INCH-POUND

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MILITARY STANDARD

TRANSPORTABILITY

CRITERIA

AMSC NO A6709

AREA PACK

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FOREWORD

1. This military standard is approved for use by all departments and agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data that may be of use in improving this document should be addressed to: Director, Military Traffic Management Command Transportation Engineering Agency, ATTN: MTTE-TR, PO Box 6276, Newport News, VA 23606-0276, by using the modified Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by memorandum or letter.

3. This standard provides transportability criteria and test information for guidance in the design, development, and procurement of military materiel that falls within the framework of the DOD Engineering for Transportability Program. This standard is in compliance with the requirements of DOD Directive 5000.2, Defense Acquisition Management Policies and Procedures. Emphasis is placed upon the maximum dimensions and weights that worldwide transportation systems can accept for transportability of materiel or equipment by all modes. Constraints applicable to each transportation mode are outlined, and criteria are included for item slinging and tiedown provisions, air delivery, shelters, overloads, assembly/disassembly, and intermodal cargo containers. This guidance will assist in evaluating the transportability characteristics of military materiel and the effect those characteristics will have on the functional performance of the materiel. It also provides design criteria for the design and development of items procured by DOD.

4. Copyright material has been included in this military standard with specific permission of the copyright holders. Appreciation is expressed to:

a. The American Trucking Associations, Inc. (ATA) and the International Road Federation (IRF) for highway information,

b. The Association of American Railroads (AAR) for rail information, and

c. USA Technical Advisory Group (USATAG) for ISO Technical Committee (TC) 104 on Freight Containers for container information.

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APPENDIXES

1. SCOPE

1.1 General. In accordance with the DOD Engineering for Transportability Program, this standard establishes basic transportability criteria for use in the development and shipment of items of materiel. The standard covers dimensional and weight limitations for all modes of transport. It also covers slinging and tiedown provisions, containerization criteria, overloads, assembly/disassembly, air delivery, shelter criteria, and transportability testing. This standard will allow materiel development and procurement activities to design military equipment to meet the transportability requirements of the various modes.

1.2 Applicability. This military standard is for use by the DOD acquisition community, to include the private sector, in the acquisition of defense materiel and systems. It should be included, by reference, in appropriate documentation of the DOD acquisition process to ensure acceptable transportability (see para 3.35).

1.3 Application guidance. The weight, dimensional, and tiedown criteria given for internal transport aboard Navy and Marine Corps fixed- and rotary-wing aircraft are intended as guidelines only. The contractor and/or materiel developer should contact: Commander, NAVAIRSYSCOM, ATTN: AIR-53033F, Washington, DC 20361, to obtain further information on specific aircraft.

1.4 Metric equivalents. Metric equivalents shall conform to FED-STD-376. Conversion tables are in appendix B.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 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 listed in the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto cited in the solicitation.

SPECIFICATIONS

MILITARY

MIL-M-8090	Mobility, Towed Aerospace Ground Equipment, General Requirements for
MIL-S-44195	Shelter, Tactical, Expandable, Two-Side
MIL-S-44196	Shelter, Tactical, Nonexpandable
MIL-S-44197	Shelter, Tactical, Expandable, One-Side
MIL-C-52661	Containers, Cargo
MIL-S-55286	Shelter, Electrical Equipment S-280()/G
MIL-S-55507	Shelter, Electrical Equipment (With or Without Equipment) Packaging of
MIL-S-55541	Shelter, Electrical Equipment S-250()/G

STANDARDS

FEDERAL

FED-STD-376	Preferred Metric Units for General Use by the Federal Government

MILITARY

MIL-STD-209	Slinging and Tiedown Provisions for Lifting and Tying Down Military Equipment
MIL-STD-648	Design Criteria for Specialized Shipping Containers

MIL-STD-669	Loading Environment and Related Requirements for Platform Rigged Airdrop Materiel
MIL-STD-810	Environmental Test Methods and Engineering Guidelines
MIL-STD-814	Requirements for Tiedown, Suspension, and Extraction Provisions on Military Materiel for Airdrop
MIL-STD-907	Engineering and Design Criteria for Shelters, Expandable and Nonexpandable
MIL-STD-910	Mobile Tactical Systems Overload Prevention Procedures
MIL-STD-913	Requirements for the Certification of Externally Transported Military Equipment by Department of Defense Rotary Wing Aircraft
MIL-STD-1290	Light Fixed- and Rotary-Wing Aircraft Crash Resistance
MIL-STD-1472	Human Engineering Design Criteria for Military Systems, Equipment and Facilities
MIL-STD-1791	Designing for Internal Aerial Delivery in Fixed-Wing Aircraft

HANDBOOKS

MILITARY

DH1-11	AFSC Design Handbook Air Transportability
MIL-HDBK-759	Human Factors Engineering Design for Army Materiel

(Unless otherwise indicated, copies of Federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

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

CODE OF FEDERAL REGULATIONS (CFRs)

CFR Title 23 Highways
CFR Title 49 Transportation

(Requests for copies should be addressed to the Superintendent of Documents, US Government Printing Office, Washington, DC 20402.)

ARMY

AR 55-162	Permits for Oversize, Overweight, or Other Special Military Movements on Public Highways in the United States
AR 70-44/OPNAVINST 4600.22B/AFR 80-18/ MCO 4610.14C/DLAR 4500.25	DOD Engineering for Transportability
AR 70-47	Engineering for Transportability

(Requests for copies should be addressed to the Superintendent of Documents, US Government Printing Office, Washington, DC 20402.)

MANUALS

MILITARY

FM 5-36	Route Reconnaissance and Classification
TM 5-312	Military Fixed Bridges
AFR71-4/TM38-250/ NAVSUP PUB 505/ MCO P 4030.19/ DLAM 4145.3	Preparation of Hazardous Materials for Military Air Shipment
DI-PACK-80880	Data Item Description Transportability Report

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

MILITARY TRAFFIC MANAGEMENT COMMAND (MTMC)

Directory of Highway Permit Officials and Mobilization Movement Control (MOBCON) Coordinators

(Requests for copies should be addressed to Director, MTMC Transportation Engineering Agency, ATTN: MTTE-TR, PO Box 6276, Newport News, VA 23606-0276.)

2.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation.

R.E.R. PUBLISHING CORPORATION, AGENT

The Official Railway Equipment Register

(Applications for copies should be addressed to the R.E.R. Publishing Corporation, Agent, 424 West 33rd Street, New York, NY 10001-2604.)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI-MH5.1	Basic Requirements for Cargo Containers
ANSI-MH5.4	American National Standard Specifications for International Standardization Organization (ISO) Freight Containers

(Applications for copies should be addressed to the American National Standards Institute, ATTN: Sales Department, 1430 Broadway, New York, NY 10018.)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO 668	Series 1 Freight Containers - Classification, Dimensions, and Ratings
ISO 1496/1	Series 1 Freight Containers - Specifications and Testing - Part 1: General Cargo Containers

(Applications for copies should be addressed to the American National Standards Institute, ATTN: Sales Department, 1430 Broadway, New York, NY 10018.)

ASSOCIATION OF AMERICAN RAILROADS (AAR)

Field Manual of the AAR Interchange Rules
Outline Diagram for Single Loads, Without End Overhang, on Open-Top Cars

(Applications for copies should be addressed to the Association of American Railroads, 50 F Street NW, Washington, DC 20001-1564.)

AMERICAN TRUCKING ASSOCIATIONS, INC. (ATA)

Summary of Size and Weight Limits

(Applications for copies should be addressed to the American Trucking Associations, Inc., 2200 Mill Road, Alexandria, VA 22314-4654.)

INTERNATIONAL ROAD FEDERATION (IRF)

Limits of Motor Vehicle Sizes and Weights

(Applications for copies should be addressed to the International Road Federation, 525 School Street SW, Washington, DC 20024.)

FEDERAL HIGHWAY ADMINISTRATION, US DEPARTMENT OF TRANSPORTATION

Bridge Gross Weight Formula

(Applications for copies should be addressed to the Federal Highway Administration, Office of Traffic Operations, HTO-33, 400 7th Street SW, Room 3103D, Washington, DC 20590.)

NATO STANDARDIZATION AGREEMENTS (STANAG)

STANAG 2021 ENGR, NATO	Computation of Bridge, Ferry, Raft, and Vehicle Classifications
STANAG 2175 VF, NATO	Classification and Designation of Flat Wagons Suitable for Transporting Military Vehicles and Equipment
STANAG 2832 VF, NATO	Restrictions for the Transport of Military Equipment by Rail on European Railways

(Unless otherwise indicated, copies of STANAGs are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the references take precedence. Nothing in this document, however, supersedes applicable laws and regulations, unless a specific exemption has been obtained.

3. DEFINITIONS

For the purpose of this document, the following definitions apply.

3.1 Airdrop (air delivery). An operation involving the delivery of supplies or equipment to combat forces wherein those items are dropped from an aircraft during flight.

3.2 Athwartship. Across the ship from side to side.

3.3 Breakbulk general-cargo ships. Breakbulk ships are designated as general cargo ships because of their ability to carry a variety of cargo. Cargo loading/unloading operations are accomplished via lift-on/lift-off using shipboard cranes.

3.4 Cargo tiedown provisions. Integral tiedown provisions in the cargo-carrying area of a cargo-transporting vehicle that are attachment points for cargo restraints.

3.5 CBTDEV. The Combat Developer (CBTDEV) is the command or agency that formulates doctrine, concepts, organization, materiel requirements and objectives. It may be used generically to represent the user community role in the materiel acquisition process (counterpart to generic use of MATDEV).

3.6 CONUS. Continental United States.

3.7 Cushioned draft gear railcar. Any railcar equipped with center or end-of-car cushioning devices. Cushioned draft gear railcar cushioning devices are covered by Rule 59 in the Field Manual of the AAR Interchange Rules. In general, the distance of draft gear (or center sill of railcars with cushioned underframe) travel from normal position to maximum extension for one end of car is 5 inches or greater.

3.8 Curb weight. For vehicles with a payload rating of 2.2 tons or less, the curb weight is the weight of the vehicle with basic issue items on board and with a full load of fuels and lubricants. For vehicles with a payload rating greater than 2.2 tons, the curb weight includes the weight of the truck (or trailer), including materials handling equipment (if applicable), with all kits, attachments, accessories, equipment, basic issue items and full complement of fuel, lubricants, coolants, hydraulic fluid, and crew.

3.9 Extraction parachutes. Parachutes used to withdraw airdrop items from aircraft in flight.

3.10 Floor contact pressure. Refers to the resultant pressure exerted by the weight of SEM on the carrying surface of the transporter through the portions of the SEM actually in contact with the carrying surface. For water transport only, the deck loading refers to the weight of the SEM distributed over the SEM's shadow area (length times width of the SEM) not including small protrusions such as the gun barrel on a tank.

3.11 Fragile item. An item of systems/equipment/munitions (SEM) that is susceptible to damage and/or loss of serviceability during transport and handling. It requires special shipping procedures or equipment, environmental control, or special packaging for protection during transport.

3.12 Gross weight. The weight of the basic equipment (curb weight for vehicles) plus the weight of any associated support items of equipment (ASIOE) and cargo attached to the equipment, contained within the equipment, or projected as payload for the equipment (that is, shelters). For light tactical vehicles (payload rating of 2.2 tons or less), crew weight is considered as payload. The weight of ammunition and/or additional fuels and lubricants (to include water) necessary to render the system combat ready is also considered as payload.

3.13 Hazardous material. A substance or device that, as determined by the Secretary of Transportation, could pose an unreasonable risk to health, safety, and property when transported in commerce and is so designated in the table set forth in 49 CFR 172.101. Included are explosives; flammable, combustible, and pyrophoric liquids; flammable solids, oxidizers, and organic peroxides; corrosive materials; compressed gases; poisons and irritating materials; etiologic agents; and radioactive materials. For air transport, see the restrictions identified in TM 38-250.

3.14 Internal aerial delivery. Internal air transport aboard military prime mission cargo aircraft or Civil Reserve Air Fleet (CRAF) aircraft.

3.15 Item disassembly. Removal of parts of an item to reduce its physical characteristics (weight and dimensions) so that transport limitations are not exceeded.

3.16 Item reassembly. Replacement of parts on an item to restore the item to its operational configuration.

3.17 LAPE (Low altitude parachute extraction). A type of airdrop used for platform loads where the load is extracted from a C-130 or C-17 aircraft, flying at approximately 130 knots, and at a ramp height between 5 and 15 feet above the ground. Recovery parachutes are not used.

3.18 Lighter. A vessel, commonly flat-bottomed, used in loading/unloading ships in logistics-over-the-shore (LOTS) operations.

3.19 Light weight. The empty weight of a railroad car including its trucks and any other appurtenances considered standard to the railcar. The light weight is stenciled on every freight car in conjunction with the capacity and load limit stenciling, and is abbreviated LT WT.

3.20 Load limit. The maximum weight that can be loaded on a railcar. For railcars meeting standard AAR design criteria, the load limit is equal to the maximum allowable gross weight on the rails (determined by axle and wheel size) less the light weight of the railcar. Load limit is stenciled on every freight car in conjunction with the capacity and light weight stenciling and is abbreviated LD LMT.

3.21 MATDEV. The Materiel Developer (MATDEV) is the research, development, and acquisition (RDA) command, agency, or office (PM/PEO) assigned responsibility for the system under development or being acquired. The term may be used generically to refer to the RDA community in the materiel acquisition process (counterpart to the generic use of CBTDEV).

3.22 Payload rating. The maximum weight a vehicle is designed to transport.

3.23 Platform. A unit-load device, similar to a pallet, designed specifically for airdrops.

3.24 Potential transportability problem item. An equipment item in its proposed shipping configuration that, because of its size, weight, fragile or hazardous characteristics, or lack of adequate means for lifting and tiedown, may be denied movement. It may require special permits or waivers and/or special equipment or handling, or may be unacceptably delayed when moving within existing or newly designed transportation systems. A more detailed, technical definition of a transportability problem item is given in paragraph 4.3 of this military standard.

3.25 Recovery parachutes. Parachutes used to retard and stabilize the descent of an airdrop item.

3.26 Reporting marks. Lettering appearing on the sides and ends of all freight cars identifying ownership such as marks including TTX for TTX Company (formerly Trailer Train Company), DODX for Department of Defense, MTMC Eastern Area, or SP identifying cars of the Southern Pacific. The "X" denotes private ownership as differentiated from railroad ownership. The first letters used with TTX are arbitrary designations used to differentiate various car types.

3.27 SEM (Systems/equipment/munitions) materiel. All items and item components necessary for equipping, maintaining, operating, and supporting military activities, without distinction as to their application for administrative or combat purposes, excluding ships.

3.28 Shipping configuration. The item/system configuration, stated in weights and dimensions, that a military unit will use for transport. It also includes the restraint arrangement for safe transport of the item/system.

3.29 Slinging provision. An integral part of an item of equipment, commonly called a padeye, lug, eye, or lifting attachment, which may include a nonremovable shackle or ring. It provides a means of attaching a shackle, hook, or sling eye to the equipment for safe lifting and handling.

3.30 Spreader bars. A bar, set of bars, or other framework used to prevent sling legs from damaging an item by compression, friction, and so forth.

3.31 Standard draft gear railcar. Any railcar that is not equipped with center or end-of-car cushioning devices. The standard draft gear devices in standard draft gear railcars are covered in Rule 21 of the Field Manual of the AAR Interchange Rules. Railcars having standard draft gear are so listed in the Universal Machine Language Equipment Register (UMLER) files. The UMLER files are maintained by the Association of American Railroads (AAR).

3.32 Strategic deployment. The continuous or sustained movement of units, personnel, and logistic support items between CONUS and oversea areas and between area commands. The C-141 and C-5 aircraft are examples of strategic airlift transporters.

3.33 Tactical deployment. Deployment within a theater of operations. The C-130 aircraft, helicopters, and landing craft are examples of tactical transporters.

3.34 Tiedown provision. An integral part of an item of equipment, commonly called a tiedown eye, fixture, attachment, or provision, which may include a ring. It has an opening for attaching a shackle, hook, tiedown cable, or airdrop lashing to the equipment for tiedown purposes during shipment.

3.35 Transportability. The inherent capability of an item to be moved efficiently by towing, self-propulsion, or carrier, using existing equipment or equipment that is planned for the movement of the item via rail, highway, water, and air. (Full consideration of available and projected transportation assets, mobility plans and schedules, and the impact of system equipment and support items on the strategic mobility of operating military forces is required to achieve this capability.)

3.36 Transportability approval. A statement by the Commander, MTMC, that an item of materiel, in its shipping configuration, is transportable by the mode(s) of transportation specified in development guides or materiel requirements, or meets amended transportability characteristics approved by higher authority.

3.37 Transportability engineering. The performance of those functions required to: identify and measure the limiting constraints, characteristics, and environments of transportation systems; integrate these data into design criteria for effective operational and planned transportation capability; and develop technical transportability guidance.

3.38 Transportability engineering analysis. An analysis of the transportability of an SEM item or its components, which assesses its ability to be transported by the modes specified in the materiel requirements documents.

3.39 Transportability report. An information package, submitted on a potential transportability problem item during SEM development/acquisition. It contains all the information required by AR 70-47 necessary for performing a comprehensive transportability engineering analysis. The transportability report is prepared by the materiel developer or contractor in accordance with the format and content of Data Item Description, DI-PACK-80880 and AR 70-47. If an SEM item requires transport by USAF aircraft only, the transportability report is prepared and submitted in accordance with AR 70-44. The materiel developer is responsible for submitting this report to the appropriate transportability agent.

3.40 'Tween-deck. In this context, 'tween-deck refers to a temporary deck between two permanent decks on a ship.

3.41 Vehicle payload. For vehicles having a payload rating of 2.2 tons or less, payload is any load placed in or on the vehicle that increases the gross vehicle weight above the curb weight. Payload includes the weight of the driver, passengers, personal gear, cargo, water cans, table of organization and equipment or common table of allowances items, kits, communications and electronics equipment, cargo cover kits, and shelterized systems (including the weight of the shelter). The trailer tongue load must be included as a part of the payload for HMMWV Group II models. Tongue loads in excess of 200 pounds must be counted as part of the payload for the CUCV and Group I HMMWV models. For vehicles having a payload rating of more than 2.2 tons, the payload shall include cargo only. For light tactical vehicles (payload rating of 2.2 tons or less), crew weight is considered as payload. The weight of ammunition and/or additional fuels and lubricants (to include water) necessary to render the system combat ready is also considered as payload.

4. GENERAL REQUIREMENTS

4.1 DOD Engineering for Transportability Program. This program provides for the inclusion of transportability requirements in the design of end items of equipment obtained through the materiel acquisition program for the military services.

Transportability is important throughout the acquisition cycle. However, it is essential that transportability be considered at the beginning of the materiel acquisition cycle when the impact on design is the greatest. Transportability can have its greatest impact at the beginning of the acquisition cycle because costs for design changes are minimal then. It is easier and less costly to make changes to a conceptual design than it is to alter or retrofit actual hardware.

Transportability is equally important in other stages of the acquisition cycle. The omission of transportability considerations during the middle or later stages of the cycle can negate all transportability efforts and advances made during the early stages.

DOD Directive 5000.2, Defense Acquisition Management Policies and Procedures, establishes transportability as a critical system characteristic and operational constraint. This directive states that transportability is a major consideration in the design of new, modified, rebuy, or commercial nondevelopmental items.

Further, transportability approval should be given by the Commander, MTMC, and strategic deployability requirements should be met where relevant.

4.2 Transportability design responsibilities. The materiel developer and/or contractor shall be responsible for incorporating transportability considerations in the design of new or modified equipment, rebuy equipment, or the adaptation of commercial nondevelopmental items.

4.3 Potential transportability problem item. An SEM item is considered a potential transportability problem item when any of the following conditions apply:

a. Item is wheeled or tracked, and is to be towed, hauled, or self-propelled on or off highway.

b. Materiel exceeds any of the following conditions:

(1) Length - 18.5 feet (5.639 m).

(2) Width - 7 feet (2.134 m).

(3) Height - 6.5 feet (1.981 m).

(4) Weight - 2,500 pounds (1134 kg).

(5) Weight per linear foot - 1,600 pounds (726 kg).

(6) Floor contact pressure - 50 pounds per square inch (344.75 kPa) (see 3.10).

c. The SEM item requires transport by USAF aircraft only and exceeds:

(1) Length - 20 feet (6.100 m).

(2) Width - 8 feet (2.438 m).

(3) Height - 8 feet (2.438 m).

(4) Weight - 20,000 pounds (9070 kg).

(5) Weight per linear foot - 1,600 pounds (726 kg).

(6) Floor contact pressure - 50 pounds per square inch (3.515 kg/sq cm).

(7) Maximum axle load (vehicle with pneumatic tires) - 5,000 pounds (2268 kg).

(8) Maximum wheel load (vehicle with pneumatic tires) - 2,500 pounds (1134 kg).

(9) Any item which requires special equipment or procedures for loading in an aircraft such as nuclear weapons.

4.4 Management of potential transportability problem items. If an SEM item meets 4.3a or exceeds the criteria of 4.3b (4.3c if SEM requires transport by USAF aircraft only), such a transportability problem item shall be identified in a transportability report submitted by the materiel developer (MATDEV) to the appropriate service transportability agent. The report shall be prepared by the materiel developer or contractor and shall be in accordance with the format and content of Data Item Description, DI-PACK-80880 (see para 6.2).

5. DETAILED REQUIREMENTS

5.1 Highway transportation.

5.1.1 General. Highway transport vehicles developed for over-the-road movement should meet the limitations imposed by the physical, legal, and administrative characteristics of roadways, bridges, and other structures. This document presents the most significant physical, structural, legal, and administrative characteristics and constraints of CONUS and various foreign highway systems. These criteria establish guidelines to ensure that new military highway transport equipment is compatible with the capabilities and limitations of CONUS and foreign highway systems. This is important, since military vehicles are not exempt from state size and weight limitations.

5.1.2 CONUS highways.

5.1.2.1 Unrestricted transport. The maximum weight and dimensions at which vehicles and vehicle cargo combinations can move throughout CONUS without permits constitute State legal limits. These weight and dimensional legal limits vary from State to State. The "Summary of Size and Weight Limits" in appendix A of the Directory of Highway Permit Officials and Mobilization Movement Control (MOBCON) Coordinators is taken from ATA data and summarizes the State legal limits for moves of oversize and overweight equipment. To ensure general unrestricted CONUS highway transport, vehicles and vehicle cargo combinations shall be designed to the following constraints when unrestricted CONUS highway transport is a requirement:

Height	162 inches
Width	96 inches
Length	35 feet for a single unit 55 feet for a combination unit 45 feet for a semitrailer
Single axle load	20,000 pounds
Tandem axle load	34,000 pounds
Triple axle load	42,000 pounds (4 States have lower limits)
Gross vehicle weight*	80,000 pounds

*NOTE: The gross vehicle weight constraint is also dependent on the highway bridge formula, which is presented in paragraph 5.1.2.2.

5.1.2.2 US highway bridge gross weight formula. The bridge gross weight formula specifies the relationship between the axle (or groups of axles) spacing and the gross weight that the axle(s) may carry to prevent overstressing highway bridges. The bridge formula is:

$$W = 500 (LN/N-1 + 12N + 36)$$

where:

W = overall gross weight on any group of two or more consecutive axles to the nearest 500 pounds

L = distance in feet between the extreme of any group of two or more consecutive axles

N = number of axles in the group under consideration

The bridge formula is incorporated into CFR Title 23, part 658. A sample problem for determining bridge formula requirements is in appendix A of this military standard.

5.1.2.3 The National Network. The National Network has been identified on which large vehicles authorized by the Surface Transportation Assistance Act (STAA) of 1982 are allowed to operate. One configuration allowed to travel on the National Network is the truck tractor- semitrailer-trailer combination. (Trailers must be no longer than 28 feet for unrestricted National Network transport.) This network includes the Interstate System plus other qualifying Federal-aid Primary System Highways. CFR Title 23, part 658, establishes the requirements for highway transport on the National Network.

5.1.2.4 US highway permit limits. The US highway permit limits are constraints within which a State will allow highway transport under its permit procedures when unrestricted highway transport is not possible. The conditions for which a State will issue movement permits without certification as essential to the national defense are in the Directory of Highway Permit Officials and Mobilization Movement Control (MOBCON) Coordinators. Note that these limits are adjusted by particular conditions at movement time and should be verified with the appropriate State highway official prior to highway transport. Vehicles and vehicle cargo combinations shall meet the permit limit criteria in the Directory of Highway Permit Officials and Mobilization Movement Control (MOBCON) Coordinators when US highway transport within permit limitations is a requirement.

5.1.2.5 Certification essential to national defense. "Highway movement essential to national defense" applies to essential materiel that cannot be reduced in size or weight to meet permit limits or cannot be moved by another mode of transportation. This materiel must be eligible for highway movement in accordance with the provisions of AR 55-162, Permits for Oversize, Overweight, or Other Special Military Movements on Public Highways in the United States. Training, maintenance, and public-relations mission movements or savings of transportation cost or time are not valid justifications for meeting certification requirements. Once the installation commander determines that the materiel meets the requirements, he/she must request that the Major Army Command (MACOM) Commander of the shipping command certify the movement is essential to national [illegible] certification. The minimum time required to complete the certification is 30 working days. Certification that the movement is essential to national defense does not guarantee that US highway authorities will allow movement. States have absolute authority over their public roadways both in peacetime and wartime and will make all final determinations of transport capability.

5.1.2.6 Safety. For movement on public highways, reference shall be made to safety, lighting, brake, and stopping-distance specifications currently required for commercial vehicles by the US Department of Transportation. Vehicles and vehicle cargo combinations shall meet the safety requirements of CFR Title 49.

5.1.3 Foreign highways. The weight and dimensional constraints at which vehicles and vehicle cargo combinations can move on foreign highways without permits constitute the foreign legal limits. These weight and dimensional legal limits vary from country to country. The legal limitations for foreign highways are shown in the Limits of Motor Vehicle Sizes and Weights, published by the IRF. Because such a wide variation exists in the foreign legal limits and some countries have limited highway systems, the following constraints are recommended to achieve general unrestricted transport in most NATO countries:

Width	2.44 meters
Height	4.00 meters
Length	12.00 meters - single unit 15.00 meters - combination unit
Single axle load	10 metric tons
Tandem axle load	16 metric tons

Gross vehicle weight is dependent on the vehicle type, as defined in the Limits of Motor Vehicle Sizes and Weights. Vehicles and vehicle cargo combinations shall meet the requirements of this paragraph and 5.1.2.1 when unrestricted worldwide highway transport is a requirement.

5.1.4 Military load classification (MLC). FM 5-36, STANAG 2021, and TM 5-312 provide guidance on route reconnaissance and classification. To make maximum use of existing routes, the military load-carrying capacity of the routes in a basic military road network must be determined. This process is called classification. The MLC system assigns whole numbers to vehicles, bridges, roads, and routes. Usually, the lowest bridge MLC number determines the MLC of a route. The materiel developer should request that MTMCTEA obtain an MLC from the Belvoir Research, Development and Engineering Center (BRDEC) for vehicles and vehicle cargo combinations during the engineering and manufacturing development phase of acquisition. Vehicles and vehicle cargo combinations shall be designed to the MLC requirement.

5.1.5 Determining crew weights. The materiel developer must account for the weight of the crew when determining the gross vehicle weight (GVW) and axle loads of highway transporters. Also, the crew weight is considered a part of the payload for vehicles such as 5/4-ton trucks. This weight includes the soldier's body weight plus the weight of the soldier's basic load of clothing, ammunition, individual equipment and weapon, and food. The MTMC Transportation Engineering Agency identifies planning guidelines for crew member weights as follows:

Total Crew Weight

Single-Soldier Crew	-	295 pounds
Two-Soldier Crew	-	566 pounds
Three-Soldier Crew	-	828 pounds
Four-Soldier Crew	-	1,080 pounds

These weight figures include 19.47 pounds of clothing, 42.22 pounds of equipment, and 31.24 pounds of existence load per person. Weight variances for multiple size crews account for reduced probability of several 95th percentile crew members being assigned to the same system. Allowances shall be made to accommodate increases in the crew weight due to operations in cold weather scenarios. For cold weather scenarios, the clothing weight will increase to 34 pounds and the equipment weight will increase to 49 pounds per person. This means a single-soldier crew weight will be 316 pounds. The information in this paragraph is based on information in MIL-STD-1472 and MIL-HDBK-759. The materiel developer/contractor shall meet the requirements of this paragraph when determining crew weights for highway transport.

