLLER CONVEYORS FOR SUPPORT.	EACH CONTACT POINT SUPPORTED BY MORE THAN ONE LONGITUDINAL ROLLER AND USES 3 OR 4 ROLLER CONVEYORS FOR SUPPORT.
UNITS	POUNDS/ROLLER	POUNDS/LATERAL ROW	POUNDS/LINEAR INCH (PLI)	POUNDS/LINEAR INCH (PLI)
LOGISTIC SYSTEM	$L_1 < 10.6$ INCHES 1,070	$L_1 < 10.6$ INCHES (1) (2) 2,140	$L_1 \geq 10.6$ INCHES (3) 100	$L_1 \geq 10.6$ INCHES (4) 200
ADS	$L_1 \leq 20$ INCHES 3,205	$L_1 \leq 20$ INCHES (1) (2) 6,410	$L_1 > 20$ INCHES (3) 160	$L_1 > 20$ INCHES (4) 320

C-5 ADS is presently unavailable.

CAUTION

THE ALLOWABLE LOAD CAPABILITY OF THE ROLLER CONVEYOR SYSTEMS MAY BE EXCEEDED BY THE LOAD CAPABILITY OF THE 463L PALLET AND THE AIRDROP PLATFORMS. CARE SHALL BE TAKEN TO SEE THAT PALLET/PLATFORMS HAVE NOT BEEN LOADED BEYOND THE LOAD CAPABILITY OF THE ROLLER CONVEYORS. FAILURE TO OBSERVE THIS CAUTION MAY CAUSE ROLLER FAILURE.

NOTE

(1) IF EACH CONTACT POINT IS SUPPORTED BY ONE LONGITUDINAL ROLLER AND USES 5 ROLLER CONVEYORS FOR SUPPORT, ADD THE ALLOWABLE LOAD IN COLUMN 1 AND COLUMN 2.

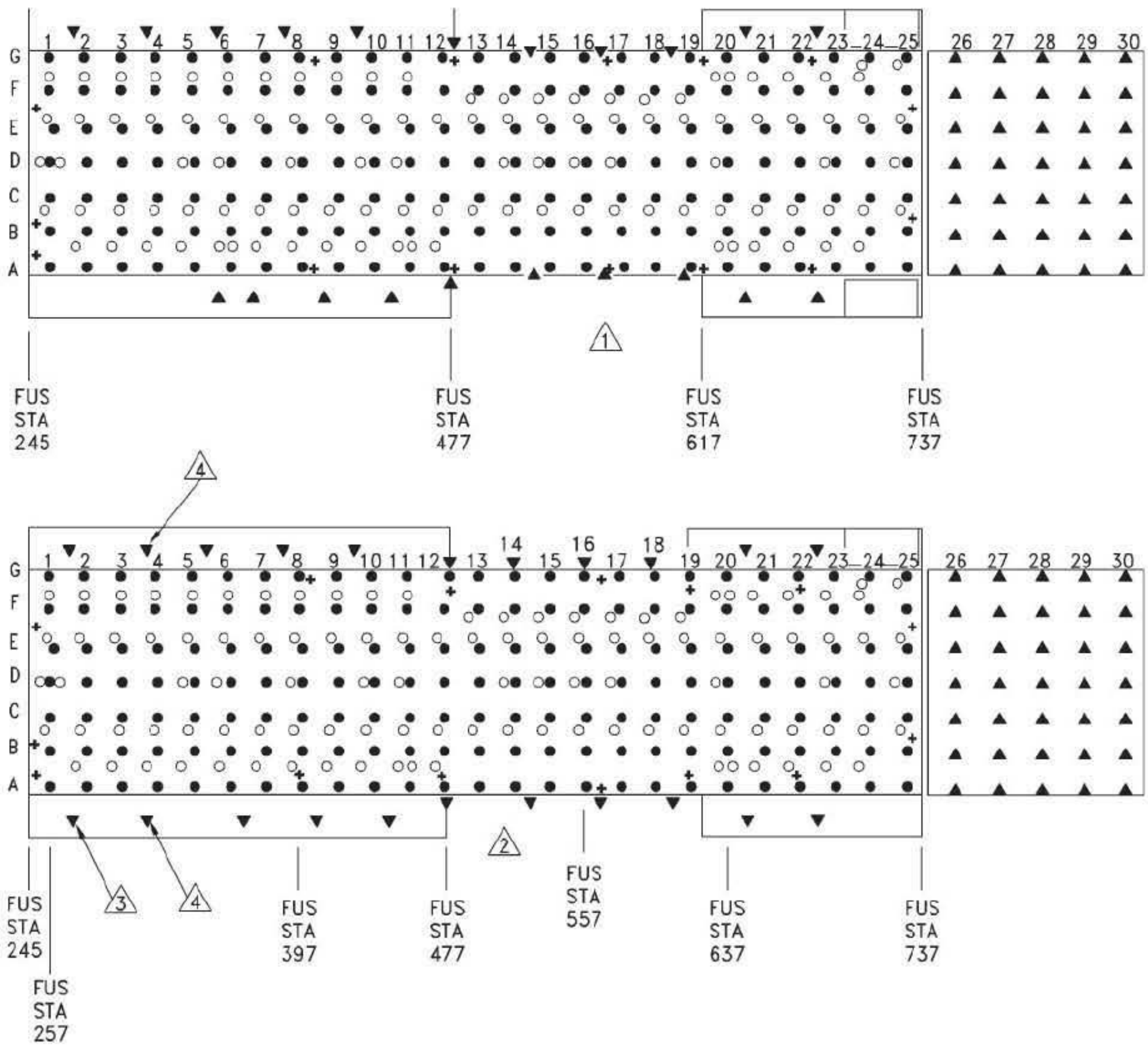
(2) IF EACH CONTACT POINT IS SUPPORTED BY ONE LONGITUDINAL ROLLER AND USES 6 OR MORE ROLLER CONVEYORS FOR SUPPORT, USE TWICE THE ALLOWABLE LOAD IN COLUMN 2.

(3) IF EACH CONTACT POINT IS SUPPORTED BY MORE THAN ONE LONGITUDINAL ROLLER AND UTILIZES 5 OR 6 ROLLER CONVEYORS FOR SUPPORT, ADD THE ALLOWABLE LOAD IN COLUMN 3 AND COLUMN 4.

(4) IF EACH CONTACT POINT IS SUPPORTED BY MORE THAN ONE LONGITUDINAL ROLLER AND UTILIZES 7 OR 8 ROLLER CONVEYORS FOR SUPPORT, USE TWICE THE ALLOWABLE LOAD IN COLUMN 4.

FIGURE B-98. C-5 roller system weight limitations

B.3.3	**Restraint**	# pages
	Tiedown	7



○ SEAT AND LITTER FITTINGS

▼ 5,000 – POUND FITTINGS ARE 24.5 INCHES ABOVE THE CARGO FLOOR AND ON THE RAMP.

● 10,000 – POUND FITTINGS

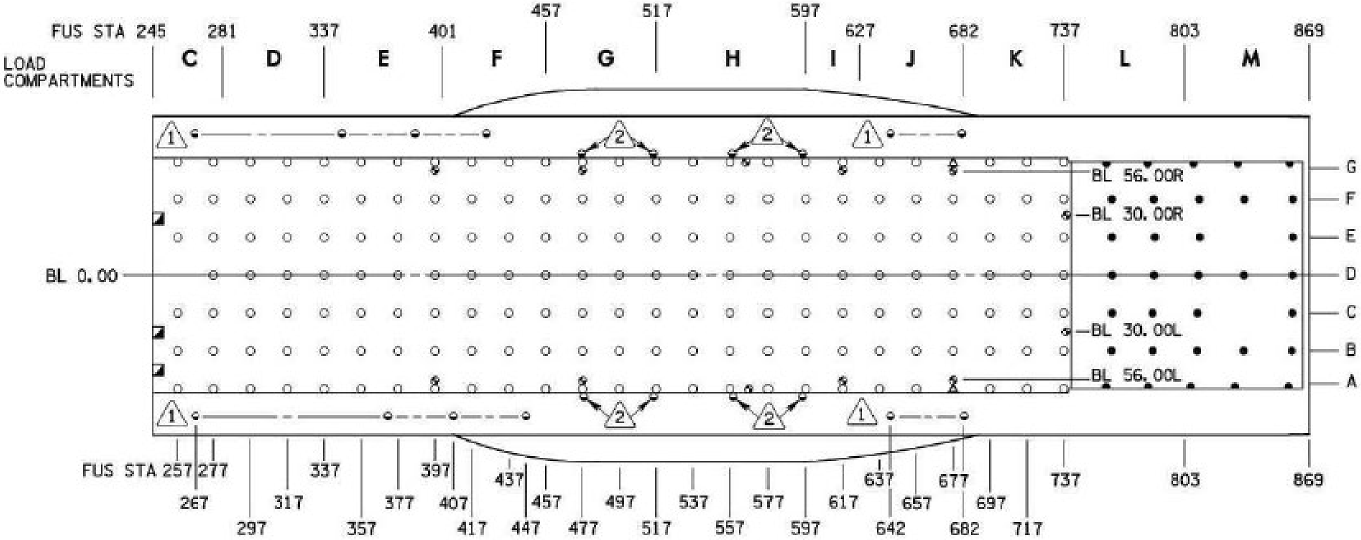
+ 25,000 – POUND FITTINGS

NOTE

1. AIRPLANES AF53–3129 THROUGH AF56–509.
2. AIRPLANES AF56–510 AND UP.
3. AIRPLANES AF62–1784 AND UP, EXCEPT MC–130H AIRPLANES.
4. FITTING DELETED ON AIRPLANES AF83–0486 AND UP.

C-130 E/H

FIGURE B-99. Cargo tiedown, seat, and litter fitting locations



NOTE

1. CENTERLINE OF RINGS AT WATERLINE 170 (24 INCHES ABOVE CARGO FLOOR AT BL 75).

2. CENTERLINE OF RINGS AT WATERLINE 170 (24 INCHES ABOVE CARGO FLOOR AT BL 61).

3. THE FOLLOWING LEGEND IDENTIFIES CARGO TIEDOWN RINGS:
   - ◒ INDICATES 5,000-POUND CAPACITY RING ON SIDE WALLS.
   - ● INDICATES 5,000-POUND CAPACITY RING ON CARGO RAMP.
   - ○ INDICATES 10,000-POUND CAPACITY RING. ROWS A AND G ARE MOUNTED ON THE SIDE RAILS. ROWS B THROUGH F ARE MOUNTED ON CARGO FLOOR.

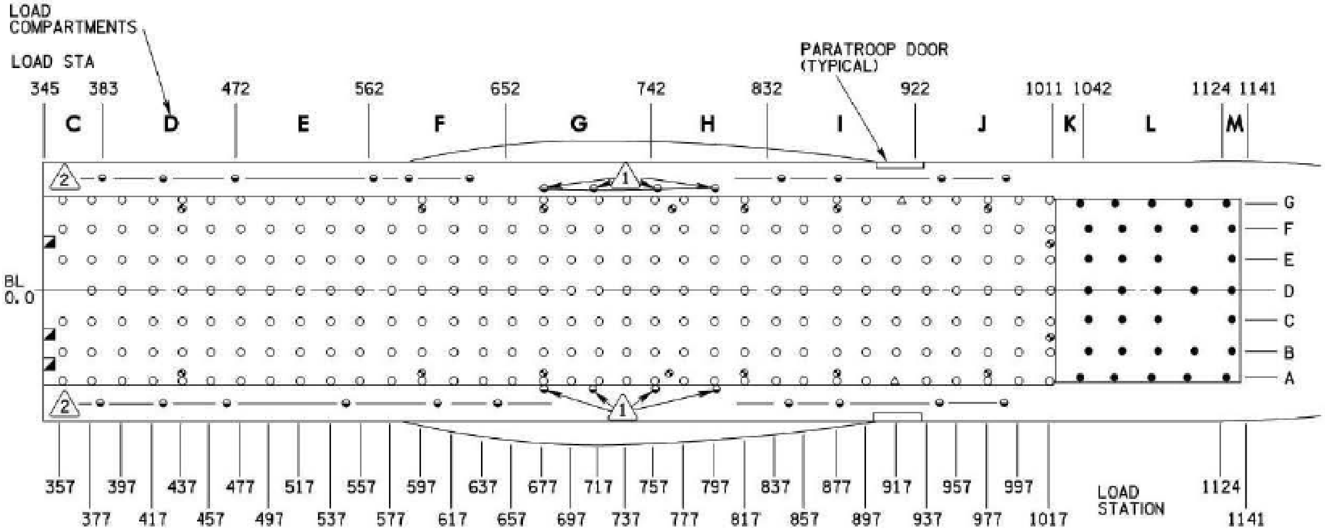
△ INDICATES 10,000 POUND CAPACITY SIDE FACING RING MOUNTED ON THE SIDE RAILS.

SOCKET FOR INSTALLATION OF EITHER TIEDOWN RING OR SNATCH BLOCK - MAX LOAD 25,000 LB. SOCKET PLUGS MUST BE REMOVED TO INSTALL TIEDOWN RINGS OR SNATCH BLOCKS. SOME OF THESE SOCKETS ARE COVERED BY NORMALLY INSTALLED EQUIPMENT AND ARE NOT AVAILABLE FOR ROUTINE USE.

◪ SOCKET FOR INSTALLATION OF SNATCH BLOCK ONLY, SOCKET PLUGS MUST BE REMOVED TO INSTALL SNATCH BLOCKS. THESE SOCKETS ARE COVERED BY NORMALLY INSTALLED EQUIPMENT AND ARE NOT AVAILABLE FOR ROUTINE USE.

FIGURE B-100. Tiedown fittings locations

C-130J



NOTE

1. CENTERLINE OF RINGS AT WATERLINE 170 (24 INCHES ABOVE CARGO FLOOR AT BL 61).

2. CENTERLINE OF RINGS AT WATERLINE 170 (24 INCHES ABOVE CARGO FLOOR AT BL 75).

3. THE FOLLOWING LEGENDS IDENTIFY CARGO TIEDOWN RINGS:

   ◒ INDICATES TIEDOWN RING ON SIDE PANELS. MAXIMUM LOAD IS 5,000 POUNDS IN ANY DIRECTION.

   ● INDICATES TIEDOWN RING ON CARGO RAMP. MAXIMUM LOAD IS 5,000 POUNDS IN ANY DIRECTION.

   ○ INDICATES TIEDOWN RING IN CARGO COMPARTMENT. MAXIMUM LOAD IS 10,000 POUNDS IN ANY DIRECTION OR 10,000 POUNDS APPLIED FORE OR AFT AND VERTICALLY SIMULTANEOUSLY. ROWS A AND G ARE MOUNTED ON THE SIDE RAILS. ROWS B THROUGH F ARE MOUNTED ON CARGO FLOOR.

△ INDICATES SIDE FACING TIEDOWN RING MOUNTED ON THE SIDE RAILS. MAXIMUM LOAD IS 10,000 POUNDS IN ANY DIRECTION.

SOCKET FOR INSTALLATION OF EITHER TIEDOWN RING OR SNATCH BLOCK. MAXIMUM LOAD IS 25,000 POUNDS IN ANY DIRECTION. SOCKET PLUGS MUST BE REMOVED TO INSTALL TIEDOWN RINGS OR SNATCH BLOCKS. SOME OF THESE SOCKETS ARE COVERED BY NORMALLY INSTALLED EQUIPMENT AND ARE NOT AVAILABLE FOR ROUTINE USE.

SOCKET FOR INSTALLATION OF SNATCH BLOCK ONLY. SOCKET PLUGS MUST BE REMOVED TO INSTALL SNATCH BLOCKS. THESE SOCKECTS ARE COVERED BY NORMALLY INSTALLED EQUIPMENT AND ARE NOT AVAILABLE FOR ROUTINE USE.

FIGURE B-101. Tiedown fittings locations

C-130J-30

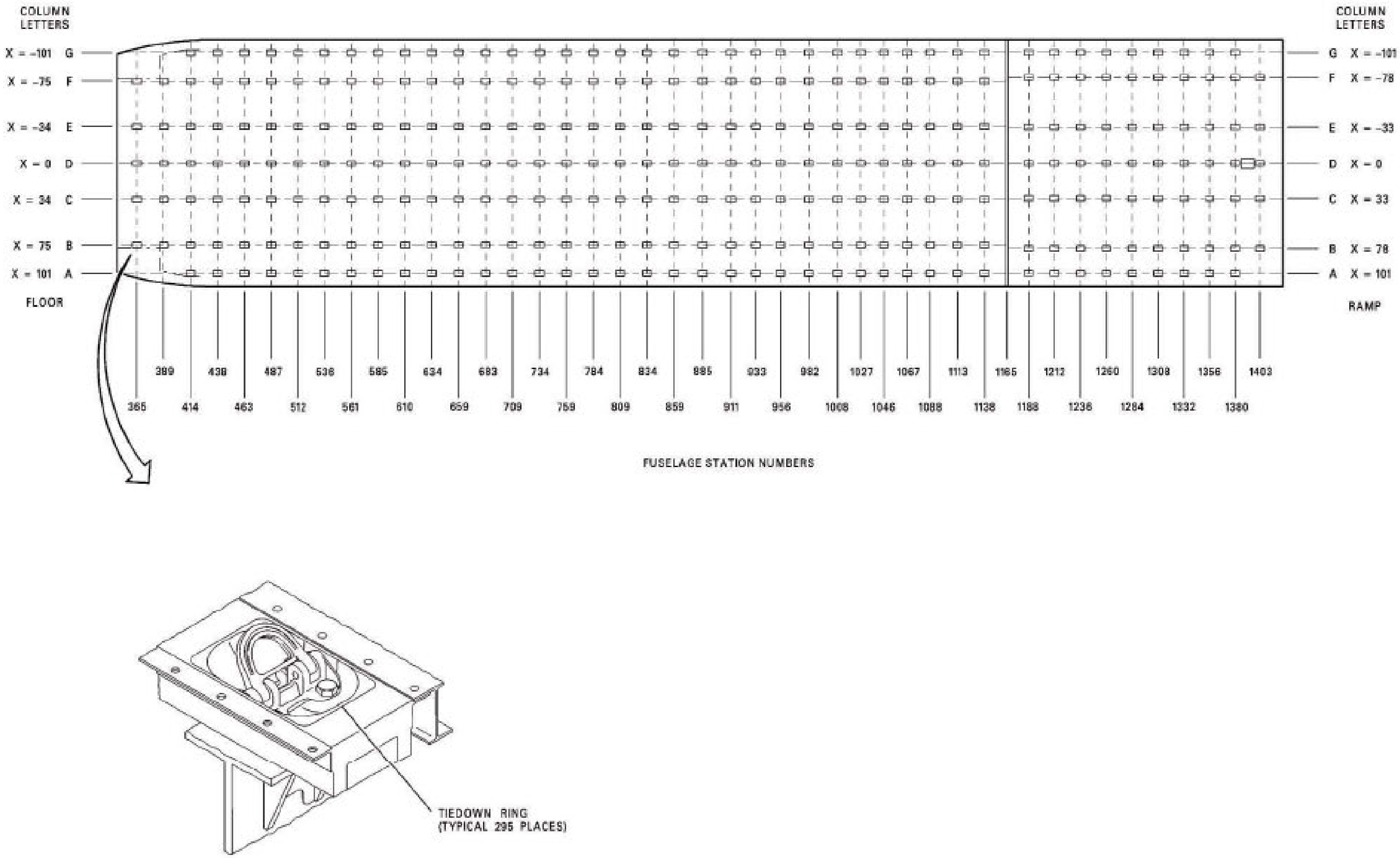


FIGURE B-102. Cargo Tiedown rings/location

C-17

TABLE X. Tiedown ring ratings

Number of Rings Used per Fus. Sta (Loaded Simultaneously)	Allowable Vertical Restraint Available Installation Condition	Per Fitting (Pounds)
1	Symmetrical or Unsymmetrical	25,000
2	Symmetrical or Unsymmetrical	25,000
3	Symmetrical or Unsymmetrical	20,000
4	Symmetrical	20,000
4	Unsymmetrical	15,000
5	Symmetrical or Unsymmetrical	15,000
6	Symmetrical or Unsymmetrical	15,000
7	Symmetrical or Unsymmetrical	15,000

C-17

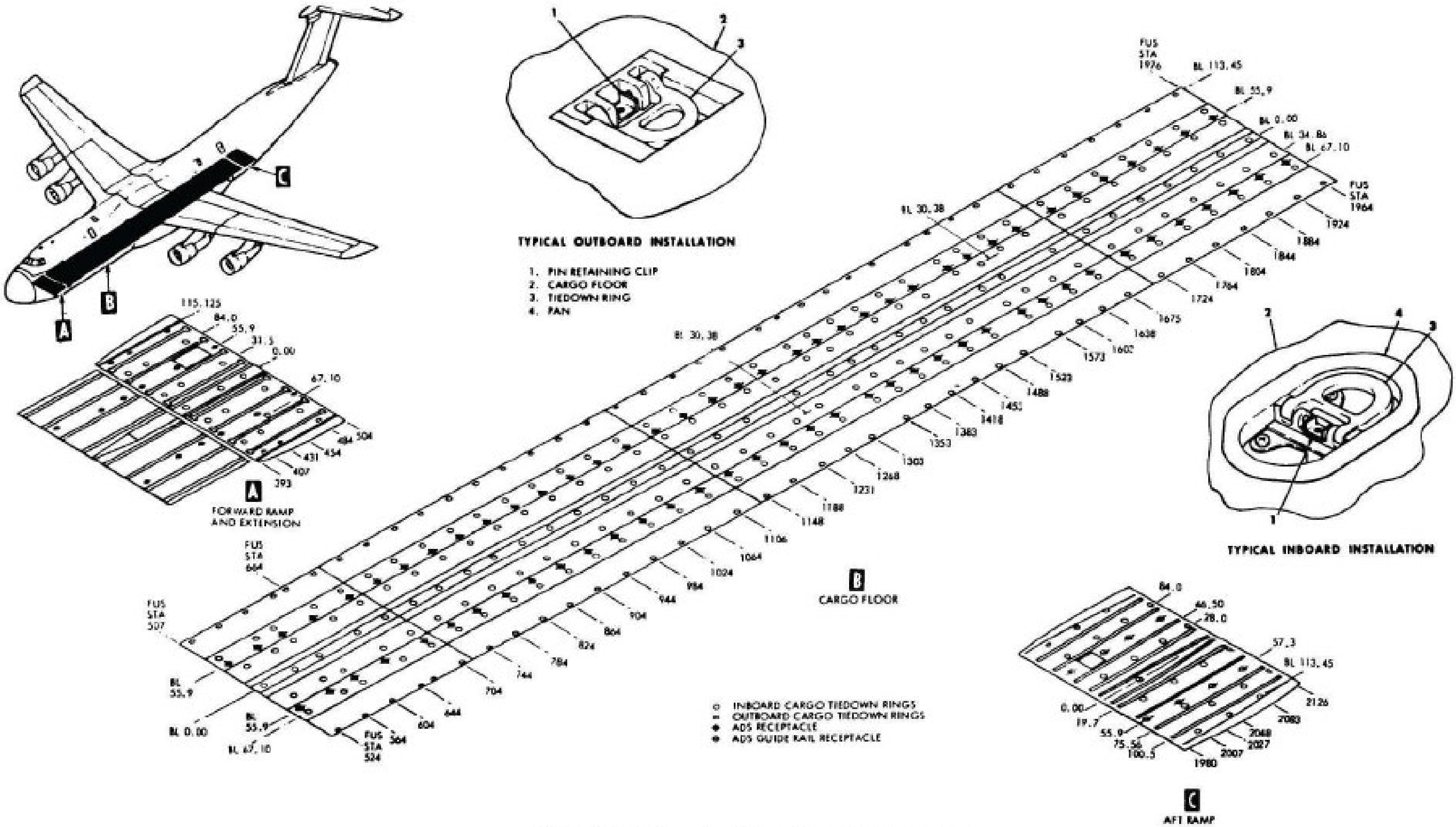
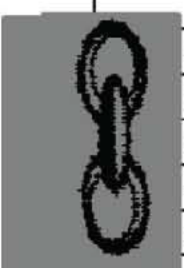


FIGURE B-103. Cargo floor tiedown rings and ABS receptables

C-5

4.11.9.2 Vertical Restraint Limits – Tiedown Rings. All tiedown rings in the cargo compartment floor have an individual restraint capacity of 25,000 pounds. Multiple chains attached to tiedown rings at a given fuselage station will decrease vertical restraint capability. An unsymmetrical tiedown is any two given devices on the same fuselage station providing vertical restraint with different floor angles. Table B-XI shows the vertical restraint that is available when more than one tiedown ring is loaded simultaneously at any one fuselage station in the cargo compartment.

TABLE XI. Vertical restraint - tiedown rings



Tiedown Rings[1]	Installation Condition	Allowable Vertical Restraint Available per Fitting
1	Symmetrical or Unsymmetrical	25,000 lb.
2	Symmetrical	25,000 lb.
3	Symmetrical	20,000 lb.
3	Unsymmetrical	18,000 lb.
4	Symmetrical or Unsymmetrical	18,000 lb.
5	Symmetrical	15,000 lb.
5	Unsymmetrical	12,000 lb.
6	Symmetrical or Unsymmetrical	12,000 lb.
7	Symmetrical	12,000 lb.

[1] Number of rings used per fuselage station (loaded simultaneously)

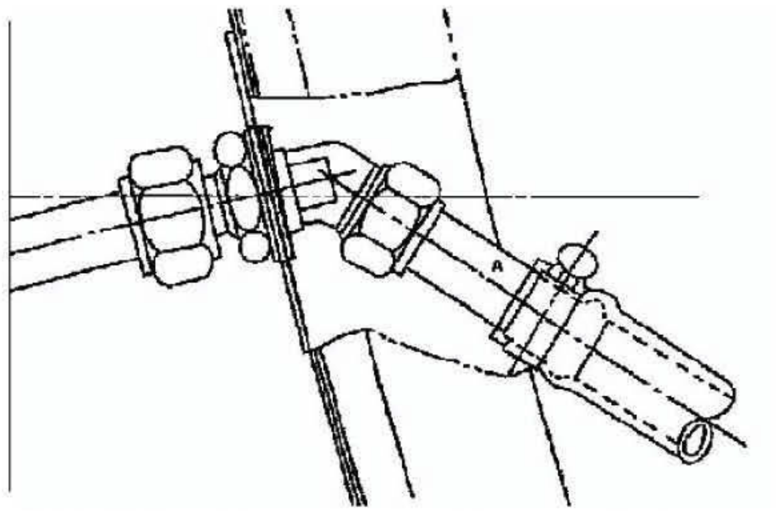


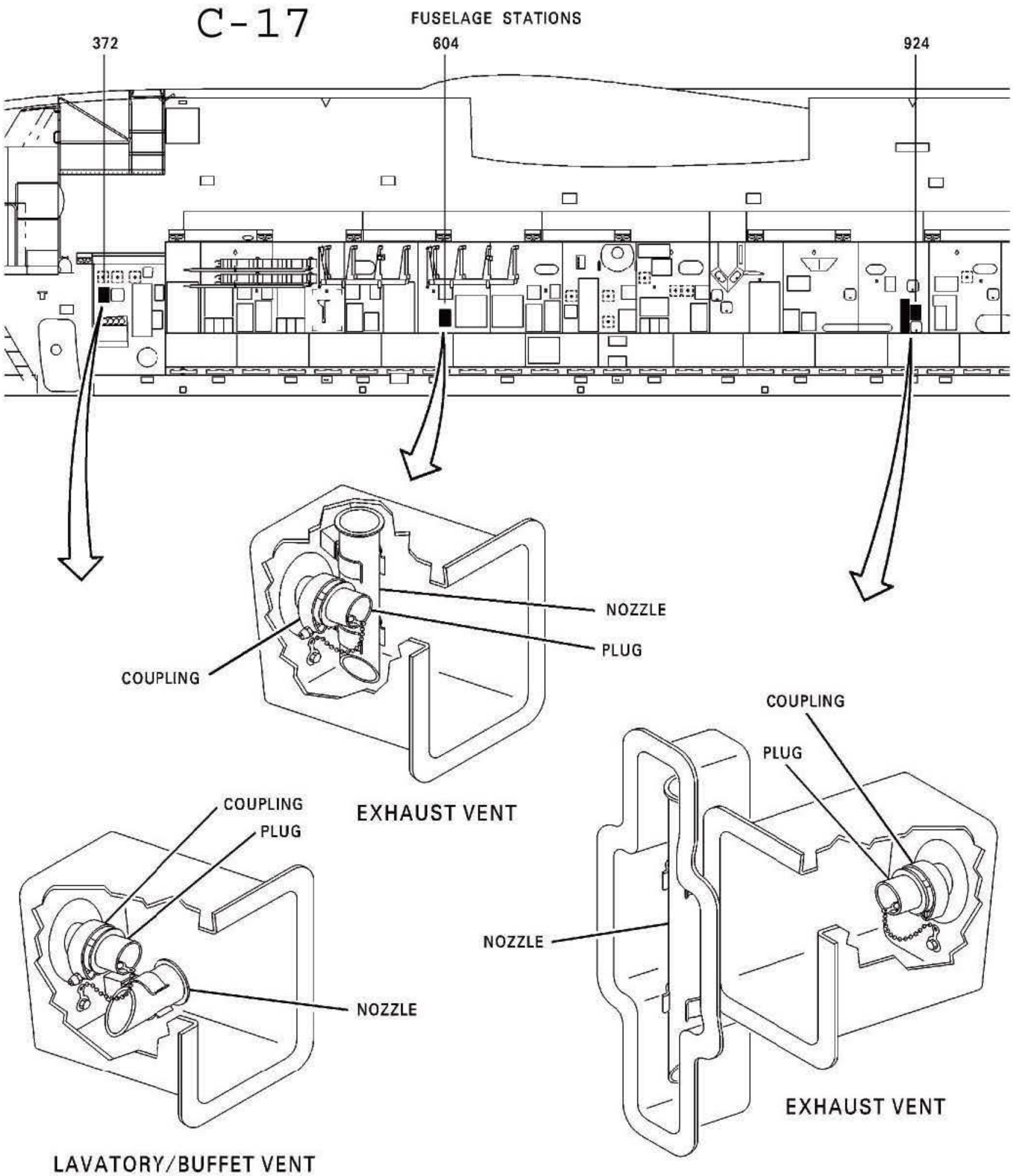
FIGURE B-104. The segment marked A is removed and replaced with a cap when not in use.

2-134. OVERBOARD VENT.

2-135. On aircraft except MC-130H, an overboard vent is located at FS 642 on the left side of the aircraft, approximately 36 inches above the floor. On MC-130H aircraft, the overboard vent is located at FS 652, left side, approximately 26 inches above the floor. To gain access, unsnap and fold back the side wall insulation in the area of the vent. Items requiring venting shall be in accordance with TO 37C2-8-1-127.

WARNING

When the overboard vent is used to vent fuel, a write-up shall be entered in the Form 781A, "Overboard vent at FS 642 is contaminated by fuel. Do not use to vent liquid oxygen until cleaned in accordance with TO 37C2-8-1-127".

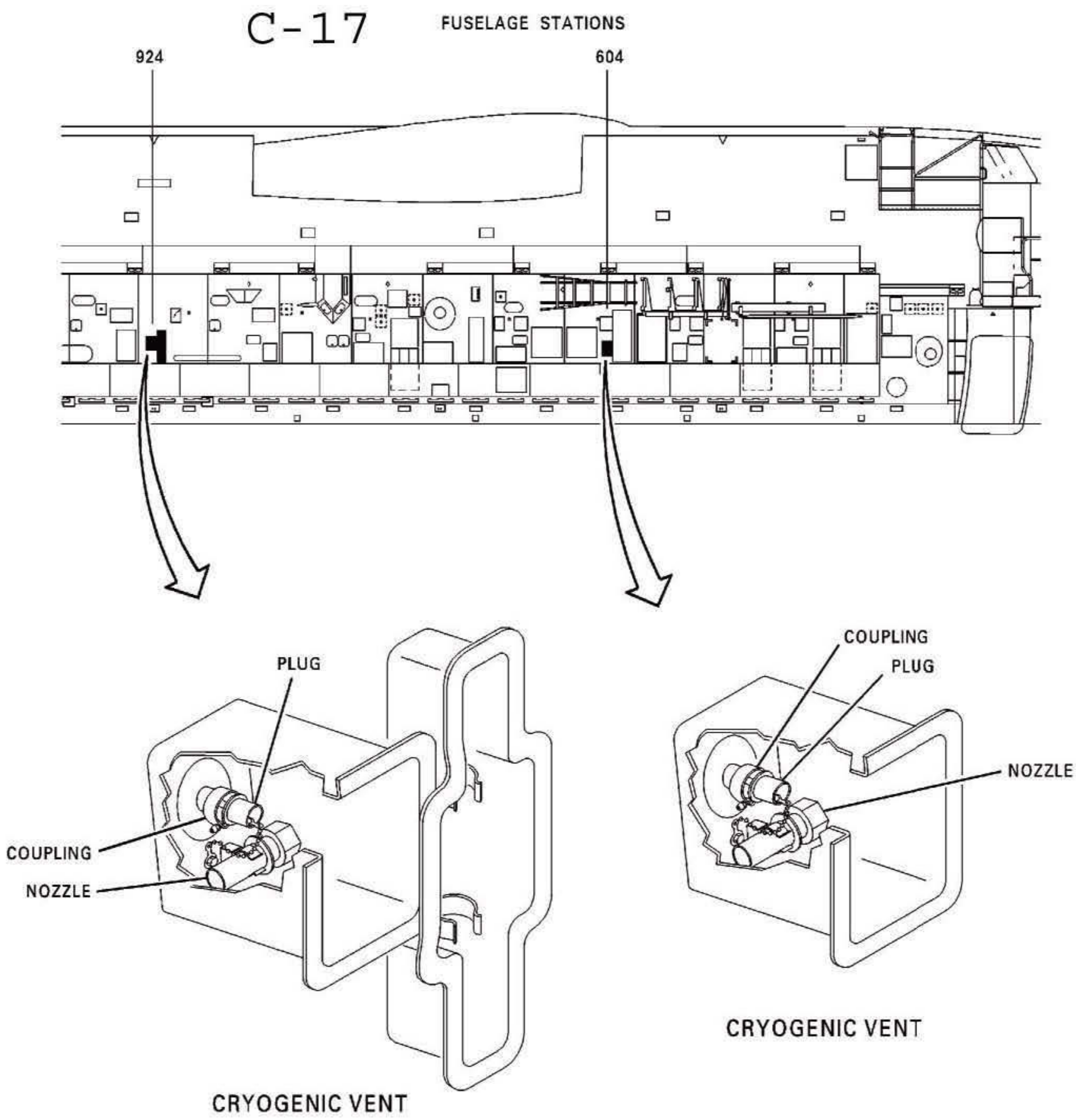


WARNING

DO NOT CONNECT EXHAUSTS FROM LOW TEMPERATURE MATERIALS TO THE RIGHT SIDE VENTS OR EXHAUSTS FROM OPERATING ENGINES TO THE LEFT SIDE VENTS. CONNECTION OF A LOW TEMPERATURE EXHAUST TO A VENT CONTAMINATED WITH OIL OR GREASE MAY CAUSE AN EXPLOSION.

CB9AA00209B

FIGURE B-105. Cargo compartment vents (sheet 1 or 2)



WARNING

DO NOT CONNECT EXHAUSTS FROM LOW TEMPERATURE MATERIALS TO THE RIGHT SIDE VENTS OR EXHAUSTS FROM OPERATING ENGINES TO THE LEFT SIDE VENTS. CONNECTION OF A LOW TEMPERATURE EXHAUST TO A VENT CONTAMINATED WITH OIL OR GREASE MAY CAUSE AN EXPLOSION.

FIGURE B-105. Cargo compartment vents (sheet 2) - continued CB9AA00210B

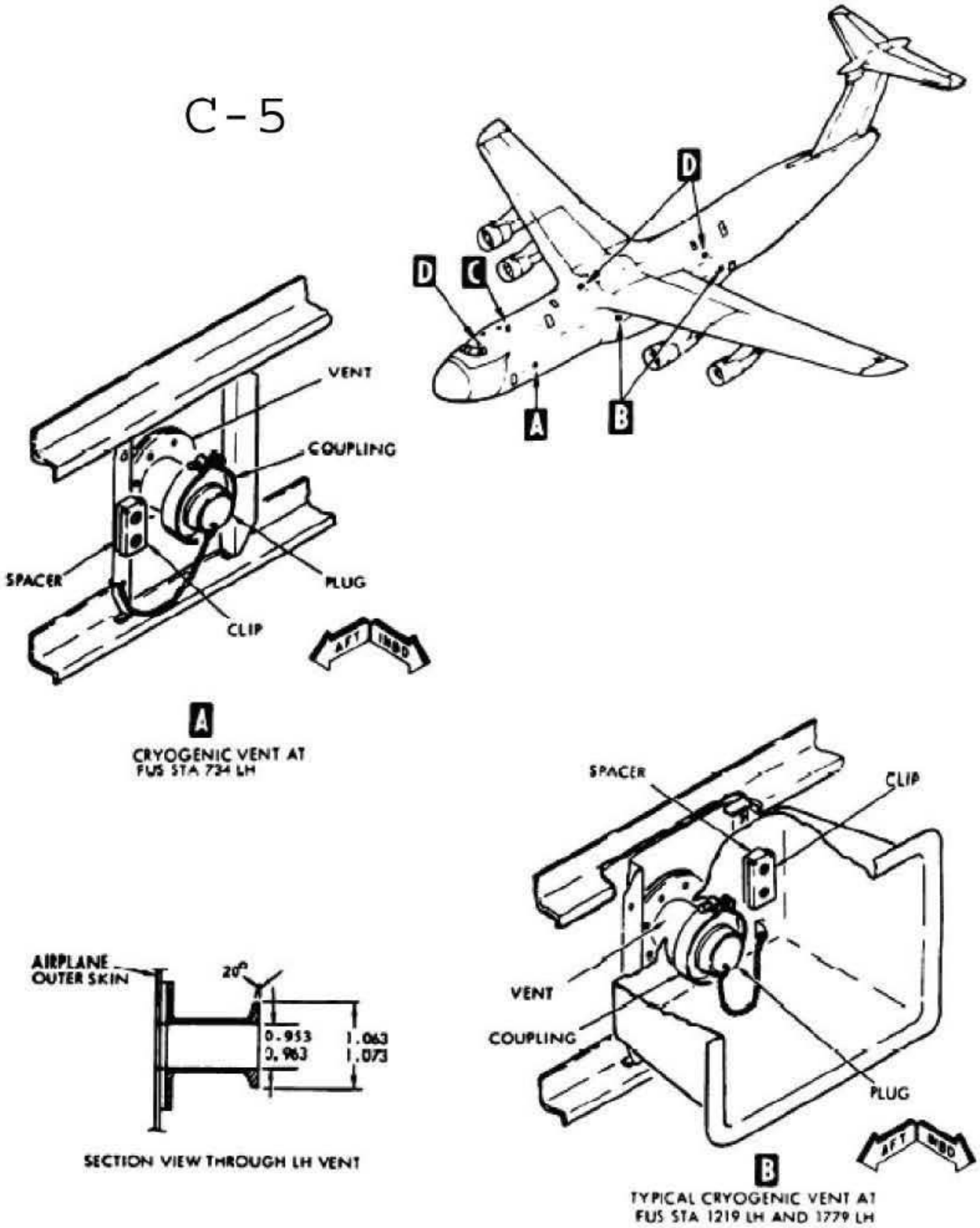
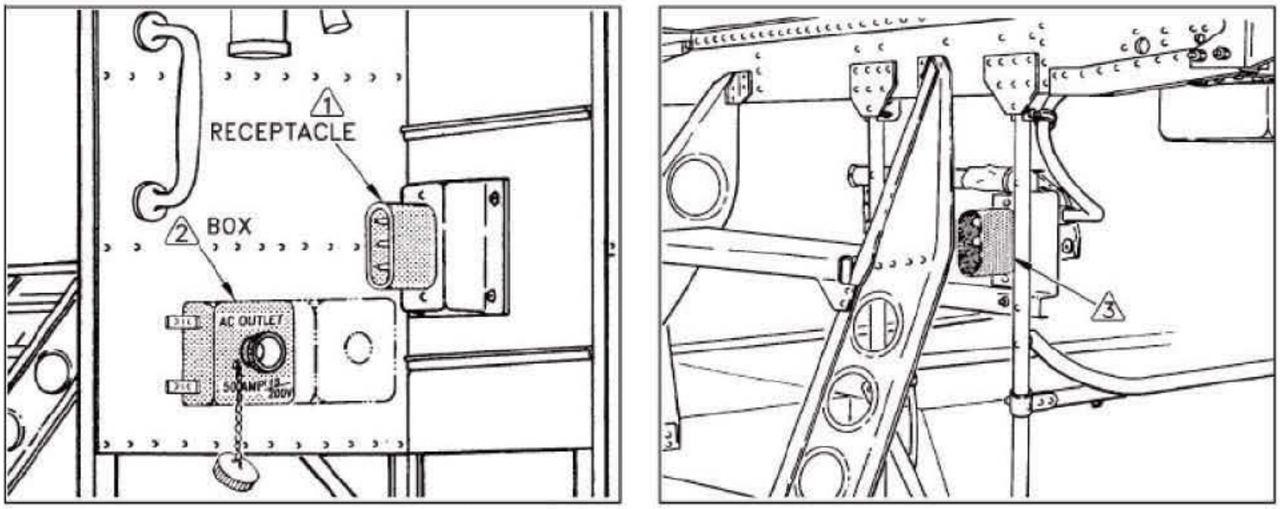


FIGURE B-106. C-5 overboard vents

Seven overboard vents are provided in the cargo compartment for overboard venting of fumes and vapors. The vents are for connection to items of cargo carried in the airplane requiring cryogenic venting, or to exhausts of vehicles or internal combustion engines that may be operating in the cargo compartment. The cryogenic vents are on the left side of the cargo compartment at FS 734, FS 1219, and FS 1779, all at WL 200. The exhaust vents are on the right side of the cargo compartment at FS 594, FS 734, FS 1219, and FS 1779, all at WL 200.



NOTE

1 AIRPLANES AF61–2358 AND UP.
2 AIRPLANES AF62–1784 AND UP.
3 AIRPLANES PRIOR TO AF61–2358.

1 & 3) A power outlet to provide 28 VDC/200 amp power is installed near the flight station steps. A portable winch or other loading equipment may be connected to the outlet.

2) On aircraft AF62-1784 and up, an additional outlet supplies 115/220-volt, 3-phase power and 28 VDC power to operate cargo winches.

FIGURE B-107. C-130E/H electrical outlets

C-130 E/H

2-33. ELECTRIC CURRENT.

2-34. GENERAL. Electric power for the aircraft is supplied either by the engine generators, the APU generator, or an external power source. Whenever possible, external power should be used as the source of electrical power. Refer to the applicable maintenance manual for connecting external power to the aircraft. If external power is not available the APU generator or engine generators can be used to supply electrical power.

2-35. EXTERNAL POWER RECEPTACLE. On the left side of the fuselage, just aft of the battery compartment, is the access door to the external power receptacle. The six prongs make up the plug-in point for an external source of AC, allowing an external generator to be plugged in here.

CAUTION

External Power must not be plugged into the internal power receptacle.

2-36. MISSILE SUPPORT CAPABILITIES.

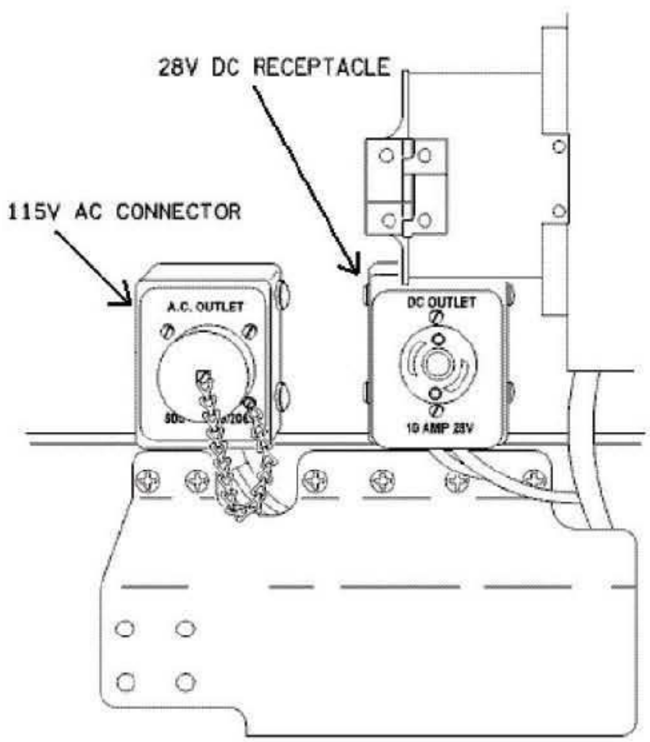
2-37. Three 20-amp, 115-volt, three-phase, AC power outlets equip the aircraft electrically for missile support capabilities. Each power outlet is mounted in a metal box and is provided with a dust cap. The relative location of the outlets is forward right, left center, and right aft of the cargo compartment. The right forward outlet is located aft of and slightly above the iron lung and galley electrical power outlets. The left center outlet is located immediately below the forward edge of the drip pan for the utility system hydraulic panel. The right aft outlet is located just aft of the main landing gear wheel well bulkhead. Power for the left center and forward right outlet is supplied by the essential AC bus through the MISSILE SUPPORT POWER circuit breaker located on the lower AC distribution circuit breaker panel. Power for the right aft outlet is supplied by the main AC bus through the MISSILE SPRT PWR circuit breaker located on the lower AC distribution circuit breaker panel.

2-39. SERVICE OUTLETS.

2-40. Seven DC and six AC service outlets are installed throughout the cargo compartment to provide power for work lights, fans, and other electrical equipment. Circuit protection for these outlets are through the CARGO OUTLET RH and CARGO OUTLET LH circuit breakers located on both the lower AC and righthand main avionics DC distribution aft panels and the CARGO OUTLETS AFT located on the aft junction box. Two iron lung and two galley outlets are located together in the cargo compartment, one on the right sidewall aft of the forward bulkhead and the other forward of the left paratroop door. Circuit protection for the iron lung outlets are through the IRON LUNG circuit breakers located on the righthand main avionic DC distribution panel located in the cargo compartment on the forward bulkhead. Circuit protection for the galley outlets are through the GALLEY PWR CARGO AREA circuit breaker located on the lower AC distribution panel aft on the forward bulkhead.

2-41. CARGO WINCH POWER OUTLETS.

2-42. Two cargo winch power outlets installed on left side of the cargo compartment forward bulk head provide electrical power for operation of AC or DC cargo winches. The AC connector is a four-pin plug type connector. The DC connector is a three prong type connector and faces outboard.



(FWD CARGO COMPARTMENT BULKHEAD LOOKING FWD)

FIGURE B-108.

C-130J and J-30 Electrical Outlets

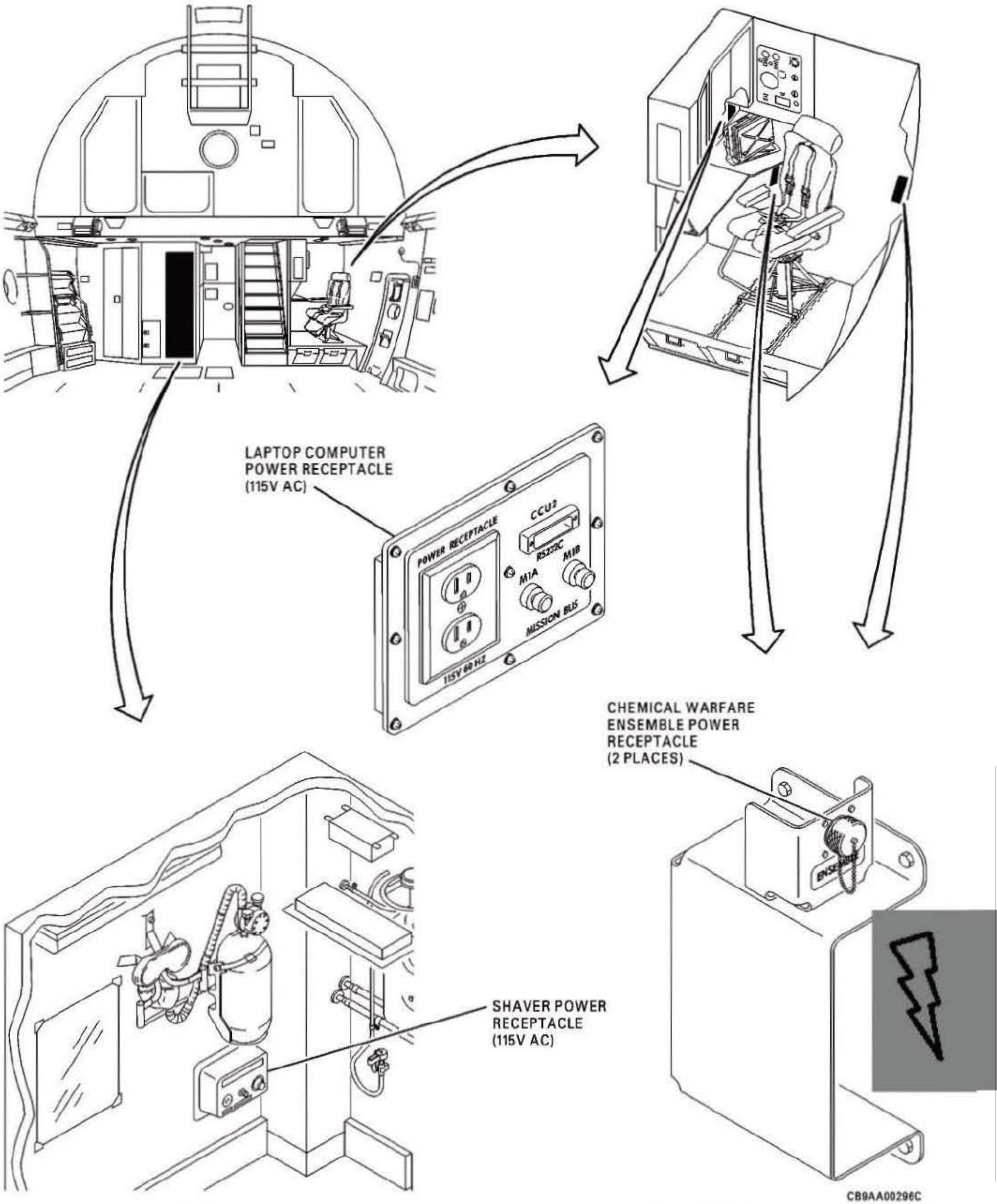
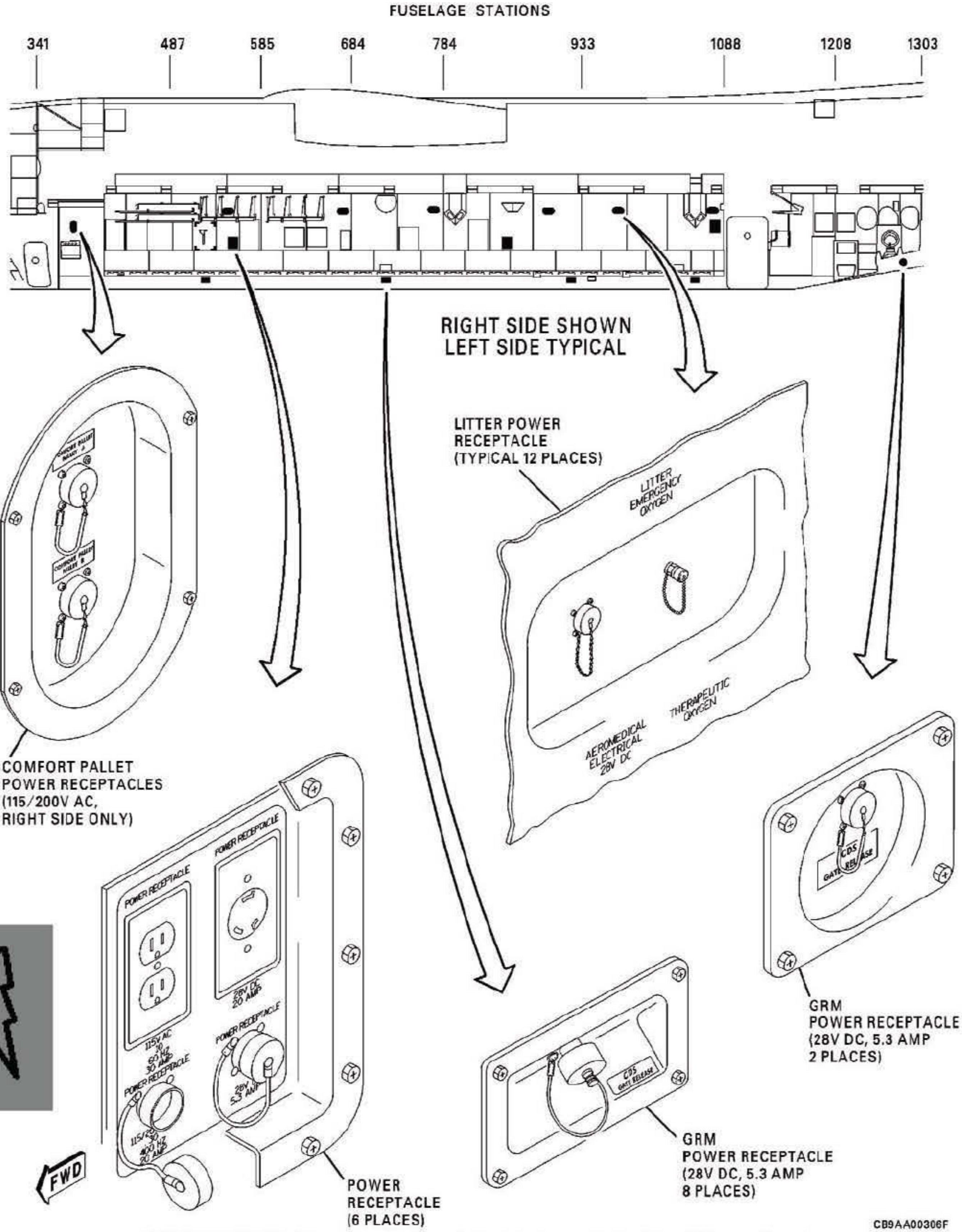


FIGURE B-109. Cargo compartment electrical receptacles (sheet 1 of 2)



FIGURES B-109. Cargo compartment electrical receptacles (sheet 2) - continued

Cargo Compartment Electrical Outlets and Power Supply. Seven 28-volt DC service receptacles and fourteen 115/200-volt AC, 400 Hz, 3-phase service receptacles are provided in the cargo compartment for operation of equipment that may be needed in the airplane. The Monitor 2 bus provides AC, 70-ampere power to the forward cargo winch compartment outlet and two forward buffet/lav unit outlets on the right side of the cargo compartment. In addition, this bus provides AC, 35-ampere power to four service outlets on the left side of the cargo compartment. The Monitor 3 bus provides AC, 70-ampere power to two aft buffet/lav unit outlets on the right side of the cargo compartment. In addition, this bus provides AC, 50-ampere power to the aft winch compartment and four service outlets on the right side of the cargo compartment. The Main DC bus No. 1 provides DC, 35-ampere power to four service outlets on the left side of the cargo compartment. The Main DC bus No. 2 provides DC, 35-ampere power to three service outlets on the right side of the cargo compartment. The following is a list of part numbers for service receptacles and plugs:

Type of Outlet	Part Number	
	Receptacle	Plug
Buffet, 115/200-VAC, 3-Ph	NSN-5935-00-853-2537	NSN-5935-00-201-8373
Service, 28-VDC	NSN-4820-00-216-9048	NSN-5935-00-259-0823 or NSN-5935-00-522-2577
Service, 115/200-VAC, 3-Ph	MS3100R18-10S	NSN-5935-00-199-2622 or NSN-5935-00-199-2623
Winch, 115/200-VAC, 3-Ph	NSN-5935-00-853-2537	NSN-5935-00-201-8373

C-5 Electrical Outlet Description

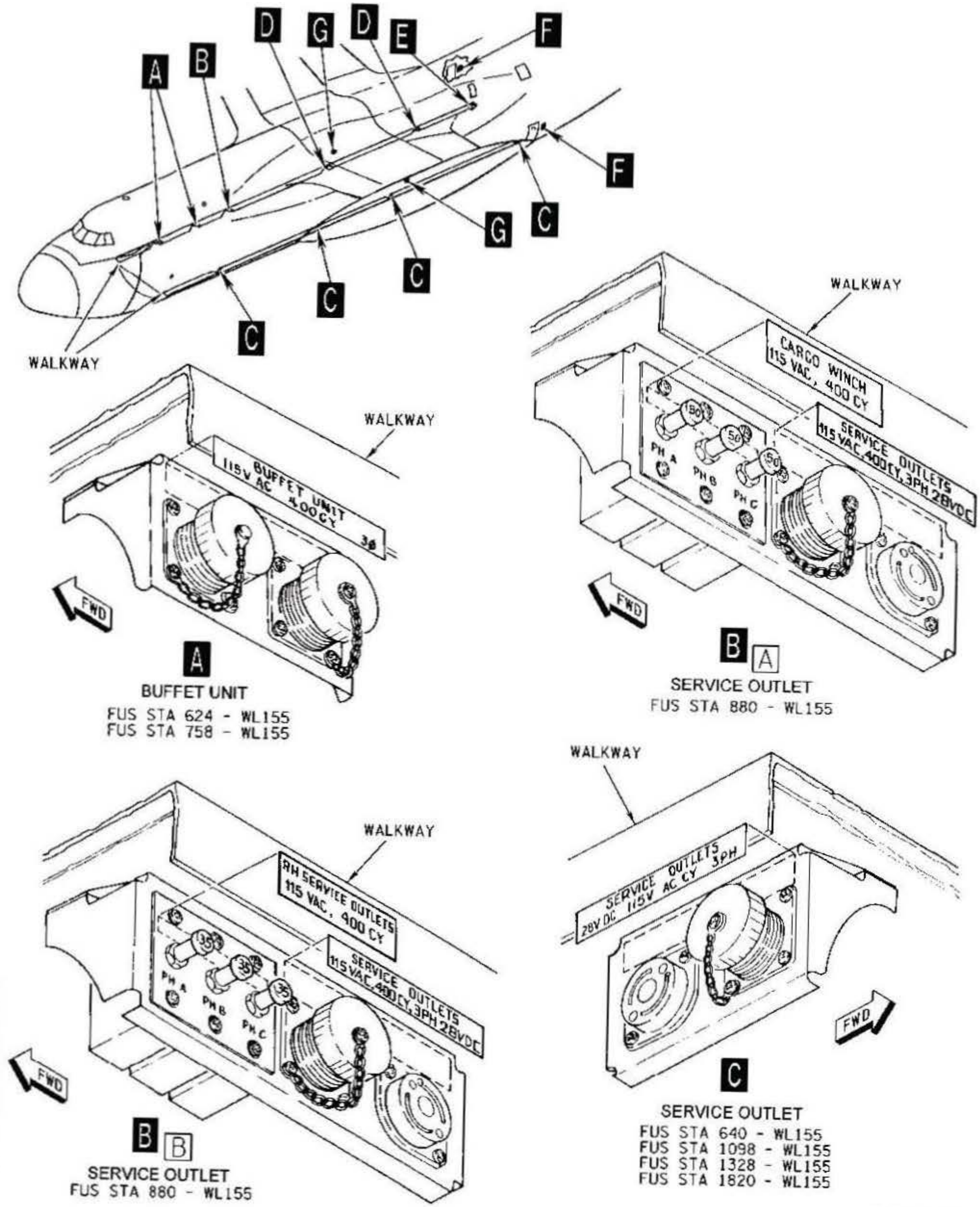
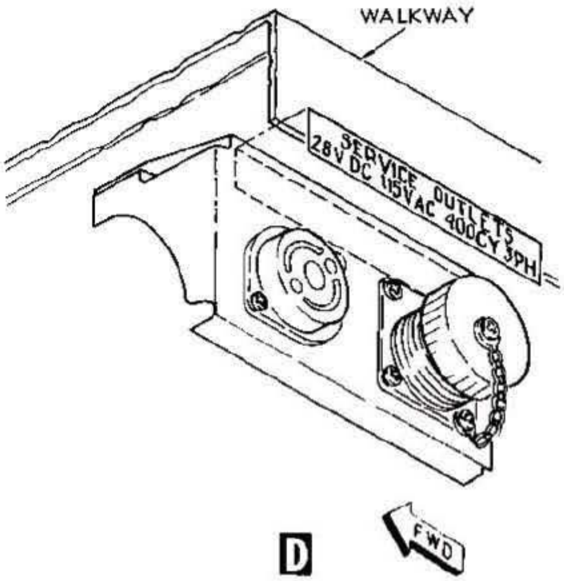
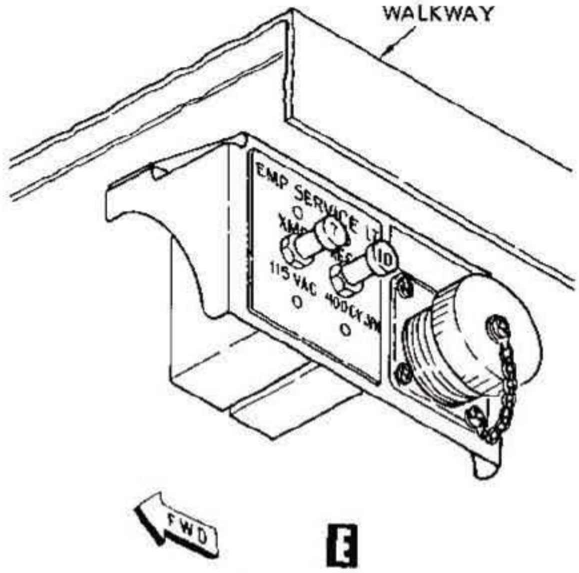


FIGURE B-110. Cargo compartment electrical outlets (sheet 1 of 2)



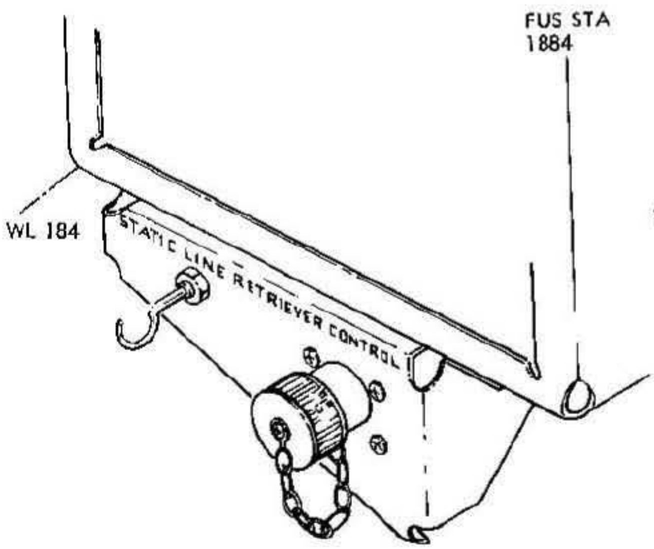
D

SERVICE OUTLET
FUS STA 1328 – WL 155
FUS STA 1608 – WL 155



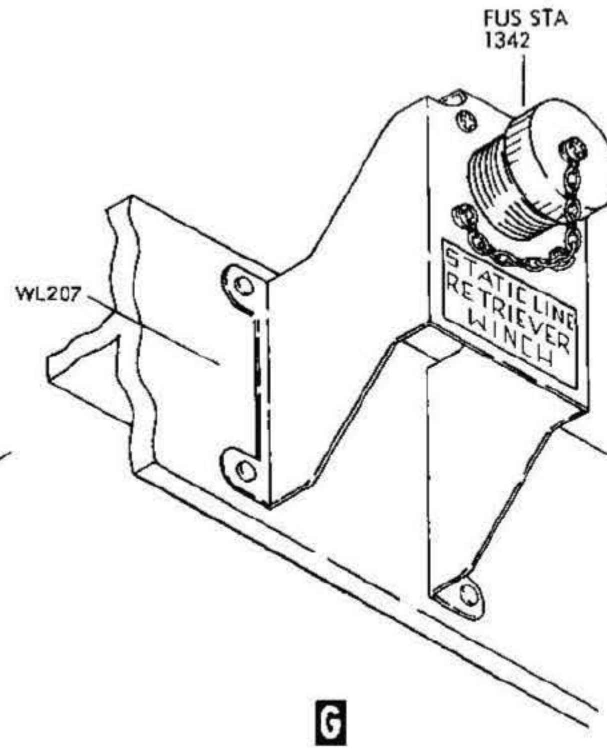
E

SERVICE OUTLET
FUS STA 1819 – WL 155



F

PARATROOP STATIC LINE RETRIEVER
SYSTEM CONTROL ELECTRICAL OUTLET



G

PARATROOP STATIC
LINE RETRIEVER WINCH
OUTLET

C5-9-2-0-002-2

FIGURE B-110. Cargo compartment electrical outlets (sheet 2) - continued

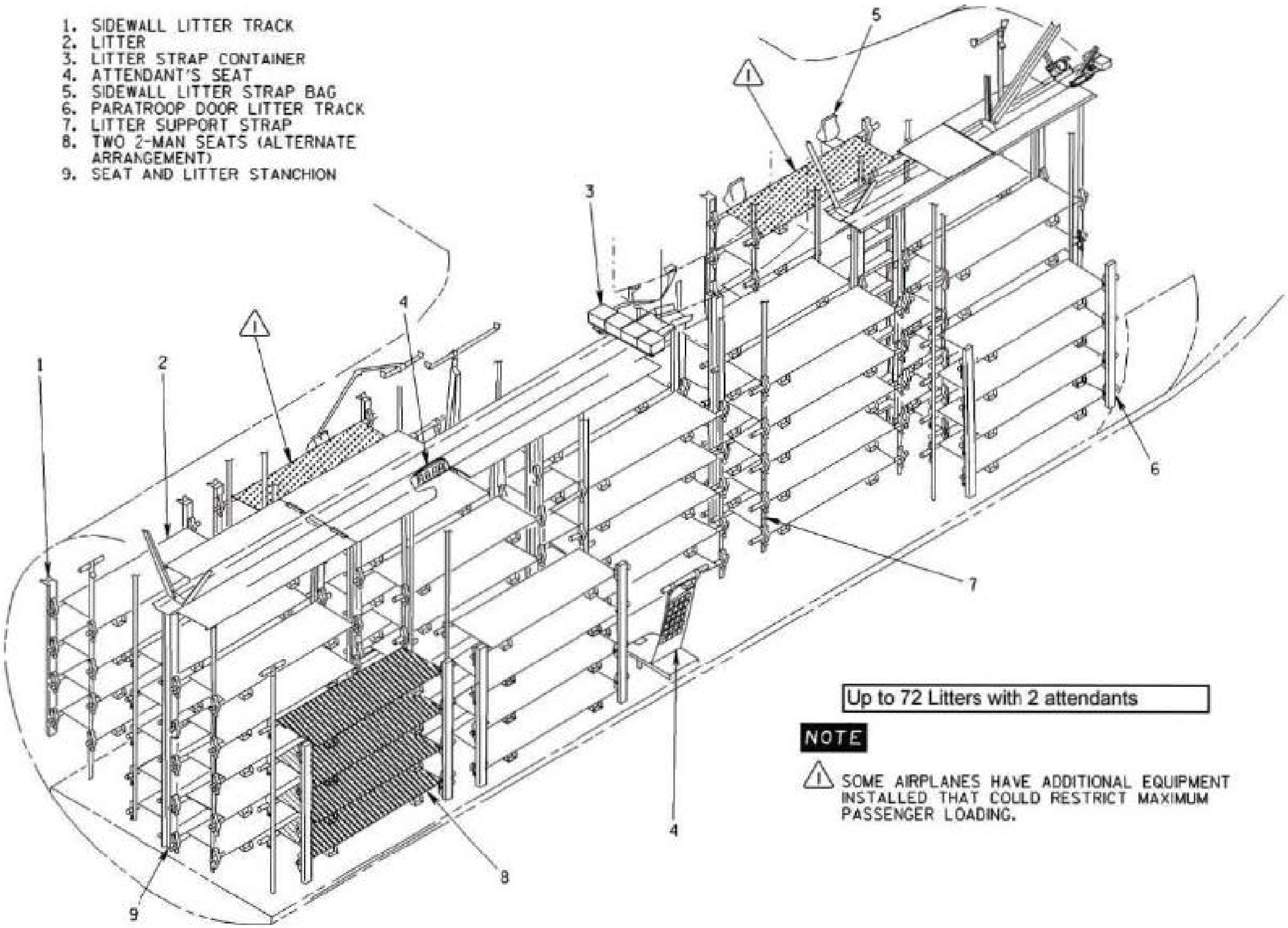


FIGURE B-111. Litter arrangement (sheet 1 of 2)

C-130E/H/J

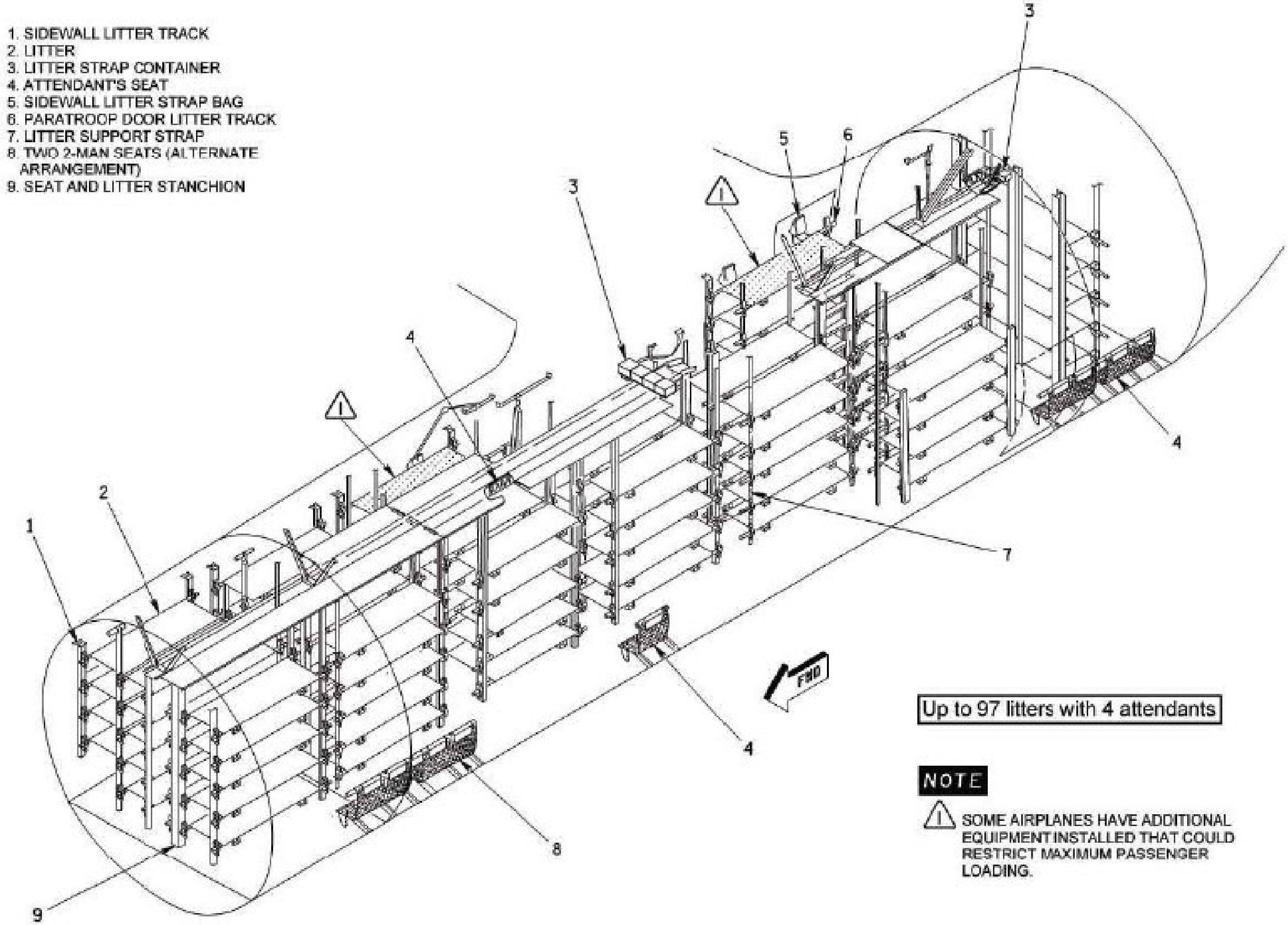


FIGURE B-111. Litter Arrangement (sheet 2) - continued
C-130J-30

AEROMEDICAL EVACUATION SYSTEM

LITTER STATIONS. Three aeromedical litter stations, each designed to accommodate three litters, are stowed in the cargo compartment at FS 547 left and right and FS 620 on the left side. Complete installation provisions are available for the 3 stowed litter stations and 9 additional litter stations. Provisions for each station include structural hard points and electrical/oxygen hookups. Each aeromedical station is a free standing design. Head and foot height are adjusted independently. Litter stations may be installed in either outboard or inboard locations. When installed the in the outboard location the adjacent sidewall seats cannot be used. Litter floor receptacles are located at BL48, BL75 and BL102 left and right. Each aeromedical station includes a utility panel that provides each litter position with a patient call button, light, and dropout oxygen mask.

