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MILITARY STANDARD

SLINGING AND TIEDOWN PROVISIONS

FOR

LIFTING AND TYING DOWN

MILITARY EQUIPMENT

AMSC N/A

FSC 2540

MIL-STD-209G

DEPARTMENT OF DEFENSE

WASHINGTON, DC 20301

Slinging and Tiedown Provisions for Lifting and Tying Down Military Equipment

1. This Military Standard is approved for use by all Departments and Agencies of the Department of Defense.

2. Recommended corrections, additions, or deletions should be addressed to the Commander, Military Traffic Management Command Transportation Engineering Agency (MTMCTEA), ATTN: MTT-TR, PO Box 6276, Newport News, VA 23606-0276, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FOREWORD

During World War II, military equipment often reached the docks without proper facilities for lifting aboard ship. In such cases, the manner of slinging was left to the ingenuity of the loading personnel. This frequently resulted in a slow, hazardous operation and the need for a wide variety of slings to cope with diverse vehicles being loaded under any one boom. With additional adverse circumstances generated by emergencies, blackouts, inexperienced crews, amphibious operations, and so forth, the importance of adequate slinging eyes becomes obvious.

This standard was first developed to ensure that all tanks and tracked vehicles would have adequate slinging eyes. Since the transportation of military equipment is not confined to shipboard loading, considerations for securing cargo while in transit by other means of transportation have necessitated additional requirements.

In securing equipment, it is not uncommon to engage either the slinging eyes or tiedown eyes or both. Sometimes provisions are made exclusively for tiedown. To reduce the total number of eyes on equipment, multipurpose lifting and tiedown eyes should be used to the maximum extent.

For efficient loading, weight ranges have been designated with appropriate eye dimensions for each weight group. This is an important standardization factor since all equipment in a weight group should be handled with a minimum of accessories.

This standard has previously been revised to include lightweight tactical vehicles, nonferrous materials in eyes, eyes for tiedown of cargo or accessories in van-type vehicles or on flatbed platforms, change in sling apex height, air transport requirement for tiedowns, new slinging requirements for helicopter external lifting and transport of equipment, new requirements for air transport of equipment, and changes in provision dimensions to meet ABCA Army Standardization/QATAG Standards, Air Standardization Coordinating Committee (ASCC) Air Standards, and NATO Standards. This revision describes analysis and test requirements for slinging and tiedown provisions and gives examples to determine the minimum required strength of the provisions.

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1. SCOPE

1.1 Coverage. This standard establishes dimensional limits, design considerations, positioning requirements, and strength requirements for slinging and tiedown provisions for lifting or tying down tanks and other tracked vehicles, tactical wheeled vehicles, helicopters, and other military equipment that is shipped assembled or disassembled in unboxed or uncrated condition and for tying cargo or accessories to such equipment.

1.1.1 Excluded equipment. This standard excludes external provisions on cargo containers (that is, ISO containers, CONEXes, and MILVANs). Each cargo container is covered by a separate standard or specification.

1.1.2 Military equipment for airdrop. Even though airdrop design criteria for military equipment are specified in MIL-STD-814, equipment must also be transported by surface modes. Therefore, slinging and tiedown provisions for airdrop-designed equipment shall meet both the requirements of this standard and MIL-STD-814.

1.2 Application. This standard applies to the following:

a. All new developmental, nondevelopmental, and military-adapted commercial items as noted above.

b. Modified equipment when the modifications result in changes to slinging or tiedown requirements.

1.3 Classification.

1.3.1 Slinging and tiedown provisions. Slinging and tiedown provisions are classified as follows:

Class 1. Slinging provisions.
Class 2. Equipment tiedown provisions, including supplementary points of tiedown.
Class 3. Multipurpose provisions.
Class 4. Cargo tiedown provisions provided within cargo compartments.
Class 5. Cargo tiedown provisions provided for cargo platforms of flatbed trailers.

1.3.2 Equipment types. Equipment shall be classified as follows:

Type I. Combat vehicles (for example, armored carriers, self-propelled artillery, tanks, and recovery vehicles).
Type II. Tactical and support vehicles (for example, semitrailers, trailers, trucks, materials handling equipment, construction equipment, modified commercial equipment, support vehicles, and other vehicles).
Type III. Support vehicles (standard commercial equipment such as construction equipment, materials handling equipment, trucks, and other vehicles).

Type IV. Other military equipment, including helicopters, shipped unboxed or uncrated and lifted separately, each as an individual unit.

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

2. REFERENCED DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. Unless otherwise specified, the following specifications and standards of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DODISS) specified in the solicitation form a part of this standard to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-P-514	- Plates, Identification, Instruction and Marking, Blank.
MIL-P-15024/9	- Aircraft Loading Dataplate.

STANDARDS

FEDERAL

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

MILITARY

MIL-STD-810	- Environmental Test Methods and Engineering Guidelines
MIL-STD-814	- Requirements for Tiedown, Suspension, and Extraction Provisions on Military Material for Airdrop.

(Copies of specifications and standards required by contractors for specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this standard to the extent specified herein. Unless otherwise indicated, the issue in effect on the date of the invitation for bids or the request for proposals shall apply.

GOVERNMENTAL

JOINT MILITARY

AR 70-44/OPNAVINST 4600.22/AFR 80-18/MCO 4610.14/DLAR 4500.25 - Research and Development, DOD Engineering for Transportability.

CODE OF FEDERAL REGULATIONS (CFR's)
CFR Title 49 - Transportation
(Application for copies should be addressed to the Superintendent of Documents, US Government Printing Office, Washington, DC 20402.)

ARMY

AVIATION SYSTEMS COMMAND

USAAMRDL Technical Report No. 72-36 - Design Guide for Load Suspension Points, Slings, and Aircraft Hard Points.
(Requests for copies should be addressed to the Director, Aviation Applied Technology Directorate, US Army Aviation Research and Technology Activity (AVSCOM), Fort Eustis, VA 23604-5000.)

2.3 Order of precedence. In the event of a conflict between the text of this standard and the references cited herein, the text with the most severe requirements shall take precedence.

2.4 Source of documents. Copies of military specifications and standards listed in the DODISS are available from the Department of Defense Single Stock Point, Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

3. DEFINITIONS

3.1 Slinging provision (class 1). An integral part of the equipment, commonly called a padeye, lug, eye, or lifting attachment, which may include a shackle or ring. A slinging provision provides a means of attaching a shackle, hook, or sling eye to the equipment for safe lifting.

3.2 Equipment tiedown provision (class 2). An integral part of an item, commonly called a tiedown eye, fixture, attachment, or provision, which may include a ring. A tiedown provision has an opening for attaching a shackle, hook, or tiedown cable to the equipment for tiedown purposes during shipment.

3.3 Multipurpose provision (class 3). A single provision that meets the requirements of this standard for both slinging and equipment tiedown.

3.4 Cargo tiedown provision (classes 4 and 5). A padeye, attachment, or provision, integral to the transporting media, for securing cargo or accessories.

3.5 Design load. The applied force, or maximum probable force, a slinging or tiedown provision, including its connecting structural members, can withstand when subjected to its most severe transport environment. This load must be less than the yield load.