5.2 Rail transportation.

5.2.1 General. Items developed for movement by the rail mode should meet the limitations imposed by physical, legal, and administrative characteristics of rail lines worldwide. This document presents the most significant constraints of CONUS and foreign rail systems. These criteria establish guidelines to ensure that new military equipment requiring rail transport is compatible with the capabilities and limitations of CONUS and foreign rail systems.

5.2.2 North American rail.

5.2.2.1 Railcar availability. Typical North American railcars and their dimensions are shown in table I. A description of cars, including numbers and types of cars available in North America, is given in The Official Railway Equipment Register. The information in this register is for railcars listed in the UMLER file, thereby meeting rule 90f of the Field Manual of the AAR Interchange Rules. Rule 90f prohibits the use of railcars not listed in the UMLER files for interchange from one rail line to another. Normally, transportability problem items will require movement on open-top railcars. New items of equipment shall be designed such that they will fit on at least one type of the flatcars listed in table I, when rail transport is a requirement.

5.2.2.2 Unrestricted transport. For generally unrestricted movement in North America, the height and width of a loaded railcar shall remain within the limitations of the AAR Outline Diagram for Single Loads, Without End Overhang, on Open-Top Cars (fig 1). A loaded railcar meeting the confines of this diagram will be capable of unrestricted transport in North America except on a very few rail lines generally considered unimportant for DOD use. Loads wider than the flatcar, or combined load plus flatcar heights greater than 15 feet 1 inch above the top of the rails, are considered "dimensional loads." All involved railroad companies will perform clearance checks on "dimensional loads" for the entire distance of shipment before such shipments will be allowed. Clearance checks may delay rail transport because they are performed during normal working hours. When a load overhangs the sides of a railcar, the width is measured as two times the largest distance from the railcar centerline to outside edge of load. For clearance purposes, this distance is

TABLE I. Typical railcar dimensions.

Type Railcar and Designation 1/ if any	Typical Deck Dimensions Length by Width (ft)	Typical 2/ Load Limit (tons)	Approximate Number Available	Notes
Flatcars ITTX and similar	89.00 by 8.50	70	Greater than 1,000 3/	4-axle, cushioned draft gear flatcar equipped with 3/8-in. chains. Chains have working load limit of 9,000 lbs and are proof tested to 18,000 lbs. Also equipped with special adjustable and foldaway pedestals.
Flatcars OTTX and similar	60.00 by 10.50	72	2,300 3/ (1,799)	4-axle, cushioned draft gear flatcar equipped with 3/8-in. chains. Chains have working load limit of 9,000 lbs and are proof tested to 18,000 lbs.
Flatcars HTTX and similar	60.00 by 10.50	73	900 3/ (731)	4-axle cushioned draft gear flatcar equipped with heavy duty tiedowns. Equipped with 1/2-in. chains with working load of 13,750 lbs and proof test of 27,500 lbs.
Flatcars MTTX and similar	60.00 by 10.50	74	950 3/ (244)	4-axle, basic multipurpose cushioned draft gear flatcar with plain wood deck but no chains.
Flatcars DODX 140-ton nominal capacity	68.00 by 10.42	149	566	Heavy duty, 6-axle, cushioned draft gear flatcar with 1/2-in. chains.
Flatcars Others (cushioned and standard) draft gear	89.33 by 8.50 to 51.33 by 10.50	50 to 70	widely 4/ available	Flatcars may have standard or cushioned draft gear.
Boxcars	50.50 by 9.58 to 86.50 by 9.17	50 to 80	widely 4/ available	Boxcars may have standard or cushioned draft gear.
Gondolas	46.00 by 9.58 to 52.50 by 9.50	70 to 100	widely 4/ available	Gondolas may have standard or cushioned draft gear.

1/ See the definition of "reporting marks" in section 3 for an explanation of flatcar designations.

2/ See Section 3 for definition of load limit. The ability of general service flatcars (excluding 84- and 89-foot flatcars) to carry a single heavy vehicle is usually limited to 75 pct of the load limit, depending on the length of the vehicle and design of the flatcar. Gondolas and boxcars have similar restrictions. The 84- and 89-foot flatcars cannot carry concentrated loads. They are generally used to carry multiple light items.

3/ For the ITTX, HTTX, OTTX, and MTTX flatcars, the number given denotes the total number of flatcars that have that or a similar designation. The number in parentheses for the HTTX, OTTX, and MTTX denotes the number of flatcars that meet Note 3 in the Trailer Train Company section of The Official Railway Equipment Register. Note 3 states, "These 60-ft flatcars are capable of carrying 90 pct of the load limit over a centered 14 ft." This means these railcars can transport tanks weighing up to about 64.8 tons.

4/ The term "widely available" means that railcars of this type are abundant; however, a specific car may not be readily available.

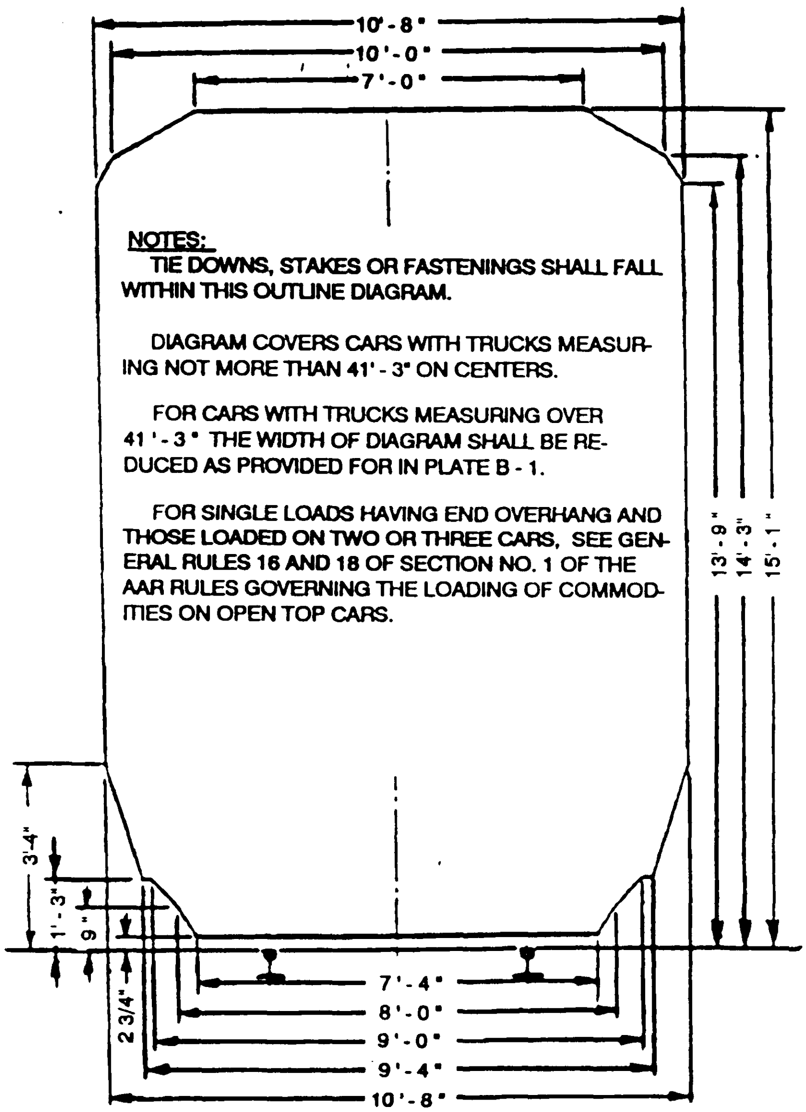


FIGURE 1. Outline diagram for single loads, without end overhang, on open-top cars.

the least critical when the load is centered on the flatcar centerline. Usually a plus/minus 1-inch tolerance is sufficient for item placement. When railcars are requested from a railroad company on short notice, the railroad company will furnish what is readily available. Deck heights of flatcars can vary. For these reasons, unrestricted rail transport is based on a "standard worst-case deck height" railcar. Based on the deck heights of railcars listed in The Official Railway Equipment Register, the "standard worst-case deck height" is 50 inches above the top of rails. When unrestricted North American rail transport is a requirement, new items of equipment shall be designed such that the item outline is within the AAR diagram (fig 1) when placed on a 50-inch-high flatcar.

5.2.3 Foreign rail.

5.2.3.1 Foreign railcar availability. The railcars listed in table II represent those available for military transport in NATO countries. The types and availability of railcars in other foreign countries vary from country to country. Items of equipment shall be designed to fit on the flatcars listed in table II, when rail transport is a requirement.

5.2.3.2 NATO unrestricted rail. Standardization Agreement (STANAG) 2175 defines two types of equipment - ordinary transport military equipment and exceptional transport military equipment.

a. Ordinary transport military equipment. Ordinary transport military equipment consists of wheeled vehicles, tracked vehicles, and equipment that presents all the following characteristics:

(1) Indivisible weight not exceeding 20 metric tons.

(2) Length not exceeding 12.5 meters.

(3) Load distribution: 16.5 metric tons maximum over a length of 2.5 meters.

(4) Require no lowering of the carrying flatcar's drop-sides.

(5) The flatcar/equipment unit conforms to the Gabarit International de Chargement (GIC), with a loading tolerance of 15 millimeters per half-width. This gauge with loading tolerance is shown in figure 2 and is called the GIC equipment gauge. The 15-millimeter-per-half-width tolerance allows for some error in the placement of an item on a railcar. Figure 2 takes this tolerance into consideration.

TABLE II. Characteristics of Deutsche Bundesbahn (DB) flatcars.

Designation of Flatcars	Description of Flatcars	Typical Deck Dimensions Length by Width (ft)	Deck Height (in.)	Typical Load Limit (lb)	Number Available
Ks	light duty flatcar, 2-axle, with removeable side and end walls	41.0 by 9.1	48.7	59,500	23,000
Rs	heavy duty flatcar, 4-axle	60.7 by 9.1	51.4	123,400	8,500
Res	heavy duty flatcar, 4-axle, with removeable side walls	60.7 by 8.7 *	48.7	124,500	4,900
Rmms	heavy duty flatcar, 4-axle, length is less than 15m	41.5 by 9.5	49.6	130,000	3,000
Remms	heavy duty flatcar, 4-axle, with removeable side walls, length is less than 15m	41.5 by 9.1 *	49.6	128,900	660
Rlmmp	heavy duty flatcar, equipped with stakes, 4-axle, length is less than 15m, does not have bulkhead	31.2 by 10.3	50.8	132,200	830
Samms	heavy duty flatcar, 6-axle, length is less than 15m	49.2 by 10.2 *	51.2	143,200	5,600

* The Res, Remms, and Samms flatcars have dropsides. The widths shown are the actual widths of these flatcars. For unrestricted rail transport, the designer should use 8.6, 9.0, and 8.3 as the maximum item/system width for the Res, Remms, and Samms flatcars respectively.

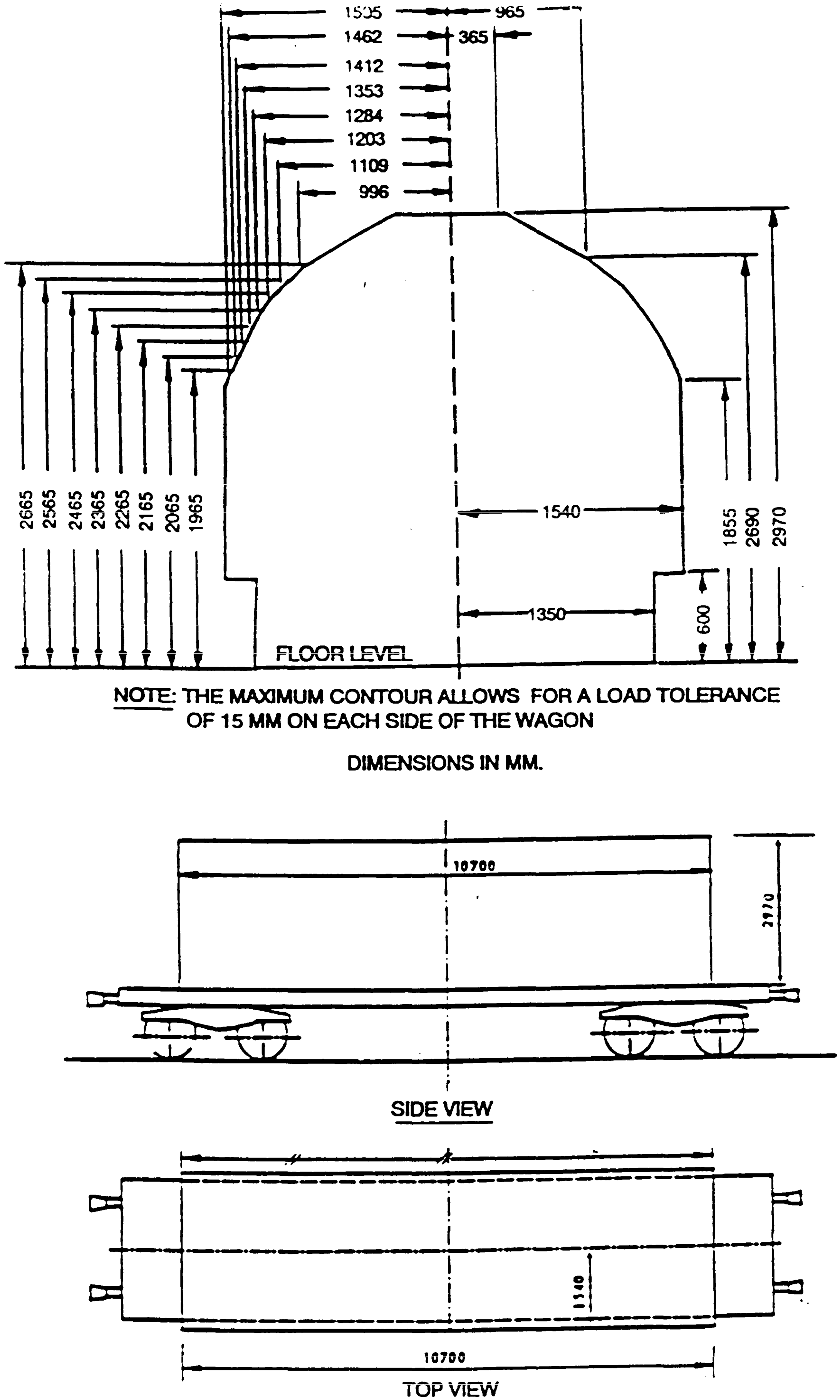


FIGURE 2. Gabarit International de Chargement (GIC) equipment gauge.

b. Exceptional transport military equipment. Exceptional transport military equipment consists of wheeled vehicles, tracked vehicles, and equipment that present at least one of the following characteristics:

(1) Indivisible weight over 20 metric tons.

(2) Length over 12.5 meters.

(3) Load distribution: more than 16.5 metric tons over a length of 2.5 meters.

(4) Require lowering of flatcar's drop-sides. (See table II.)

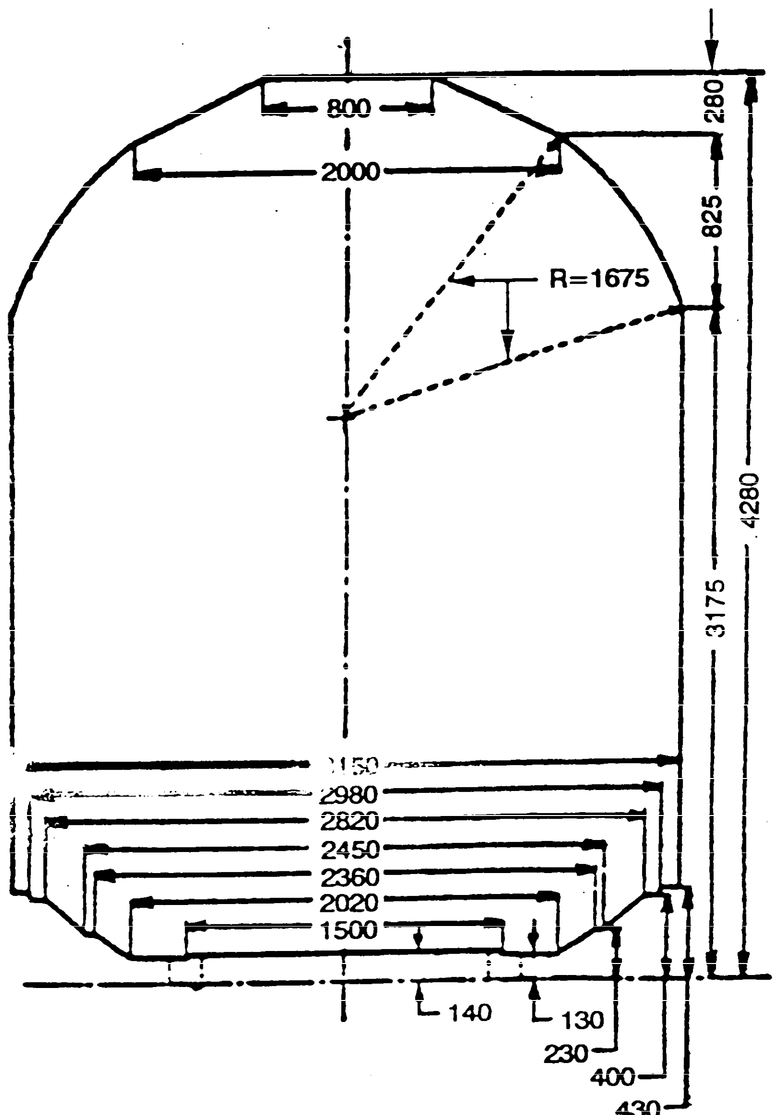
(5) The flatcar/equipment unit is not in conformity with (exceeds) the GIC diagram (fig 3). The GIC diagram does not include the 15-millimeter-per-half-width tolerance.

c. Military equipment not ordinary or exceptional for transport. Items that have dimensions that exceed the GIC equipment gauge but do not exceed the GIC diagram are not classified as either ordinary or exceptional transport. These items must be centered on the flatcar longitudinal centerline to avoid an exceptional transport military equipment classification.

Table II shows that a majority of the available heavy duty flatcars have deck heights of at least 50 inches. For practical purposes, these flatcars will be considered as the worst case for European rail transport. Therefore, when unrestricted foreign rail transport is a requirement, the item of equipment shall be designed to meet requirements (1) through (5) in the definition of ordinary transport military equipment (see para 5.2.3.2.a) when placed on a 50-inch-high flatcar.

5.2.3.3 NATO rail transport on major rail lines. Items of equipment that do not meet GIC diagram clearances may still be transported on the major NATO rail lines provided they meet envelope B (fig 4). Figure 5 shows the design gauge for military equipment that is 8.80 meters long or less (ensures meeting envelope B). This gauge is envelope B plus a tolerance to allow for railcar "swing-in" and "swing-out" when a train is negotiating a curve during rail transport. Items of equipment 8.80 meters long or less that meet this diagram will be assured rail transport on major NATO rail lines. Items of equipment greater than 8.80 meters but less than 11.7 meters long and exceeding figure 5 will still be assured transport on the major NATO rail lines provided they do not exceed the outline of figure 6. Figure 6 is envelope B plus a "swing-in and

GIC DIAGRAM AS DEFINED BY STANAG 2832 (ALSO STANAG 2175)



NOTE: DIMENSIONS IN MILLIMETERS.

FIGURE 3. Gabarit International de Chargement (GIC) diagram.

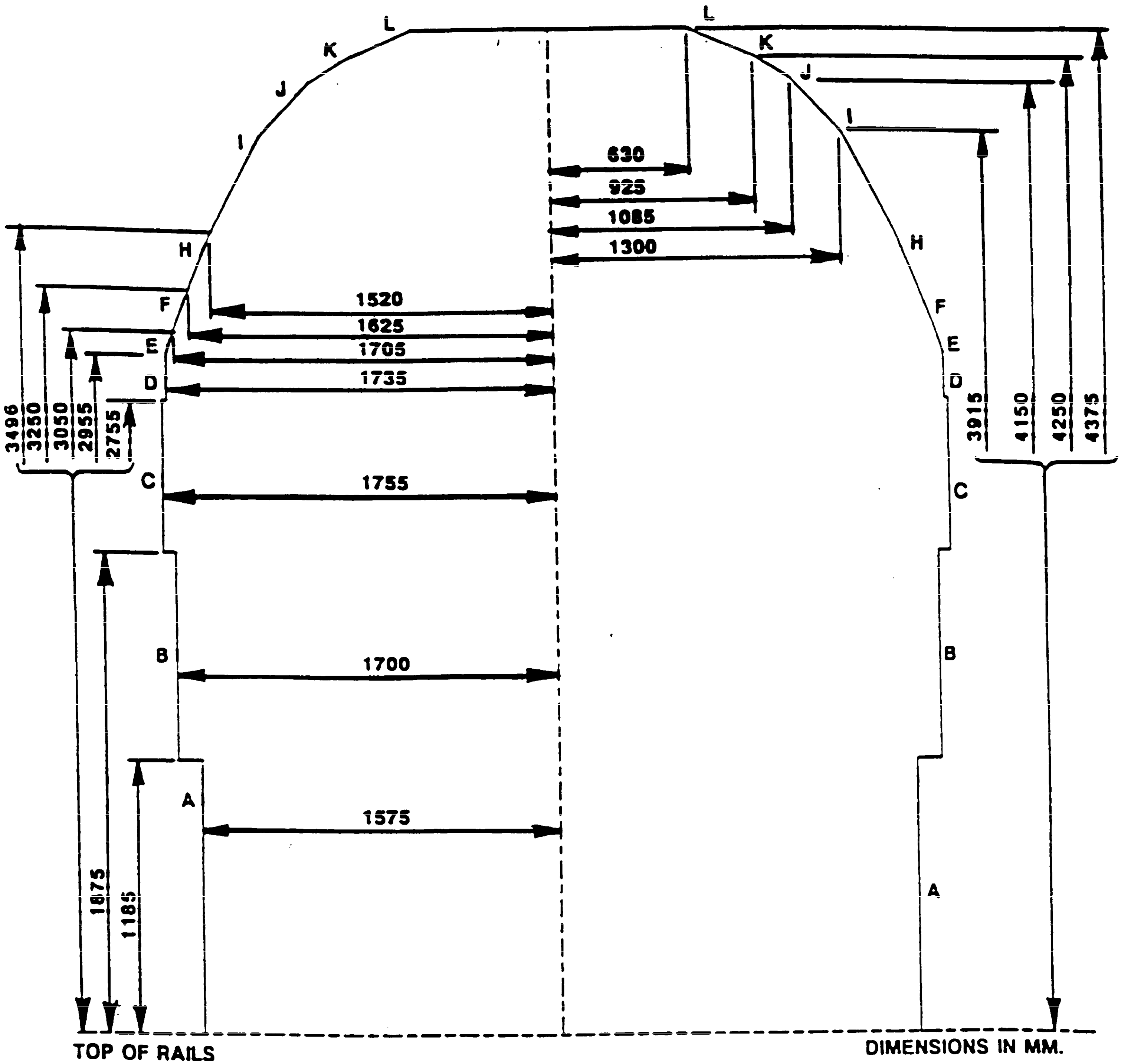


FIGURE 4. Diagram of envelope B.

THE TRANSVERSE CENTRE LINE OF THIS GAUGE COINCIDES WITH THAT OF THE WAGON.
THE HALF-WIDTHS IN THE DIAGRAM ARE THE MAXIMUM VALUES PERMISSIBLE WHEN $0 \leq l_{gt} \leq 4.00$ M.
THE DIMENSIONS IN BRACKETS APPLY WHEN $l_{gt} = 4.40$ M.
l_{gt} = THE DISTANCE FROM THE EQUIPMENT GAUGE SECTION BEING CONSIDERED TO THE TRANSVERSE CENTRE LINE OF THE WAGON.
IT IS ASSUMED THAT THE MAXIMUM PERMISSIBLE HALF-WIDTHS VARY LINEARLY BETWEEN SECTIONS ACCORDING TO WHETHER l_{gt} = 4.00 M OR 4.40 M.

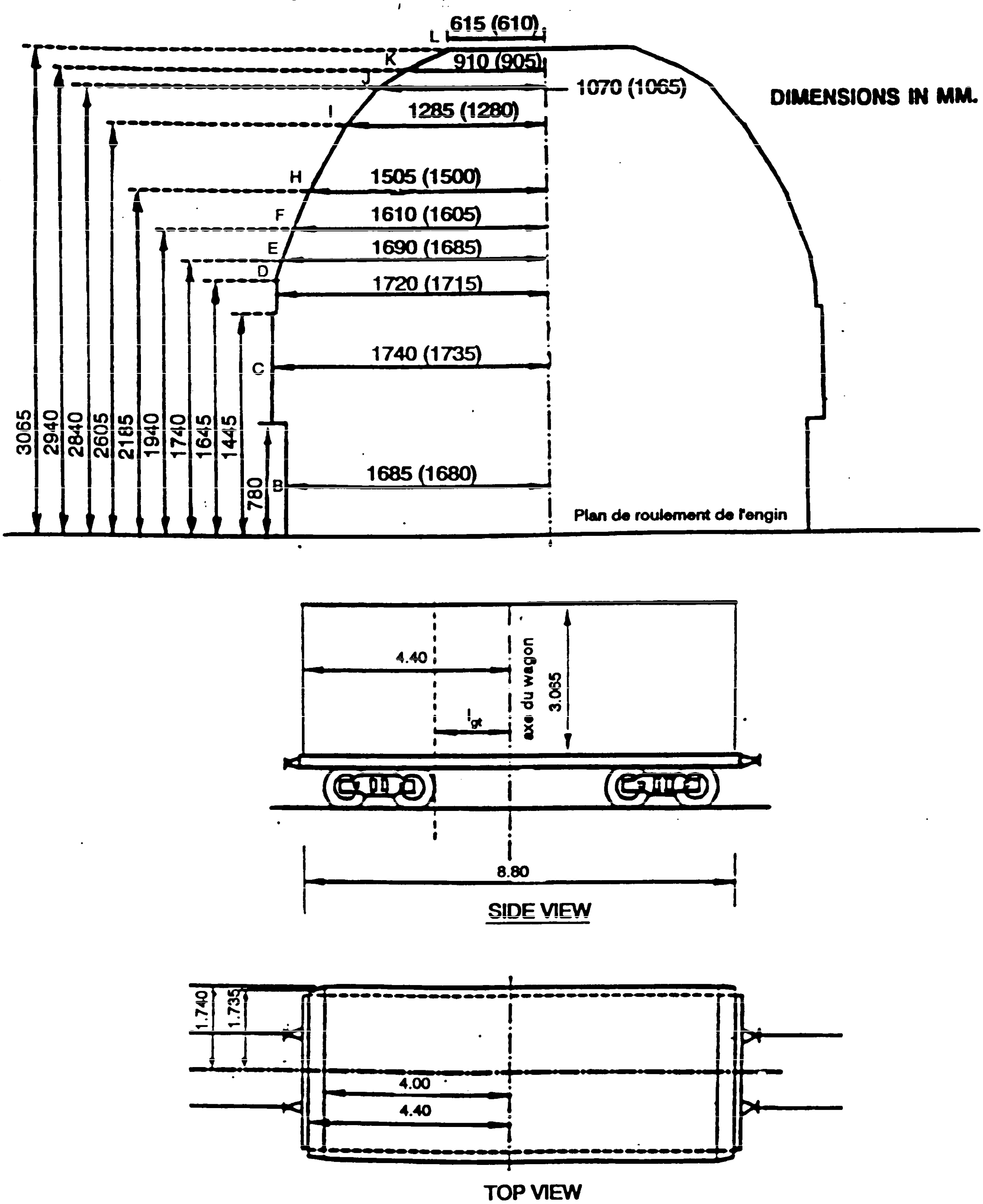


FIGURE 5. Military equipment gauge for military equipment 8.80 m long or less.

THE TRANSVERSE CENTRE LINE OF THIS GAUGE COINCIDES WITH THAT OF THE WAGON.
THE HALF- WIDTHS IN THE DIAGRAM ARE THE MAXIMUM VALUES PERMISSIBLE WHEN $0 \leq l_{gt} \leq 4.40$ M.
THE DIMENSIONS IN BRACKETS APPLY WHEN $l_{gt} = 5.85$ M.
l_{gt} = THE DISTANCE FROM THE EQUIPMENT GAUGE SECTION BEING CONSIDERED TO THE TRANSVERSE CENTRE LINE OF THE WAGON.
IT IS ASSUMED THAT THE MAXIMUM PERMISSIBLE HALF-WIDTHS VARY LINEARLY BETWEEN SECTIONS ACCORDING TO WHETHER l_{gt} = 4.40 M OR 5.85 M.