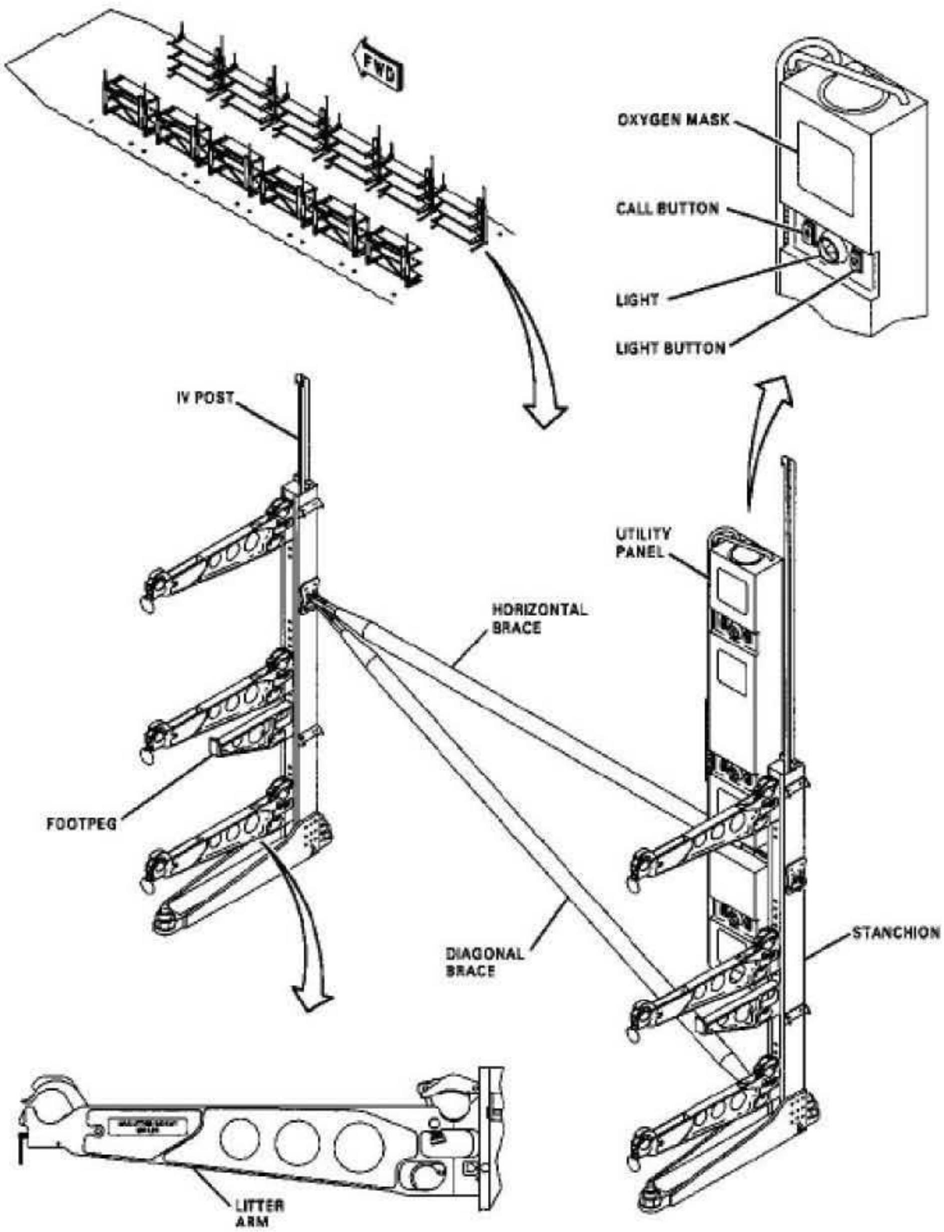
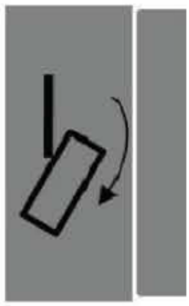


FIGURE B-112. C-17 aeromedical litter stations

B.3.5	Special Procedures	# pages
B.3.5.1	Tipoff Curves	3
B.3.5.2	130 Prybar	1
B.3.5.3	C-17/C-5 Minimum Approach Shoring Width	2
B.3.5.4	Payload-Range	3



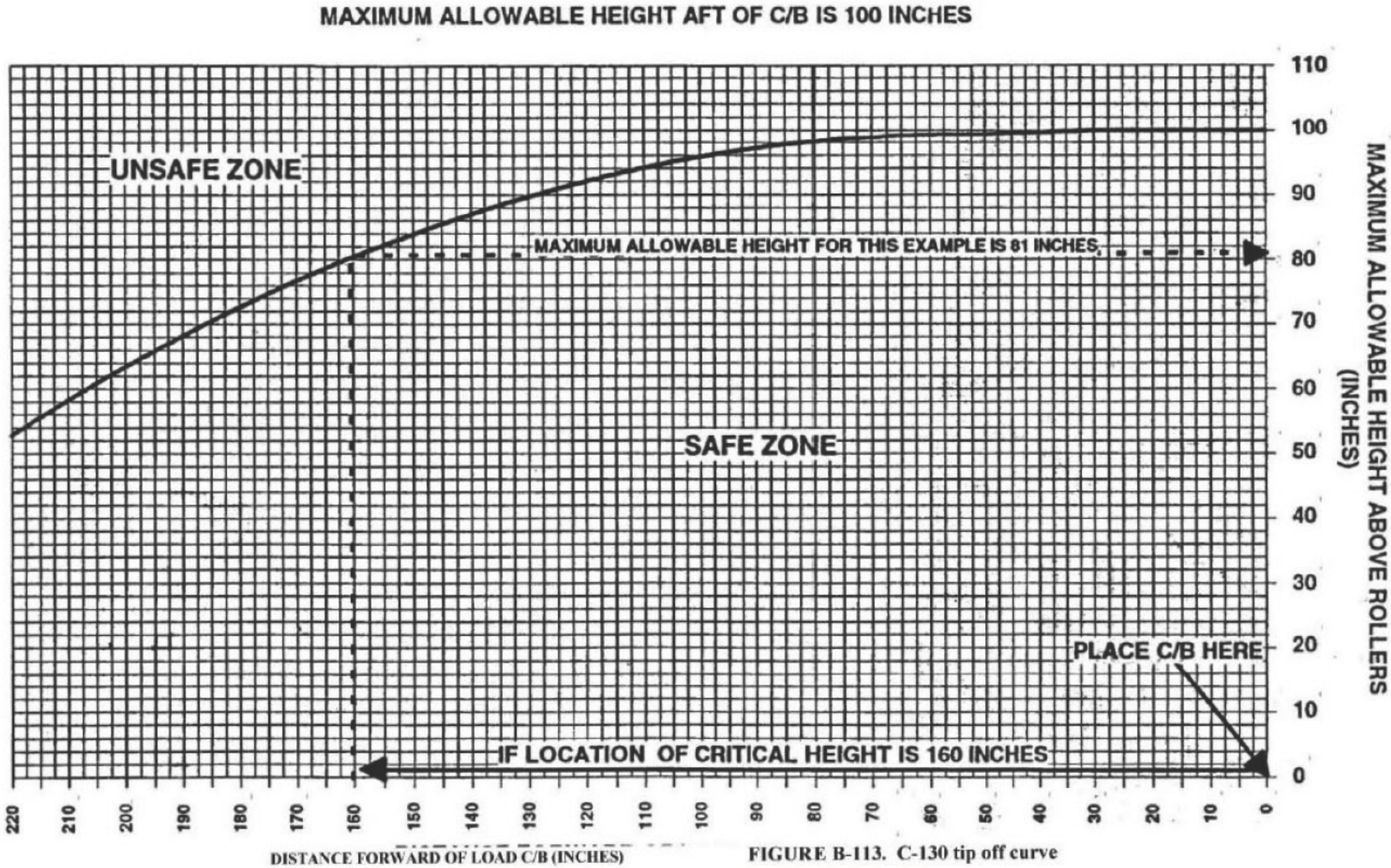


FIGURE B-113. C-130 tip off curve

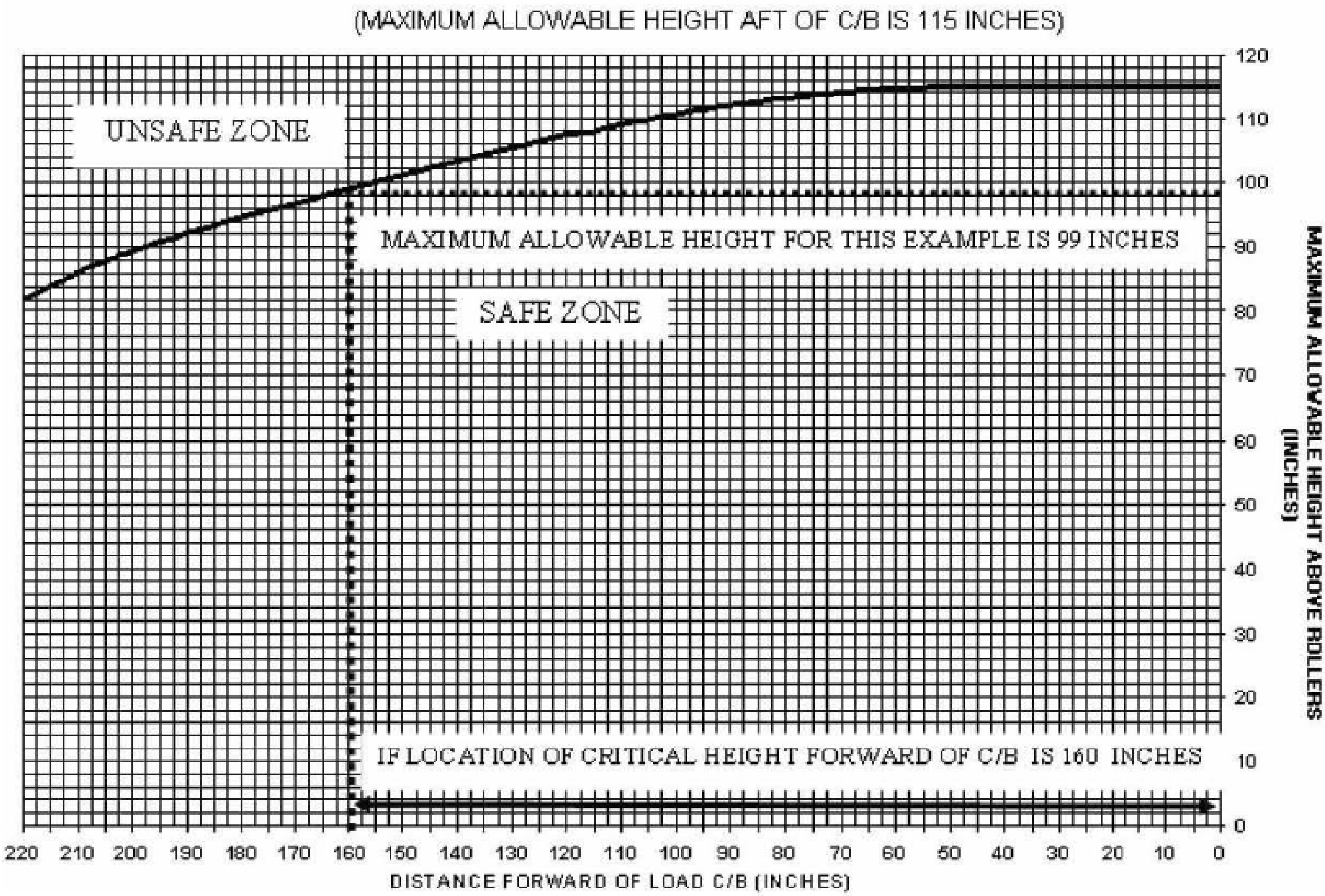
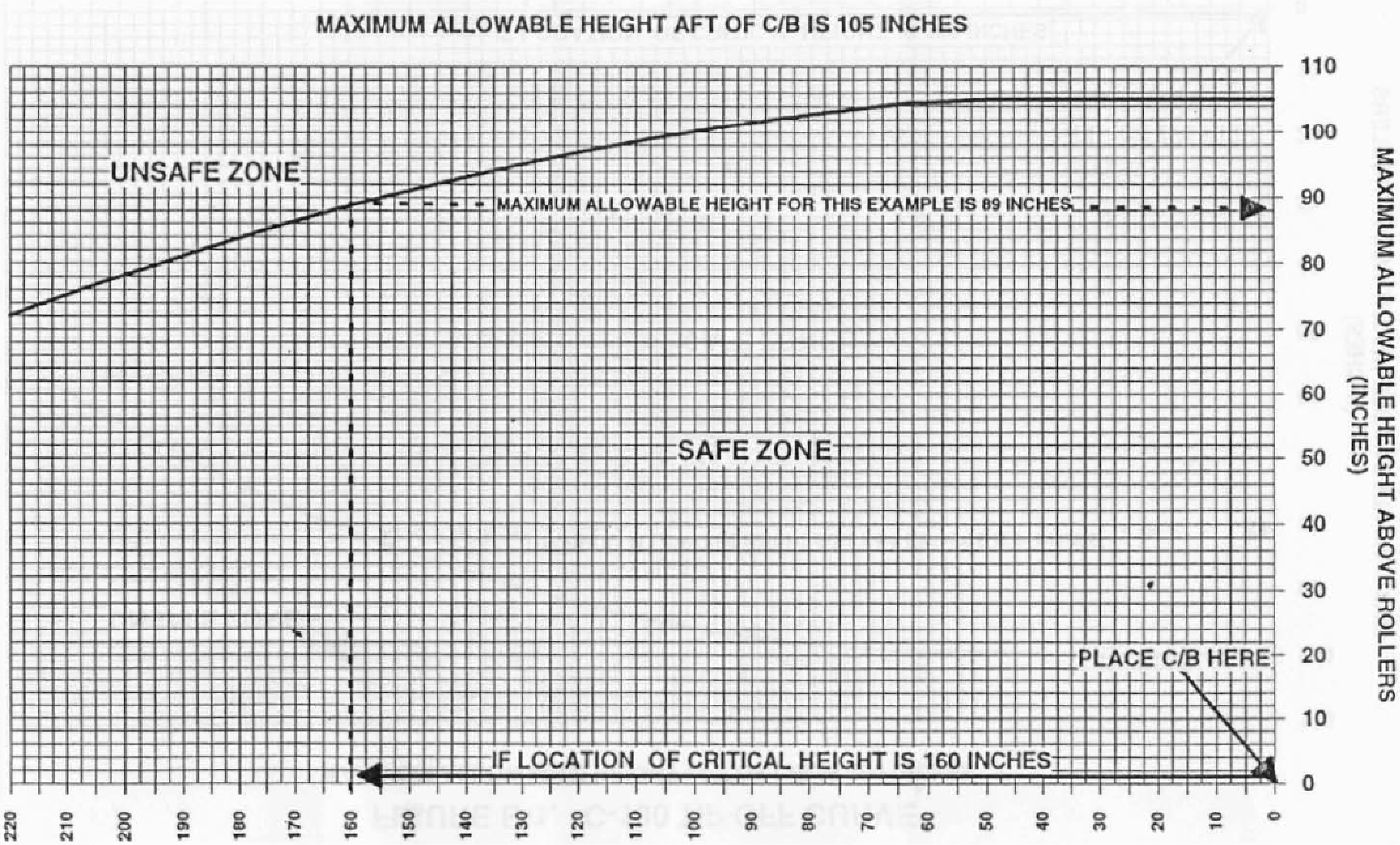


FIGURE B-114. C-17 tip off curve



DISTANCE FORWARD OF LOAD C/B (INCHES)

FIGURE B-115. C-5 tip-off curve

NOTE

WHEN THE WHEEL WIDTH IS NOT DIRECTLY REPRESENTED BY THE GIVEN INTERSECT LINES, MOVE VERTICALLY TO AN INTERPOLATED POINT BETWEEN THE GIVEN INTERSECT LINES.

EXAMPLE

A. ASSUME THE WHEEL DIAMETER IS 2 INCHES AND WHEEL WIDTH IS 3 INCHES. FIND THE MAXIMUM ALLOWABLE LOAD PER WHEEL.

B. ENTER THE GRAPH ON THE HORIZONTAL SCALE AT 2 INCHES AND MOVE VERTICALLY UPWARD TO INTERSECT WHEEL WIDTH CURVE OF 3 INCHES.

C. MOVE HORIZONTALLY ACROSS TO VERTICAL SCALE AND READ A MAXIMUM ALLOWABLE LOAD PER WHEEL OF 1,000 POUNDS.

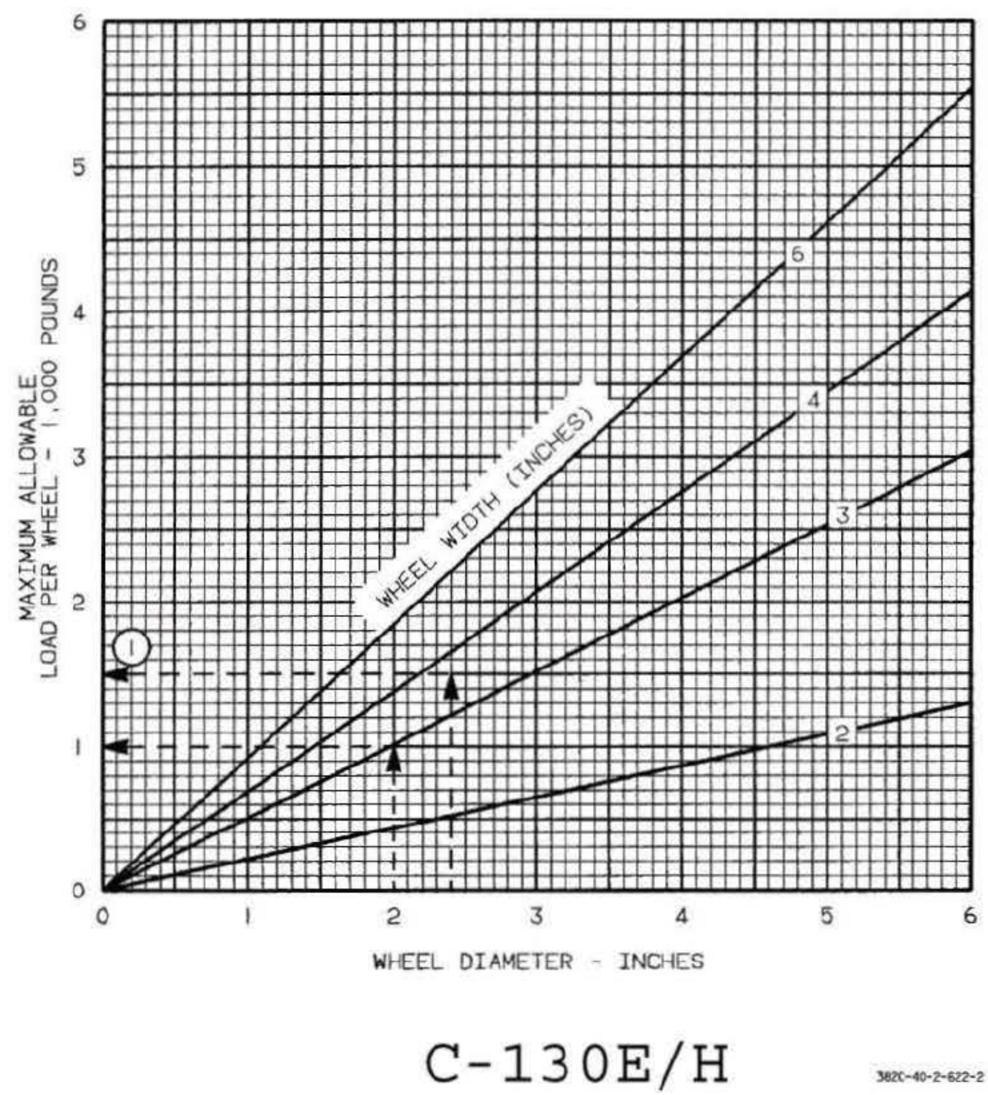
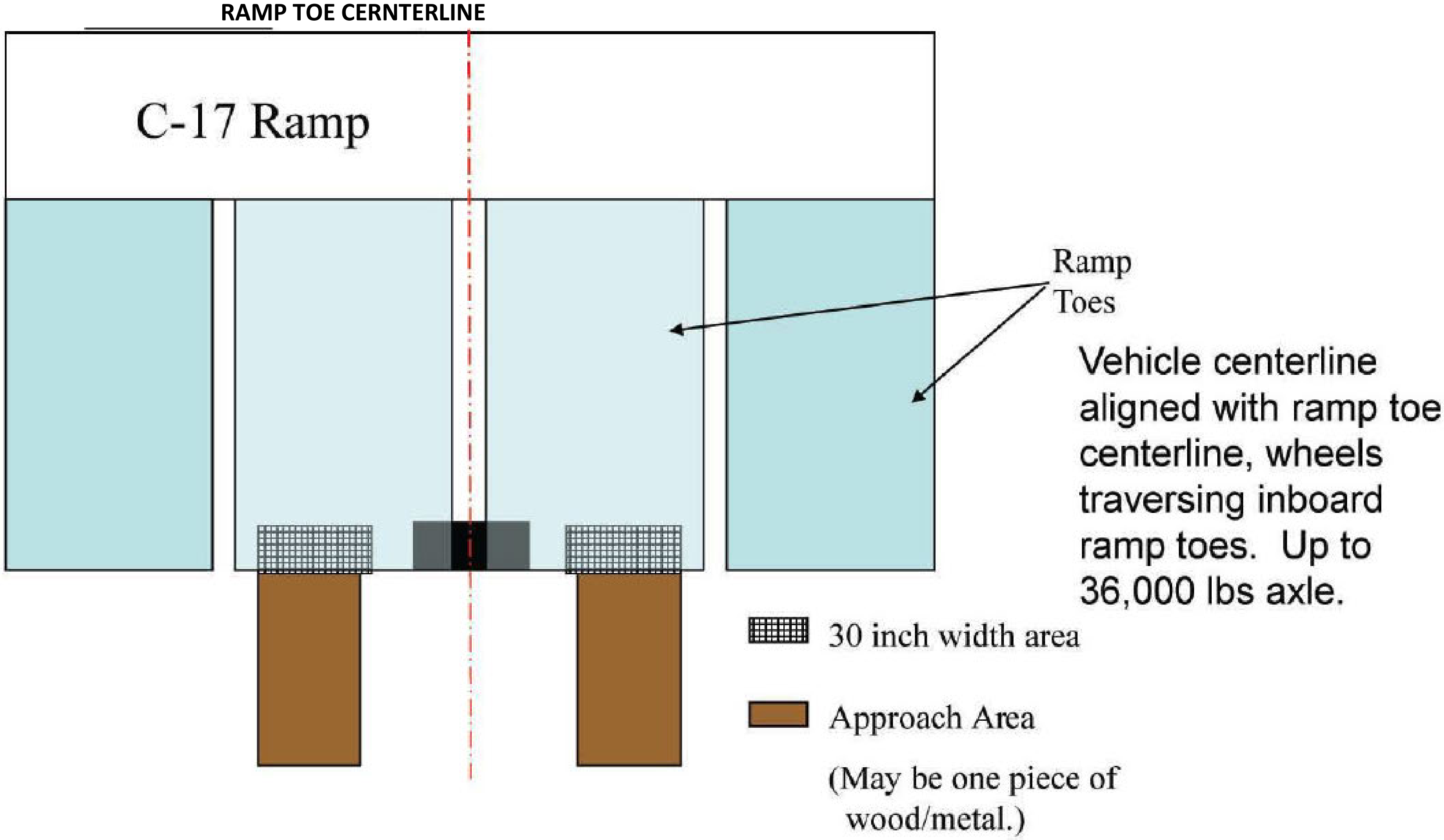


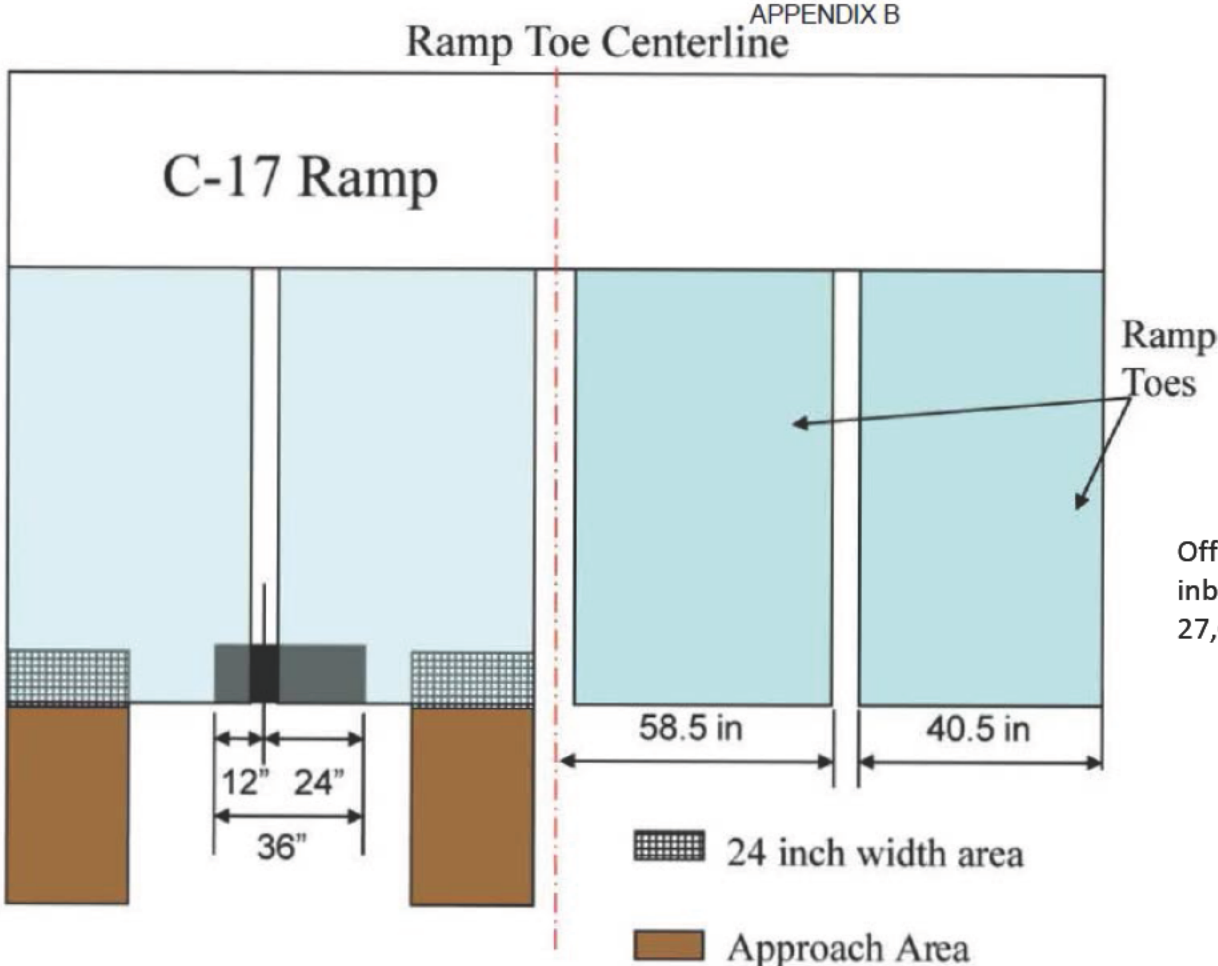
FIGURE B-116. Wheeled pry bar maximum allowable load per wheel



Center approach pedestal must be 36" wide x 11" long and the same height as the approach ramps.

The shoring width aft of the ramp toe support area can be narrower than 30". Minimum width for approach area is width of the tire contact area plus 2 inches.

FIGURE B-117. C-17 minimum approach shoring width under ramp toes (sheet 1 of 2)



Center approach pedestal must be 36" wide x 11" long and the same height as the approach ramps.

FIGURE B-117. C-17 minimum approach shoring width under ramp toes (sheet 2) - continued

Off-center loading, wheels traversing inboard and outboard ramp toes. Up to 27,000 lbs axle.

The shoring width aft of the ramp toe support area can be narrower than 24 inches. Minimum width for approach area is width of the tire contact area plus 2 inches

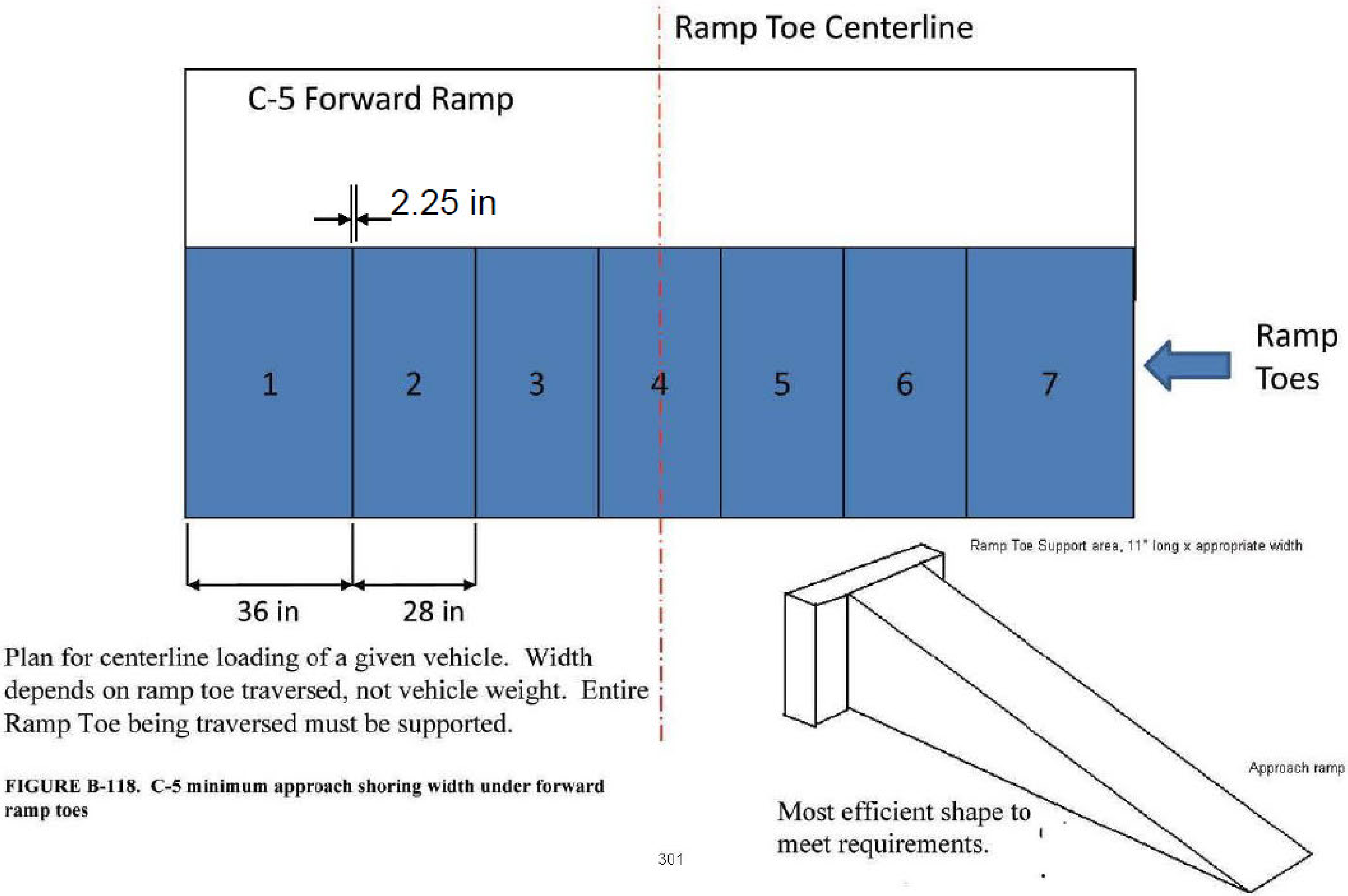
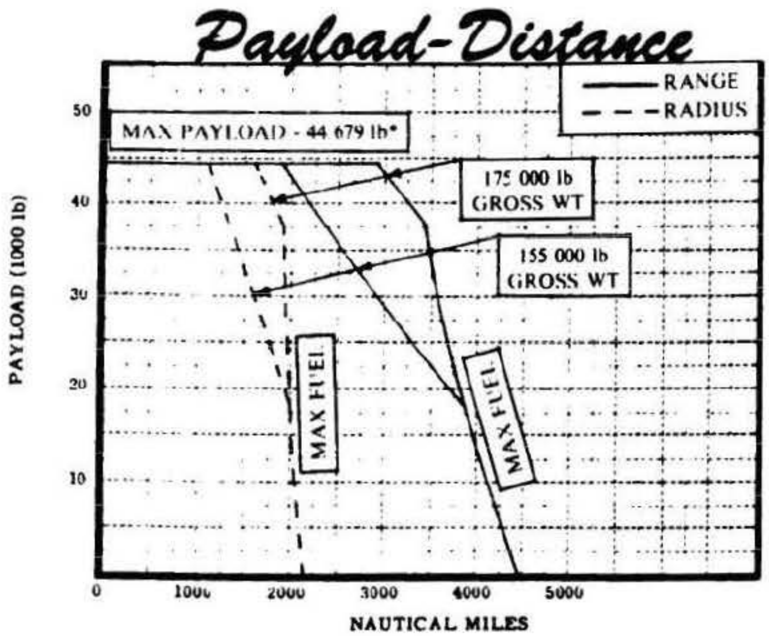


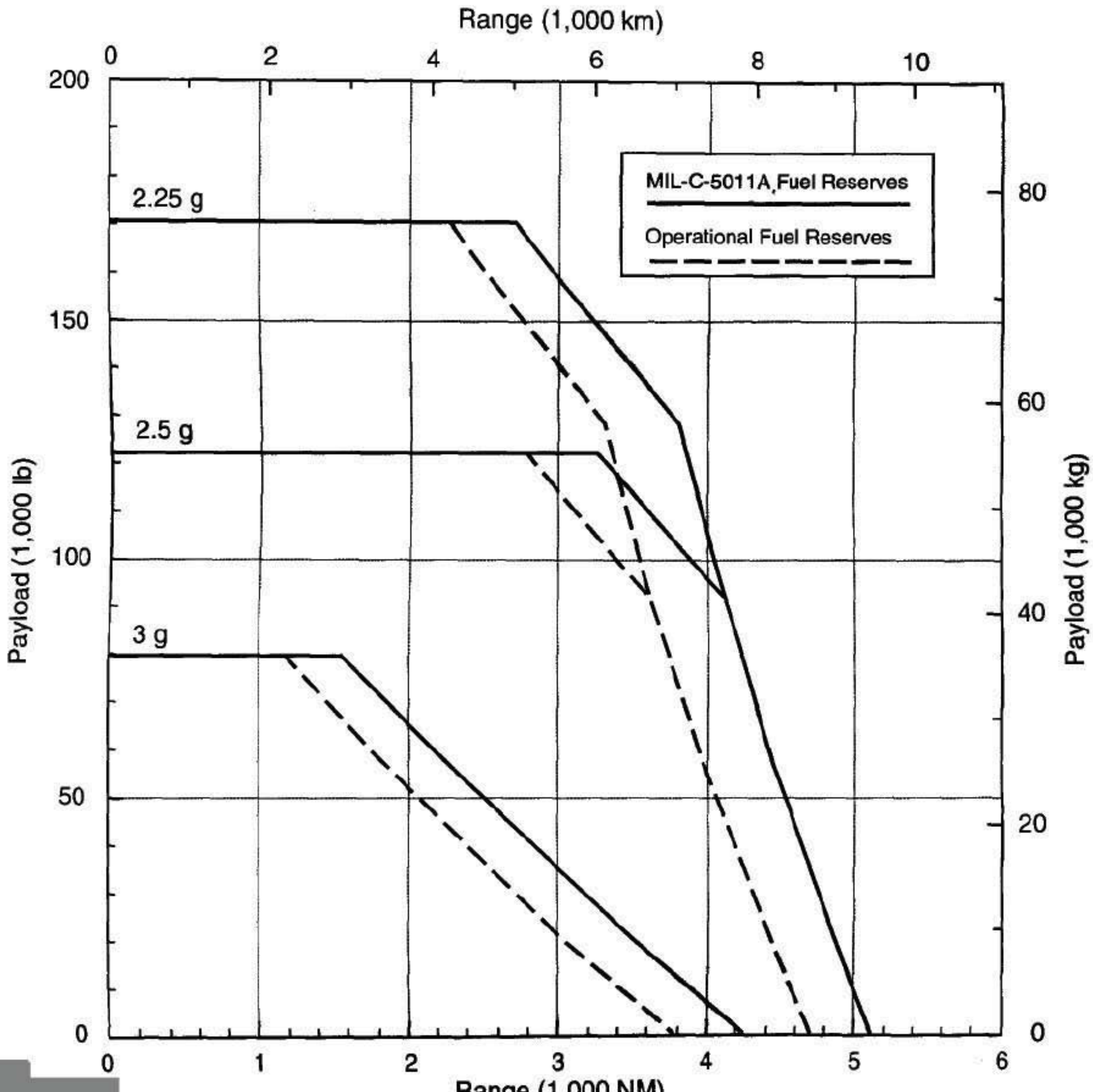
FIGURE B-118. C-5 minimum approach shoring width under forward ramp toes



METRIC EQUIVALENTS			
lbs	kg	nmi	km
10 000	4 536	1000	1852
20 000	9 072	2000	3704
30 000	13 608	3000	5556
40 000	18 144	4000	7408
44 679	20 266	5000	9260
50 000	22 680		
75 000	34 019		
155 000	70 307		
175 000	79 379		

FIGURE B-119. Payload-range

C-130E/H



C-17 non-ER

Based on: Baseline Operating Weight of 277,000 lb (125,645 kg)
JP-8 Fuel at 6.7 lb/gal (0.80 kg/liter)

Max. Takeoff Gross Weights (MTOGWs):

2.25 g:	585,000 lb (265,352 kg)
2.5 g:	549,000 lb (249,022 kg)
3.0 g:	423,000 lb (191,870 kg)

FIGURE B-120. C-17 payload rang (non ER)

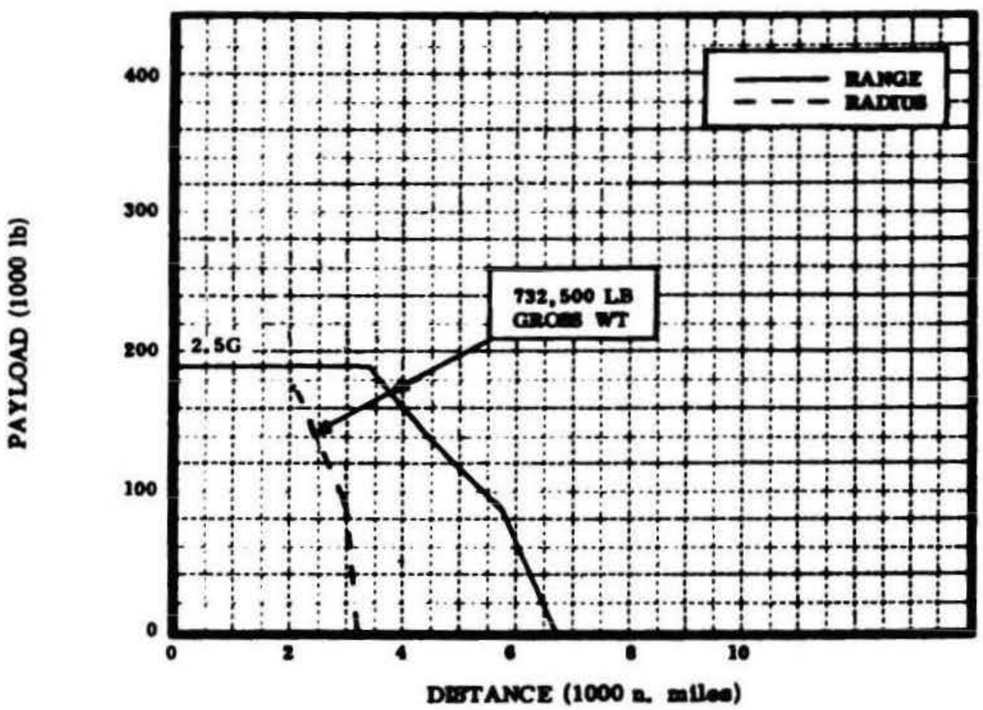


FIGURE B-121. Payload distance

B.4	**C-27**	# pages
B.4.1	Size	8
B.4.2	Weight	2
B.4.3	Restraint	1
B.4.4	Electrical	2
B.4.5	Aeromed	2

C-27A data is presented as preliminary information for the C-27J. Final aircraft configuration and capability data is not presently available. Contact ATTLA if C-27J information is required.