3.6 Maximum frontal area (helicopter transport only). For single point suspension, the maximum area projected on a vertical plane as the item is rotated about a vertical axis through the suspension point. For multipoint suspension, the maximum projected area on a vertical plane in the direction of flight.

3.7 Maximum shipping weight (MSW). The weight of the basic equipment plus the weight of any additional ancillary equipment (for example, generator sets, radar sets, equipment shelters, and so forth), components, accessories, and cargo that are shipped with and contained within or attached to the equipment. The vehicle or the equipment specification shall specify what items are to be included on the basic equipment for determining its MSW. The gross weight rating of a cargo vehicle (excluding personnel weight) is used to determine its MSW. For multi-use (non-dedicated) trucks and trailers, the MSW is the vehicle weight plus the maximum allowable payload for the vehicle.

3.8 Rated strength. The safe load capacity (without exceeding yield load), in any direction, recommended for a slinging or tiedown provision.

3.9 Set (permanent deformation). Any permanent change in the original dimensions or shape of the slinging or tiedown provision resulting from an applied force.

3.10 Sprung weight. The weight of all structural members above the suspension system of wheeled or tracked vehicles.

3.11 Ultimate load. The maximum force a slinging or tiedown provision, including its connecting structural members, can sustain.

3.12 Working load. The anticipated maximum resultant load imposed on the eye or other slinging provision under actual working conditions at its MSW, with the attached lifting leg acting at a 45° true angle with the vertical.

3.13 Yield load. The force at which a slinging or tiedown provision, including its connecting structural members, exhibits a permanent deformation or set.

4. GENERAL REQUIREMENTS

4.1 Slinging, equipment tiedown, and multipurpose provisions (classes 1, 2, and 3 for types I, II, III, and IV equipment).

4.1.1 Number. The number of provisions for slinging and tiedown on all equipment shall be adequate to provide safety and stability. Unless otherwise specified in the equipment specification, types I and II vehicles within the scope of this standard shall have four multipurpose provisions. If specified in the equipment specifications, four slinging provisions and four tiedown provisions or a combination of multipurpose, slinging, and tiedown provisions may be provided. Types III and IV equipment shall have four multipurpose provisions or four slinging provisions and a minimum of four tiedown

provisions or a combination of multipurpose, slinging, and tiedown provisions; or, if specified in the equipment specifications, the provisions in option 4.1.3 may be provided. If vehicles or equipment are sectionalized for shipping, these requirements shall apply to each section and to the vehicle when assembled.

4.1.2 Location.

4.1.2.1 All provisions. All provisions shall be located so that:

a. Not less than 1 inch of clearance shall be maintained between the slings, or tiedown cables, and the equipment except when a structure (such as an overhead guard, tracks, tanks attached to the chassis, and so forth), specified by the contractor, has strength to withstand contact with the sling or cable without permanent deformation of any part of the equipment or the contact will not adversely affect the sling or cable.
b. There is no interference with the functioning of the equipment.
c. Increase in square or cubage is minimized.
d. Maximum accessibility to the provision or point is maintained.

4.1.2.2 Slinging provisions. Slinging provisions shall be located so that:

a. Attached sling legs shall converge over the center of gravity of the equipment when at its MSW, with attached sling legs inclined no more than 45° true angle with the vertical. (This is not applicable to items with only one provision.)
b. The attached sling apex does not exceed a height of 24 feet above the lowest extremity of the equipment when suspended, with each sling leg at the maximum 45° true angle (see fig 1). (This is not applicable to items with only one provision.)
c. Spreader bars shall not be used unless specified in the new equipment specification. Stowage provisions must be provided to ensure the spreader bars stay with the item.
d. Stability can be maintained during lifting.
e. The sling leg will be in approximate alignment with the plane of the provision.
f. For external helicopter transport, provisions are to be located so that, when the equipment is freely suspended, there is a minimum clearance of 8 inches between the centerline of the sling leg and the equipment (AVSCOM Technical Report No. 72-36).

4.1.2.3 Equipment tiedown provisions. Tiedown provisions shall be located in the elevation view so that the tiedown legs may be placed anywhere from vertically downward to 45° from the vertical and, in the plan view, 90° to either side of the principal direction of the tiedown provision (see fig 2). Tiedown provisions shall be located so as to restrain the sprung weight that is on the chassis of wheeled vehicles or on the hull of tracked vehicles. If possible, tiedown points on the equipment should be located symmetrically about the vehicle or item of equipment and higher than its center of gravity.

4.1.2.4 Deviations. Modifications or special considerations that deviate from the above requirements shall be directed to the appropriate service transportability agent. The designated agents are listed in joint regulation AR 70-44/OPNAVINST 4600.22/AFR 80-18/MCO 4610.14/DLAR 4500.25, DOD Engineering for Transportability.

4.1.3 Option for types III and IV equipment. If types III and IV equipment do not have classes 1, 2, or 3 provisions, the contractor shall specify, to the project manager, points to be used for slinging and tiedown. The selected points shall meet the requirements in sections 4 and 5 of this standard. If holes are used as tiedown provisions, they shall be formed in the main structural members and shall conform to columns D and E in figure 3.

4.1.4 Multipurpose, slinging, and tiedown provision surface. The material edges shall be rounded, or chamfered, and smooth to prevent cutting of the sling or tiedown cables.

4.1.5 Marking.

4.1.5.1 Shipping dataplate. A shipping data plate shall be furnished and shall conform to MIL-P-514, type III, composition C, of type I, grade A, class 1 material or MIL-P-15024/9. The silhouette of the equipment in transport position, which indicates the center of gravity along each axis, location and rated strength of the slinging and primary tiedown provisions, and the location of any alternate or supplementary points of tiedown shall be included on the dataplate. Nomenclature characters shall not be less than 0.187 inch, and other characters shall not be less than 0.093 inch in height. The dataplate shall be attached by screws, bolts, or rivets in a conspicuous location.

4.1.5.2 Identification. The identification of slinging, tiedown, or multipurpose provisions used for transport shall be stenciled in appropriate locations on the exterior of the equipment in letters not less than 1 inch in height. Interior cargo tiedown provisions do not have to be marked. Accessories resembling provisions unsuitable for slinging or tiedown shall be located or designed to avoid mistaken use.

4.2 Hub attachments. Hubs shall not be designed for or used as slinging or tiedown points.

4.3 Removable provisions. Provisions with threaded shanks that can be removed from the vehicle or item of equipment shall not be used.

4.4 Cargo tiedown provisions (classes 4 and 5).

4.4.1 Number. The number of cargo tiedown provisions shall be determined by the design and size of the cargo compartment or platform.

4.4.2 Location.

a. Class 4 tiedown provisions shall be recessed inside van-type vehicles and the cargo compartment of trucks and trailers (with metal-stake bodies). Spacing of provisions shall be about 24 inches on center along each side and end of the cargo body of the vehicle, with spacing between provisions adjusted as necessary to avoid vehicle structural members. Provisions located on the side and end walls of cargo bodies shall be located as close to the floor of the cargo body as practical.
b. Class 5 tiedown provisions shall be located on the perimeter of the cargo bed so as not to increase the dimensions of the bed. Spacing of provisions shall be about 24 inches on center along each side of the vehicle, with spacing between provisions adjusted as necessary to avoid vehicle structural members.