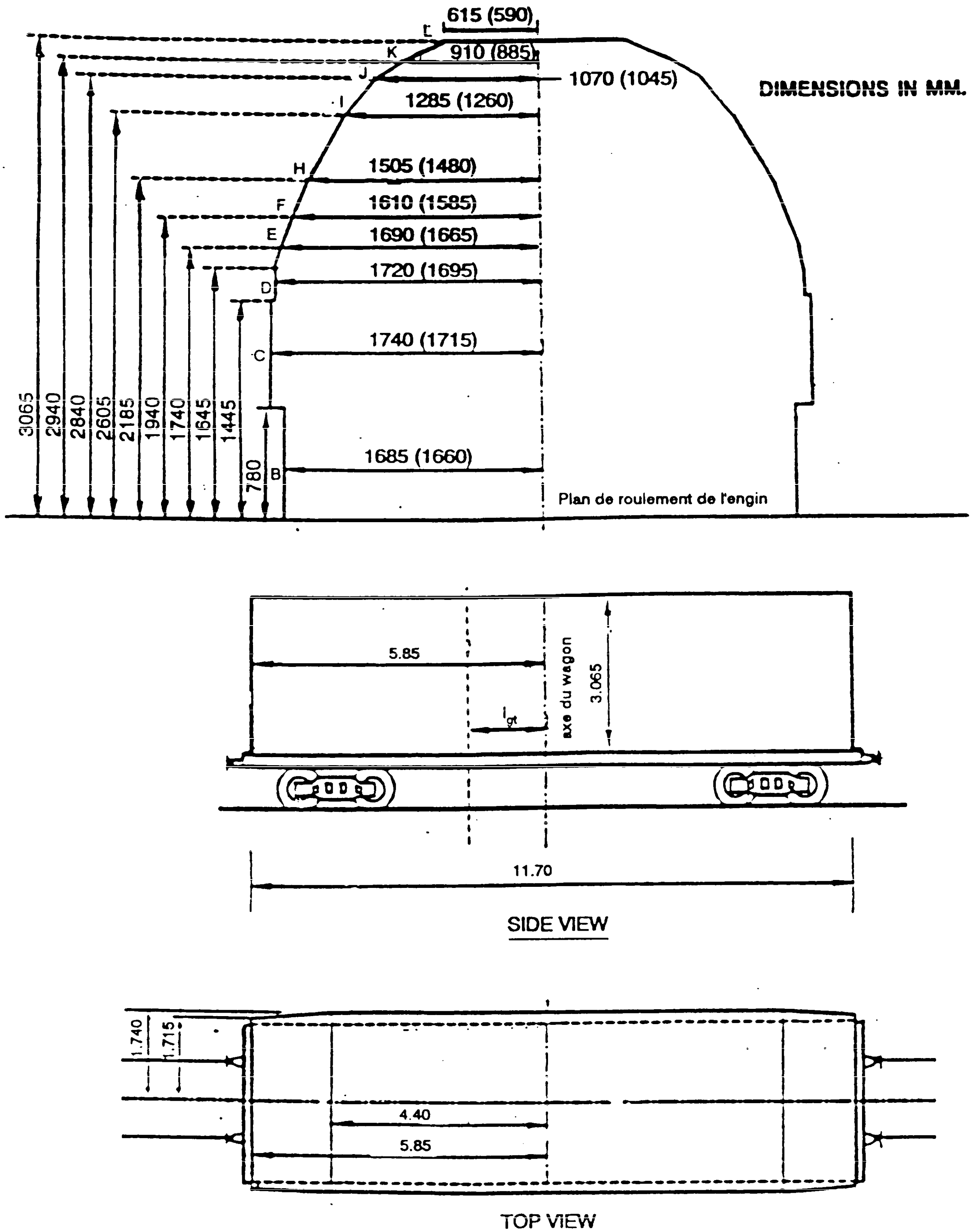


FIGURE 6. Military equipment gauge for lengths between 8.80 m and 11.70 m.

swing-out" tolerance for equipment lengths greater than 8.80 meters but less than 11.70 meters. When transport on major NATO rail lines is a requirement, the item of equipment shall be designed to be within the appropriate envelope B design gauge when placed on a 50-inch-high, flatcar.

5.2.3.4 Other foreign rail clearances. Rail transport clearances in foreign countries other than NATO will vary from country to country. Therefore, for simplicity, when

unrestricted foreign rail transport in countries other than NATO is a requirement, the item shall meet the requirements in paragraph 5.2.3.2.

5.2.4 Rail impact testing. Rail transport subjects items of equipment to severe longitudinal forces. Therefore, items of equipment must undergo testing to determine suitability for rail transport. The MIL-STD-810 rail impact test is used to validate the structural integrity of the item and the adequacy of the item tiedown provisions and procedures. Any item that passes the MIL-STD-810 test should be capable of rail transport without damage to the item or tiedowns. Therefore, items of equipment shall be subjected to and successfully complete the MIL-STD-810 rail impact test when rail transport is a requirement.

5.3 Water transportation.

5.3.1 General. Water transport is used for both strategic and tactical deployments. During strategic deployment, the majority of US Army equipment will be transported by ship. Marine Corps equipment belonging to the assault follow-on-echelon (AFOE) will be transported by strategic sealift ships. Most of the dry cargo vessels available for the shipment of military cargo and used in military exercises are under the control of the Maritime Administration (MARAD) or Military Sealift Command (MSC). Such fleets include the Fast Sealift Squadron, the Maritime Prepositioning Ship Program, the National Defense Reserve Fleet (NDRF), and the Ready Reserve Fleet (RRF),a subfleet of the NDRF. The US dry cargo fleet consists of four conventional ship types: breakbulk, container, barge carriers, and roll on/roll off (RORO). Various combinations of these four ship types also exist. For example, combination container/breakbulk, container/RORO, and container/barge vessels are in service.

5.3.2 Breakbulk general-cargo ships. The hold configuration on most breakbulk ships is generally the same, consisting of five to seven holds. Each hold has three to five decks and hatch covers that allow access to the different decks.

Cargo operations on breakbulk vessels are lift on/lift off (LOLO). Each hold on a breakbulk vessel is served by ship's gear. Table III gives dimensional and weight capability data for two representative classes of breakbulk vessels.

5.3.3 Containerships.

5.3.3.1 General. Modern containerships (to include combination ships) are designed to carry all or part of their cargo load in containers. The containership allows containers to be secured without the use of dunnage. Containerships also have the capability for transporting containers that are stacked on the vessel deck. SEM is transportable on containerships as ondeck cargo or in flatracks and seasheds that fit in the containership's cell guides.

5.3.3.2 Full containerships. These vessels carry containers as their normal, full cargo load and have little or no capability for carrying other types of cargo except for cargo placed on the hatch covers. All modern, full containerships are nonself-sustaining. Shoreside container gantry cranes, mobile cranes, or floating derrick cranes are required for cargo operations. Cargo dimensions are dictated by the characteristics of the container(s) used (see para 5.8).

5.3.4 Combination ships. A great number of combination containerships are currently in service. These vessels are usually smaller than full containerships and are generally self-sustaining. In many cases, the combination containership is a modified breakbulk or RORO vessel. Table IV provides the characteristics for carrying breakbulk cargo on combination ships.

5.3.5 Barge carriers.

5.3.5.1 General. The Lighter Aboard Ship (LASH) and Sea Barge (SEABEE) transportation systems operate similar to a containership. In these systems, cargo is stowed in unitized lighters or barges. The barges or lighters are then stowed aboard a barge carrier or mother ship. One major difference between containerships and barge carriers is the amount of cargo that barges or lighters can handle. LASH lighters and SEABEE barges have cubic capacities of 20,000 and 40,000 cubic feet, respectively. The barge carrier/mother ship is self-sustaining. The LASH system uses a gantry crane to load its lighters, while the SEABEE system has an elevator to load its barges.

5.3.5.2 LASH. The LASH system consists of a fleet of lighters and a lighter-carrying vessel or mother ship. The

TABLE III. Deck and hatch data of typical breakbulk vessels.

MARAD Design	Hold No	Hatch Opening 1/ Length by Width (ft)	Height in Hold 2/ Minimum to Maximum (ft)	Allowable Deck Load Minimum to Maximum (lb/sq ft)	Boom Lift Capacity (LTON)
C3-S-37c	1	31 ft 3 in. by 17 ft 10 in.	8 ft 8 in. to 10 ft 7 in.	495 to 1,790	15
	2	39 ft 9 in. by 24 ft 10 in.	8 ft 9 in. to 13 ft 2 in.	468 to 2,060	10 and 60
	3	34 ft 9 in. by 24 ft 10 in.	8 ft 8 in. to 13 ft 1 in.	452 to 2,060	15
	4	34 ft 9 in. by 24 ft 10 in.	8 ft 6 in. to 13 ft 0 in.	452 to 2,060	15
	5	29 ft 9 in. by 24 ft 10 in.	9 ft 6 in. to 15 ft 10 in.	452 to 1,360	10
C4-S-57a	1	27 ft 0 in. by 16 ft 0 in.	7 ft 10 in. to 13 ft 2 in.	400 to 1,000	10
	2	42 ft 6 in. by 23 ft 0 in.	10 ft 3 in. to 12 ft 2 in.	495 to 1,865	10 and 15
	3	42 ft 6 in. by 16 ft 0 in.	8 ft 7 in. to 14 ft 10 in.	430 to 1,740	10, 15 and 70
	4	42 ft 6 in. by 16 ft 0 in.	7 ft 11 in. to 14 ft 10 in.	390 to 1,740	10, 15 and 70
	5	35 ft 0 in. by 23 ft 0 in.	8 ft 3 in. to 12 ft 11 in.	380 to 1,630	10 and 15
	6	35 ft 0 in. by 23 ft 0 in.	7 ft 9 in. to 8 ft 8 in.	390 to 1,260	10

1/ Values given are actual dimensions. For design purposes, subtract 12 in. from the listed values to ensure adequate clearance.
2/ Values given are actual dimensions. For design purposes, subtract 6 in. from the listed values to ensure adequate clearance.

TABLE IV. Deck and hatch characteristics of a typical combination vessel.

MARAD Design	Hold No	Hatch Opening 1/ Length by Width (ft)	Height in Hold 2/ Minimum to Maximum (ft)	Allowable Deck Load Minimum to Maximum (lb per sq ft)	Boom Lift Capacity (LTON)
C5-S-78a (combination)	1	41 ft 11 in. by 8 ft 10 in. (port and stardboard) 41 ft 11 in. by 17 ft 3 in. (center)	15 ft 11 in. to 22 ft 6 in.	380 to 810	5
	2	41 ft 11 in. by 17 ft 11 in. (port and starboard) 41 ft 11 in. by 17 ft 3 in. (center)	16 ft 0 in to 22 ft 6 in.	340 to 810	30
	3	41 ft 11 in. by 25 ft 8 in. (port and starboard) 41 ft 11 in. by 17 ft 3 in. (center)	15 ft 9 in. to 22 ft 6 in.	650 to 2,450	30
	4	41 ft 11 in. by 25 ft 8 in. (port and starboard) 41 ft 11 in. by 17 ft 3 in. (center)	15 ft 9 in. to 22 ft 6 in.	650 to 2,450	30 and 70
	5	41 ft 11 in. by 25 ft 8 in. (port and starboard) 41 ft 11 in. by 17 ft 3 in. (center)	15 ft 9 in. to 22 ft 6 in.	650 to 2,450	30 and 70
	6	41 ft 11 in. by 25 ft 8 in. (port and starboard) 41 ft 11 in. by 17 ft 3 in. (center)	15 ft 9 in. to 22 ft 6 in.	650 to 2,450	30
	7	41 ft 11 in. by 25 ft 8 in.	16 ft 9 in. to 22 ft 6 in.	190 to 490	5

1/ Values given are actual dimensions. For design purposes, subtract 12 in. from the listed values to ensure adequate clearance.

2/ Values given are actual dimensions. For design purposes, subtract 6 in. from the listed values to ensure adequate clearances.

lighters are handled by a 500-LTON, rail-mounted, gantry crane, which can travel the entire length of the cargo area. During a typical loading cycle, lighters are lifted over the transom stern by the gantry crane. The gantry crane then travels forward, stacking the lighters in deep hold cells, athwartship.

5.3.5.3 LASH lighters. Figure 7 shows specific lighter characteristics. The interior of the lighters is fitted with two levels of tiedowns. The first level of tiedowns consists of five per side and four per end and are located 2 feet 6 inches above the deck. The second level has the same number of tiedowns as the first level. These tiedowns are located 8 feet above the deck. Each LASH lighter has a 370 LTON capacity.

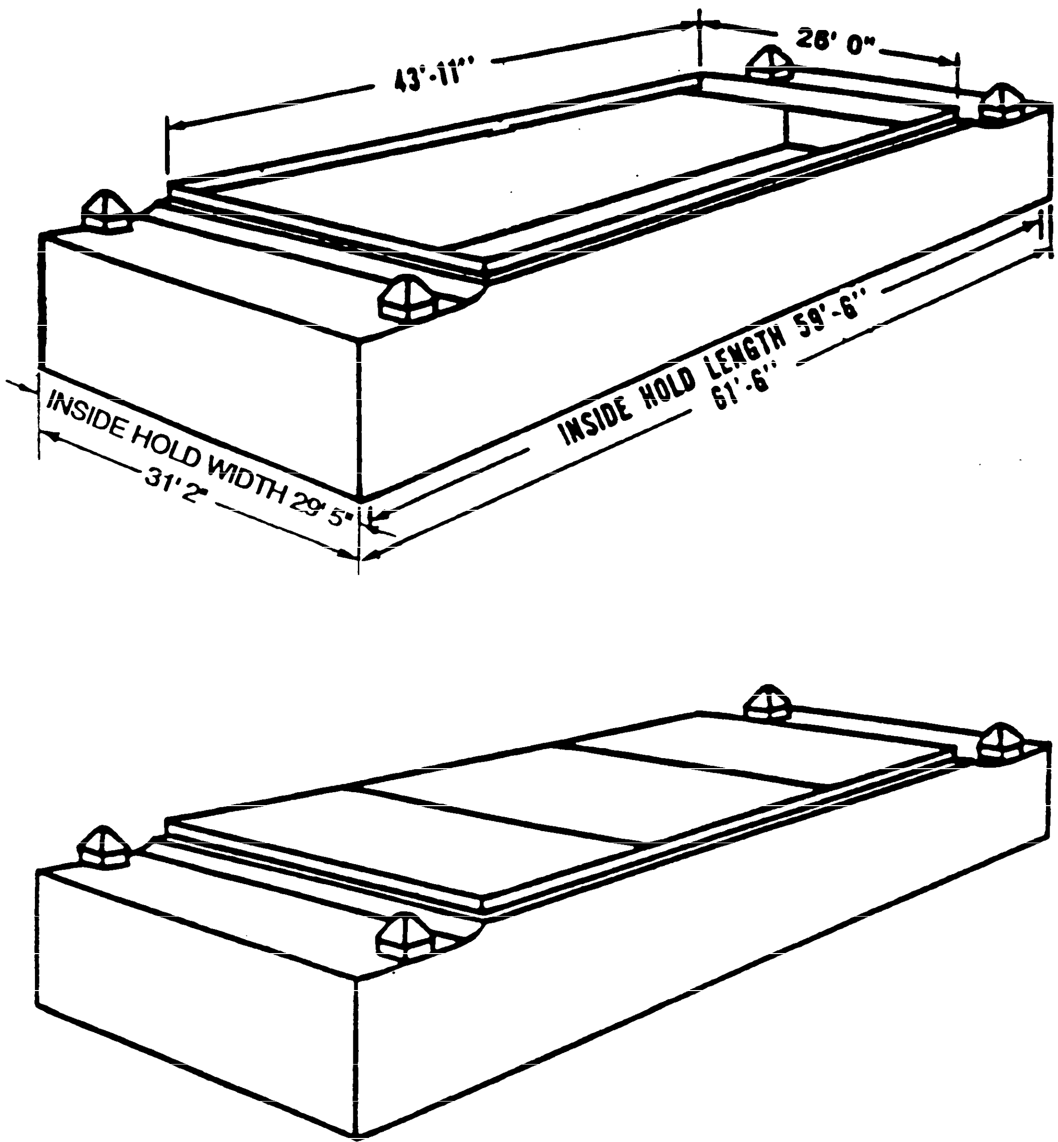
5.3.5.4 SEABEE. The SEABEE system operates similarly to the LASH system. Barge stowage is configured for deck loading. Barges are stowed and discharged by a stern-mounted, submersible ship elevator. Barges are transferred from the elevator platform to one of the three decks for stowage by two large transporters.

5.3.5.5 SEABEE barges. Figure 8 presents the characteristics of a typical SEABEE barge. Each SEABEE barge has a 834 LTON capacity.

5.3.6 Roll-on/roll-off (RORO) ships.

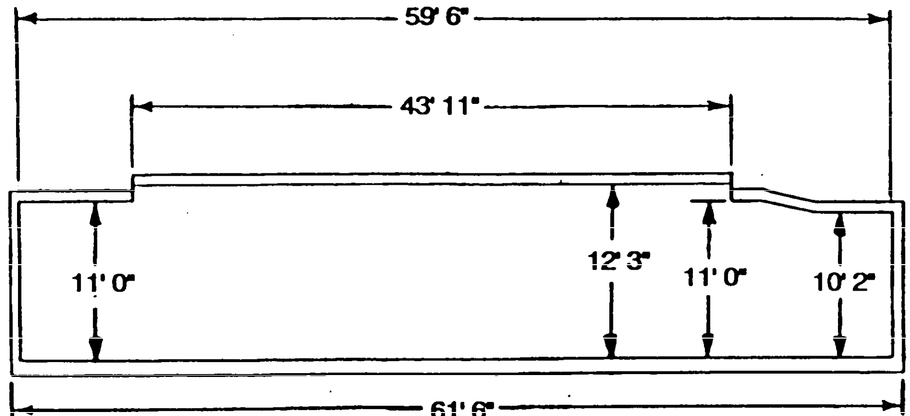
5.3.6.1 General. The RORO ship is primarily a vehicle transporter that allows vehicles to drive on or off the ship via ramps. RORO cargo includes wheeled, tracked, self-propelled, and towed vehicles and equipment. Most modern RORO vessels not only carry vehicles but also carry a combination of containers and/or breakbulk cargo. A series of external and internal ramps facilitate the loading and discharge of RORO cargo. To maintain safe operations, the ramp angle for loading/unloading procedures is no greater than 15°. When designing wheeled or tracked equipment, the materiel developer/contractor must allow for adequate clearance underneath the vehicle to prevent contact at the ramp crest/toe for a 15° ramp angle.

5.3.6.2 Fast sealift ships (FSS). The most prevalent RORO vessels available for military training and exercises are the FSS of the MSC Fast Sealift Squadron. These vessels have secondary container, seashed, and breakbulk capabilities. The FSS is a side-ramp loading vessel. Figure 9 shows the general layout of the FSS vessels and tables V and VI give specific hold and ramp information. Figures 10 through 12 show detailed profiles of the FSS vessel.



NOTE:
VALUES ARE ACTUAL DIMENSIONS. FOR DESIGN PURPOSES, SUBTRACT 12" FROM THE HATCH OPENING VALUES TO ENSURE ADEQUATE OVERHEAD CLEARANCE.

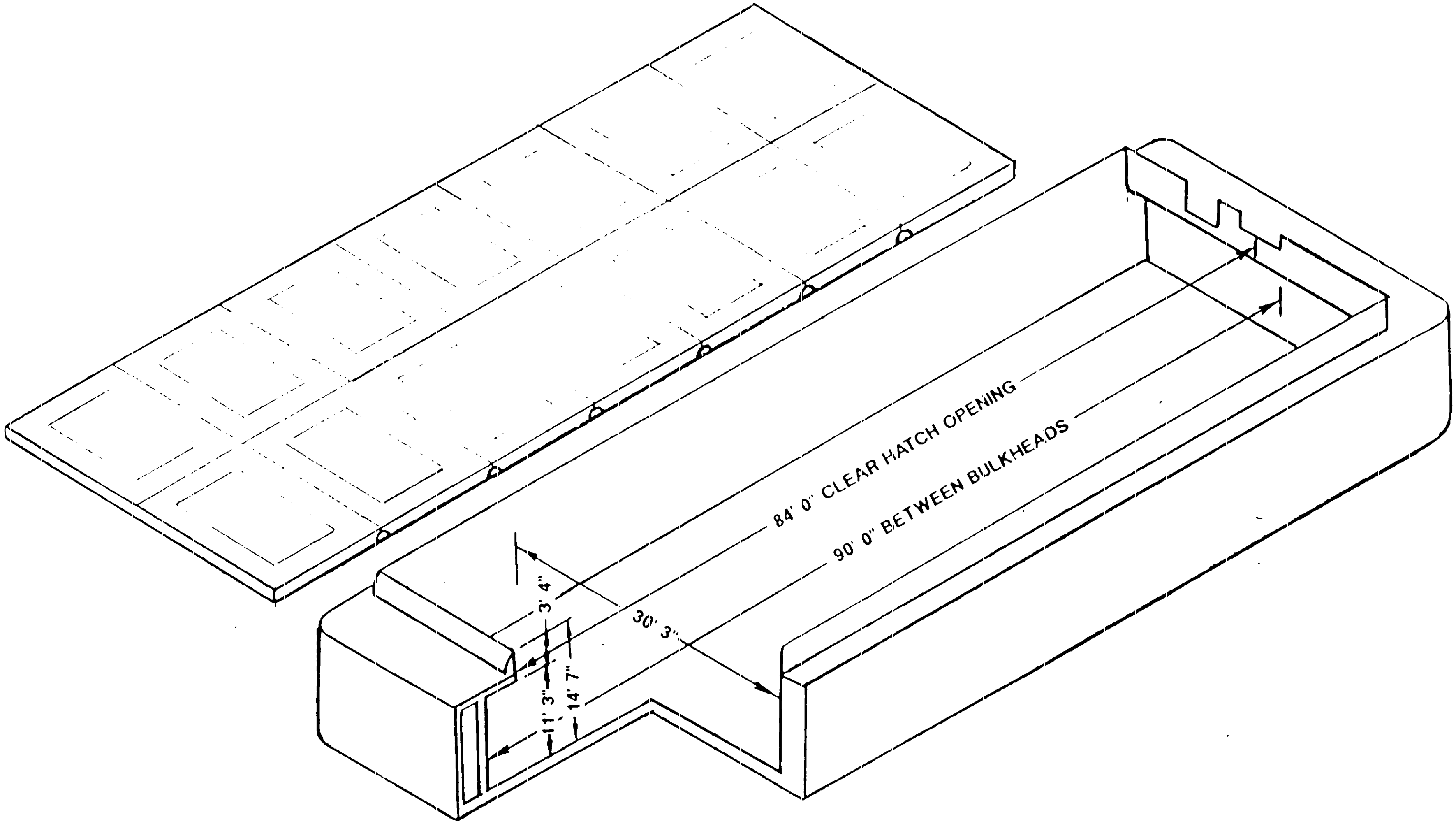
FIGURE 7 (sheet 1 of 2). LASH lighter characteristics.



NOTE: VALUES GIVEN ARE ACTUAL DIMENSIONS. FOR DESIGN PURPOSES, SUBTRACT 6" FROM THE ACTUAL GIVEN HEIGHTS TO ENSURE ADEQUATE OVERHEAD CLEARANCE.

SIDE VIEW

FIGURE 7 (sheet 2 of 2). LASH lighter characteristics.



NOTE:

VALUES GIVEN ARE ACTUAL DIMENSIONS. FOR DESIGN PURPOSES, SUBTRACT 12" FROM CLEAR HATCH OPENING VALUES, AND 6" FROM HEIGHT VALUES TO ENSURE ADEQUATE CLEARANCE.

FIGURE 8. SEABEE barge dimensional data.

TABLE V. FSS hold summary.

Hold	Deck	Deck Strength (lb per sq ft)	RORO Clear Height (ft)	LOLO Clear Height (ft)
1	Main	200	NA	8 ft 0 in.
	Second	525	8 ft 0 in.	NA
	37 ft Flat	200	NA	12 ft 8 in.
2	Weather	200	13 ft 0 in.	NA
	A	525	13 ft 0 in.	19 ft 6 in.
	B	525	13 ft 0 in.	13 ft 6 in.
	C	525	13 ft 0 in.	13 ft 6 in.
	D	525	13 ft 0 in.	13 ft 6 in.
	E	200	8 ft 2 in.	NA
3	Weather	200	13 ft 0 in.	NA
	A	525	13 ft 0 in.	19 ft 6 in.
	B	525	13 ft 4 in.	13 ft 6 in.
	C	525	13 ft 0 in.	13 ft 6 in.
	D	525	13 ft 0 in.	13 ft 6 in.
	E	200	8 ft 2 in.	8 ft 6 in.
4	Weather	200	13 ft 0 in.	NA
	A	525	13 ft 0 in.	19 ft 6 in.
	B	525	13 ft 4 in.	NA
	C	525	13 ft 0 in.	NA
	D	525	13 ft 0 in.	NA
	E	200	8 ft 2 in.	NA

NOTE: RORO clear heights are based on smallest constraints (height of watertight doors) on route from side port opening to hold. These values are actual dimensions. For design purposes, subtract 6 in. from the RORO and LOLO clear heights to ensure adequate clearance.

TABLE VI. FSS fixed-ramp characteristics.

Leading		Width (ft-in)	Height (ft-in)	Ramp Strength (lb per sq ft)
From	To			
2d Deck, 1	B Deck	12 ft 0 in.	10 ft 0 in.	525
A Deck	B Deck	18 ft 0 in.	13 ft 0 in.	525
B Deck	C Deck	18 ft 0 in.	13 ft 0 in.	525
C Deck	D Deck	18 ft 0 in.	13 ft 0 in.	525
D Deck	E Deck	12 ft 10 in.	8 ft 2 in.	200
MD (AFT)	A Deck	12 ft 0 in.	8 ft 4 in.	200

NOTE: The width and height values given are actual dimensions. For design purposes, subtract 12 in. from the width values, and 6 in. from the height values to ensure adequate clearance.

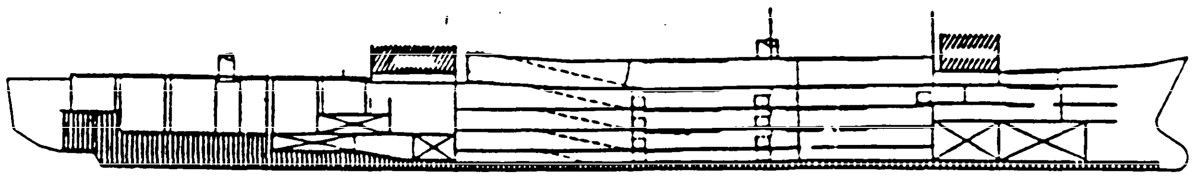
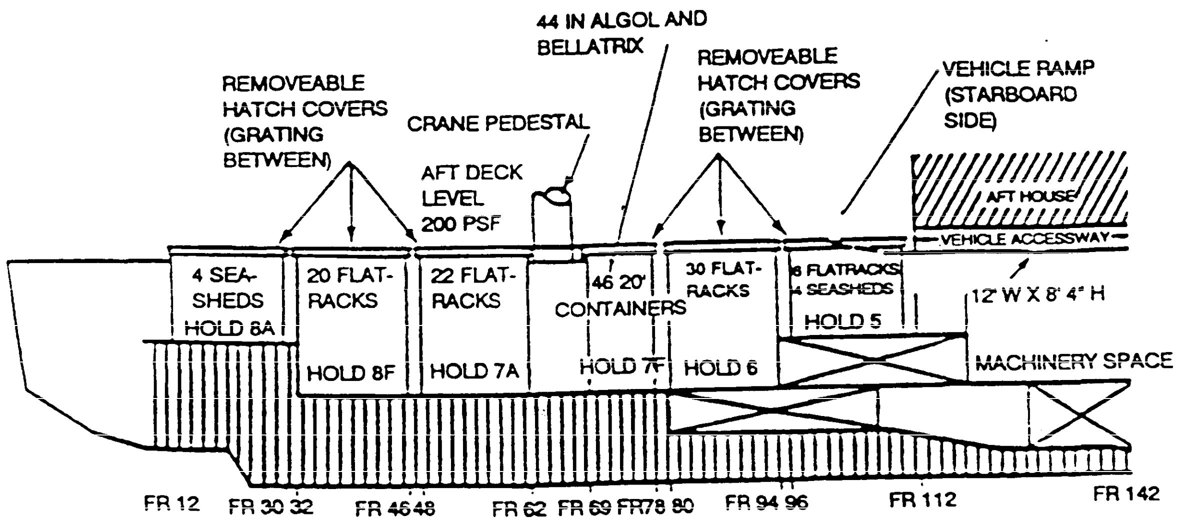


FIGURE 9. FSS ship general layout.