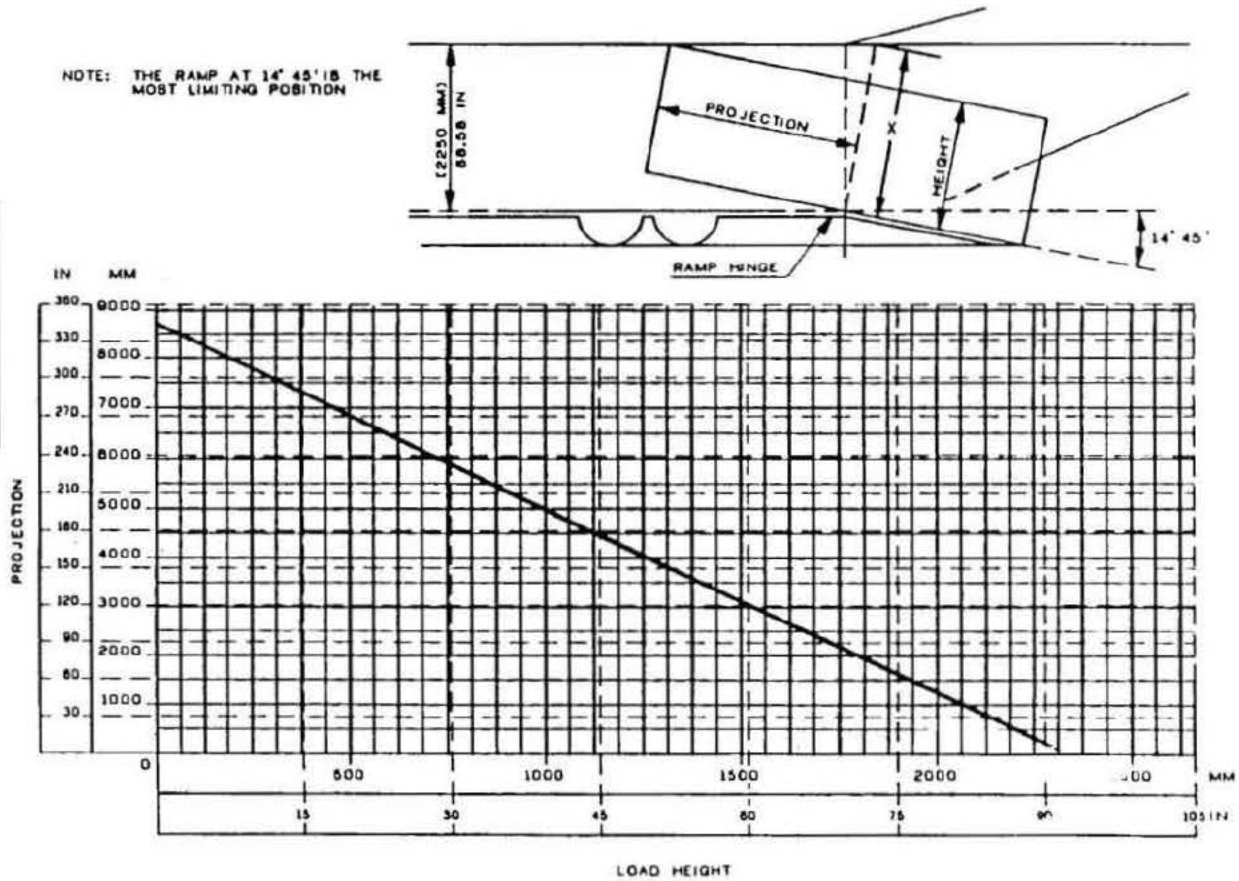


FIGURE B-122. Cargo projection limits

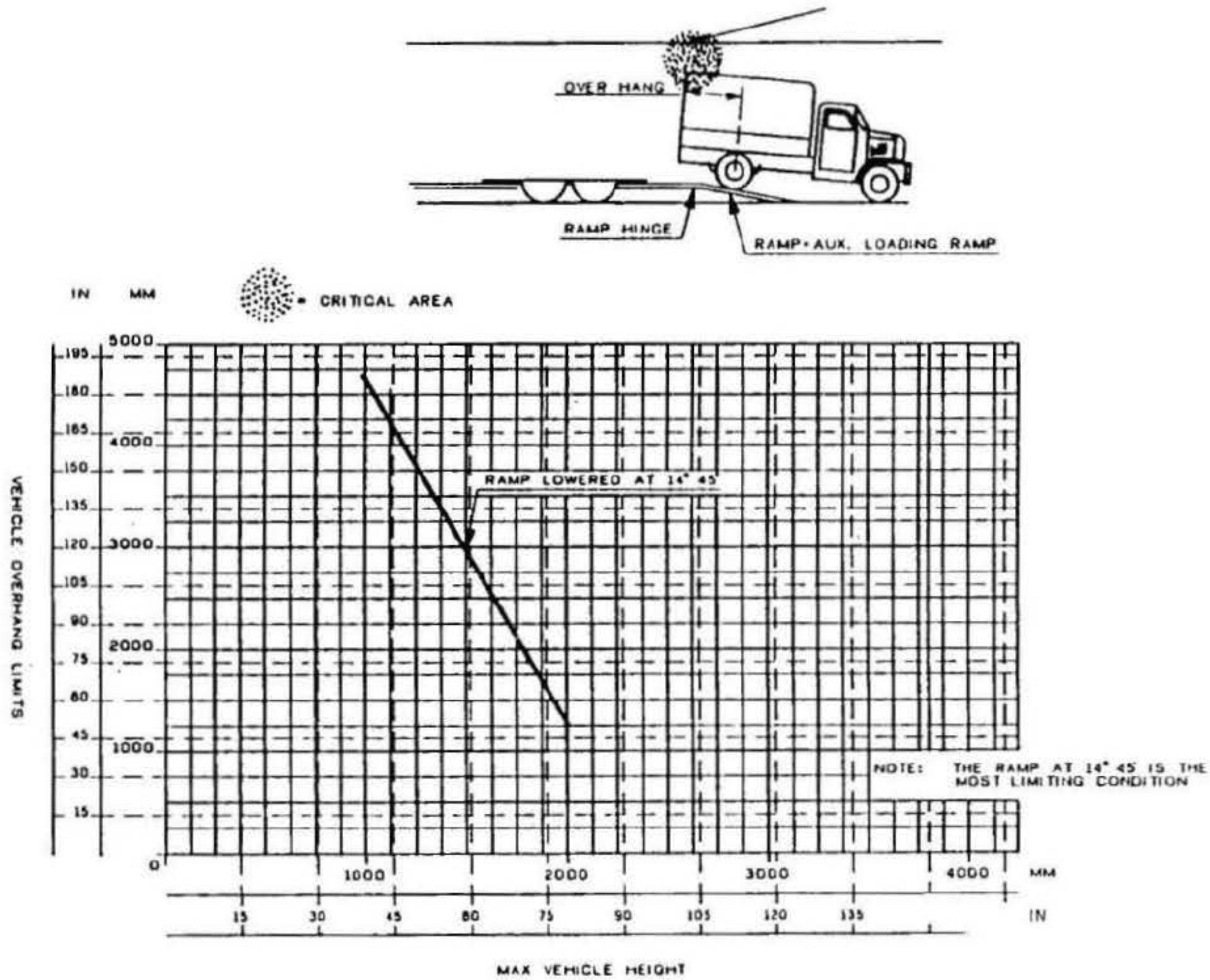


FIGURE B-123. Vehicle projection limits

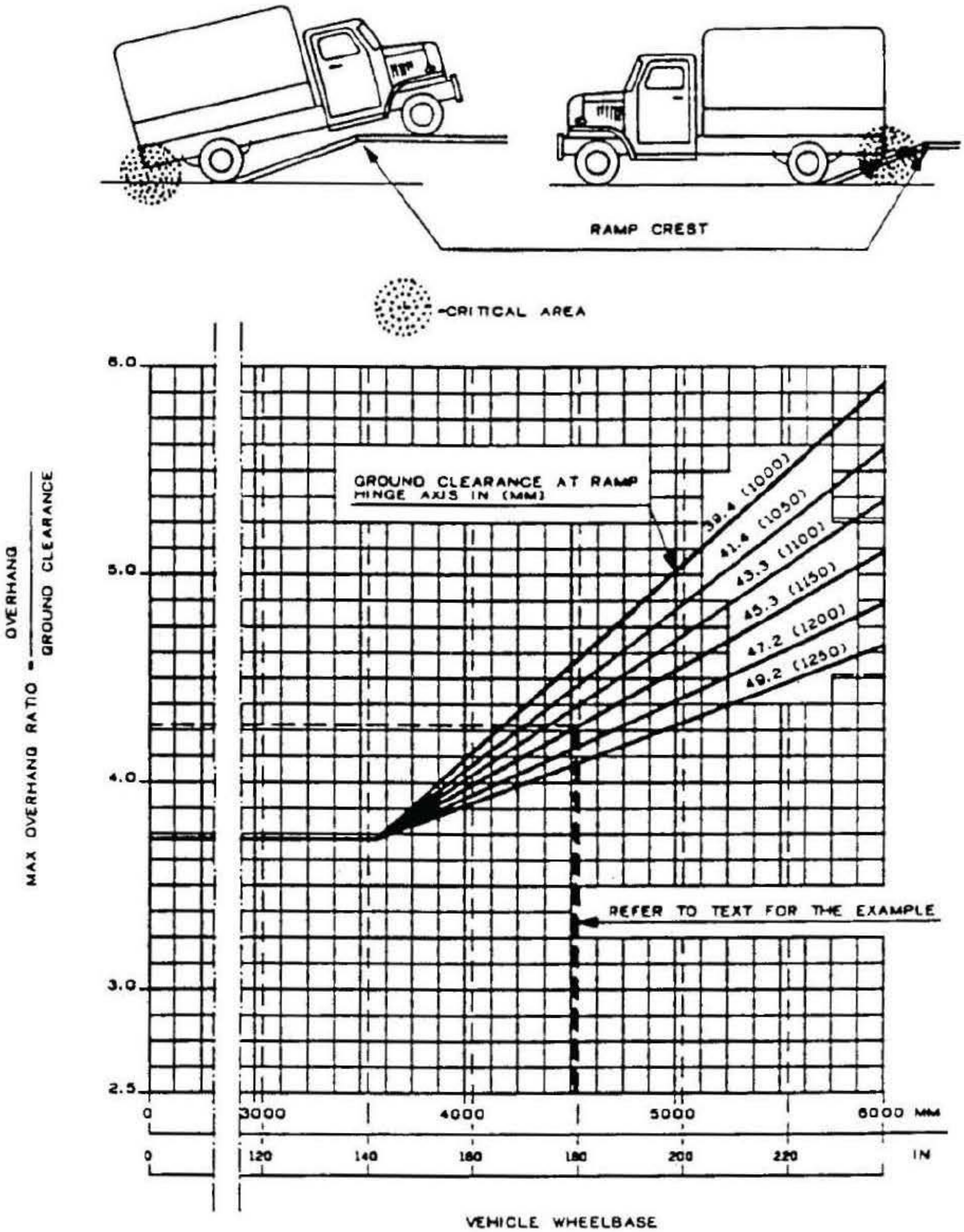


FIGURE B-124. Loading overhang limits

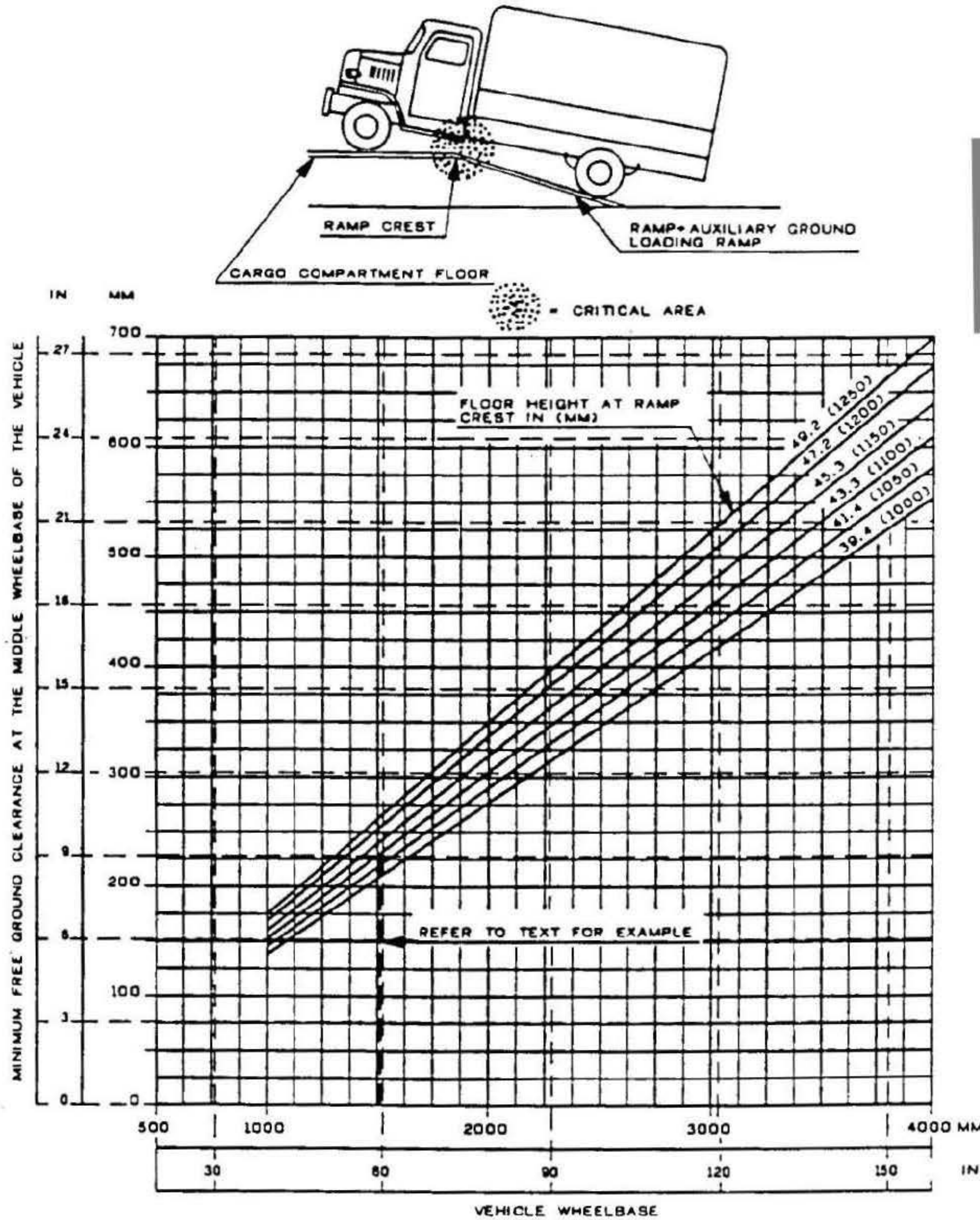


FIGURE B-125. Ramp crest limits

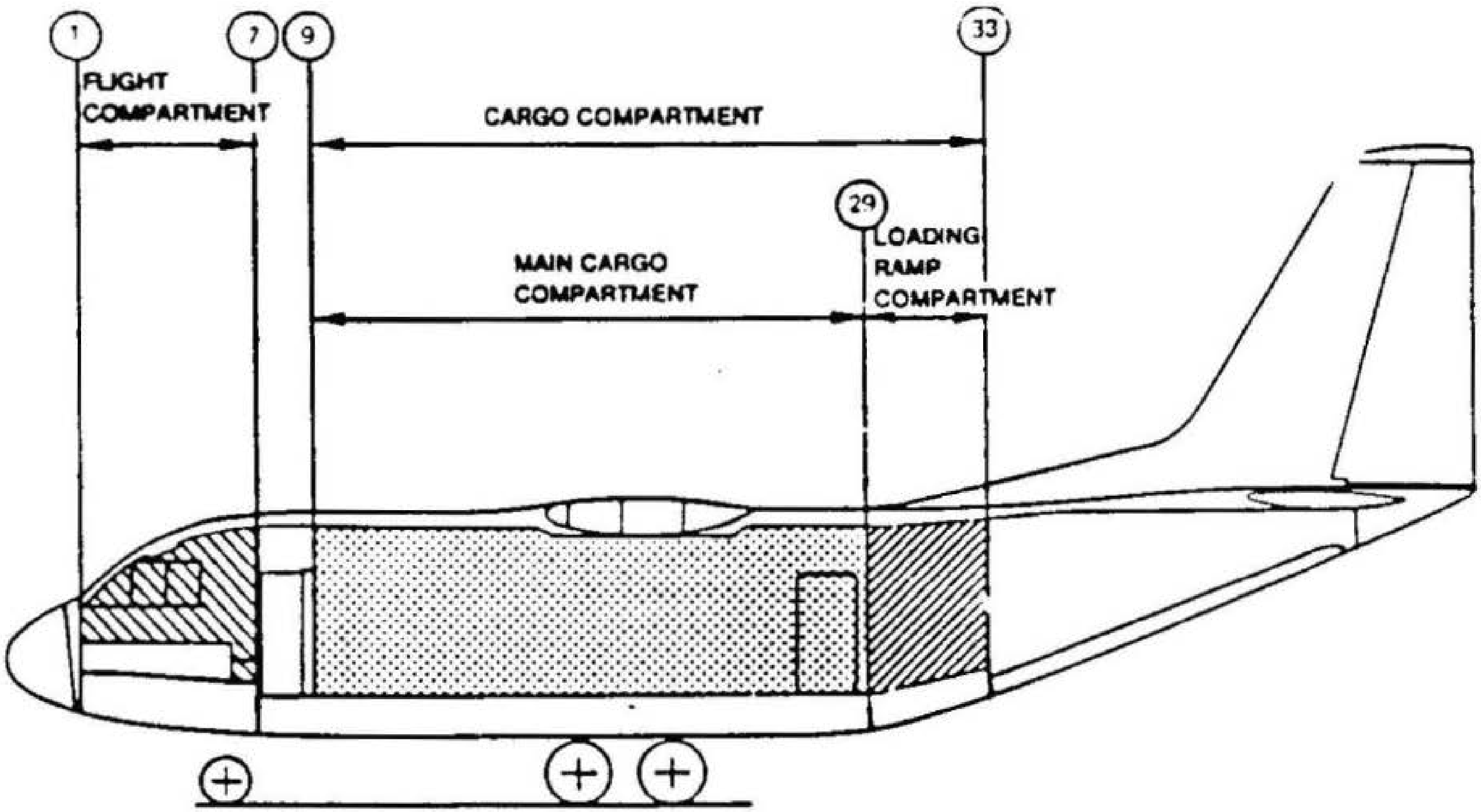


FIGURE B-126. Aircraft inner profile

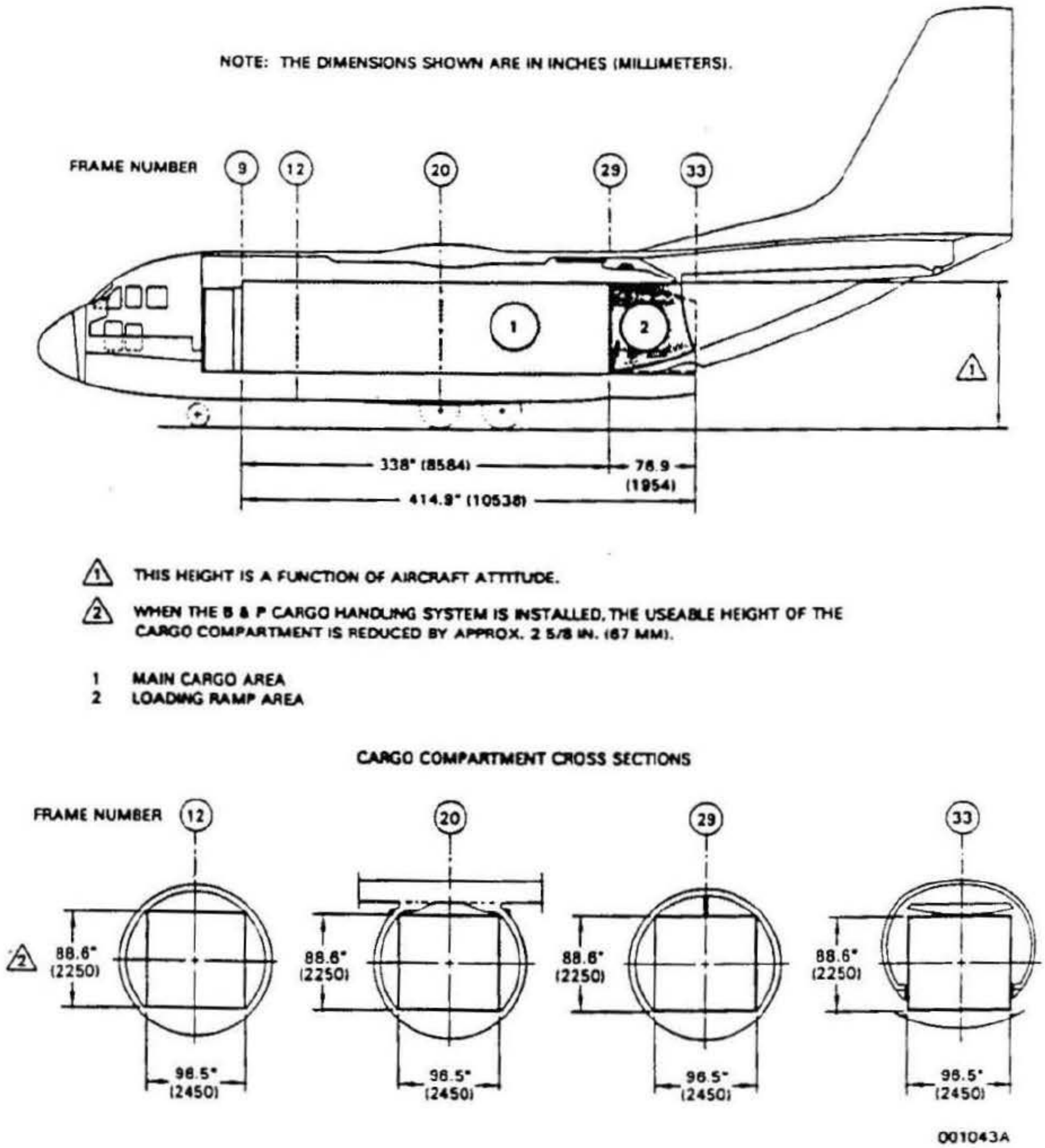


FIGURE B-127. Cargo compartment useful dimensions

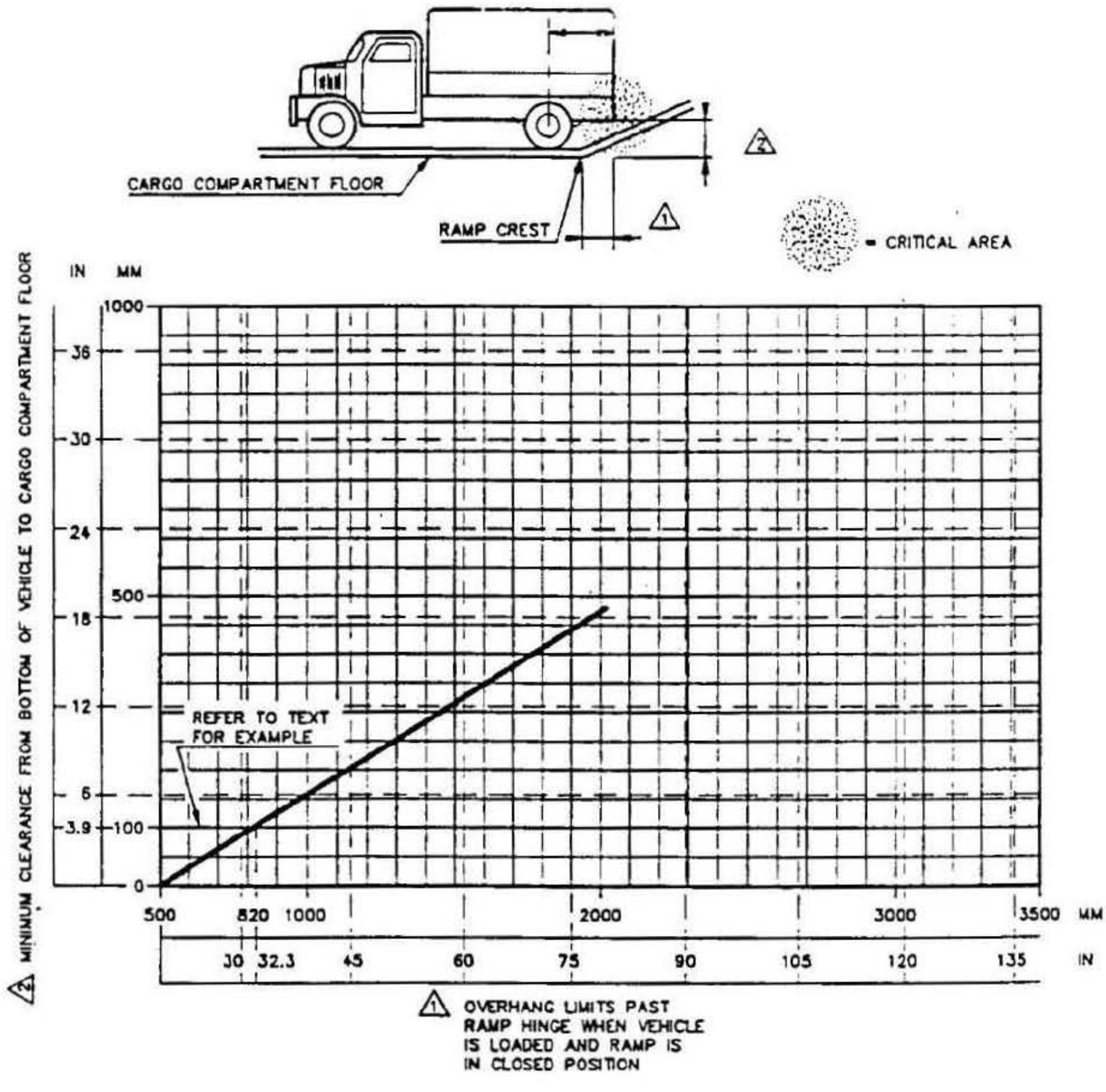


FIGURE B-128. Parking overhand clearance limits

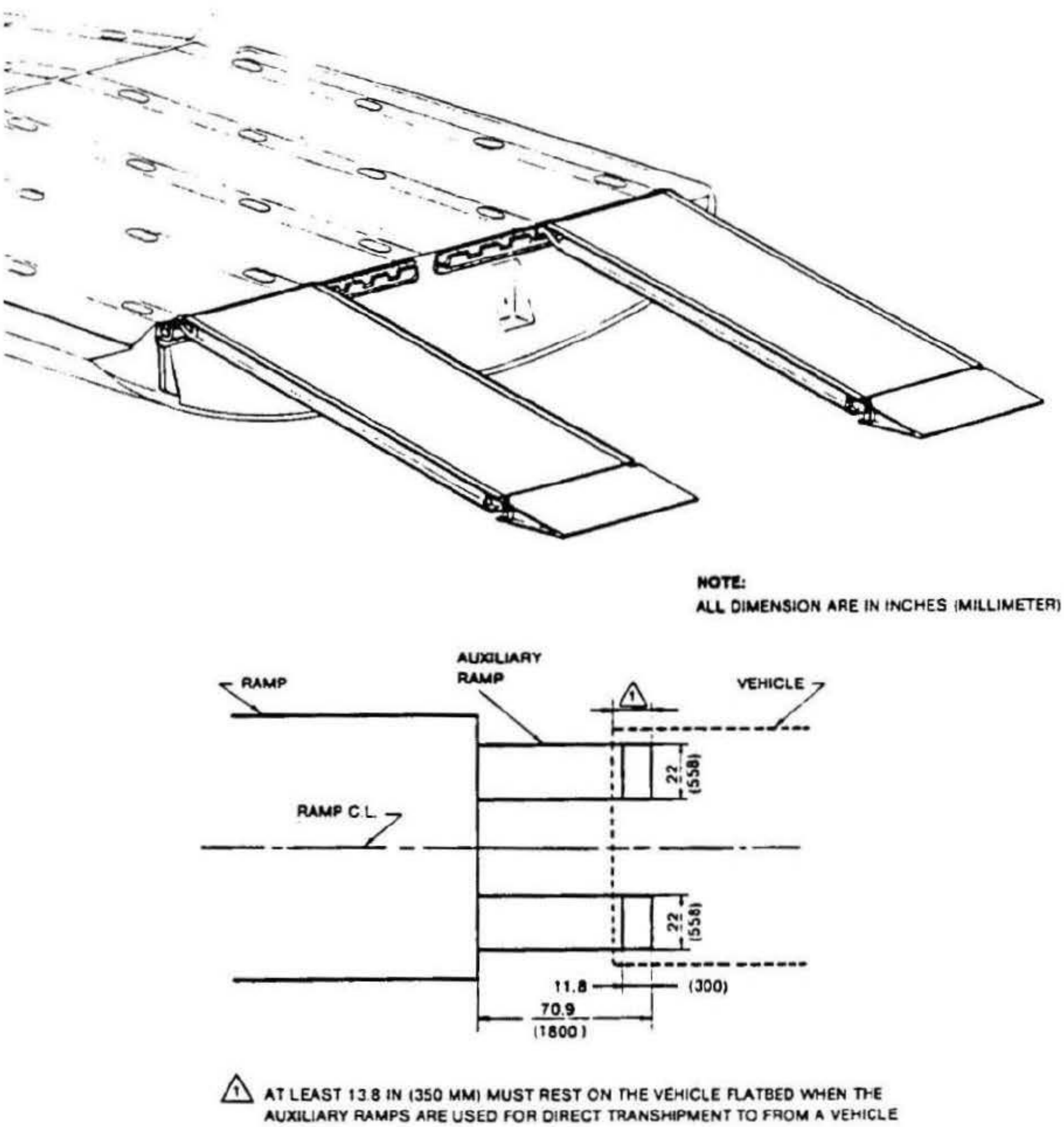
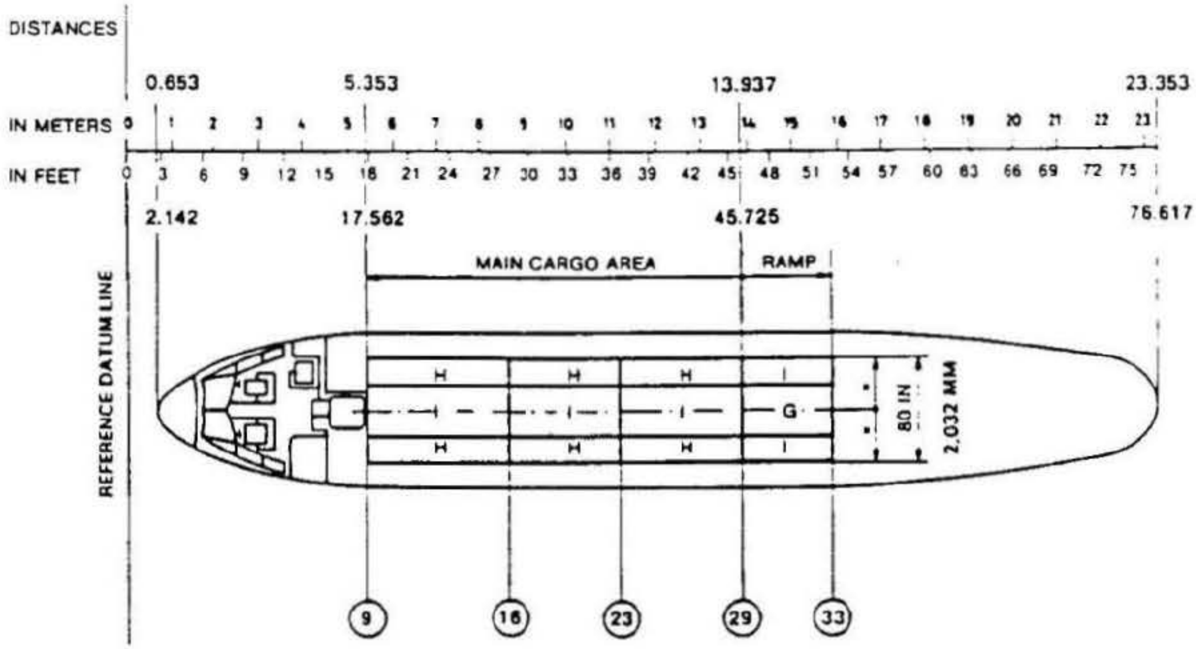


FIGURE B-129. Auxiliary ground loading ramps



INFLIGHT LIMITS FOR CONCENTRATED LOADS*

MAXIMUM CONCENTRATED LOADS AND LOADS PER WHEEL ON THE CARGO COMPARTMENT AND RAMP FLOOR				
LOAD TYPE / ZONE	MAX TIRE PRESSURE – 85 PSI MINIMUM DISTANCE BETWEEN AXLES – 3 FT MAX LOAD PER WHEEL		MAX LOAD PER UNIT FLOOR AREA	
	LB	KG	LB/SQ IN	KG/CM²
G	661	300	7	0.5
H	2645	1200	29	2.1
I	1322	600	14	1

NOTE: DURING LOADING AND UNLOADING OPERATION ON THE GROUND IT IS POSSIBLE TO EXCEED THE MAXIMUM LOADS PER WHEEL ON THE "G" AND "I" ZONE, UP TO 2,645 LB (1200 KG).

CAUTION : THE LOAD MUST SATISFY BOTH LIMITS SHOWN IN TABLE.

* A CONCENTRATED LOAD IS DEFINED AS A LOAD WHOSE WEIGHT IS CONCENTRATED ON ONE POINT OF THE AIRCRAFT FLOOR AND WHOSE LOAD CONTACT AREA ON THE FLOOR IS VERY SMALL COMPARED TO THE DIMENSION AND WEIGHT OF THE LOAD ITSELF.

FIGURE B-130. Cargo compartment floor loading limits

	GENERAL														
1	Fuselage frames		2	9	11	13	15	18	20	23	25	27b	29	31	33
2	Compartments		A	B	C	D	E	F	G	H	I	L	M	N	O
3	Floor area	m²	–	–	1.791	2.490	2.490	2.490	2.130	2.855	2.490	2.776	1.530	2.150	2.210
		sq ft	–	–	19	26	26	26	22	30	26	29	16	23	23
4	Useable volume	m³	–	–	4.030	5.600	5.600	5.600	4.790	6.420	5.600	6.250	3.440	4.840	4.960
		sq ft	–	–	142	197	197	197	169	226	197	220	121	170	175
5	Arm	m	1303	3.853	5.718	6.592	7.607	8.623	9.566	10.582	11.672	12.747	13.625	14.450	15.425
		ft	4	12	18	21	24	28	31	34	38	41	44	47	50

Cargo in compartment C + D + E = max 15,873 lb (7200 kg)

Cargo in compartment F + G + H = max 16,975 lb (7700 kg)

Cargo in compartment I + L + M = max 15,873 lb (7200 kg)

Cargo in compartment N + O = max 5,291 lb (2400 kg)

	INFLIGHT LIMITS FOR DISTRIBUTION LOADS														
6	Max loading capacity of compartment	kg	–	–	2400	2400	2400	2400	2400	2900	2400	2400	2400	1200	1.
		lb	–	–	5291	5291	5291	5291	5291	6393	5291	5291	5291	2645.5	2645.5
7	Max superficial load on floor	kg/cm²	–	–	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.10	0.10
		lb/sq in	–	–	2	2	2	2	2	2	2	2	2	1	1
8	Max load per floor length unit	kg/m	–	–	1500	1500	1500	1500	2500	2500	2500	1500	1500	1000	1000
		lb/ft	–	–	1008	1008	1008	1008	1680	1680	1680	1008	1008	672	672
	GROUND LIMITS FOR DISTRIBUTED LOADS														
9	Max loading capacity of compartment	kg	–	–	5400	5400	5400	7200	7200	9570	5400	5400	5400	3600	3600
		lb	–	–	11905	11905	11905	15873	15873	21098	11905	11905	11905	7937	7937
10	Max superficial load on floor	kg/cm²	–	–	0.495	0.495	0.495	0.495	0.495	0.495	0.495	0.495	0.495	0.33	0.33
		lb/sq in	–	–	7	7	7	7	7	7	7	7	7	4	4
11	Max load per floor length unit	kg/m	–	–	4950	4950	4950	4950	8250	8250	4950	4950	4950	3300	3300
		lb/ft	–	–	3326	3326	3326	3326	5544	5544	3326	3326	3326	2218	2218

FIGURE B-131. Cargo compartment loading limits for distributed loads

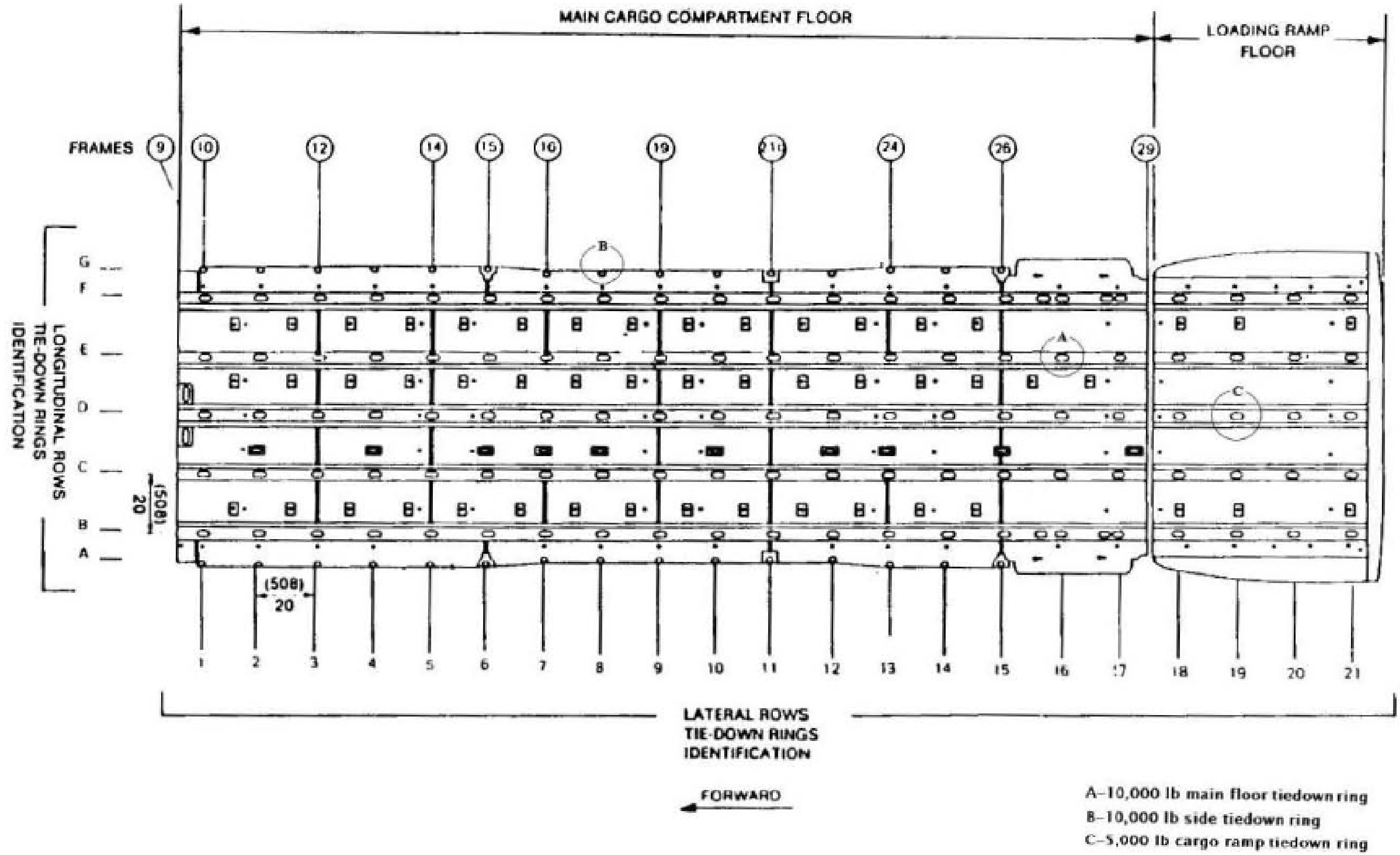
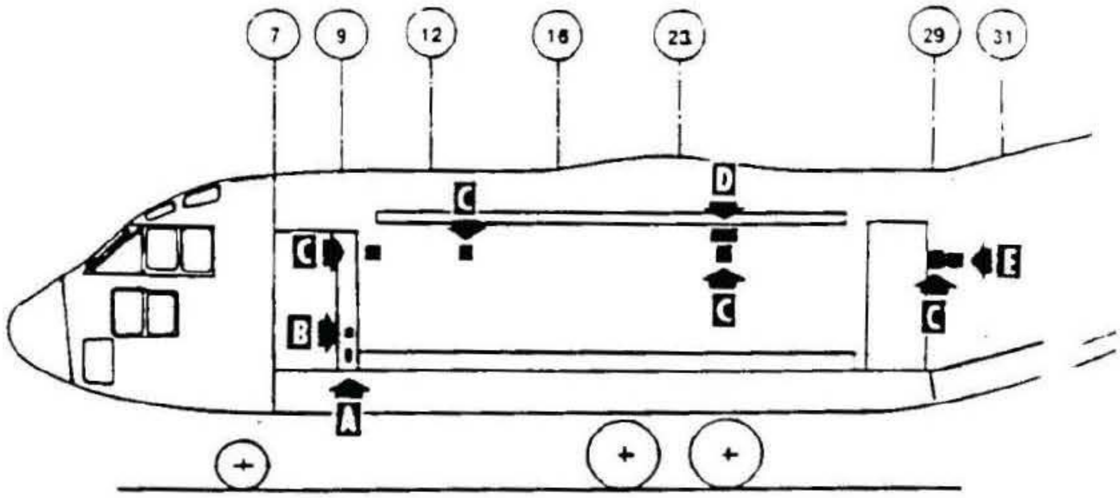
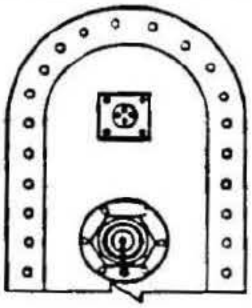


FIGURE B-132. Cargo compartment tiedown rings & studs



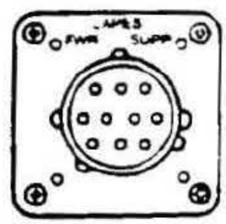
DETAIL A

28 VDC ELECTICAL POWER RECPT
FOR ELECTRO-HYDRAULIC LOADING WINCH



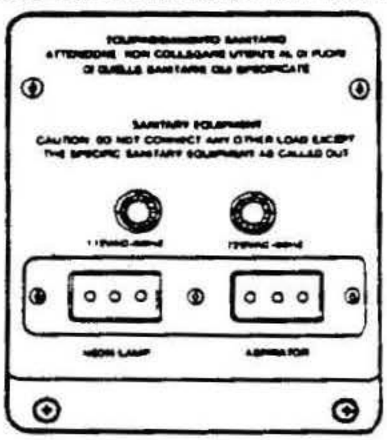
DETAIL B

28 VDC LAPE SYSTEM SUPPLY RECPT



DETAIL D

ELECTRICAL POWER RECPT
FOR SANITARY EQUIPMENT
(115 VAC - 60 HZ AND 220 VAC - 60 HZ)



DETAIL C

ELECTRICAL POWER RECPT
(200 VAC - 400 HZ)

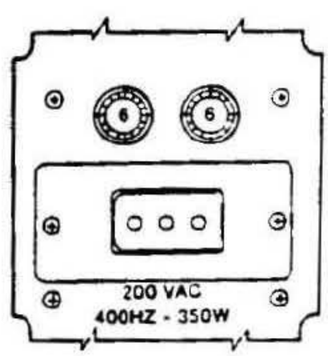


FIGURE B-133. Internal power receptacles (sheet 1 or 2)

C-27

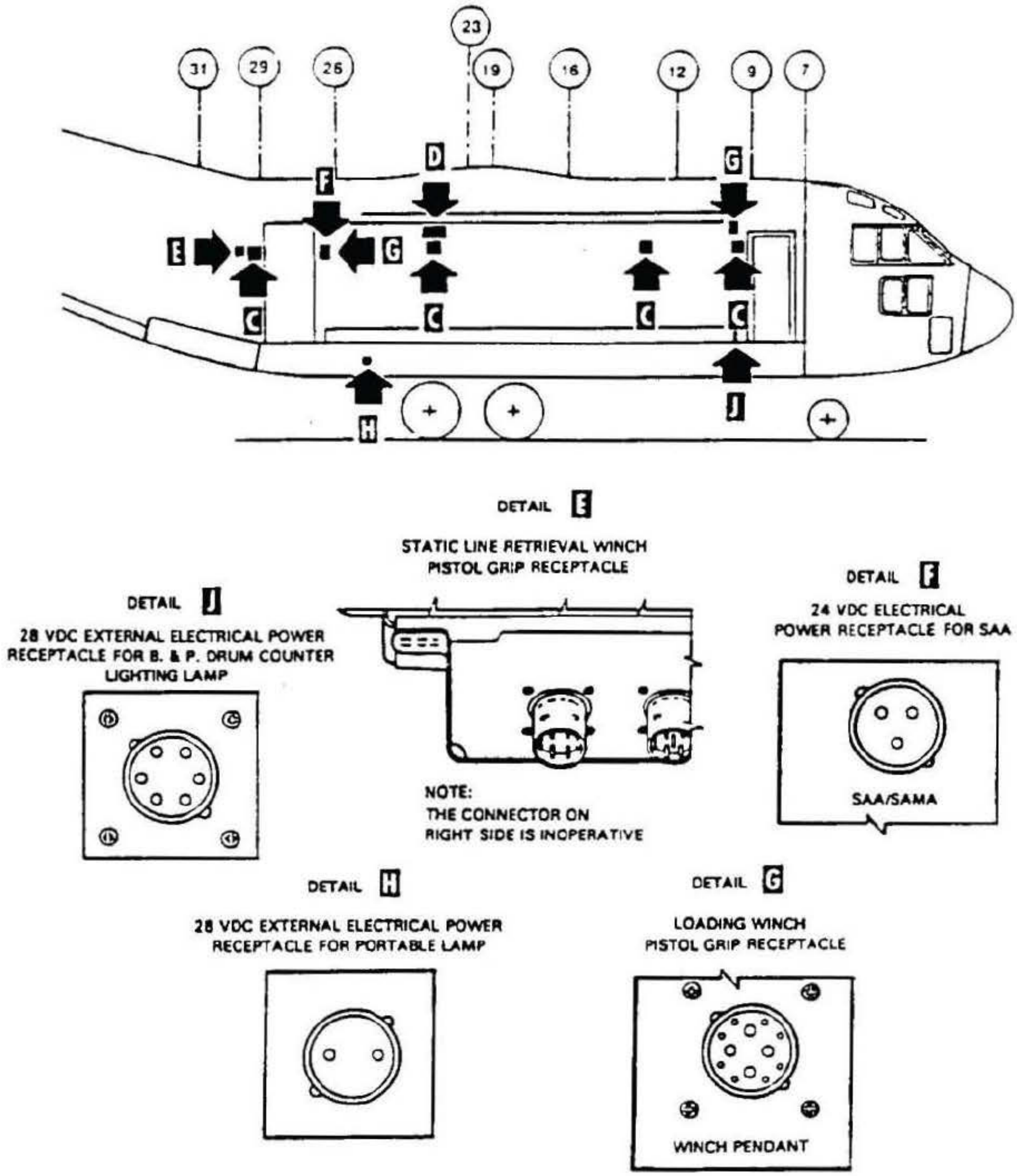
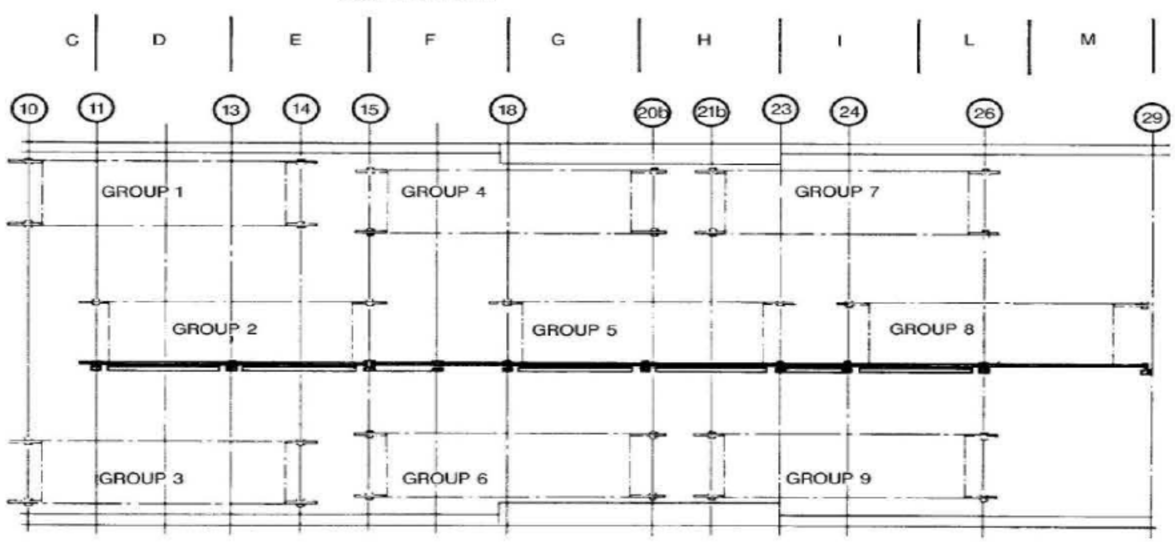


FIGURE B-134. Internal power receptacles (sheet 2)

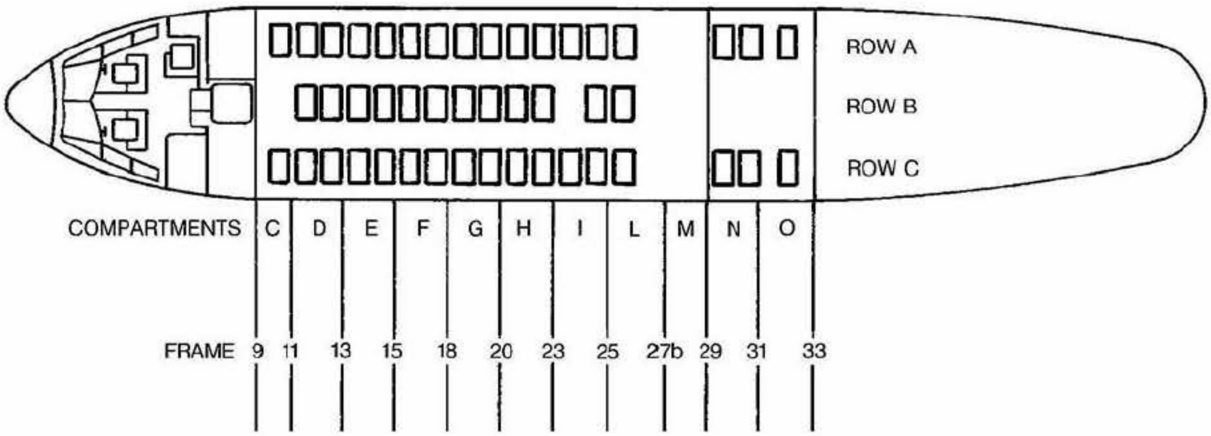
LITTERS ARM		
GROUP	INCH	MILLIMETERS
1	259.528	6592
2	279.528	7100
3	259.528	6592
4	358.540	9132
5	400.000	10160
6	358.540	9132
7	459.798	11670
8	502.362	12760
9	459.798	11670



36 PATIENT LITTER CONFIGURATION

FIGURE B-135. Plan view of stretchers

PASSENGERS 46 SEATS MAX



Appendix C Tankers

USAF tanker aircraft have an auxiliary capacity as cargo haulers. Since they are commercial derivative aircraft they load through a side door, from K-loaders. Therefore, projection, ramp and ground contact, and cresting limits are not applicable. However, the commercial floors lack the strength of dedicated cargo aircraft and most cargo is loaded on or over pallets on the aircraft roller system.

Size

KC-135 Loading Envelope

Max Length	Max Height 45	50	60	70	78
130	116	112	103	87	68
140	108	102	96	80	63
150	99	95	90	75	59
160	95	90	84	70	55
170	89	85	79	66	51
180	85	81	75	63	49
190	80	76	71	59	45
200	76	73	67	56	43
210	72	69	63	53	40
220	68	66	60	51	38
230	65	62	57	48	36
240	62	60	55	47	34
250	59	57	51	45	32
260	57	55	50	43	31
270	55	52	47	41	29
280	53	50	46	40	28
290	51	48	44	38	27
300	49	47	42	37	26
310	48	45	41	36	25
320	47	44	40	35	24
330	45	43	37	34	24
340	44	41	38	34	23
350	43	40	37	33	23
360	42	39	36	32	22
370	41	39	35	31	21
380	40	38	35	31	21
390	39	37	34	30	20
400	38	37	33	30	20
410	38	36	33	29	20
420	37	35	32	29	0
430	36	34	32	29	0
440	35	33	31	28	0
450	35	33	31	28	0
458	34	33	30	28	0

Explanation of Chart:
The maximum dimensions are based on the cargo door opening and internal cargo compartment dimensions. No allowance is made for protrusions or handling difficulties. Height must include handling equipment (pallet, etc.).

To Use:
Round up all dimensions.
At the intersection of the height column and the length row is the maximum allowable width.

Example Use:
Package Size 150"L x 90"W x 50"H.

1) Enter chart at 150" on length column.
2) Go horizontally to vertical 50" on height column.
3) At the intersection, maximum package width = 95"

Conclusion: Package should be loadable.

NOTE:

- Cargo door opening is approximately 117"W x 78"H, with 8"H x 13"W areas in the top corners obstructed by the door actuator supports.
- Chart does not reflect installation of the A/M135 cargo roller system.
- A/M135 cargo system occupies 3.5" of vertical height across the entire width.

TANKER

FIGURE B-137.

KC-10 Loading Envelope

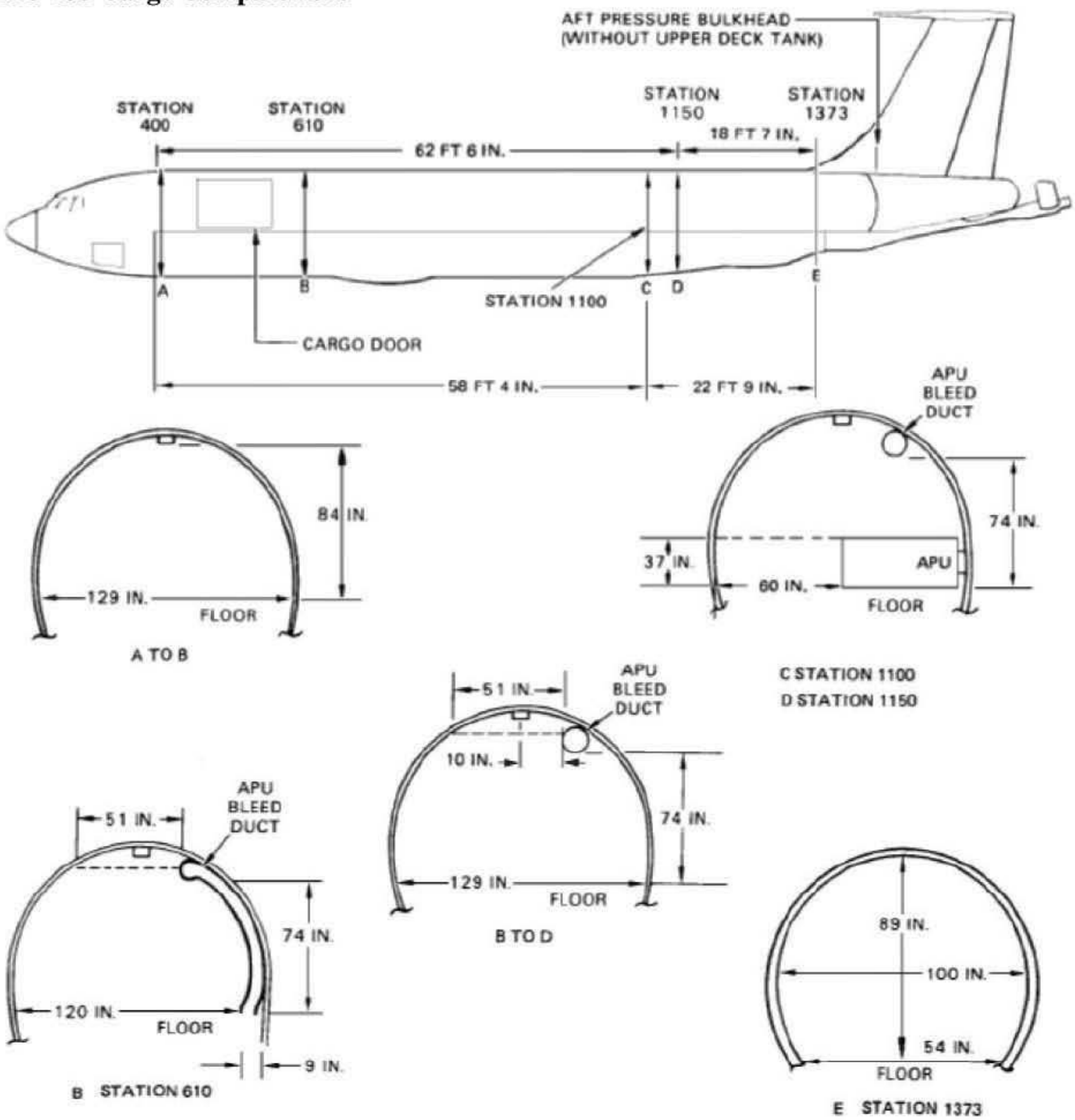
Max Height	Max Width aft of cargo door 12	24	36	48	60	72	84	96	108	120	132
36	1323	982	660	520	440	380	330	295	265	240	205
48	1266	900	620	500	430	370	330	290	260	230	200
60	1016	680	550	470	390	350	310	275	250	220	195
72	740	600	490	410	360	320	280	255	230	205	180
84	590	490	420	370	325	285	255	230	210	185	160
96	490	420	370	325	285	260	235	210	185	170	145

Max Height	Max Width forward of cargo door 12	24	36	48	60	72	84	96	108	120	132
36	330	325	320	312	305	290	270	250	235	225	215
48	325	320	315	310	305	290	270	250	235	220	213
60	320	315	310	305	300	280	265	240	225	214	205
72	315	310	303	295	290	275	255	230	215	200	190

FIGURE B-138.

To Use:
Round up all dimensions.
At the intersection of the width column and the height row is the maximum allowable length.
Thickness of pallet must be included in height dimension.

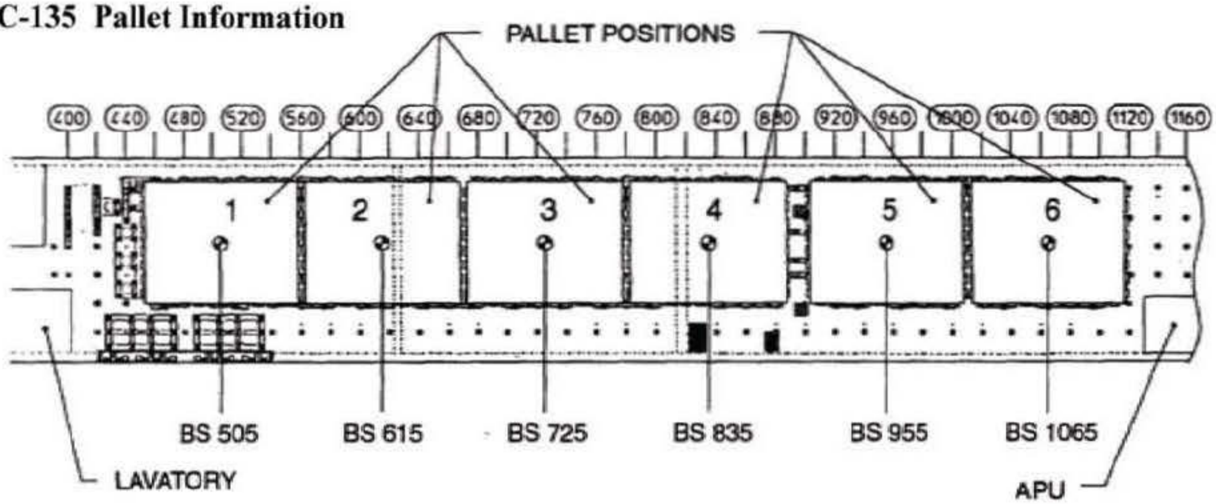
KC-135 Cargo Compartment



KC-135 R/T cargo compartment

FIGURE B-139.

KC-135 Pallet Information



A/M135 System Layout With Pallets in the Six Basic Positions

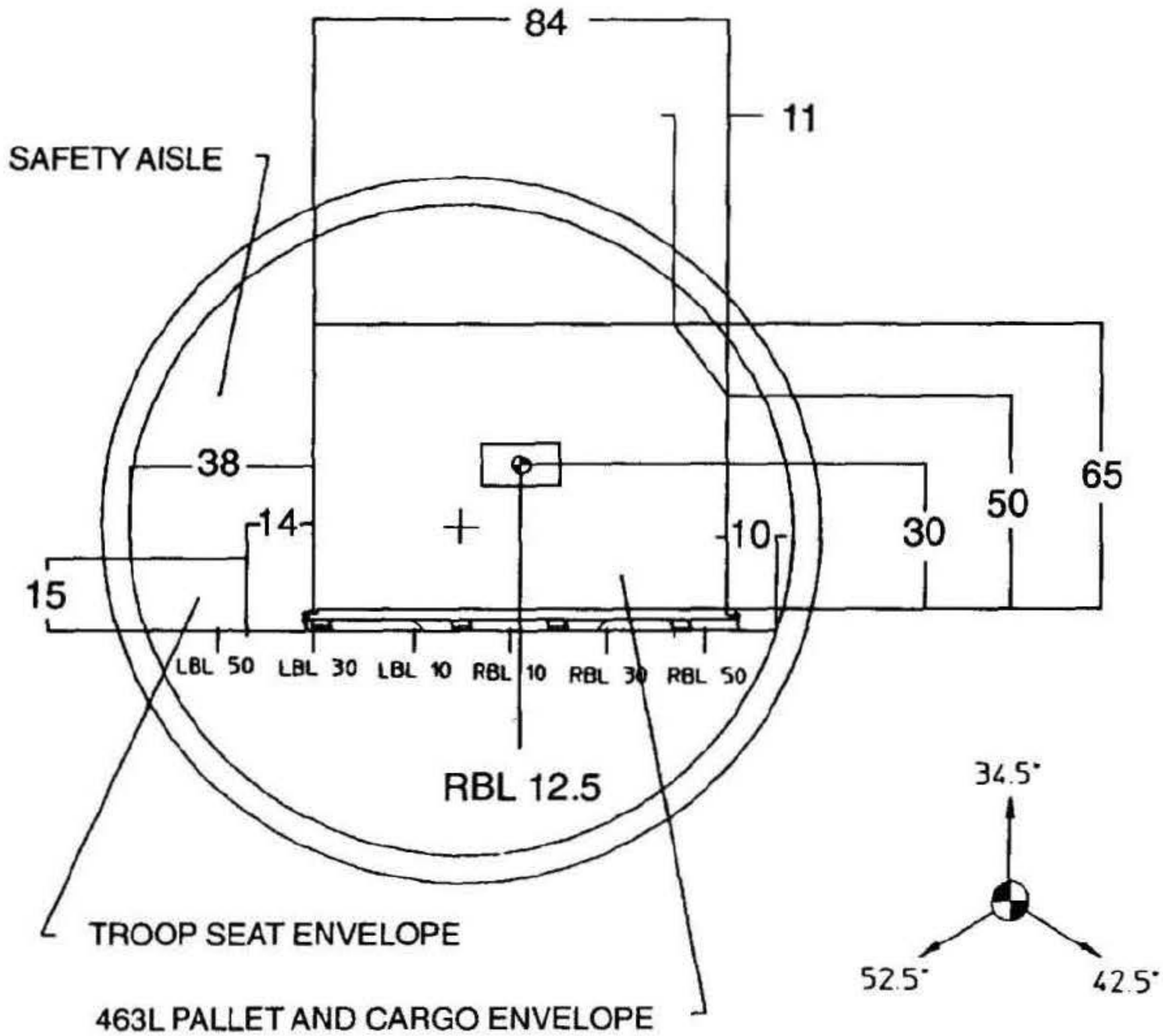


FIGURE B-140. Cargo contour

TANKER

KC-10 Cargo Compartment

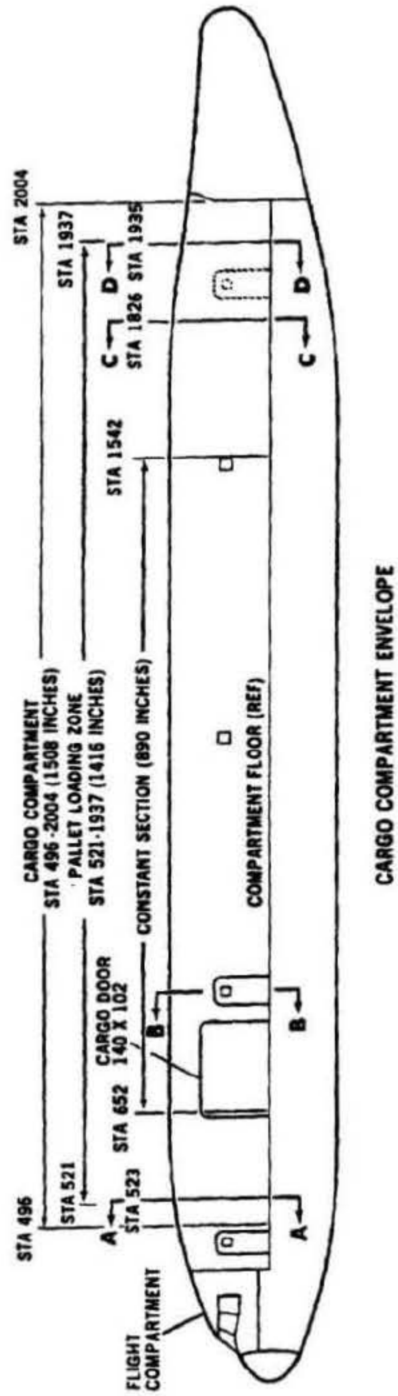


FIGURE B-141. Cargo compartment envelope

TANKER

KC-10 Cargo Door

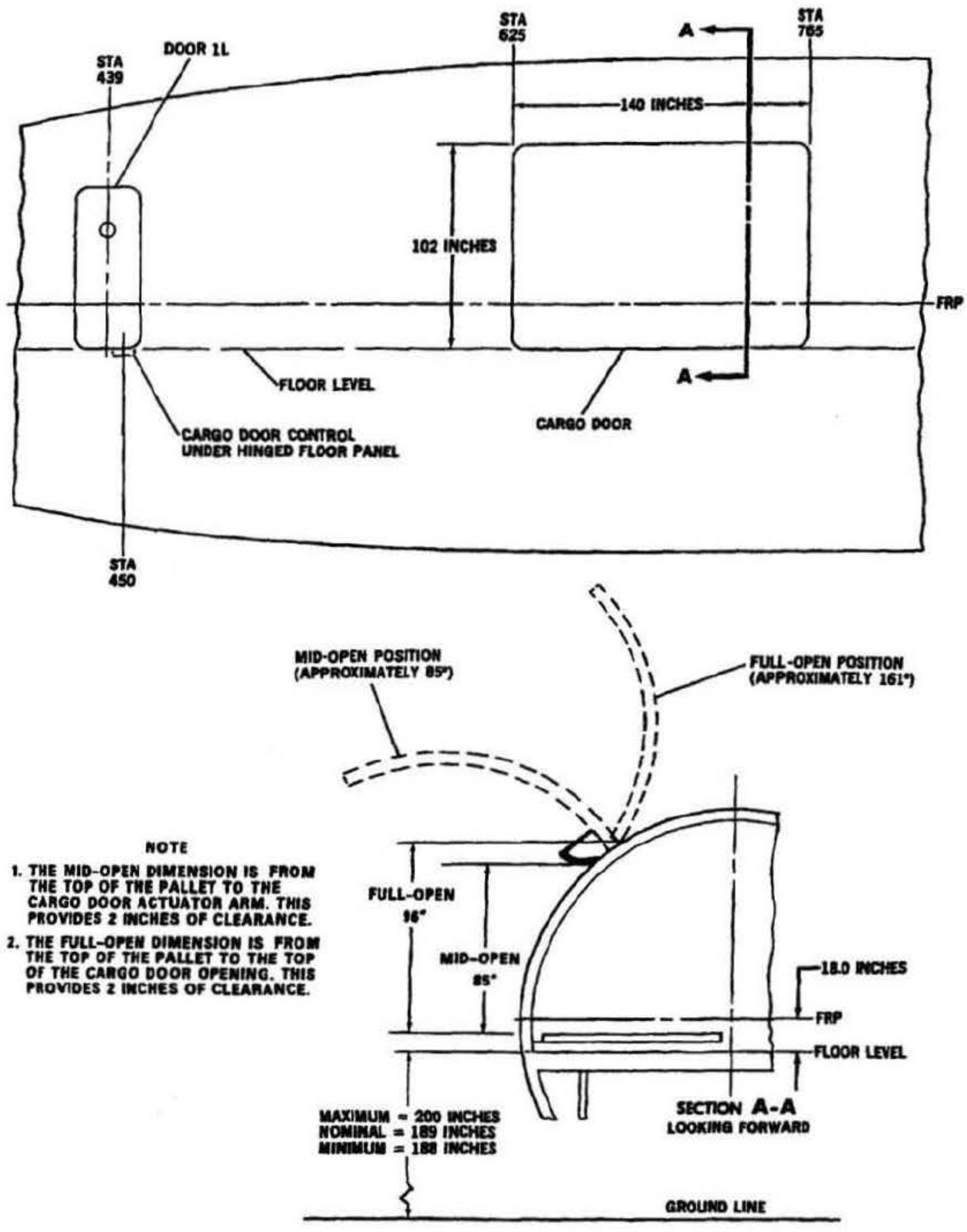


FIGURE B-142. Cargo door

KC-10 Cargo Contour

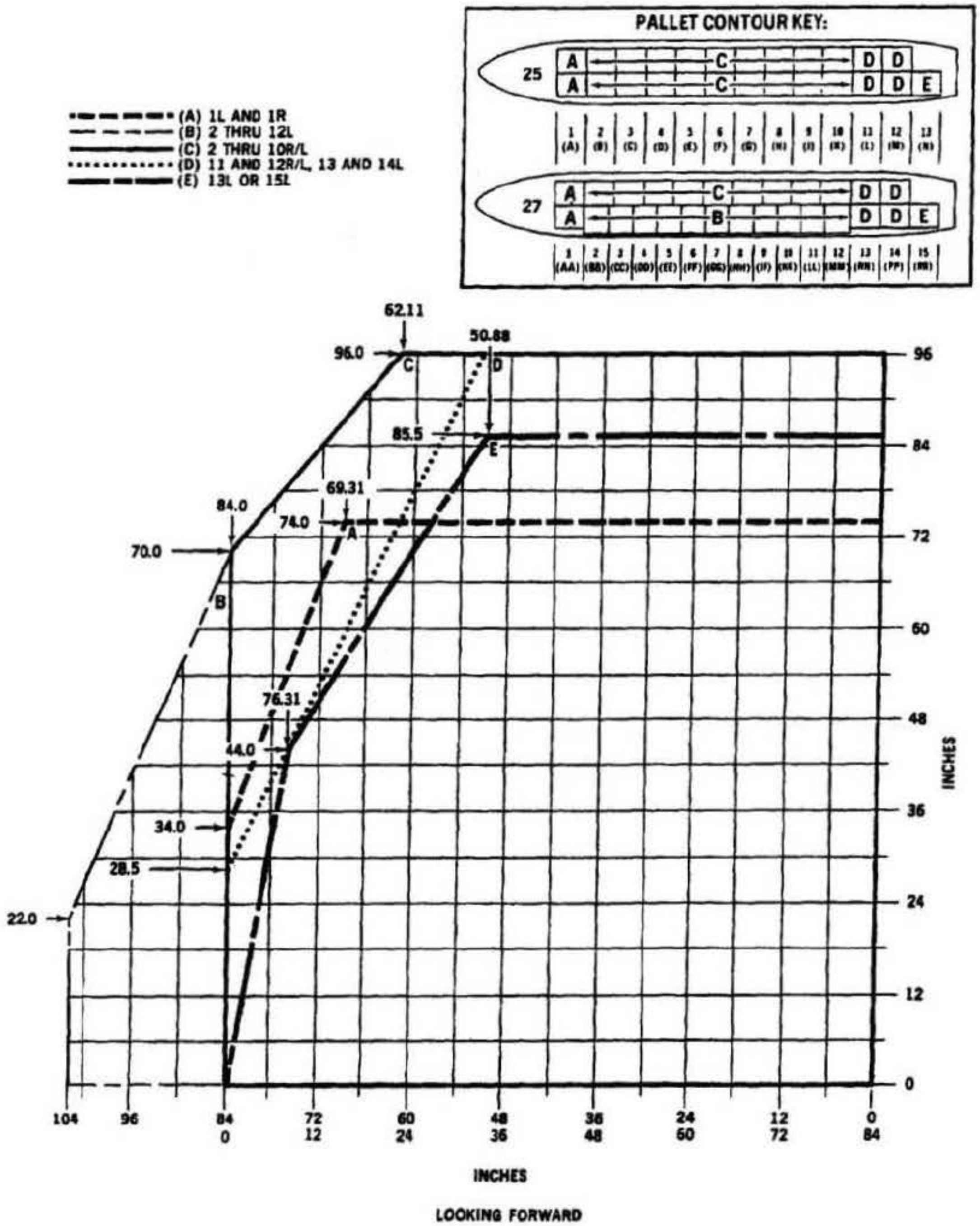
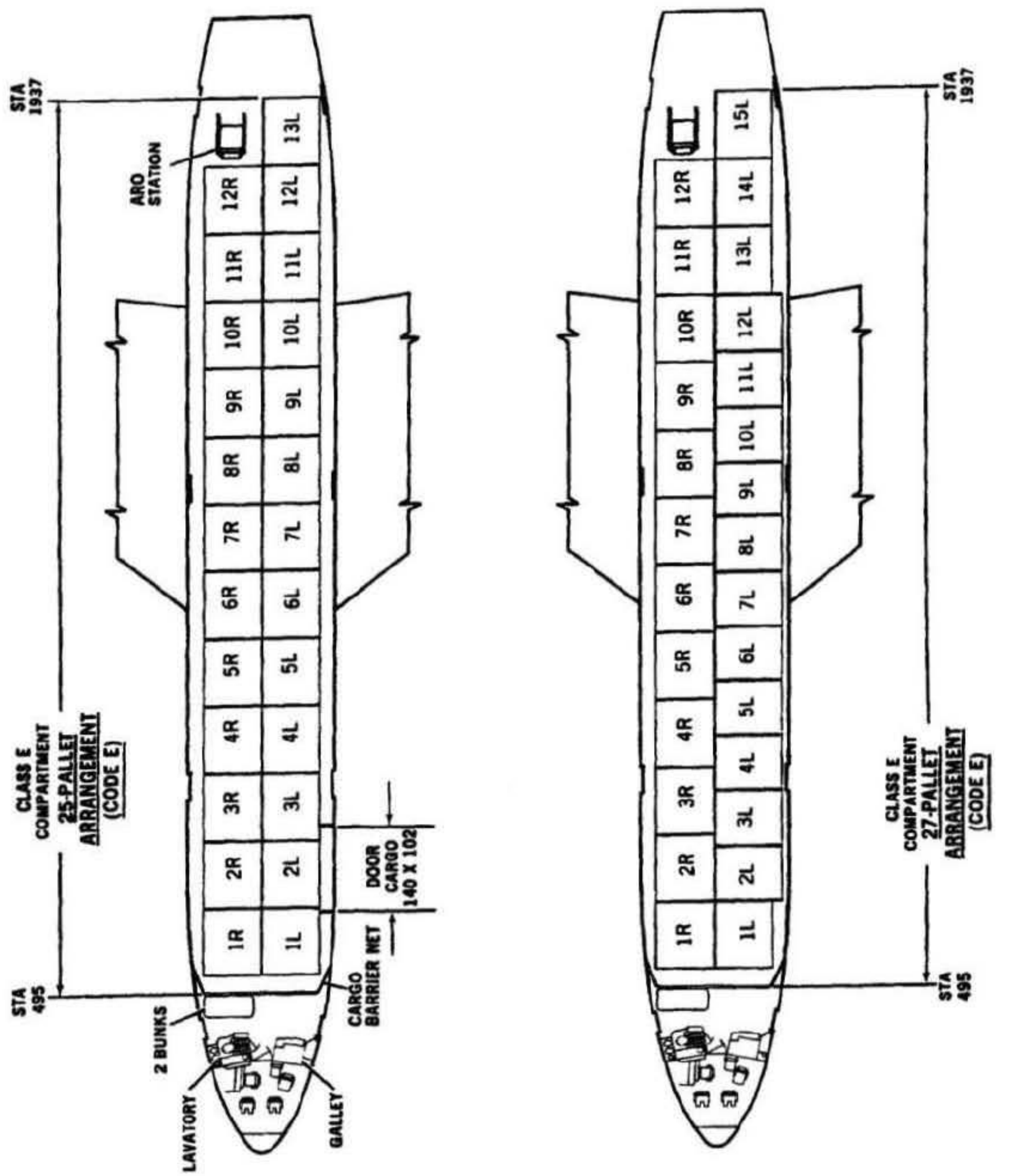