4.4.3 Freezing. Tiedown provisions located in the floor of a vehicle shall be designed to prevent the movable parts from freezing in place during cold weather. (Drain holes shall meet the requirements of Title 49, Code of Federal Regulations, for ammunition shipments.)

4.5 Stowable slinging provisions. "Hideaway" provisions, which are nonremovable parts of the equipment and can be stowed out of the way, are acceptable for use where other types of slinging eyes would interfere with loading and unloading of cargo.

5. DETAILED REQUIREMENTS

5.1 Strength of eyes and provisions.

5.1.1 Class 1 slinging provisions.

5.1.1.1 For equipment with MSW of less than 25,000 pounds. Each class 1 provision, including the connection to the structural member(s), shall meet the following requirements (AVSCOM Technical Report No. 72-36):

a. A design load of not less than 3.2 times the working load.
b. An ultimate load of not less than 1.5 times the design load.
c. The slinging provisions shall be tested for validation, in accordance with paragraph 5.5 of this standard.

The working load is determined by a static test or by mathematical analysis. A sample problem that shows how to determine the required strength of the slinging provisions appears in appendix A. For external helicopter transport, the requirements for slinging provisions as stated above apply to equipment with an MSW-to-maximum-projected-frontal-area ratio of 60 pounds per square foot or greater. Each slinging provision, including the connection to the structural member(s), shall meet the following requirements for equipment with an MSW-to-maximum-projected-frontal-area ratio of less than 60 pounds per square foot:

d. A design load of not less than 5.6 times the working load.

e. An ultimate load of not less than 1.5 times the design load.
f. The slinging eyes or provisions shall be tested for validation, in accordance with paragraph 5.5 of this standard.

Cargo vehicles that have a curb weight of less than 25,000 pounds and a gross vehicle weight (GVW) of greater than 25,000 pounds shall meet the requirements of this paragraph.

5.1.1.2 For equipment with MSW of 25,000 pounds or more. Each class 1 provision, including the connection to the structural member(s), shall meet the following requirements (AVSCOM Technical Report No. 72-36):

a. A design load of not less than 2.3 times the working load.
b. An ultimate load of not less than 1.5 times the design load.
c. The slinging eyes or provisions shall be tested for validation, in accordance with paragraph 5.5 of this standard.

For external helicopter transport, the requirements for slinging provisions as stated above apply to equipment with an MSW-to-maximum-projected-frontal-area ratio of 60 pounds per square foot or greater. Each slinging provision, including the connection to the structural member(s), shall meet the following requirements for equipment with an MSW-to-maximum-projected-frontal-area ratio of less than 60 pounds per square foot:

d. A design load of not less than 5.1 times the working load.
e. An ultimate load of not less than 1.5 times the design load.
f. The slinging eyes or provisions shall be tested for validation, in accordance with paragraph 5.5 of this standard.

5.1.2 Class 2 tiedown provisions. Each class 2 provision, including the connection and the structural frame, shall withstand its proportionate share of the following loadings: 4.0 times the MSW in the forward and aft direction of the longitudinal axis of the equipment, 2.0 times the MSW in the downward direction of the vertical axis, and 1.5 times the MSW in each direction of the lateral axis. For determining the required force on each provision, these inertia forces (loadings) shall be applied statically and independently through the center of gravity of the equipment. The directional load (design load) shall be distributed among the tiedown eyes or provisions that would effectively resist motion along that axis. There shall be no permanent deformation or set of the provision or other equipment structural components as a result of application of the loads to the tiedowns. The ultimate load that each tiedown eye or provision can withstand shall be at least 1.5 times the design load.

5.1.3 Class 3 multipurpose provisions. Each class 3 provision shall meet the requirements of both slinging and tiedown provisions as stated in paragraphs 5.1.1 and 5.1.2.

5.1.4 Classes 4 and 5 cargo tiedown provisions.

a. Each class 4 provision shall withstand the following forces:

	Lb	Lb
Load carrying range of equipment	0 - 10,000	over 10,000
Load carrying capacity of tiedown provisioning	5,000	10,000

The ultimate load that each tiedown provision can withstand shall not be less than 1.5 times the yield load.

b. Each class 5 provision shall withstand a force of 15,000 pounds without exceeding the yield load. The ultimate load that each tiedown provision can withstand shall not be less than 1.5 times the yield load.

5.2 Provision dimensions.

5.2.1 Classes 1 and 3 slinging and multipurpose provisions. Classes 1 and 3 provisions shall conform to the dimensions specified in figure 3.

5.2.2 Class 2 tiedown provisions. Class 2 provisions shall conform to the dimensions specified in table 1.

5.2.3 Class 4 cargo tiedowns. Class 4 provisions shall have openings of not less than 1 inch in diameter and shall have a thickness of not greater than 1/2 inch. An example of an acceptable class 4 tiedown is shown in figure 4.

5.2.4 Class 5 cargo tiedowns. Class 5 provisions shall have openings of not less than 2 inches in diameter and shall have a thickness of not greater than 1/2 inch. An example of an acceptable class 5 tiedown is shown in figure 5.

5.3 Directional capabilities of cargo tiedowns.

5.3.1 Class 4 cargo tiedowns. Class 4 provisions shall permit the cargo ring to swivel a minimum of 180° and have an included angle of lateral movement of not less than 150°.

5.3.2 Class 5 cargo tiedowns. Class 5 provisions (with movable parts) shall have an included angle of lateral movement of not less than 90° and shall be capable of 90° movement from the vertical toward the longitudinal centerline of the vehicle.

5.4 Figures. Illustrations are not intended to preclude requirements that are otherwise specified in this standard.

5.5 Analysis and test considerations.

5.5.1 General. All slinging and tiedown provisions shall be tested attached to the equipment. For test purposes, only wire rope, wire rope with a thimble loop, or a chain attached to the provision shall be used . Textile straps such as nylon and polyester (Dacron) and synthetic ropes shall not be used.

5.5.2 Slinging provisions.

a. Prior to First Article or Preproduction Model testing, the contractor shall provide, to the project manager, design and ultimate loads for the provisions to show that they meet the slinging requirements of section 5.0. For items to be carried externally by helicopter, the contractor shall determine and provide the MSW-to-maximum-projected-frontal-area ratio.

b. The contractor analysis and testing shall meet the following requirements:

(1) A static pull to the required design load shall be conducted on all provisions; however, all provisions do not have to be tested at the same time.
(2) The direction of pull shall be 45°. If the provisions cannot be pulled at this angle, then the angle shall coincide with the procedure shown in appendix A.
(3) The points used to apply the load to the equipment shall be located so they do not interfere with or reduce the loading on the structural member adjacent to the provisions.
(4) Loads in each sling leg shall be measured with an appropriate measuring device such as a load cell.
(5) The maximum load applied to each provision shall be not less than the required design load and shall be applied for not less than 90 seconds. (Note: For helicopter transport, the required design load will be based on the highest factor required in paragraph 5.1.1).
(6) No permanent deformation or set in the provision or other equipment structural components shall result from application of the loads to the provisions.
(7) Calculations shall be performed, as indicated in appendix A, to show the ultimate load is not less than 1.5 times the required design load for the provisions.