FRAME NUMBERING IN THE T-AKR COMMENCES AFT AND SEQUENTIALLY MOVES FORWARD TO THE FORWARD PERPENDICULAR. NUMBERING COMMENCES AT FRAME -20 AND TERMINATES AT FRAME 365. THE AFTER PERPENDICULAR IS LOCATED AT FRAME -1.5.

FIGURE 10. Profile of aft section of FSS.

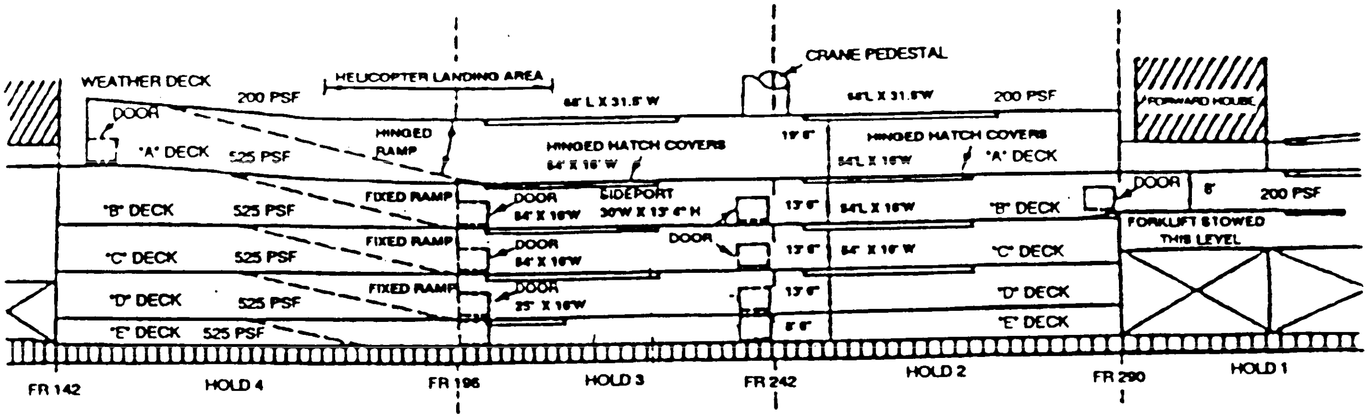
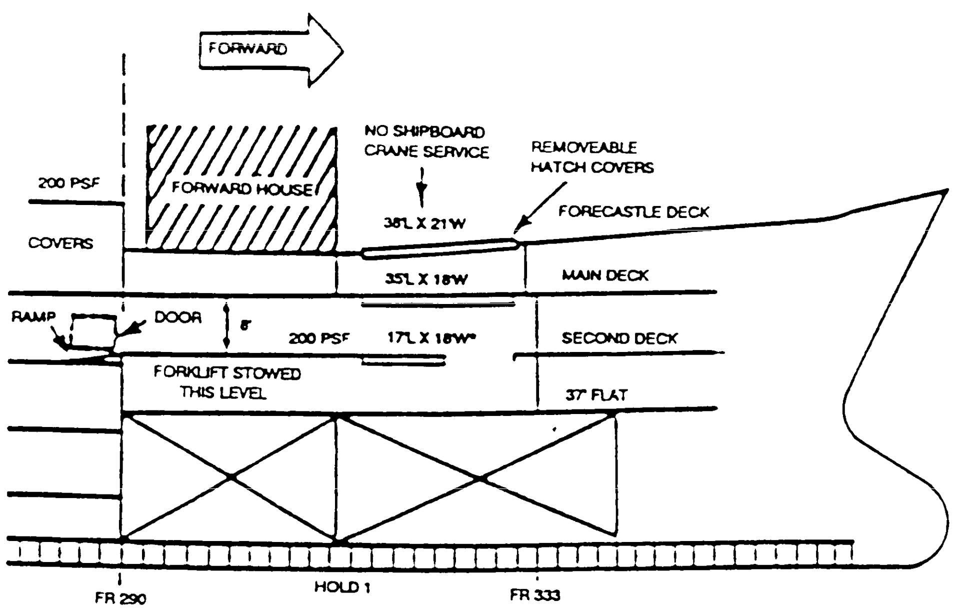


FIGURE 11. Profile of center section of FSS.



*IF PARTIAL HATCH COVER IN PLACE. IF REMOVED, CLEAR OPENING INCREASED TO 35'L X 18'W. THE OTHER 1/2 OF THE PARTIAL HATCH COVER IS STOWED ASHORE. IF USED, A SHORESIDE OR BARGE-MOUNTED CRANE WOULD BE REQUIRED TO OPEN IT.

FIGURE 12. Profile of forward section of FSS.

5.3.6.3 Cape D class. The Cape D class of RORO ships were designed and built as commercial vehicle transporters. Currently, these vessels are configured as wheeled and tracked RORO carriers with some container stowage capability. Table VII provides Cape D vessel characteristics.

5.3.6.4 Cape H class. The Cape H class of RORO ships were designed as combination RORO and container carriers for operations in underdeveloped ports. Lift-on operations are accomplished with a 39-LTON capacity pedestal crane. Table VII provides Cape H vessel characteristics.

5.3.6.5 Miscellaneous RORO vessels. Other RORO vessels in the current RRF and available for military use include the Cape I class, Lyra, Ambassador, American Eagle, and the Admiral Wm. M. Callaghan. Table VII provides specific ship characteristics of these vessels.

5.3.7 Support vessels. To support cargo operations at underdeveloped ports, the military is establishing a fleet of support vessels. Such vessels include auxiliary crane ships (T-ACS). The primary function of these vessels is to load or discharge nonself-sustaining cargo; however, these vessels can also carry cargo and watercraft both on and below deck. Table VIII provides transport characteristics for the T-ACS.

5.3.8 Logistics-over-the-shore (LOTS) operations and inland waterways.

5.3.8.1 General. LOTS operations involve transferring military equipment and supplies from cargo ships anchored offshore to the beach in support of forces ashore. This transfer of cargo from ship to shore is accomplished by military lighterage. The lighterage used to offload cargo vessels positioned offshore consists of amphibian and landing craft (conventional) vessels. The lighterage must be compatible with the vessels they service and the cargo needing transportation. Table X lists the lighterage as they are best paired to particular cargo vessels. The designer must allow for adequate clearance underneath the vehicle to prevent contact at the ramp crest/toe for a 15^{o} ramp angle.

5.3.8.2 Amphibian. Amphibious craft fall under two basic categories, wheeled and air cushioned. The lighter amphibious resupply cargo-60 tons (LARC-LX) is an example of a wheeled amphibious craft. An example of an air cushioned amphibious craft is the lighter air cushion vehicle-30 tons (LACV-30). The transport weight and dimensional constraints for the amphibious watercraft are given in table XI.

TABLE VII. RORO ship characteristics.

Vessel Class	No of Ships	Length (ft)	Beam (ft)	Crane Capacity (LTON)	Cargo Deadweight (LTON)	Total Square Feet	No of Lower Decks 1/	Deck Height Range 2/	External Ramp Access Door (width by height) 3/	Ramp Capacity (LTON)
FSS	8	946	105	100	25,500	190,547	5	8 ft 0 in. to 19 ft 6 in.	30 ft 0 in. by 13 ft 6 in.	65.0 4/
Cape D	5	681	97	N/A	21,650	183,603	6	5 ft 5 in. to 17 ft 9 in.	23 ft 0 in. by 17 ft 0 in.	65.0
Cape H	3	750	106	40	26,742	198,846	5	5 ft 2 in. to 20 ft 7 in.	39 ft 4 in. by 20 ft 8 in.	63.9
American Eagle	3	635	92	35	18,219	183,178	11	5 ft 6 in. to 20 ft 8 in.	24 ft 10 in. 5/ by 22 ft 3 in.	91.6
Ambassador	2	534	71	N/A	7,030	79,558	3	15 ft 0 in. to 20 ft 6 in.	30 ft 0 in. by 22 ft 0 in.	59.1
Lyra	2	634	88	N/A	11,386	82,730	3	13 ft 3 in. all decks	36 ft 9 in. by 24 ft 7 in.	160.0
Cape I	4	685	102	30	14,876	135,924	4	9 ft 11 in. to 17 ft 11 in.	40 ft 0 in. by 16 ft 0 in.	100.0
Comet	2	499	78	60	8,730	88,757	4	6 ft 11 in. to 12 ft 9 in.	19 ft 0 in. by 12 ft 0 in.	60.0
Adm Wm. M. Callaghan	1	694	92	120	9,519	148,281	4	7 ft 11 in. to 14 ft 6 in.	17 ft 5 in. by 18 ft 0 in.	55.8

1/ The number of lower decks includes any car or retractable decks.

2/ The values given are actual dimensions. For design purposes, subtract 6 in. from the maximum deck height value to ensure adequate clearance.

3/ The values given are actual dimensions. For design purposes, subtract 12 in. from the width values and 6 in. from the height values to ensure adequate clearance.

4/ The value given is for pierside operations. The ramp capacity for instream operations is 53.57 LTONS.

5/ This number represents the actual width of the ramp. Therefore, wheeled and tracked vehicles cannot exceed this value from outside-of-tire to outside-of-tire or outside-of-track to outside-of-track. Otherwise the external ramp access door width is 19 ft 0 in.

TABLE VIII. Auxiliary crane ship characteristics.

MARAD Classification	Number of Vessels	Vessel Name	Length (ft)	Beam (ft)	Max Draft (ft)	Speed (kn)	Cargo Deadweight (LTON)	Max Boom1/ Capacity (LTON)
C6-S-1qd	1	Keystone State (T-ACS 1)	669	76	33	22	10,000	105 (tandem)
C6-S-1qd	2	Gem State (T-ACS 2) Grand Canyon State (T-ACS 3)	669	76	33	22	11,000	105 (tandem)
C5-S-MA73c	3	Gopher State (T-ACS 4) Flickertail State (T-ACS 5) Cornhusker State (T-ACS 6)	610	78	32	20	12,700	120 (tandem)
C6-S-MA1xb	2	Diamond State (T-ACS 7) Equality State (T-ACS 8)	668	76	33	20	11,700	120 (tandem)
C6-S-MA60d	2	Green Mountain State (T-ACS 9) Beaver State (T-ACS 10)	665	75	32	20	6,500	120 (tandem)

Clear hatch opening dimensions for T-ACS 1-3. (Gem State)

Hold	Deck	Hatch 2/ Dimensions (Ft-In)	
		Center	Port & Starboard
1	Focsle	21' - 0" x 19' - 4"	
2	Main		43' - 3" x 26' - 10" 43' - 3" x 18' - 2"
3	Main		43' - 3" x 26' - 10"
4	Main	43' - 2" x 26' - 10"	43' - 2" x 18' - 2"
4A	Main	43' - 2" x 26' - 10"	43' - 2" x 18' - 2"
4B	Main	43' - 2" x 26' - 10"	43' - 2" x 18' - 2"
5	Main	41' - 11" x 26' - 10"	
6	Main	43' - 3" x 26' - 10"	
7	Main	25' - 10" x 26' - 10"	

1/ See Table IX for additional T-ACS crane capabilities.
2/ The values given are actual dimensions. For design purposes, subtract 12 in. from the length and width values to ensure adequate clearance.

TABLE IX. T-ACS ship crane capabilities.

Please note that the capacities and outreaches are based on the trim and stability of each particular ship and not necessarily the maximum crane capabilities.

	Single**	Twin**	Tandem
T-ACS 1	30 L.T. @ 111' Stbd.	60 L.T. @ 86' Stbd.	105 L.T. @ 14' Port
T-ACS 2	30 L.T. @ 111' Stbd.	60 L.T. @ 86' Stbd.	105 L.T. @ 14' Port
T-ACS 3	30 L.T. @ 111' Stbd.	60 L.T. @ 86' Stbd.	105 L.T. @ 14' Port
T-ACS 4	30 L.T. @ 110' Stbd.	60 L.T. @ 110' Stbd.	120 L.T. @ 14' Port
T-ACS 5	30 L.T. @ 110' Stbd.	60 L.T. @ 110' Stbd.	120 L.T. @ 14' Port
T-ACS 6	30 L.T. @ 110' Stbd.	60 L.T. @ 110' Stbd.	120 L.T. @ 14' Port
T-ACS 7	30 L.T. @ 111.5' Stbd.	60 L.T. @ 111.5' Stbd.	120 L.T. @ 14' Port
T-ACS 8	30 L.T. @ 111.5' Stbd.	60 L.T. @ 111.5' Stbd.	120 L.T. @ 14' Port
T-ACS 9*	30 L.T. @ 111' Stbd.	60 L.T. @ 111' Stbd.	120 L.T. @ 14' Port
T-ACS 10*	30 L.T. @ 111' Stbd.	60 L.T. @ 111' Stbd.	120 L.T. @ 14' Port

* estimated ** turntable parallel to centerline

TABLE X. LOTS lighterage compatibility.

Ship Type	Lighterage
Breakbulk	LCU, LCM-8, LARC-LX, LACV-30
Container	Causeway ferry, LCU, LARC-LX, LACV-30
RORO	Causeway ferry, LCU, LCM-8
LASH	Craft for barge towing
SEABEE	Craft for barge towing

TABLE XI. US Army and Navy lighterage.

	Cargo Deck Length (ft)	Cargo Deck Width (ft)	Cargo Capacity (short tons)	Bow Ramp Capacity (short tons)	Bow 1/ Ramp Width (ft)	Bow 1/ Height Limit (ft)	Stern Ramp Capacity (short tons)	Stern 1/ Ramp Width (ft)	Stern 1/ Height Limit (ft)
LACV-30	51.50	32.50	22.5 2/	NA	NA	NA	NA	NA	NA
LARC-LX	42.25	13.83 3/	60.0	60.0	13.83	NA	NA	NA	NA
LCM-8	42.75	14.50	60.0	60.0	14.50	NA	NA	NA	NA
LCU-1466	75.50	29.50	168.0	-	14.33	NA	NA	NA	NA
LCU-1646	110.00	28.00	179.2	65.0	14.00	NA	97.50	18.00	NA
LCU-2000	108.00	38.75	350.0	129.0	16.00	30.00	NA	NA	NA
LSV	256.00	60.00	2,016.0	-	28.00 4/	43.50	-	25.00	21.50
LCM Mark 6 5/	37.50	10.83	34.0	-	10.83	NA	NA	NA	NA
LCM Mark 8-MOD-2 (Steel)	42.00	14.00	60.0	-	14.50	NA	NA	NA	NA
(Aluminum)	42.00	17.00	65.0	-	14.50	NA	NA	NA	NA
LCU-1646 5/	100.00	12.75	200.0	-	14.00	NA	-	18.00	NA
LCAC 6/	67.00	27.00	75.0	75.0	28.33	NA	75.00	14.83	NA

1/ Values given are actual dimensions. For design purposes, subtract 12 in. from the width and 6 in. from the height limitations for ramps to ensure adequate clearance.
2/ See figure 13 for LACV-30 deck strengths.
3/ Width is restricted to 12.91 ft so that the item is within the inside tiedown rings. (See figure 14)
4/ For wheeled and tracked items, the width of the ramp itself is 19 feet. Therefore, the maximum item width from outside-of-tire to outside-of-tire or outside-of-track to outside-of-track is 19 feet minus 1 foot to ensure adequate clearance on the LSV bow ramp.
5/ The LCMs 6 and 8 and LCU 1646 are USMC landing craft. The cargo deck width of the LCU 1646 varies from 12.75 ft to 25.00 ft throughout the vessel. For design purposes, use the 12.75-foot worst case value.
6/ The Landing Craft, Air Cushioned (LCAC) is a Navy landing craft. The cargo deck contact-area pressure limit is 80 psi. Areas used for loading or unloading cargo, such as ramps, are restricted to wheel or track loads equal to a vertical load factor of 1.5 g of the vehicle weight. The cargo capacity listed for the LCAC is at its overload rate (maximum cargo capacity). The normal capacity load is 60.0 tons.

5.3.8.3 Landing craft. Landing craft are conventional watercraft designed to transport cargo from ship to shore. Landing craft consist of three basic classes: landing craft mechanized (LCM), landing craft utility (LCU), and logistic support vessel (LSV). Table XI provides transport weights and dimensional constraints for the landing craft.

5.3.9 Designing for transport aboard amphibious ships. When transport aboard amphibious shipping is a requirement, the materiel developer and/or contractor shall design SEM to the constraints identified in the Ship's Loading Characteristics Pamphlet (SLCP) for the required class of amphibious ship. The SLCPs are prepared by the Navy for each amphibious ship. SLCPs can be obtained from the Defense Technical Information Center, Cameron Station, Alexandria, VA 22304-6145.

5.4 Fixed-wing air transportation.

5.4.1 General. MIL-STD-1791, Military Standard, Designing for Internal Aerial Delivery in Fixed-Wing Aircraft, establishes general design and performance requirements for transport of military equipment in Military Airlift Command (MAC) cargo aircraft and long-range international Civil Reserve Air Fleet (CRAF) aircraft. This standard also contains general design and performance requirements for military equipment to be airdropped from US Air Force cargo aircraft.

5.4.2 Air transport by MAC and CRAF aircraft. New items of equipment shall be designed to meet MIL-STD-1791 requirements when fixed-wing air transport is a requirement. The MIL-STD-810 rail impact test is often used to verify the shock requirements of MIL-STD-1791.

5.4.3 Air transport by Navy and Marine Corps fixed-wing aircraft. New items of equipment requiring air transport aboard Navy and Marine Corps fixed-wing aircraft, must meet weight, dimensional, and tiedown limitations of the aircraft. Tables XII and XIII and figure 15 establish general design requirements for transport of military equipment aboard Navy and Marine Corps fixed-wing aircraft.

5.4.4 Air transport by Army fixed-wing aircraft. New items of equipment requiring air transport aboard Army fixed-wing aircraft must meet weight and balance, dimensional, and tiedown limitations of the aircraft. Tables XIV and XV and figures 16 and 17 establish general design requirements for transport of military equipment aboard Army fixed-wing aircraft. The materiel developer/contractor shall design and demonstrate the SEM to meet these requirements.

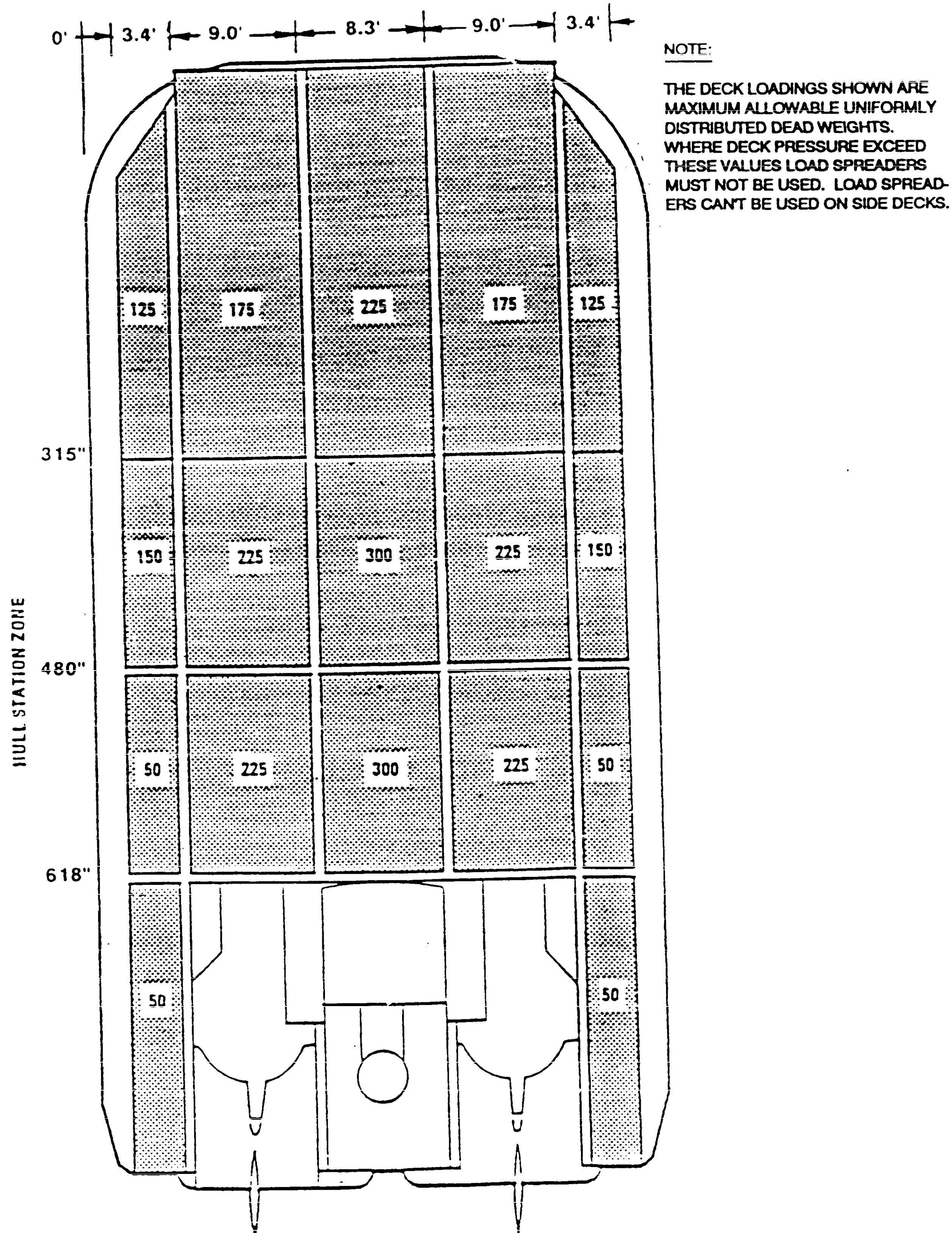


FIGURE 13. LACV-30 deck loading limits, uniformly distributed cargo in pounds per square foot.

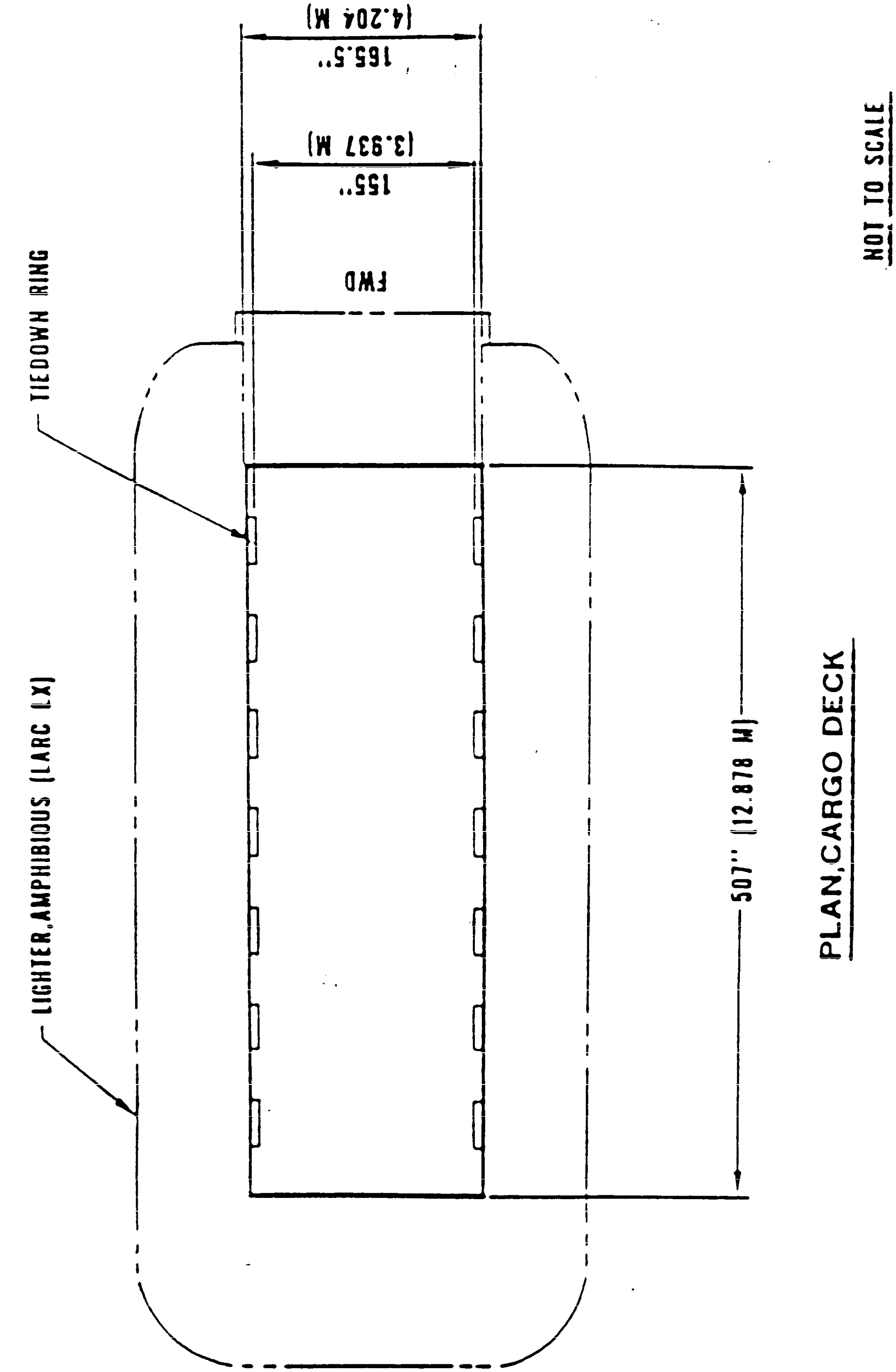


FIGURE 14. Lighter, amphibious (LARC LX).

TABLE XII. Navy/Marine Corps fixed-wing cargo aircraft

Aircraft	Conditions	Take-Off Wt. (lb)	Fuel Internal/ External (JP-5) Wt. (lb/lb)	Payload (lb)
C-2A(R)	Basic Cargo Mission (with cargo cage)	54,354	12,400	7,240 (cage installed)
	Max. Payload Mission (without cargo cage)	54,354	9,640	10,000 (cage removed)
KC-130R	Design Max. Payload (Load Factor (LF) = 2.5)	155,000	47,328/0	34,965
	Design Max. Fuel (LF = 2.5)	155,000	47,328/15,592	19,373
	Max. Overload (LF = 2.25)	175,000	47,328/9,965	45,000
C-9B	8 Full-Size Pallets (463 L, 108 in. by 88 in.)	110,000	18,215/None	32,444
	6-1/2 Full-Size Pallets (full-size 463L pallet, 108 in. by 88 in.) (half-size 463L pallet, 54 in. by 88 in.)	110,000	27,779/None	22,880

NOTE: V-22 aircraft criteria are in the Navy/Marine Corps rotary-wing aircraft section.

TABLE XIII. Constraints for Navy/Marine Corps fixed-wing aircraft.