FIGURE B-143. Pallet contours and aisle configurations

KC-10 Cargo Loading Configurations



SA9-39A

FIGURE B-144. All-cargo configuration

KC-10 Cargo Loading Configurations

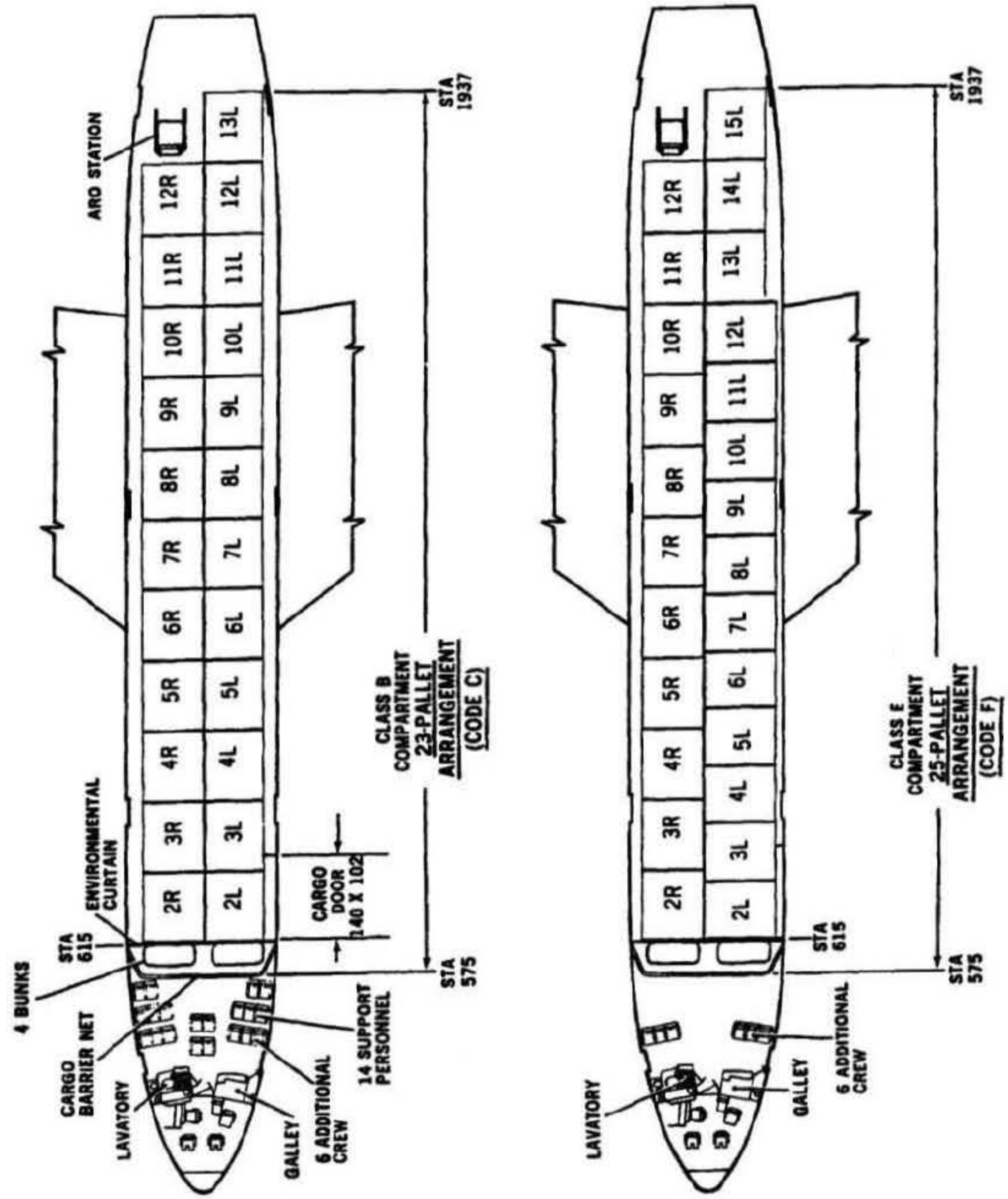


FIGURE B-145. Mixed cargo/personnel configuration

KC-10 Cargo Loading Configurations

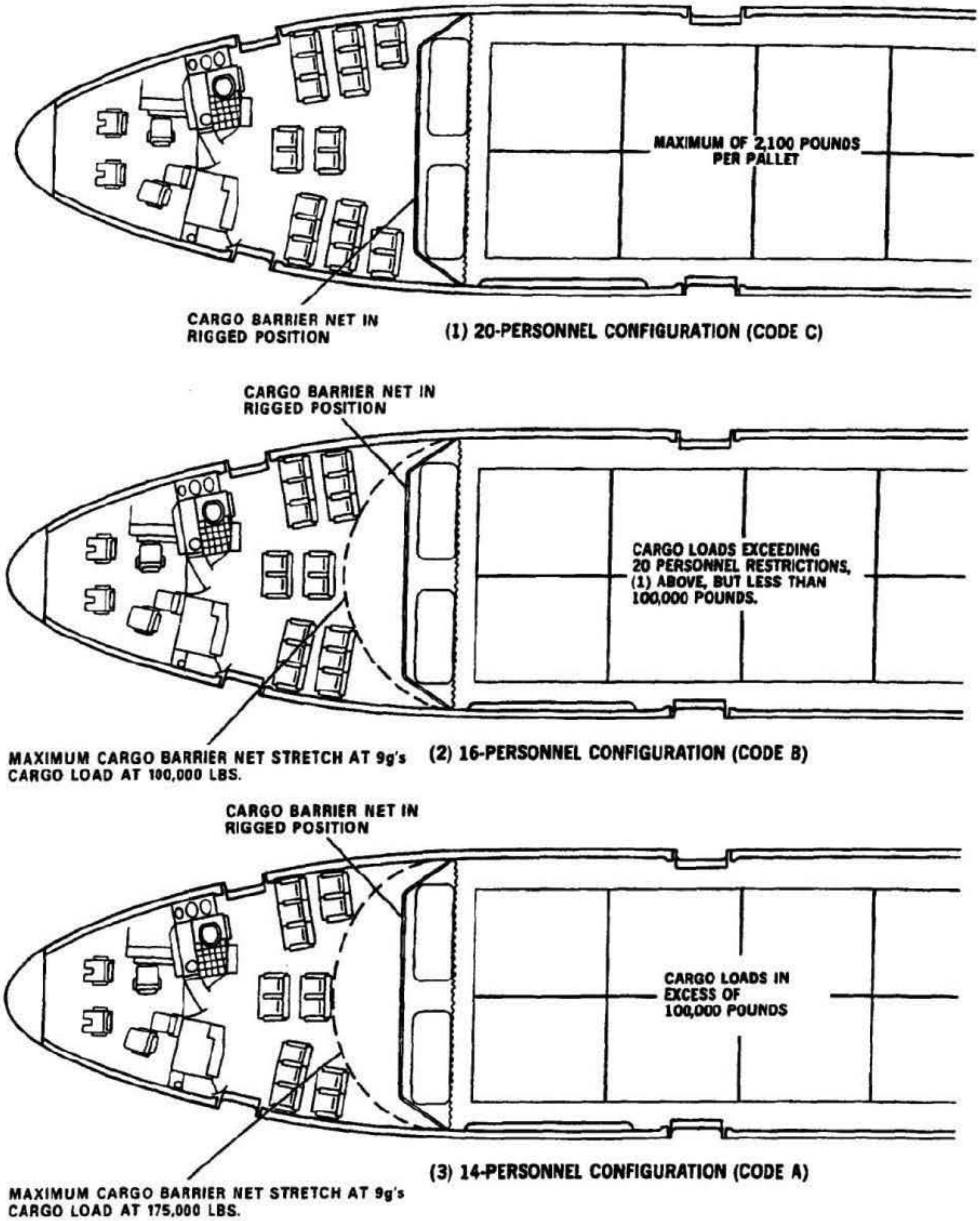


FIGURE B-146. Mixed cargo/personnel configuration

KC-10 Cargo Loading Configurations

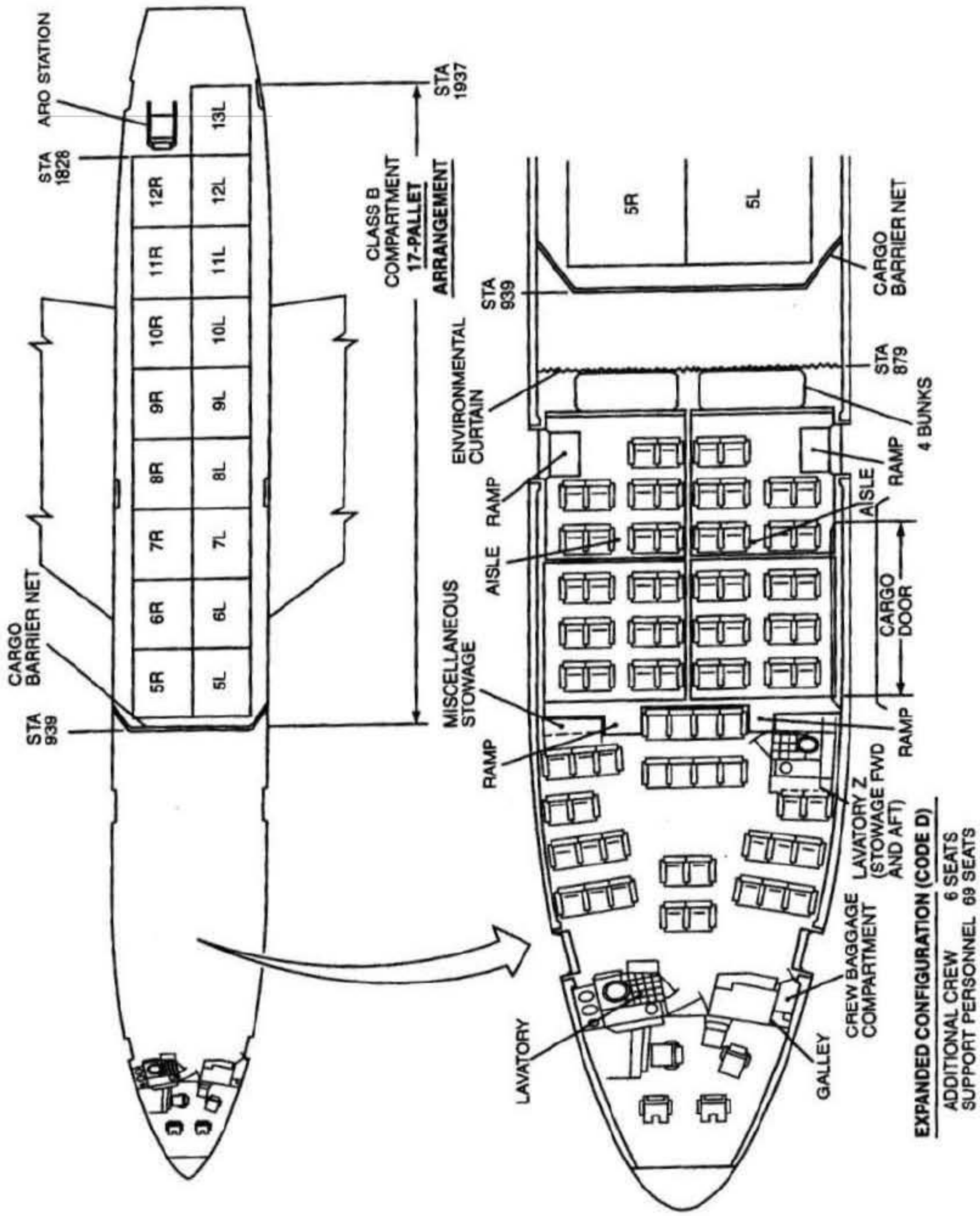


FIGURE B-147. Mixed cargo/personnel configuration

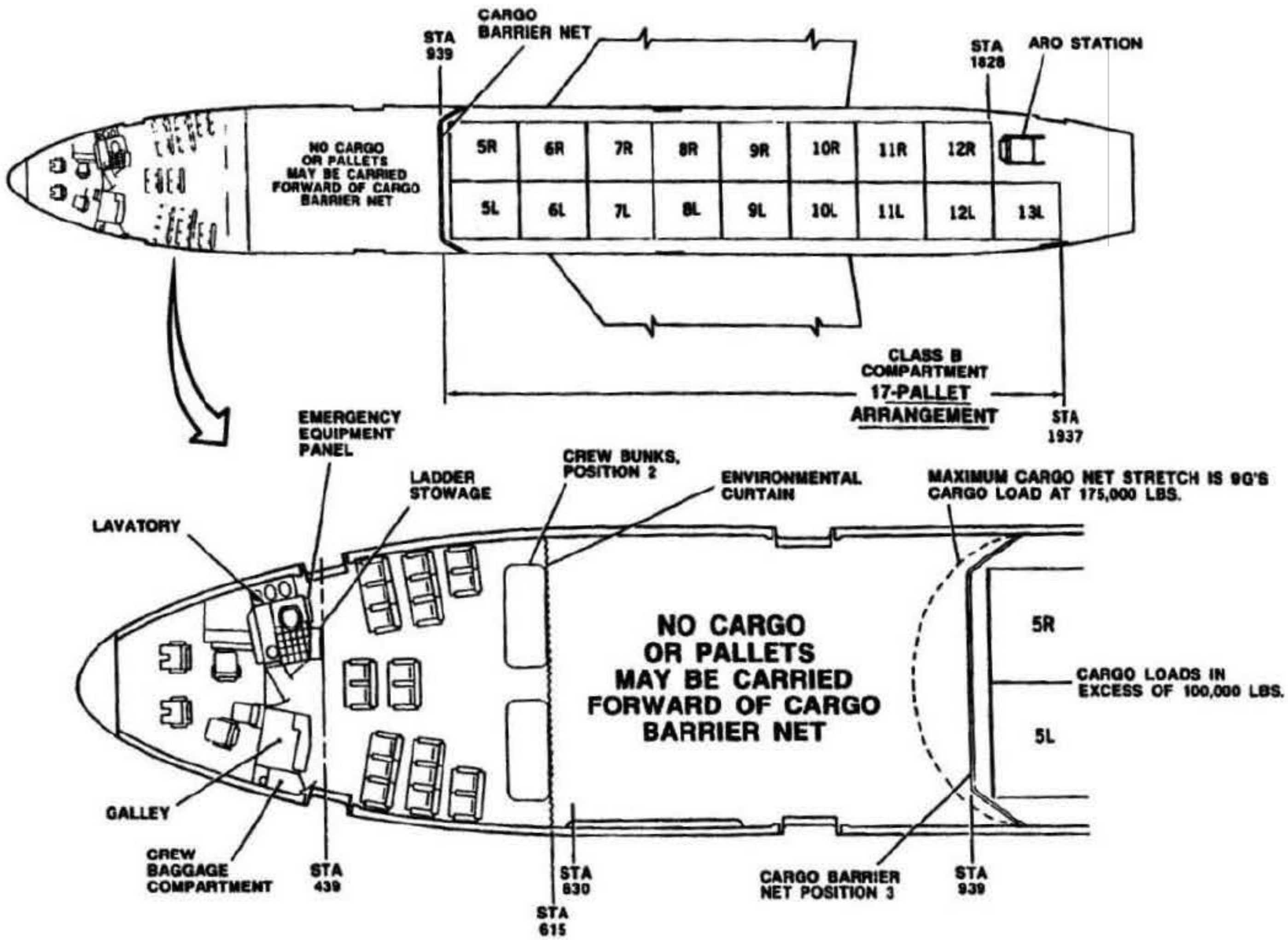


FIGURE B-148. Mixed cargo/personnel configuration

TANKER

Weight

KC-135 Compartment Limits

TABLE B-XII. Compartment structural capacity

COMPT	INCHES FROM REF DATUM: CEN-TROID (INCHES)	INCHES FROM REF DATUM: COMPARTMENT LIMITS	LENGTH (INCHES)	LB/IN.	FLOOR AREA (SQ FT)	FLOOR STRENGTH (LBS/SQ FT)	VOLUME (CU FT)	MAX CARGO COMPT CAP (LB)
A	159	130 – 178	48	–	120	–	210	–
B	269	178 – 360	182	–	54	100	620	–
C	390	360 – 420	60	40	36	100	330	2400
D	450	420 – 480	60	100	54	200	330	6000
E	510	480 – 540	60	100	54	200	330	6000
F	580	540 – 620	80	100	72	200	430	8000
G-1 [1]	650	620 – 680	60	89	54	200	330	5340
G-2 [1]	650	620 – 680	60	106	54	200	330	6360
G-3 [1]	650	620 – 680	60	123	54	200	330	7380
G-4 [1]	650	620 – 680	60	140	54	200	330	8400
H-1 [1]	710	680 – 740	60	89	54	200	330	5340
H-2 [1]	710	680 – 740	60	106	54	200	330	6360
H-3 [1]	710	680 – 740	60	123	54	200	330	7380
H-4 [1]	710	680 – 740	60	140	54	200	330	8400
I-1 [1]	780	740 – 820	80	89	72	200	430	7120
I-2 [1]	780	740 – 820	80	106	72	200	430	8480
I-3 [1]	780	740 – 820	80	123	72	200	430	9840
I-4 [1]	780	740 – 820	80	140	72	200	430	11200
J	860	820 – 900	80	100	72	200	430	8000
K	930	900 – 960	60	100	54	200	330	6000
L	990	960 – 1020	60	70	54	200	330	4200
M	1050	1020 – 1080	60	70	54	200	330	4200
N	1110	1080 – 1140	60	70	54	200	230	4200
O	1170	1140 – 1200	60	70	54	200	220	4200
P	1220	1200 – 1240	40	70	36	200	180	2800
Q	1288	1240 – 1340	100	–	51	40	501	1040
R	1359	1340 – 1380	40	–	27	100	170	250
S	1408	1380 – 1440	60	–	33	100	230	–
T	–	1440 – 1676	236	–	–	–	–	–

CAUTION

Any troops or equipment not categorized as cargo must be accounted for in the total compartment capacity. Compartment limitations must not be exceeded.

NOTE

- When total cargo requirements exceed 77,000 pounds, the maximum capacity of compartments L thru O is increased to 6000 pounds per compartment, and compartment P is increased to 4000 pounds (100 pounds per inch of compartment length.
- The capacity of each individual compartment cannot be exceeded.
- The weight of shoring material should be added to the weight of cargo in determining compartment capacity.

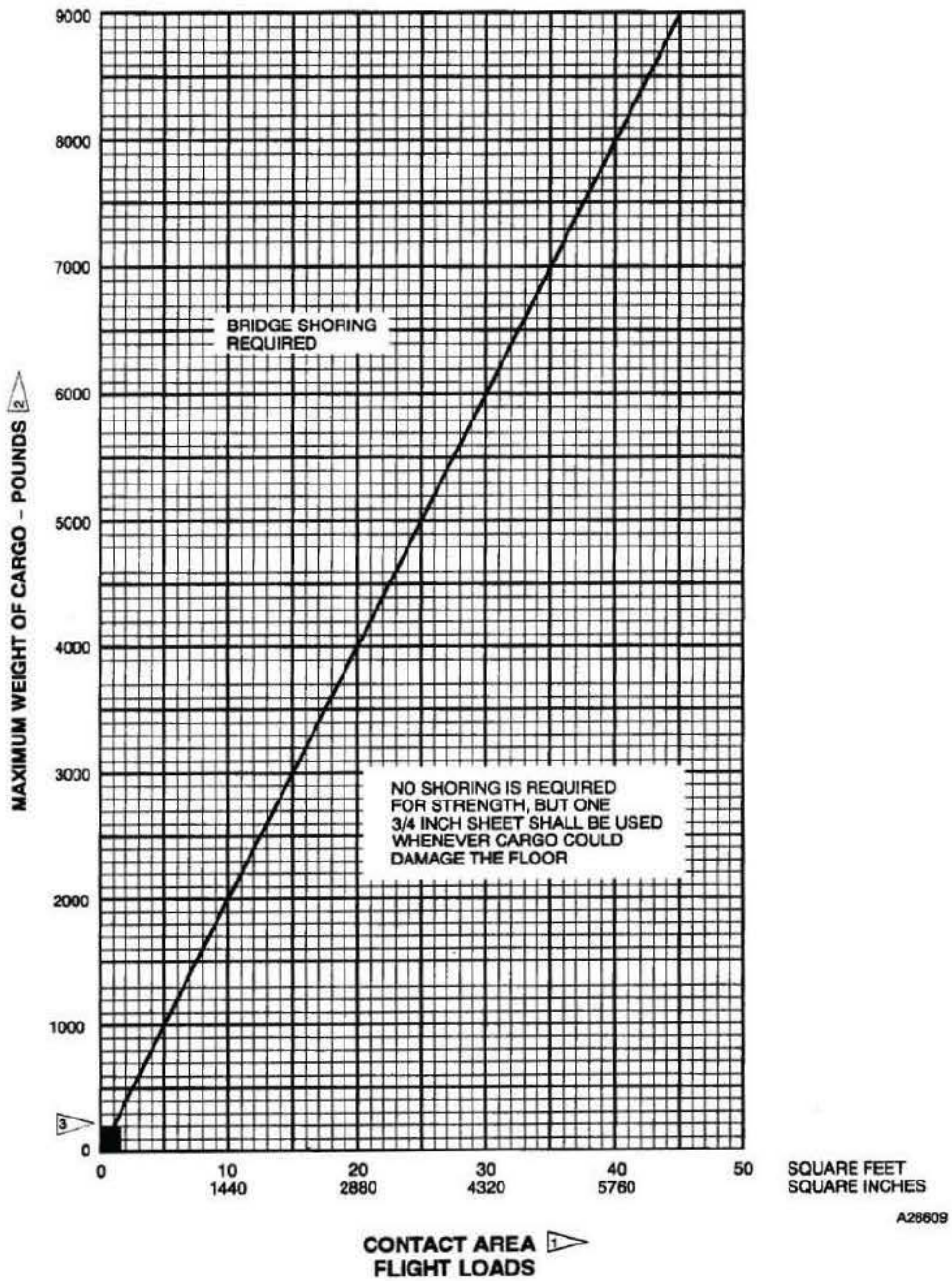
FUEL QUANTITY - CENTER SEC (LB) [1]	COMPTS G	H	I
OVER 44,100	1	1	1
40,700 TO 44,100	2	2	2
37,500 TO 40,700	3	3	3
TO 37,500	4	4	4

EXAMPLE: Center section tank contains 39.000 lbs fuel. MAX CARGO COMPT CAP (LB) values for G-3, H-3, and I-3 must be used and are as follows:

G-3 = 7380 lbs
H-3 = 7380 lbs
I-3 = 9840 lbs

KC-135 "Large Area" Loads

Large Area = more than 1.5 square feet



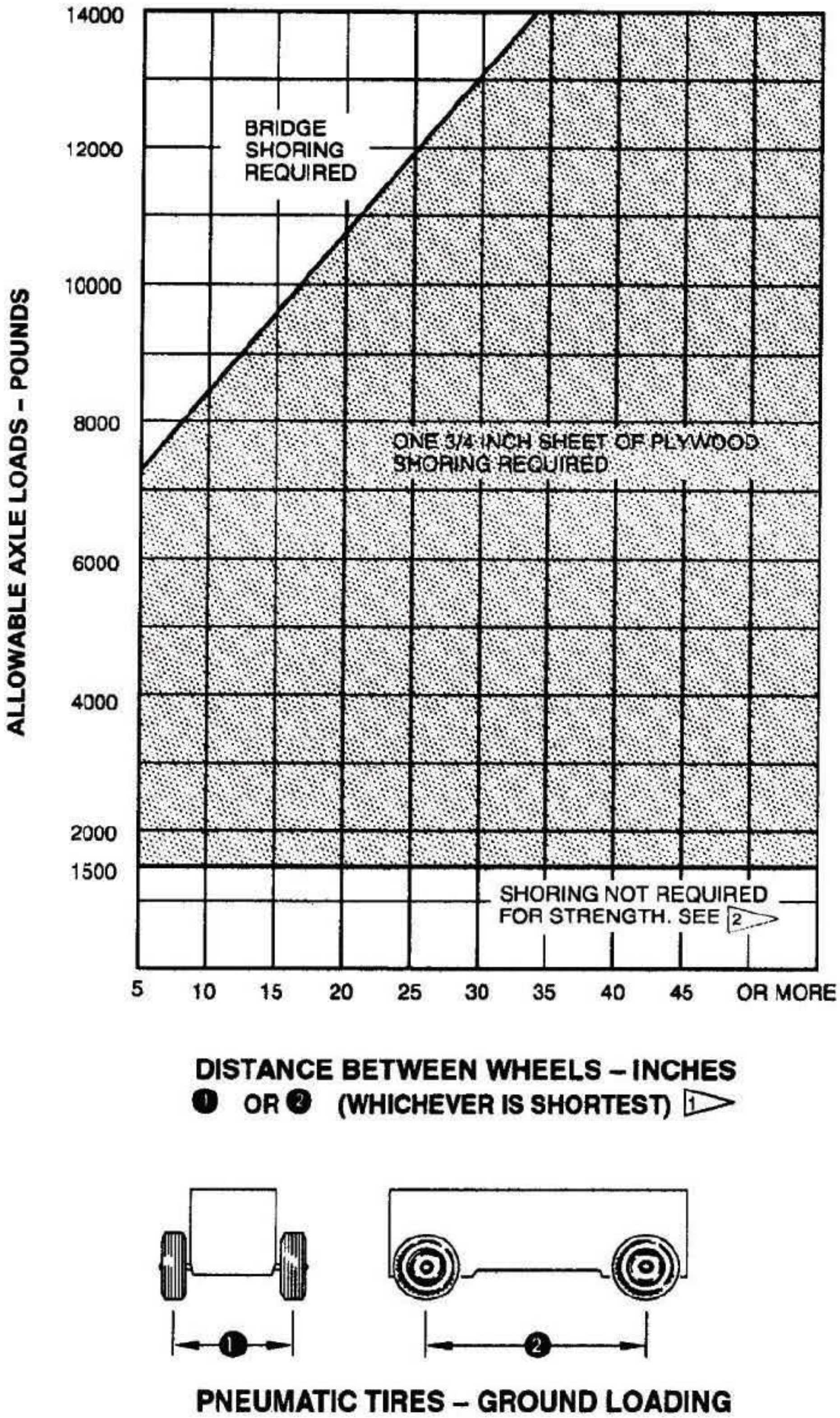
1. This area is the total contact area of all cargo placed next to each other on the cargo floor.
2. This is the total weight of all cargo placed over the contact area.
3. For loads of less than 1.5 square feet and 200 pounds (shaded area), see figure 4-27 for allowable load limitations.

CAUTION

- Do not exceed compartment load limits given in table 4-2.
- Do not exceed 1600 pounds per square foot for ground loading.

FIGURES B-149. Large area loads (greater than 1.5 square feet)

KC-135 Pneumatic Tire Limits (Ground Loading)

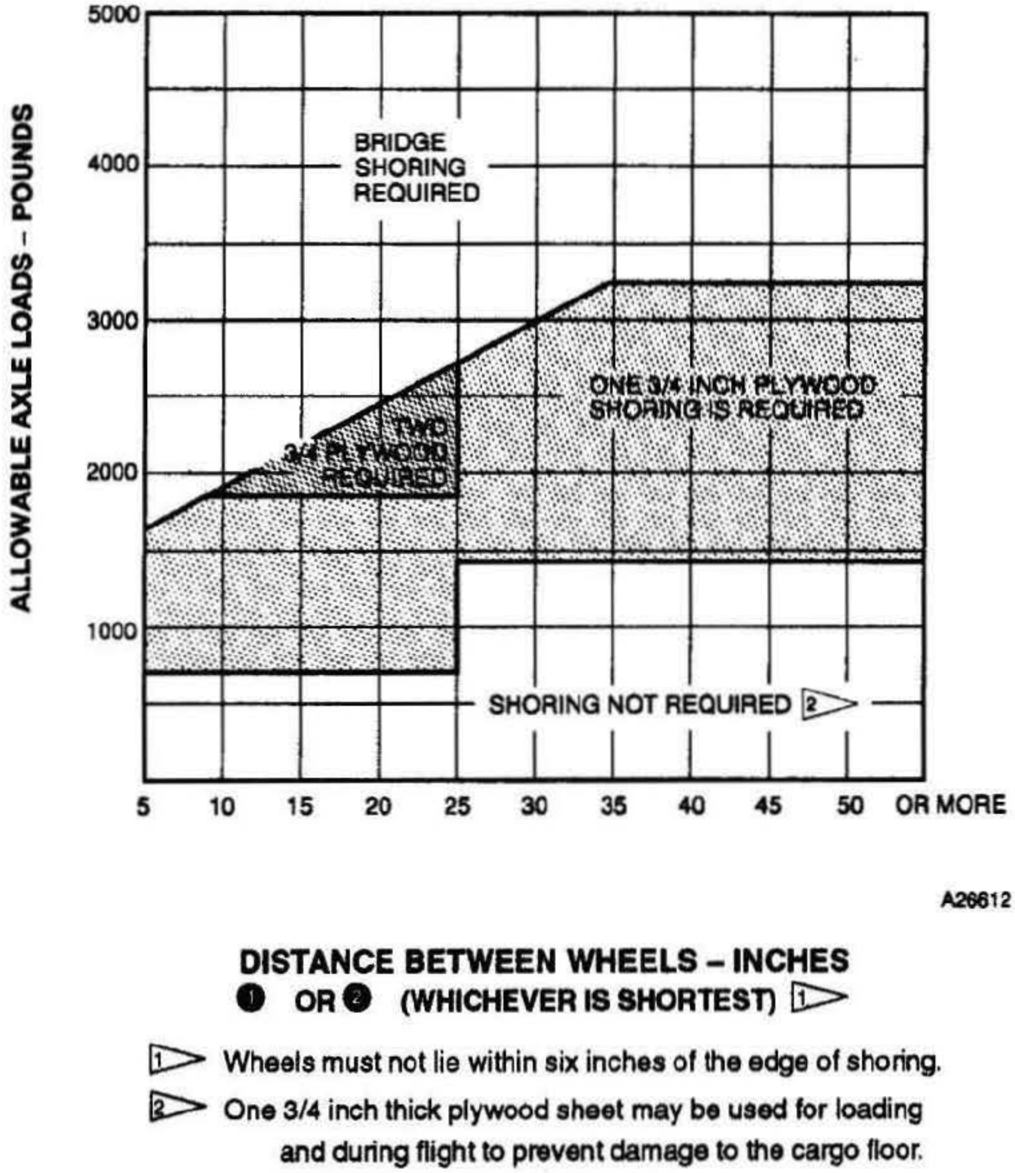


1 Pneumatic tires must not lie within six inches of the edge of the shoring.

2 One ¾ inch thick plywood sheet may be used for loading and during flight to prevent damage to the cargo floor.

FIGURE B-150. Allowable axle loads for pneumatic tires (sheet 1 of 2)

KC-135 Pneumatic Tire Limits (Flight Loading)



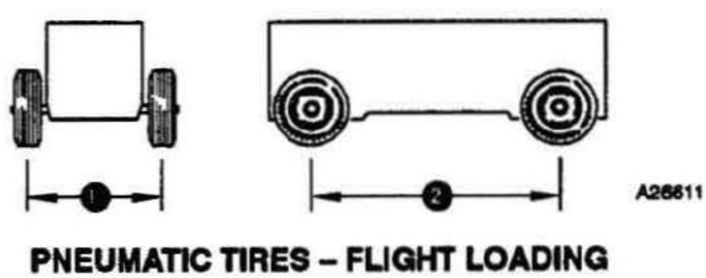


FIGURE B-150. Allowable axle loads for pneumatic tires (sheet 2) - continued

KC-135 Steel/Hard Rubber Wheel Limits

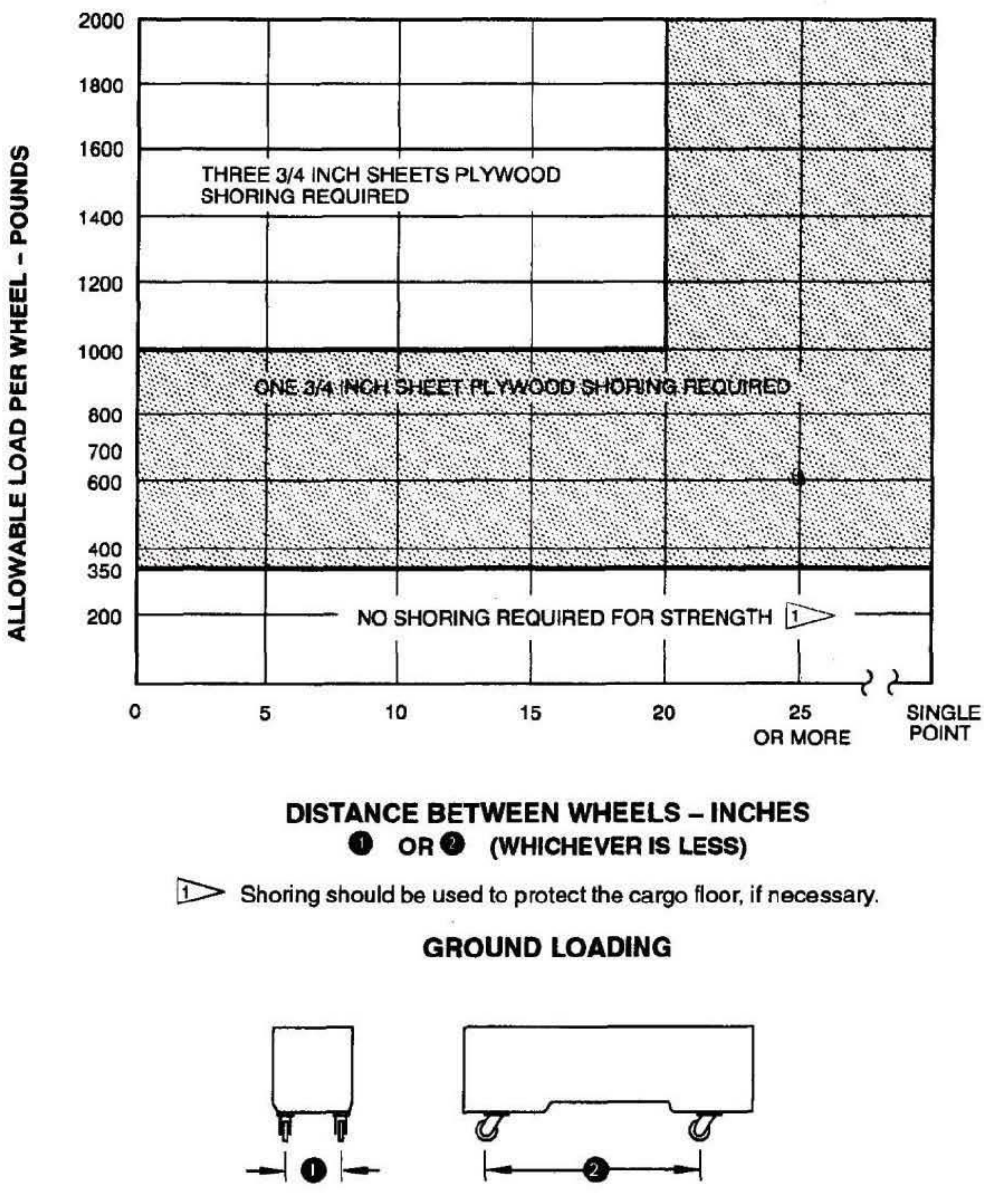


FIGURE B-151. Allowable load for hard rubber and steel wheels (sheet 1 of 2)

KC-135 Steel/Hard Rubber Wheel Limits

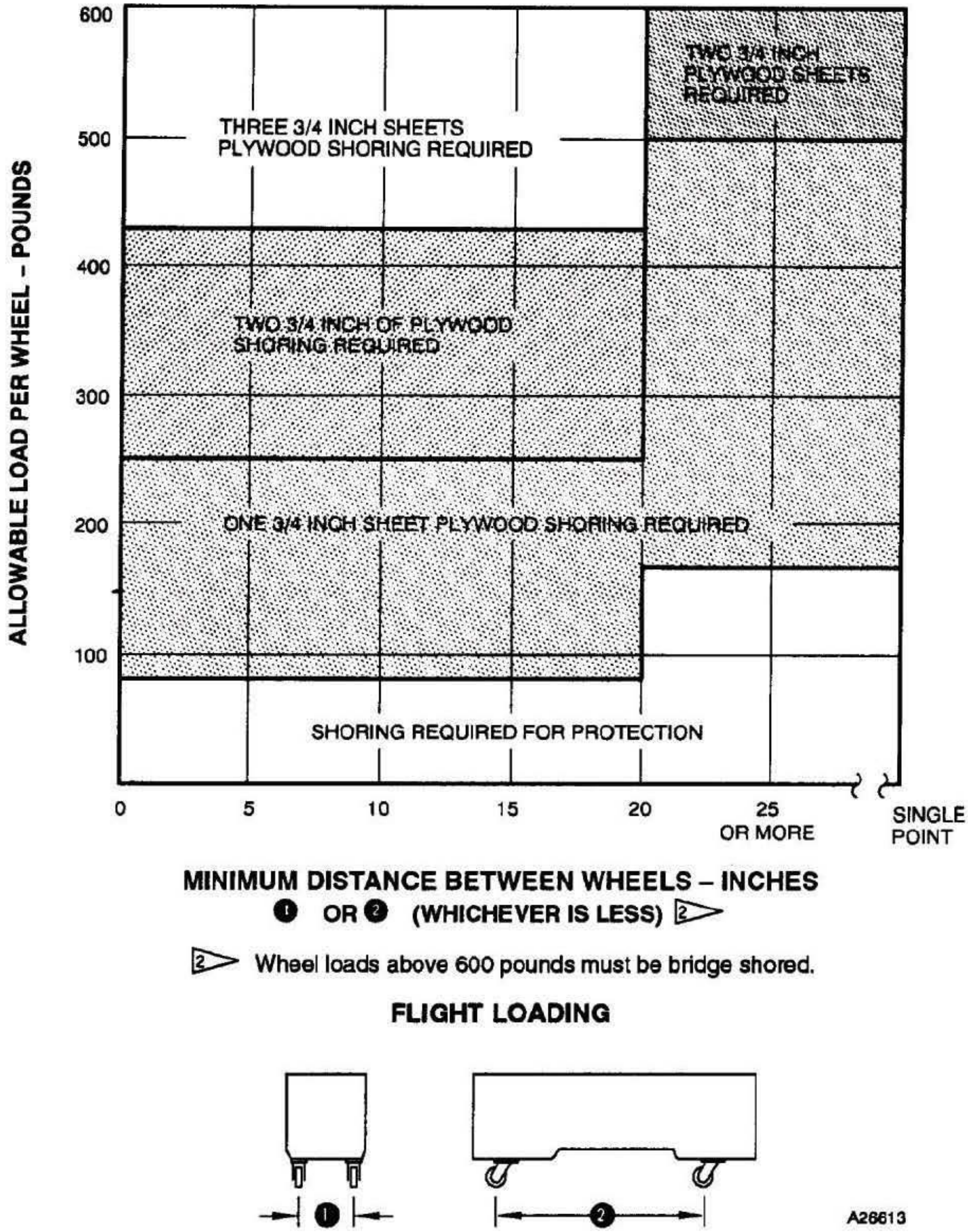


FIGURE B-151. Allowable load for hard rubber and steel wheels (sheet 2) - continued

KC-135 Palletized Cargo CG Limits

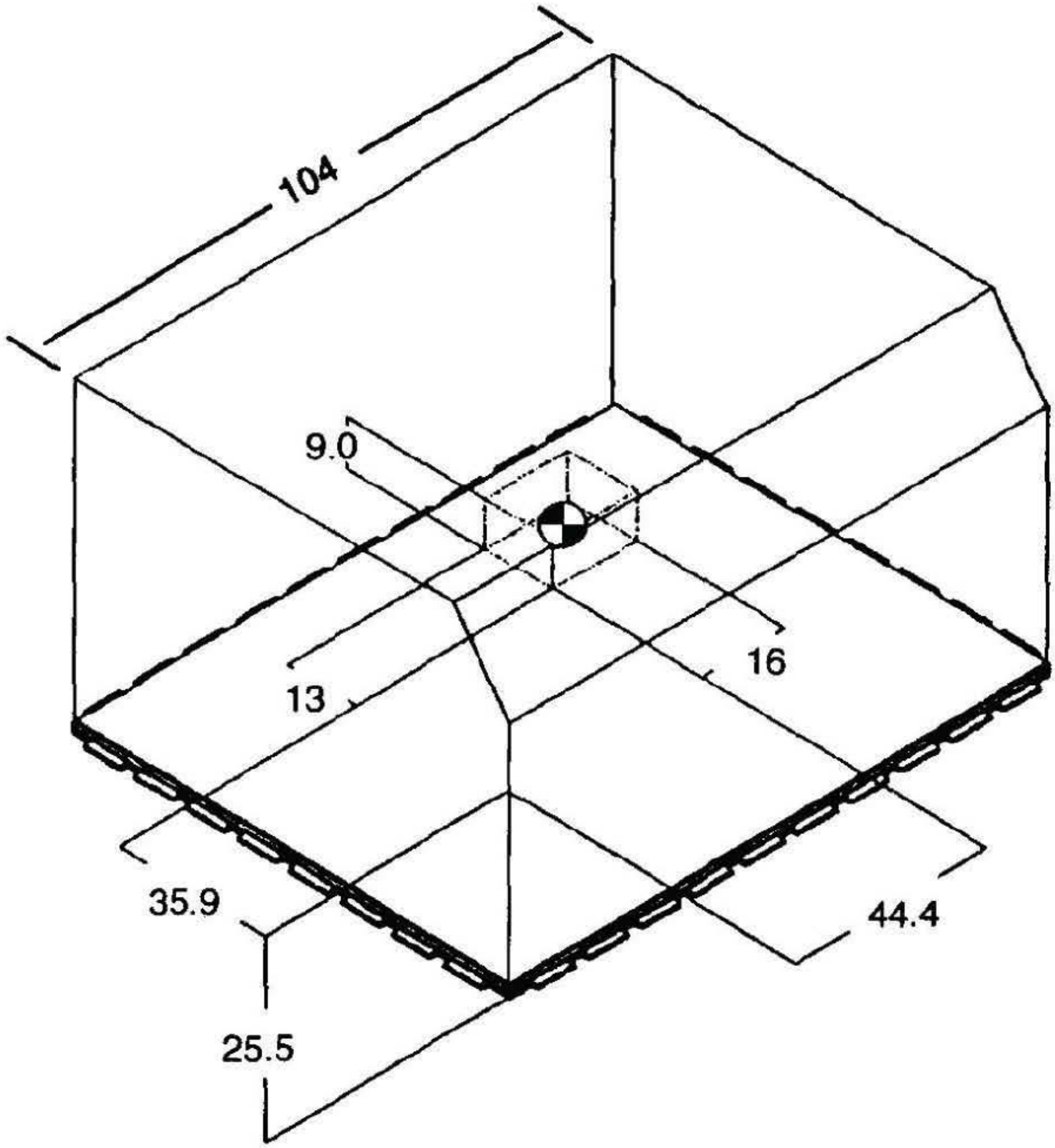


FIGURE 152. KC-135 pallet CG requirements

TANKER

FIGURE B-153. Loading data - 25 pallet all-cargo configuration

PALLET POSITIONS (FLOOR MARKINGS) LEFT OR RIGHT	REFERENCE DATA				(3) COMPARTMENT LOAD LIMITATIONS		MAXIMUM AXLE AND WHEEL WEIGHTS (2) FOR VEHICLES, PNEUMATIC (3) TIRES (LBS)		PALLET POSITIONS (FLOOR MARKINGS) LEFT OR RIGHT
					MAXIMUM FLOOR LOADING (LBS/LINEAR FOOT)	MAXIMUM TOTAL COMPARTMENT LOAD (LBS) LEFT OR RIGHT	(4) FLIGHT		
	CENTROID	VOLUME (CUBIC FEET)	FORWARD LIMIT STATION	AFT LIMIT STATION	FLIGHT	FLIGHT (5)	MAXIMUM TIRE	MAXIMUM AXLE (7)	
1	575	356	521	630	738	6,500	-	-	1
2	684	468	630	739	738	6,500	2,250	4,500	2
3	793	468	739	848	738	6,500	2,250	4,500	3
4	902	468	848	957	738	6,500	2,250	4,500	4
5	1,011	468	957	1,066	738	6,500	2,250	4,500	5
6	1,120	468	1,066	1,175	888	6,500	2,400	4,800	6
7	1,229	468	1,175	1,284	1,452	10,000	1,600	3,200	7
8	1,338	468	1,284	1,393	1,452	10,000	1,600	3,200	8
9	1,447	468	1,393	1,502	1,452	10,000	1,600	3,200	9
10	1,556	468	1,502	1,611	1,368	10,000	2,000	4,000	10
11	1,665	395	1,611	1,720	1,110	10,000	2,000	4,000	11
12	1,774	395	1,720	1,829	738	6,500	2,000	4,000	12
(1) 13	1,883	371	1,829	1,937	738	6,500	2,000	4,000	13

NOTES:

(1) COMPARTMENT 13 PERTAINS TO LEFT SIDE ONLY.

(2) WHEELS MUST BE 48 INCHES APART. THESE ALLOWABLES ARE FOR ANY LOCATION ON THE PALLET. SEE FIGURE 4-21 FOR OTHER CONDITIONS. TREAT DUAL WHEELS AS ONE WHEEL.

(3) THE MAXIMUM WEIGHT FOR LOADING/OFF-LOADING FOR ALL PALLET POSITIONS IS; 1452 POUNDS PER LINEAR FOOT; 10,000 POUNDS TOTAL WEIGHT PER COMPARTMENT; 3,000 POUND WHEEL LOAD; 6,000 POUND AXLE LOAD.

(4) SPECIFIC VEHICLES WITH LARGER AXLE LOADS MAY BE TRANSPORTED IN SPECIAL LOCATIONS (SEE SECTION V).

(5) WHEN PALLET POSITION 10L OR R CONTAINS CONCENTRATED LOADS, THE MAXIMUM COMPARTMENT GROSS WEIGHT IS 7,000 LBS. WHEN LOADED EXCLUSIVELY WITH A UNIFORM LOAD, PALLET POSITIONS 10L OR R MAY BE LOADED TO THE PLF LIMITATION NOT TO EXCEED THE MAXIMUM COMPARTMENT GROSS WEIGHT OF 10,000 POUNDS.

(6) WHEN PALLET POSITION 11L OR R CONTAINS CONCENTRATED LOADS, THE MAXIMUM COMPARTMENT GROSS WEIGHT IS 7,500 LBS. WHEN LOADED EXCLUSIVELY WITH A UNIFORM LOAD, PALLET POSITIONS 11L OR R MAY BE LOADED TO THE PLF LIMITATION NOT TO EXCEED THE MAXIMUM COMPARTMENT GROSS WEIGHT OF 10,000 POUNDS.

(7) WHEN LOADED EXCLUSIVELY WITH AXLE LOADS THE MAXIMUM COMPARTMENT GROSS WEIGHT FOR PALLET POSITIONS 10L OR R AND 11L OR R IS 8,000 POUNDS PROVIDED THE AXLES ARE SEPARATED BY 48 INCHES OR MORE. HOWEVER, BECAUSE THE AXLE LIMIT COULD BE LESS, REFER TO FIGURE 4-21.

TANKER

PALLET POSITIONS (FLOOR MARKINGS) (1)	REFERENCE DATA				COMPARTMENT LOAD LIMITATIONS (3)		MAXIMUM AXLE AND WHEEL WEIGHTS (2) FOR VEHICLES, PNEUMATIC (3) TIRES (LBS)		PALLET POSITIONS (FLOOR MARKINGS) (1)
					MAXIMUM FLOOR LOADING (LBS/LINEAR FOOT)	MAXIMUM TOTAL COMPARTMENT LOAD (LBS)	(4) FLIGHT		
	CENTROID	VOLUME CUBIC FEET)	FORWARD LIMIT STATION	AFT LIMIT STATION	FLIGHT	FLIGHT (5)	MAXIMUM TIRE	MAXIMUM AXLE (7)	
1L	577	356	523	632	738	6,500	-	-	1L
2L	676	423	632	721	738	5,400	2,250	4,500	2L
3L	765	423	721	810	738	5,400	2,250	4,500	3L
4L	854	423	810	899	738	5,400	2,250	4,500	4L
5L	943	423	899	988	738	5,400	2,250	4,500	5L
6L	1,032	423	988	1,077	738	5,400	2,250	4,500	6L
7L	1,121	423	1,077	1,166	888	6,500	2,400	4,800	7L
8L	1,210	423	1,166	1,255	1,452	10,000	1,600	3,200	8L
9L	1,299	423	1,255	1,344	1,452	10,000	1,600	3,200	9L
10L	1,388	423	1,344	1,433	1,452	10,000	1,600	3,200	10L
11L	1,477	423	1,433	1,522	1,452	10,000	1,600	3,200	11L
12L	1,566	423	1,522	1,611	1,368	10,000	2,000	4,000	12L
13L	1,665	395	1,611	1,720	1,110	10,000	2,000	4,000	13L
14L	1,774	395	1,720	1,829	738	6,500	2,000	4,000	14L
15L	1,883	371	1,829	1,937	738	6,500	2,000	4,000	15L

NOTES:

(1) THIS FIGURE INCLUDES DATA FOR THE LEFT SIDE OF THE AIRCRAFT ONLY. REFER TO FIGURE 4-7 FOR THE RIGHT SIDE.

(2) WHEELS MUST BE 48 INCHES APART. THESE ALLOWABLES ARE FOR ANY LOCATION ON THE PALLET. SEE FIGURE 4-21 FOR OTHER CONDITIONS TREAT DUAL WHEELS AS ONE WHEEL.

(3) THE MAXIMUM WEIGHT FOR LOADING/OFF-LOADING FOR ALL PALLET POSITIONS IS; 1452 POUNDS PER LINEAR FOOT; 10,000 POUNDS TOTAL WEIGHT PER COMPARTMENT; 3,000 POUND WHEEL LOAD; 6,000 POUND AXLE LOAD.

(4) SPECIFIC VEHICLES WITH LARGER AXLE LOADS MAY BE TRANSPORTED IN SPECIAL LOCATIONS (SEE SECTION V).

(5) WHEN PALLET POSITION 11L OR 12L CONTAINS CONCENTRATED LOADS, THE MAXIMUM COMPARTMENT GROSS WEIGHT IS 7,000 LBS. WHEN LOADED EXCLUSIVELY WITH A UNIFORM LOAD, PALLET POSITIONS 11L OR 12L MAY BE LOADED TO THE PLF LIMITATION NOT TO EXCEED THE MAXIMUM COMPARTMENT GROSS WEIGHT OF 10,000 POUNDS.

(6) WHEN PALLET POSITION 13L CONTAINS CONCENTRATED LOADS, THE MAXIMUM COMPARTMENT GROSS WEIGHT IS 7,500 LBS. WHEN LOADED EXCLUSIVELY WITH A UNIFORM LOAD, PALLET POSITION 13L MAY BE LOADED TO THE PLF LIMITATION NOT TO EXCEED THE MAXIMUM COMPARTMENT GROSS WEIGHT OF 10,000 POUNDS.

(7) WHEN LOADED EXCLUSIVELY WITH AXLE LOADS THE MAXIMUM COMPARTMENT GROSS WEIGHT FOR PALLET POSITIONS 11L, 12L AND 13L IS 8,000 POUNDS PROVIDED THE AXLES ARE SEPARATED BY 48 INCHES OR MORE. HOWEVER, BECAUSE THE AXLE LIMIT COULD BE LESS, REFER TO FIGURE 4-21.

FIGURE B-154. Loading data - lateral loading (left side of aircraft)

KC-10 Weight Limits

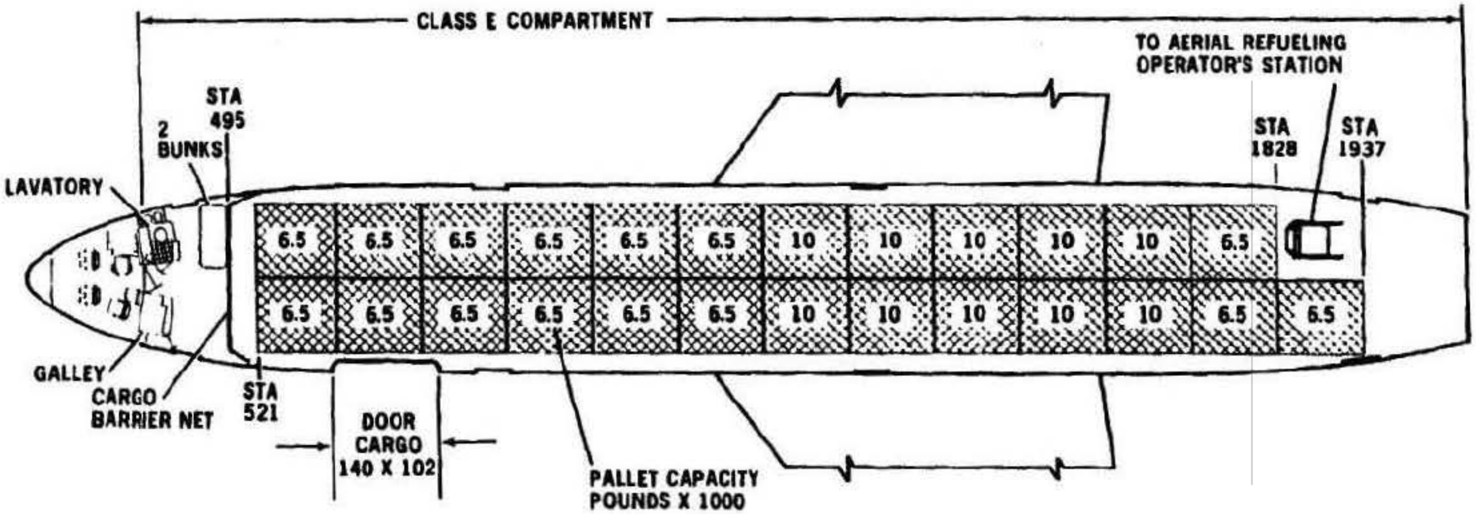
ALLOWABLE AXLE WEIGHT ON HCU-6/E PALLETS

DISTANCE BETWEEN WHEELS (INCHES)	PALLET POSITIONS/COMPARTMENT ALLOWABLE WEIGHT (POUNDS)			
	B C D E / BB CC DD EE FF	F / GG	G H J / HH JJ KK LL	K L M N / MM NN PP RR
8	2,250	2,400	1,600	2,000
9	2,306	2,460	1,640	2.050
10	2,362	2,520	1,680	2,100
11	2,419	2,580	1,720	2.150
12	2,475	2,640	1,760	2,200
13	2,531	2,700	1,800	2,250
14	2,587	2,760	1,840	2,300
15	2,644	2,820	1.880	2,350
16	2,700	2,880	1.920	2,400
17	2,756	2,940	1.960	2,450
18	2,812	3,000	2,000	2,500
19	2,869	3,060	2,040	2,550
20	2,925	3,120	2,080	2,600
21	2,981	3,180	2,120	2,650
22	3,037	3,240	2.160	2,700
23	3,094	3,300	2,200	2,750
24	3,150	3,360	2,240	2,800
25	3,206	3,420	2,280	2,850
26	3,262	3,480	2,320	2,900
27	3,319	3,540	2,360	2,950
28	3,375	3,600	2,400	3,000
29	3,431	3,660	2.440	3,050
30	3.487	3,720	2,480	3,100
31	3,544	3,780	2,520	3,150
32	3,600	3,840	2,560	3,200
33	3,656	3,900	2,600	3,250
34	3,712	3,960	2.640	3,300
35	3,769	4,020	2.680	3,350
36	3,825	4,080	2,720	3,400
37	3,881	4,140	2,760	3.450
38	3,938	4,200	2,800	3,500
39	3,994	4,260	2,840	3,550
40	4,050	4,320	2,880	3,600
41	4,106	4,380	2,920	3,650
42	4,162	4,440	2,960	3.700
43	4,219	4,500	3,000	3,750
44	4,275	4,560	3,040	3.800
45	4.331	4,620	3,080	3,850
46	4,387	4,680	3,120	3,900
47	4,444	4,740	3,160	3.950
48	4,500	4,800	3,200	4,000

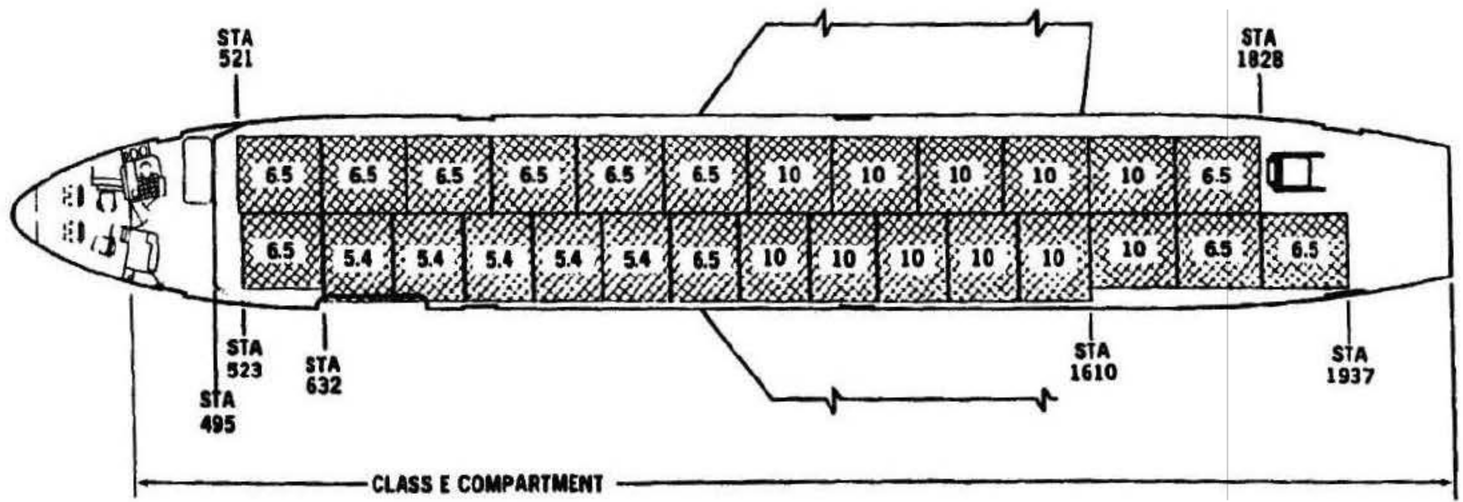
AXLE LOADS

1. USE LESSER OF TREAD OR WHEELBASE.
2. CHECK BOTH AXLES TO DETERMINE ACCURATE TREAD DIMENSION.
3. TREAT DUAL WHEELS AS ONE WHEEL.
4. ZONE LOAD LIMITATIONS AND COMPARTMENT LOAD LIMITATIONS MUST ALSO BE COMPLIED WITH.
5. FOR SINGLE WHEELS USE ONE-HALF OF VALUES LISTED ABOVE. USE 8-INCH LINE WHEN WHEELS ARE LESS THAN 8 INCHES APART (LATERALLY OR LONGITUDINALLY).
6. WHEEL TREAD MEASUREMENTS WILL BE TAKEN FROM THE MIDDLE OF THE TIRE, DUAL WHEELS WILL BE MEASURED FROM THE MIDDLE OF THE TWO TIRES.
7. REFER TO SECTION 5F FOR CENTERLINE LOADED VEHICLES.

FIGURE B-155. Vehicle axle weight limitations

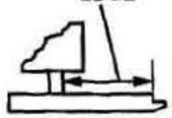
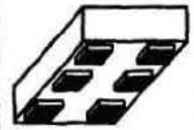
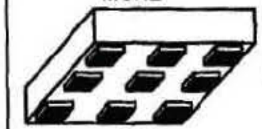


25-PALLET ALL-CARGO ARRANGEMENT (CODE E)



27-PALLET ALL-CARGO ARRANGEMENT (CODE E)

FIGURE B-156. Pallet load limitations

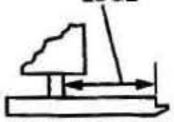
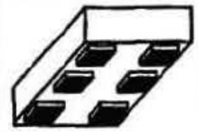
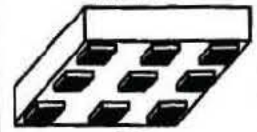
PALLET POSITION L OR R	SET BACK REQUIREMENT  EDGE, HCU-6/E PALLET, FWD AND AFT	NET WEIGHT LIMIT PER ITEM: ANY CONFIGURATION OF CONTACT POINTS OR SKIDS (1)	6 CONTACT POINTS  OR 2 SKIDS  (2)	9 CONTACT POINTS OR MORE  OR 3 SKIDS OR MORE  (3)	PALLET MAXIMUM WEIGHT	PALLET POSITION L OR R
1	NONE	1,600	1,700	2,200	6500	1
2, 3	NONE	3,800	3,800	5,700	6500	2, 3
4	NONE	5,200	6,100	6,100	6500	4
5	NONE	3,800	5,800	6,100	6500	5
6	< 10 INCHES	2,500	3,600	4,000	6500	6
	≥ 10 INCHES	4,000	5,800	6,100	6500	
7, 8	< 10 INCHES	1,800	3,700	4,400	10000	7, 8
	≥ 10 INCHES	2,500	5,000	5,900	10000	
9	NONE	2,500	5,000	5,900	10000	9
10	NONE	4,700	6,600	6,600	7000	10
11	NONE	4,000	6,100	6,100	7500	11
12	NONE	4,300	6,100	6,100	6500	12
13	NONE	6,100	6,100	6,100	6500	13

NOTES

1. IF TYPE AND NUMBER OF SUPPORTS CANNOT BE DETERMINED, USE COLUMN 1.
2. IF THE ITEM OF CARGO IS LESS THAN 20 INCHES WIDE, USE ONE-HALF OF THE ABOVE LISTED LOADS.
3. WHEN PALLET POSITION 10L OR R CONTAINS CONCENTRATED LOADS, THE MAXIMUM COMPARTMENT GROSS WEIGHT IS 7,000 LBS. WHEN LOADED EXCLUSIVELY WITH A UNIFORM LOAD, PALLET POSITIONS 10L OR R MAY BE LOADED TO THE PLF LIMITATION NOT TO EXCEED THE MAXIMUM COMPARTMENT GROSS WEIGHT OF 10,000 POUNDS.
4. WHEN PALLET POSITION 11L OR R CONTAINS CONCENTRATED LOADS, THE MAXIMUM COMPARTMENT GROSS WEIGHT IS 7,500 LBS. WHEN LOADED EXCLUSIVELY WITH A UNIFORM LOAD, PALLET POSITIONS 11L OR R MAY BE LOADED TO THE PLF LIMITATION NOT TO EXCEED THE MAXIMUM COMPARTMENT GROSS WEIGHT OF 10,000 POUNDS.
5. WHEN LOADED WITH AXLE LOADS THE MAXIMUM COMPARTMENT GROSS WEIGHT FOR PALLET POSITIONS 10L OR R AND 11L OR R IS 8,000 POUNDS PROVIDED THE AXLES ARE SEPARATED BY 48 INCHES OR MORE. HOWEVER, BECAUSE THE AXLE LIMIT COULD BE LESS, REFER TO FIGURE 4-21

TANKER

FIGURE B-157. Concentrated load limitations - 25-pallet all-cargo configuration

PALLET POSITION	SET BACK REQUIREMENT	NET WEIGHT LIMIT PER ITEM			PALLET MAXIMUM WEIGHT	PALLET POSITION
	EDGE  HCU-6/E PALLET ← → FWD AND AFT	ANY CONFIGURATION OF CONTACT POINTS OR SKIDS	6 CONTACT POINTS  OR 2 SKIDS 	9 CONTACT POINTS OR MORE  OR 3 SKIDS OR MORE 		
		1	2	3		
1L	NONE	1,600	1,700	2,200	6,500	1L
2L, 3L, 4L	NONE	3,800	3,800	5,000	5,400	2L, 3L, 4L
5L	NONE	3,800	5,000	5,000	5,400	5L
6L, 7L	< 10 INCHES	2,500	3,600	4,000	5,400 (6L)	6L, 7L
	≥ 10 INCHES	4,000	5,000	5,000	6,500 (7L)	
8L, 9L, 10L	< 10 INCHES	1,800	3,700	4,400	10000	8L, 9, 10L
	≥ 10 INCHES	2,500	5,000	5,900		
11L	NONE	2,500	5,000	5,900	7,000	11L
12L	NONE	4,700	6,600	6,600	7,000	12L
13L	NONE	4,000	6,100	6,100	7,500	13L
14L	NONE	4,300	6,100	6,100	6,500	14L
15L	NONE	6,100	6,100	6,100	6,500	15L

NOTES

1. IF TYPE AND NUMBER OF SUPPORTS CANNOT BE DETERMINED, USE COLUMN 1.
2. IF THE ITEM OF CARGO IS LESS THAN 20 INCHES WIDE, USE ONE-HALF OF THE ABOVE LISTED LOADS.
3. WHEN PALLET POSITION 10L OR R CONTAINS CONCENTRATED LOADS, THE MAXIMUM COMPARTMENT GROSS WEIGHT IS 7,000 LBS. WHEN LOADED EXCLUSIVELY WITH A UNIFORM LOAD, PALLET POSITIONS 10L OR R MAY BE LOADED TO THE PLF LIMITATION NOT TO EXCEED THE MAXIMUM COMPARTMENT GROSS WEIGHT OF 10,000 POUNDS.
4. WHEN PALLET POSITION 11L OR R CONTAINS CONCENTRATED LOADS, THE MAXIMUM COMPARTMENT GROSS WEIGHT IS 7,500 LBS. WHEN LOADED EXCLUSIVELY WITH A UNIFORM LOAD, PALLET POSITIONS 11L OR R MAY BE LOADED TO THE PLF LIMITATION NOT TO EXCEED THE MAXIMUM COMPARTMENT GROSS WEIGHT OF 10,000 POUNDS.
5. WHEN LOADED WITH AXLE LOADS THE MAXIMUM COMPARTMENT GROSS WEIGHT FOR PALLET POSITIONS 10L OR R AND 11L OR R IS 8,000 POUNDS PROVIDED THE AXLES ARE SEPARATED BY 48 INCHES OR MORE. HOWEVER, BECAUSE THE AXLE LIMIT COULD BE LESS, REFER TO FIGURE 4-21

FIGURE B-158. Concentrated load limitations - lateral loading (left side of aircraft)

Restraint

KC-135 Tiedown Rings

The KC-135 uses removable tiedown rings. Five and ten thousand capacity fittings engage the aircraft floor. 1,250 pound capacity fittings engage the seat restraint studs when the seats are not installed.