5.5.3 Tiedown provisions.

a. Prior to First Article or Preproduction Model testing, the contractor shall provide, to the project manager, design and ultimate loads for the provisions to show that they meet the tiedown requirements of section 5.0.

b. The contractor analysis and testing shall meet the following requirements:

(1) A static pull to the required design load shall be conducted

on all tiedown provisions; however, all provisions do not have to be tested at the same time.

(2) Loads applied to each provision shall be measured with an appropriate measuring device such as a load cell.

(3) The points used to apply the load to the equipment shall be located so they do not interfere with or reduce the loading on the structural member adjacent to the tiedown provisions.

(4) Maximum loads applied in the longitudinal, vertical, and lateral directions shall be applied statically and independently for not less than 6.0 seconds and shall be not less than the required load in each direction.

(5) No permanent deformation or set in the provisions or other equipment structural components shall result from application of the loads to the provisions.

(6) Calculations shall be performed, as shown in appendix B, to show the ultimate load is not less than 1.5 times the required design load for the provisions.

5.5.4 Multipurpose provisions. These provisions shall meet the analysis and test requirements of paragraphs 5.5.2 and 5.5.3.

6. NOTES

6.1 International standardization agreements. Certain provisions of this standard are the subject of international standardization agreements (QSTAG-328, ASCC Air Standard 44/21, and STANAG-3548). When an amendment, a revision, or a cancellation of this standard is proposed that will modify the international agreement concerned, the preparing activity will take appropriate action through international standardization channels, including departmental standardization offices, to change the agreement or make other appropriate accommodations.

6.2 Tiedown system. If a proposed tiedown system differs from that represented in MIL-STD-810, a waiver shall be granted by MTMCTEA prior to testing.

6.3 Subject term (key word) listing.

Document identifiers
Eyes, slinging
Eyes, tiedown
Lifting
Military standards
Provision, multipurpose
Provision, slinging
Provision, tiedown
Requirements
Slinging
Standards
Tiedowns
Tiedowns, cargo

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

Review activities:
Army - GL, SM, MI, ME, ER, TE, AT, AR
Navy - MC
Air Force - 84, 99
DLA - CS

User activities:
Army - AV
Navy - SA

Preparing activity:
Army - MT

Project No. 2540-0357

LOCATE SLINGING PROVISIONS WITHIN SHADED AREA

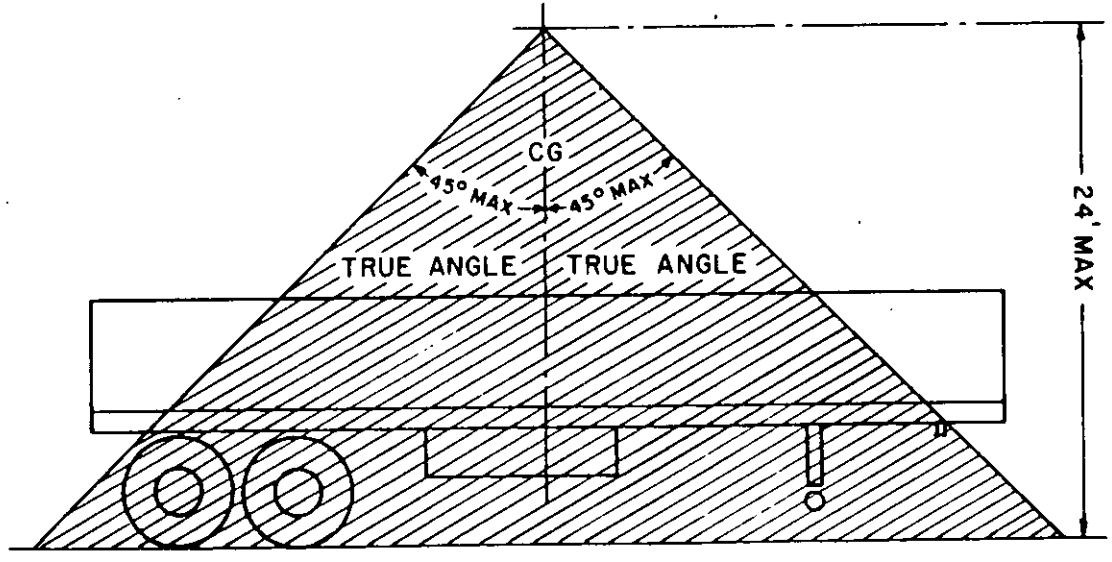
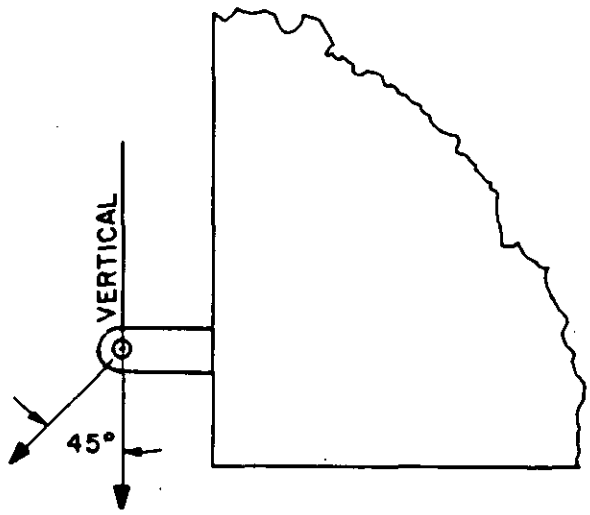
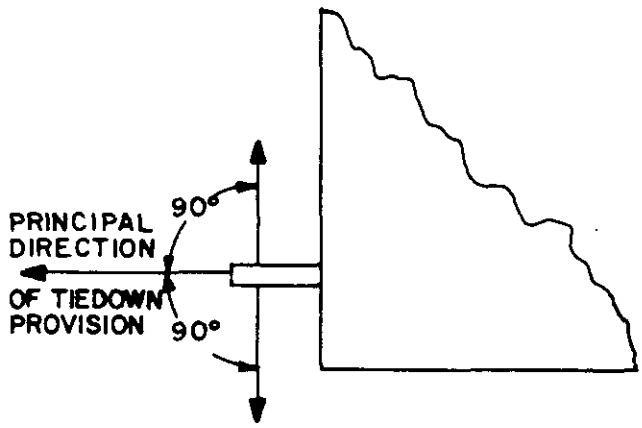


FIGURE I. Apex height.