Aircraft	Cargo Opening Dimensions 1/			Cargo Compartment				Max. Payload 3/	Crash Load Restraint Criteria				
	Location	Width (in.)	Height (in.)	Length (in.)	Width (in.)	Height (at floor line) (in.)	Structural Floor Load Limits 2/ (lb/ft sq)	(lb)	Fwd G's	Aft G's	Lateral G's	Up G's	Down G's
C-2A	Rear Ramp	88/62 4/ 83/57 5/	65 63 5/	325 5/	86 5/	63 5/	300	10,000 3/	20.0	7.0	7.0	4.0	10.0
C-9B	Side	136	80	725	115	80	300	32,444 3/	9.0	1.5	1.5	3.0	2.0
C-12B	Side	52	52	156	48	40	200	2,000	9.0	1.5	1.5	3.0	3.0
KC-130R	Rear Ramp	120	105	492	120	105	50 psi Local Pressure	35,000 3/	8.0	4.0	1.5	4.0	4.5

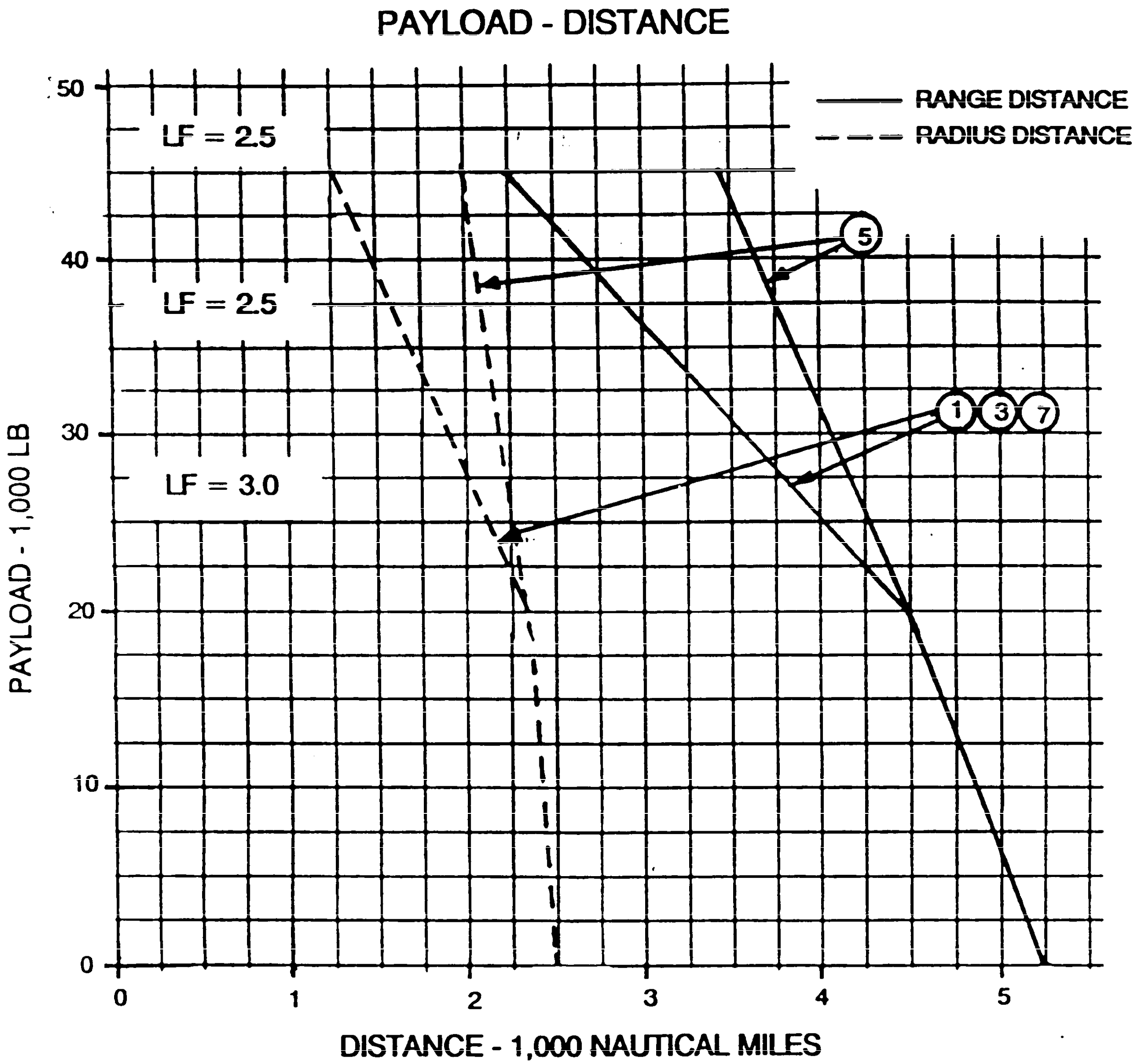
1/ Dimensional limits given are airframe dimensions. Additional clearance must be provided. For the C-9B and KC-130R provide 6 in. at top and 5 in. on both sides. For the C-2A and C-12B provide 6 in. at top, 10 in. on one side where a passage way is required, and 5 in. on the other side.

2/ Structural floor load limits for entire cargo compartment. For wheeled vehicle, conveyor, etc. load limits, see respective cargo loading manual, Naval Air Training and Operating Procedures Standardization Program (NATOPS) Flight Manual, Aircraft Weight and Balance Manual for each aircraft.

3/ Payload shown is design maximum payload. See table XII for payload-distance mission profile for each aircraft.

4/ The two width dimensions refer to the widths at the floor line and top (floor line/top) of the cargo opening.

5/ Limits are Cargo Cage Installed Dimensions.



NOTE:
L.F. = 2.25 WHEN ZERO FUEL WEIGHT (ZFW) EXCEEDS 117,892 LB OR GROSS WEIGHT EXCEEDS 155,000 LB

(1) DESIGN MAXIMUM PAYLOAD

(3) DESIGN MAXIMUM FUEL

(5) MAXIMUM OVERLOAD

(7) TACAMO MISSION

FIGURE 15. (sheet 1 of 3) Navy/Marine Corps fixed-wing cargo aircraft loading conditions.

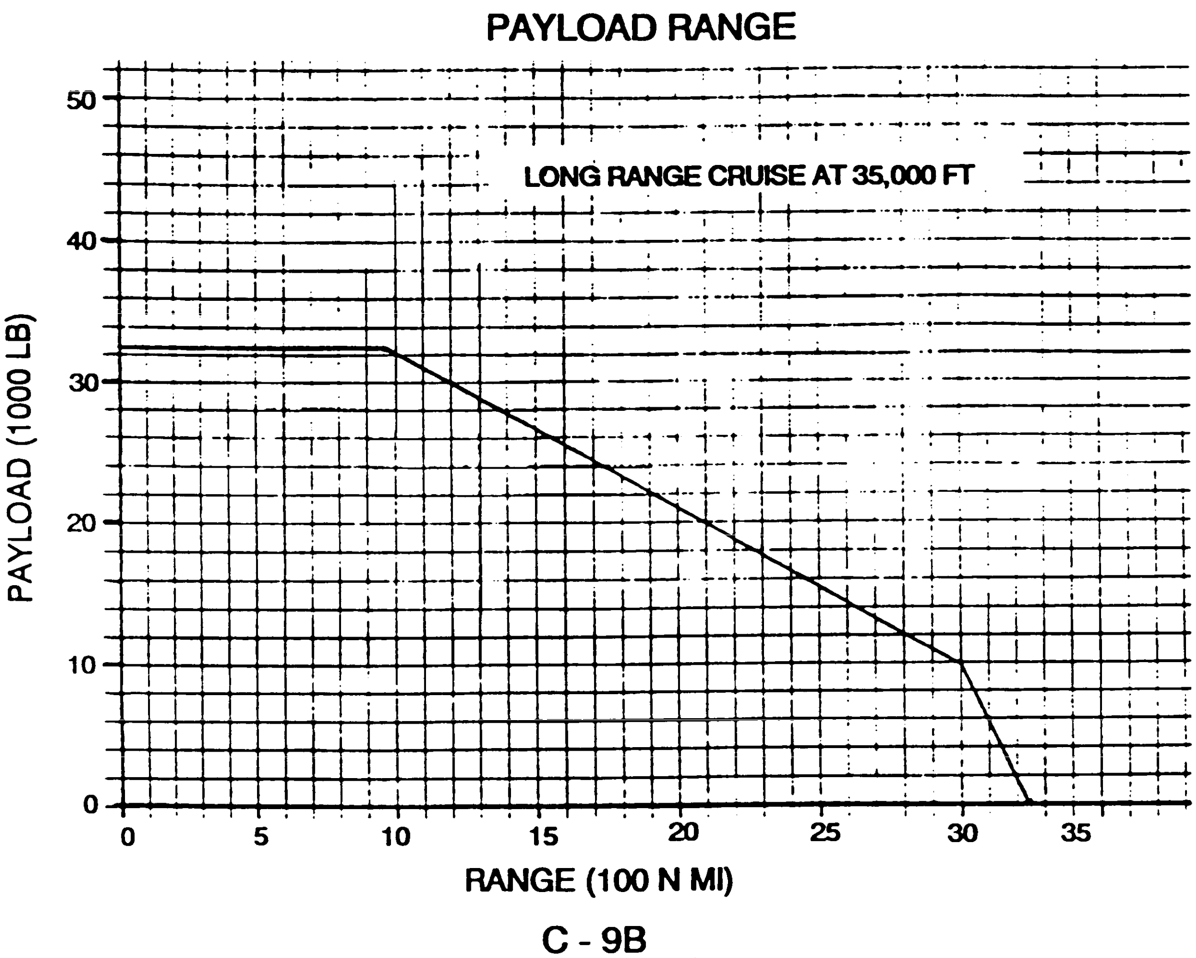


FIGURE 15. (sheet 2 of 3) Navy/Marine Corps fixed-wing cargo aircraft loading conditions.

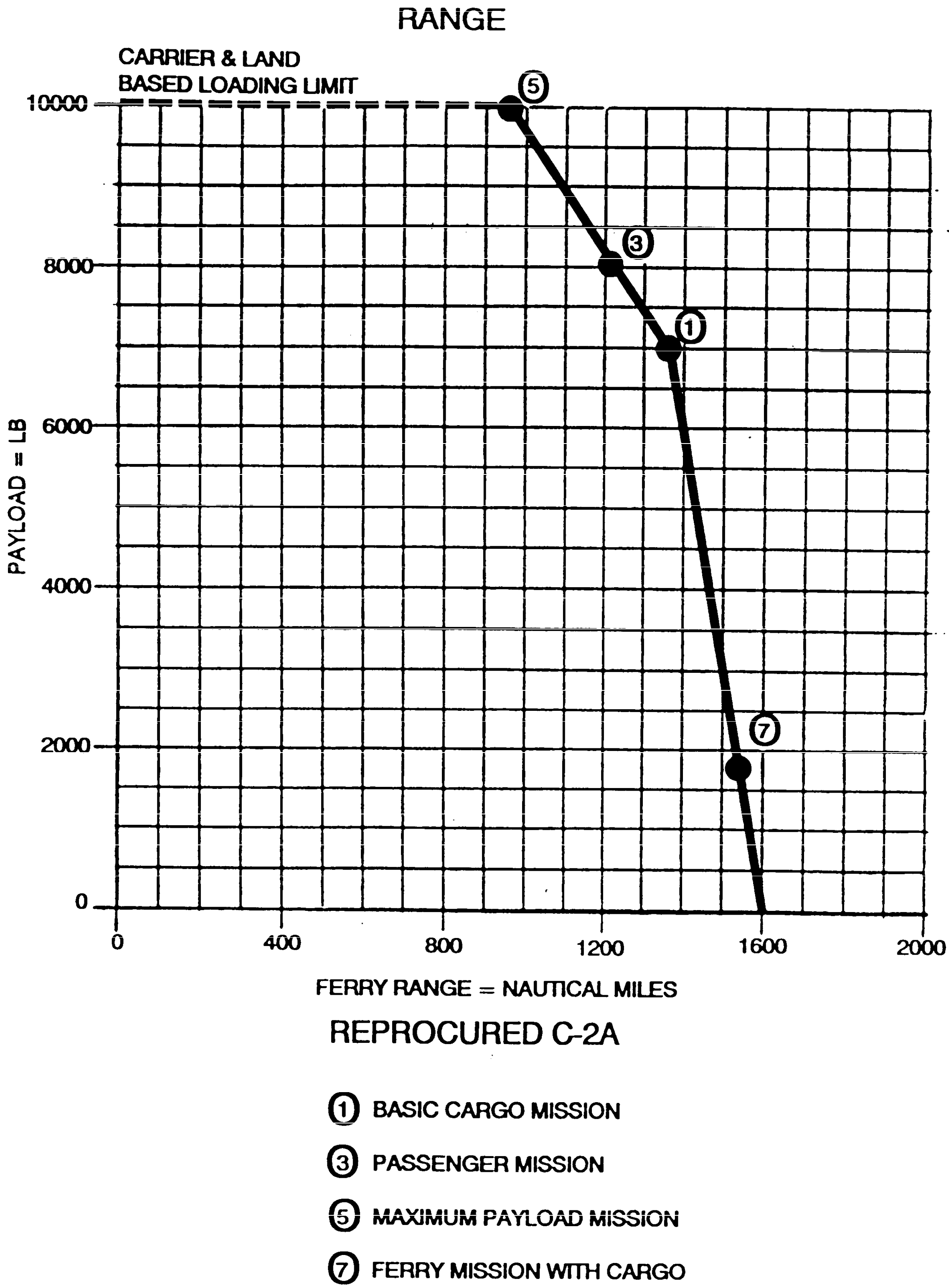


FIGURE 15 (sheet 3 of 3). Navy/Marine Corps fixed-wing cargo aircraft loading conditions.

TABLE XIV. Army fixed-wing cargo/utility aircraft.

Aircraft	Conditions	Take Off Weight (lb)	Usable Fuel (lb)	Maximum Payload (lb)	Range (nm)
C-12	1. Standard Day 2. Zero Wind 3. Max Range Pwr 4. Fuel: JP-4* 5. 10,000 ft. MSL 6. Figures based on Max Payload	12,500	2,000	2,000	880
U-21		9,650	1,550	2,000	540
C-23A		22,900	1,600	4,950	400
C-23B		25,600	1,990	7,280	500
*Use of different type fuels may alter data slightly.					

TABLE XV. Constraints for Army fixed-wing aircraft.

Aircraft Type	Cargo Opening Dimensions 1/			Cargo Compartment				Maximum Payload 6/ (lb)	Crash Load Restraint Criteria				
	Location	Width (in.)	Height (in.)	Length (in.)	Width (in.)	Height 4/ (in.)	Structural Floor Load Limits (lb/ft^2)		Fwd G's	Aft G's	Lateral G's	Up G's	Down G's
C-23B	Rear Ramp	70	75	306 3/	0-57 10/ 57-65.5	69 60	See Figure 16	4,950 7/8/	9.0	1.5	4.0	3.0	6.0
	Cargo Door	55.6	65.6	50	65.5	60	See Figure 16	4,950 7/8/	9.0	1.5	4.0	3.0	6.0
C-23A	Rear Ramp 2/	63.4	75	296 3/	60 10/	69	See Figure 17	2,414 7/8/	9.0	1.5	4.0	3.0	6.0
C-12D/F	Side	52	52	167	39 9/	51	200 5/	2,000	9.0	1.5	1.5	3.0	3.0
U-21A	Side	53.5	51.5	150	40 9/	51	200 5/	2,000	9.0	1.5	1.5	3.0	6.6
U-21F	Side	26.75	51.5	167	33 9/	36	200 5/	2,000	9.0	1.5	1.5	3.0	6.6

1/ Dimensional limits are airframe dimensions. Additional clearance must be provided. Also, subtract additional 2.5 inches in height if rollers are installed for C-23A and C-23B.
2/ Due to the location of the flight mechanics seat, the cargo door on the C-23A should not be used for loading of cargo.
3/ Due to ramp angle and overhead structure on the C-23A and C-23B, the length of maximum height cargo must be carefully calculated to avoid contact with ground or structure for roll-on/roll-off loading.
4/ Height limitations include 6.0 inch clearance at top. If rollers are installed on C-23A and C-23B aircraft, subtract additional 2.5 inches in maximum height allowance.
5/ The structural floor load limit for the C-12 and U-21 is 200 lbs/ft^2 when cargo is placed on the seat tracks and 100 lbs/ft^2 when placed on the floor boards.
6/ Maximum payload is calculated based on full fuel. See table XIV for Mission Profile data.
7/ Maximum payload includes all aircraft compartments.
8/ Maximum simultaneous compartment loading is variable dependent, (i.e. wheeled vehicles, cargo on floor, rollers, etc) check appropriate loading manual for aircraft loading.
9/ Dimension includes 10 in. on one side where passageway is required, and 5 in. on the other side.
10/ Dimension includes 5-inch clearance on both sides of aircraft.

COMPARTMENT DATA

COMPARTMENT DESIGNATION	A NOSE BAY	J FLIGHT COMPT.	K FWD CABIN	B MAIN CABIN	C MAIN CABIN	D MAIN CABIN	E MAIN CABIN	F MAIN CABIN	G MAIN CABIN	H TAIL FUSELAGE	L UPPER DECK
CENTROID FROM C.G. REFERENCE DATUM (1)	-225	-161	-109	51	14	52	72	118	194	273	53
FORWARD FUSELAGE STATION	-60	3	74	108	190	238	265	280	356	432	74
AFT FUSELAGE STATION	3	74	108	190	238	265	280	356	432	514	432
MAXIMUM CAPACITY(lb)	400			(2) 2730	(2) 2400 2125 (3)	(2) 1330 1175 (3)	(2) 760 670 (3)	(2) 2530	(2) 2530	800 (4)	
FLOOR CAPACITY(lbs./sq.ft)	50			125	150	150	150	125	125	125	
FLOOR AREA(sq.ft.)	16			40	23	13	7	37	37	40	
APPROX. VOLUME(cu.ft.)	44			232	133	75	41	215	215	140	
RUNNING LOAD(lb./linear ft.)	150			(2) 400	(2) 600	(2) 600 530 (3)	(2) 600 530 (3)	(2) 400 530 (3)	(2) 400	300	
CONCENTRATED LOAD(lb./sq.in.)				10.5 (5)	12.5 (6)	12.5 (6)	12.5 (6)	10.5 (5)	10.5 (5)	10.5 (5)	
LOCAL CRUSHING STRENGTH (lb./sq.in.)ON ONE LOCAL SQ.IN.				45	45	45	45	45	45	45	

(1) Centroids quoted are not necessarily compartment mid points due to fuselage tapering and equipment stowage.

(2) Applies when two outer rows or 3 rows of rollers are being used or when cargo is distributed on floor.

(3) Lower values in Compartments C, D and E apply when center roller and either left or right roller are being used.

(4) In the Personnel/Troop Transport Role any cargo/baggage carried in compart 'H' must be stowed in containers which meet FAR 25.857 (d)/BCAR D4-3.6.3.4 requirements.

(5) Subject to a maximum distributed loading of 125 lb/sq. foot.

(6) Subject to a maximum distributed loading of 150 lb/sq. foot.

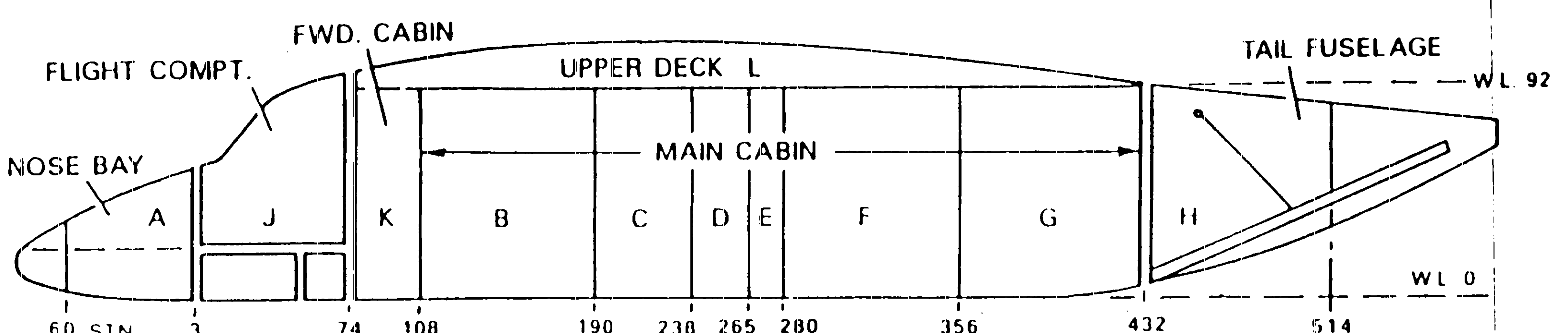
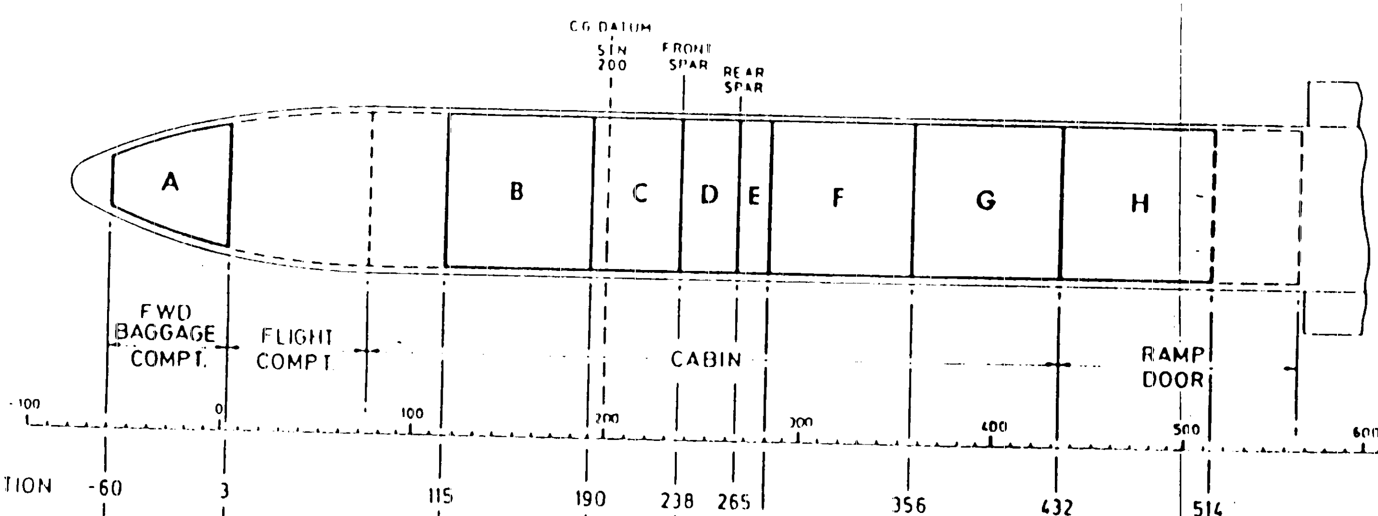


FIGURE 16. C-23B compartment data.



COMPARTMENT	A	-	B	C	D	E	F	G	H
COMPARTMENT CENTROID	-225	-	-48	+14	+52	+72	+118	+194	+273
APPROX. FLOOR AREA SQ.FT.	16	-	36	23	13	7	37	37	40
APPROX. USABLE VOLUME CU.FT.	45	-	208	133	75	41	215	215	140

FIGURE 17 (sheet 1 of 2). C-23A compartment dimensional and loading (distributed cargo) data.

COMPARTMENT	A	B	C	D	E	F	G	H
Maximum distributed Loading (PSF)	50	125	150	150	150	125	125	125
Running Load (PLF) 1/	150	400	600	600	600	400	400	400
Maximum Individual Compartment Capacity (lb) 2/ 3/	500	2500	2400	1330	760	2530	2530	600
Concentrated Ld (PSI) (see T.O. 1C-23A-9)	-	10.5 4/	12.5 5/	12.5 5/	12.5 5/	10.5 4/	10.5 4/	10.5 4/
Local Crushing Strength (PSI) on one local sq. in. (see T.O. 1C-23A-9)	-	45	45	45	45	45	45	45

NOTE: 1/ & 2/ apply when center roller conveyor and either right or left roller are used.

	C	D	E
1/ Running Load (PLF)	530	530	530
2/ Maximum individual compartment capacity (lb)	2125	1175	670
3/ Cargo to be distributed with the heaviest load about F.S. 251.5			
4/ Subject to the max distributed loading of 125 PSF			
5/ Subject to the max distributed loading of 150 PSF			

FIGURE 17 (sheet 2 of 2). C-23A compartment dimensional and loading (distributed cargo) data.

5.5 Rotary-wing air transportation.

5.5.1 General. Rotary wing aircraft are mainly for short-range, tactical transport missions. These aircraft have the advantage of transporting essential equipment directly to a forward area without having to contend with en route terrain obstacles or damaged road or railroad systems. The US Army rotary-wing fleet has three types of helicopters that are used to transport cargo: the UH-1 and UH-60 utility helicopters and the CH-47 cargo helicopter. These helicopters can transport loads externally underneath a helicopter via a helicopter sling. All three have an internal air transport capability. The US Navy/Marine Corps lists the UH-1N, SH-2F, SH-3G, CH-46E, CH-53A, CH-53D, RH-53D, CH-53E, MH-53E, SH-60B, SH-60F, HH-60H, and MV-22 helicopters as having an external payload capability. The UH-1N, SH-2F, SH-3G, CH-46A/D/E, CH-53A, CH-53D, RH-53D, CH-53E, MH-53E, SH-60B, SH-60F, HH-60H, and MV-22 helicopters are US Navy/Marine Corps rotary-wing aircraft having an internal payload capability.

5.5.2 Rotary-wing aircraft external air transport capabilities. Each helicopter has a maximum payload rating; however, the lift capability and range of each helicopter differ for each mission. The temperature, altitude, and fuel carried in the helicopter must be considered for each mission. Helicopters rarely fly at their maximum payload rating. The maximum external loads given in table XVI are for the US Army rotary-wing aircraft. Table XVII provides the maximum external loads for the US Navy/Marine Corps rotary-wing aircraft.

5.5.3 Rotary-wing aircraft internal air transport capabilities. The weight and dimensional design limits for equipment to be internally transported by US Army rotary-wing aircraft are in tables XVIII and XIX. These design limits allow for required safety clearances between the equipment and side walls and ceiling of the helicopter. The information for the UH-1, UH-60, and CH-47 cargo tiedown provisions is shown in figures 18, 19, and 20. Charts for maximum package sizes are given for information in figures 21, 22, and 23. Weight and dimensional limits for equipment to be internally transported by US Navy/ Marine Corps helicopters are given in tables XX and XXI, respectively. Cargo configurations shall be considered in the design to allow the use of sufficient cargo tiedown rings without overloading the tiedown provisions for the applicable aircraft using the required crash load restraint criteria.

5.5.4 Natick helicopter certification. The US Army Natick Research, Development and Engineering Center (Natick) is the responsible agency for the certification of all SEM transported via external air transport (EAT) under all DOD rotary-wing

TABLE XVI. US Army rotary-wing aircraft maximum external payloads.

Helicopter	Cargo Hook Limit (lb)	Sea level, 60° F 30 n.m.	2,000 ft, 70° F 30 n.m.	4,000 ft, 95° F 30 n.m.
UH-1H w/Comp. Main Rotor Blade	4,000	2,550	2,600	1,150
UH-60A	8,000	7,850	7,350	4,750
UH-60L	8,000	8,000	8,000	6,800
MH-60K	8,000	6,700	5,900	3,250
CH-47C w/-712 Eng. & Fiber-glass Rotor Blades	20,000	20,000	19,200	17,550
CH-47D	26,000 cntr 17,000* fwd/aft	25,150	23,200	16,450
MH-47E	26,000 cntr 17,000* fwd/aft	20,650	19,200	16,400

Mission:
(1) Warm-up, 8 min. at idle power.
(2) Take-off/hover (OGE) 1 min. at T/O power.
(3) Cruise at 100 KTAS for 30 nautical miles with external load.
(4) Hover (OGE) 1 min.
(5) Offload payload.
(6) Return at best range speed for 30 nautical miles.
(7) Reserves: 20 min. at best range speed.

* 25,000 using forward and aft hooks in tandem (maximum single load).

TABLE XVII. US Navy and Marine Corps rotary-wing aircraft maximum external payloads.

Helicopter	Cargo Hook Limit (lb)	Mission Profile 1/ Ambient Conditions Maximum External Load (lb)		
		Sea level, 60° F 30 nautical miles	2,000 ft, 70° F 30 nautical miles	4,000 ft, 95° F 30 nautical miles
UH-1N	5,000	2,646	2,681	1,937
SH-2F	4,000	2,512	2,474	1,033
SH-3G	8,000	4,335	2,852	94
CH-46E	10,000	5,915	5,481	3,783
CH-53A	20,000	13,763	9,522	3,982
CH-53D	20,000	14,693	13,891	7,860
RH-53D	20,000	11,218	11,299	7,438
CH-53E	36,000	34,771	28,298	18,177
MH-53E	36,000	30,668	23,311	13,492
SH-60B	6,000	4,896	4,372	1,611
SH-60F	6,000	5,286	4,925	2,006
HH-60H	6,000	5,090	4,625	1,565
MV-22	15,000	13,325	9,335	7,480

1/ Mission profile:
(1) Warm-up, 8 min. at idle power.
(2) Take-off/hover 1 min. at intermediate rated power (IRP).
(3) Cruise at 100 knots for 30 nautical miles with external load.
(4) Hover 1 min. at IRP.
(5) Offload payload.
(6) Return at best range speed for 30 nautical miles.
(7) Reserves: 20 min. at best range speed.

TABLE XVIII. US Army rotary-wing aircraft maximum internal payloads.

Helicopter	Sea level, 60° F 30 n.m.	2,000 ft, 70° F 30 n.m.	4,000 ft, 95° F 30 n.m.
UH-1H w/Comp. Main Rotor Blade	2,600	2,600	1,150
UH-60A	8,050	7,500	4,850
UH-60L	8,450	8,500	6,950
MH-60K	6,900	6,100	3,400
CH-47C w/-712 Eng. & Fiber-glass Rotor Blades	20,300	19,700	18,000
CH-47D	23,300	23,350	16,900
MH-47E	21,250	19,750	16,900
Mission: (1) Warm-up, 8 min. at idle power. (2) Take-off/hover (OGE) 1 min. at T/O power. (3) Cruise at best range speed for 30 nautical. (4) Hover (OGE) 1 min. (5) Offload payload. (6) Return at best range speed for 30 nautical miles. (7) Reserves: 20 min. at best range speed.			