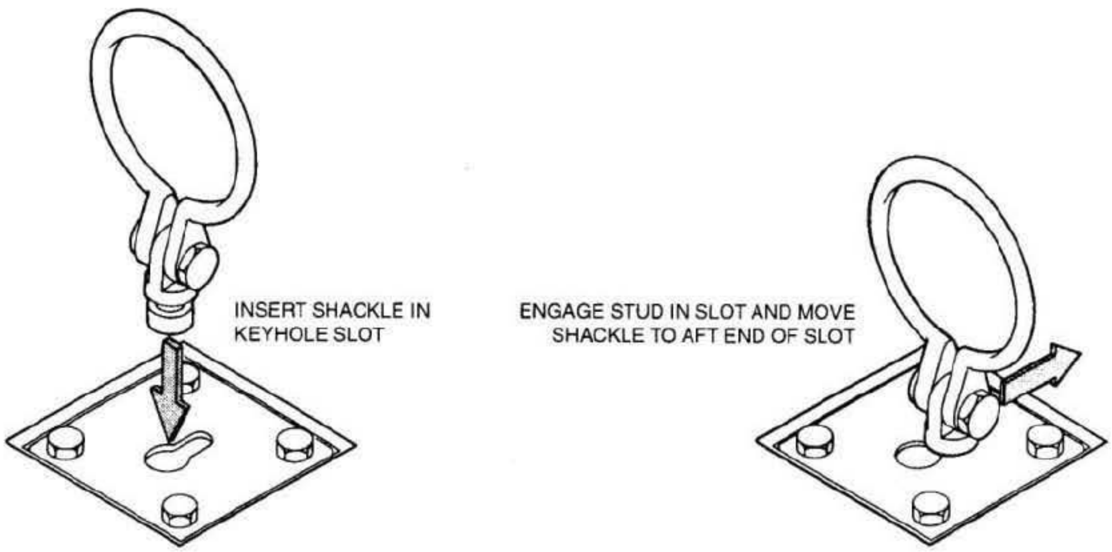
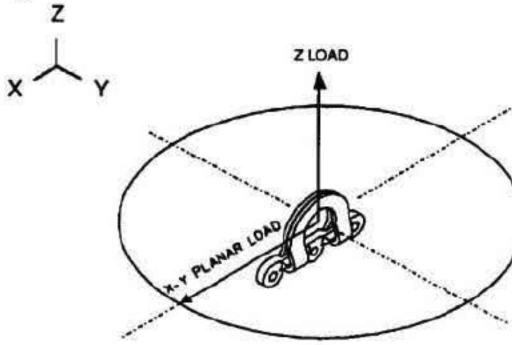


FIGURE B-159. Installation of tiedown shackles 5000 and 10,000 pound capacity

KC-135 Tiedown Rings



ASSEMBLY NUMBER	DESCRIPTION	FLOOR FITTING BODY STATION	MAX LOAD X–Y PLANE	MAX LOAD Z–DIR.
9330058-1	Restraint Assembly, Omni Roller, Aft	440-460	5500	4200
9330058-2	Restraint Assembly, Omni Roller, Forward	480-500, 520-540	5500	4200
93300580-1	Restraint Assembly, Right-hand	Rt Side of Acft	5500	4200
93300605-1	Restraint Assembly, Right-hand, Fus. Sta. 780 & 880	Rt Side of Acft	5500	4200
93300605-2	Restraint Assembly, Right-hand, Fus. Sta. 840	Rt Side of Acft	5500	4200
93300623-1	Threshold Restraint Assembly, Forward	460-480	4800	4800
93300623-2	Threshold Restraint Assembly, Aft	500-520	4800	4800
93300628-1	Restraint Assembly, Left-hand, Long, Fus. Sta. 960 & 1060	960-1000, 1060-1100	6400	5600
93300628-2	Restraint Assembly, Left-hand, Long, Fus. Sta. 840	840-880	6400	5600
93300628-3	Restraint Assembly, Left-hand, Long, Fus. Sta. 640, 700 & 760	640-680, 700-740, 760-800	7200	5600
93300629-1	Restraint Assembly, Left-hand, Short, Fus. Sta. 600 & 920	600-620, 920-940	4900	5600
93300629-2	Restraint Assembly, Left-hand, Short, Fus. Sta. 1020	1020-1040	6400	5600
93300630-1	Restraint Assembly, Left-hand, Forward	540-580	5400	5600

FIGURE B-160. Allowable tiedown ring load rating (per ring)

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KC-10 Restraint

The KC-10 provides restraint with removable floor fittings. These are not available when nearby seat track is covered by pallets.

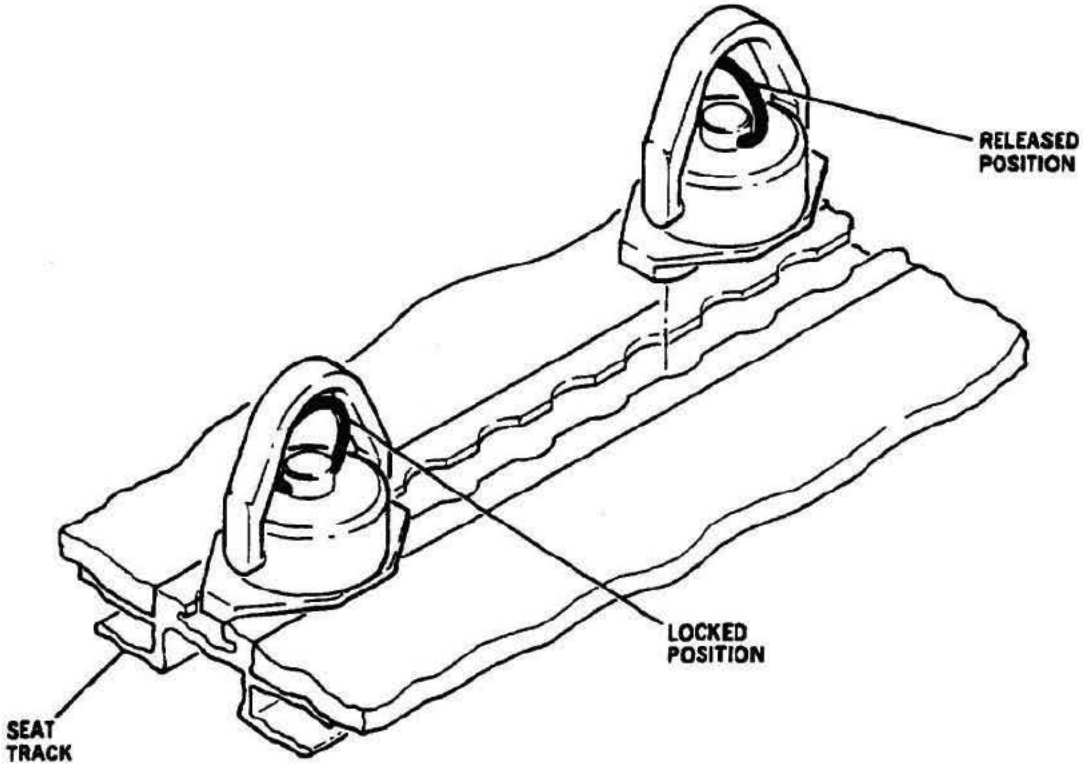


Figure A-7000 Tiedown Fitting

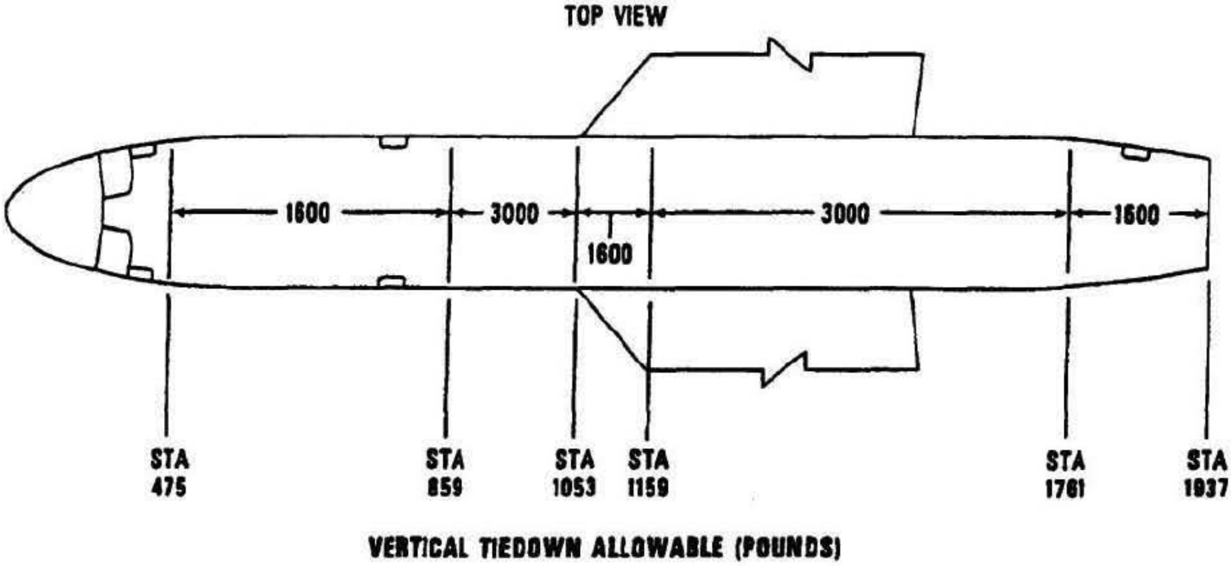
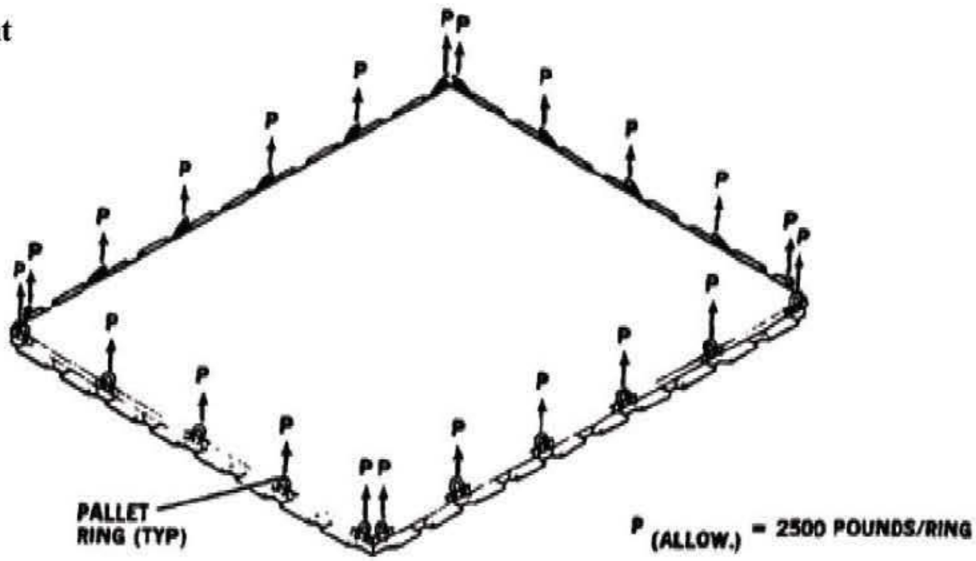
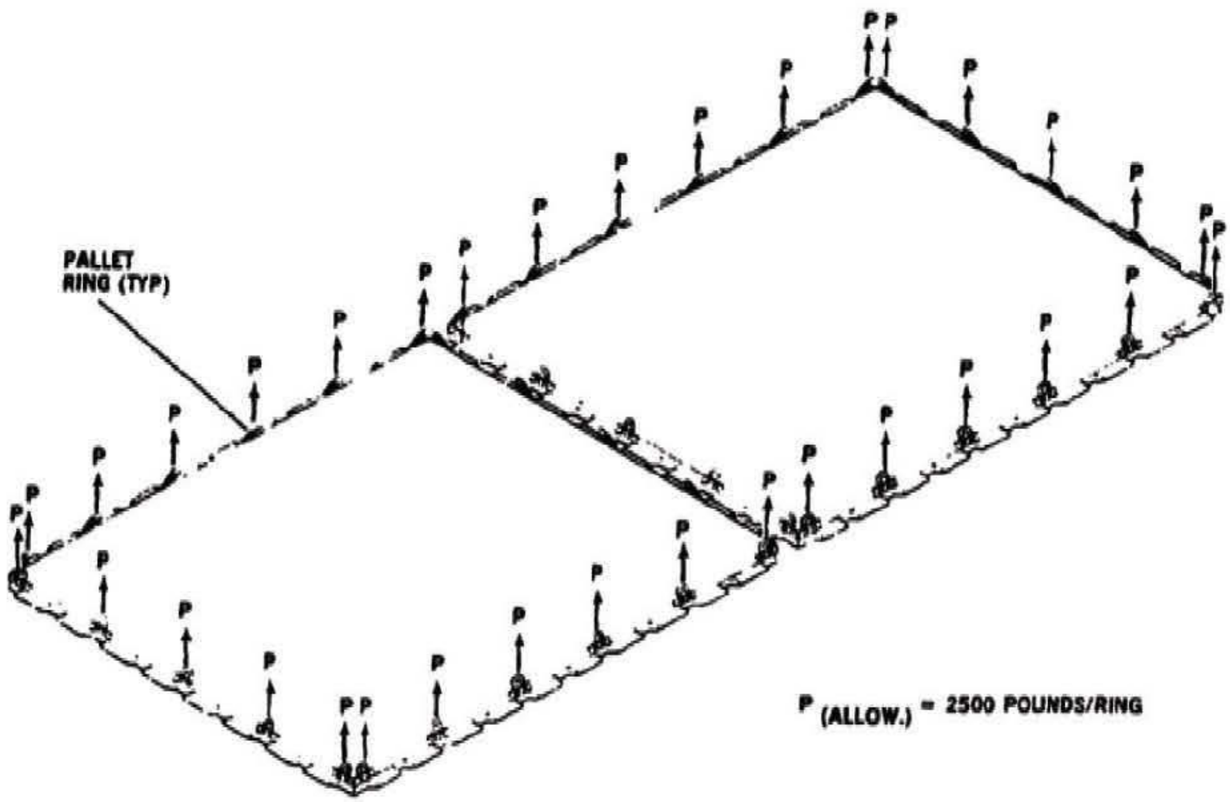


FIGURE B-161. A-7000 vertical tiedown allowables

KC-10 Restraint



SINGLE HCU-6/E PALLETS



COUPLED HCU-6/E PALLETS

FIGURE B-162. HCU-6/E pallet ring vertical allowables

Special Considerations

KC-10 Electrical Info

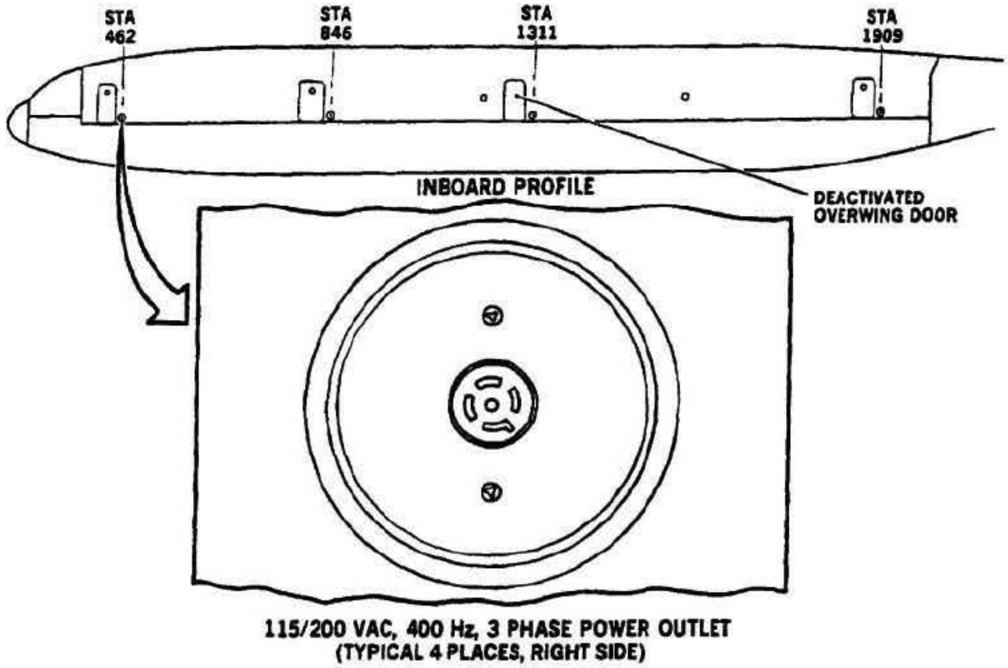


FIGURE B-163. Cargo compartment electrical outlets

Electrical power for the cargo compartment area during loading and offloading operations is normally supplied by the aircraft's auxiliary power unit (APU). If required, electrical power may be supplied by an external ground power source. The aircraft's normal 28VDC and 115/200 VAC, 400Hz, 3-phase electrical power system is contained in TO 1C-10(K)A-1.

The cargo compartment APU and external power control panel is located in the left-hand crew baggage compartment, inside the upper left stowage compartment, at station 420. Annunciator lights on the panel indicate availability of either power source. When the applicable power switch is moved to the ON position, the appropriate IN USE light will come on, indicating that electrical power is being supplied to the cargo compartment for the operation of the cargo door, cabin doors, lighting, powered rollers, and the cargo winch.

Circuit breakers for the cargo compartment electrical power supply are on three separate equipment service panels. Two panels are located overhead, behind ceiling doors, at station 516. The third service panel is located on the extreme upper left-hand side of the control panel in the ARO compartment. In the event of an isolated malfunction, the boom operator can reset the applicable circuit breaker or determine if maintenance is required.

Four 115/200 VAC, 400Hz, 3-phase power outlets are installed along the fight all of the cargo compartment, at approximately 10 inches above the floor, at stations 462, 846, 1311, and 1909. These outlets provide the electrical power required for operating the portable cargo winch. The locations of the four outlets allow the winch to be installed wherever required for loading and offloading operations.

KC-135 Venting Information

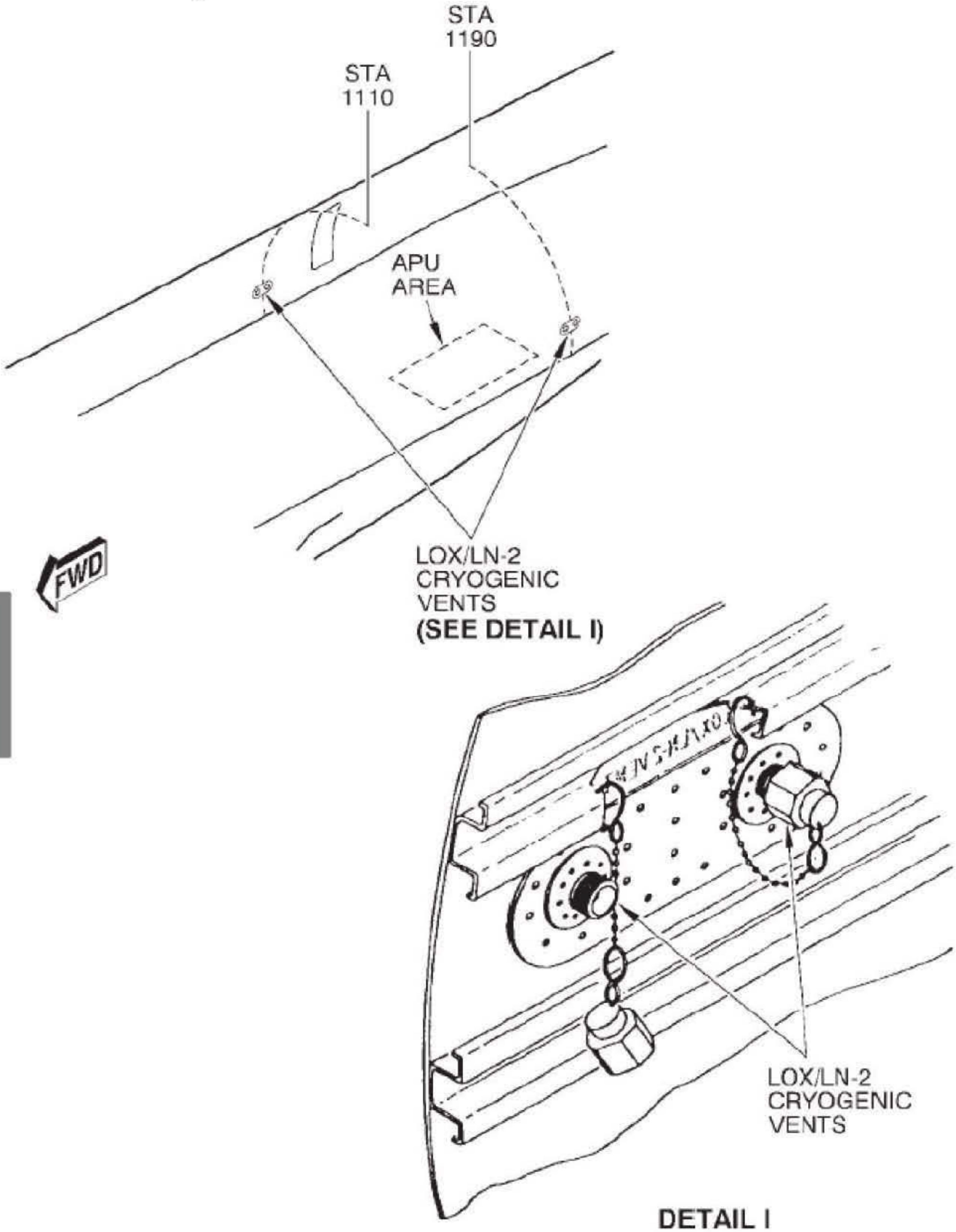


FIGURE B-164. KC-135 cryogenic vents

KC-10 Venting Information

CARGO COMPARTMENT CRYOGENIC VENT

A cryogenic vent (figure 2-6) is installed to provide venting of liquefied oxygen, nitrogen, and other liquefied gases carried in containers as cargo. It is an integral part of the fuselage structure, and is located on the left side at station 1149, approximately 10 inches above floor level. The vent assembly consists of an integrally-fitted vent tube, a recessed pan surrounding the tube, a hose adapter, a vent plug, and a coupling to retain either the hose adapter or plug in the vent.

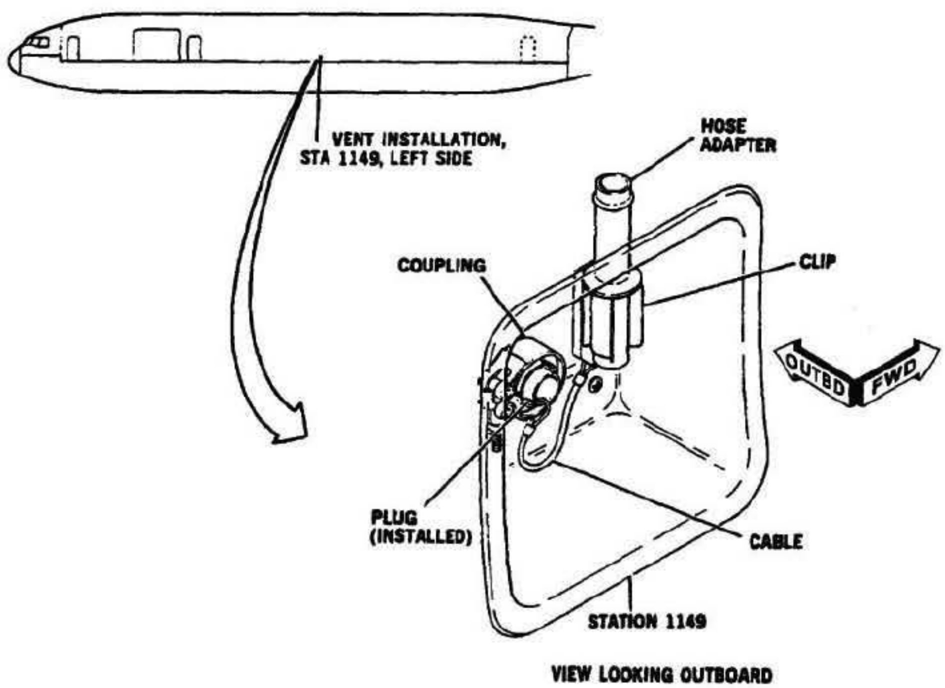


FIGURE B-165. Cargo compartment cryogenic vent

Special Loading and Flight Procedures

Winching

The KC-10 is equipped with a portable winch to aid in loading heavy pallets or vehicles.

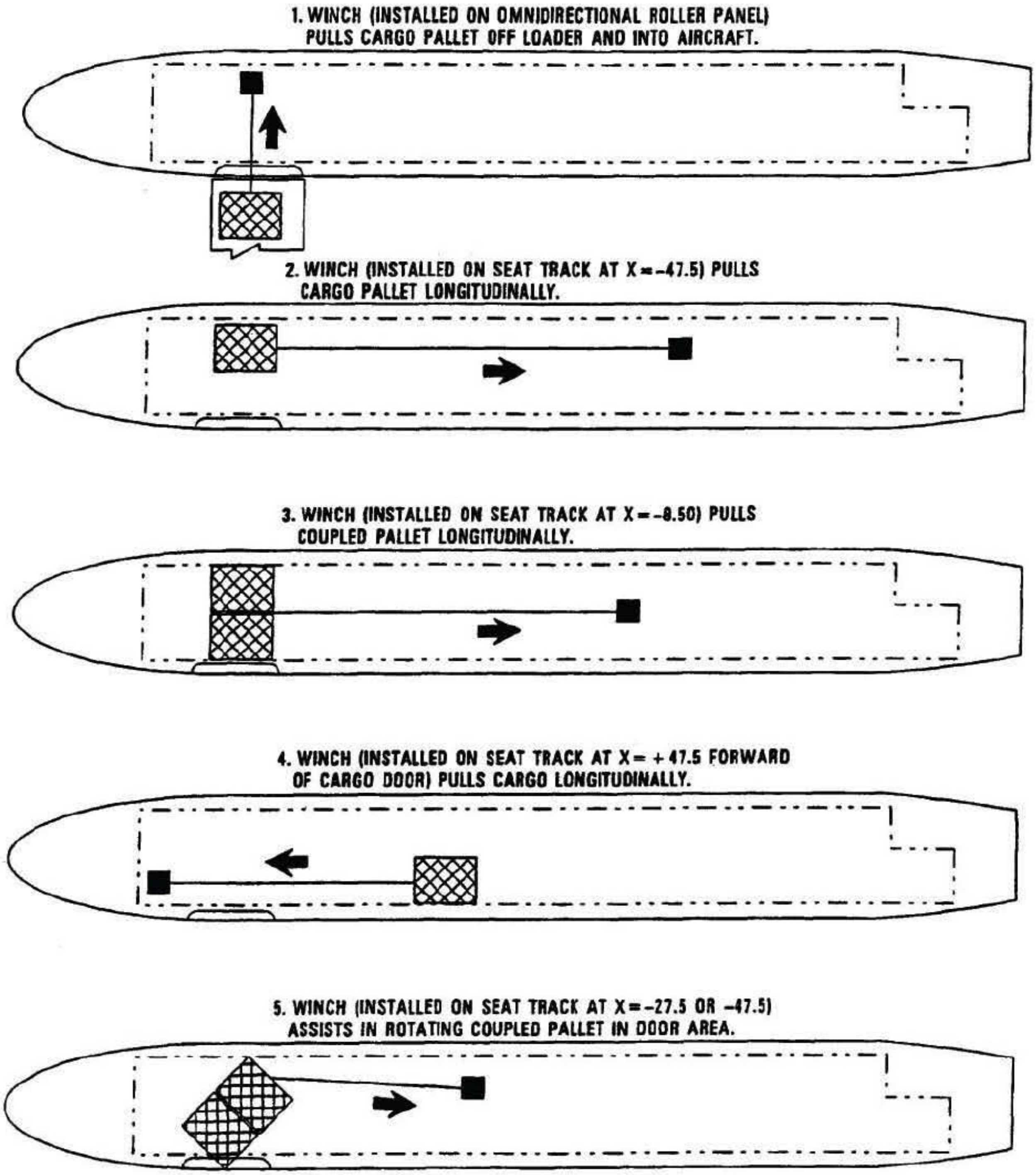


FIGURE B-166. Winching arrangements

KC-10 Winching

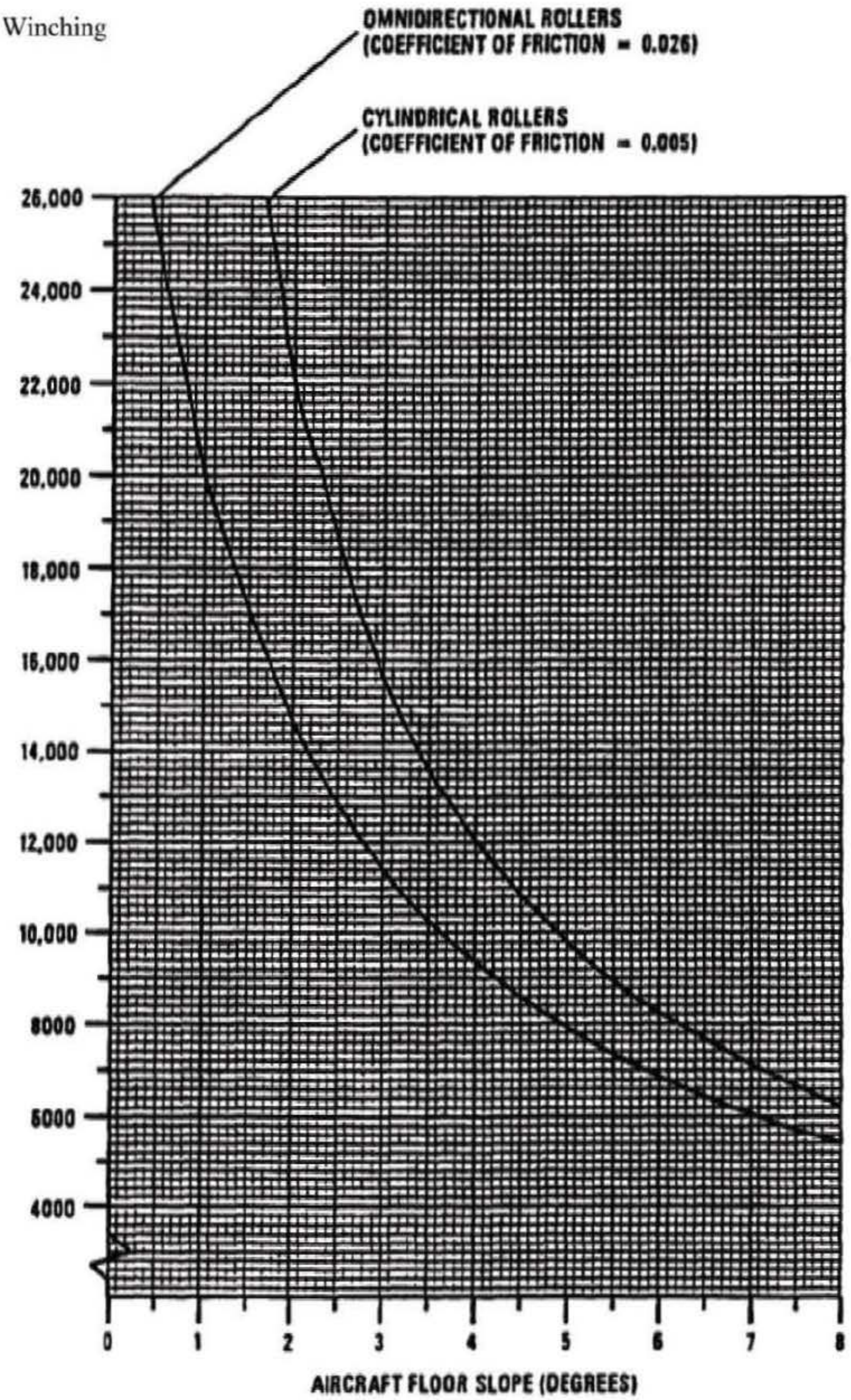


FIGURE B-167. Maximum capability of cargo winch on sloped aircraft floor

B.6 CIVIL RESERVE AIR FLEET (CRAF)

B.6.1 Introduction.

This appendix briefly describes the CRAF aircraft and their cargo carrying capabilities.

The Civil Reserve Air Fleet (CRAF) program uses commercial aircraft of select US civil air carriers to augment transport of military equipment and forces during crises. The fleet consists of the Airbus A310, A330, Boeing(B) 707 (KC-135), B747, B757, B767, B777, Douglas DC-10 (KC-10), Douglas MD11, and Lockheed L1011. Air Mobility Command is the manager of the CRAF. The number of CRAF aircraft changes monthly based on contract negotiations.

While ATTLA can determine if the cargo meets the technical requirements for CRAF airplanes, the final authority for acceptance of the item lies with the carrier or representative authority.

NOTE: Detailed data on aircraft limits are not addressed in this document due to the sheer volume of information and the variability between airlines. Detailed information can be found in Air Mobility Command Pamphlet (AMCP) 24-2 series for each aircraft and from the commercial carrier. Contact ATTLA for assistance.

B.6.2 Common characteristics.

CRAF airplanes are purpose built freighters, combi aircraft configured as cargo carriers, or primarily passenger configurations that carry cargo in the lower lobe (compartment) and passengers in the main, upper compartment. The B767 can also be configured to carry patients for medevac missions. Cargo is usually carried in commercial containers or on military logistic pallets.

B.6.2.1 Cargo floor.

The basic cargo floor is composed of a floor panel, support beam and seat tracks (see Figure 170. The lateral floor beams and seat tracks are the main structural members of the cargo floor.

The seat track has notches for attaching roller trays, seat pallets, and tiedowns. The floor panel is very weak compared to the strictly cargo aircraft such as a C-130. The floor limits are shown in terms of pounds per square foot (PSF) rather than pounds per square inch (PSI). Longitudinal running load is also an important limitation on board CRAF aircraft.

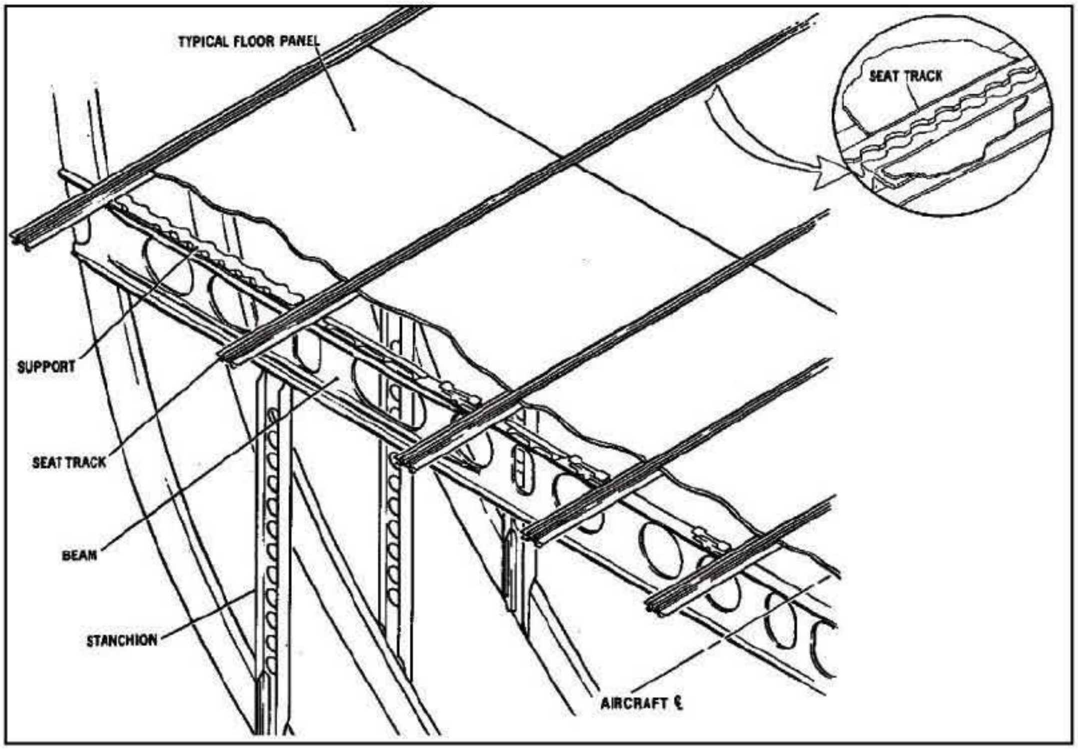


FIGURE B-168. Aircraft floor panel

The floor limit for the B707 (KC-135) is 200 psf (1.39 psi) and for the DC-10 (KC-10) the limit is 75 psf (0.52 psi). Cargo is shipped either on pallets or on a minimum 2 inch thick wooden shoring to increase the floor limit to 3600 psf (250 psi).

B.6.2.2 Roller systems.

Each cargo-configured aircraft has a roller system installed on the cargo floor to move pallets or containers. The majority are bidirectional rollers. Ball-type roller mats are commonly found at the entrance door on CRAF aircraft to rotate containers or pallets. Nonstandard pallets without continuous, flat bottoms usually cannot be used on these, as they overload the balls and do not roll. Some types of aircraft have omnidirectional rollers. The rollers are portable and sectionalized as shown in Figure 171. They are installed on the floor seat tracks where needed.

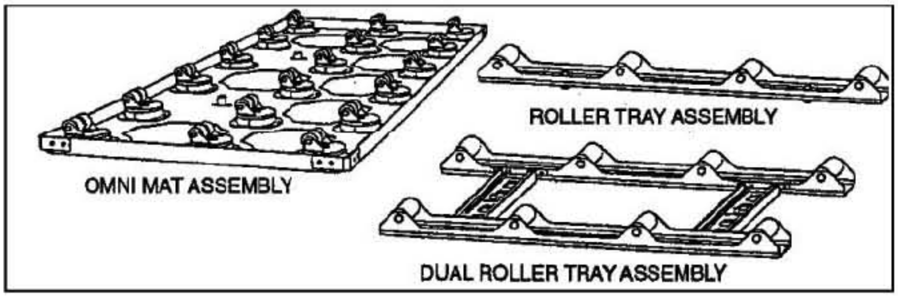


FIGURE 169. CRAF/KC-135 roller trays

B.6.2.3 Restraint systems.

B.6.2.3.1 Locks.

Each aircraft has different types of portable, retractable locks that can be placed at various locations on the seat tracks. The locks typically engage the pallet at the forward and aft ends, rather than on the side as with USAF cargo locks.

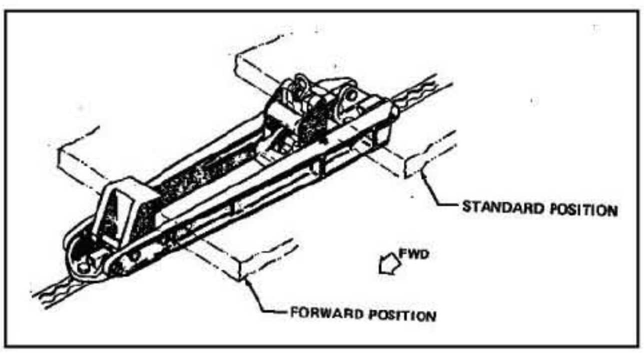


FIGURE B-170. Typical pallet lock

B.6.2.3.2 Barrier net.

A 9G barrier net is placed at the front of the cargo compartment. The minimum required forward restraint on the cargo is lowered from 3Gs to 1.5Gs if the cargo barrier is installed.

B.6.2.3.3 Tiedown devices and rings.

Tiedown rings are portable and are inserted into receptacles along the floor. Very few aircraft come with onboard tiedown equipment.

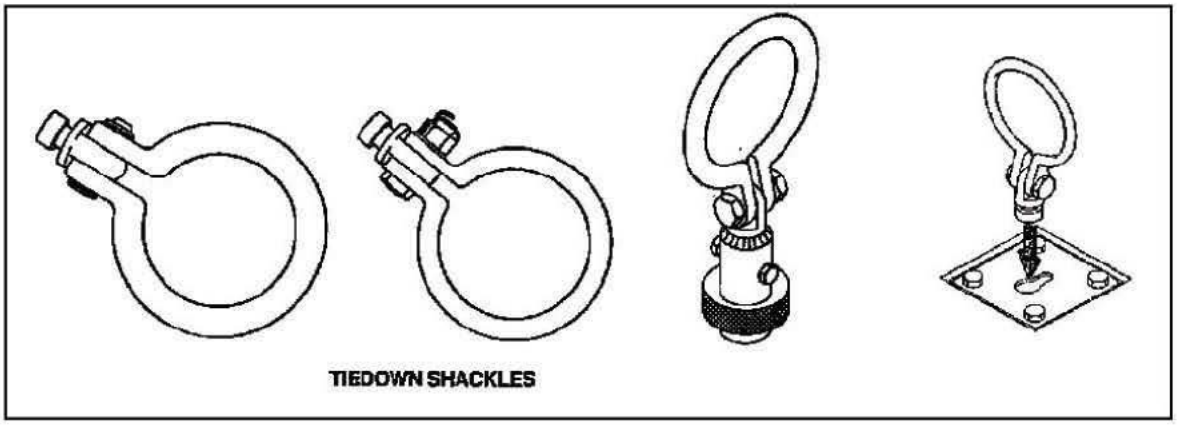


FIGURE B-171. Typical floor tiedown rings

B.6.2.4 winch.

Some aircraft are equipped with portable winches to assist with movement of pallets.

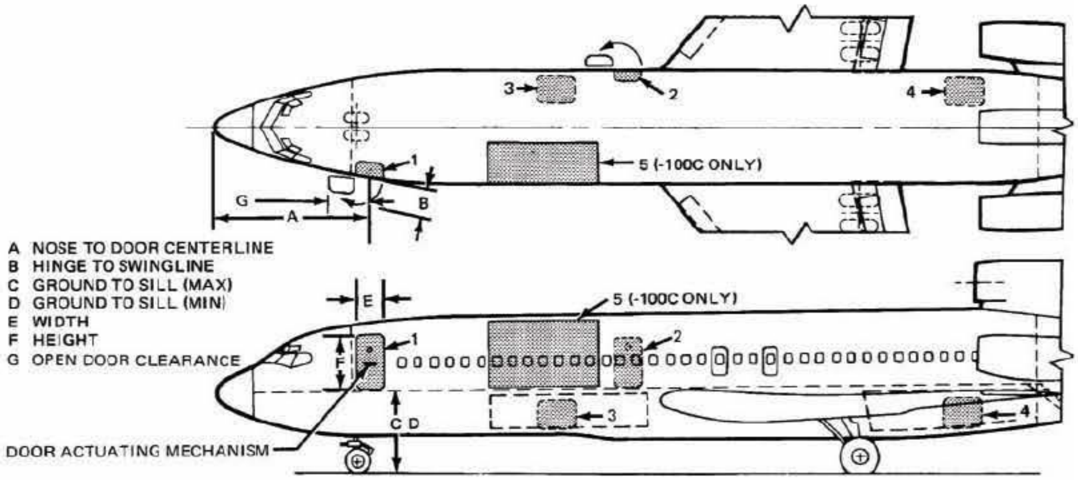
B.6.3 Individual aircraft information.

The following sections illustrate each aircraft's cargo carrying and, for some aircraft, medevac features and limits. It is organized the same way as the rest of the spec, in this case size, weight, aeromed configurations.

Information on lower lobe cargo compartments is not presented (unless it is contiguous with the main deck information).

Note: At this time there is no A310, A330, B737, B777, or MD80 freighter available to the CRAF. No data is presented.

Door Clearances, B727-100, - 100C



DOOR CLEARANCES B727-100,-100C

DOOR NO.	DOOR		DIMENSION A	B	C	D	E	F	G
1	FORWARD ENTRY	FT-IN.	16-6	-42.3	9-8	8-2	-34	-72	-81
		M	5.03	1.07	2.94	2.48	0.86	1.83	2.05
2	GALLEY SERVICE	FT-IN.	43-11	-41.5	9-10	8-9	-33	- 65	-57
		M	13.4	1.05	2.99	2.67	0.84	1.65	1.45
3	FORWARD CARGO	FT-IN.	36-4	*	5-4	4-3	-48	-35	-
		M	11.07	-	1.62	1.30	1.22	0.89	-
4	AFT CARGO	FT-IN.	79-6	*	5-5	4-3	-48	-35	-
		M	24.23	-	1.66	1.30	1.22	0.89	-
5	UPPER CARGO (-100C ONLY)	FT-IN.	35-0	9-4	9-6	8-6	-134	-86	-
		M	10.67	2.85	2.96	2.58	3.40	2.18	-

*SWINGS IN

TYPICAL DOOR CROSS SECTIONS

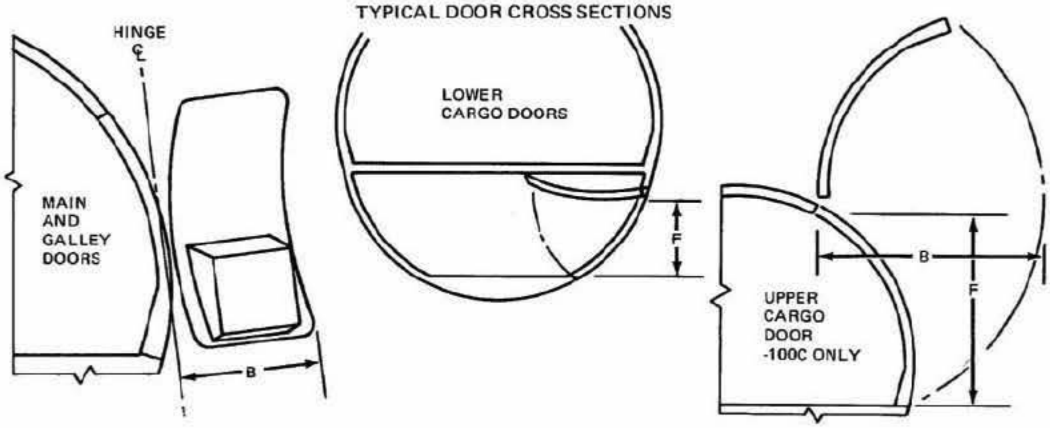


FIGURE B-172. Model B727-100, -100C door clearances

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B727 Cabin Cross Section - All Models

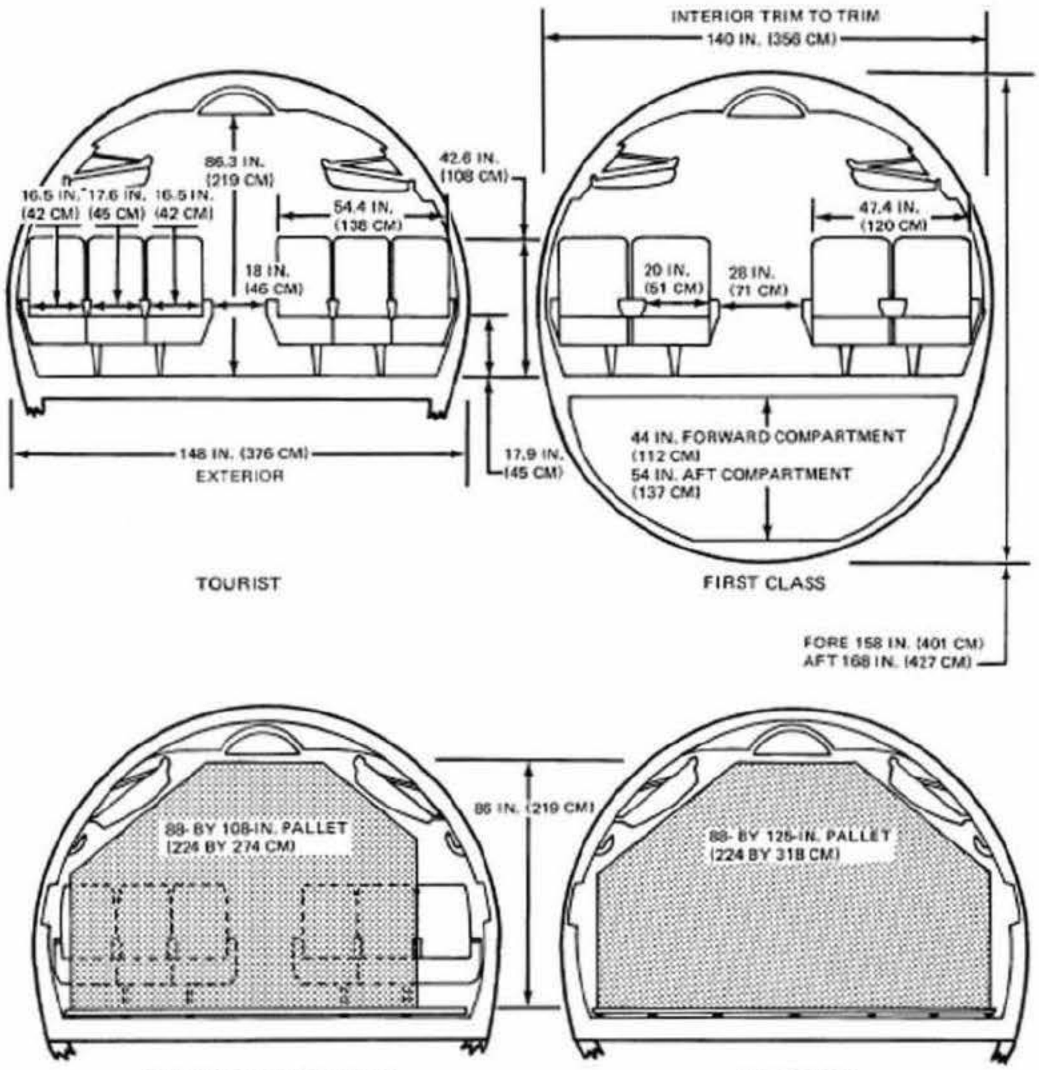


FIGURE B-173. Cabin cross section all models

CRAF

B727 Cabin Cross Section - All Models with Larger Overhead Storage

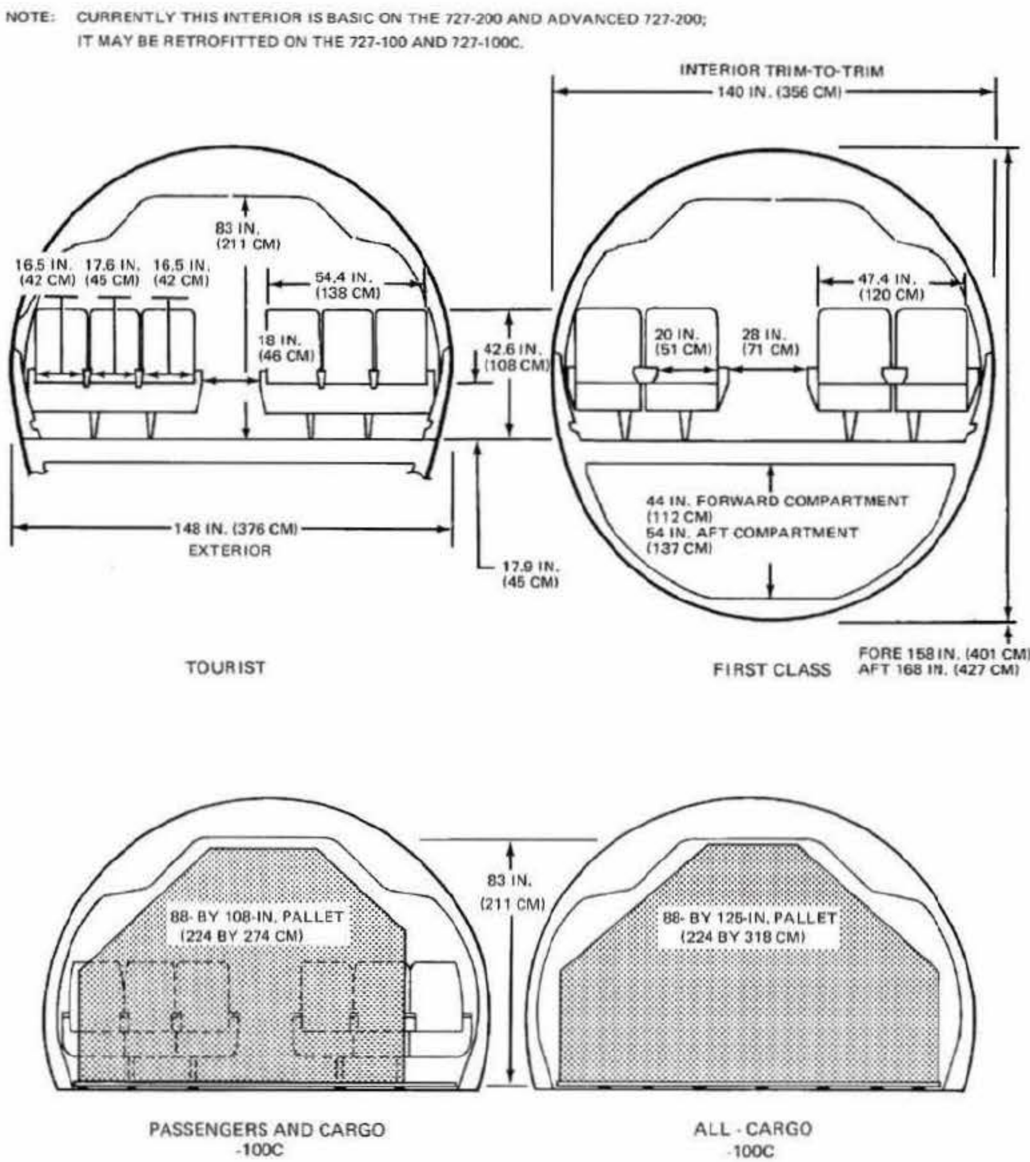


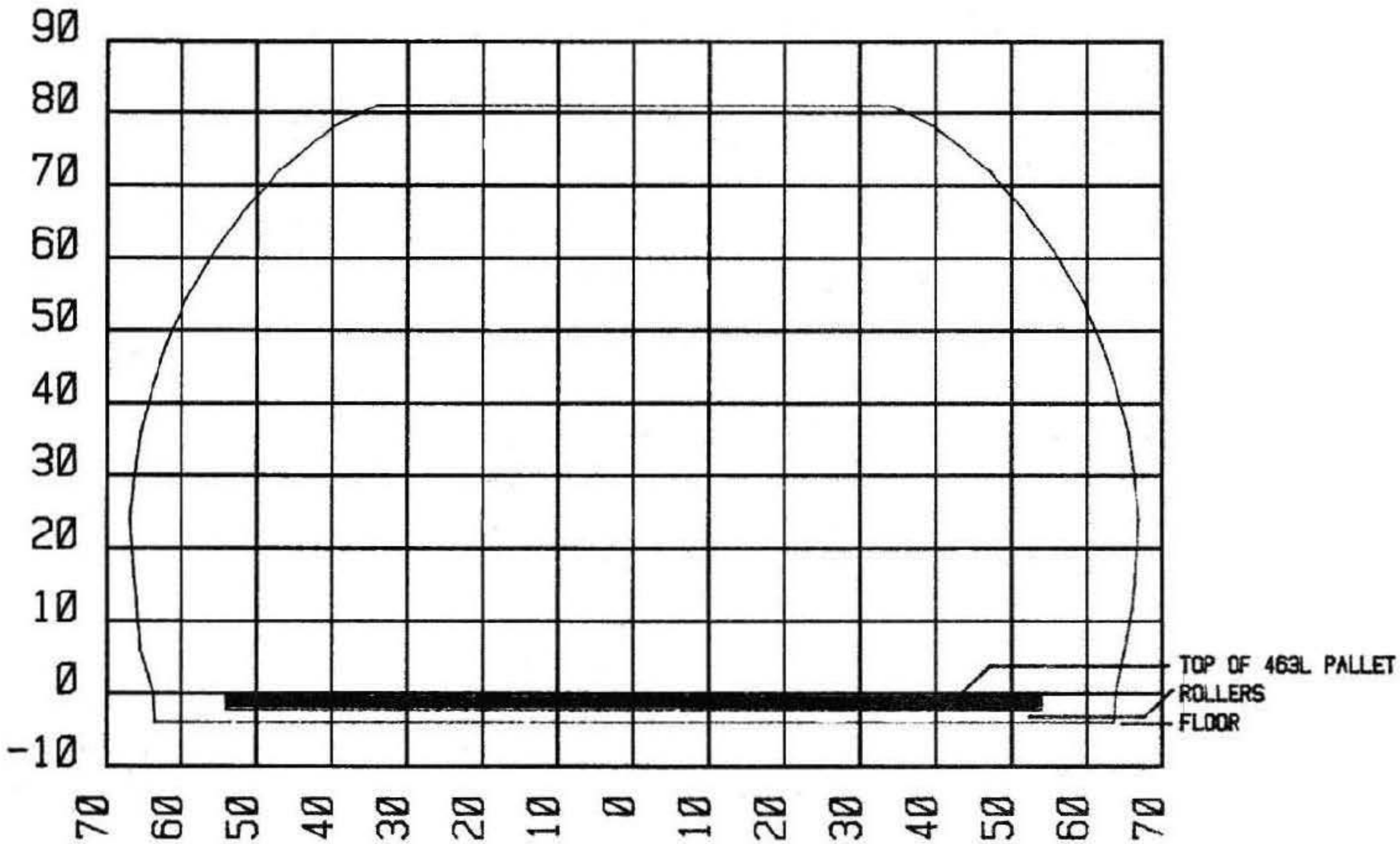
FIGURE B-174. Cabin cross section with larger overhead storage

CRAF

CROSS SECTION DC-8

(CENTER ISLE POSITIONING OF PALLET)

81"h x 127"w at Pallet Surface



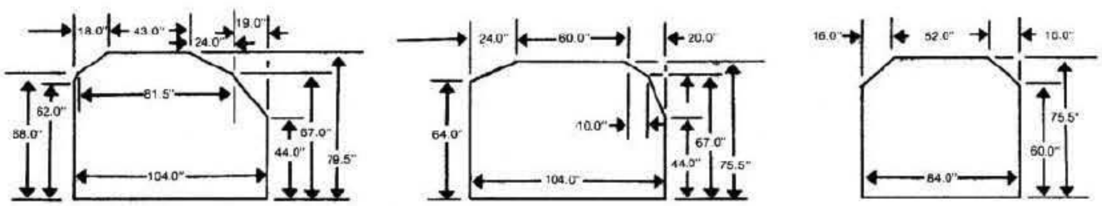
NOTE: Variations of about 1"-3" larger than this contour shows may be found depending on carrier insulation. HEIGHT ROUNDED DOWN TO NEAREST INCH.

FIGURE B-175. DC 8 Cross Section.

DC 8 Pallet Profile.

1. In this configuration the pallet rails are moved in on only one side to accommodate the 108-inch pallet. The 44-inch high side is loaded on the right side of the aircraft.
NOTE: confirm restraint rail configuration with the specific carrier prior to pallet buildup.

Aircraft	Pallet Positions		
DC-8-62F/CF	12	13	14
All DC-8-61, 63, 71, 73F/CF	16	17	18



2. These pallet profiles are for DC-8s that have their pallet restraint rails moved to the center to allow for centerline loading.
NOTE: Confirm restraint rail configuration with the specific carrier prior to pallet buildup.

Aircraft	Pallet Positions		
DC-8-62F/CF	1-12	13	14
All DC-8-61, 63, 71, 73F/CF	1-16	17	18

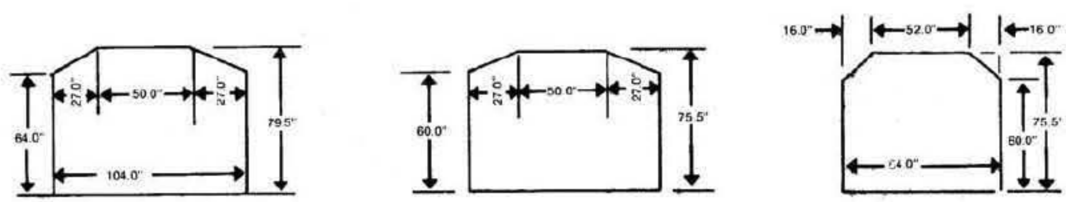


FIGURE B-176.

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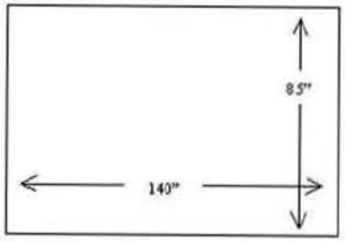
SIDE CARGO DOOR MAXIMUM HEIGHT CALCULATIONS:

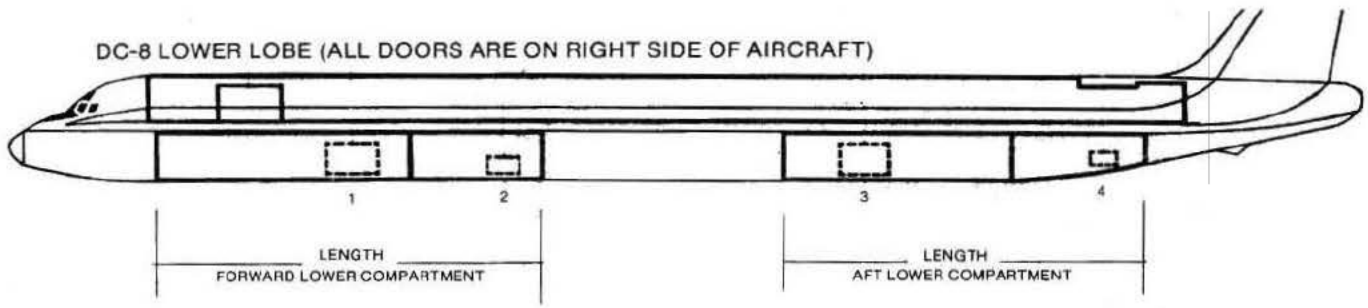
Door Height		85.00
Roller Height	-	1.25
Pallet Height	-	2.25
Top Clearance	-	2.00
Max Cargo Height		79.50

GENERAL RULES

1. ALL CARGO MUST BE ON A SUBFLOOR.
2. WOODEN SUB-FLOOR SHOULD BE AT LEAST 2" THICK.
3. PALLET WEIGHTS ARE FIGURED AT 290 LBS. PLUS 64 LBS FOR NETS/TIE DOWN EQUIPMENT.
4. ROLLING STOCK ON A 463L PALLET IS LIMITED TO 250 PSI.
5. ALL PALLET WEIGHTS ARE MAXIMUM AND INCLUDE THE WEIGHT OF PALLETS AND NETS.