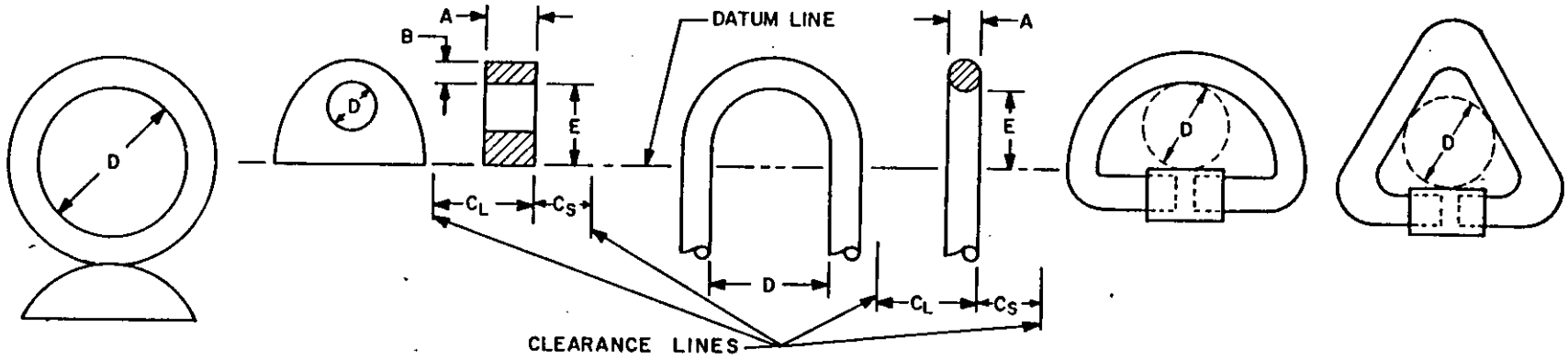


ELEVATION VIEW



PLAN VIEW

FIGURE 2. Working angles for tiedown provisions. (Type provision shown is for illustration only.)

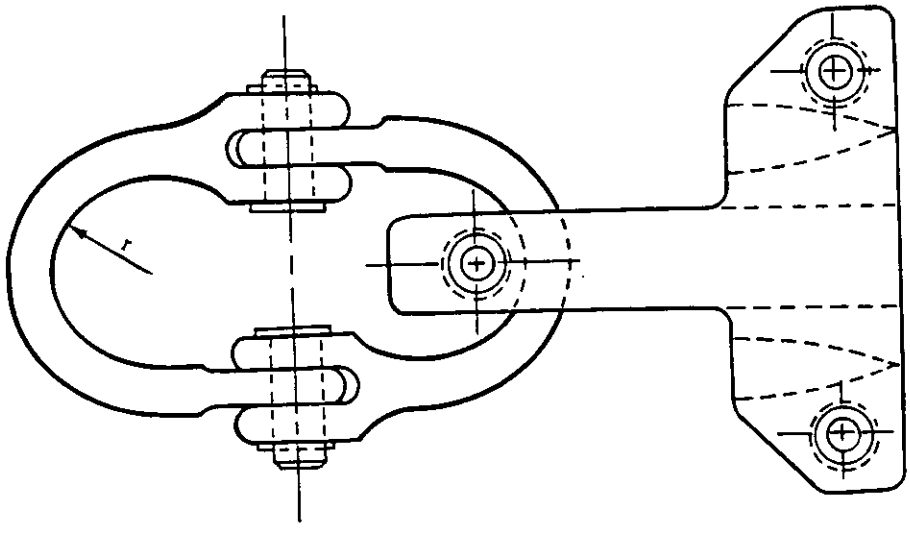


WEIGHT RANGE OF EQUIPMENT		DIMENSIONS IN INCHES AND MILLIMETERS															
		A MAX		B MAX		C_L MIN*		C_S MIN*		D MAX		D MIN		E MAX		E MIN	
LB	KILO-GRAMS	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM
UP TO 11,200	5,080	1	25.4	1.0	25.4	7	177.8	3	76.2	3.5	76.2	3	76.2	5	127.0	3	76.2
11,200 to 22,400	10,160	1.5	38.1	1.125	28.56	9	228.6	4	101.6	3.5	88.9	3	76.2	5	127.0	3	76.2
22,400 to 49,280	22,353	2	50.8	1.5	38.1	12	304.8	5	127.0	3.5	88.9	3	76.2	5	127.0	3.5	88.9
49,280 to 100,800	45,722	2	50.8	1.5	38.1	16	406.4	7	177.8	4	101.6	3.5	88.9	6	152.4	5	127.0
100,800 to 145,600	66,043	2.5	63.5	2	50.8	20	508.0	8	203.2	5	127.0	4	101.6	6	152.4	5.5	139.7

* There shall be no interference or obstruction within the dimensions C_L and C_S that could interfere with engaging a shackle and pin in the eye. Either side of the eye may be used as the datum from which to measure C_L and C_S.

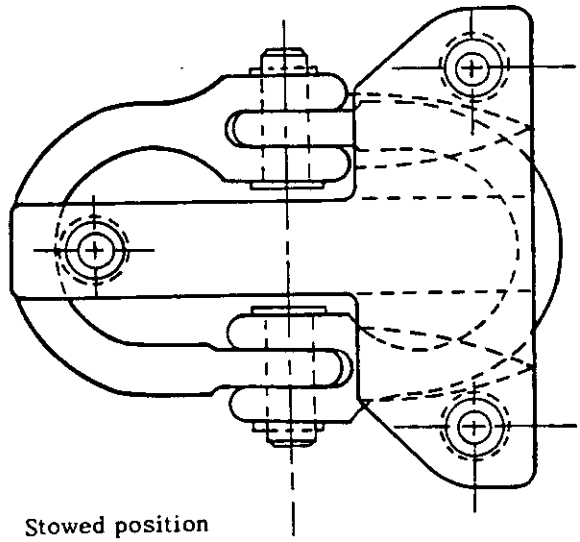
NOTE: Eye may be designed to swivel.

FIGURE 3. Classes 1 and 3 openings and clearance dimensions for slinging provisions on types I, II, III and IV equipment.



r = 1 inch min.

Operating position



Stowed position

FIGURE 4. Example of class 4 cargo tiedown eye.