TABLE XIX. Constraints for Army rotary-wing aircraft.

	Cargo Opening Dimensions 1/			Cargo Compartment 3/				Crash Load Restraint Criteria				
Aircraft Type	Location	Width (in.)	Height (in.)	Length (in.)	Width (in.)	Height (in.)	Structural Floor Load Limits (lb/ft^2)	Fwd G's	Aft G's	Lateral G's	Up G's	Down G's
UH-1H	Each side	92/74 2/	49	82/47.5 4/	77/15 4/	46	100	8	8	8	4	8
UH-60 (A/L/K)	Each side	68	52	92/127.5 5/	50/46 5/	46	300	12	3	8	3	
CH-47 (C/D/E)	Rear ramp	90	78	331	80	72	300 or (2500 on treadway)	4	2	1.5	2	4

1/ Dimensions given are airframe dimensions. Additional clearance of 6 in. between the equipment and the aircraft ceiling must be provided.
2/ Dimensions are for both doors and sliding door opened respectively.
3/ Dimensions allow a 5 inch clearance inside the centerline of the perimeter tiedown fittings and clearance of 6 inches between the equipment and the aircraft ceiling.
4/ See figure 18. The first length and width dimensions are for the total cargo compartment. However, they do not allow for the transmission box. The second length dimension is the unobstructed allowable cargo length from front of cargo compartment to transmission box. The second width dimension is the allowable cargo width for the areas on either side of the transmission box.
5/ Second dimension includes gunner's area.

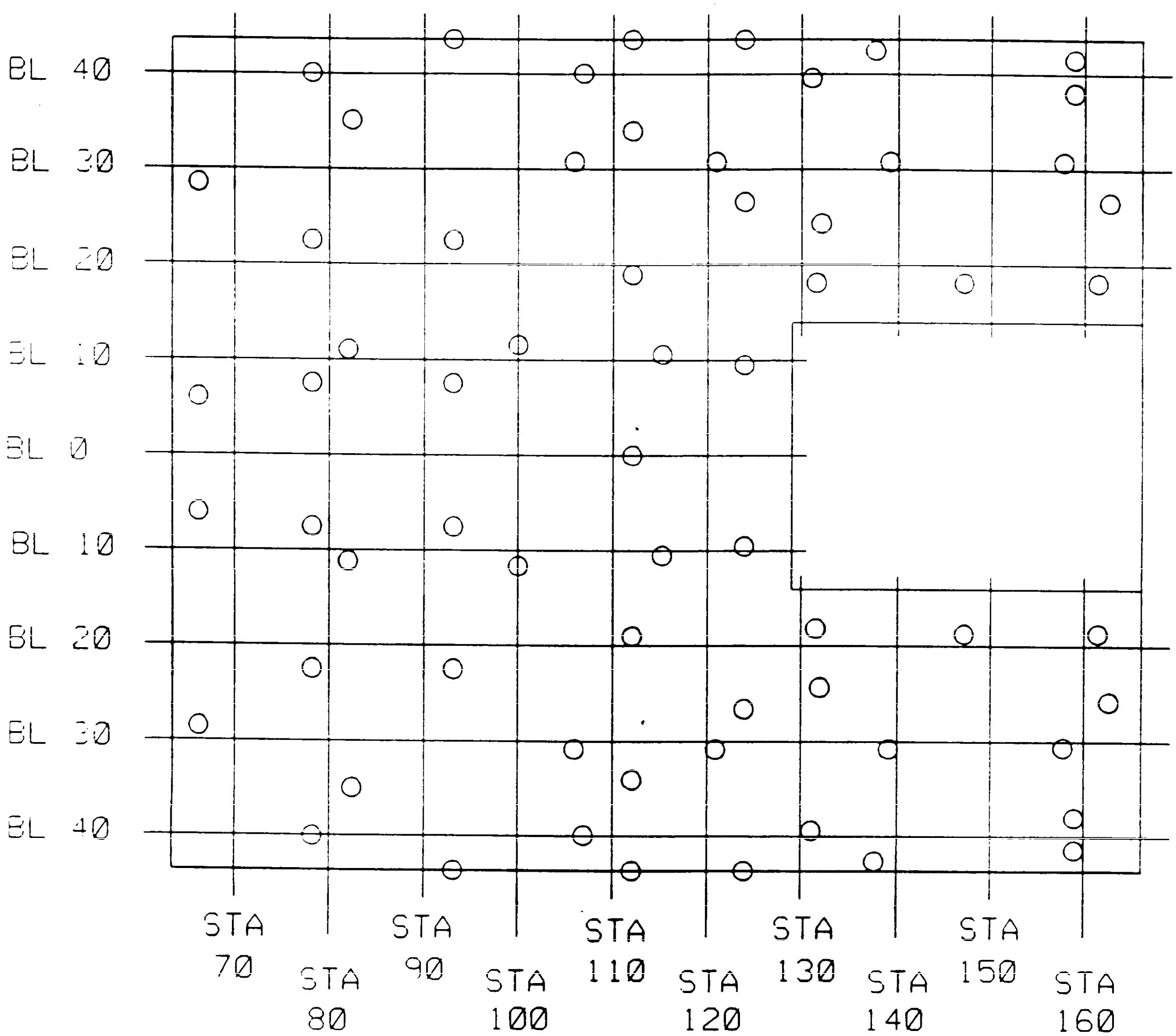
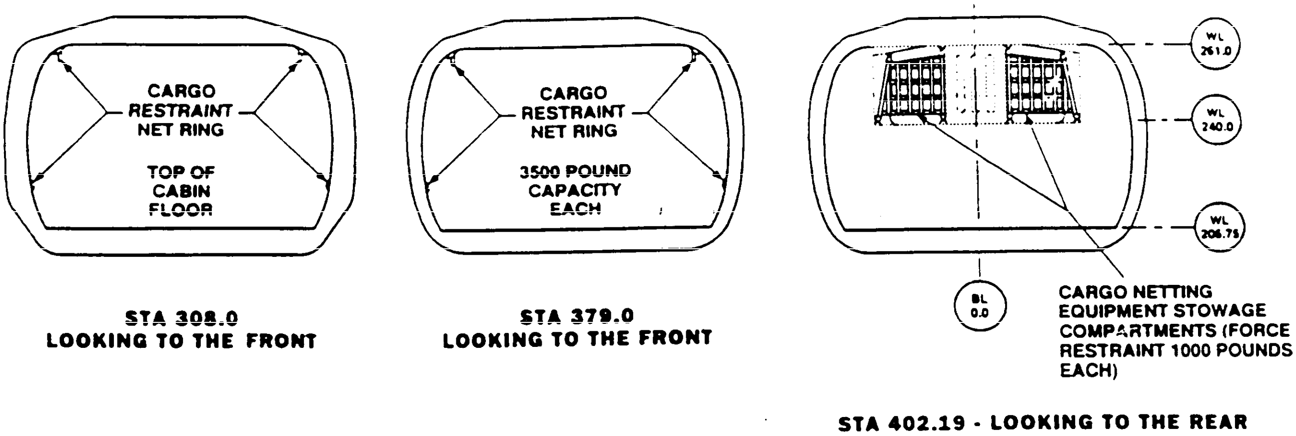
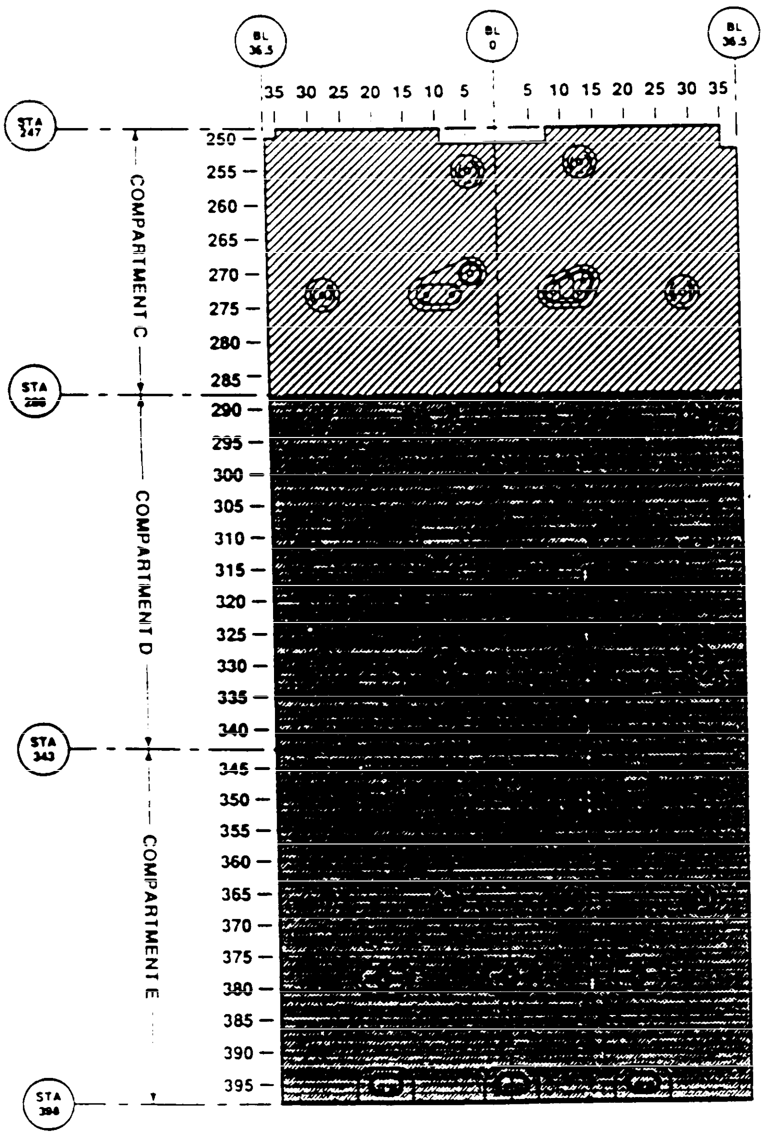


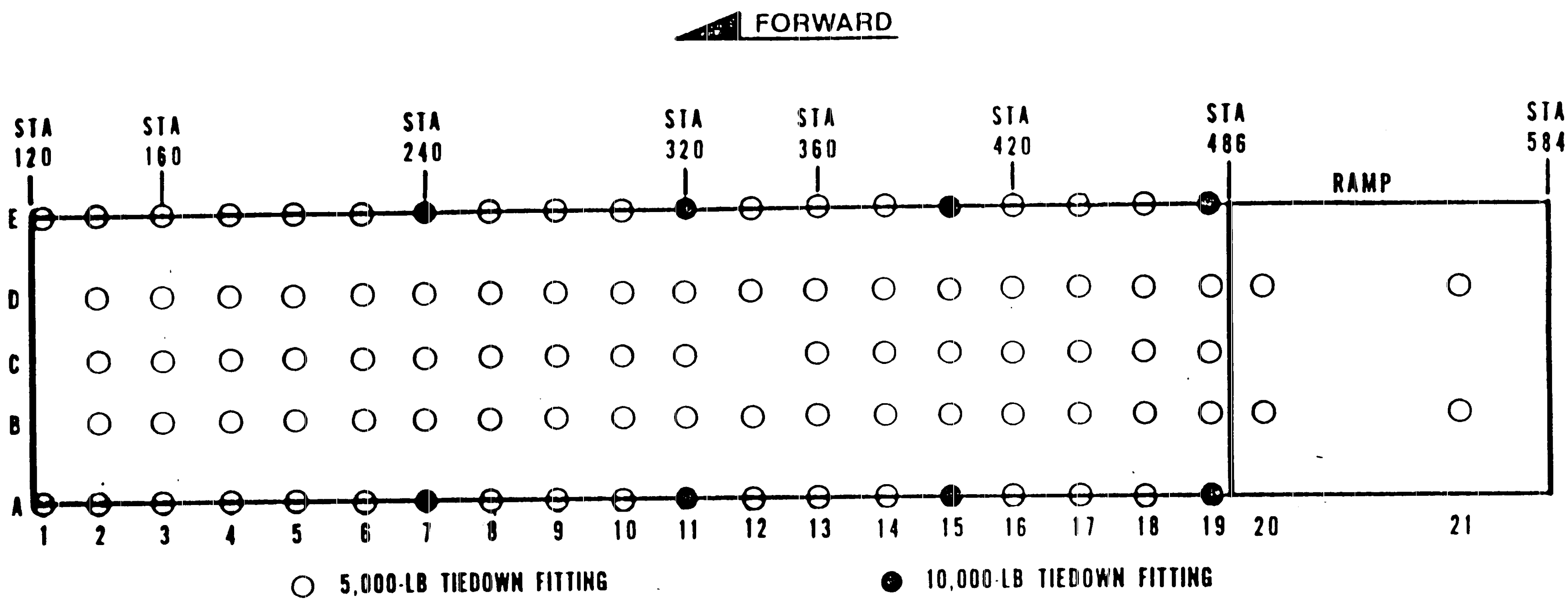
FIGURE 18. UH-1 CARGO TIEDOWN FITTING DATA.





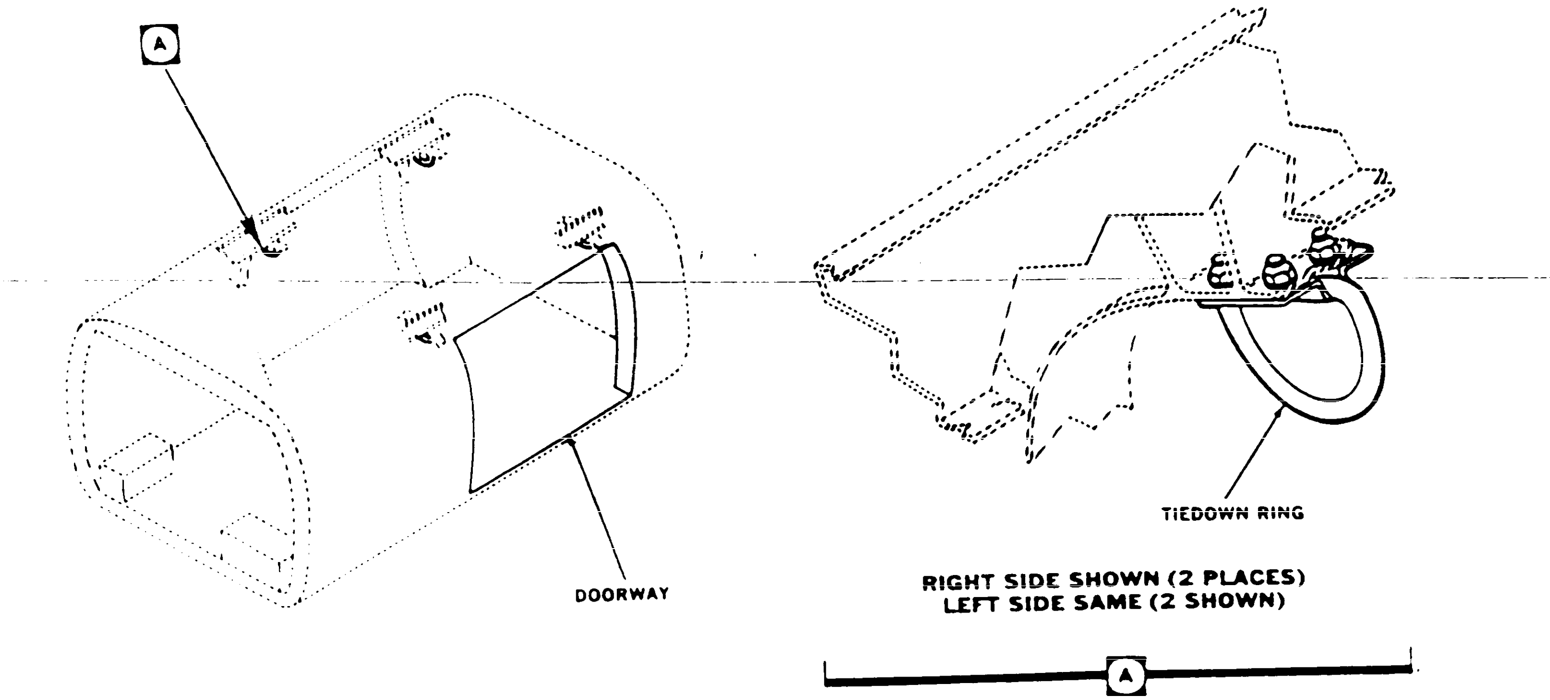
	MAXIMUM COMPARTMENT CAPACITY IN POUNDS	FLOOR CAPACITY POUNDS PER SQUARE FOOT
(hatched)	5460	300
(dark)	8370	300

FIGURE 19. UH-60 cargo tiedown arrangement.



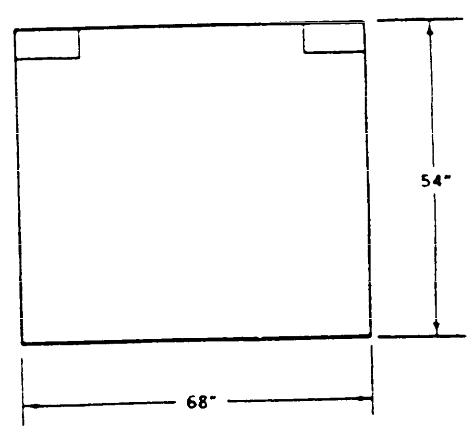
NOTE: UTILITY HATCH DOOR IS LOCATED IN THE CENTER OF THE FLOOR BETWEEN STATIONS 320 AND 360

FIGURE 20. CH-47D tiedown fitting locations.



MAXIMUM PACKAGE SIZE TABLE
CABIN DOORS

WIDTH INCHES	HEIGHT - INCHES				
	50 & UNDER	51	52	53	54
	MAXIMUM LENGTH - INCHES				
46	102	102	102	96	93
48	102	102	102	96	93
50	101	101	101	95	92
52	100	100	100	94	92
54	99	99	99	93	91
56	98	98	98	93	91
58	97	97	97	93	91
60	96	96	96	91	90
62	93	93	93	89	87
64	91	91	91	87	
66	86	86	86	80	
68	80	80	80	77	



CABIN DOOR - BOTH SIDES

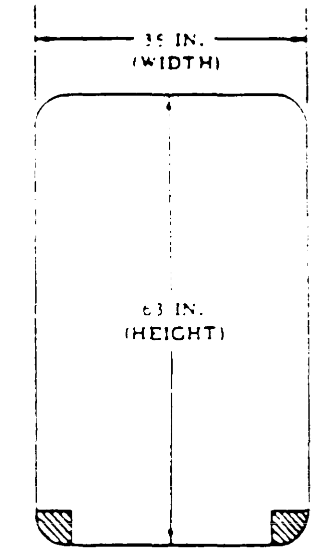
NOTE
IF GUNNERS AREA NOT USED, LENGTHS ARE APPROXIMATELY 90% OF TABLE VALVES

FIGURE 21. UH-60 maximum package size.

to be handled mechanically rather than manually. Details are given with

MAXIMUM PACKAGE SIZE TABLE
FORWARD DOOR--RIGHT SIDE

WIDTH (Inches)	HEIGHT--INCHES									
	53 & Under	54	55	56	57	58	59	60	61	62
	MAXIMUM LENGTH--INCHES									
12	249	246	242	238	234	223	170	170	170	165
13	233	230	227	224	221	211	162	162	162	157
14	217	215	213	210	208	199	154	154	154	150
15	205	204	203	199	197	187	147	147	147	144
16	195	194	193	189	187	176	141	141	141	138
17	186	185	183	180	178	166	136	136	136	133
18	177	176	174	172	170	157	131	131	131	128
19	169	168	166	164	162	149	126	126	126	124
20	161	160	159	157	155	142	122	122	122	120
21	155	154	153	151	146	135	118	118	118	116
22	149	148	147	145	141	129	114	114	114	112
23	143	143	142	140	135	124	111	111	111	109
24	138	138	137	135	129	119	108	108	108	106
25	133	133	132	130	124	114	105	105	105	103
26	128	128	127	125	119	110	103	103	103	101
27	125	124	123	121	115	106	101	101	101	99



NOTE

Shaded part shows approximate area obstructed due to door opening linkage.

FIGURE 22. CH-47 maximum package size for forward door - right side.

WIDTH (INCHES)	MAXIMUM PACKAGE SIZE TABLE RAMP DOOR — HEIGHT - INCHES															
	62 & Under	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
	MAXIMUM LENGTH--INCHES															
62 & Under	362	362	362	362	362	362	362	362	330	282	230	180	135	100	67	30
63	362	362	362	362	362	362	362	362	328	280	228	178	133	98	66	
64	362	362	362	362	362	362	362	362	326	278	226	176	130	96	64	
65	362	362	362	362	362	362	362	362	322	274	222	173	127	93		
66	362	362	362	362	362	362	362	362	318	270	218	169	123	90		
67	362	362	362	362	362	362	362	362	313	266	214	165	119	86		
68	362	362	362	362	362	362	362	357	307	260	208	160	114	81		
69	362	362	362	362	362	362	362	348	299	252	201	154	107	75		
70	362	362	362	362	362	362	362	339	290	243	193	146	99			
71	362	362	362	362	362	362	362	330	281	234	185	139	91			
72	362	362	362	362	362	362	362	321	272	226	177	131	83			
73	362	362	362	362	362	362	352	312	263	216	167	122	75			
74	362	362	362	362	362	362	339	298	250	203	156	112				
75	362	362	362	362	362	362	325	284	237	190	144	101				
76	362	362	362	362	362	348	311	270	223	177	132	90				
77	362	362	362	362	362	334	297	256	209	164	119					
78	362	362	362	362	346	316	278	237'	191	147	104					
79	362	362	362	362	329	298	258	218	173	129	85					
80	362	362	362	362	310	276	236	195	151	108						
81	362	362	362	362	289	253	213	172	128	85						
82	362	362	362	362	267	230	188	148	105							
83	362	362	362	362	241	202	161	121								
84	362	362	362	362	213	174	133	93								
85	362	362	362	362	182	142	100									
86	362	362	362	362	146	105										
87	362	362	362	362	105											
88	362	362	362	362												
89	362	362	362	362												
90	362															

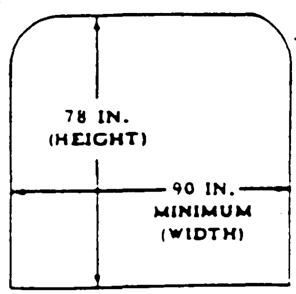


FIGURE 23. CH-47 maximum package size for ramp door.

TABLE XX. US Navy and Marine Corps rotary-wing aircraft maximum internal payloads.

Helicopter	Mission Profile 1/ Ambient Conditions Maximum Internal Load (lb)		
	Sea level, 60°F 30 nautical miles	2,000 ft, 70°F 30 nautical miles	4,000 ft, 95°F 30 nautical miles
UH-1N	2,713	2,754	1,997
SH-2F	2,663	2,659	1,140
SH-3G	4,480	2,954	153
CH-46E	6,026	5,596	3,886
CH-53A	13,841	9,561	3,990
CH-53D	14,768	13,972	7,910
RH-53D	11,268	11,310	7,442
CH-53E	34,986	28,600	18,591
MH-53E	30,883	23,613	13,906
SH-60B	5,025	4,494	1,720
SH-60F	5,434	5,065	2,144
HH-60H	5,219	4,747	1,682
MV-22	13,845	9,838	8,011

1/ Mission profile:
(1) Warm-up, 8 min. at idle power.
(2) Take-off/hover 1 min. at intermediate rated power (IRP).
(3) Cruise at best range speed for 30 nautical miles.
(4) Hover 1 min. at IRP.
(5) Offload payload.
(6) Return at best range speed for 30 nautical miles.
(7) Reserves: 20 min. at best range speed.

TABLE XXI. Constraints for Navy/Marine Corps rotary-wing aircraft.

Aircraft	Cargo Opening Dimensions 1/			Cargo Compartment				Crash Load Restraint Criteria				
	Location	Width (in.)	Height (in.)	Length (in.)	Width (in.)	Height (at floor line) (in.)	Structural Floor Load Limits 2/ (lb/ft sq)	Fwd G's	Aft G's	Lateral G's	Up G's	Down G's
SH-3G	Side	68	60	231	76	71	300	8	4	4	4	4
H-46A/D/E	Rear Ramp	70	69	290	72	69	300	10	7.5	3	3	10
SH-60B	Side	44	54	130	73	54	225	8	4	4	4	8
SH-60F	Side	44	54	130	73	54	75 Fwd Cabin 300 Aft Cabin	8	4	4	4	8
HH-60H	Side	44	54	130	73	54	75 Fwd Cabin 300 Aft Cabin	8	4	4	4	8
CH-53A	Rear Ramp	96	77	450	90	77	300	10	7.5	3	3	10
CH-53D	Rear Ramp	96	77	450	90	77	300	10	7.5	3	3	10
RH-53D	Rear Ramp	96	77	450	90	77	300	10	7.5	3	3	10
CH-53E	Rear Ramp	96	77	450	90	77 3/	300	10	7.5	3	3	10
MH-53E	Rear Ramp	96	77	450	90	77 4/	300	10	7.5	3	3	10
V-22	Rear Ramp	72	90	290	71	68	300	16 5/	5	10 5/	5	16

1/ Dimensional limits given are airframe dimensions. Clearances must be provided as follows: 6 in. at the top, 10 in. (minimum) on one side for personnel passageway, and 5 in. on the other side.
2/ Structural floor load limits for entire cargo compartment. For wheeled vehicle, conveyor, etc. load limits, see respective cargo loading manual, Naval Air Training and Operating Procedures Standardization Program (NATOPS) Flight Manual, Aircraft Weight and Balance Manual for each aircraft.
3/ 73 in. when single point cargo hook is stowed and 75 in. unstowed.
4/ 58 in. aft cabin when Mine Counter Measure (MCM) equipment is installed.
5/ Dynamic restraint requirements of figures 8 and 9 of MIL-STD-1290A for maximum controlled displacement of cargo to the peak acceleration shown.

aircraft. Natick is also responsible for certification of all SEM transported internally via US Army rotary-wing aircraft. This responsibility does not include certification of US Army nuclear SEM for internal helicopter transport by US Army helicopters. The purpose of the Natick certification is to provide technical assurance that the equipment being transported can withstand the stresses of the internal and external helicopter flight environment while providing the most efficient and safest rigging/loading procedures possible. To obtain EAT helicopter certification, the SEM must meet the criteria in MIL-STD-913. For internal Army helicopter certification, the SEM must meet loading/flight clearance requirements and be capable of being restrained to the criteria of the particular helicopter for which certification is required. In general, the Natick helicopter external air transport certification is based upon:

a. An engineering evaluation of load characteristics and the slinging provisions for helicopter flight environments.

b. Proof load testing of the slinging provisions in accordance with MIL-STD-209 (see para 5.7; Slinging, tiedown, and cargo tiedown provisions).

c. Static lift testing to verify sling lengths and clearances.

d. Helicopter flight testing to determine maximum stable airspeed and demonstrate maneuver stability during flight.

In general, the Natick helicopter internal air transport certification is based upon:

a. An engineering evaluation of load characteristics and the tiedown provisions for helicopter flight environments.

b. Proof load testing of the tiedown provisions in accordance with MIL-STD-209 (see para 5.7; Slinging, tiedown, and cargo tiedown provisions).

c. Validation test loading to verify tiedown and clearances.

5.6 Air delivery by low velocity airdrop (LVAD) and low altitude parachute extraction system (LAPES).

5.6.1 General. LVAD and LAPE support two types of military operations: mass assault and resupply. In a mass assault operation, a large quantity of personnel, supplies, and equipment are airdropped into an opposing force's territory to establish a position. In a resupply operation, items such as rations, equipment, ammunition, water, fuel, and medical supplies are airdropped into an area held by friendly forces. LVAD and LAPE procedures take place when landing an aircraft is impossible. The C-130, C-141, C-5, and C-17 aircraft all have an airdrop capability. Energy-dissipating material is placed between the item and the airdrop platform to absorb the impact shock when the platform strikes the ground. The transport characteristics of the rigged load (airdrop platform, energy-dissipating material, and the item to be airdropped) must meet aircraft limitations. For C-130 and C-141 aircraft, the rigged load should not exceed a height of 100 inches and a width of 108 inches. The height is further restricted forward of the item's center of gravity to allow extraction under malfunction conditions. With these height restrictions, the estimated maximum airdrop height for vehicles with rubber tires and vehicles with suspension is 90 inches. The maximum airdrop height for all other equipment being airdropped by C-130 and C-141 aircraft is 84.5 inches.