Cargo Door Dimensions



AIRCRAFT	FORWARD LOWER COMPARTMENT							AFT LOWER COMPARTMENT						
	DOOR #1		DOOR #2					DOOR #3		DOOR #4				
	WxH	MAX AGL	WxH	MAX AGL	LENGTH	MAX WT 2/	BULK CUBE 3/	WxH	MAX AGL	WxH	MAX AGL	LENGTH	MAX WT 2/	BULK CUBE 3/
DC-8-61CF/71CF	63"x54"	80"	44"x36"	82"	570"	19,350	1290	63"x54"	92"	44"x36"	100"	560"	18,150	1210
DC-8-62CF	44"x36" 1/	77"	44"x36"	82"	370"	12,000	800	44"x36" 1/	92"	44"x36"	100"	400"	12,225	815
DC-8-63CF/73CF	63"x54"	81"	44"x36"	82"	570"	19,350	1290	63"x54"	92"	44"x36"	100"	560"	18,150	1210

NOTES:
1/ Door size may be 63"x54" on some aircraft.
2/ 15 lbs/cu ft structural floor limit.
3/ The area immediately adjacent to these doors is unusable for cargo placement and represents an approximate 18 percent loss of space due to the facilitation of belly door opening and closing.

FIGURE B-177. DC 8 Side Cargo Door Dimensions and Lower Lobe Dimensions. (All Series)

TABLE B-XIII.

DC-8 Aircraft Cargo Dimensions Chart.

NOTE: Chart values show maximum length in inches for given height and width. Reduce package height by thickness of cargo handling system when bulk loading with the palletized cargo system installed.

MAIN DECK:

Pkg Ht.	Package Width (inches)																			
(inches)	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	128
6 thru 48	1170	361	688	566	478	414	367	·330	299	272	249	230	213	199	185	175	165	158	151	146	140
54	1128	630	660	547	463	403	359	323	293	255	245	225	210	196	184	174	164	157	149	144	
60	1012	738	600	503	433	383	342	308	280	257	237	220	206	192	181	171	162	154	147	140	
66	760	630	620	445	389	346	312	283	259	239	221	206	193	183	171	161	152	144			
72	629	518	441	385	340	305	278	253	233	216	202	189	178	167	157	148	140				
78	496	421	366	327	294	267	245	226	209	195	182	170	150	149	140						
84	369	325	294	263	239	219	202	188	174	161	148	136									

LOWER DECK:

Pkg Height (inches)	Package Width (inches)																	
	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	52
3	264	264	264	264	265	243	221	203	185	170	155	145	135	130	126	114	103	100
6	264	264	264	264	250	231	213	196	180	166	152	142	132	127	122	111	100	97
9	264	264	264	265	237	221	205	190	175	162	150	140	130	125	120	109	98	95
12	264	264	264	251	229	213	197	183	170	158	147	137	127	122	117	106	95	92
15	264	264	250	240	221	205	190	177	165	155	145	135	125	120	115	104	93	90
18	264	264	250	231	213	199	185	171	157	148	140	130	120	115	110	100	90	87
21	264	270	240	227	205	192	180	165	150	142	135	124	115	110	105	96	88	85
24	264	257	232	215	200	187	175	161	147	138	130	120	110	106	102	93	85	82
27	265	245	225	210	195	182	170	157	145	135	125	115	105	102	100	91	83	80
30	252	233	215	201	187	173	160	148	137	128	120	111	102	98	95	87	80	77
33	240	222	205	192	180	165	150	140	130	122	115	107	100	95	90	84	78	75
36	215	201	187	175	165	151	137	128	120	110	100	93	87	83	80	75	70	67
39	190	180	170	160	150	137	125	117	110	97	85	80	75	72	69	66	63	60
42	147	138	130	122	115	106	95	90	85	77	70	66	62	59	56	52	49	46
45	105	97	93	86	70	72	65	62	60	57	56	52	50	46	43	39	35	32

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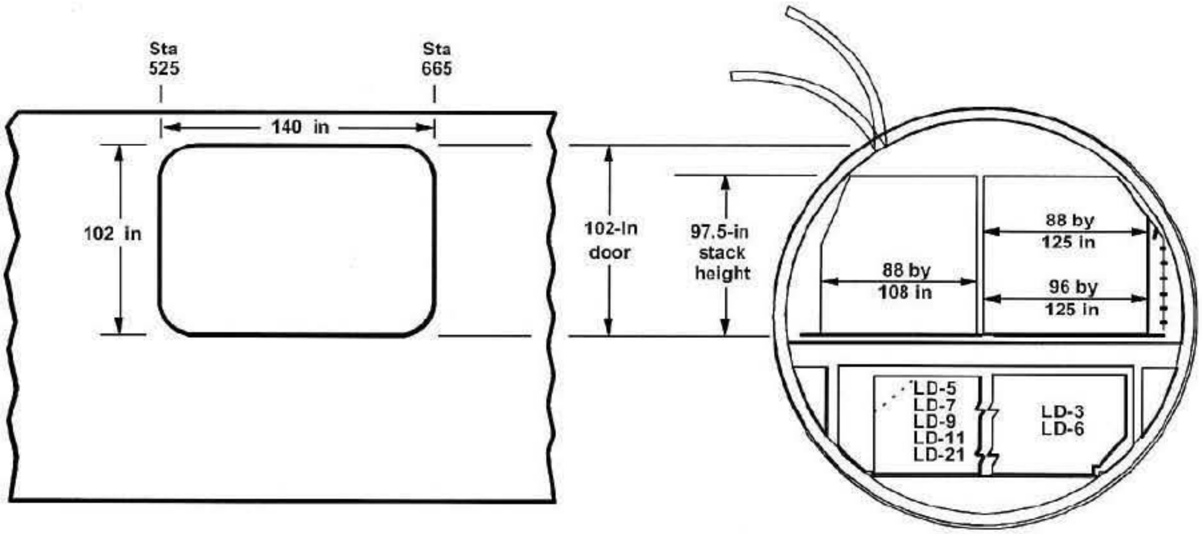
MD-11 Cargo Loading Door, Main Deck.

Main Deck Cargo Door



- Normal cargo door operation employs an independent hydraulic system with pressure supplied by an electrically driven pump
- If electrical power is not available, the cargo door can be operated with a manual hydraulic pump

Figure 15. MD-11 Cargo Load Cut Away View.

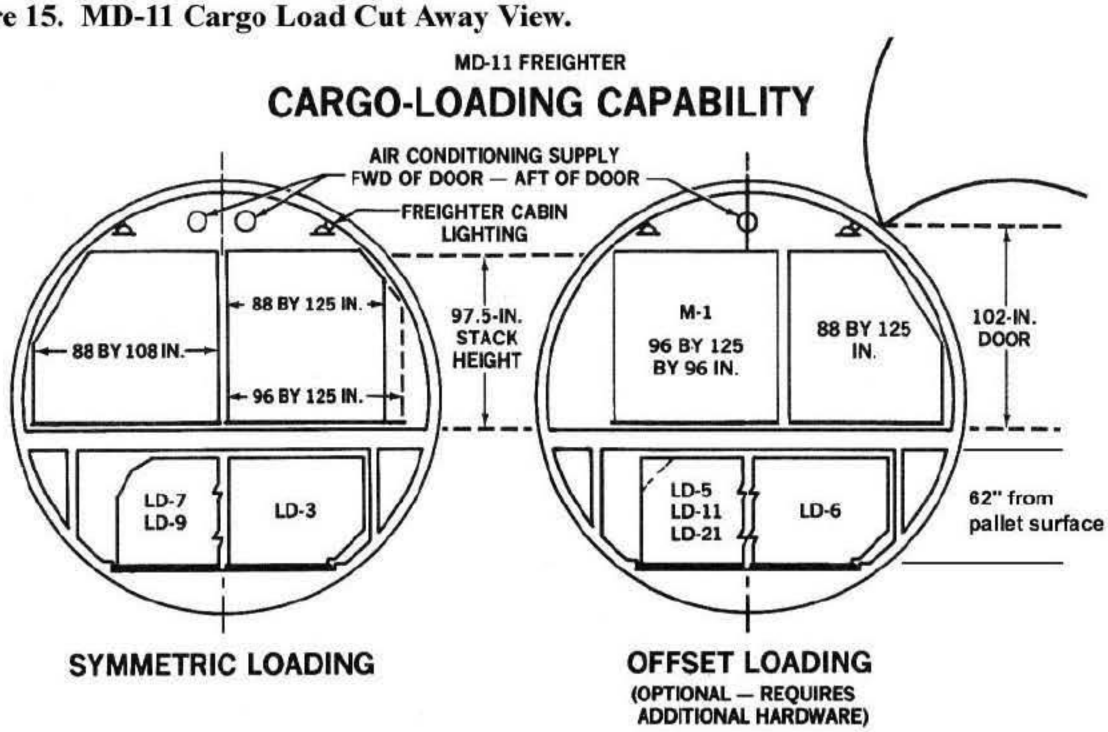


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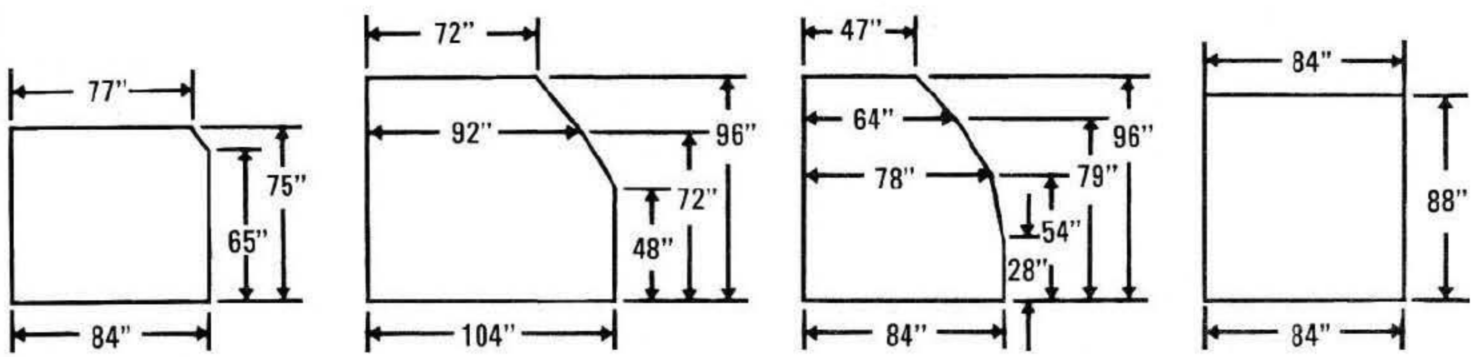
FIGURE B-178.

MD-11 FREIGHTER

Pallet profiles for B and C limited by door height restrictions.

A. PALLET POSITIONS	B. PALLET POSITIONS	C. PALLET POSITIONS	D. PALLET POSITION
1 L&R	2-14 L&R	15-17 L&R	18C



NOTE: Pallet Profiles are shown with the RIGHT SIDE OUTBOARD

FIGURE B-179. MD-11 463L Pallet Load Profiles (88" x 108" pallets).

MD-11 Pallet Load Profiles for the 88 and 96 inch Pallets.

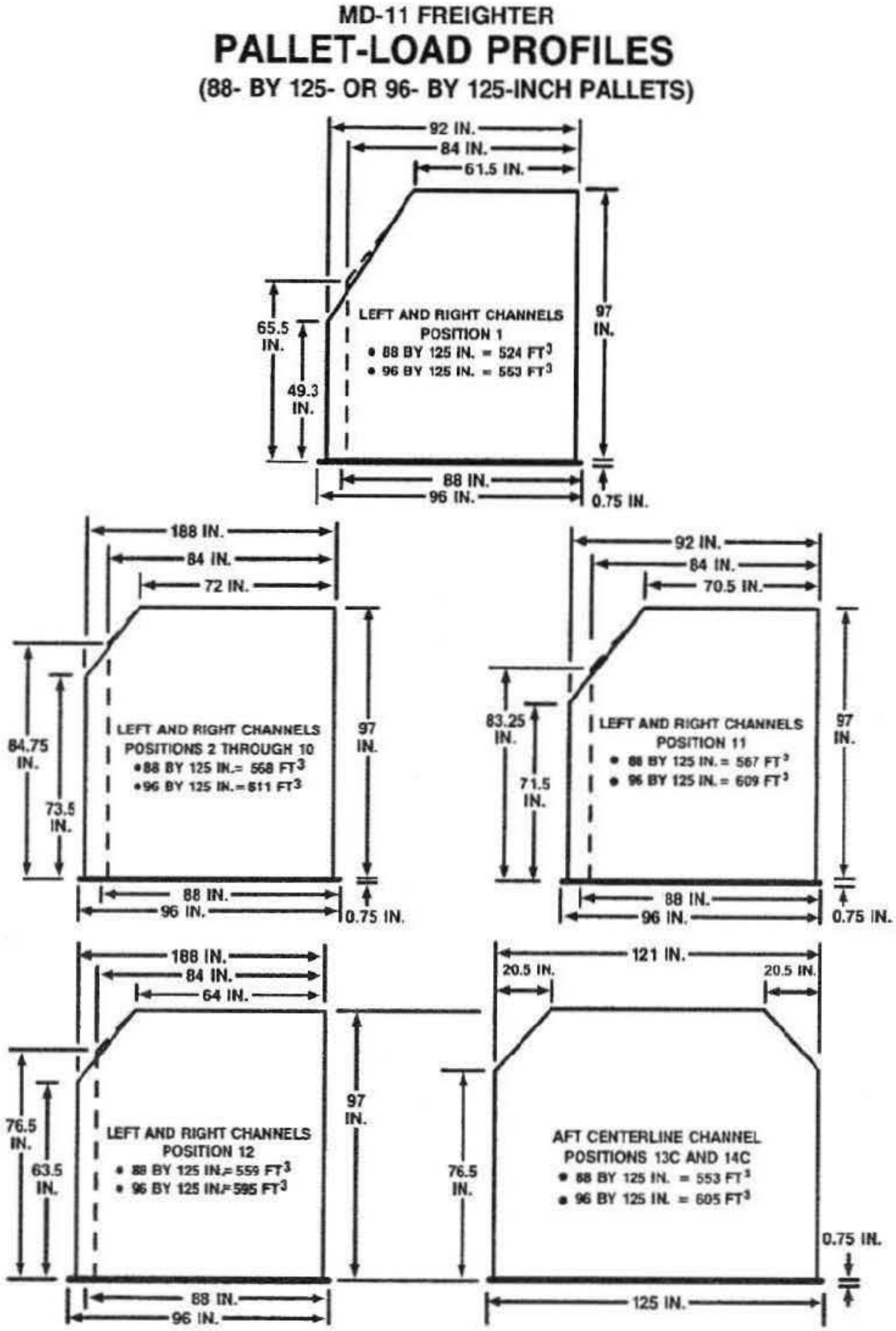


FIGURE B-180.

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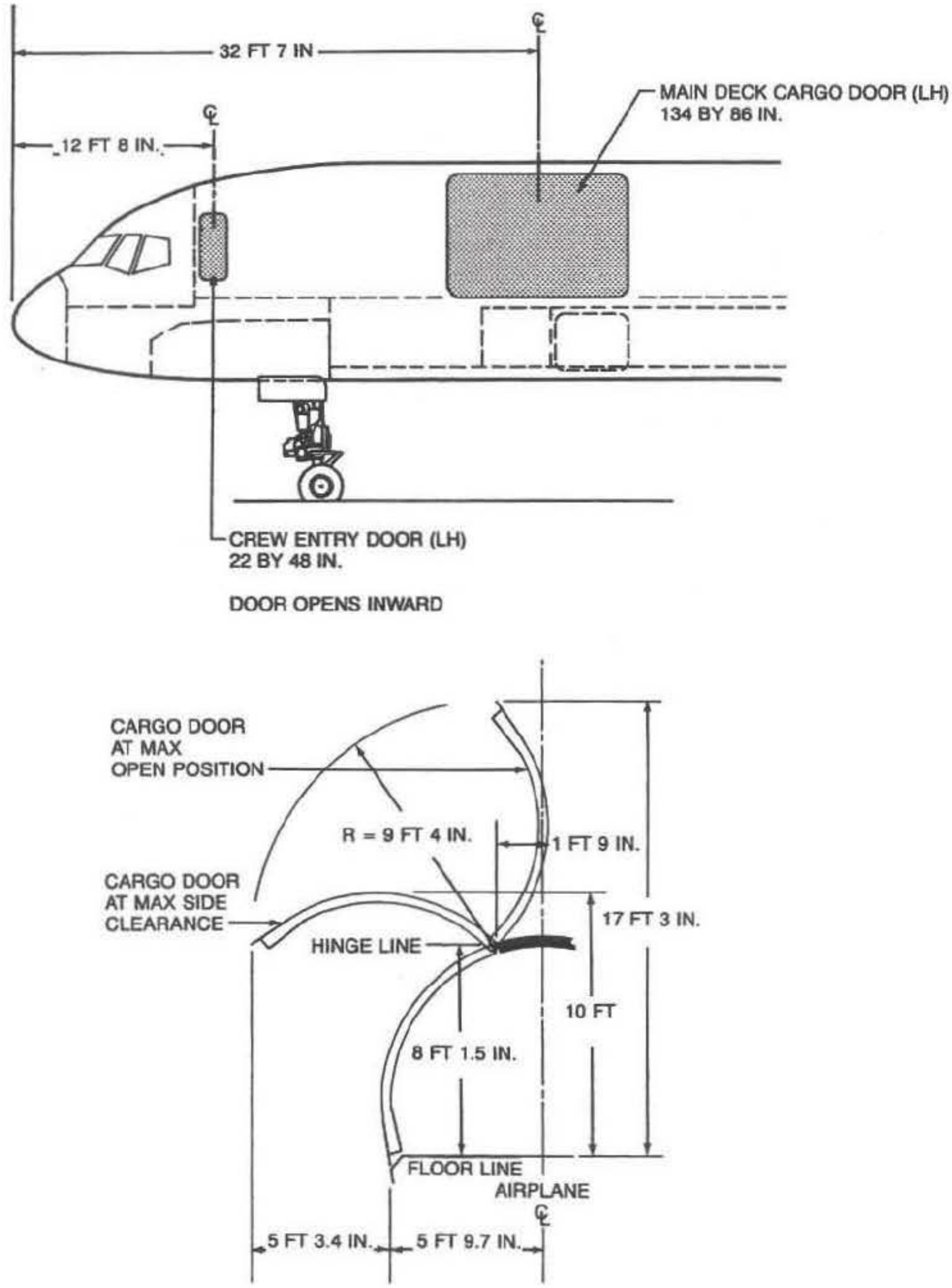
Door Clearances for Main Deck Doors Model 757-200PF.



DOOR CLEARANCES—MAIN DECK DOORS
MODEL 757-200PF

FIGURE B-181.

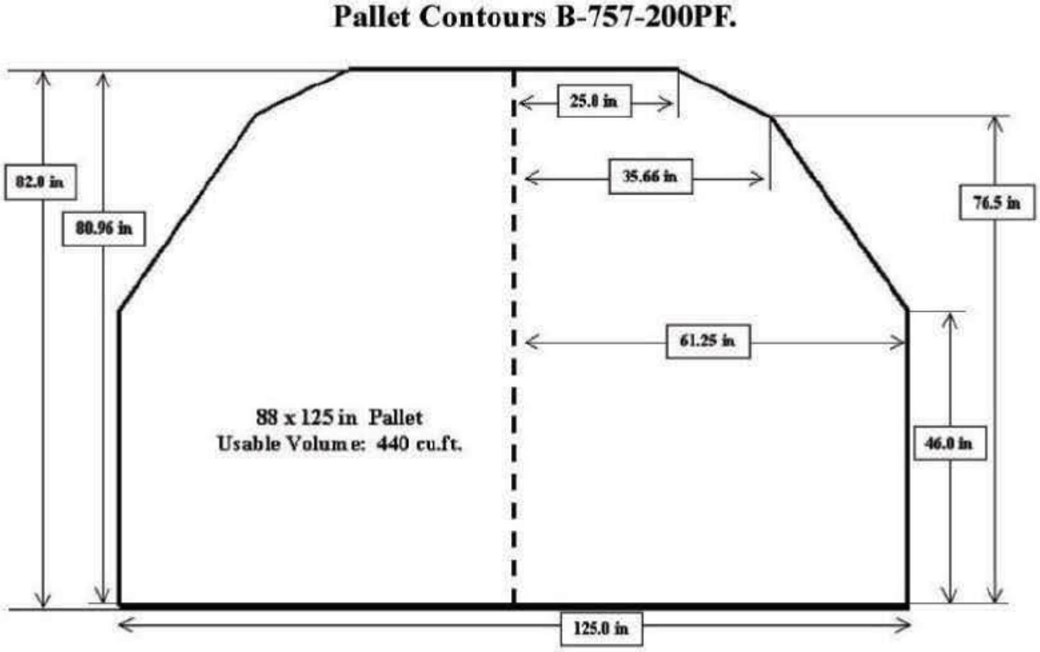
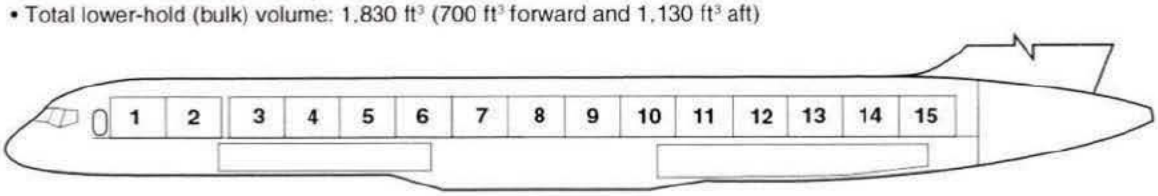


FIGURE B-182. Model 757-200F freight

Cargo Arrangement

757-200 Freighter

- 88- x 125-in (223- x 317-cm) ULD main deck arrangement, 15 pallet or container positions
- Total ULD volume: 6,600 ft³ (187 m³)
- Total lower-hold (bulk) volume: 1,830 ft³ (700 ft³ forward and 1,130 ft³ aft)



Cross sections

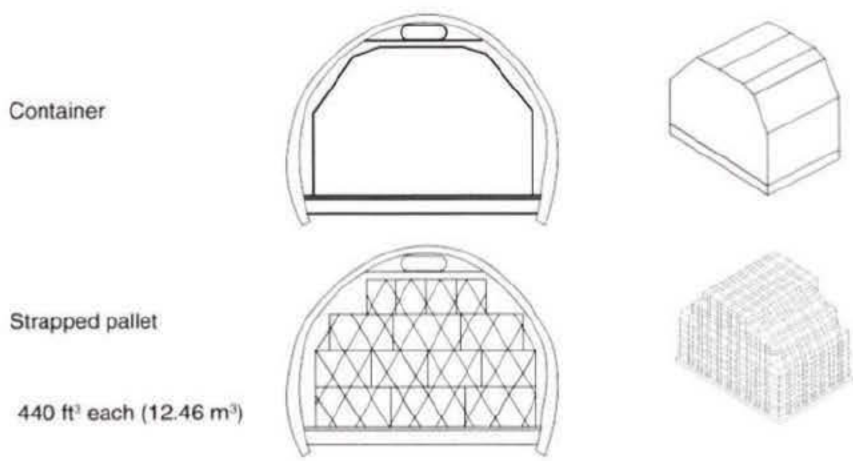
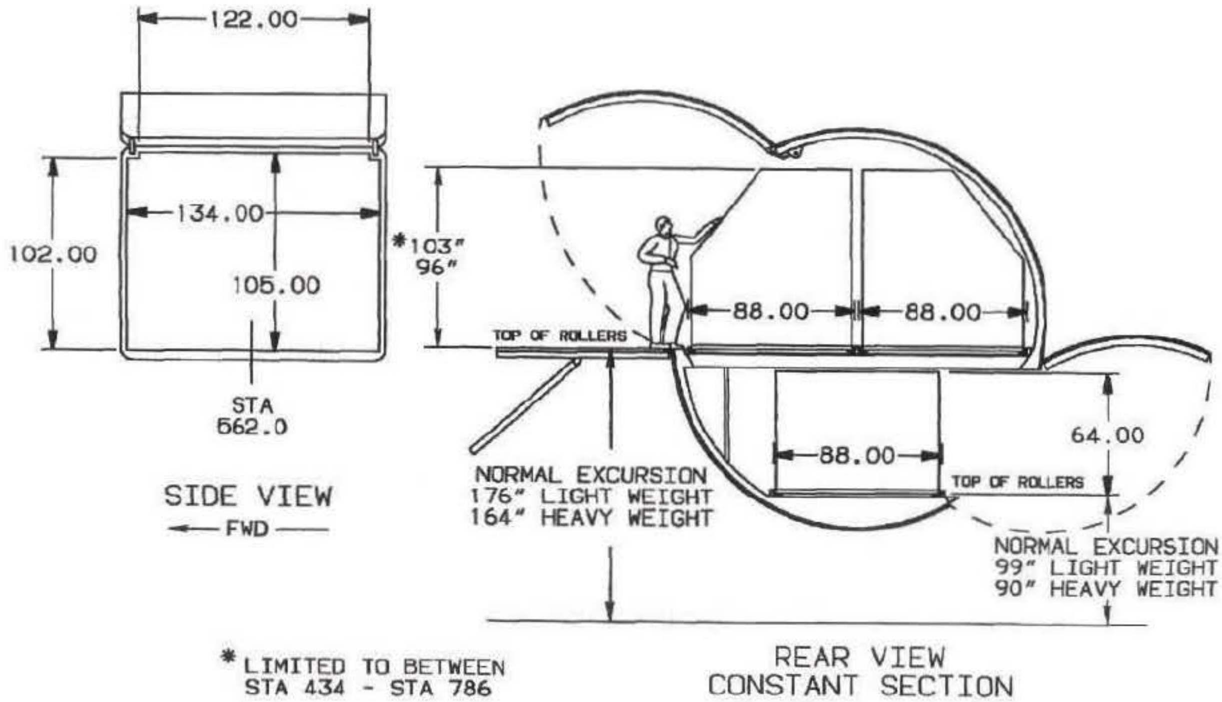


FIGURE B-182.

B767 Cargo Configuration Cross Section.



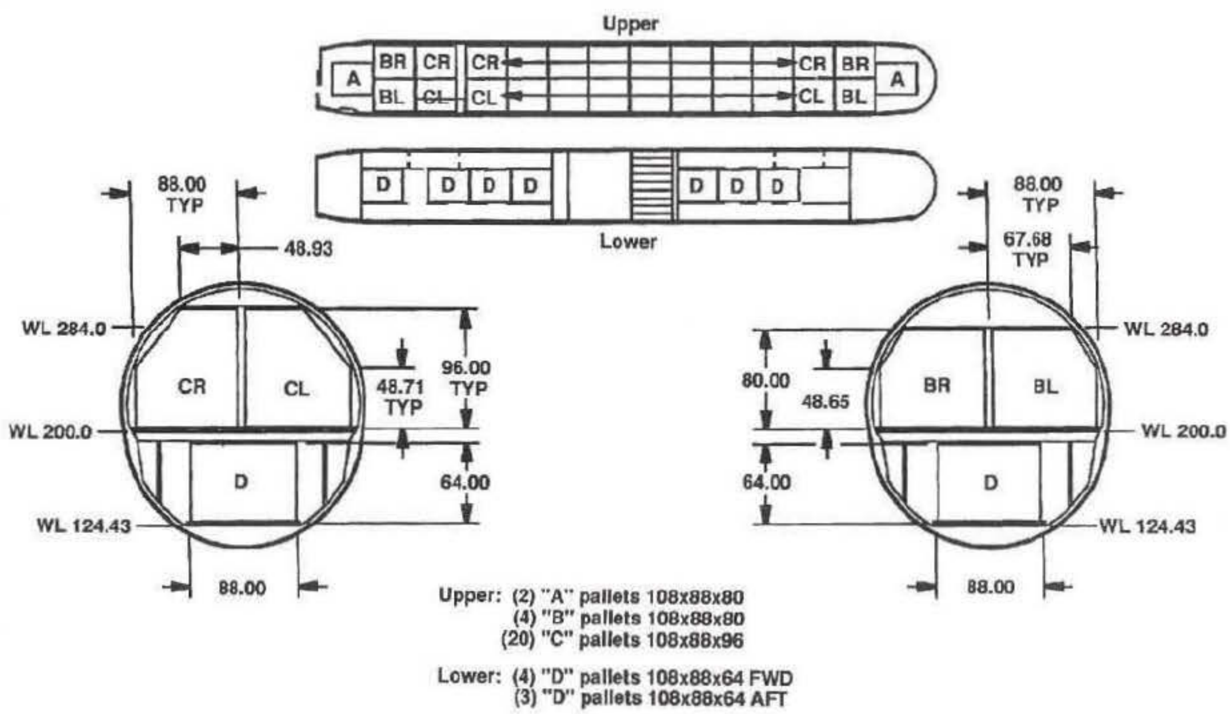


FIGURE B-183.

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If the forward lower lobe door is not consistent with the following tables, then use the data based on the most restrictive parameter, either the door size or galley length.

NOTE: This is the maximum height only between Stations 624 and 774 (pallet positions 1 and 2). See figures 6.12 for additional height restrictions

TABLE B-XIV.

DC-10 Forward Cargo Door, Max Length Chart (pallet positions 1 and 2)

Package Height	**Package Width (inches)**										
(inches)	**12**	**24**	**36**	**48**	**60**	**72**	**84**	**96**	**108**	**120**	**132**
12	340	329	324	317	310	300	278	283	275	252	228
24	340	329	324	317	310	300	278	283	275	252	228
36	340	329	324	317	310	305	278	283	275	250	226
48	330	328	323	316	310	305	278	283	274	248	224
60	326	321	316	310	305	300	284	285	261	239	218
72	318	312	307	305	300	297	288	264	244	226	211
84	308	303	297	293	285	285	263	243	227	213	202

DC-10 Forward Cargo Door, Max Length Chart (pallet positions 3 through 15)

Package Height	**Package Width (inches)**										
(inches)	**12**	**24**	**36**	**48**	**60**	**72**	**84**	**96**	**108**	**120**	**132**
12	1323	1000	730	578	478	402	350	311	280	252	229
24	1323	992	730	578	478	402	350	311	280	252	229
36	1323	982	725	572	472	400	349	308	277	250	228
48	1266	900	675	542	452	390	341	303	275	247	225
60	1066	750	582	482	410	359	318	284	261	242	221
72	800	610	500	425	366	326	288	261	243	224	204
84	620	500	420	370	325	285	256	241	227	202	184
96	490	420	370	325	285	260	235	210	185	170	145

NOTE: Maximum package charts for DC-10 side door for cargo pushed forward to pallet positions 1 and 2 Left and Right (Table 3.); All other pallet positions except 1 and 2, use Table 4. (Example: A package 60 inches high and 48 inches wide loaded toward the aft of the aircraft can be up to 482 inches long and fit into the cargo area). Longer vehicles can be loaded due to the variable shape, contact carrier for details.

TABLE B-XV.

DC-10 lower lobes maximum loading length charts. FLL, upper deck galley, 104" x 66" door.

MAXIMUM LENGTH IN INCHES FOR HEIGHT AND WIDTH SHOWN																	
Package Height (inches)	Package Width (inches)																
	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102
64	363	327	302	283	266	251	239	227	220	203	191	180	166	154	143	134	126
60	369	331	305	284	268	251	239	227	220	203	191	180	166	154	143	134	126
54	378	338	306	286	270	251	239	227	220	203	191	180	166	154	143	134	126
48	382	346	313	292	271	253	239	227	220	203	191	180	166	154	143	134	126
42	388	350	317	295	273	255	240	228	220	203	191	180	166	154	143	134	126
36	402	357	321	299	275	257	241	228	220	203	191	180	166	154	143	134	126
30	415	367	330	306	279	260	242	228	220	203	191	180	166	154	143	134	126
24	415	388	342	312	286	263	246	228	220	203	191	180	166	154	143	134	126
18	415	407	360	323	293	268	248	231	220	203	191	180	166	154	143	134	126
12	415	409	385	336	300	276	252	233	220	203	191	180	166	154	143	134	126
6	415	409	407	348	315	284	257	238	220	203	191	180	166	154	143	134	126

DC-10 lower lobes maximum loading length charts. FLL, lower galley, 70" x 66" door.

Package Height	Package Width (inches)										
(inches)	6	12	18	24	30	36	42	48	54	60	66
64	246	241	233	216	205	197	184	171	156	142	130
60	246	241	235	218	206	197	184	171	156	142	130
54	246	241	235	218	207	197	184	171	156	142	130
48	246	241	236	220	207	197	184	171	156	142	130
42	246	241	238	221	207	197	184	171	156	142	130
36	246	241	238	222	207	197	184	171	156	142	130
30	246	241	237	224	207	197	184	171	156	142	130
24	246	241	237	225	207	197	184	171	156	142	130
18	246	241	237	231	211	198	184	171	156	142	130
12	246	241	237	233	217	198	184	171	156	142	130
6	246	241	237	233	224	204	186	171	156	142	130

TABLE B-XVI.

DC-10 Lower Lobes Maximum Loading Length Charts. CLL, 70"x66" Door.

Package Height	Package Width (inches)										
(inches)	6	12	18	24	30	36	42	48	54	60	66
64	266	251	233	216	205	197	184	171	156	142	130
60	268	252	235	218	206	197	184	171	156	142	130
54	274	254	235	218	207	197	184	171	156	142	130
48	277	254	236	220	207	197	184	171	156	142	130
42	280	258	238	221	207	197	184	171	156	142	130
36	283	259	238	222	207	197	184	171	156	142	130
24	283	275	248	225	207	197	184	171	156	142	130
18	283	279	255	231	211	198	184	171	156	142	130
12	283	279	273	240	217	198	184	171	156	142	130
6	283	279	274	252	224	204	186	171	156	142	130

DC-10 Aft Bulk Compartment (ABC), 44"x48" Door.

Package Height	Package Width (inches)						
(inches)	6	12	18	24	30	36	42
48	167	164	158	148	140	132	123
42	175	175	165	153	145	133	123
36	180	176	167	153	147	134	123
30	183	177	168	155	148	136	124
24	185	178	169	155	148	137	125
18	186	179	169	155	148	138	125
12	188	180	170	156	149	138	125
6	190	180	170	158	150	139	126

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TABLE B-XVII.

DC-10 Aft Bulk Compartment (ABC), 30"x36" Door.

Package Height (inches)	Package Width (inches) 6	12	18	24	30	36	42	48	54	60	66
64	--	--	--	--	--	--	--	--	--	--	--
60	113	112	--	--	--	--	--	--	--	--	--
54	113	113	--	--	--	--	--	--	--	--	--
48	128	122	117	117	107	103	101	100	97	93	93
42	142	135	126	126	120	118	118	118	120	109	98
30	142	136	131	127	122	120	120	120	120	109	98
24	143	138	131	128	122	121	121	121	120	109	98
18	144	138	132	129	123	122	122	122	120	109	98
12	144	138	133	130	124	122	122	122	120	109	98
6	144	138	133	131	125	123	123	123	120	109	98

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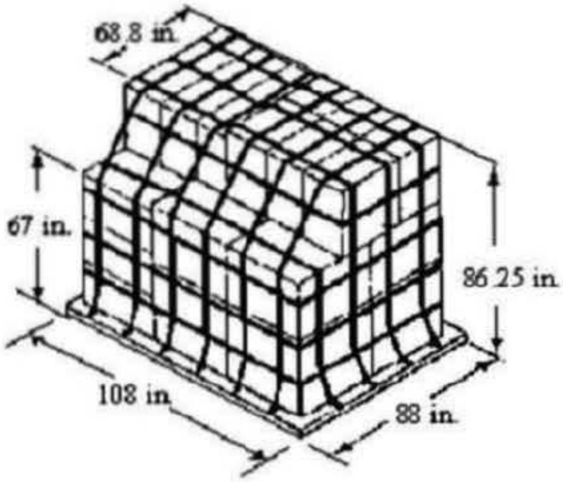
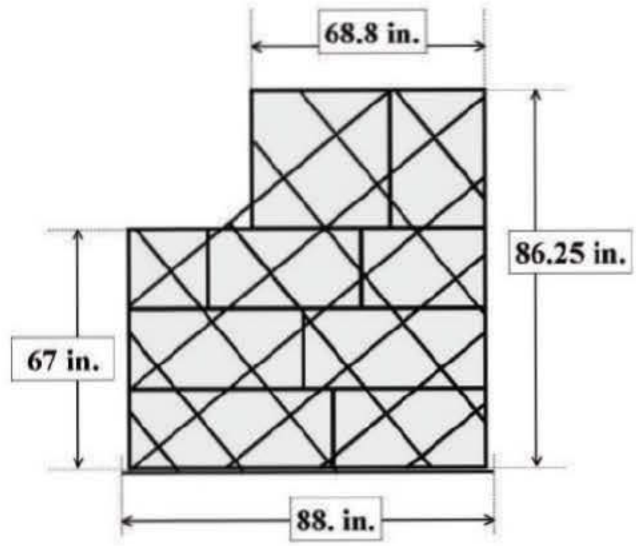
463L Bulk Cargo Pallet Dimensions for a -200 Series Aircraft. (Models L-1011 -200)





This example of a Bulk Cargo pallet contour Should be followed for all pallets loaded in the Cabin Cargo Compartment on Configuration "C" aircraft. This contour affords 423 cu. ft. on each pallet. See Figure 7.19 for the maximum gross weight allowed.

FIGURE B-184.

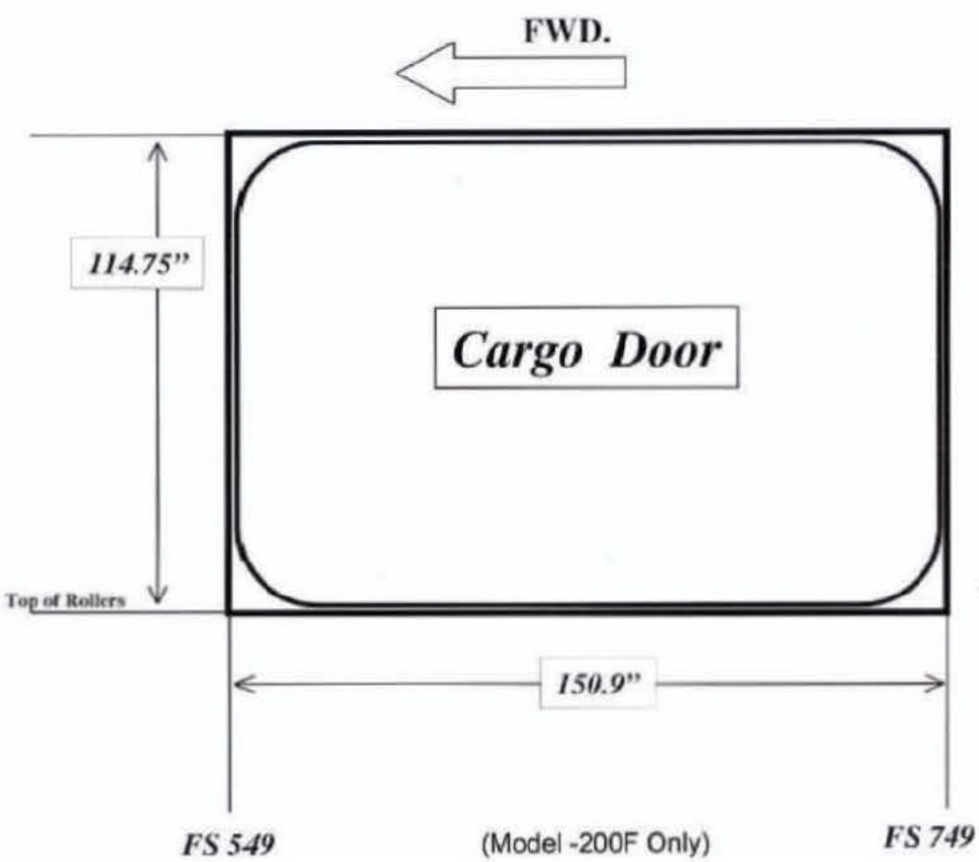
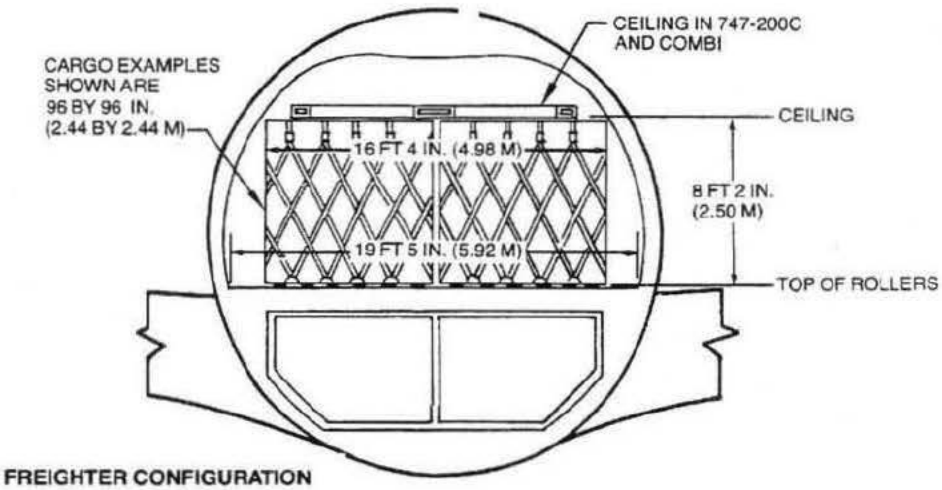


FIGURE B-185. B-1011-200-F main deck cargo door

L1011 Cabin Cross Section.



FREIGHTER CONFIGURATION

NOTE: The above configuration is applicable only on the Convertible and Combi versions only.

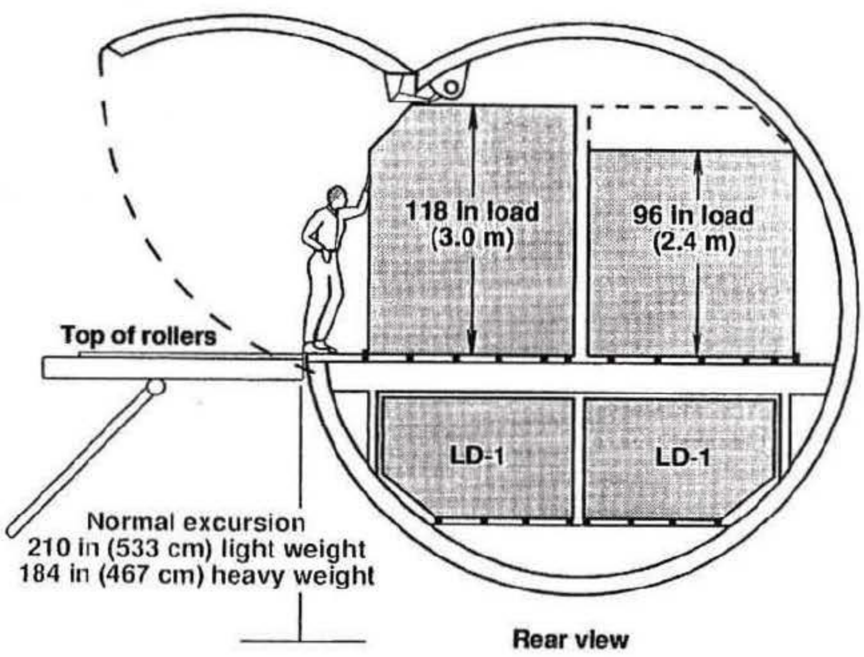
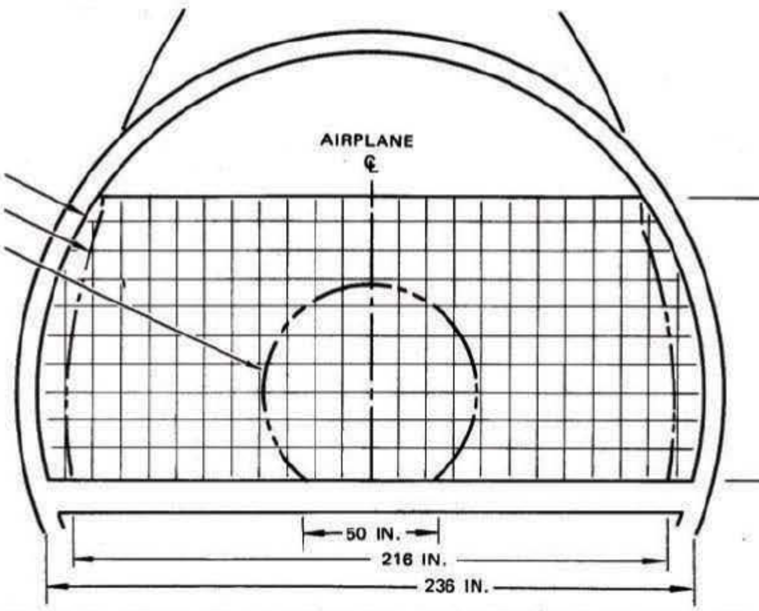


FIGURE B-186.

CRAF

B747–100F Cross Section.

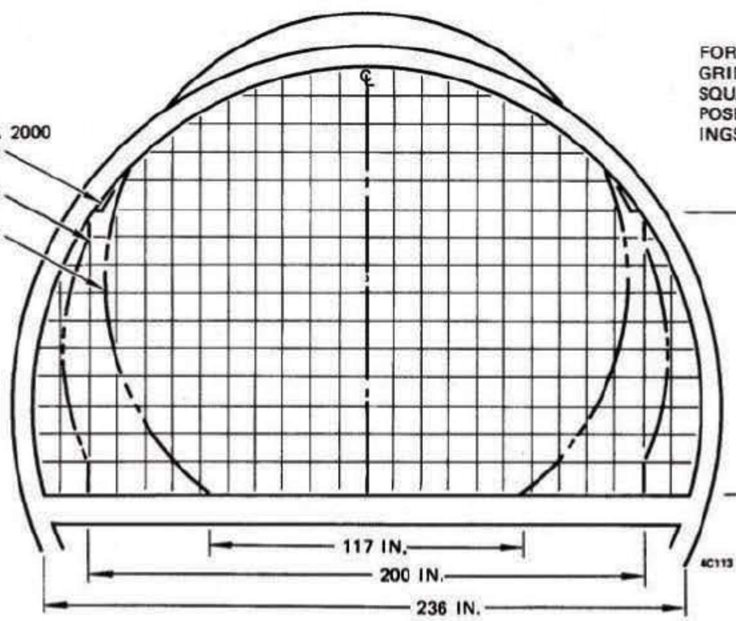
CARGO AREA CROSS SECTIONS AND VOLUMES



CROSS SECTIONS - LINED BUT UNFURNISHED MAIN DECK STA 140 THRU STA 1000

NOTE

FOR CONVENIENCE A GRID HAVING 10-INCH SQUARES IS SUPERIMPOSED ON THE DRAWINGS



MAIN DECK STA 1000 THRU STA 2360

FIGURE B-187.

B747 Cross Section 200F Series.

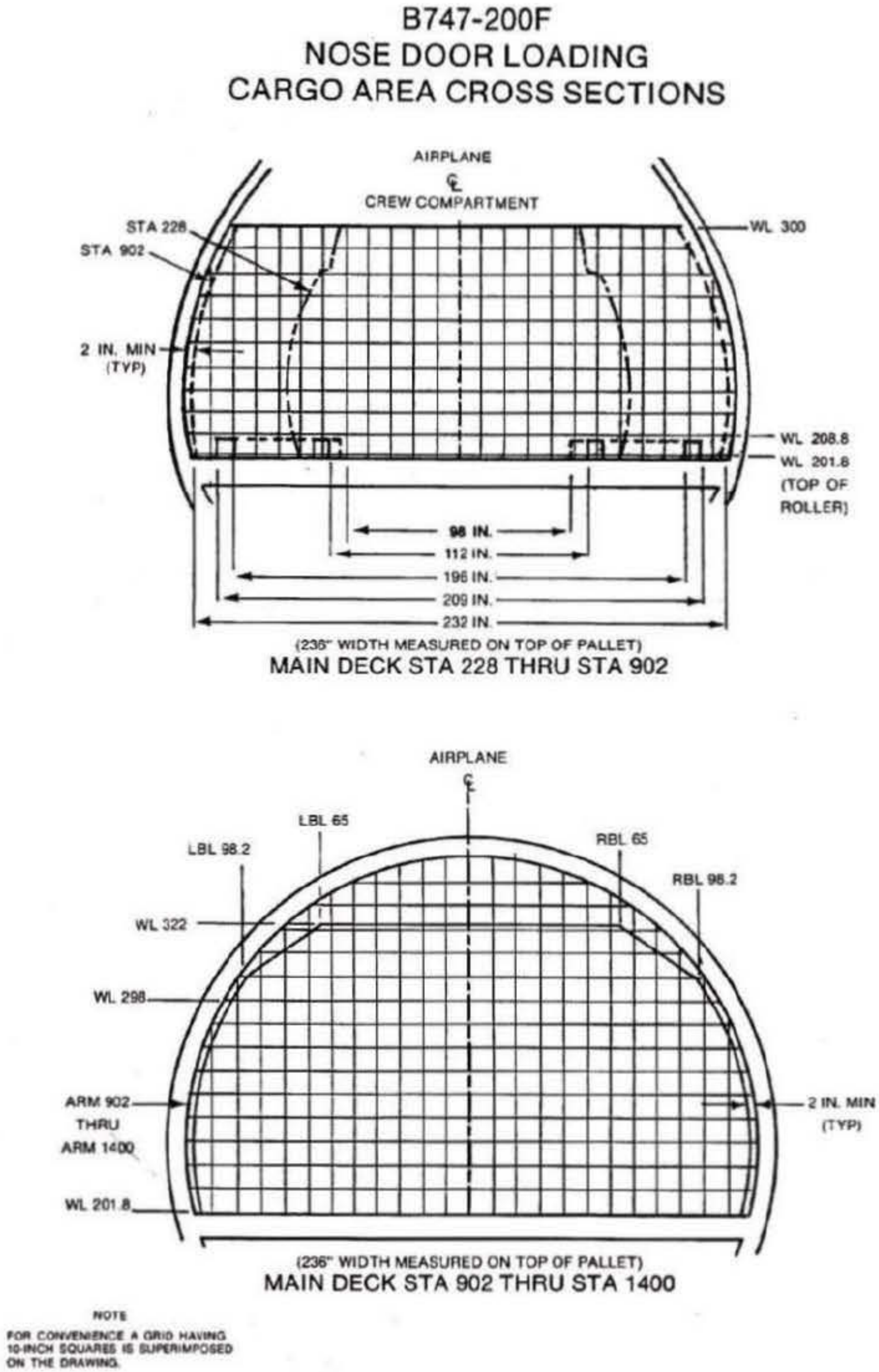
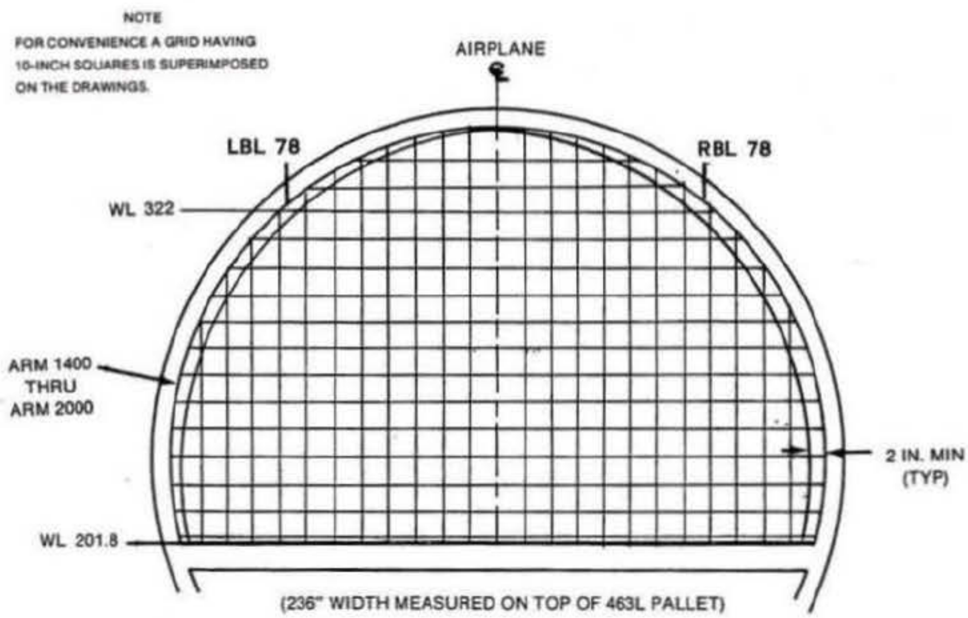


FIGURE B-188.

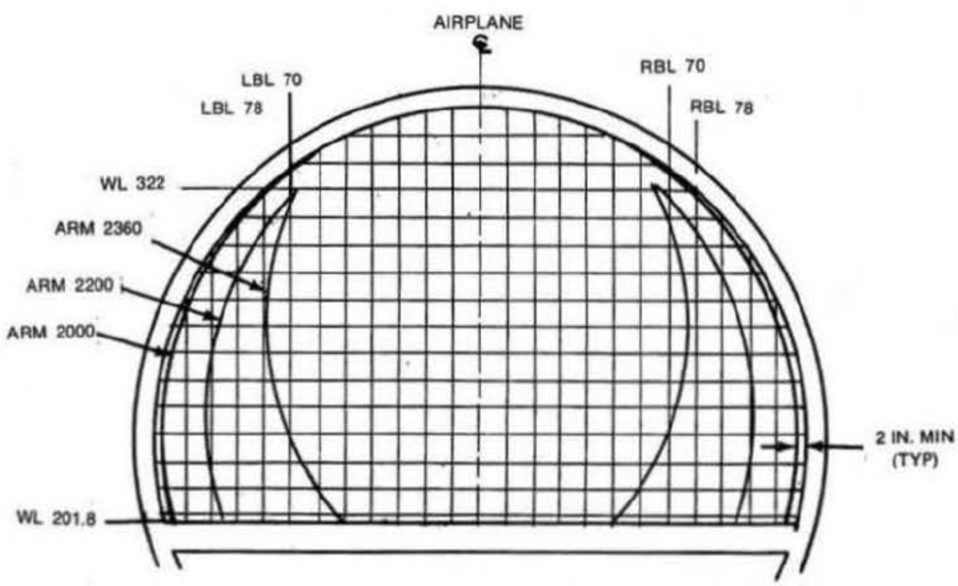
CRAF

B747 Cross Section 200F Series.

B747-200F
CARGO AREA CROSS SECTIONS (CONT)



MAIN DECK STA 1400 THRU STA 2000



MAIN DECK STA 2000 THRU STA 2300

CRAF

FIGURE B-189.

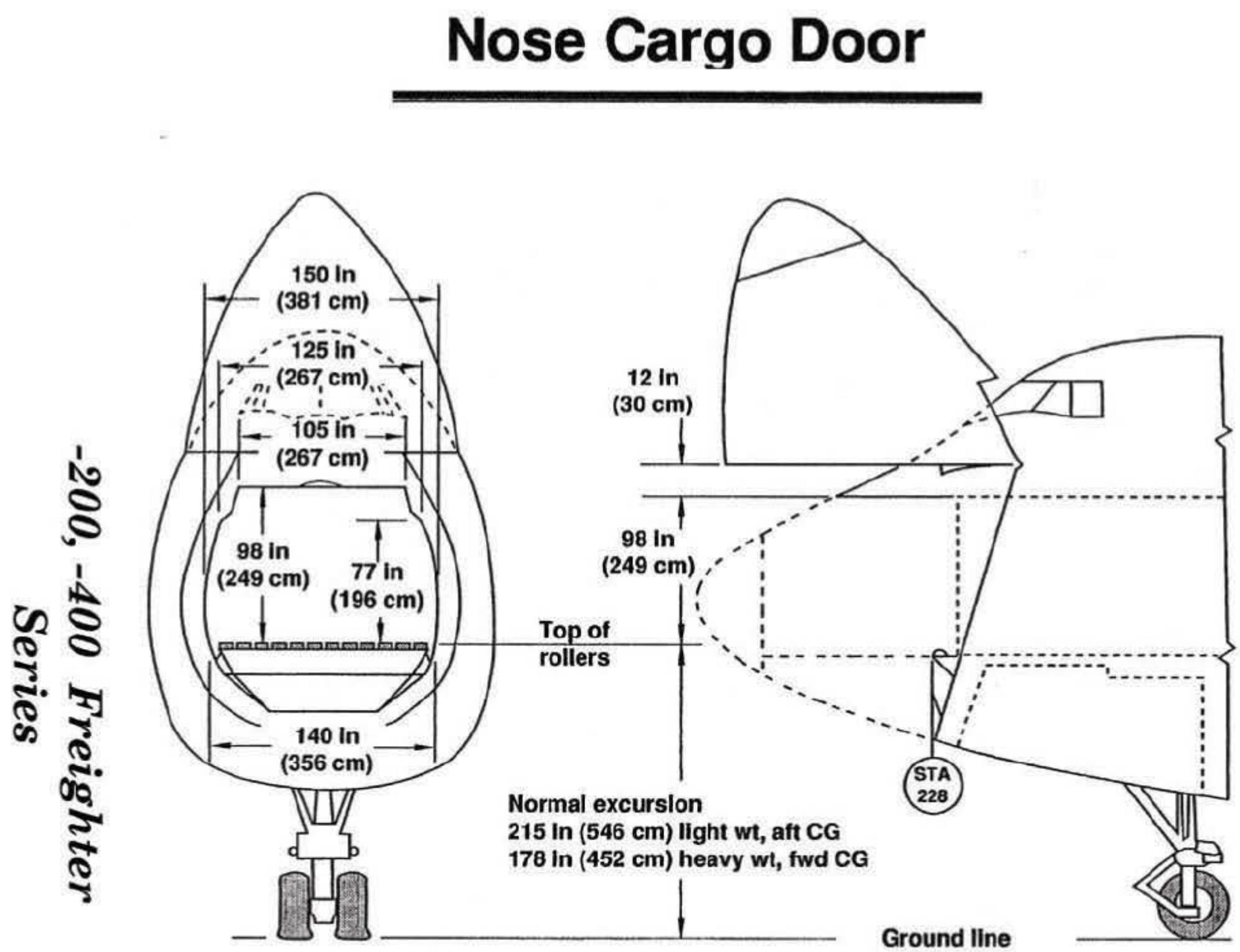


FIGURE B-190. B747 nose door clearances

Freighter Cargo Door Arrangement.

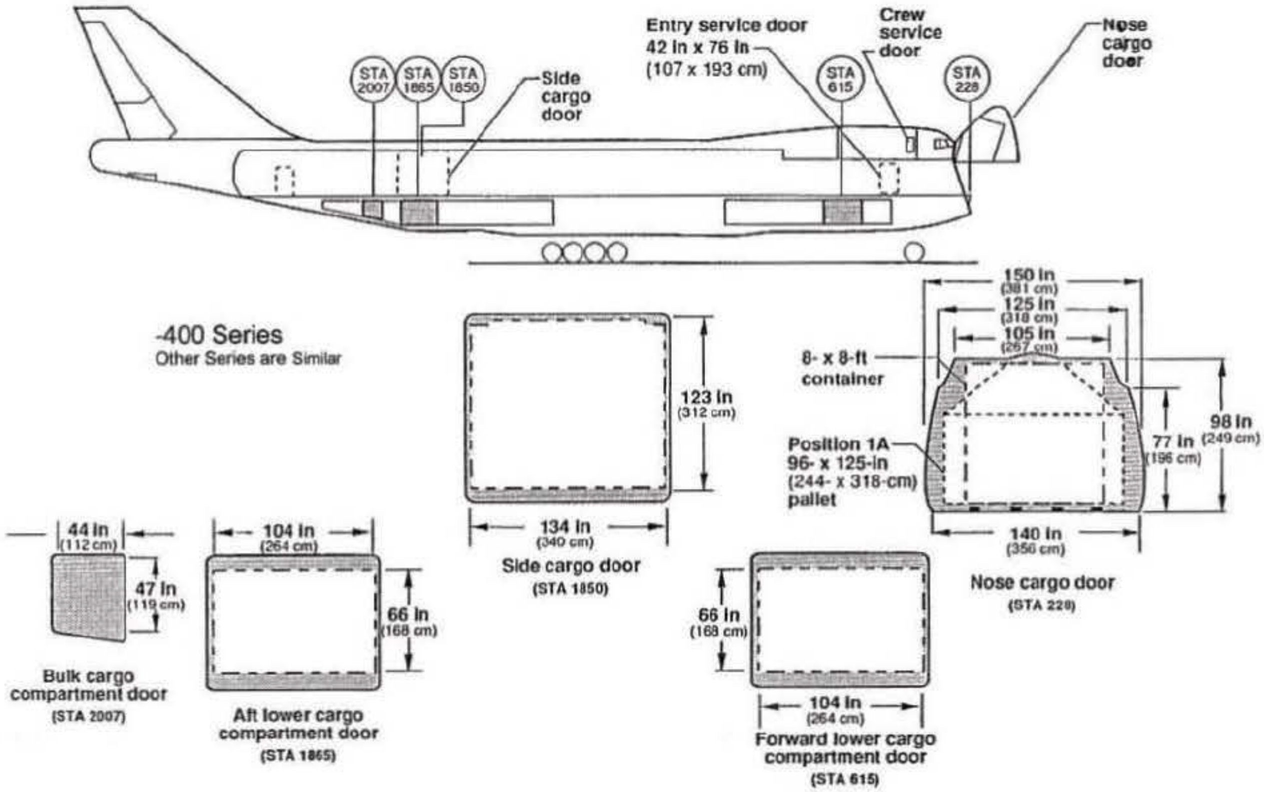
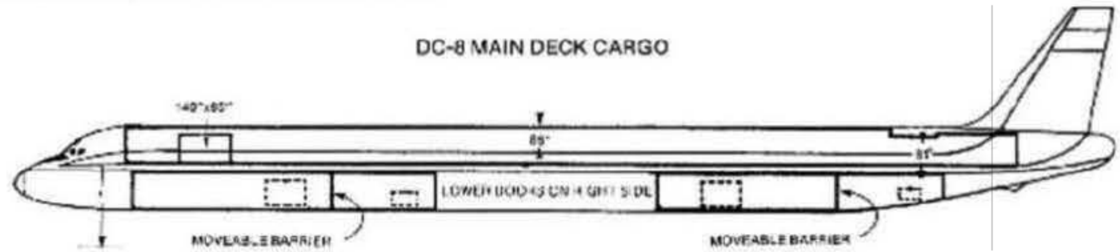


FIGURE B-191.

CRAF

DC 8 Maximum Pallet Weights, All Series.

NOTE: Users are advised to verify pallet weight allowables and restrictions with specific carriers prior to aircraft arrival.



(Note: This page not to scale.)