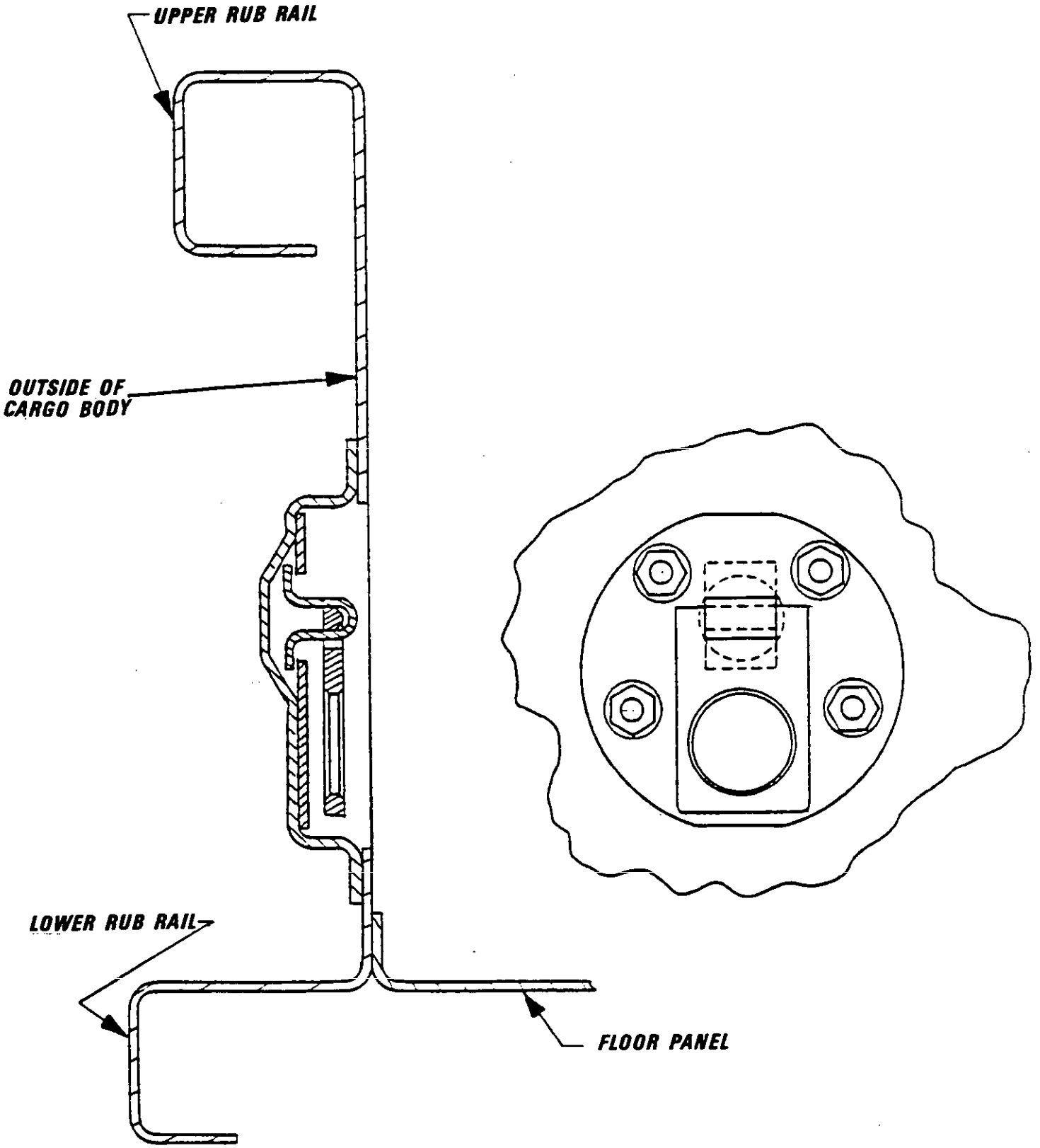


FIGURE 5. Example of class 5 cargo tiedown eye.

TABLE I

Characteristics for class 2 tiedown eyes and other provisions on Types I, II, III, and IV equipment.

MSW RANGE OF EQUIPMENT		MAXIMUM DIAMETER OF CROSS SECTION		MINIMUM DIAMETER OF CROSS SECTION		MINIMUM INSIDE CLEARANCE (DIAMETER)	
LB	KG	IN	MM	IN	MM	IN	MM
up to 5000	up to 2,270	0.787	20	0.433	11	1.969	50
5000 to 15,000	2,270 to 6,810	0.787	20	0.433	11	1.969	50
Above 15,000	Above 6,810	0.945	24	0.433	11	2.992	76
		0.945	24	0.433	11	3.504	89

APPENDIX A
SAMPLE PROBLEM FOR DETERMINING THE REQUIRED STRENGTH OF THE SLINGING PROVISIONS

10. GENERAL

10.1 Scope. This appendix establishes a method for determining the required strength of the slinging provisions.

20. REFERENCED DOCUMENTS

Not applicable.

30. NOTATION

30.1 Symbols. The following letter symbols are used throughout this appendix.

L_f = location of center of gravity (CG) from the front, in feet

L_r = location of CG from the rear, in feet

D = overall width of item, in feet

D_s = location of CG from right front edge, in feet

V_f = vertical reaction (load) at each front provision, in pounds

V_r = vertical reaction (load) at each rear provision, in pounds

h_f = distance from front provision to CG, in feet

h_r = distance from rear provision to CG, in feet

H = overall height of item, in feet

H_a = apex height above lowest extremity of item, in feet

K = distance from apex to CG for plane ABCD, in feet

S_r = length of rear sling leg, in feet

θ = true sling leg angle from the vertical, in degrees

S_f = length of front sling leg, in feet

R_f = resultant (working) load on front provisions, in pounds

R_r = resultant (working) load on rear provisions, in pounds

T_f = design load of front provisions, in pounds

T_r = design load of rear provisions, in pounds

U_f = ultimate load of front provisions, in pounds

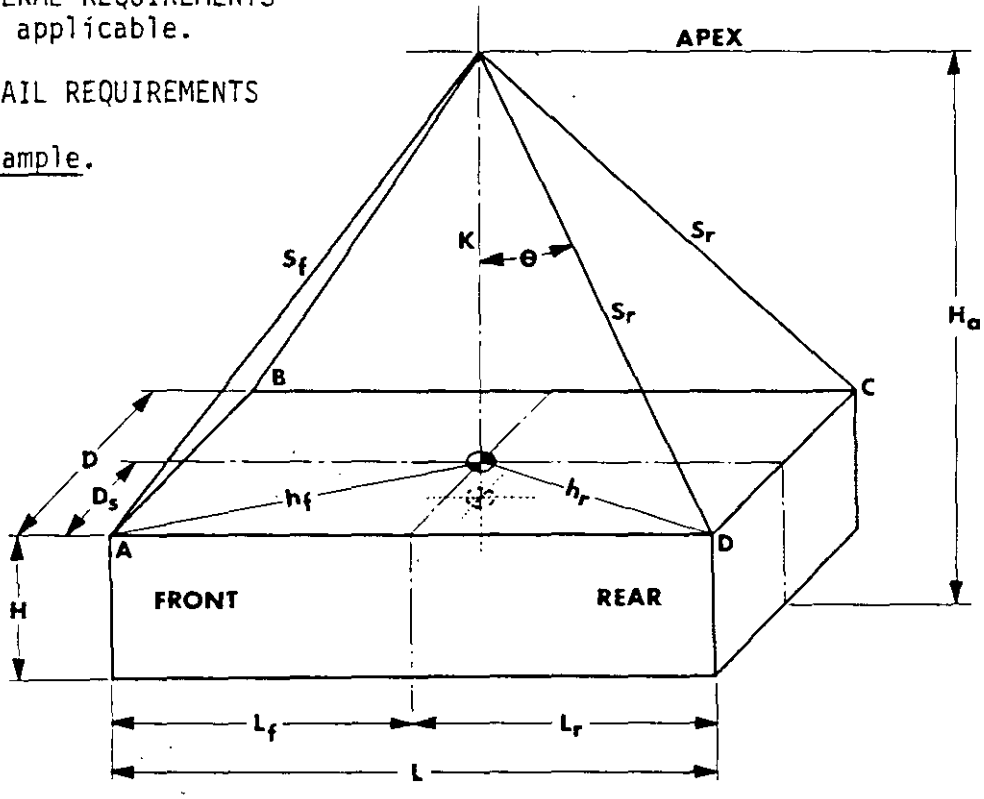
U_r = ultimate load of rear provisions, in pounds