The information in paragraphs 5.6.2 and 5.6.3 and other necessary LVAD and LAPE criteria are given in MIL-STD-669, Military Standard Loading Environment and Related Requirements for Platform Rigged Airdrop Materiel; MIL-STD-814, Military Standard Requirements for Tiedown, Suspension, and Extraction Provisions on Military Materiel for Airdrop; and MIL-STD-1791, Military Standard Designing for Internal Aerial Delivery in Fixed-wing Aircraft.

5.6.2 LVAD criteria. LVAD can be used for all supplies and equipment certified for airdrop. Cargo parachutes reduce the rate of descent to no more than 28 feet per second. The delivery aircraft fly at airspeeds of 130-150 knots and an altitude of 750 feet or more. Extraction parachutes from one 15-foot to two 28-foot parachutes and recovery parachutes are used for LVAD. An item must be restrained to 3 g's forward, 2 g's up, and 1.5 g's lateral and aft on the airdrop platform for LVAD. When the extraction parachute is attached to the item, the aft restraint required will be 2 times the towed extraction force. (See section 4a in chap 4 of AFSC Design Handbook DH1-11 for determining the towed extraction force.) The maximum airdrop weights for fully rigged loads in C-130, C-141, and C-5 aircraft are 42,000, 38,500, and 42,000 pounds, respectively. The C-17 maximum airdrop weight for fully rigged loads has not been established but is required to be 60,000 pounds. Depending on the rigging requirements, the maximum item weights for airdrop are about 34,200 pounds for C-130 and C-5 aircraft and 31,270 pounds for the C-141 aircraft. The maximum gross rigged weight of an item to be airdropped is estimated based on the formula: gross rigged weight = 1,600 lb + (1.18 x item weight for airdrop).

5.6.3 LAPE criteria. LAPE airdrops usually take place at 5 to 15 feet above ground. The aircraft flies at airspeeds of about 130 knots, and from one to three 28-foot or two 35-foot extraction parachutes are used during the airdrop. There are no recovery parachutes used during LAPE. C-130 and C-17 aircraft have LAPE capability. When the extraction parachute is attached to the platform, an item must be restrained to 12 g's forward, 4 g's up, and 3 g's lateral and aft off the platform for LAPE drops. When the extraction parachute is attached to the item, restraint requirements are 8 g's forward, 4 g's up, 3 g's lateral, and 2 times the towed extraction force for aft restraint. (See section 4a in chap 4 of AFSC Design Handbook DH1-11 for determining the towed extraction force.) Because of differences in rigging requirements, the maximum weight of an item to be delivered by LAPES will differ from the maximum item weight for LVAD. Depending on rigging requirements, the maximum item weight for LAPE is about 37,600 pounds. The maximum LAPE weight for fully rigged loads is the same as the maximum LVAD weight. The maximum gross rigged weight of an item for LAPE is estimated by the formula: gross rigged weight = 2,500 lb + (1.05 x item weight for LAPE).

5.7 Slinging, tiedown, and cargo tiedown provisions. New items of equipment, reprocurements of existing equipment, and modified equipment that meet the definition of a transportability problem item must have slinging, tiedown, and for cargo carrying equipment, cargo tiedown provisions conforming to MIL-STD-209. MIL-STD-209, Military Standard, Slinging, and Tiedown Provisions for Lifting and Tying Down Military Equipment establishes dimensional limits, design considerations, positioning requirements, and strength requirements to ensure military equipment can be safely and efficiently lifted or tied down for transport. To avoid common design errors, the following paragraphs provide general guidance on lifting, tiedown, and cargo tiedown provisions.

a. Tiedown provisions.

1. Tiedown provision strengths are based on the gross weight of the item/systems.

2. Tiedown provisions shall have the required strength to meet the MIL-STD-209 directional load factors. These forces are to be applied statically and independently. The directional load shall be distributed among the tiedown eyes or provisions that would effectively resist motion along that axis.

3. In general, the number of tiedown provisions that items/systems must have is four.

b. Slinging provisions.

1. Slinging provision required strengths are based on the equipment gross weight and item/system's lift requirements (requirement for helicopter transport and crane lift).

2. When locating slinging provisions, the designer shall consider the angle of pull required for a slinging provision pull test. In general, this angle will be based on a 45^{o} angle from the vertical, or sling leg lengths not longer than 12 feet, whichever is less severe.

3. Slinging provisions shall be located such that the item/system will not be damaged due to compressive forces exerted on the item through contact with a sling leg.

c. Cargo tiedown provisions.

1. All cargo carrying vehicles shall have cargo tiedown provisions.

2. The designer shall design cargo tiedown provisions such that the movable provision parts do not freeze or rust in place due to severe weather.

d. All provisions.

1. In general, slinging, tiedown, and cargo tiedown provisions shall be designed such that they are not removable as defined by MIL-STD-209.

2. When determining where to locate lifting and tiedown provisions on a vehicle/item, the designer should consider how the equipment/item will be lifted and tied down for each mode of transport.

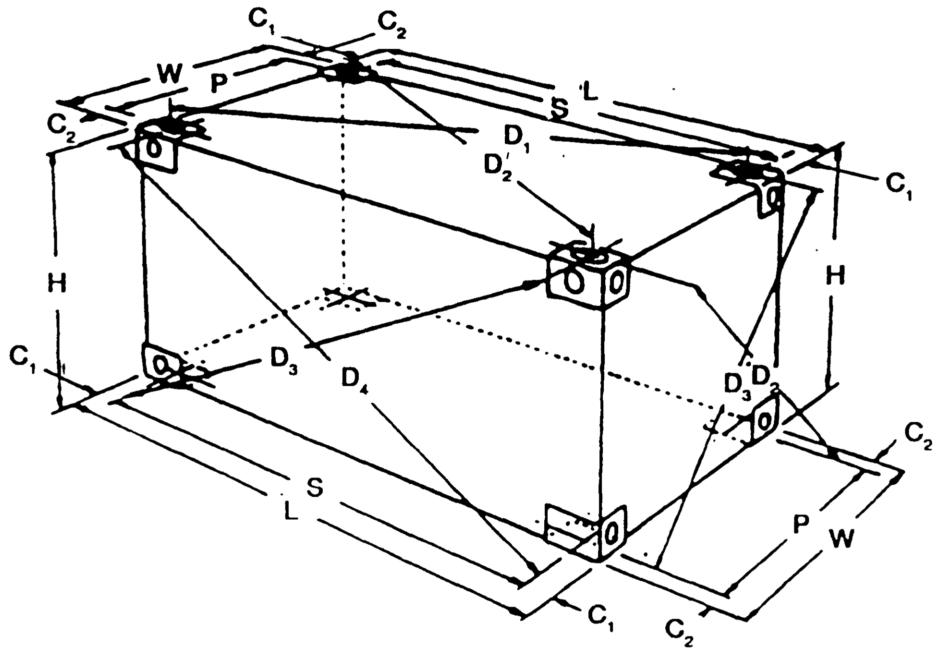
5.8 Intermodal cargo containers.

5.8.1 Classification and dimensions of cargo containers. To take full advantage of the intermodal benefits of containerization, materiel should be transportable, when practical, in International Organization for Standardization (ISO) Series 1 or American National Standards Institute (ANSI) containers. Capacities and dimensional characteristics of ANSI/ISO containers are shown in table XXII and figure 24. Containers are designed to withstand a concentrated floor load of 25,000 pounds over any 10 linear feet for the highway, rail, and marine modes. For the air mode, the floor is designed to withstand a concentrated load of 14,900 pounds over any 10 linear feet. Container standards require the container floor to withstand a uniformly distributed load of not less than the maximum gross weight of the container. For series 1AA, 1A, and

TABLE XXII. Dry cargo ISO containers.

Container ISO Designation	Nominal Dimensions W by H by L (ft)	Actual Exterior Dimensions W by H by L (ft)	Approx 1/ Interior Dimensions W by H by L (in.)	Door 1/ Opening W by H (in.)	Gross 1/ Weight Ratings (lb)
1C	8 by 8 by 20	8 by 8.00 by 19.88	90.5 by 86.5 by 231	90 by 84	52,900
1CC	8 by 8.5 by 20	8 by 8.54 by 19.88	90.5 by 92.5 by 231	90 by 89	52,900
Not an ISO container	8 by 8.5 by 35	8 by 8.54 by 35.00	92.5 by 94.38 by 415	90 by 90.88	61,600
1A	8 by 8 by 40	8 by 8.00 by 40.00	90.5 by 86.5 by 472.38	90 by 84	67,200
1AA	8 by 8.5 by 40	8 by 8.54 by 40.00	90.5 by 92.5 by 472.38	90 by 89	67,200
1AAA	8 by 9.5 by 40	8 by 9.51 by 40.00	90.5 by 104.67 by 472.50	90 by 102	67,200
Has not yet been assigned an ISO designation as of 16 Jan 92	8 by 9.5 by 45 2/	8 by 9.51 by 45.00	90.5 by 104.67 by 532.50	90 by 102	67,200
Has not yet been assigned an ISO designation as of 16 Jan 92	8.5 by 9.5 by 48 2/	8.53 by 9.51 by 48.00	98.36 by 104.67 by 568.5	96 by 102	67,200

1/ Approximate interior dimensions, door opening, and gross weight rating criteria for MILVANs are provided in paragraph 5.8.4.
2/ Containers over 40-ft long and/or 8-ft wide have ISO corner provisions positioned the same as a standard 40-ft-long, 8-ft-wide container. At the 40-ft intermediate handling frames, the upper handling aperture fittings protrude into the container cargo space. The protrusions measure 6-inch square by 2-in. deep.



S = LENGTH BETWEEN CENTERS OF APERTURES IN CORNER FITTINGS
P = WIDTH BETWEEN CENTERS OF APERTURES IN CORNER FITTINGS
C_1 = CORNER FITTING MEASUREMENT 4 $^{+0}_{-1/16}$ INCHES (101.5 $^{+0}_{-1.5}$ MM)
C_2 = CORNER FITTING MEASUREMENT 3 1/2 $^{+0}_{-1/16}$ INCHES (89 $^{+0}_{-1.5}$ MM)
L = EXTERNAL LENGTH OF CONTAINER
D = DISTANCE BETWEEN CENTERS OF APERTURES OF DIAGONALLY OPPOSITE CORNER FITTINGS RESULTING IN 6 MEASUREMENTS: D_1, D_2, D_3, D_4, D_5, AND D_6
K_1 = DIFFERENCE BETWEEN D_1 AND D_2 OR BETWEEN D_3 AND D_4; i.e., $K_1 = D_1 - D_2$ OR $K_1 = D_2 - D_1$ OR $K_1 = D_3 - D_4$ OR $K_1 = D_4 - D_3$
K_2 = DIFFERENCE BETWEEN D_5 AND D_6; i.e., $K_2 = D_5 - D_6$ or $D_6 - D_5$
H = OVERALL HEIGHT

NOMINAL LENGTH FEET	LENGTH OVERALL (L)		S		P		K_1 MAX		K_2 MAX	
	MM	FT-IN.	MM	FT-IN.	MM	FT-IN.	MM	IN.	MM	IN.
40	12190 $^{+2}_{-8}$	40' 0 $^{+0''}_{-3/8}$	11985	39' 3-7/8''	2259	7' 4-31/32''	19	3/4	10	3/8
30	9125 $^{+0}_{-10}$	29' 11-1/4 $^{+0''}_{-3/8}$	8918	29' 3-1/8''	2259	7' 4-31/32''	16	5/8	10	3/8
20	6055 $^{+3}_{-3}$	19' 10-1/2 $^{+0''}_{-1/4}$	5853	19' 2-7/16''	2259	7' 4-31/32''	13	1/2	10	3/8
10	2990 $^{+1}_{-4}$	9' 9-3/4 $^{+0''}_{-3/16}$	2787	9' 1-23/32''	2259	7' 4-31/32''	10	3/8	10	3/8

WIDTH OVERALL (W): 8 FT. 0 $^{+0}_{-3/16}$ IN., 2435 $^{+3}_{-2}$ MM
HEIGHT OVERALL (H): 8 FT. 0 $^{+0}_{-3/16}$ IN., 2435 $^{+3}_{-2}$ MM OR 8 FT. 6-1/2 $^{+0}_{-3/4}$ IN., 2600 $^{+3}_{-16}$ MM

NOTE: DIMENSIONS S AND P ARE REFERENCE DIMENSIONS ONLY. THE TOLERANCES TO BE APPLIED TO S AND P ARE GOVERNED BY THE TOLERANCES SHOWN FOR THE OVERALL LENGTH (L) AND OVERALL WIDTH (W)

FIGURE 24. Container dimensions.

1C containers, the floor must withstand a wheel load of not less than 6,000 pounds per wheel, applied to a contact area of not greater than 22 square inches, assuming a wheel width of not less than 7 inches and a distance between wheel centers of 30 inches.

5.8.2 Designing for containerization. When designing items of equipment for transport via ANSI/ISO containers, the designer should allow for adequate clearance for the equipment to fit inside the container and be tied down. The design criteria in table XXIII allows for clearances to prevent SEM from contacting the door and/or walls of the container during loading. In addition, the item of equipment shall not exceed the container floor load limitations described in paragraph 5.8.1. Additional weight limitations may be imposed on item design, depending on the mode of transport involved. Container gross operating weights shall not exceed the weight limitations in table XXIV when a fixed-wing aircraft transport requirement exists.

5.8.3 Rocket and missile containers. Containers shall meet the criteria of MIL-STD-648, and shall protect rockets or missiles in all environments encountered during transportation, handling, and storage.

5.8.4 Designing for item transport inside a military-owned demountable container (MILVAN). A MILVAN is a US Army 8- by 8- by 20-foot or 8- by 8.5- by 20-foot cargo container constructed to ISO standards (MIL-C-52661C(ME)). There are four types of MILVAN containers. They are as follows:

Type I - 8 foot 0 inch high ISO-1C without mechanical restraint system.

Type II - 8 foot 0 inch high ISO-1C with mechanical restraint system.

Type III - 8 foot 6 inches high ISO-1CC without mechanical restraint system.

Type IV - 8 foot 6 inches high ISO-1CC with mechanical restraint system.

With the installation of the internal, mechanical load-bracing system (types II and IV), MILVAN containers are used to transport ammunition; however, they are also used for other cargo. The maximum gross weight for these containers is 44,800 pounds. Empty MILVAN weight and dimensional characteristics are in table XXV. The MILVAN door is 84 inches high and 90 inches wide for types I and II MILVANs and 89 inches high and 90 inches wide for types III and IV MILVANs. To allow for clearances,

TABLE XXIII. Design limits for equipment requiring transport in containers.

External Container Dimensions (ft)	Maximum Item Dimensions 1/			Gross 1/ Weight (lb)
	Width (in.)	Height (in.)	Length (in.)	
8 by 8 by 20	85	80	219	52,900
8 by 8.5 by 20	85	85	219	52,900
8 by 8.5 by 35	85	85	403	61,600
8 by 8 by 40	85	80	460	67,200
8 by 8.5 by 40	85	85	460	67,200
8 by 9.5 by 40	85	100	460	67,200
8 by 9.5 by 45 2/	85	100	520	67,200
8.5 by 9.5 by 48 2/	91	100	556	67,200

1/ Maximum item dimensions and gross weight criteria for items requiring transport in MILVANs are given in table XXVI.
2/ The equipment designer must also consider the constraints that the upper handling aperture fittings produce at the 40-ft intermediate handling frames. The constraints are given in the footnote to table XXII.

TABLE XXIV. Maximum gross weight of container (fixed-wing).

Freight Container Designation	Maximum Gross Weight (lb)
1A	45,000
1C	25,000

TABLE XXV. Empty MILVAN weight and dimensional characteristics.

Container Type	Actual Internal Width (in.)	Actual Internal Height (in.)	Actual Internal Length (in.)	Tare * Weight (lb)
I	91.75	86.5	231	5,000
II	91.25	86.5	231	5,940
III	91.75	92.5	231	5,200
IV	91.25	92.5	231	6,140

*When forklift pockets are furnished, the tare weight will increase by 150 pounds.

TABLE XXVI. Design limits for equipment requiring transport in MILVANs.

Container Type	Maximum Item Dimensions			Maximum Item* Weight (lb)
	Width (in.)	Height (in.)	Length (in.)	
I	85	82	219	39,800
II	85	82	219	38,860
III	85	87	219	39,600
IV	85	87	219	38,660

*When forklift pockets are furnished, the maximum item weight will decrease by 150 pounds.

item design should not exceed the criteria in table XXVI. When transport by MILVANs is a requirement, item design shall not exceed table XXVI limitations and shall not exceed the MILVAN gross weight, minus the tare weight. When container transport by fixed-wing aircraft is a requirement, the container gross operating weight shall not exceed that shown in table XXIV.

5.8.5 Flatracks. This section addresses the FSS (35-foot) flatracks and the conventional containership (40-foot) heavy-duty units. There are other flatracks available in varying sizes, configurations, and methods of employment. Flatracks are portable, open-top, open-side, 'tween-deck (see para 3.40) containers that fit into the standard 35- or 40-foot cells of container-carrying ships (figs 25-26). The heavy-duty flatracks have approximately twice the cargo capacity of commercial flatracks. The FSS and heavy-duty flatracks provide the capability to stow aircraft, vehicles, oversize, and breakbulk cargo that cannot be placed into containers. Heavy-duty and FSS flatracks are provided with wood flooring and recessed 70,000-pound-capacity D-rings for securing cargo.

5.8.5.1 FSS flatracks. The FSS flatracks have a maximum gross weight of 55,000 pounds. The FSS (35-foot) flatracks were produced in three types to maximize the cargo capacity of the ships. Flatrack weight and dimensional limitations are provided in table XXVII. When designing an item/system for transport in FSS flatracks, the item/system weight and dimensions shall not exceed the limitations given in table XXVII.

5.8.5.2 Conventional containership heavy-duty flatracks. The general characteristics of the 40-foot heavy-duty flatrack are as shown below. When designing an item/system for transport in the 40-foot heavy-duty flatracks, the item/system weight and dimensions shall not exceed the maximum cargo limitations cited in this paragraph.

External Dimensions:	Length	40 feet 0 inch
	Width	8 feet 0 inch
	Height	13 feet 0 inch *

*Flatracks have adjustable endposts allowing a height range from 8 feet 6 inches to 13 feet 0 inch.

Internal Dimensions: (cargo maximums)	Length	38 feet 6 inches
	Width	8 feet 0 inch
	Height	10 feet 6 inches

Flatrack weight (nominal):	18,000 pounds
Maximum cargo weight:	144,000 pounds

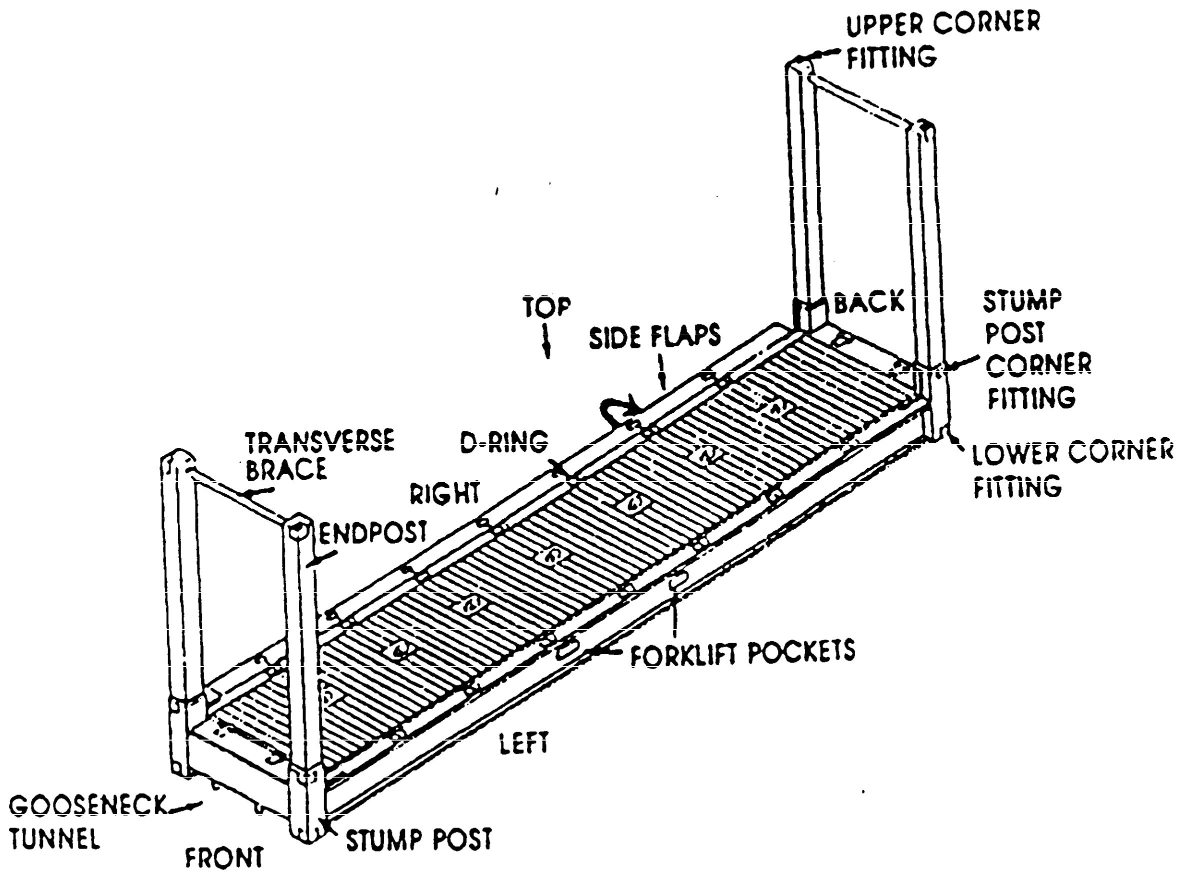


FIGURE 25. View of flatrack.

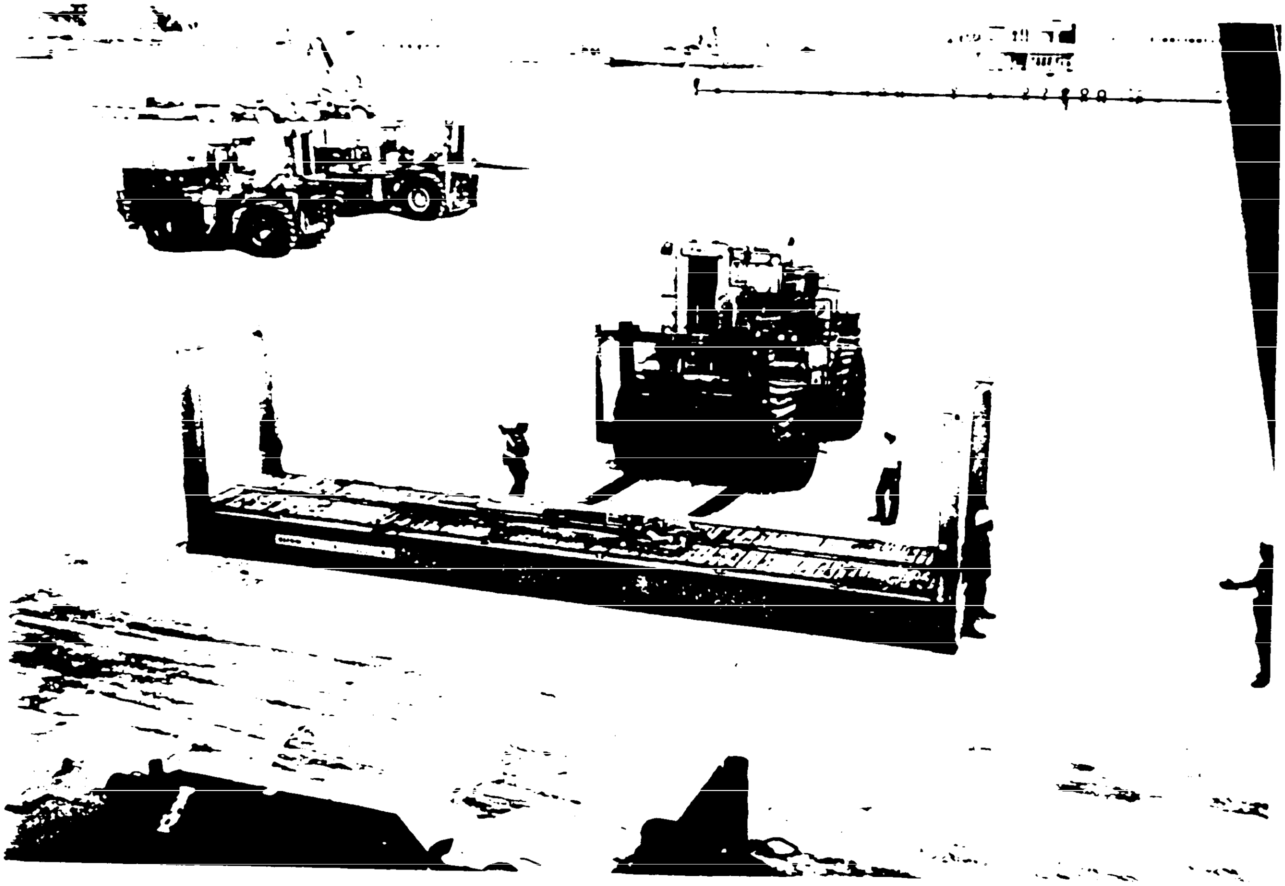


FIGURE 26. Flatrack in operation.

TABLE XXVII. FSS flatrack dimensions, weights and capacities.

	Type I	Type II	Type III
Quantity Aboard	53	22	3
Dimensions (External) Length Width Height	 35 ft 0 in. 8 ft 0 in. 15 ft 3 in.	 35 ft 0 in. 8 ft 0 in. 12 ft 0 in.	 35 ft 0 in. 8 ft 0 in. 10 ft 3 in.
Dimensions (Internal), or Maximum Cargo Size Length Width Height (Clear)	 33 ft 9 in. 8 ft 0 in. 13 ft 6 in.	 33 ft 9 in. 8 ft 0 in. 10 ft 3 in.	 33 ft 9 in. 8 ft 0 in. 8 ft 6 in.
Weight of Flatrack	19,300 lb	17,841 lb	17,511 lb
Area per Flatrack	270 sq ft	270 sq ft	270 sq ft
Volume per Flatrack	3,645 cu ft	2,768 cu ft	2,295 cu ft
Weight Capacities Lifting 1/ Maximum 2/	 35,700 lb 134,000 lb	 37,159 lb 134,000 lb	 37,489 lb 134,000 lb

1/ The maximum weight that can be placed on a flatrack that is to be lifted with a 35 ft container lifting spreader.
2/ The most weight that can be placed on a flatrack that has been positioned in a cargo hold.

Maximum point load:	190 psi
Maximum uniform load:	525 psf

NOTE: The maximum gross lifting weight of a heavy-duty flatrack, using a 40-foot spreader is 67,200 pounds.

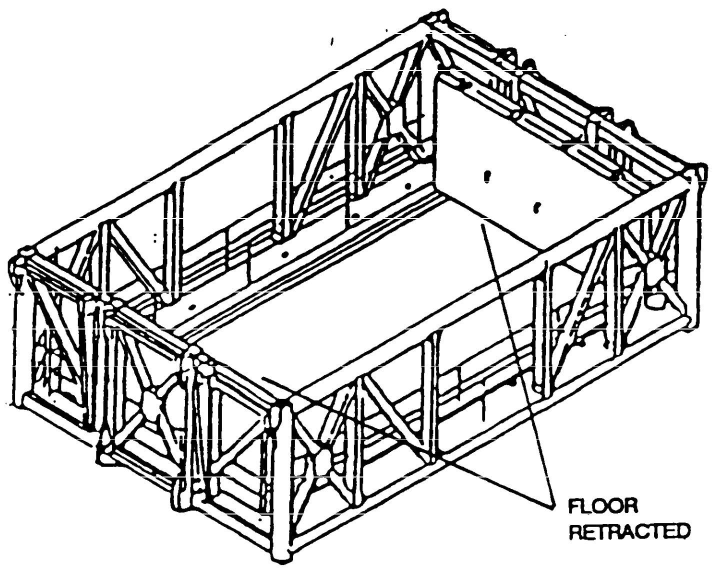
5.8.6 Containership cargo stowage adapter and seasheds. This section addresses the FSS seasheds (fig 27) and commercial containership seasheds with containership cargo stowage adapter (CCSA). Seasheds are open-top, 'tween-deck (see para 3.40) conversions that fit into container cells of container-carrying vessels. There are two basic types of seasheds - one with a hinged, work-through floor and the other with a fixed wooden floor. Both types will support up to 220,000 pounds (98.2 LTON) of cargo. The seashed decks are equipped with 70,000-pound cloverleaf-type, flush-mounted cargo securing devices positioned in a 6- by 6-foot rectangular grid. Except for the hinged floor, the basic design and load characteristics of both types of seasheds are essentially the same. When designing for transport in seasheds, the item/system weight and dimensions shall not exceed the criteria in this and the following paragraphs.