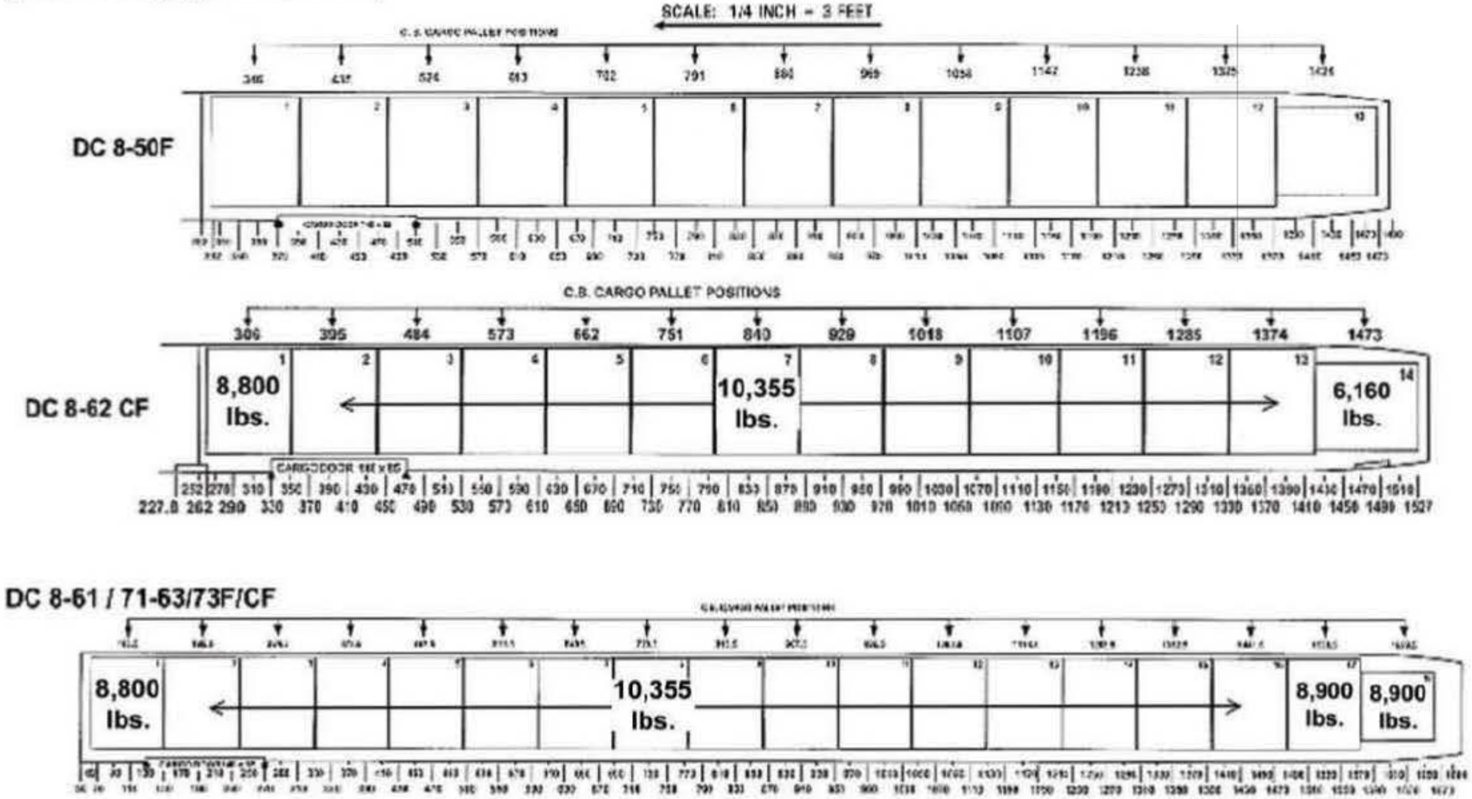
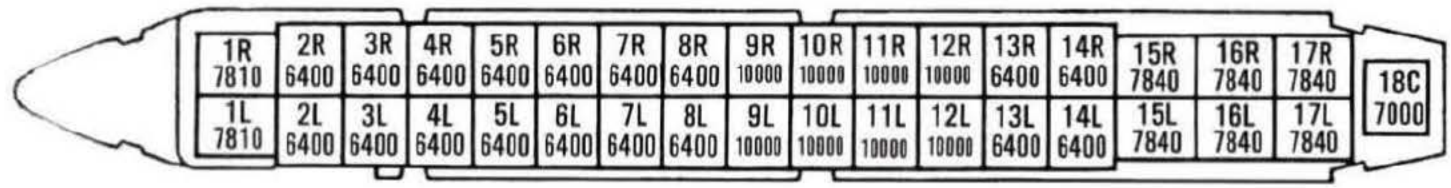
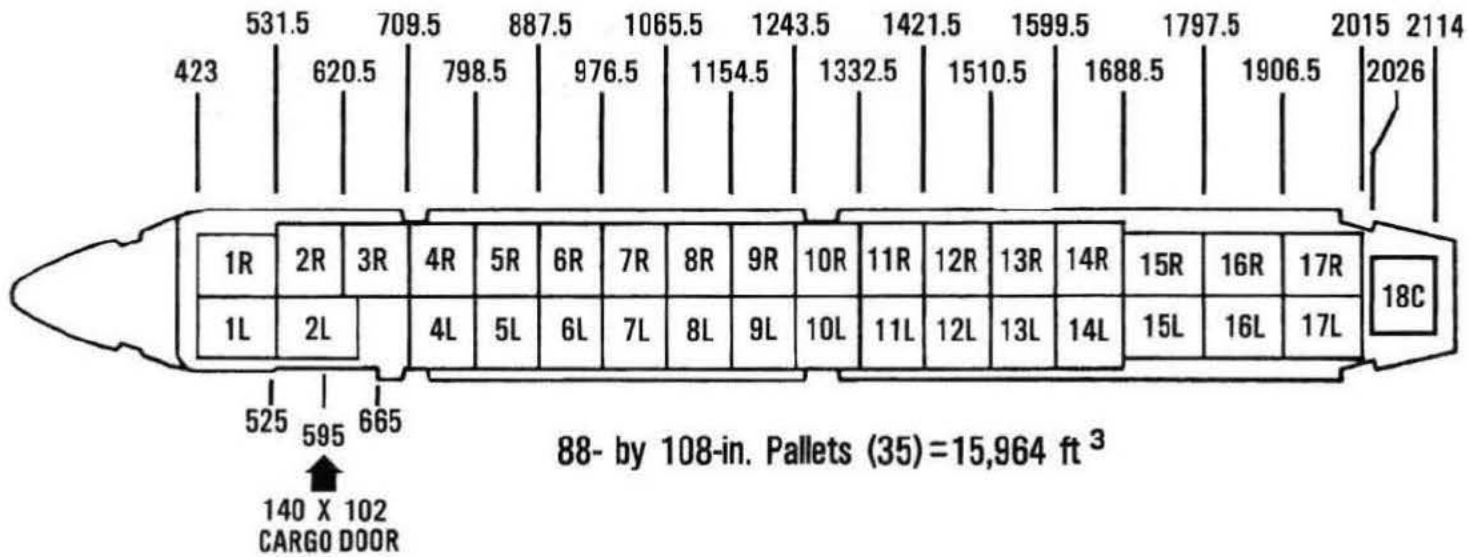


FIGURE B-192.

CRAF



88- by 108-in. Pallets (35)=15,964 ft ^{3}



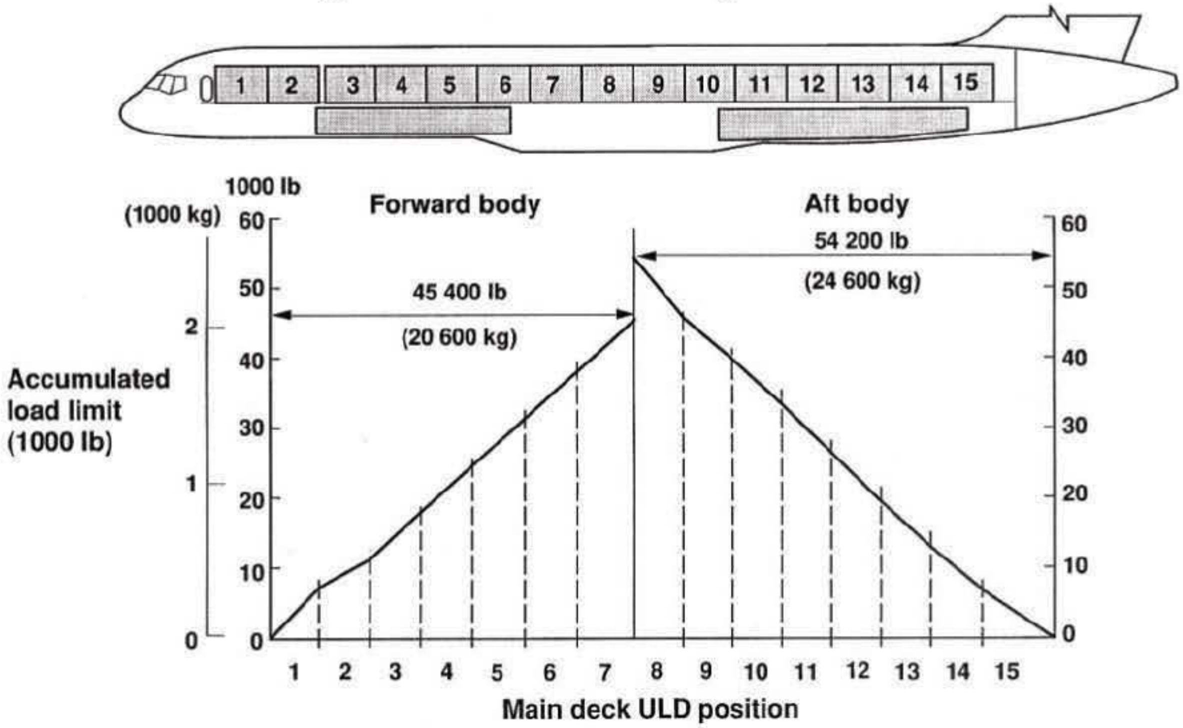
88- by 108-in. Pallets (35)=15,964 ft ^{3}

MD-11 FREIGHTER MAIN DECK PALLETIZED CARGO CAPABILITY

MD-11 Main Deck 463L Pallet Load Plan.

FIGURE B-193.

Model 757F Freighter Accumulated Load Diagram.



• Combined main deck and lower deck loads
• 88- x 125-in (223- x 317-cm) containers/pallets on main deck

Model 757F Freighter Pallet and Zone Load Limits.

757-200F Provides Load-Carrying Flexibility

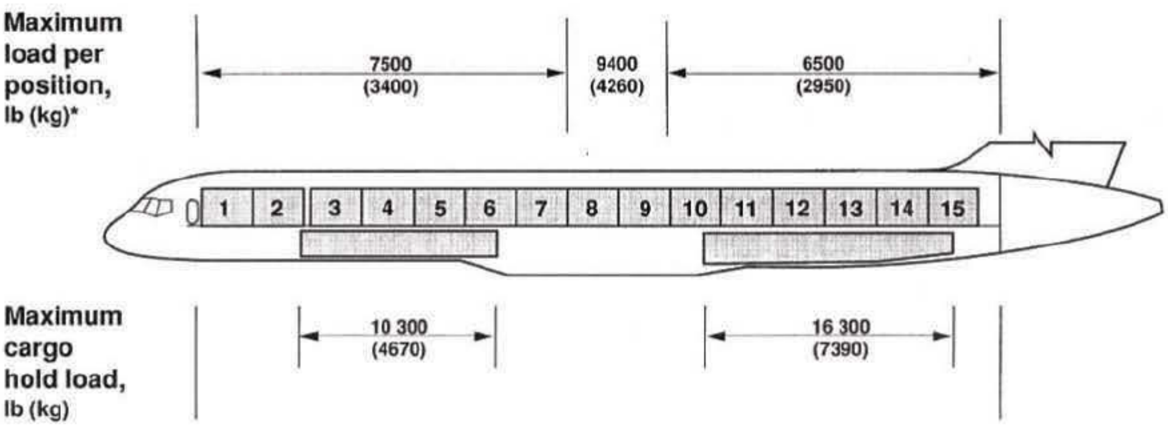
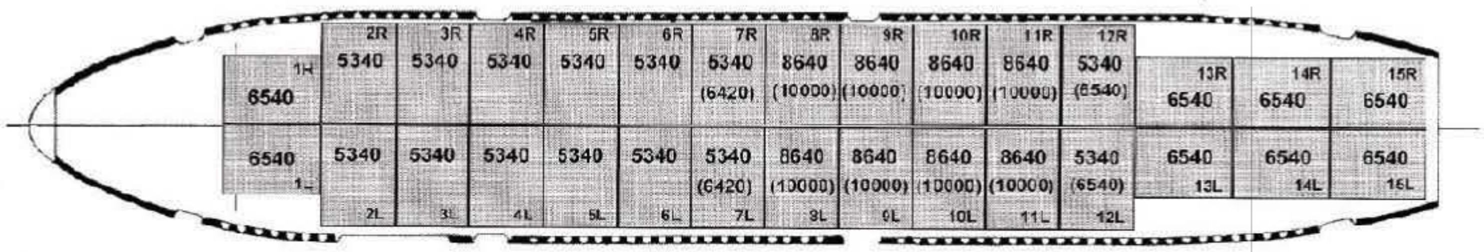


FIGURE B-194. B757 pallet weight capacity

DC-10 Floor Plan using 30 463L pallets (88" x 108")



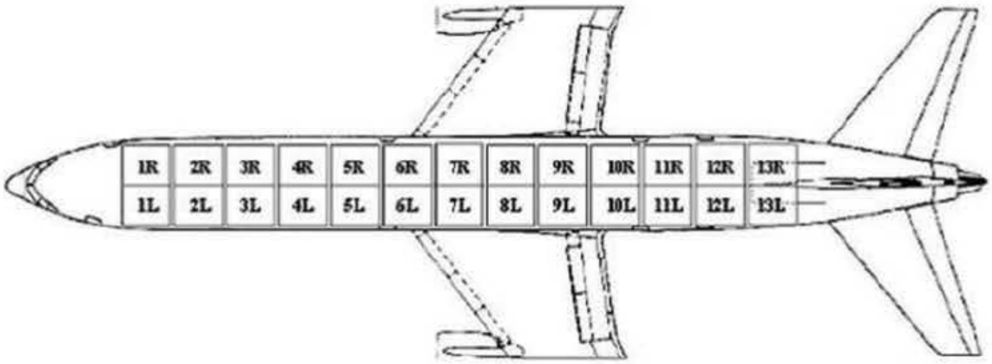
DC-10 Series -10	10,900	8,900	8,900	8,900	8,900	8,900	8,900	14,400	14,400	14,400	14,400	8,900	10,900	10,900	10,900
DC-10 Series -30	10,900	8,900	8,900	8,900	8,900	8,900	10,700	21,500	21,500	21,500	21,500	10,900	10,900	10,900	10,900

Pallet weight in parentheses are for the -30 series aircraft. All weights include the weight of the pallet and nets.

The combined weight for any left and right pallet at each position cannot exceed the weights given above. As an example: If the pallet in position 3L is 5,100 lbs., the pallet in 3R is limited to 3,800 lbs. That is 8,900 lb. limit - 5,100 in 3L = 3,800 allowed in 3R.

FIGURE B-195. DC-10-30F (Freighter) Floor Plans 30 Pallets, ca. 88" x 108" (463L).

Maximum Individual Pallet Loads. (Models L-1011-200-F)



Configuration C

Pallet Position		Max Gross Weight Per Pallet *	CG ARM Fls. Sta.
1L	1R	3200	415.5
2L	2R	6500	524.5
3L	3R	6300	651.5
4L	4R	6400	760.5
5L	5R	6500	869.5
6L	6R	6500	978.5
7L	7R	6500	1087.5
8L	8R	6500	1196.5
9L	9R	6500	1305.5
10L	10R	6500	1414.5
11L	11R	6500	1523.5
12L	12R	6500	1632.5
13L	13R	6450	1741.5

* *The Gross weight includes the tare weight of the pallets and nets.*

L-1011
-200
ONLY

FIGURE B-196.

CRAF

B747 Maximum Pallet Weight Limits 37 pallet Configuration.

B747 MAX WEIGHT TABLE, 37 PALLET

Note: All weight limitations are for general planning purposes, carrier is final authority. Some carriers will not accept a floor planned in a 37 pallet configuration.

1. All weights are maximums and include weight of pallet and nets.

2. All weights are for 200 series except for those is parentheses () are for 100 series.

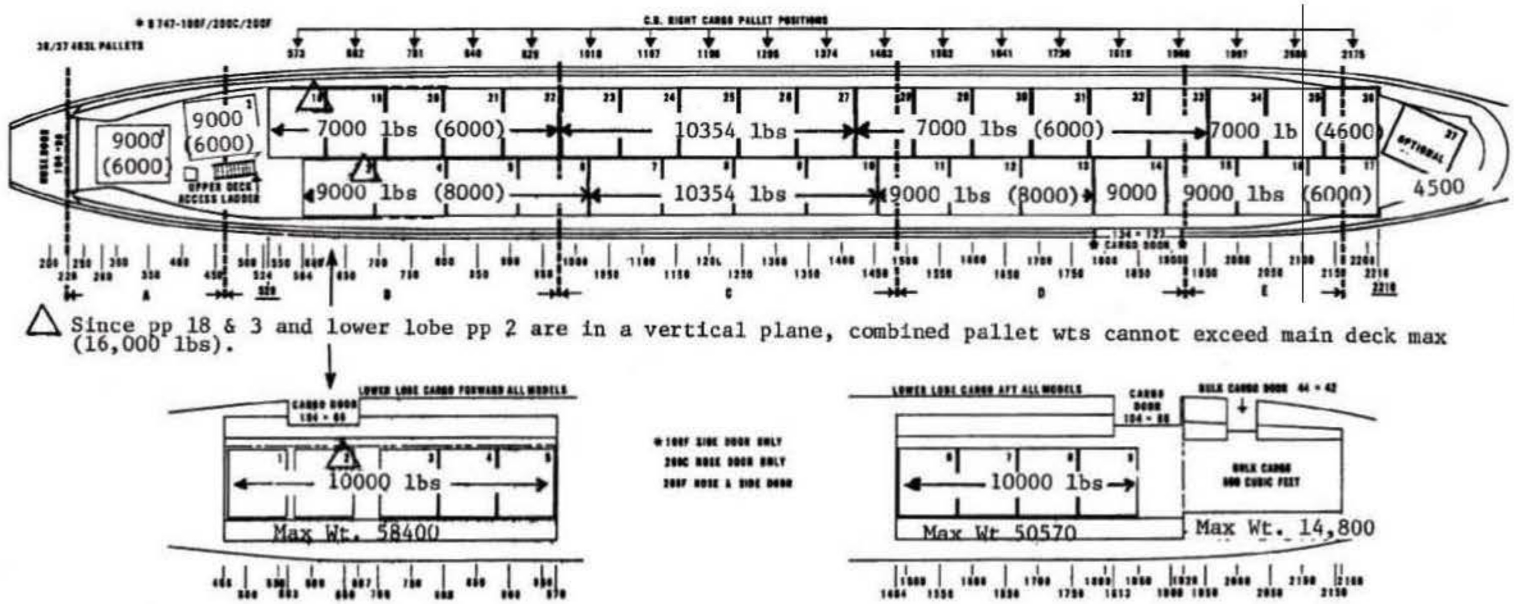
3. All weights are for individual pallets.

Directions;

1. Weights on main deck assume empty lower lobe.

2. Weights in lower lobe assume empty main deck.

△3 Combined main deck/lower lobe weights cannot exceed main deck limits on a vertical plane (i.e., 9,000 lbs on pp 18+3 limits LL plt 2 to 7,000 lbs).



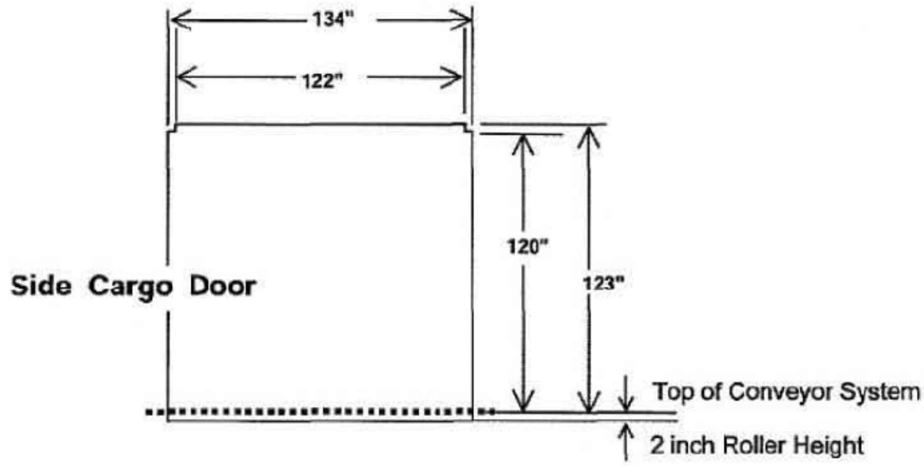
△ Since pp 18 & 3 and lower lobe pp 2 are in a vertical plane, combined pallet wts cannot exceed main deck max (16,000 lbs).

FIGURE B-197.

747 Maximum Package Chart, Side Doors Only.

SIDE Cargo Door MAX height calculations:

Door Height:	123.00
Pallet Height (minus)	- 2.25
Top Clearance (minus)	- 2.00
MAX Height:	118.75



Maximum package chart for B747 side door.

WIDTH INCHES
(measured from bottom of pallet)

HEIGHT INCHES	10	20	30	40	50	60	70	80	90	100	110	120	130	134
120	470	412	367	331	302	280	259	239	219	198	179	161	----	-----
118	470	412	367	331	302	280	259	239	219	198	179	161	144	137
114	536	458	404	361	326	299	277	256	237	217	196	177	158	153
108	600	509	441	391	350	318	293	271	251	231	212	192	173	165
102	600	561	481	418	373	338	309	284	263	243	224	204	185	180
0-96	600	600	517	447	395	355	323	297	275	254	232	213	186	192

EXAMPLE: A package118" high and 70" wide can be up to 259" long and still fit into the main deck.

Maximum Package Chart for B747

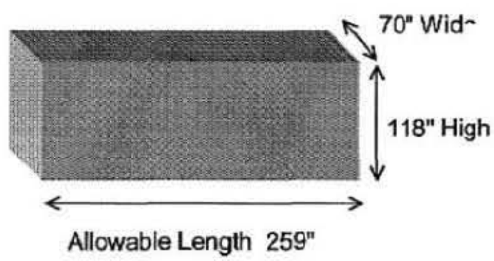


FIGURE B-198.

B747 LOWER LOBE, MAXIMUM LENGTH CHARTS
(Exception: B747SP and other B747 models with lower galley)

The following table can be used to determine the maximum package size that will fit through the 104 by 66-inch door found in the lower lob of the B747. Example: A package which is 90 inches wide and 60 inches high can be as long as 135 inches and still fit into the cargo compartment through the cargo door. Or, if the package is 80 inches wide and 195 inches long, it can be up to 40 inches high and still fit into the cargo area. However, these charts are for approximate measurements only.

TABLE B-XVIII. B747 lower lobe maximum length chart

		Width										
		10	20	30	40	50	60	70	80	90	100	104
		Maximum Length										
Height	66	280	245	220	195	170	155	125	125	125	125	125
	60	330	285	240	220	196	175	160	145	135	125	125
	55	385	325	280	245	215	195	175	155	124	165	135
	50	440	360	305	265	230	210	185	165	150	145	140
	45	440	430	360	300	260	225	200	170	155	150	140
	40	440	440	410	345	290	255	220	195	175	160	155
	35	440	440	440	380	330	270	235	205	180	160	155
	30	440	440	440	420	345	285	245	210	190	165	160
	25	440	440	440	440	360	300	255	220	190	165	160
	20	440	440	440	440	385	315	265	225	195	170	160
	15	440	440	440	440	415	330	280	235	200	175	160
	10	440	440	440	440	440	360	295	245	210	180	165
	5	440	440	440	440	440	440	320	265	225	185	170

The following Table B-IX is for the aft bulk cargo compartment, loading through the 104 by 66-inch door of the aft cargo compartment, but pushing the package in the aft direction into the bulk cargo compartment.
NOTE: A removable curtain separates the two cargo compartments.

TABLE B-XIX. B747 lower lobe aft bulk cargo door (104 x 66 inch)

		Width									
		10	20	30	40	50	60	70	80	90	100
		Maximum Length									
Height	47	140	140	140	140	140	140	140	140	135	120
	43	155	155	155	155	155	155	155	145	135	120
	39	180	180	180	180	180	175	155	145	135	120
	36	200	200	200	200	180	175	160	145	135	120
	32	230	230	230	230	205	180	160	145	135	120
	24-28	235	235	235	235	215	180	160	145	135	120
	4-20	240	240	240	240	215	180	160	145	135	120

The following Table X is for the aft bulk cargo compartment, loading through the 44 by 47-inch door, but pushing the package in the forward direction into the aft cargo compartment.

NOTE: The block area indicates pushing the package toward the aft section of the aft bulk cargo compartment.

TABLE B-XX. B747 lower lobe aft bulk cargo door (44 x 47 inches)

		Width										
		4	8	12	16	20	24	28	32	36	40	44
		Maximum Length										
Height	47	140	140	140	132	126	121	117	114	110	108	108
	43	160	160	155	145	140	135	130	125	120	115	110
	39	180	165	155	150	140	135	130	125	120	120	120
	36	185	170	160	150	145	135	130	125	120	120	120
	32	190	175	165	155	150	140	135	130	125	120	120
	28	200	185	170	160	155	145	135	130	125	120	120
	24	220	190	175	165	155	145	135	130	125	120	120
	20	220	195	180	170	155	145	135	130	125	120	120
	16	230	205	190	175	160	150	140	135	125	120	120
	12	235	220	200	180	165	155	145	135	130	125	120
	8	235	235	215	195	175	160	150	140	130	125	120
	4	235	235	225	210	185	170	155	145	135	125	120

B747-400 Running Load (Pound Per Linear Foot) Limits.

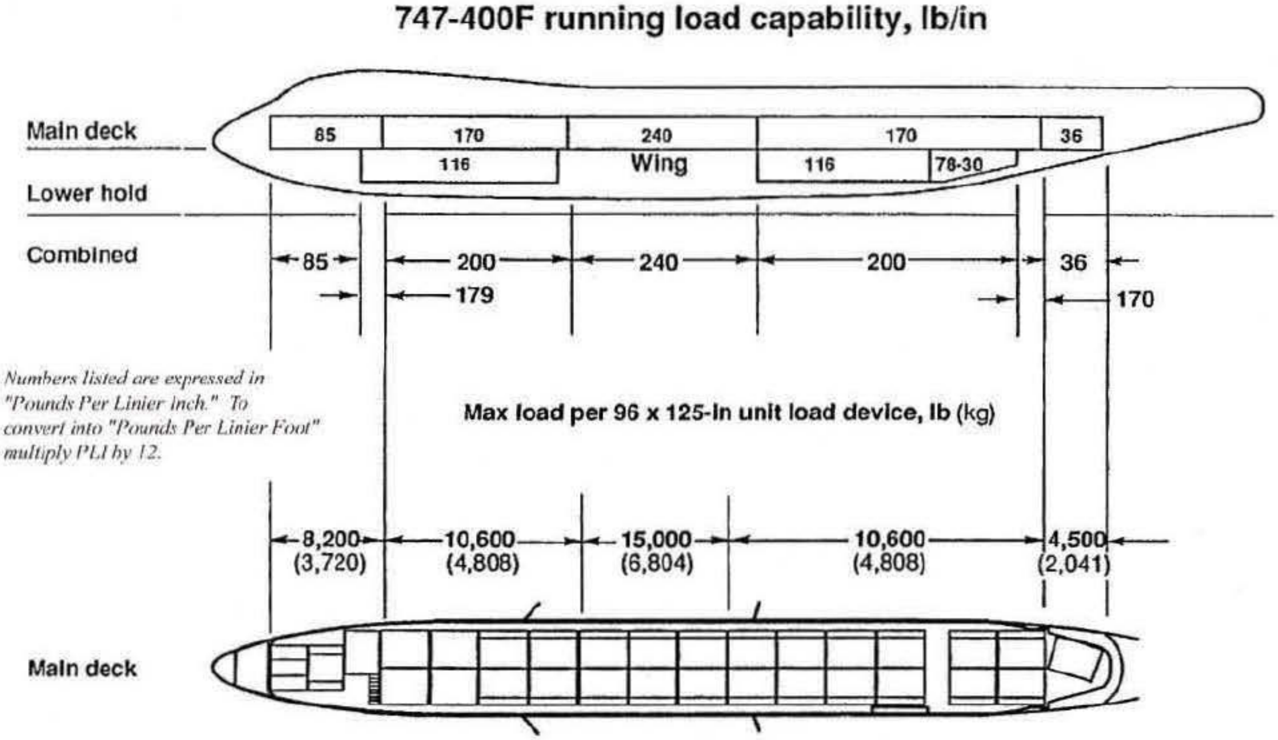
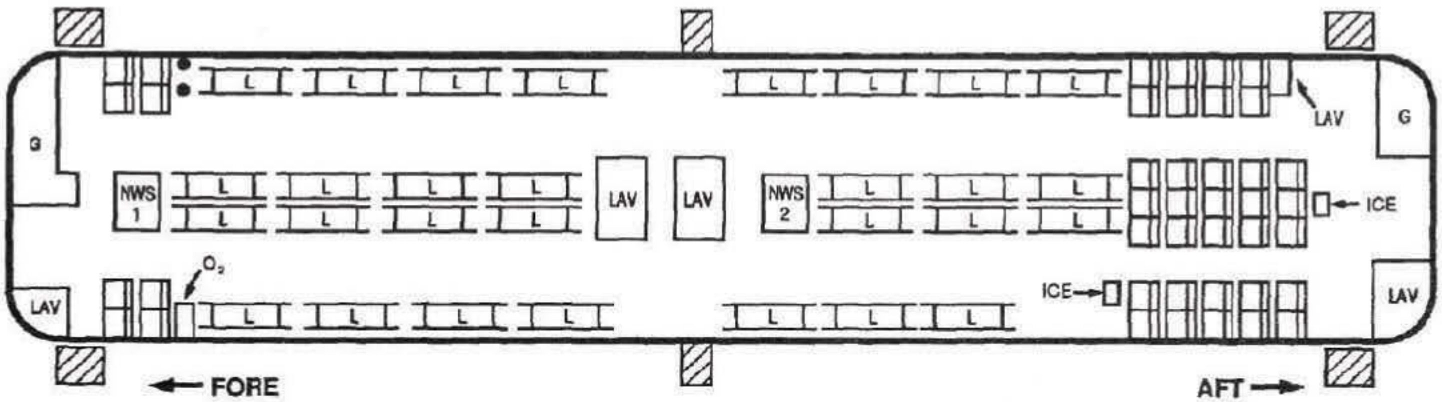


FIGURE B-197.

FIGURE B-200. B767-200 Areomedical Evacuation Configuration.

BOEING 767/200 Series



LEGEND:

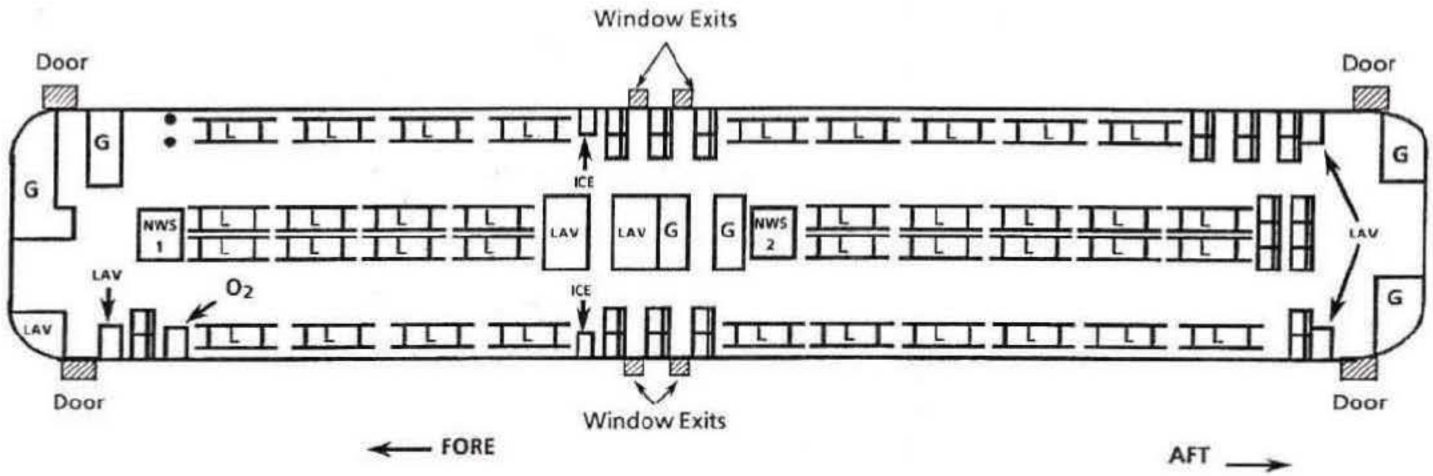
- ● = Power Distribution System
- G = Galley
- L = Litter
- Lav = Lavatory
- NWS = Nurse's Work Station
- O_2 = Oxygen Management Panel
- (hatched box) = Emergency Exit
- (seat block) = Seats

87 Litters
41 Ambulatory /Crew

B767-200 Series Aeromedical Evacuation Configuration

FIGURE B-201. B767-300 Areomedical Evacuation Configuration.

Boeing 767/300 Series



Legend
- ● = Power Distribution System
- G = Galley
- L = Litter
- Lav = Lavatory
- NWS = Nurse's Work Station
- O_2 = Oxygen Management Panel

= SEATS = Emergency Exit

111 Litters
30 Ambulatory/Crew

CRAF

APPENDIX C
AIR TRANSPORT CONCEPTS

C.1. SCOPE
This appendix discusses basic air transport concepts such as load planning and the 463L Air Cargo System. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

C.2. DEFINITIONS

Explosive atmosphere	A condition in which the cargo compartment is filled with enough fuel vapor to explode or cause fire if ignited by a spark or high temperature. (Requirements only apply to tanker aircraft.)
Rapid decompression	Pressure differential of 8.3 psi developed in 0.5 sec.

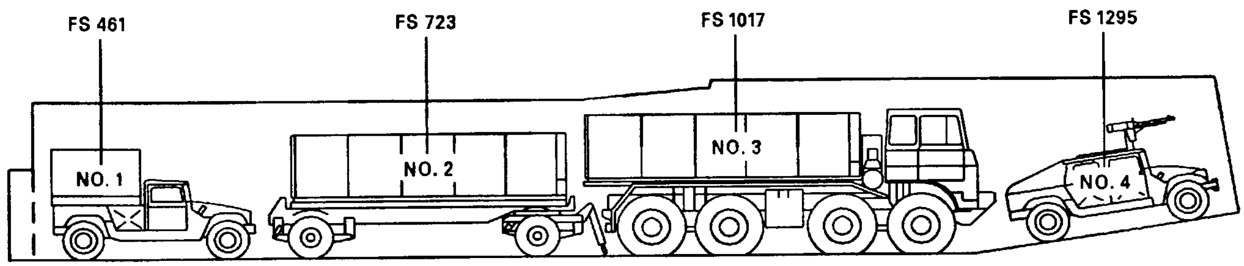
C.3. LOAD PLANNING
Load planning is the process of identifying possible locations to park the item in the aircraft. Cargo should be parked at locations that meet aircraft flight weight limits, size limits, and any location affected by special considerations (such as venting) or special procedures (such as parking shoring). The item's proximity to other cargo and the loadmaster's ability to route tiedown chains/straps and have in-flight access are also considerations.

Not all limits defined below apply to all aircraft. Consult the T.O. 1C-XXX-9 cargo loading manuals or appendix B for details.

C.3.1 Access to aircraft systems.
Consideration should be given to positioning cargo near vent ports when necessary to discharge hazardous vapor, near access to aircraft communication systems if necessary, near electrical outlets if necessary, away from oxygen masks if necessary, or away from any other location identified by the loadmaster.

C.3.2 Aircraft CG limits.
Cargo shall be positioned within the aircraft's allowable CG limits. Figure C-1 is an example of multiple loads in the aircraft. The location of all the loads shall result in an overall center of gravity with the aircraft limits. Figure C-2 shows a typical aircraft cargo loading center of gravity (C.G.) limit. The overall CG location shall fall under the curve to keep the aircraft in balance.

The overall CG shall be computed as follows: Multiply the item's CG fuselage or load station position by its weight. Sum the values and divide by the sum of weights for all cargo in the cargo compartment. The result is the location of the CG, in terms of fuselage station. The calculation is shown on figure C-1. The result of the calculation for the loads shown on figure C-1 is fuselage station 891. Weights of baggage, fuel, and personnel should be included for actual missions.



	COLUMN 1	COLUMN 2	COLUMN 3 $\left(\frac{\text{COLUMN 1 X COLUMN 2}}{10{,}000}\right)$
VEHICLE	FUS STA ITEM CG	VEHICLE WT (POUNDS)	MOMENT (INCH POUNDS x 10,000)
NO. 1 TRUCK	461	9,000	415
NO. 2 TRAILER	723	20,000	1,446
NO. 3 TRUCK	1,017	30,000	3,051
NO. 4 TRUCK	1,295	8,500	1,101
TOTAL	——	67,500	6,013

$$\frac{60{,}130{,}000}{67{,}500} = 890.8 \text{ CG OF TOTAL LOAD}$$

FIGURE C-1. Multiple loads in aircraft.

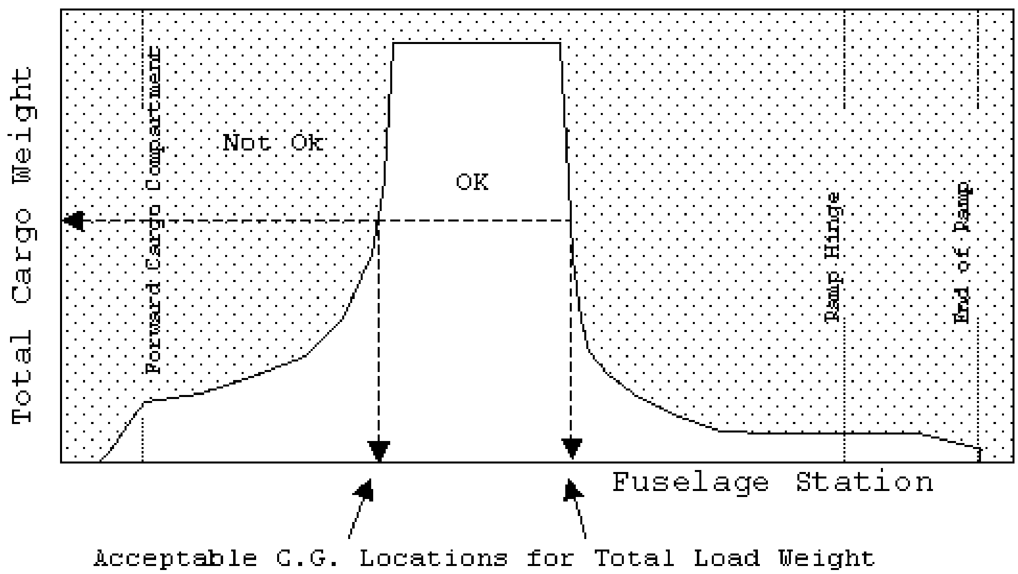


FIGURE C-2. Allowable CG locations.

C.3.3 Aircraft cargo payload.

The total weight of the cargo item, total system of multiple items, and accompanying shoring and special equipment shall not exceed the total payload capability of the aircraft. The payload weight is reduced to allow the aircraft to take off or land in hot weather, on short runways, and/or at high altitude location. The item's mission scenario or operational concept can limit the aircraft allowable payload and affect whether the item can be certified for a given type of aircraft.

For example, if the mission requires the cargo to be delivered to a high altitude area above 8,000 feet in 100 degree temperature on a 4,000 foot runway, the maximum payload will be significantly reduced for any aircraft. The published aircraft payload weight and CG limits for landing are based on a nominal mission flying into a 10,000 foot runway at standard sea level conditions.

C.3.4 Availability of tiedowns.

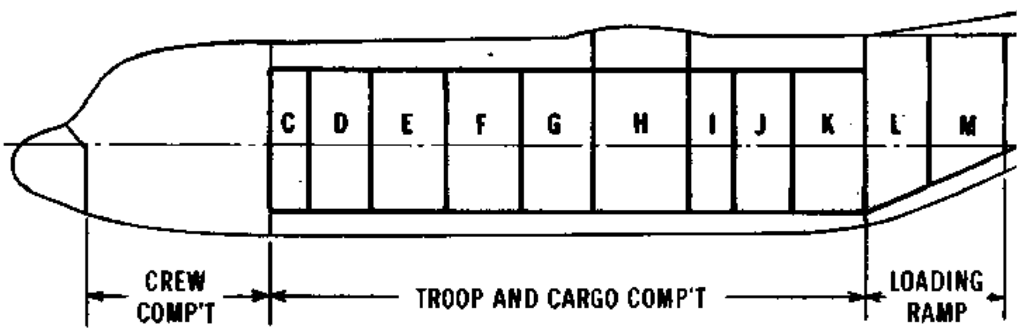
Location of the item shall allow access to a sufficient number of tiedowns (both on the aircraft floor and on the cargo item) to meet minimum restraint criteria as specified in 4.3.3 and 5.3.3.

C.3.5 Compartment size limit.

The item shall be sized to be at least 6 inches from the aircraft ceiling while maintaining access to critical areas of the aircraft, maintaining a safety passageway for egress, and sometimes, available areas for passengers. Parking shoring shall be considered, as it will increase the item's height and footprint. If the item has variable height, such as with air ride suspension, it shall not contact the ceiling at maximum inflation. (Reinflating air ride suspension after landing can result in a taller vehicle than when it was driven aboard.) Other situations that might temporarily increase the height may include raising trailer tongue or gooseneck to disconnect from prime mover or lifting (by any means) to install shoring or jack stands.

C.3.6 Compartment weight limits.

The aircraft cargo compartment is partitioned into multiple compartments for the purposes of weight limits (compartment limits) (figure C-3). Cargo shall be placed so it does not exceed individual compartment limits. The total weight of all compartments shall not exceed the aircraft's total payload limit.



GENERAL

1	Fuselage Station	245 281 337 401 457 517 597 627 682 737 803 869											
2	Compartments		C	D	E	F	G	H	I	J	K	L	M
3	Floor Area (approx)	Sq Ft	31	48	55	48	51	68	26	47	47	56	56
4	Usable Volume	Cu Ft	280	430	495	430	460	610	235	420	420	450	280

FLIGHT LIMITS

1	Maximum Individual Compartment Capacity	lb	8400	12 900	19 500	28 000	30 000	40 000	15 000	24 400	12 700	2500	2500

FIGURE C-3. Compartment limit chart.

C.3.7 Interference with other cargo.

Systems with multiple loads or missions requiring multiple loads also affect cargo location within the aircraft and even the ability of the aircraft to carry the cargo. Cargo placed on the ramp will rotate forward as the ramp closes. The ramp cargo shall be placed far enough aft so as not to contact cargo located forward of the ramp hinge (figure C-4).

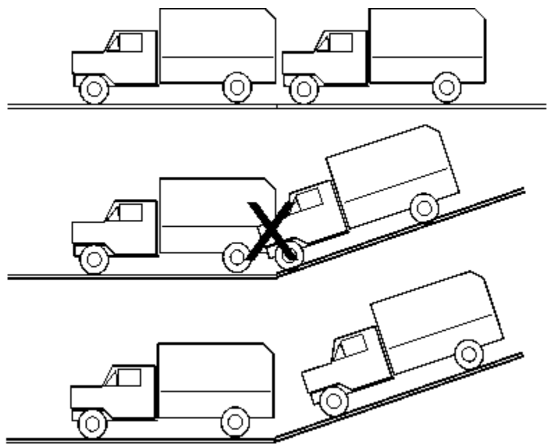


FIGURE C-4. Ramp cargo placement.

C.3.8 Lateral weight and axle limit.

Placement of cargo to one side or multiple loads side-by-side shall not exceed the aircraft lateral load limits.

C.3.9 Ramp contact.

Cargo shall have sufficient overhang ground clearance or be parked sufficiently far forward to prevent contact with the ramp when it is closed. (See B.3.1.5)

C.3.10 Sensitive areas.

Cargo shall not be parked in sensitive areas as cited by the aircraft T.O. 1C-XXX-9 cargo loading manual or appendix B. The C-17 and C-5 aircraft have lower weight limits when traversing or parking over roller trays and rail covers.

C.4 LOADING CARGO.

There are several ways cargo can be loaded into the aircraft. Cargo can be carried, pulled, or rolled up the ramp. Examples of cargo are small boxes, wounded on stretchers, large boxes, and vehicles. Cargo can also be rolled, pulled, or carried straight in from another vehicle, or moved by MHE over the cargo floor or roller conveyors. Examples are palletized cargo and vehicles.

Any preparations or reconfiguring shall be completed prior to loading for cargo to be safe to fly. Loading equipment or support material shall also be available prior to flight. Sometimes this equipment and/or material should be positioned before the cargo is loaded. Examples of loading equipment are K-loaders and forklifts. Examples of loading material are approach shoring, lubricants, loading kits, and rolling shoring.

C.4.1 Loading through cargo door and ramp.

C.4.1.1 Ground loading.

For ground loading, the aircraft cargo door is opened and the ramp is lowered to the ground. The cargo door is rotated up and locked to the ceiling of the cargo compartment. The ramp has a skid plate at the underside of the end to support the ramp on the ground and protect the ramp during combat offload. The ramp angle varies with the height of the cargo floor above the ground. (Cargo floor height is determined by how much weight is already on the aircraft, cargo and fuel combined.) The higher the cargo floor is from the ground, the steeper the ramp angle. A steep ramp angle can cause loads with lower ground clearance to contact the ramp or the ramp hinge. Loads with a tall projected height can contact the ceiling. To prevent contact with the aircraft and prevent overloading of aircraft components, shoring may be necessary. Approach shoring decreases the ramp angle by degrees sufficient to prevent the item from contacting the ground, the aircraft ramp toes, ramp, ramp hinge, and/or ceiling (see 5.3.1.1.1). Approach shoring can also be used to prevent overloading the axles of the cargo, particularly wheeled vehicles where all axles must remain in contact with the ground or ramp. Rolling shoring under the wheels brings the weight distribution within the cargo floor's limits. See A.5.4.2, for information about approach and rolling shoring.

A ramp extension or ramp toe is attached to the lower end of the ramp to bridge the ramp top surface with the ground. The C-5 forward ramp has ramp extensions and ramp toes to bridge this gap (see appendix B). The angle for each subsequent segment differs from the ramp angle.

C.4.1.2 Straight-in loading.

Some items such as palletized cargo or cargo with extremely low ground clearance have to be loaded with the ramp in the coplanar position with the cargo floor. The cargo is carried by MHE, such as a K-loader or forklift. If the item cannot be pushed or driven in from the MHE, it may be winched in.

C.4.1.3 Material handling equipment (MHE).

Cargo can also be loaded using material handling equipment (MHE). MHE are forklifts, K-loaders, mobilizers, or special handling tools. Forklifts carry the item into the aircraft, push the item into the aircraft, and/or pick up part of the item to help the item overcome obstacles. If the forklift goes with the item inside the aircraft, the combined weight and size characteristics shall be evaluated as rolling stock to ensure the forklift and item are loaded and offloaded safely. The forklift does not necessarily have to be transported with or attached to the item. K-loaders raise the item to be level with the cargo ramp and load the cargo straight into the aircraft. Mobilizers are wheeled frames that attach to bulk cargo and convert the item into rolling stock. Special handling tools are specifically designed to load and unload unusual cargo. Adjustments to any of the MHE during the loading process are allowed. However, the procedure may need to be evaluated if there is anticipated risk of damage or loss of control.

KC-10, KC-135 and the CRAF aircraft have side cargo doors for loading cargo. Cargo is palletized and carried up to the door by a K-loader.

C.4.2 Winching.

Winching is a method of on/offloading extremely heavy cargo units such as large, skidded boxes, palletized cargo, or vehicles when it is not practical to drive them on or off the aircraft using their own power. Winching is also used to pull palletized or skidded loads that have become stuck during the onloading and offloading process. Winching can also be used as a safety to prevent loads from moving too quickly or getting out of control during the loading and offloading process. Each aircraft has an on-board winch; item-mounted winches may also be used (subject to their own limitations).

C.4.2.1 Winching operation.

All winching operations shall be closely monitored by a crew of at least three personnel, the loadmaster and two guides, to judge clearances and control the vehicle. During vehicle loading, clearance shall be monitored and the driver kept informed through the use of the headset or by use of prearranged hand signals. Guides shall be stationed at strategic points and remain in contact with the loadmaster. During winching operations, the guides shall check clearances between the cable and vehicle to prevent fouling or snagging of the cable.

NOTE: If the load must be stopped on the ramp during onloading or offloading, safety tiedowns may be secured between tiedown rings and the item. These are used to prevent a runaway item in case the winch cable breaks, or if there is a need to stop and adjust the load.

During offloading, ensure cable slack is removed before the cargo transits the ramp crest. If a slack cable condition occurs as the cargo transits the ramp crest during offload, the cargo may lunge aft, jerk the cable, and cause cable failure. Injury to personnel and damage to equipment may result.

C.4.2.2 Preparations.

Before winch loading, the aircraft should be prepared for the loading operation. Equipment such as the winch, winch cable, snatch blocks, tiedowns, item attachment points and tow bars are inspected for serviceability. Shoring should be positioned, as required. Chocks should be positioned to prevent vehicles from rolling beyond their final position.

C.4.2.3 Winching calculations.

The critical parameters for determining if the item can be winched are friction and item weight, these affect winch cable force. The current winches are limited to about 2,000 pounds of cable tension when pulling at high speed. See table III for detailed winch cable limitations. For extremely heavy cargo, cable force can be reduced by routing the cable through pulleys called purchases or snatch blocks. Calculations for winching follow:

C.4.2.3.1 Coefficient of friction.

Each material or combination of materials has an average coefficient of friction. To simplify the problem of variable coefficients of friction, an average value under normal conditions is used for each material. The cargo loading (T.O. 1C-XXX-9 series) manuals and table C-I contain average coefficients of friction for all loading methods.

C.4.2.3.2 Calculating cable force.

To calculate exact cable pull, use the following formula:

Cable Pull = (sine x W) + (cosine x W x FC)

W = Weight of Cargo

FC = Coefficient of Friction

sine and cosine refer to the sine and cosine value for the ramp angle

For example, a 20,000 pound wheeled item being pulled up a 15-degree ramp requires a winch cable pull of

FC = 0.03

W = 20,000

For 15-degree ramp, sine = 0.259, cosine = 0.966

Cable Pull = (0.259x20000) + (0.966x20000x0.03) = 5,756 pounds

Using the same calculation method, cable pull forces for different types of loads at 20,000 pounds, using 0, 10, and 15-degree ramps, are shown in table C-I.

TABLE C-I. Winch cable force, various surfaces.

	Rolling On			Sliding On				
Item Wt 20,000 lb	**Pneu-matic Tires**	**Tracks**	**Steel/ Hard Rubber Wheels**	**Roller Con-veyors**	**Greased Shoring**	**Dry Shoring**	**Skids on Non-Skid Surface**	**Non-Skid Surface**
Coefficient of Friction	***0.030***	***0.080***	***0.018***	***0.020***	***0.260***	***0.490***	***0.815***	***1.000***
0-Degrees	600	1,600	360	400	5,200	9,800	16,300	20,000
10-Degrees	4,064	5,049	3,827	3,867	8,594	13,124	19,525	23,169
15-Degrees	5,756	6,722	5,524	5,563	10,199	14,642	20,921	24,495

C.4.2.4 Using snatch blocks/purchases.

Snatch blocks (or tackle blocks, or purchases) are portable pulleys that attach to the cargo floor tiedown rings, or the item, or both. They reduce the winch cable force and increase the winch's capability to pull in heavy loads. The limitation then becomes available cable length. C-130E/H with HCU-9/A winch has 200 feet of usable cable. The C-130J and J-30 have 200 usable feet with the internal winch, the C-17 has 250 usable feet, the C-5A has 175 usable feet, and the C-5B has 250 usable feet.

The snatch blocks are rated up to 20,000 pounds. On the C-130, the tiedown ring reduces the rating per snatch block to 10,000 pounds.

Figure C-5 and figure C-6 show the use of snatch blocks when cargo is pulled in by the winch or the item self-winching into the aircraft.

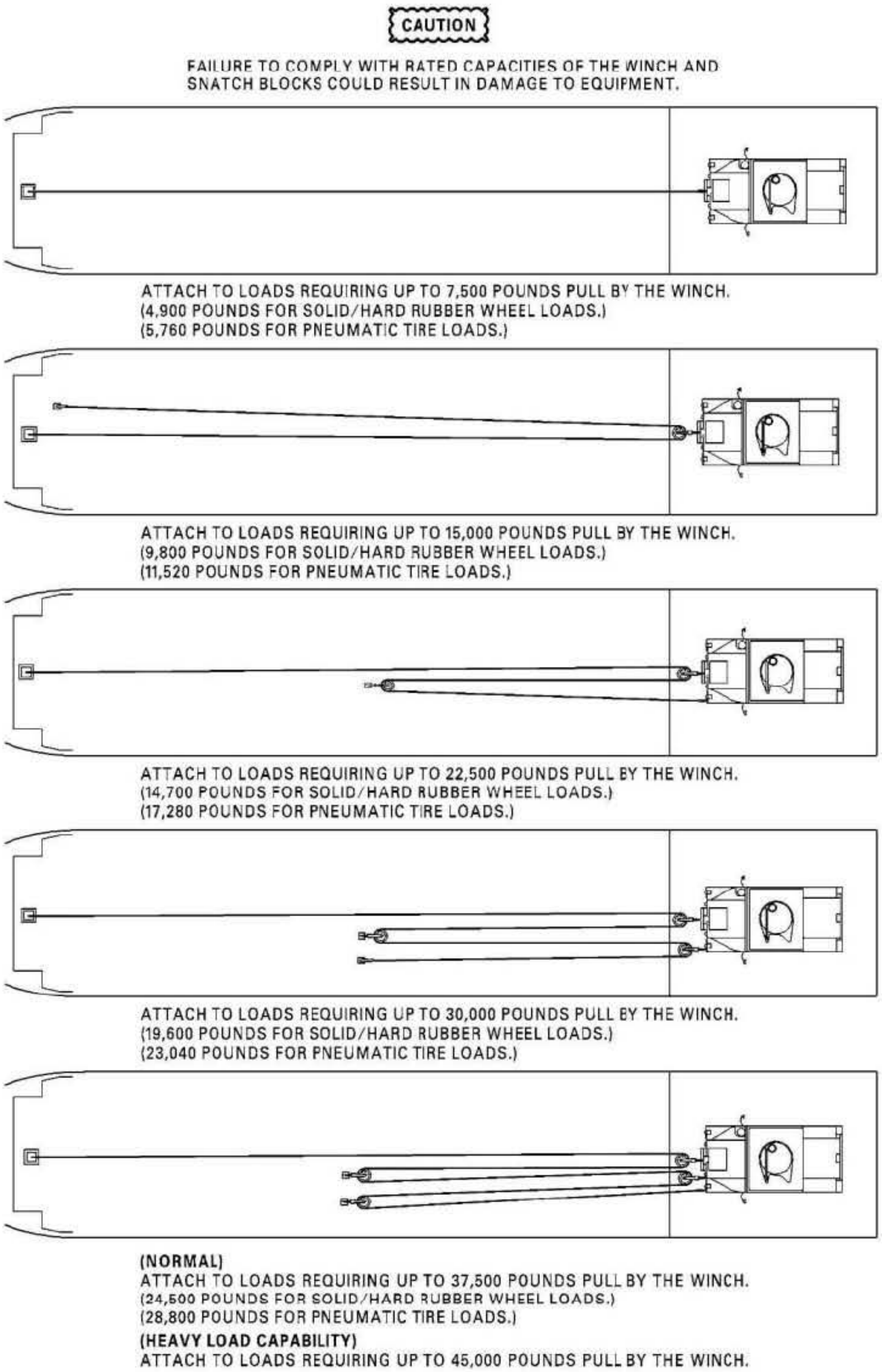


FIGURE C-5. Winching with snatch blocks.

CAUTION

FAILURE TO COMPLY WITH RATED CAPACITIES OF THE WINCH AND SNATCH BLOCKS COULD RESULT IN DAMAGE TO EQUIPMENT.

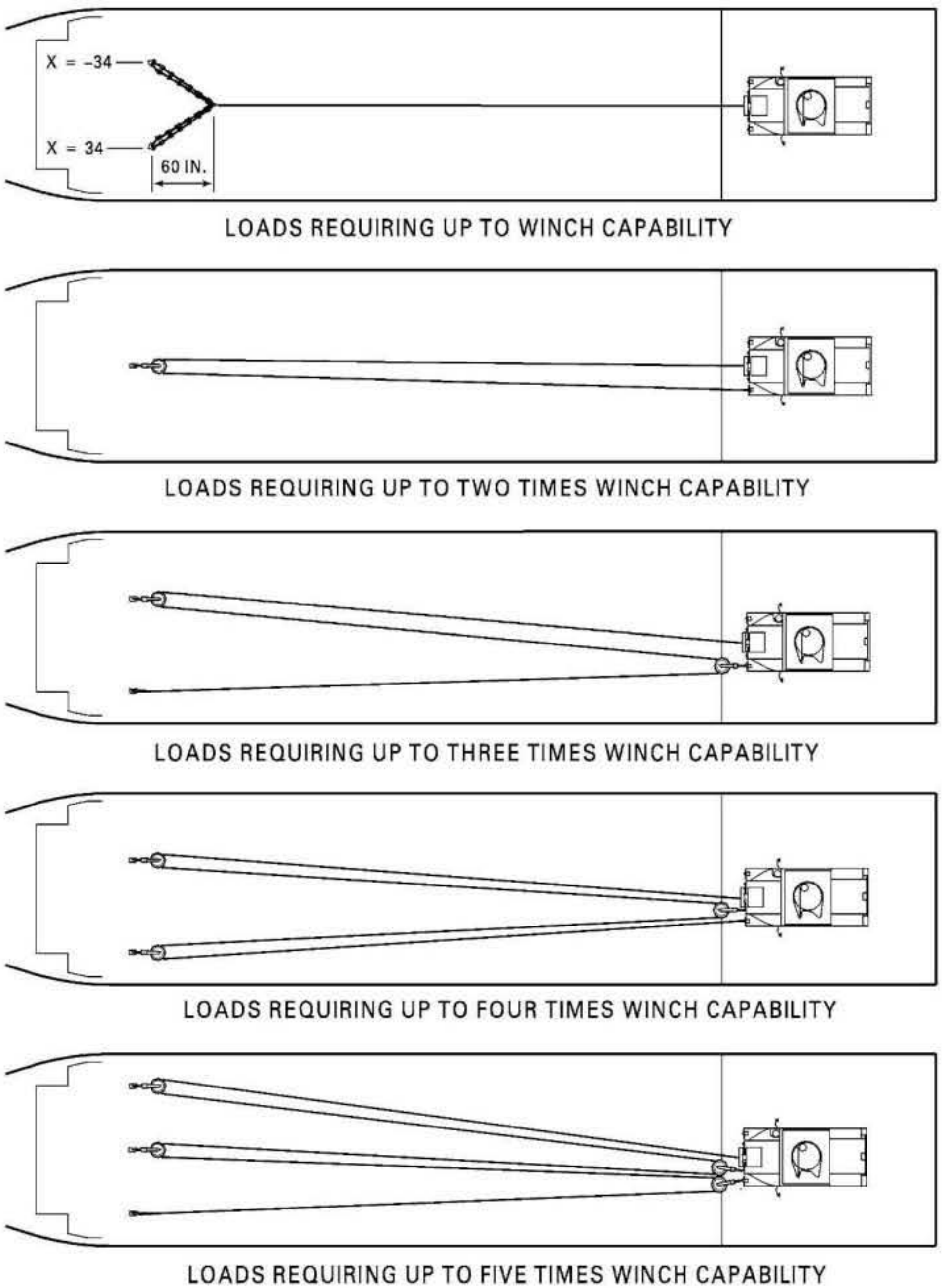


FIGURE C-6. Self-winching using snatch blocks.

C.5 RESTRAINING CARGO.

C.5.1 General.

All airlifted cargo must be restrained so it will not shift during any of the flight conditions that can normally be experienced by the aircraft. Dynamic forces caused by various flight conditions (air turbulence, rough landings, extreme flight attitudes, survivable crashes, etc.) tend to move the cargo in a forward, aft, side, or vertical direction or combinations of these directions. These forces are directly proportional to the cargo object's mass (weight) and to the rate of change in the aircraft's flight velocity. These forces are commonly expressed in units of gravitational force, signified herein by the letter "G". (See figure C-7)

These dynamic forces may be resisted by the application of restraining static loads to equal the dynamic loads. Except for vertically down, the restraining static load is achieved through the use of nets, straps, chains, etc. attached between the cargo object and the aircraft. The amount of restraint needed in each primary direction is equal to the weight of the object multiplied by the anticipated G loads.

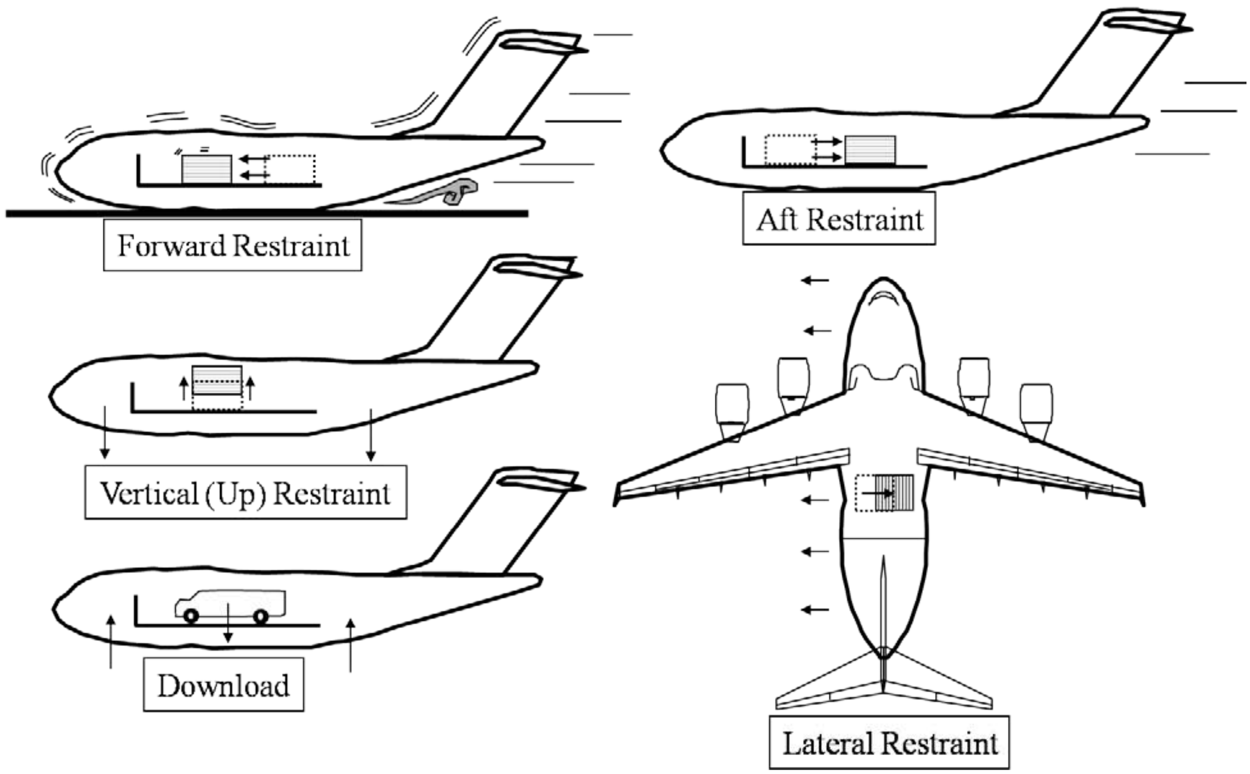


FIGURE C-7. Restraint for various situations.

C.5.2 Aircraft systems.

There are two restraint systems on the aircraft. Palletized loads generally use the rail system locks. Rolling stock and bulk loads generally use the floor tiedown rings along with aircraft provided tiedown devices (figure C-8). Tiedown rings are also used to restrain palletized or accompanying loads when the load-carrying system, such as a pallet or trailer, cannot fully restrain the item.

C.5.2.1 Aircraft tiedown ring.

On the C-27 and C-130 the majority of tiedown rings are rated at 10,000 lbs in any direction. The C-130 ramp rings are rated at 5,000 lbs. On the C-17 and C-5, the rings are rated at 25,000 lbs. Each aircraft comes equipped with tiedown devices, chains and straps, so that the item owner does not have to provide the tiedown material. The tiedown device and its associated chains or straps are stowed separately throughout the cargo compartment. See the appendices for each type of aircraft or the appropriate T.O. 1C-XXX-9 cargo loading manual for more detail.

C.5.2.2 Tiedown devices.

All aircraft are equipped with straps and chains and their associated tensioning devices to secure the item to the airplane.