MSW = maximum shipping weight of item (including payload), in pounds

40. GENERAL REQUIREMENTS
Not applicable.

50. DETAIL REQUIREMENTS

50.1 Example.



Assume: MSW (including payload) = 10,000 lb,

L_f = 12 ft, L_r = 13 ft, H_t = 2 ft, H_b = 2 ft,

D = 8 ft, D_s = 4 ft

50.1.1 Vertical load on each provision.

a. Front provisions $V_f = \frac{L_r}{L} \times \frac{MSW}{2} = \frac{13}{25} \times \frac{10,000}{2} = 2,600$ lb

b. Rear provisions $V_r = \frac{L_f}{L} \times \frac{MSW}{2} = \frac{12}{25} \times \frac{10,000}{2} = 2,400$ lb

50.1.2 Horizontal distance from the slinging provisions to the center of gravity.

a. Front provisions $h_f = \sqrt{L_f^2 + D_s^2} = \sqrt{12^2 + 4^2} = 12.65$ ft

b. Rear provisions $h_r = \sqrt{L_r^2 + D_s^2} = \sqrt{13^2 + 4^2} = 13.60$ ft

50.1.3 Minimum vertical distance from AB and CD to the point above the center of gravity.

CAUTION: Not to exceed 45° vertical angle and 24-ft apex height requirements (para 4.1.2.2).

a. Let the longest horizontal distance be equal to K. (Sling legs 45° from the vertcal). Therefore, for this example, K = h_r = 13.60 ft

b. Check the apex height:
H_a = K + H = 13.60 + 4 = 17.60 ft

Since H_a is less than 24 ft, the apex height is correct.

If H_a had exceeded 24 feet, the provisions would have to be moved to satisfy paragraph 4.1.2.2 and figure 1.

c. The vertical angle Theta (θ) for the front legs (S_f) is:

$\theta = \tan^{-1} \frac{12.65}{13.60} = 42.93°$

This angle is less than 45°, which verifies that the angle assumption for plane ABCD results in the worst-case arrangement.

50.1.4 Determine sling lengths.

a. Front $S_f = \sqrt{K^2 + h_f^2} = \sqrt{13.60^2 + 12.65^2} = 18.57$ ft

b. Rear $S_r = \sqrt{K^2 + h_r^2} = \sqrt{13.60^2 + 13.60^2} = 19.23$ ft

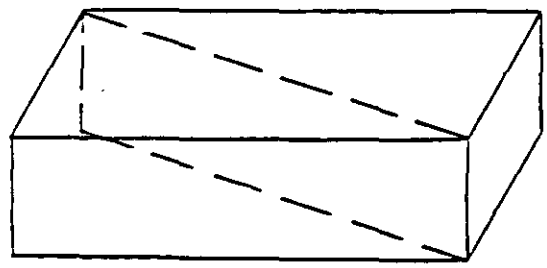
50.1.5 Determine resultant (working) load.

a. Front $R_f = V_f\left(\frac{S_f}{K}\right) = 2{,}600 \times \frac{18.57}{13.60} = 3{,}550$ lb

b. Rear $R_r = V_r\left(\frac{S_r}{K}\right) = 2{,}400 \times \frac{19.23}{13.60} = 3{,}394$ lb

50.1.6 Determine the required design load. Since the item is less than 25,000 pounds and if external helicopter transport were a requirement, determine the MSW-to-maximum-projected-frontal-area ratio. Use this number to determine the design load factor.

a. Based on the assumption that the vehicle or item of equipment is enclosed in a rectangle, the maximum frontal area is the diagonal across the rectangle. Determine if the item has a 60 lb/ft² or larger MSW-to-maximum-projected-frontal-area ratio.



(1) Determine the cross sectional projected area:

$= H\sqrt{D^2 + L^2}$

$= 4\sqrt{8^2 + 25^2} = 4\sqrt{64 + 625}$

$= 4\sqrt{689} = 105 \text{ ft}^2$

(2) Determine the MSW-to-frontal-area ratio (60 lb/ft² = base)

$$\frac{10{,}000 \text{ lb}}{105 \text{ ft}^2} = 95.24 \text{ lb/ft}^2$$

95.24 lb/ft² is greater than 60 lb/ft²

Therefore, the design load factor is 3.2. (If the frontal area ratio from this method was less than 60 lb/ft² , the design load factor would be 5.6.)

c. The required design loads (T) are:

Front $T_f = 3.2 \times R_f = 3.2 \times 3{,}550 = 11{,}360$ lb

Rear $T_r = 3.2 \times R_r = 3.2 \times 3{,}394 = 10{,}861$ lb

d. The required ultimate loads (U) are:

Front $U_f = 1.5 \times T_f = 1.5 \times 11{,}360 = 17{,}040$ lb

Rear $U_r = 1.5 \times T_r = 1.5 \times 10{,}861 = 16{,}292$ lb

APPENDIX B
SAMPLE PROBLEM FOR DETERMINING THE REQUIRED STRENGTH OF THE TIEDOWN PROVISIONS

10. GENERAL

10.1 Scope. This appendix establishes a method for determining the required strength of the tiedown provisions.

20. REFERENCED DOCUMENTS

Not applicable.

30. NOTATION

30.1 Symbols.

T_L = design load in longitudinal direction, in pounds

U_L = ultimate load in longitudinal direction, in pounds

T_V = design load in vertical direction, in pounds

U_V = ultimate load in vertical direction, in pounds

T_S = design load in lateral direction, in pounds

U_S = ultimate load in lateral direction, in pounds

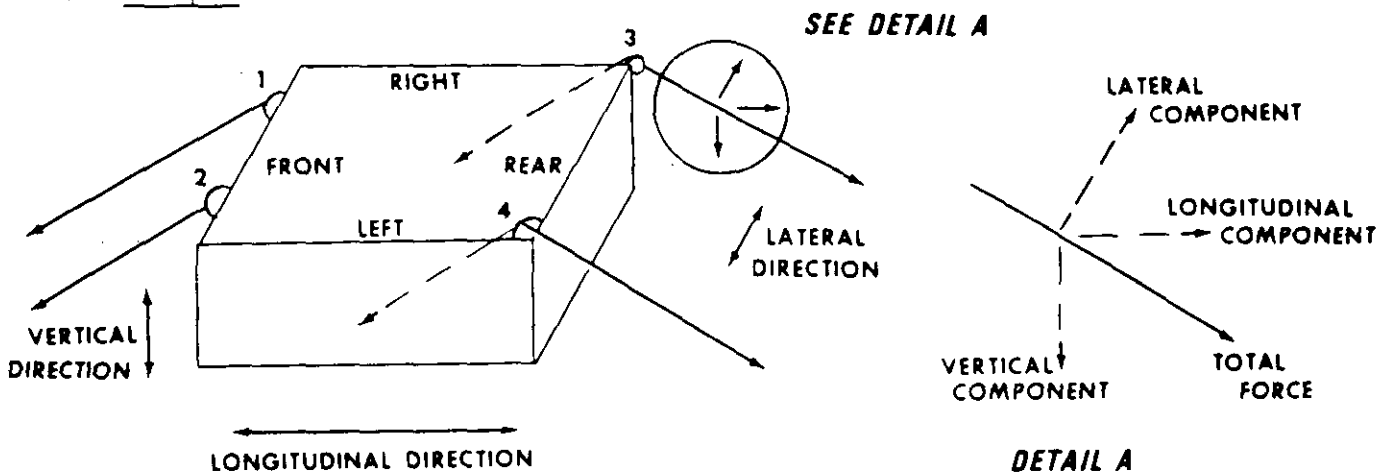
MSW = maximum shipping weight of item (including payload), in pounds

40. GENERAL REQUIREMENTS

Not applicable

50. DETAIL REQUIREMENTS

50.1 Example.



Assume: MSW (including cargo weight) = 20,000 lb.