5.8.6.1 Commercial containership seasheds and CCSA. The seashed system enables commercial containerships to carry breakbulk cargo, oversized cargo, and large military equipment. The system uses three adjacent container cells. A CCSA is used to distribute seashed loads to existing hard points in containership tank tops and also provides a 22-foot 9-inch by 38-foot 6-inch by 11-foot 3-inch area for cargo stowage. A commercial containership seashed system consists of up to three seasheds stacked above a CCSA. A CCSA consists of a bolted frame assembly and three 40- by 8-foot pontoons. The pontoons distribute the seashed and cargo loads to existing hard points in a ship's tank top and the adapter frame is adjustable to accommodate variations in cell guide spacing. The CCSA will support the weight of three fully loaded seasheds, up to 400 LTON. The commercial containership seasheds are the type with a fold-up "work-through" deck. The general characteristics of the commercial containership seashed system are:

CCSA

External height:	14 feet
Maximum cargo height:	11 feet 3 inches
External width (nominal):	25 feet
Cargo area width:	22 feet 9 inches
External length:	40 feet
Cargo area length:	38 feet 6 inches
Maximum uniform deck load:	525 psi
Maximum cargo weight per pontoon:	134,400 pounds

VIEW OF SEASHED



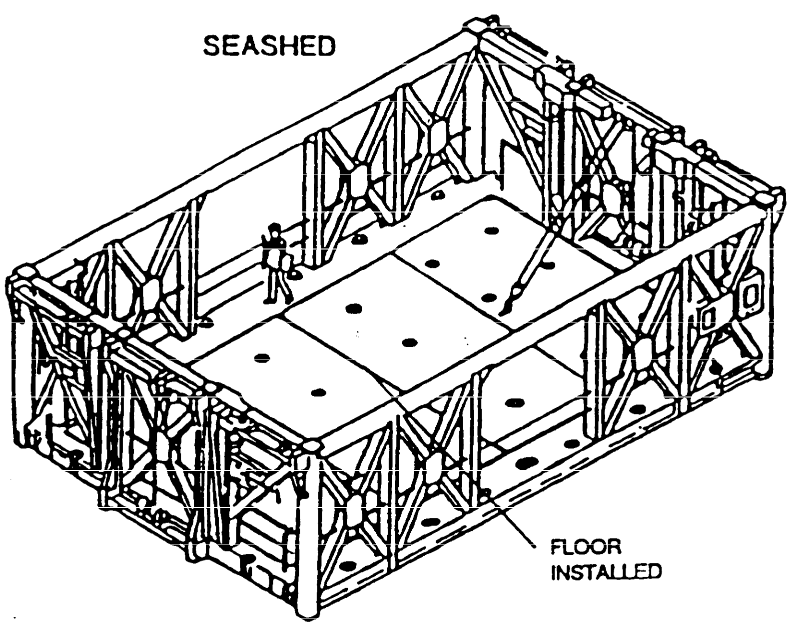


FIGURE 27. Seashed.

Commercial Containership Seashed

External height:	12 feet 6 inches
Cargo height:	10 feet 10 inches
External width	25 feet
Cargo area width:	22 feet 9 inches
External length:	40 feet
Cargo area length:	36 feet
Maximum cargo weight:	220,000 pounds (approx. 98.2 LTON)
Work through deck clear opening:	18 feet by 30 feet
Uniform deck loading:	569 psf
Maximum point loading:	Two 6,000 pound loads spread over a 22 in^2 footprint

5.8.6.2 FSS seasheds. With the exception of physical size, the FSS and commercial containership seasheds are the same. CCSAs are not required for the FSS because the tank tops were strengthened for seashed installation during conversion. The FSS seasheds are designed to fit in 35-foot-long container cells and are provided in the two types described in 5.8.6. FSS seasheds are normally installed two high with the hinged deck-type on the top.

FSS seashed cargo stowage limitations are:

Length:	31 feet
Width:	21 feet
Height:	11 feet 2 inches
Work through deck clear opening:	18 feet by 30 feet
Weight:	220,000 pounds (approx. 98.2 LTON)

NOTE: **The uniform and point loading criteria for the FSS seasheds are the same as the commercial containership seasheds.**

It is possible to load extremely high cargo into the lower seashed by not lowering the hinged floor of the upper seashed. However, this is not desired, since it sacrifices the stowage area of the upper seashed to carry outsize cargo. Because the upper seashed has no top, its design-height limit may be exceeded. The vertical clearance between the floor of the upper seashed and the bottom of the hatch cover above is 14 feet on FSS ships.

5.9 Shelters.

5.9.1 General. A shelter is a transportable facility designed and constructed to house equipment, such as electronics and communication systems, shop sets, medical equipment, and so forth. Shelters provide protection from the weather and from various threats (depending on installed kits) such as EMI, EMP, and chemical/biological attack during transport and operations. Standard military shelters include the S-250 (MIL-S-55541), S-280 (MIL-S-55286), ISO nonexpandable (MIL-S-44196), ISO one-side expandable (MIL-S-44197), and ISO two-side expandable (MIL-S-44195). Weight and dimensional characteristics are given in figures 28 through 30. Guidance for shipping shelters is in MIL-S-55507. When items are attached to a shelter, the modified shelter shall meet paragraph 5.9.2.

5.9.2 Testing for nonstandard and modified shelters. All items/systems that use nonstandard or modified shelters may be required to pass shelter testing depending upon the transport modes involved for item/system movement. All requests for nonstandard and modified shelter analysis should be submitted to US Army Natick Research, Development and Engineering Center (NRDEC), ATTN: STRNC-UST, Natick, MA 01760-5017. An information copy should be sent to the Military Traffic Management Command Transportation Engineering Agency, ATTN: MTTE-TRD, PO Box 6276, Newport News, VA 23606-0276. The analysis request should include: the top drawings of the shelter, with racks, cutouts, and structural members detailed; weight and center of gravity data of the fielded system; test reports or test plans covering the shelter tests; and requirements on types of transport modes the system will use when fielded. The shelter tests include:

a. Rail impact testing in accordance with MIL-STD-810 for shelters with a rail transport requirement.

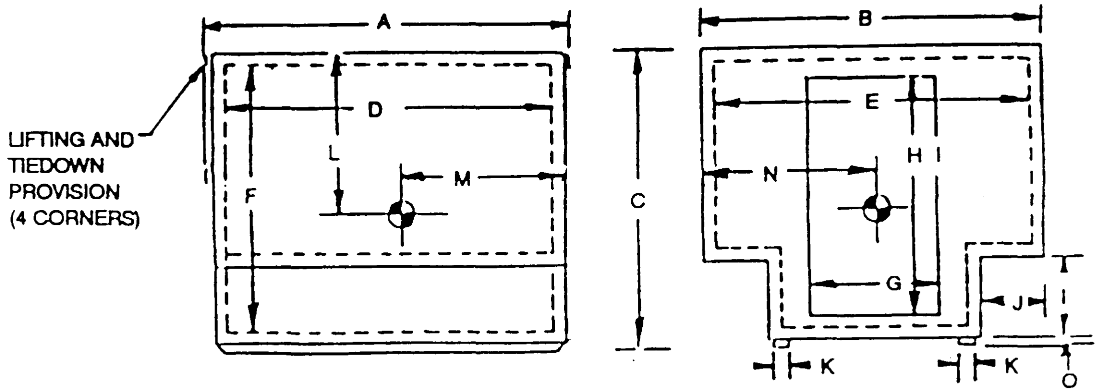
b. A simulated towing test in accordance with MIL-STD-907 to ensure that the shelter's skid mounts, if so equipped, can withstand the shear loads encountered when the shelter is towed or skidded.

c. Flat and rotational drops in accordance with MIL-STD-907.

d. A 3.2 g simulated accelerated lift test for nonstandard and modified shelters that have a lifting requirement.

e. A roadability test in accordance with MIL-M-8090, table III, type V mobility, or the applicable transportability requirements of the system.

5.10 Overloads.



ROADSIDE VIEW

AFT VIEW

DIMENSIONS IN INCHES

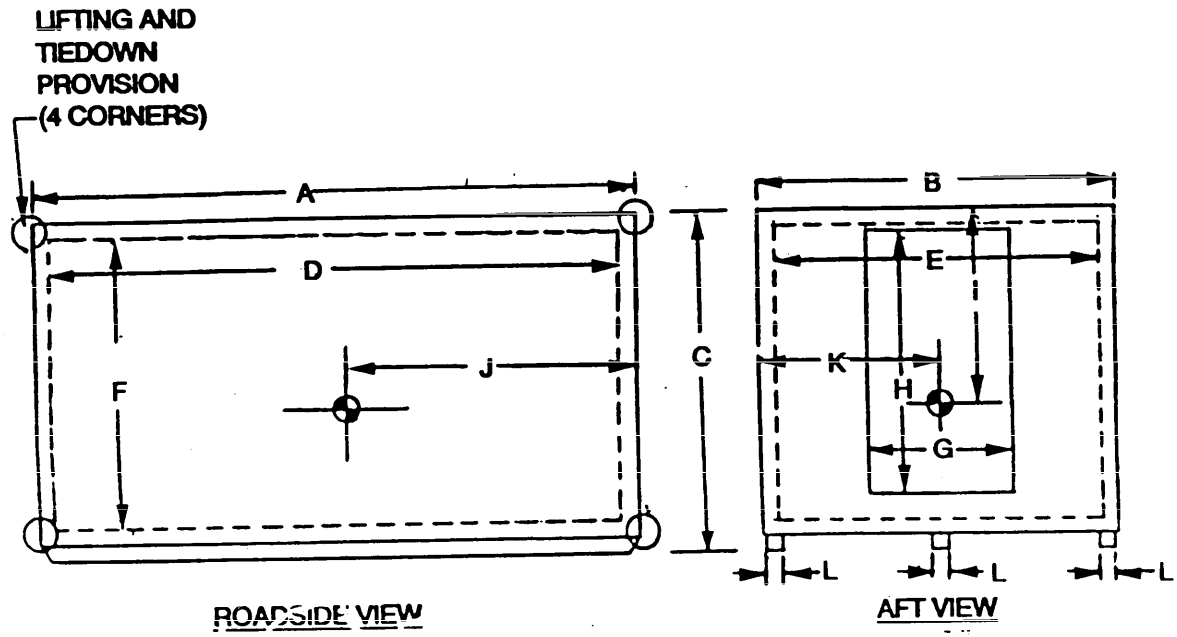
S-250 SHELTER (MIL-S-55541)

EMPTY WEIGHT: 770 LB
GROSS WEIGHT: 2,670 LB
LIFTING AND TIEDOWN PROVISION CAPACITY: 5,000 LB

SHELTER DIMENSIONAL AND WEIGHT DATA

NOMENCLATURE	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
S-250/G	86 5/8	79 1/16	70 1/8	78 1/16	75 3/32	64 3/32	30	55	19 9/32	15 7/32	3 1/2	37	36	39	2 3/32

FIGURE 28. S-250 shelter criteria.



S-280 SHELTER (MIL-S-55286)

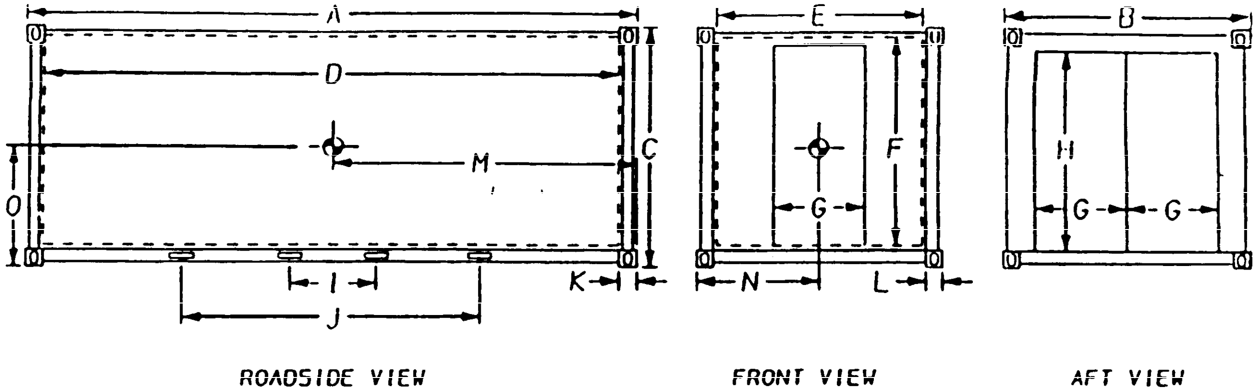
SHELTER DIMENSIONAL AND WEIGHT DATA

NOMEN-CLATURE	A	B	C	D	E	F	G	H	I	J	K	L
S-280/G,A/G S-280B/G	147	87	83 3/8	138	81 1/2	74 1/2	35	64 1/2	47	71	44	4
S-280C/G	147	87	86 3/8	138	81 1/2	77 1/8	35	64 1/2	55	68	44	4

	S-280/G, A/G, B/G	S-280 C/G
EMPTY WEIGHT	1,380 LB	1,400 LB
GROSS WEIGHT	6,380 LB	6,400 LB
LIFTING AND TIEDOWN PROV. CAPACITY	11,000 LB	14,400 LB

DIMENSIONS IN INCHES

FIGURE 29. S-280 shelter criteria.



ISO SHELTER

SHIPPING MODE DIMENSIONS

DIMENSIONS ARE IN INCHES

NOMENCLATURE	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
NON EXPANDABLE	238.5	96	96	229.3	90.8	85.3	36	80	34	82.5	7	6.3	120	49	42
1 SIDE EXP	238.5	96	96	229.3	84	85.3	35	80	34	82.5	7	6.3	121	59	46
2 SIDE EXP	238.5	96	96	229.3	77.8	85.3	36	68	34	82.5	7	6.3	122	49	48

SHIPPING MODE

NOT TO SCALE

WEIGHTS ARE IN POUNDS

	NON EXP	1 SIDE EXP	2 SIDE EXP
EMPTY WT.	3,860	5,520	6,950
PAYLOAD	11,140	9,480	8,050
TOTAL	15,000	15,000	15,000

FIGURE 30. ISO shelter criteria.

5.10.1 General. Items of equipment developed for movement by any mode of transport should meet the payload limitations imposed by the transport equipment. Staying within the payload capabilities of the transport equipment promotes safe transport, reduces potential damage to transport equipment, and reduces transporter maintenance requirements. When determining the payload and/or gross weight of the transport equipment, the designer must consider all associated items of equipment that are transported with the item or system. Consistent with the definition of gross weight and vehicle payload, associated items of equipment may include such items as camouflage, concertina, tents, extra fuel, water, and tools and spare parts.

5.10.2 Overload determination and prevention. MIL-STD-910, provides procedures for calculating shelter, trailer, and prime mover payloads, and for determination of overloads.

a. Trailer overloads.

As defined by MIL-STD-910, the actual equipment weight on the trailer must not exceed the trailer available payload. If the equipment weight exceeds the trailer available payload, the trailer is overloaded. The designer shall resolve trailer overloads by removing some of the operational equipment, substituting lighter weight equipment, or using an alternative trailer.

b. Shelter overloads.

As defined by MIL-STD-910, the system payload must not exceed the shelter payload capacity. If the system payload exceeds the shelter payload capacity, then the shelter is overloaded. The designer shall resolve shelter overloads by removing some of the operational equipment, substituting lighter weight equipment and/or using a shelter with a larger payload capacity.

c. Prime mover payload overloads.

As defined by MIL-STD-910, the system payload must not exceed the prime mover available payload. If the system payload weight is greater than the prime mover available payload, the prime mover is overloaded. The designer shall resolve overloaded prime movers by using an alternate shelter, reducing the crew size, removing some of the operational equipment, and/or using a larger prime mover.

5.10.3 Other prime mover overload considerations. For SEM requiring highway transport, the following prime mover characteristics shall not be exceeded. They are: towed load allowance for a cargo truck or truck tractor pintle, towed load allowance for a truck tractor fifth wheel receptacle, vertical pintle load allowance, fifth wheel receptacle vertical load allowance, and prime mover vehicle weight rating.

5.10.4 Designing for transport. Unless otherwise specified, new items of equipment shall be designed such that their weight does not exceed the payload capabilities of the required transport equipment. When an item of equipment/system is designed for transport by specific transport equipment, the item/system shall meet MIL-STD-910 requirements to prevent overloads.

5.11 Assembly/disassembly.

5.11.1 General. The objective of transportability design is to ensure developed items of equipment are capable of rapid and efficient deployment by all required transport modes. Large and heavy items of equipment may not meet weight and dimensional transport limitations, thereby requiring alternate routing, special procedures, and/or disassembly for transport. This can cause unnecessary delays during item transport, costly delays for receiving units, and use of valuable time to reassemble the item. When practical, an item of equipment should be designed such that transport can be achieved without major disassembly of the item.

5.11.2 Transportability design for assembly/disassembly. Unless otherwise required by the combat developer (CBTDEV), items to be used in the initial support of forces deployed in a contingency operation, including supply by air, shall be operational immediately, except for selected engineer construction equipment, which must be capable of employment within 1 hour.

6. NOTES

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

6.1 Intended use. This standard is intended for use as an element of the overall engineering for transportability program as both design and evaluation criteria for the development of DOD systems and equipment.

6.2 Data requirements. Data Item Description (DID) DI-PACK-80880, Transportability Report, must be listed on the Contract Data Requirement List (DD Form 1423) when this standard is applied on a contract, to obtain the data, except where DOD Federal Acquisition Regulation (FAR) Supplement 27.475-1 exempts the requirement for a DD Form 1423.

6.3 Tailoring guidance for contractual application. The Government project or acquisition manager is responsible for tailoring the contract work statements to ensure the timely development of transportability for the system or equipment and submittal of needed data. The work statements must be geared to the complexity of the system or equipment being procured and the life cycle phase. These work statements may be invoked by citing this standard and the pertinent paragraphs. To ensure proper application of this standard, invitations for bids, requests for proposals, and contractual statements of work should tailor the requirements in sections 4 or 5 of this standard to exclude unnecessary requirements. Personnel with expertise in transportability should be involved in the tailoring process.

6.4 Subject term (key word) listing.

Approval, transportability
Criteria
Engineering, transportability
Lifting
Military standards
Provision, lifting
Provision, slinging
Provision, tiedown
Report, transportability
Slinging
Tiedowns
Transport, air
Transport, highway
Transport, rail
Transport, water
Transportability
Transportability engineering analysis
Transportability problem item

6.5 International standardization agreements. Certain provisions of this standard are the subject of international standardization agreements (STANAG 2021, STANAG 2173, STANAG 2175, STANAG 2832, STANAG 3400, STANAG 3542, STANAG 3548, STANAG 3854, STANAG 4062, QSTAG 328, AIR STD 44/9, AIR STD 44/12, and AIR STD 44/21). When a change notice, revision, or cancellation of this standard is proposed that will modify the international agreements concerned, the preparing activity for this standard will take appropriate action through international standardization channels, including departmental standardization offices, to change the STANAG(s) or make other appropriate accommodations.

Custodians:
Army-MT
Navy-SA
Air Force-11

Preparing activity
Army-MT

Project No. PACK 0933

Review Activities:
Army - AR, AT, AV, CR, GL, ME, MI, SM, TE
Navy - AS, EC, MC, OS, SA, SH, YD
Air Force - 11, 13, 18, 43, 69, 99
Other - DH

APPENDIX A

SAMPLE PROBLEM FOR DETERMINING BRIDGE FORMULA REQUIREMENTS

10. GENERAL

10.1 Scope. This appendix establishes a sample application of the bridge formula.

20. APPLICABLE DOCUMENTS. This section is not applicable to this appendix.

30. NOTATION

30.1 Symbols. As stated in paragraph 5.1.2.2, the following letter symbols apply.

W - overall gross weight on any group of two or more consecutive axles to the nearest 500 pounds.

L - distance in feet between the extreme of any group of two or more consecutive axles.

N - number of axles in the group under consideration.

40. GENERAL REQUIREMENTS

None

50. DETAILED REQUIREMENTS

50.1 Example. See figure 31. For a vehicle with weights and axle dimensions as shown in this figure, bridge formula requirements are determined as follows.

50.1.1 Determine axle combinations to be analyzed. The contractor and/or MATDEV must determine bridge formula requirements for all axle combinations. For the example in figure 31, the possible axle combinations are:

1 through 2
1 through 3
1 through 4
1 through 5
2 through 3
2 through 4
2 through 5
3 through 4
3 through 5
4 through 5

Bridge formula requirements must be met for all of these combinations.

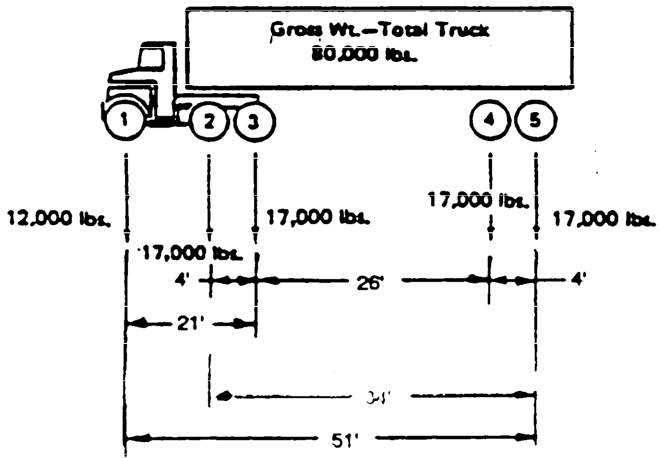


FIGURE 31. Sample case for determining bridge formula requirements.

50.1.2 Using bridge formula, determine maximum allowable loading for each axle combination.

a. For the single axle (axle 1), tandem axles (axles 2-3 and 4-5), and vehicle gross weight (axles 1-5); the actual axle loads must not exceed 20,000 pounds, 34,000 pounds, and 80,000 pounds respectively. Please note that the bridge gross weight formula defines a tandem axle as two or more consecutive axles whose centers may be included between parallel vertical planes spaced more than 40 inches and not more than 96 inches apart, extending across the full width of the vehicle. In figure 31, axle groupings 2 through 3 and 4 through 5 are each spaced 4 feet apart. Therefore, these two axle groupings are both tandem axles. As shown in the figure, the actual axle loads for the single axle, tandem axles, and gross weight are 12,000 pounds, 34,000 pounds (for both 2-3 and 4-5), and 80,000 pounds respectively. Hence, the bridge formula is not exceeded for these combinations.

b. For the other axle combinations, the following calculation shows an example of a bridge formula calculation. This calculation is for the axle combination 1 through 3.

$$W = 500\ \left(\frac{LN}{N-1} + 12N + 36\right)$$

$$W = 500\ \left[\frac{(21 \times 3)}{(3 - 1)} + (12 \times 3) + 36\right]$$

W = 51,500 pounds (rounded to nearest 500 pounds)

This is the maximum allowable load for axles 1 through 3 under the bridge formula.

All other axle combinations would be computed similarly to this.

50.1.3 Compare maximum allowable loading to actual loading.

For axle combinations 1 through 3

W actual = 12,000 + 17,000 + 17,000 = 46,000 pounds

For this axle combination, W actual (46,000 pounds) < W maximum (51,500 pounds).

Hence, the bridge formula is met for axle combination 1 through 3.

c. Using the bridge formula, the maximum allowable loading for each of the possible axle combinations for this example (see 50.1.1) are:

1 through 2 = 47,000 pounds	2 through 4 = 58,500 pounds
1 through 3 = 51,500 pounds	2 through 5 = 64,500 pounds
1 through 4 = 73,500 pounds	3 through 4 = 56,000 pounds
1 through 5 = 80,000 pounds (maximum allowable for gross weight)	3 through 5 = 58,500 pounds
	4 through 5 = 34,000 pounds (maximum allowable for tandem axle)

d. There is one exception to the bridge formula. Two consecutive sets of tandem axles may carry a gross load of 34,000 pounds each providing the overall distance between the first and last axles of such consecutive sets of tandem axles is 36 feet or more. In figure 31, the distance between the first axle of grouping 2 through 3 and the last axle of 4 through 5 is 34 feet. Hence, this example does not meet the exception.

e. Please note that for this example:

For axle combination 2 through 5

W actual (68,000 pounds > W maximum (64,500 pounds)

Therefore, the example in figure 31 does not meet the bridge formula because the loading for axle combination 2 through 5 exceeds the bridge formula allowable.

APPENDIX B

CONVERSION TABLES

10. GENERAL

10.1 Scope. This appendix provides information for converting US Customary System measurements to metric.

20. APPLICABLE DOCUMENTS. This section is not applicable to this appendix.

30. COMMON METRIC ABBREVIATIONS

m = meter
dm = decimeter
cm = centimeter
mm = millimeter
Hz = hertz
mhp = metric horsepower

kg = kilogram
km = kilometer
t = metric ton
Pa = pascal
rad = radian
km/hr = kilometers per hour

40. COMMON METRIC CONVERSIONS

40.1 Length

1 mi = 1609.35 m
1 yd = 0.9144 m
1 ft = 0.3048 m
1 in = 0.0254 m
1 m = 10 dm = 100 cm =1000 mm

1 km = 0.6214 mi
1 m = 1.0936 yd
1 m = 3.2808 ft
1 m = 39.3700 in.

40.2 Area

1 sq yd = 0.8361 sq m
1 sq ft = 0.0929 sq m
1 sq in = 0.00065 sq m

1 sq m = 1.196 sq yd
1 sq m = 10.764 sq ft
1 sq m = 1,550 sq in.

40.3 Volume

1 cu yd = 0.76456 cu m
1 cu ft = 0.02831 cu m
1 cu in. = 0.000016 cu m
1 litre = 1.00×10^{-3} cu m

1 cu m = 1.31 cu yd
1 cu m = 35.31 cu ft
1 cu m = 61023 cu in.
1 gal = 0.0038 cu m

40.4 Mass

1 STON = 907.185 kg
1 LTON = 1016 kg
1 lb = 0.45359 kg

1 kg = 2.2046 lb
1 t = 1000 kg
1 t = 2204.62 lb

40.5 Acceleration

1 foot/second^2 = 0.3048 m/s^2
free fall, standard = 9.807 m/s^2

40.6 Velocity (includes speed)

1 foot/second = 0.3048 m/s
1 knot (international) = 0.5144 m/s
1 mile/hour = 0.4470 m/s
1 rev/min = 0.1047 rad/s
1 kilometer/hour = 0.278 m/s

40.7 Mass/Area

1 pound-mass/foot^2 = 4.882 kg/m^2
1 pound-mass/inch^2 = 703.1 kg/m^2

40.8 Pressure/Stress

1 pound-force/inch^2 = 6895 Pa
1 pound-force/foot^2 = 47.88 Pa

40.9 Angular Measure

1 degree = 0.01745 rad

40.10 Force

1 pound-force = 4.448 newton

40.11 Power

1 horsepower = 1.014 metric horsepower

40.12 Quick conversions. The following simplified conversion factors are accurate within 2 percent for quick computations:

Inches to centimeters - Multiply in. by 10 and divide by 4.
Yards to meters - Multiply yd by 9 and divide by 10.
Miles to kilometers - Multiply mi by 8 and divide by 5.
Pounds to kilograms - Multiply lb by 5 and divide by 11.

40.13 Measurement Ton. A measurement ton equals 40 cubic feet of volume.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-STD-1366C	2. DOCUMENT DATE *(YYMMDD)* 27 February 1992

3. DOCUMENT TITLE
Military Standard Transportability Criteria

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*	b. ORGANIZATION	
c. ADDRESS *(Include Zip Code)*	d. TELEPHONE *(Include Area Code)* (1) Commercial (2) AUTOVON *(If applicable)*	7. DATE SUBMITTED *(YYMMDD)*

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE *(Include Area Code)*	
A. Grey Marsh, Project Engineer	(1) Commercial (804) 599-1106	(2) AUTOVON 927-4646
c. ADDRESS *(Include Zip Code)* Director, MTMC Transportation Engineering Agency, ATTN: MTTE-TR P.O. Box 6276, Newport News, VA 23606-0276	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340	

DD Form 1426, OCT 89 *Previous editions are obsolete.* 198-290

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