The only tiedown devices currently approved for air transport use are those currently in USAF inventory, illustrated on figure C-9. Commercial restraint straps or chains, regardless of rating, are not approved at this time. Any nonstandard tiedown device shall be evaluated by ATTLA. Chains or metal tiedown devices shall have a minimum safety factor of 1.5 whereas fabric tiedown straps or devices such as webbing shall have a minimum safety factor of 2.

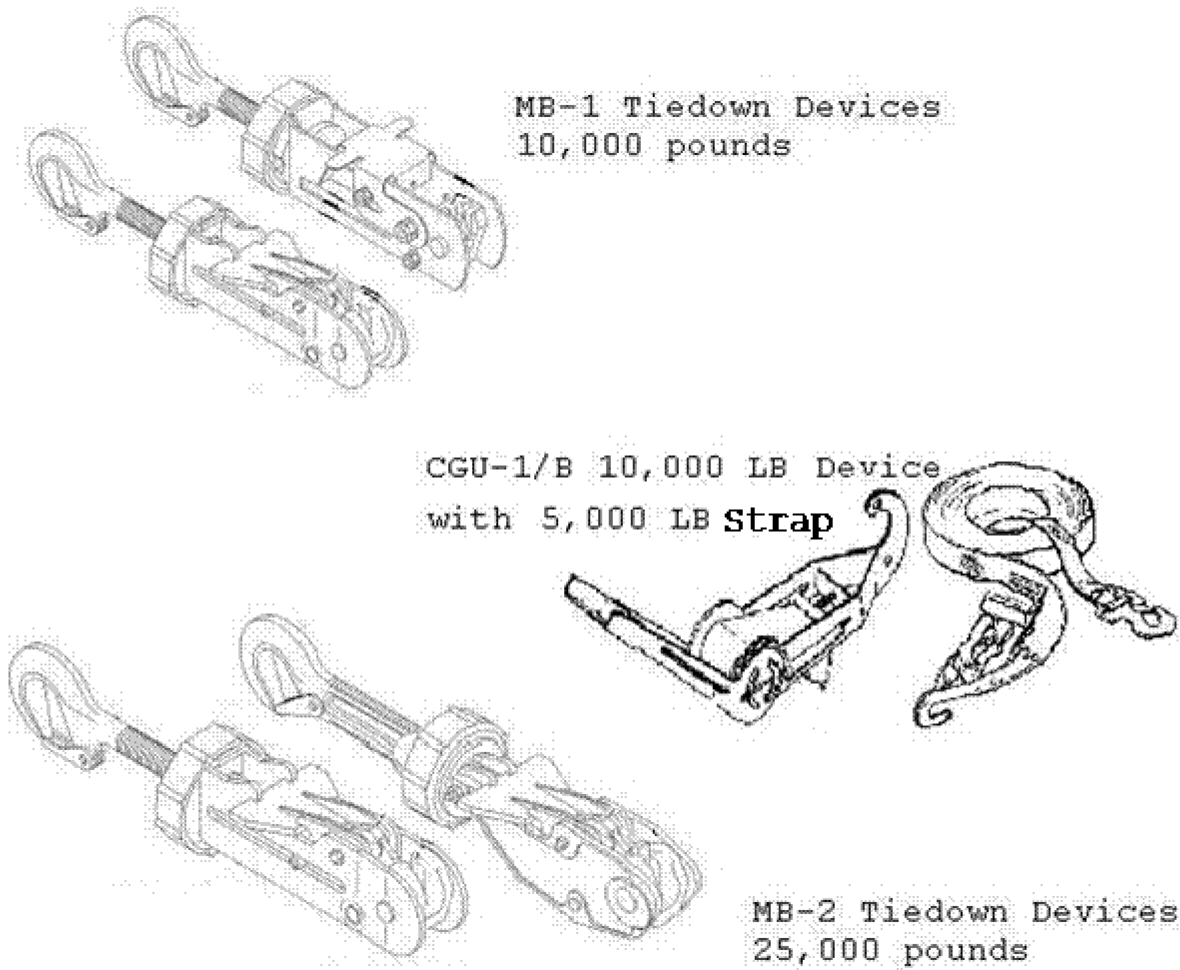


FIGURE C-8. Tiedown devices.

C.5.2.3 Restraint levels.

All cargo must be restrained to prevent movement during normal flight conditions, extreme flight conditions, and hard landings. The published limits are summarized in table C-II. The limits for tanker aircraft (KC-135 and KC-10) are different and the KC-10 limits are in accordance with FAA rules.

If there are personnel in front of cargo the cargo item must be restrained to 9Gs forward. Lateral and vertical restraint requirements are greater for KC-135 and KC-10 aircraft. For further details on calculations see C.5.3.

TABLE C-II. Summary restraint levels for cargo.

Direction	Load Factor	Input Condition
Forward	3G & 10 ft/sec	Hard Landing or sudden deceleration
Aft	1.5G & 5 ft/sec	Sudden acceleration
Lateral	1.5G & 5 ft/sec	Skidding
Up	2G & 10 ft/sec	Extreme turbulence
Down [1]	4.5G & 11.5 ft/sec	Hard landing
[1] Primary cargo restrained by cargo floor. Secondary cargo must be restrained by primary cargo.		

C.5.3 Principles.

Certain fundamental principles must be observed when restraining cargo for flight. Although the details of tying down each unit of cargo vary with its bulk, weight, configuration, and position in the airplane, these basic principles of restraint are always applicable. If the principles are observed, satisfactory restraint of cargo movement can be achieved.

C.5.3.1 Basis of analysis.

To develop sufficient strength in a tiedown, the strap, chain, or tension member must lead off in the general direction of the load to be restrained. The closer the tiedown can lie to the direction of the load, the more efficient the tiedown will be. This important point is illustrated below:

Consider a weight that is suspended by a pair of 10,000-pound capacity chains that are hanging perfectly vertical. The maximum amount of weight that can be suspended from the two chains is 20,000 pounds:

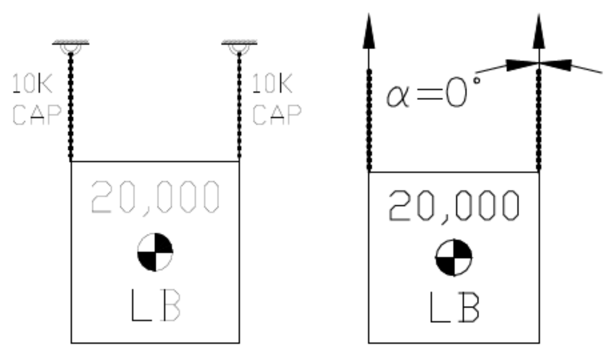


FIGURE C-9. Chain angle 1.

The drawings below illustrate that the amount of weight that can be suspended by the 10,000 pound capacity chains is dependent upon the angle ("α") formed with the direction of required force:

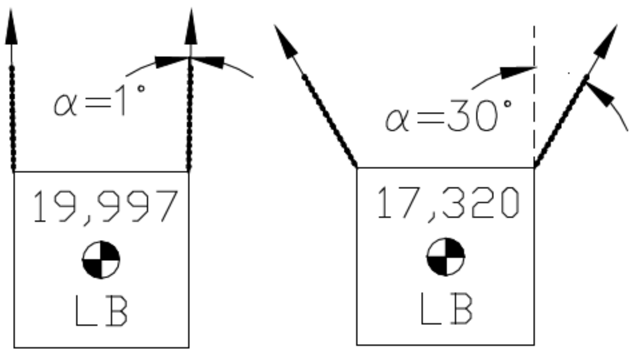


FIGURE C-10. Chain angle 2.

As the angle "α" increases, the vertical component of the chain strength decreases, as does the amount of weight that can be supported:

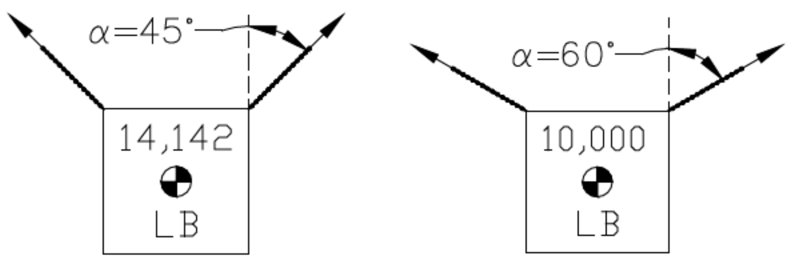


FIGURE C-11. Chain angle 3.

As "α" approaches 90 degrees, the amount of weight that can be supported approaches zero:

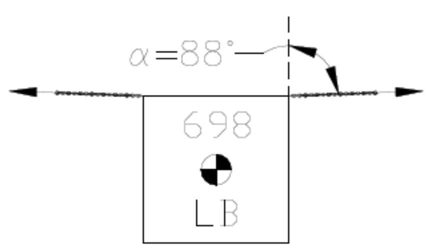


FIGURE C-12. Chain angle 4.

The above illustrations can also be visualized as a birds-eye view of a cargo item resting on the aircraft floor. The item weight would then be analogous to the restraint capability of the chain configuration used.

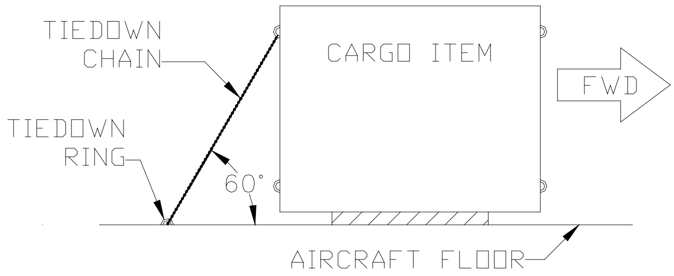


FIGURE C-13. Cargo item chain angle 1.

Assume the tiedown ring and chain hardware on figure C-13 has a working load limit of 10,000 pounds. If the chain is applied at a floor angle of 60 degrees, the strength available for restraint in the forward direction will be 5,000 pounds:

If the tiedown chain is adjusted to a shallower attachment angle, the strength available for restraint in the forward direction will increase proportionally with the decrease in floor angle. For example, if the tiedown chain is attached at a floor angle of 30 degrees as shown below, the strength available for restraint in the forward direction will increase to 8,660 pounds:

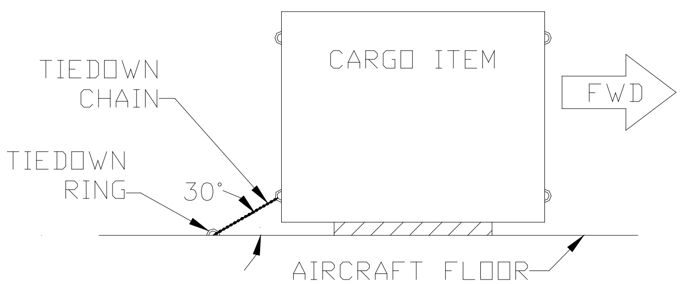


FIGURE C-14. Cargo item chain angle 2.

C.5.3.2 Usage rules.

Determining types and quantities of tiedown devices to be used in restraining cargo should be based on the following:

(1) Always secure cargo for the required amount of restraint with the minimum number of tiedown devices.

(2) The maximum available restraint for any tiedown is determined by using the lesser rating of the following: the tiedown (floor) fittings used, the tiedown attachment points on the cargo item, or the effective strength of the tiedown device used.

(3) Straps and chains shall not be mixed to restrain cargo in the same direction (due to different elongation characteristics). However, 10,000 and 25,000 pound rated devices with the appropriate chains may be used for a given direction of restraint.

(4) Units of general cargo may be grouped and effectively restrained by cargo nets. Concentrated cargo units within such groupings must rest on the cargo floor or on pallets and be individually restrained by appropriate tiedown devices.

(5) Tiedowns should be attached in a symmetrical pattern by using corresponding fittings on each side of the cargo floor centerline.

(6) Use nylon tiedown devices on crates, boxes, or items that might crush easily. Nylon devices that are under tension loads can be easily cut; therefore, do not use nylon tiedown devices over sharp edges.

(7) Use steel tiedown devices on heavy objects that have attachment lugs or a hard surface for the chains to wrap around.

When tiedown devices are attached to cargo, the lines of action for the tiedown devices should, if possible, intersect above the cargo center of gravity as shown below. Such a tiedown configuration reduces the tendency of cargo to overturn when subjected to combined upward and side loads.

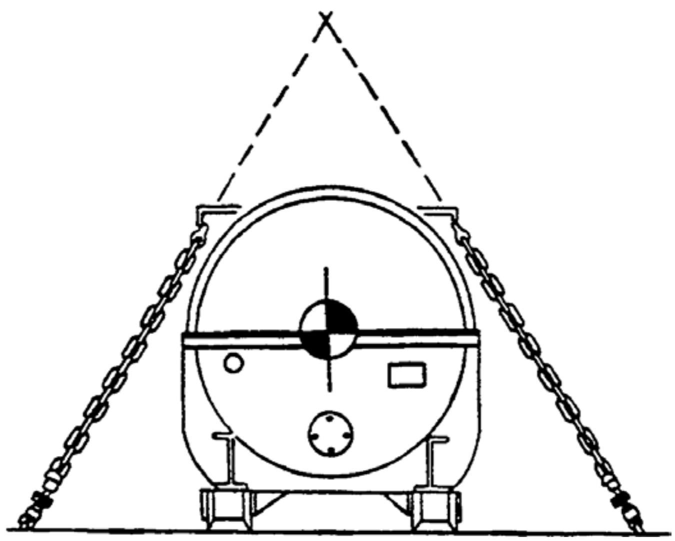


FIGURE C-15. CG location for effective restraint.

The point of attachment of a tiedown device to a cargo unit must be substantial enough to withstand the loads for which the cargo unit is being restrained. A tiedown device cannot be secured to any convenient protrusion on a cargo unit without due consideration of the protrusion's strength.

Although all materials stretch in direct proportion to the applied load, materials have varying rates of stretch. Under tension, nylon devices stretch more readily than steel and permit the steel device to assume the majority of the load. Therefore, when two or more tiedown devices are used in the same direction, the devices shall be of similar material and equally tensioned to ensure the load is evenly distributed.

Restraint straps or chains that are simply passed over or around a unit of cargo (instead of being attached directly to it) can provide double the strength of a single restraint, provided the capacity of the fittings is equal to or greater than the strap or chain capacity. Commonly called a strap or chain gate, this type of tiedown configuration can only provide restraint in a single direction. To increase the utility of this concept, a chain bridle may be used to obtain restraint in more than one direction:

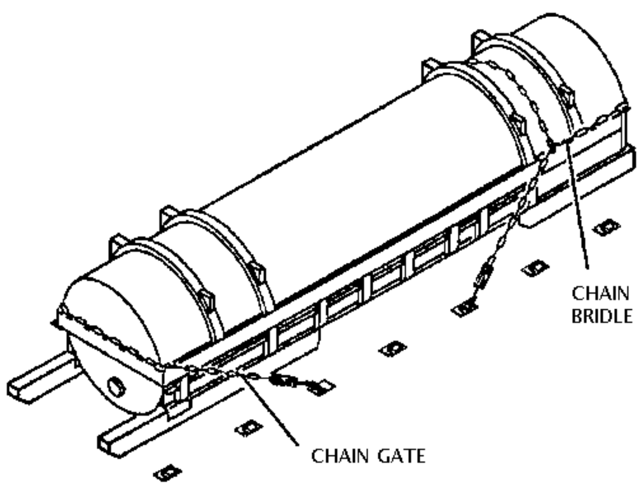


FIGURE C-16. Chain gate and chain bridle.

Unsymmetrical tiedowns permit load distributions that may ultimately result in tiedown device failure. Such a failure would result from the different load-deflection rates of dissimilar materials or of identical materials of different length. Any material subjected to a tension load will stretch. A longer length tiedown has more stretch potential than a shorter length tiedown. If two tiedowns of the same type and capacity are used to restrain a load in a given direction and one is longer than the other, the longer tiedown, with its greater stretch potential, will permit the shorter tiedown to assume the majority of any load that may develop. If the shorter tiedown becomes overstressed and fails, the longer tiedown would then be subjected to the full load and it, too, would likely fail. Therefore, symmetrical tiedowns should be as close to the same length as possible.

Tiedown device attachment generally follows similar patterns because of cargo floor tiedown ring layout and symmetrical restraint requirements. The following procedures shall be used when attaching tiedown devices to the cargo and to the tiedown rings on the compartment floor: (All references are to figure C-18)

(1) Always compute the number of tiedown chains required. Apply aft restraint (tiedowns 1, 2, 5, and 6) in the opposite direction but at the same angle as the forward restraint (tiedowns 3, 4, 7, and 8). Use the same attachment point (points A, B, C, or D) on the cargo for attaching a forward and aft restraint chain if possible.

(2) Apply restraint in a symmetrical pattern around the cargo unit being restrained. Always attach an even number of tiedowns (4 chains, or 6 chains, etc.) in pairs (1 and 2, 3 and 4, 5 and 6, 7 and 8, etc.) for forward or for aft restraint. The tiedown chains should be attached in a symmetrical pattern by connecting to opposite fittings (A opposite B, C opposite D, E opposite F) across the cargo floor centerline.

(3) If the center of gravity is not located at the geometric center of the load--when possible--add an additional tiedown (tiedowns 9 and 10) on each side of the load to place the center of gravity equal distance between a pair of tiedowns.

(4) Tiedown chains are normally attached to the cargo unit. Tensioning devices are attached first to the floor rings and then to the tiedown chains. Slack in the chains is removed by adjusting the tensioning device.

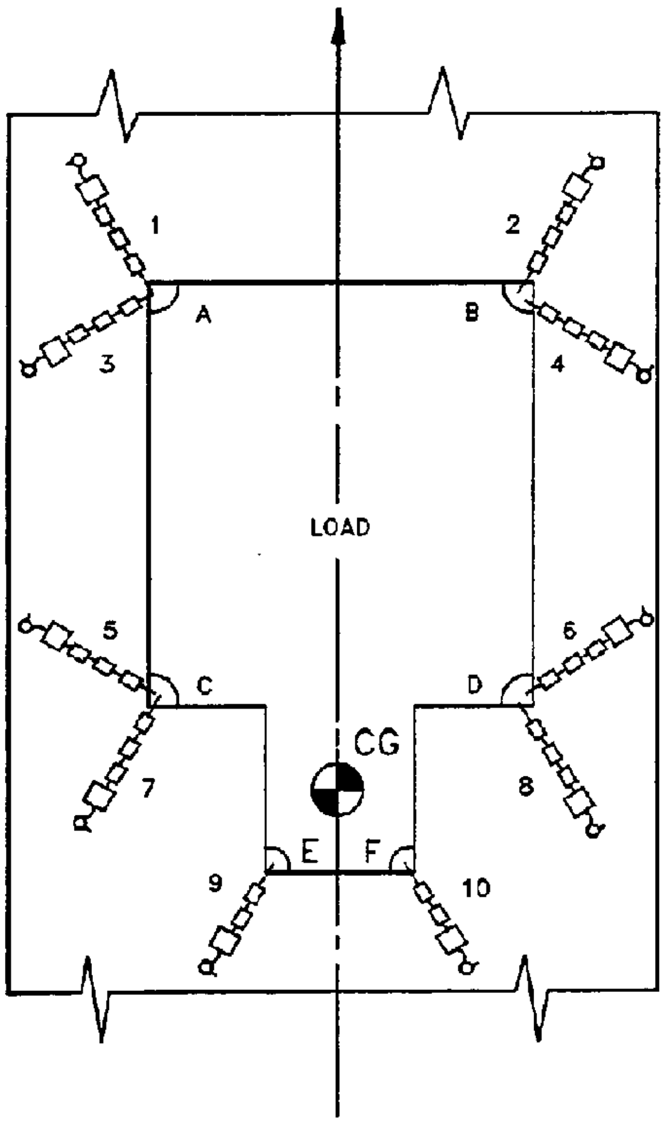


FIGURE C-17. Sample tiedown pattern.

C.5.3.3 Bulk cargo.

Cargo shall be tied down in such a manner that the load will be prevented from moving or changing shape. In the case of non-rigid cargo such as stacked boxes, it is important that the stack be prevented from collapsing or shifting. Inadvertent shifting of a single box within the load could loosen all the tiedowns. In the following example, tiedown is satisfactory for upward restraint, but not for sideward or forward/aft restraint.

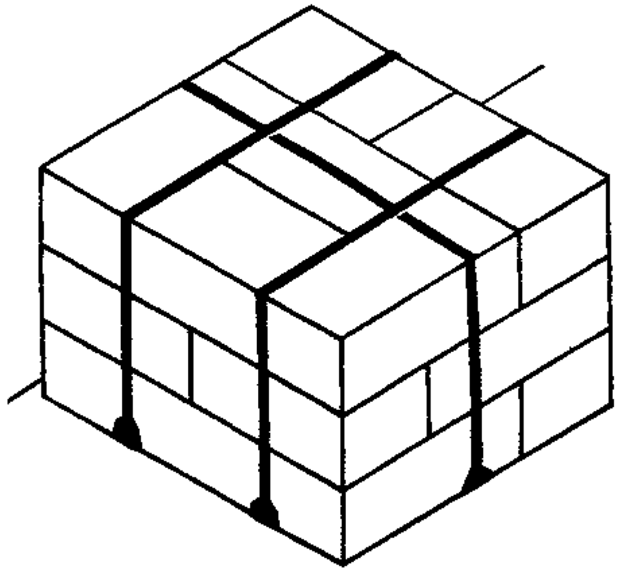


FIGURE C-18. Unsatisfactory bulk cargo restraint.

If the tiedowns are very long across the top of the load, a severe upward force will permit the cargo to move as shown below. Hence, the length of ties across the top of a load should be kept as short as possible. Alternatively, such cargo is commonly stacked in an "igloo" shape to begin with.

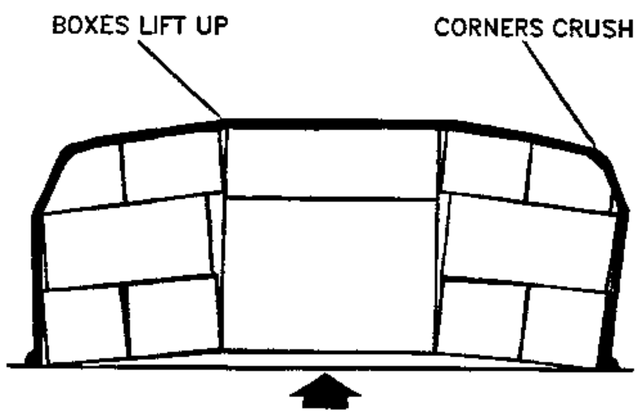


FIGURE C-19. Vertical cargo shift.

For forward or aft restraint, the type of tiedown shown below will not prevent the cargo shifting except for the friction forces introduced. Neglecting friction, the tiedown cannot begin to restrain the load until it has shifted so that the tiedowns begin to go in the same direction as the force.

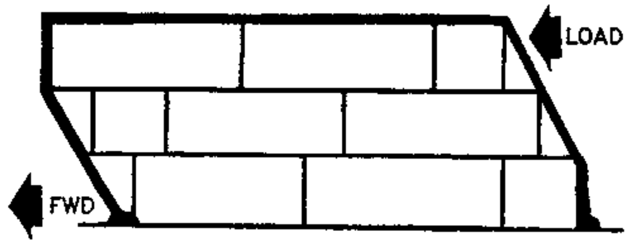


FIGURE C-20. Longitudinal/Lateral cargo shift.

C.5.3.4 Rolling stock.

Certain vehicles are constructed such that each major component part must be tied down. An example is the truck-mounted crane. The crane is mounted on the truck chassis using a large diameter kingpin. There are no provisions to prevent the kingpin from becoming disengaged in vertical accelerations, so both the truck chassis and the crane must be independently designed to be secured to the aircraft. All major components of such vehicles must be viewed in this respect. The entire vehicle, including any additional cargo, must be fully restrained at its gross transported weight. Loose items such as tool boxes and other cargo must have provisions to be secured to the frame of the vehicle. The following is a typical list of items that fall within this category:

a. All cargo in vehicles
b. Spare wheels
c. Stake panels on stake body trucks
d. Tools and tool box covers
e. Machines and tools in shop trucks
f. Dump truck bodies (hydraulic or mechanical lift mechanisms)
g. Cranes or booms on wrecking trucks, etc.
h. Towing chains, pinch bars, etc.
i. Bulldozer blades and blade attachment latches

Inspect axles and other structures for the presence of hydraulic lines or electrical cables before attaching tiedown chains around these hidden areas.

Less than one half of the total restraint required should be achieved through application of tiedowns to the axles or other un-sprung parts of vehicular suspensions. Rationale: The sprung part of a vehicle (upper body and chassis) will exhibit excessive movement under dynamic loading if the vehicle is primarily restrained through only the lower un-sprung components such as wheels or axles. It is highly desired that all restraint be achieved through tiedown of the vehicle frame.

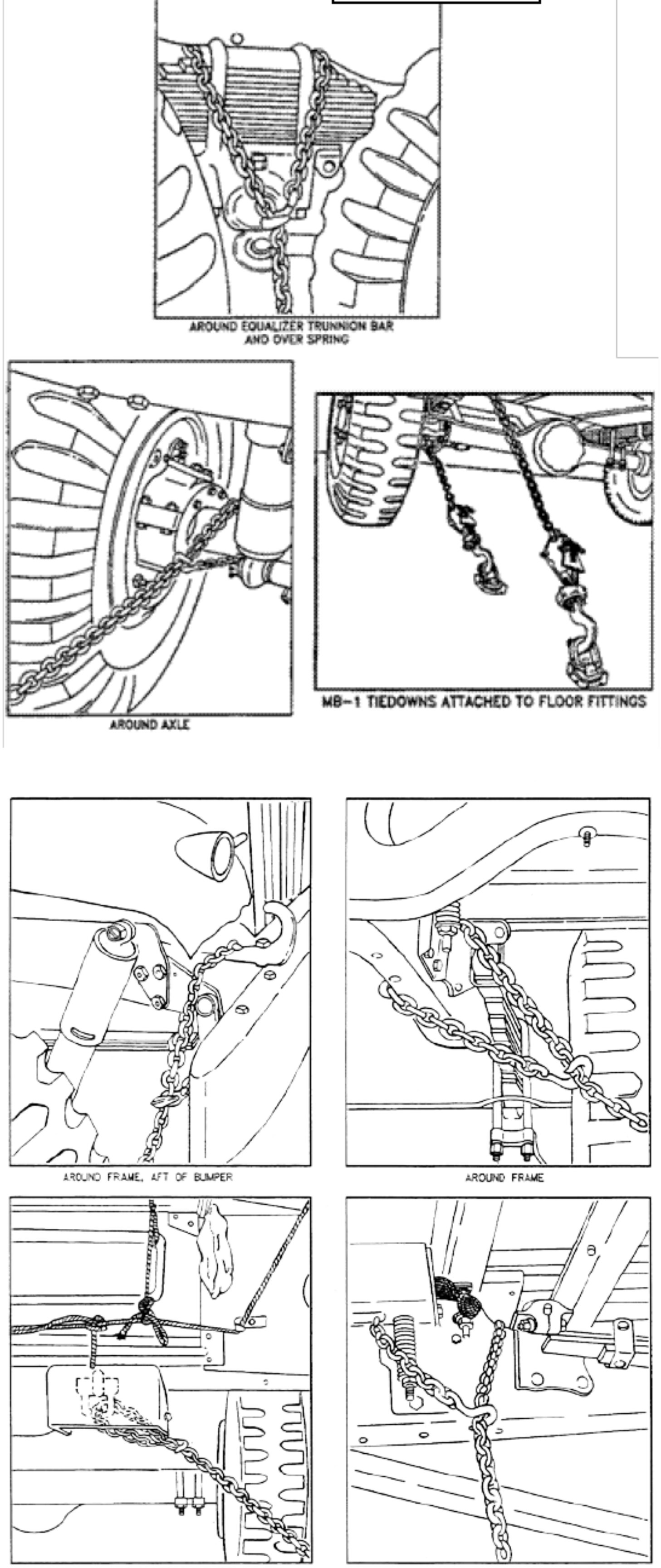


FIGURE C-21. Restraining around structures.

C.5.3.5 Palletized cargo.

Restraint of palletized cargo is usually accomplished by restraining to pallet side rings. Large or heavy cargo may also be restrained to the aircraft floor.

C.5.3.5.1 Restraining cargo to the pallet.

Cargo is typically restrained to the pallet side rings as shown in A.4, figure A-10. Cargo may be covered by a cargo net or restrained directly to the side rings. A.4, figure A-8 shows the cargo net. The 463L pallet side rings are rated at 7500 pounds each, and the rings for Type V and Type VI (DRAS) platforms are rated at 10,000 pounds each.

C.5.3.5.2 Palletized cargo to aircraft floor.

Cargo may also attach directly to the aircraft tiedown rings if the pallet/platform cannot provide sufficient restraint to the item or if the pallet is only used as a means of transport in and out of the aircraft. Pallets oriented such that the width does not engage the aircraft rail system are also restrained to the cargo floor. The pallet/platform itself, if it is in the rail system, will usually engage the rail locks to restrain the pallet while the item is restrained to the floor (figure C-22).

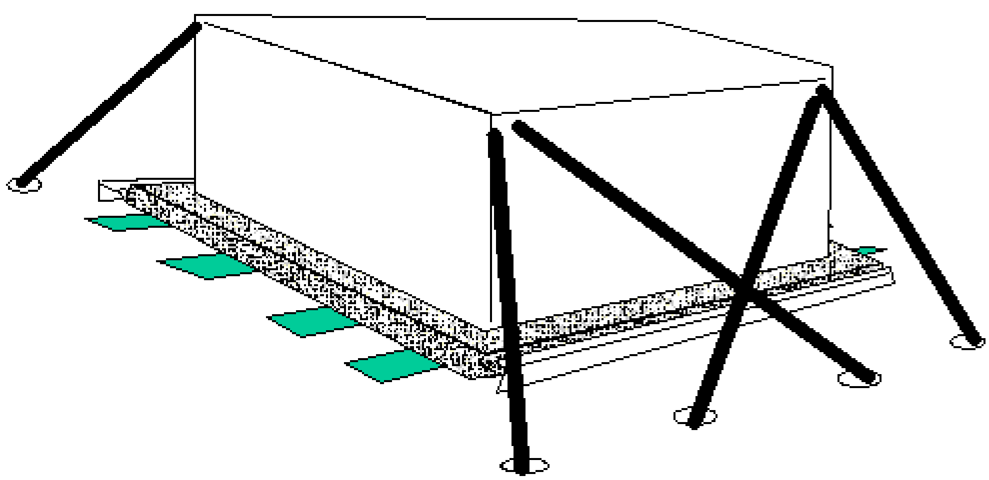


FIGURE C-22. Palletized cargo restrained to aircraft floor rings.

C.5.4 Analysis methods.

Effective and efficient use of available aircraft hardware requires certain considerations in the design and/or analysis of restraint methods.

C.5.4.1 Effect of angles.

Every tiedown device is capacity rated based on its ability to withstand a force exerted parallel to, and in the opposite direction of, its line of application (standard pull test). While it is possible to attach tiedowns to act in the same way, it is not efficient to do so since attachment in such a manner provides restraint against movement in only one direction. Separate-acting tiedowns would have to be applied to resist movement in the other directions to fully restrain the item. The total number of tiedowns needed to fully restrain a heavy object in this manner would be prohibitive.

By attaching a tiedown device at some angle to the direction of anticipated movement, it is possible to apply restraint in more than one direction, depending on the angle of pull. By varying the angle of pull, one tiedown device can provide simultaneous restraint in three directions.

Usually, attachment to the cargo is made at some point above the cargo floor. When attached as shown below, part of the rated capacity of the tiedown is available to prevent longitudinal movement of the item and part is available to provide restraint in the vertical (up) direction but no restraint is provided in the lateral direction.

The tiedown shown below will provide simultaneous restraint in all three directions (longitudinal, vertical, and lateral) and illustrates the most desirable and efficient configuration for each tiedown used. If only two of the three directions can be achieved, supplemental restraint will be required using separate tiedowns. Full restraint of the item below would be obtained by attaching tiedown devices symmetrically, in pairs, to the opposite corners/ends of the cargo item.

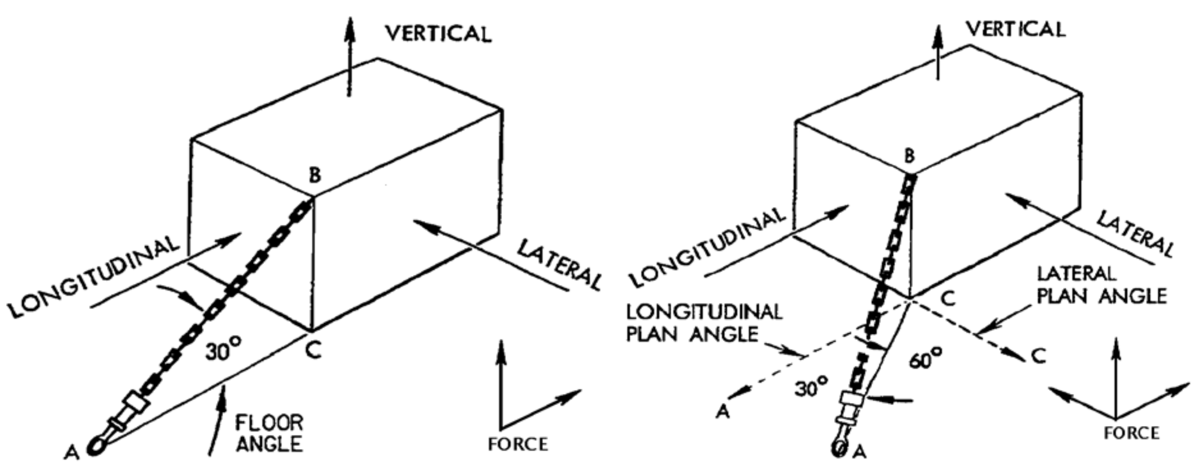


FIGURE C-23. Tiedown angles.

There are three angles formed by a tiedown chain that is attached to a load at a point above the cargo floor:

(1) The floor angle (sometimes called the vertical angle) is the angle between the chain and the floor.

(2) The longitudinal plan angle is the angle between the chain and a line that runs fore and aft in the cargo compartment through the attachment point on the load.

(3) The lateral plan angle is the angle between the chain and a line that runs laterally across the cargo compartment through the attachment point on the load.

Tiedown chains attached at floor and plan angles of 30 degrees provide the best compromise for adequate restraint of the cargo in all directions. Frequently, it will not be possible to use the 30-degree angles and other arrangements will be necessary.

Increasing the floor angle while keeping constant plan angles will provide a higher value of vertical restraint but will reduce the amount of longitudinal and lateral restraint. Keeping the same floor angle but increasing one of the plan angles (thus decreasing the other plan angle) will not affect the vertical restraint but will change the quantities of longitudinal and lateral restraint.

Assuming that the tiedown is the weakest link in the system and using the optimum 30 degree angles, a 5,000 pound capacity tiedown strap (CGU-1B) will provide 3,750 pounds of longitudinal restraint, 2,500 pounds of vertical restraint, and approximately 2,150 pounds of lateral restraint at attachment point B. Similarly, a 10,000-pound capacity (MB-1) chain will provide 7,500 pounds of longitudinal restraint, 5,000 pounds of vertical restraint, and approximately 4,300 pounds of lateral restraint. A 25,000 pound capacity (MB-2) chain will provide 18,750 pounds of longitudinal restraint, 12,500 pounds of vertical restraint, and approximately 10,800 pounds of lateral restraint when ideal angles can be achieved.

It is unlikely that the results above will be achieved in practice because it will not always be possible to achieve ideal chain angles. Tiedowns that are applied at other than the ideal angles will produce different (proportional) amounts of longitudinal, vertical, and lateral restraint. The amount of available restraint for such tiedowns should be calculated by using the tiedown angle ratio method (see C.5.4.3).

C.5.4.2 Calculating required tiedown.

An initial estimate of the number of tiedown chains or straps needed to restrain a unit of cargo should always be computed before a proposed tiedown configuration is attempted. A method that usually produces a good estimate is outlined below:

(1) Determine the gross shipping weight of the item as it will be loaded onto the aircraft (including any stowed gear).

(2) Multiply the weight in Step 1 by 3.0 to determine the forward restraint requirement (see 5.3.3.1).

(3) Divide the result in Step 2 by 7,500 if 10,000 pound capacity chains will be used or by 18,750 if 25,000 pound capacity chains will be used*.

*Note: If the attachment points on the cargo item or the floor tiedown rings on the aircraft are weaker than the capacity of the chain that is being used, divide the result in Step 2 by the weakest capacity.

(4) Round up the result from Step 3 to the next EVEN whole number (chains should always be attached in pairs). The result will be an estimate of the number of chains that will be needed to restrain the cargo item to 3.0 G's forward.

(5) Example: A 30,000-pound vehicle is to be airlifted on a C-17. An additional 2,375 pounds of crew gear will be stowed inside the vehicle prior to loading. There are 2 attachment points on each end of the vehicle, plus 2 additional points down each side of the vehicle, for a total of 8 points, each rated at 65,000 pounds capacity.

Step 1: 30,000 + 2,375 = 32,375 lb. (gross shipping weight)

Step 2: 32,375 x 3.0 G = 97,125 lb. (restrain to 3.0 G forward)

Step 3: 97,125 ÷ 18,750 = 5.2

Step 4: Rounding up to the next even number gives a total of 6 (3 pairs) 25,000-pound capacity chains that will be required for forward restraint.
Note: If 10,000-pound capacity chains will be used, the results would be: 97,125 ÷ 7,500 = 12.95. In this case, a total of 14 (7 pairs) 10,000-pound capacity chains would be required for forward restraint.

(6) Repeat the process for aft, vertical, and lateral (left and right) directions. Generally, the total number of chains required to achieve forward and aft restraint will also provide enough vertical and lateral restraint; if not, additional chains should be added in pairs until the required amount of vertical and lateral restraint is achieved.

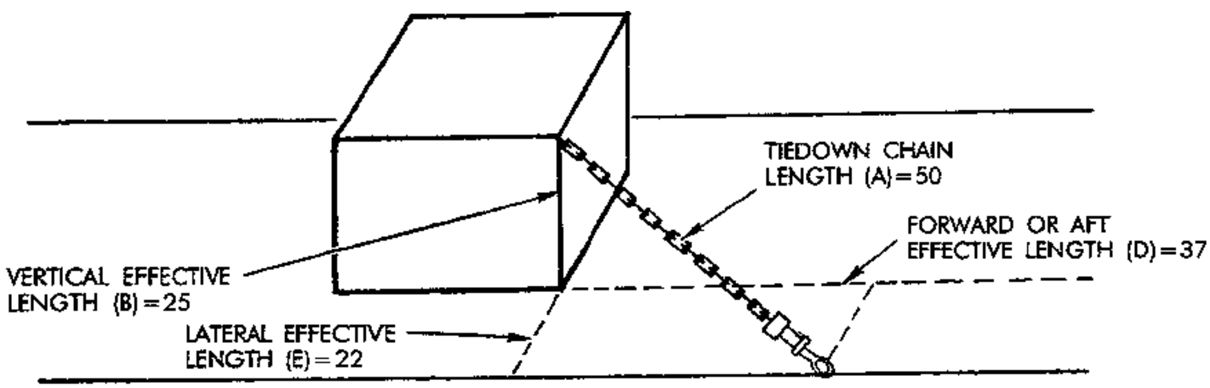
Use the initial estimate to determine a proposed tiedown configuration. The tiedown angle ratio method (see C.5.4.3 and figure C-24) should then be used to calculate the exact amount of restraint that is available from each device in the proposed configuration. Results should be checked against the restraint requirements of C.5.2.3 to ensure that the item has been properly restrained to requirements.

C.5.4.3 Calculating available tiedown.

The tiedown angle ratio method, illustrated by the example problem shown on figure C-24, is used to calculate the actual amount of restraint available from any given tiedown. The method shown is the same method used by USAF loadmasters when they restrain cargo aboard the aircraft.

When calculating the amount of restraint that is available for any given tiedown, consideration shall be given to the weakest component in the tiedown loop, i.e. the chain, device, floor ring, pallet ring, or cargo item attachment point that has the smallest capacity rating. For example, an MB-1 (10,000 pound capacity) chain and device attached to a 463L pallet ring is limited by the 7,500 pound capacity of the pallet ring. Similarly, if an MB-2 (25,000-pound capacity) chain and device were attached to a cargo item attachment point that has a rated capacity of 15,000 pounds, the maximum amount of restraint available to the MB-2 chain and device would be limited to the 15,000 pound capacity of the attachment point. (This assumes the floor ring attachment point is rated at more than 15,000 pounds capacity. If the floor ring attachment point were rated at less than 15,000 pounds capacity, then the floor ring attachment point would become the limiting factor.)

When multiple tiedowns are attached to floor rings that are in the same lateral row (i.e. pulling on the same floor bulkhead), the amount of vertical restraint may be limited. Example: four MB-1 devices attached to floor fittings in the same lateral row may each provide forward and aft restraint to their maximum capacity but the amount of vertical restraint available per floor ring may be limited. The vertical restraint reduction varies depending on the aircraft, and depending on the number of other devices attached to the same lateral tiedown row. Consult the respective aircraft loading manual (T.O. 1C-XXX-9) to determine the extent to which vertical restraint is reduced when multiple tiedowns are attached to the same lateral row of floor rings.



This figure illustrates a method of determining restraint provided by a cargo tiedown. As illustrated, tiedown ratios can be determined by dividing the directional distance in which restraint is required by the chain (or strap) length. This ratio is then multiplied by the strength of the tiedown, device, or attachment point on the cargo, whichever is less, to find the effective restraint received from the tiedown pattern used.

FIGURE C-24. Tiedown angle ratio method.

EXAMPLE (Note: Quantities used are from the figure example above)

1) First, measure the tiedown chain length (A) from the attachment point on the cargo to the tiedown fitting on the cargo floor (50 inches). You will use this measurement in each calculation.

2) **CALCULATING THE VERTICAL RESTRAINT:**

   a) For determining vertical restraint, measure the vertical dimension (B) from the attachment point on the cargo to a point directly beneath it on the cargo floor (25 inches).

   b) Divide the vertical dimension (B) by the tiedown chain length (A) to determine a ratio:

$$\frac{25}{50} = 0.50 RATIO$$

   c) Multiply this ratio by the rated strength of the tiedown chain or the rated strength of the tiedown fitting on the cargo or the rated strength of the tiedown floor fitting, *whichever is less*:

$$0.50 \times 10{,}000^{*} = 5{,}000 POUNDS$$ ← **VERTICAL RESTRAINT RECEIVED FROM TIEDOWN**

3) **CALCULATING THE FORWARD OR AFT RESTRAINT:**

   a) For determining forward or aft restraint, obtain a forward or aft dimension (D) by measuring from a point directly beneath the attachment point on the cargo along a longitudinal axis to a point lateral to the tiedown fitting being used on the cargo floor (37 inches).

   b) Divide the forward or aft dimension (D) by the tiedown chain length (A) to determine a ratio:

$$\frac{37}{50} = 0.74 RATIO$$

   c) Multiply this ratio by the rated strength of the tiedown chain or the rated strength of the tiedown fitting on the cargo or the rated strength of the tiedown floor fitting, whichever is less:

$$0.74 \times 10{,}000^{*} = 7{,}400 POUNDS$$ ← **FWD OR AFT RESTRAINT RECEIVED FROM TIEDOWN**

4) **CALCULATING THE LATERAL RESTRAINT:**

   a) For determining lateral restraint, obtain a lateral dimension (E) by measuring from a point directly beneath the attachment point on the cargo, along the cargo floor, to the row of tiedown fittings being used (22 inches).

   b) Divide the lateral dimension (E) by the tiedown chain length (A) to determine a ratio:

$$\frac{22}{50} = 0.44 RATIO$$

   c) Multiply this ratio by the rated strength of the tiedown chain or the rated strength of the tiedown fitting on the cargo or the rated strength of the tiedown floor fitting, whichever is less:

$$0.44 \times 10{,}000^{*} = 4{,}400 POUNDS$$ ← **LATERAL RESTRAINT RECEIVED FROM TIEDOWN**

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* Note: This quantity should always represent the weakest link in the system. If the rated strength of the chain or either attachment point being used is less than 10,000 pounds, the ratio should be multiplied by the weakest rated strength.

FIGURE C-24. Tiedown angle ratio method – Continued.

C.6 FLIGHT.

The aircraft is not a stable environment during flight. The aircraft experiences vibration, bumps, and shock in normal flight. During emergencies, rapid pressure loss and sudden temperature loss may also be experienced. The following section describes these flight conditions.

C.6.1 Shock and vibration.

Cargo should be designed, or be packaged, to withstand sudden acceleration or shock when the aircraft has a hard landing or has to break or accelerate. From takeoff to landing, the aircraft will vibrate at various frequencies and amplitudes that may be beyond levels at which the item normally operates or is designed to withstand. For example, a medivac litter had screws loosen when exposed to C-141 climb vibration. The time for which the item should be tested depends on the longest anticipated duration of flight (e.g., 6 hour mission).

These levels, for various types of aircraft, are shown in MIL-STD 810, appendix C, test methods 513.5 and 514.5. Jet aircraft vibration spectrum from MIL-STD-810 is shown on figure C-25.

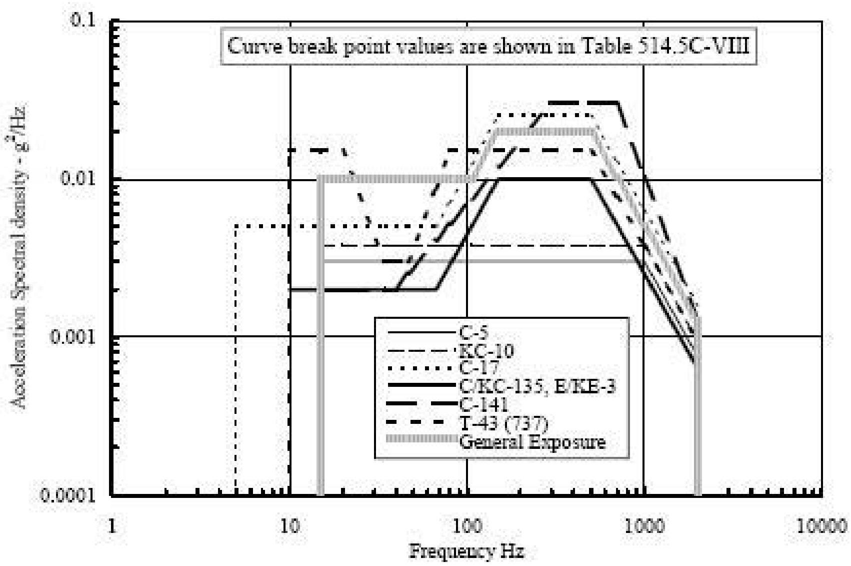

FIGURE C-25. Vibration spectrum.

C.6.2 Delicate structure.

Some cargo has delicate components or structures that are inadequate for the flight environment. ATTLA can assist in determining the most efficient way of configuring these areas for flight. The first thing is to identify the components at risk. The cargo's owner may elect to reinforce or redesign the item or brace the sensitive areas. Figure C-26 shows examples of items of concern that ATTLA has seen in the past.

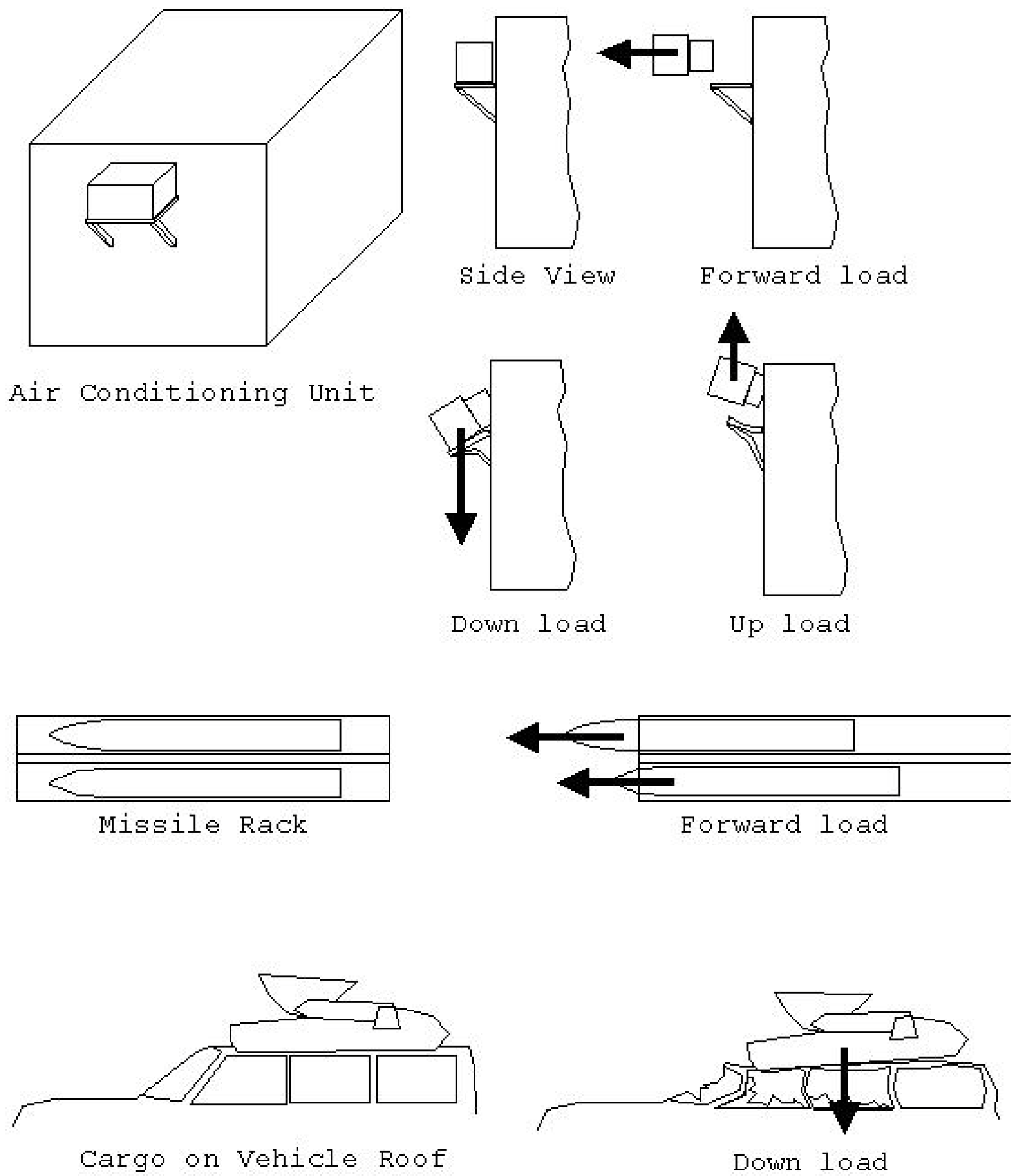

FIGURE C-26. Potential problem areas.

C.6.3 Pressure change.

C.6.3.1 Rapid decompression.

Containers should be designed to withstand a loss of the pressure differential of 8.3 psi in 0.5 seconds. Future aircraft may operate unpressurized and sealed vessels should be designed to withstand at least 15 psi or from ground pressure to at least 50,000 ft altitude. Electronic circuits with sealed membranes may also susceptible to damage under this level of pressure change.

Vented and unvented containers of fluid shall also be able to contain the fluid and prevent the lid/cap from opening if the fluid expands under low ambient pressure. An expansion or overflow tank is allowed.

Flexible containers are allowed to expand in flight but not break. The expansion volume shall not cause a loss of restraint, damage other items in the vicinity, or block required access/egress routes.

C.6.3.2 Nominal pressure differential.

For a perfectly sealed container, the differential pressure can attain a value of about 90 kPa (13 psi) at a 15,240-m (50,000 ft) altitude. This does not take into consideration the temperature of the air within the void space of the container.

For example, consider a sealed metal container of a volatile liquid that has been stored in the sun for a prolonged period of time. There will be an excessive internal pressure due to the increased temperature within the container. Therefore, if this container is put aboard an aircraft and transported within a short period of time after its removal from storage, the resultant differential pressure in flight will consist of the difference between the high internal pressure and the decreased external pressure due to the reduced atmospheric pressure at the flight altitude.

Assure that any container with volatile fluids will contain the maximum possible differential pressure without rupture.

C.6.4 Temperature change.

The temperature in the cargo compartment can be extremely hot or cold. The temperature can rise to at least 120 degrees F if the aircraft sits in a hot location for a prolonged period of time. Ambient temperature decreases rapidly at higher altitudes. Cabin temperature can decrease to minus 60 degrees if a there is an unexpected opening in the fuselage or loss of pressure seal.

C.6.5 Explosive atmosphere.

Cargo carriers that are also used as air refueling tankers (e.g., KC-10, KC-135, and KC-130) are at risk of having fuel vapor leak into the cargo compartment. The level of explosive concentration is also affected by ambient temperature and humidity. The risk of it occurring is low since cargo is not normally transported while the aircraft is used as a refueler. However, any cargo that can cause a spark or burn if it malfunctions or is exposed to intense electromagnetic fields shall be evaluated. A circuit may be shorted out and spark or catch fire in flight. An ungrounded metallic object may spark while the aircraft flies through a thunder storm.

Most cargo is grounded through contact with the cargo floor or through tiedown chains so the risk of sparking is extremely remote.

C.7 CARGO JETTISON.

C.7.1 General.

The aircraft has the capability to jettison palletized loads and loads that can be manhandled if aircraft weight needs to be reduced during an in flight emergency. Cargo jettison is effectively an unscheduled gravity airdrop, similar to a combat offload in the air. The operation is performed only on aircraft with a rear opening cargo door and ramp. The loadmaster configures the ramp for airdrop. For palletized cargo, the aircraft pitches up to allow gravity to pull the cargo out. The average pitch is 2-3 degrees . The locks are released manually or electronically, depending on the airplane. Jettison of rolling stock is not performed.

Prior to loading the aircraft, the loadmaster selects the loads which are the best candidates for jettisoning and places them in the aft portion of the cargo compartment. The defining parameters are the cargo's height profile (as palletized) and location of the center of gravity.

Cargo height profile limits for jettison are shown for each aircraft on a graph called a tip-off curve. The tip-off curve represents the maximum height, forward of the cargo center of gravity (CG), to which an item can be rigged and still not contact the aircraft ceiling during an exit. Without use of an extraction force, the pallet will rotate at its highest possible rate. These curves have been derived under the following assumptions: radius of gyration of the cargo is 6.33 feet, the aircraft is experiencing 1.4 positive G's downwards, CG height of the cargo is 55 inches, and velocity of the cargo at the ramp edge is 20 ft/sec in the C-130. A margin of clearance is maintained. Variance from any of these assumptions invalidates the curve to some degree, the most important factor being the exit velocity.

C.7.2 How to read a tip-off curve.

A typical tip-off curve is shown on figure C-27. The bottom axis, starting from the right end, is the distance from the cargo's C/B. The vertical axis, starting from the bottom, is the height as measured from the bottom of the pallet. The load planner or loadmaster will measure the cargo's height in its palletized configuration at various locations forward of the C/B. The height is compared with the aircraft's tip-off curve. If the cargo's height is below the curve, the cargo can be jettisoned. This curve is also used to limit cargo height on airdrop cargo.

C.7.3 Aircraft tip-off curves.

The tip-off curves for C-130, C-17, and C-5 are shown in B.3.5.

Tip-off Curve Illustrated

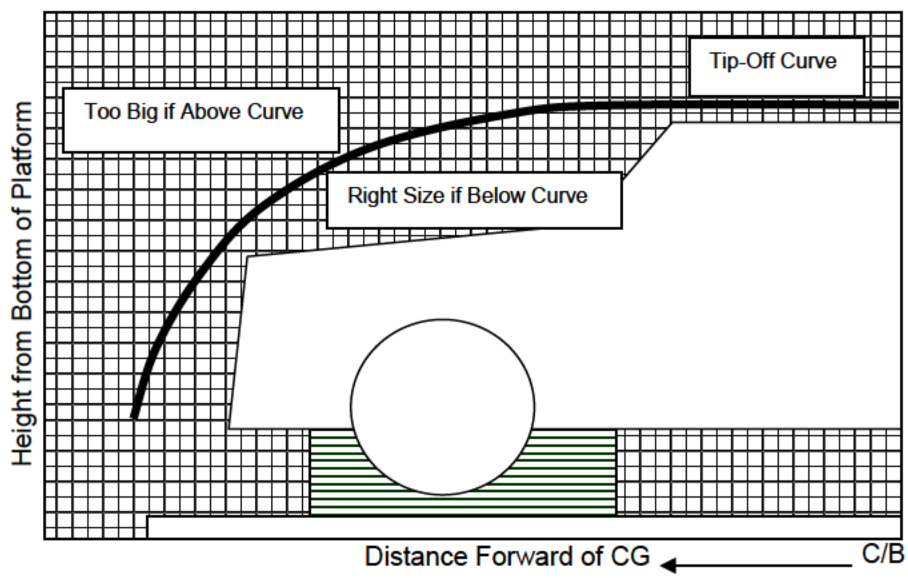

FIGURE C-27. Tip-off curve (example 1).

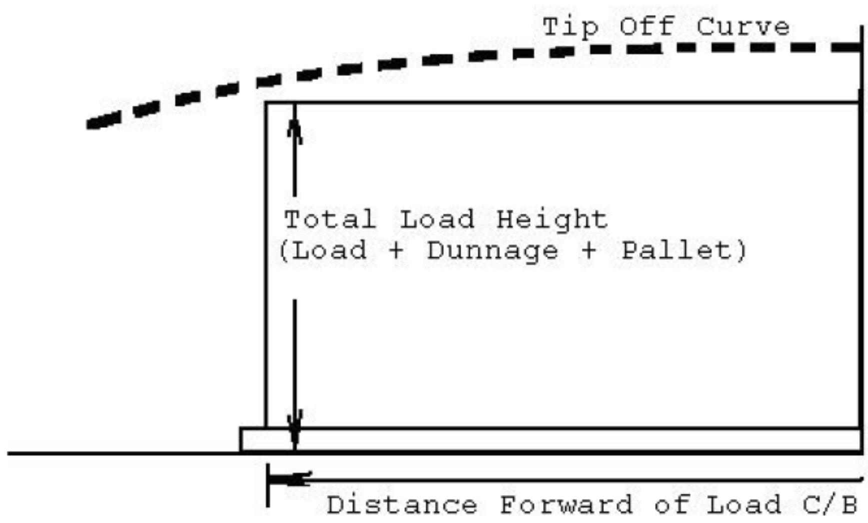

FIGURE C-28. Tip-off curve (example 2).

C.8 COMBAT OFFLOAD.

Combat offload is a special cargo delivery procedure for rapidly offloading palletized cargo (see A.4). Only the C-130 and C-17 perform this operation. Combat offload is most often used in an emergency but it can also be a planned event.

C.8.1 Procedures.

Combat offload procedures are as follows:

(1) The aircraft is parked and the cargo door and ramp are opened. Combat offload operations on the C-17 will be conducted with the ramp links installed. For the C-130 operations, the ramp will be lowered almost to ground level.

(2) The rail locks are retracted, leaving the pallets free to roll.

(3) The aircraft accelerates forward and the pallets roll aft, falling off the aircraft ramp as the aircraft moves forward.

C.8.2 Limits.

As pallets exit, the aircraft center of gravity moves aft, lifting the aircraft nose gear up, which may cause the ramp to contact the ground. To prevent ramp ground contact or prevent the nose gear from losing contact with the runway, restrictions are defined for the number of pallets to offload at once as well as the weight limit of the loads. (Refer to T.O. 1C-XXX-9 cargo loading manual for each aircraft.)

C.9 463L Air cargo system.

The 463L system is an air cargo material handling system developed by the Air Force for efficient cargo handling, both on the ground and in the aircraft. This was the first system of its type developed and has become the basis for many systems used by commercial airlines. The Air Force has updated the 463L system as necessary. The system consists of four separate but interdependent families of equipment. These families are described in the following paragraphs.

C.9.1 Terminals.

The air cargo terminal is an intermediate point through which cargo moves in the 463L material handling system. Each air cargo terminal must have the capability to process and maintain an efficient and rapid flow of cargo at all times. Under emergency conditions, the terminal must be able to expand its capability so that it will not become a bottleneck in the material movement. Air cargo terminals vary in size and configuration depending on location, existing terminal buildings, and cargo volume. However, the function of each terminal is the same, i.e., to receive, ship, process, document, label, and sort cargo for air shipment.

C.9.2 Cargo preparation.

The cargo preparation family provides the material handling system with equipment which will enable palletization and restraint of air transport cargo. Provisions have also been made for protective containers for fresh and frozen goods. The following items are identified within this family.

a) The variety of cargo aircraft active in the military and commercial fleet presents a complex problem when considering aircraft loading door sizes and locations and floor bed dimensions of standard loading vehicles. To meet this need, three sizes of logistic support pallets (HCU-6/E, HCU-10/C, and HCU-12/E) and two sets of cargo restraint nets (HCU-7/E and HCU-15/C for use with the HCU-6/E pallet and HCU-11/C and HCU-16/C for use with HCU-10/C and HCU-12/E pallets) were standardized. Presently the Air Force only utilizes the HCU-6/E and its associated nets. The HCU-12/E is used by other services and the HCU-10/E is no longer produced.

b) Pallet coupling devices. When cargo is too large to be placed on one 108 x 88 in. pallet, two or more pallets (up to a maximum of six) may be joined together. Depending on the airframe, a 2 inch (NSN-1670-01-061-0990CT) coupler or a 1.5 inch (NSN 1670-01-487-8743CT) coupler is required between pallets to ensure the married pallets will mate with the aircraft restraint locks.

C.9.3 Ground handling systems.
This family is concerned with the movement of palletized cargo between the air cargo terminal and the aircraft. The family is made up of mobile loading equipment of various types and sizes which have been designed to provide the versatility and efficiency required to effectively load/unload various types of aircraft. In addition, each is capable of being air transported to remote sites. The elements of this family are:

a) Truck, Aircraft Cargo Loading/Unloading, 60,000 lb Capacity, A/S32H-23. The common name is Tunner 60K loader. This truck is used primarily at major command terminals for mechanized loading, unloading, and ground transport of air cargo. It services low and high floor aircraft. The capability exists to handle palletized cargo and skidded and wheeled loads in a method resulting in minimum aircraft turnaround time.

b) Truck, Aircraft Cargo Loading/Unloading, 40,000 lb Capacity, A/S32H-6. The common name is 40K loader. This truck is used at major command terminals for mechanized loading, unloading, and ground transport of air cargo while servicing military and commercial aircraft. The capability exists to handle palletized cargo and skidded and wheeled loads in a method resulting in minimum aircraft turnaround time.

c) Truck, Aircraft Cargo Loading/Unloading, 25,000 lb Capability. The common name is Halvorsen 25K loader (NGSL). This truck is a lightweight, air transportable vehicle for use at intermediate class terminals to load and unload low and high floor cargo aircraft.

d) Truck, Aircraft Cargo Loading/Unloading, 25,000 lb Capacity, A/S32H-5. The common name is 25K loader. This truck is a lightweight, air transportable vehicle for use at intermediate class terminals to load and unload military and commercial aircraft. (There are several manufacturers for this model. See figure B-88 for variations in lateral roller spacing.)

e) Forklifts: A variety of commercial and military forklifts and wheel loaders (fitted with fork tines) are presently used to fill this roll instead of just 463L specific equipment.

C.9.4 Aircraft systems.
The aircraft systems family provides the 463L system with the capability to rapidly load, offload, and restrain cargo in transport-type aircraft. This encompasses all equipment and components actually installed or placed in the aircraft for specific cargo handling and restraint. The 463L compatible aircraft handling systems are described in the aircraft specific sections of this standard and A.4.2.2.

C.9.5 Interrelationship.

The entire system revolves around the 463L pallet (2.24 x 2.74 m (88 x 108 in.), HCU-6/E) and the use of roller conveyor systems. The equipment is designed to load and secure this unit. The designer can also use this system to effectively move other cargo; e.g., he could use the automatic locking system to secure pallet components used to build custom pallets. See 5.3.6.2 and 6.5.3.2 for more information on custom pallets.

CONCLUDING MATERIAL

Custodian:

Air Force – 11

Preparing Activity:

Air Force – 11

(Project 1510-2009-001

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil/.