This example does not represent a particular item, but rather the way tiedown provisions will be used based on their location. All four provisions will be used to restrain items in the vertical and lateral directions. Provisions 3 and 4 will restrain forces in both longitudinal directions (fore and aft). However, provisions 1 and 2 will restrain forces in only one longitudinal direction (aft).

50.1.1 Minimum required longitudinal design and ultimate loads. The longitudinal inertia force acting through the center of gravity is:

$$4 \times MSW = 4 \times 20{,}000 = 80{,}000 \text{ lb}$$

Assume the inertia force will be balanced/restrained by the longitudinal force components of the applicable tiedown provisions to prevent movement of the item in the forward and aft directions.

a. To prevent movement in the forward direction, two provisions can be used:

$$T_{3L} + T_{4L} = 80{,}000 \text{ lb}$$

Based on the assumption that all provisions are located symmetrically about the center of gravity,

$$T_{3L} = T_{4L}$$

each provision must withstand a longitudinal force (required design load) of 40,000 pounds applied in the aft direction.

b. To prevent movement in the aft direction, all four provisions can be used. In this example:

$$T_{1L} + T_{2L} + T_{3L} + T_{4L} = 80{,}000 \text{ lb}$$

Based on the assumption that all provisions are located symmetrically about the center of gravity,

$$T_{1L} = T_{2L} = T_{3L} = T_{4L}$$

each provision must withstand a longitudinal force (required design load) of 20,000 pounds applied in the forward direction.
Ultimate load requirements (1.5 x design load) are:

forward $\quad U_{3L} = U_{4L} = 1.5 \times 40{,}000 = 60{,}000$ lb

aft $\quad U_{1L} = U_{2L} = U_{3L} = U_{4L} = 1.5 \times 20{,}000 = 30{,}000$ lb

50.1.2 Minimum required vertical design and ultimate loads. The vertical inertia force acting through the center of gravity is:

$$2 \times \text{MSW} = 2 \times 20{,}000 = 40{,}000 \text{ lb}$$

It should be assumed that this force will be restrained by the vertical force components of the tiedown provisions against upward movement of the item.

$$T_{1v} + T_{2v} + T_{3v} + T_{4v} = 40{,}000 \text{ lb}$$

Based on the assumption that the vertical force on each provision will be equal,

$$T_{1v} = T_{2v} = T_{3v} = T_{4v}$$

each provision must withstand a vertical force (required design load) of 10,000 pounds applied in the downward direction.
Ultimate load requirement (1.5 x design load) is:

$$U_{1v} = U_{2v} = U_{3v} = U_{4v} = 1.5 \times 10{,}000 = 15{,}000 \text{ lb}$$

50.1.3 Minimum required lateral design and ultimate loads. The lateral inertia force acting through the center of gravity is:

$$1.5 \times \text{MSW} = 1.5 \times 20{,}000 = 30{,}000 \text{ lb}$$

It should be assumed that this force will be restrained by the lateral force components of the tiedown provisions toward the left and right.

a. To prevent movement toward the right, two provisions can be used:

$$T_{2s} + T_{4s} = 30{,}000 \text{ lb}$$

Based on the assumption that all provisions are located symmetrically about the center of gravity,

$$T_{2s} = T_{4s}$$

each provision must withstand a lateral force (required design load) of 15,000 pounds applied toward the right.

b. To prevent movement toward the left, two provisions can be used:

$$T_{1s} + T_{3s} = 30{,}000 \text{ lb}$$

Based on the assumption that all provisions are located symmetrically about the center of gravity,

$$T_{1s} = T_{3s}$$

each provision must withstand a lateral force (required design load) of 15,000 pounds applied toward the left.

Ultimate strength requirements (1.5 x design load) are:

right $\quad U_{2s} = U_{4s} = 15{,}000 \times 1.5 = 22{,}500$ lb

left $\quad U_{1s} = U_{3s} = 15{,}000 \times 1.5 = 22{,}500$ lb

(If the tiedown pattern used has the cables crossing, then the lateral force will be opposite from that shown above.)

1. Common Metric Abbreviations

m = meter	kg = kilogram
dm = decimeter	km = kilometer
cm = centimeter	t = metric ton
mm = millimeter	Pa = pascal
Hz = hertz	rad = radian
gal = gallon	s = second
mhp = metric horsepower	km/hr = kilometers per hour

2. Length

1 mi = 1609.35 m	1 km = 0.6214 mi
1 yd = 0.9144 m	1 m = 1.0936 yd
1 ft = 0.3048 m	1 m = 3.2808 ft
1 in. = 0.0254 m	1 m = 39.3700 in.

1 m = 10 dm = 100 cm = 1000 mm

3. Area

1 sq yd = 0.8361 sq m	1 sq m = 1.196 sq yd
1 sq ft = 0.0929 sq m	1 sq m = 10.764 sq ft
1 sq in. = 0.00065 sq m	1 sq m = 1550 sq in.

4. Volume

1 cu yd = 0.76455 cu m	1 cu m = 1.31 cu yd
1 cu ft = 0.02831 cu m	1 cu m = 35.30 cu ft
1 cu in. = 0.000016 cu m	1 cu m = 61 023 cu in.
1 litre = 1.00×10^{-3} cu m	1 gal = 0.0038 cu m

5. Mass

1 STON = 907.185 kg	1 kg = 2.2046 lb
1 LTON = 1016 kg	1 t = 1000 kg
1 lb = 0.45359 kg	1 t = 2,204.62 lb

6. Acceleration

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

7. 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

8. Mass/Area

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

9. Pressure/Stress
1 pound-force/inch^2 = 6895 Pa
1 pound-force/foot^2 = 47.88 Pa

10. Angular Measure
1 degree = 0.01745 rad

11. Force
1 pound-force = 4.448 newton

12. Power
1 horsepower = 1.014 metric horsepower

13. The following simplified conversion factors are accurate within 2 percent for quick computations:

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

14. A measurement ton equals 40 cubic feet of volume.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-STD-209 G	Slinging and Tiedown Provisions for Lifting and Tying Down

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
Military Equipment	☐ VENDOR ☐ USER ☐ MANUFACTURER ☐ OTHER *(Specify)*: _____
b. ADDRESS *(Street, City, State, ZIP Code)*	

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

(TO DETACH THIS FORM, CUT ALONG THIS LINE.)

DD FORM 82 MAR 1426 PREVIOUS EDITION IS OBSOLETE.