

LASHING HANDBOOK
FOR
MARINE MOVEMENTS

THIRD EDITION

August 2005

(Electronically Revised July 2009)

Gary Horton

John T. Atwood
Daniel J. Nonnemacher

MILITARY SURFACE DEPLOYMENT AND DISTRIBUTION COMMAND
TRANSPORTATION ENGINEERING AGENCY
SCOTT AIR FORCE BASE, ILLINOIS

Director
Military Surface Deployment and Distribution Command
Transportation Engineering Agency
ATTN: SDDCTEA - DPE (G. Horton)
Building 1990, 709 Ward Drive
Scott AFB, IL 62225

Telephone: DSN 770-5765, 618-220-5765, or 1-800-722-0727

FAX: DSN 770-5551 or 618-220-5551

E-mail: gary.horton1@us.army.mil

Make requests for additional copies or latest updated copy of these references can be downloaded from our website: http://www.tea.army.mil/pubs/pubs_order.htm

This book is part of the series started with MTMCCTEA PAM 55-19, *Tiedown Handbook for Rail Movements*. The books in the series are:

Handbooks for Military Movements

PAM 55-19, *Tiedown Handbook for Rail Movements*

PAM 55-20, *Tiedown Handbook for Truck Movements*

PAM 55-21, *Lifting and Tiedown Handbook for Helicopter Movements*

PAM 55-22, *Marine Lifting and Lashing Handbook*

PAM 55-23, *Tiedown Handbook for Containerized Movements*

PAM 55-24, *Vehicle and Equipment Preparation Handbook for Fixed Wing Air Movements*

Planning and User's Guide

PAM 70-1 *Transportability for Better Deployability*

PAM 700-2 *Logistics Handbook for Strategic Mobility Planning*

PAM 700-4 *Vessel Characteristics for Shiploading*

PAM 700-5 *Deployment Planning Guide*

PAM 700-6 *Large, Medium Speed, Roll-On/Roll-Off Ships Users' Manual*

PAM 700-7 *Fast Sealift Ship Users' Manual*

Notes

Preface

This is the third edition of the pamphlet. It supersedes the second edition (March 1995) and MTMCTEA PAM 56-1, *Marine Terminal Lifting Guidance*. It contains some changes and improvements over the previous editions.

The end of the Cold War and the increasing threat of terrorism have enormously increased the scale and complexity of force projection. The threats can be asymmetric, and the probable battlefields can lie in areas surrounded by rugged terrain and served by fragile transportation infrastructure. While airlift is essential for moving people, supplies, and priority items, sealift is the primary means of moving military equipment. Because of the time required to deploy by sea and the relative weight and cube of the equipment involved, strategic sealift becomes the longest leg of the fort-to-foxhole deployment scenario. The purpose of this reference is to shorten this leg by providing standard marine terminal guidance for lifting and lashing military equipment on various strategic ships.

This pamphlet provides users with the proper lifting and lashing methods for loading and securing general and military equipment aboard marine vessels. The pamphlet includes equipment characteristics condensed from TACOM vehicle characteristics sheets, transportability guidance technical manuals (TGTMs), and field experience gained through participating in military exercises and deployments. The handbook does not include all military equipment found in the Army inventory. Rather, it covers military equipment commonly encountered during stevedore operations. Helicopters are not covered in this reference. We have published a separate reference, PAM 55-21, and have created an interactive CD which specifically addresses helicopters.

Throughout the pamphlet, warnings, cautions, and notes emphasize important or critical guidance.

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WARNING

Highlights an operating or maintenance procedure, practice, condition, statement, and so forth, that, if not strictly observed, could result in injury to or death of personnel.

CAUTION

Highlights an operating or maintenance procedure, practice, condition, statement, and so forth, that, if not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness or long term health hazards to personnel.

NOTE

Highlights an essential operating or maintenance procedure, condition, or statement.

SDDCTEA welcomes comments and recommendations for improving this pamphlet. Readers may send their suggestions by letter or on a marked copy of a page(s) of the pamphlet to Director, Military Surface Deployment and Distribution Command Transportation Engineering Agency, ATTN: SDTE-DPE (G. Horton), Building 1990, 709 Ward Drive, Scott AFB, IL 62225. You may also email gary.horton1@us.army.mil to submit suggestions.

Questions can be answered by contacting us using the information from page ii. Please feel free to make copies of this pamphlet at your own discretion.

Section I. Introduction

The reverse portion of this reference deals specifically with lifting military materiel during port operations. Military shippers are primarily responsible for marine lifting operations, to include procedures, hardware, and supervision. However, this responsibility changes once the materiel has been placed on board the ship. At that point, the ship's officers assume responsibility for the equipment. Therefore, they typically have the final say as to how equipment is secured on the vessel. As a result, marine lashing procedures typically vary for different vessels, subject to the discretion of the individual inspecting the load and the anticipated voyage. The following sections will help alleviate this problem by standardizing tiedown procedures for strategic transport ships. Appendix A briefly describes the restraint criteria used to develop these procedures.

Section II provides tips and common mistakes prior to loading vehicles, while loading them, and while securing them. Section III describes various types of lashing hardware and introduces appropriate geometric and strength considerations for the lashing assemblies. Sections IV through VII apply these considerations to wheeled vehicles, trailers, tracked vehicles, and watercraft, respectively. Each section includes diagrams and tables that illustrate the required lashing strengths, numbers, and patterns based on various equipment weight ranges.

While applicable under most circumstances, the general guidance presented in Sections IV through VII has some practical limitations. Field situations sometimes present ships with inadequate tiedown points, equipment with missing shackles, and so forth. In such cases, creative lashings, extra tiedown materials, or blocking may be necessary.

Section II. Tips and Common Mistakes

A. Preparing Vehicles Prior to Loading

1. Make sure all lifting/tiedown shackles are attached to the vehicle. Do not use bumpers, axles, towing pintles, or towing hooks as points of attachment, except where specifically shown in the following sections.
2. Remove or band canvas and bows to prevent wind damage on the weather deck.
3. Secure all secondary cargo in the beds of trucks/trailers with appropriate restraint devices (banding, chain, straps, wire rope, and so forth) to counteract longitudinal (fore and aft), lateral (side to side), and vertical (up and down) forces encountered during lifting and tiedown operations. Bands should be at least $\frac{3}{4}$ by 0.020 inches.
4. Make sure fuel tanks are filled to the level specified in the SDDC port call message, but never more than $\frac{3}{4}$ full.
5. Make sure vehicle weights and dimensions are **accurately** measured and documented. Inaccurate measurement will throw-off load plans, creating potential trim and stability problems for the ship. Also, if vehicles are overloaded, shippers must be aware of the potential handling hazards to prevent safety risks. All movements of oversize, overweight, or special equipment must be according to **DOD 4500.9-R, Defense Transportation Regulation (DTR)**, Part III, Mobility.
6. Using accurate equipment weight data, calculate weights hold-by-hold **before** loading to ensure you have adequate GM before loading.
7. Ensure all vehicle weapons and equipment are certified as cleared of ammunition and explosives.

NOTE

GM refers to the ship's metacentric height, which is an indicator of initial stability. Stability increases with the height of the GM and decreases as the GM is reduced. Excessive GM causes a ship to become "stiff," decreasing the roll period and placing additional strain on the lashings. Without a proper GM, as determined from the ship's stability book in conjunction with the Chief Officer/Master, ships will not leave port. If incorrect, ship's officers may require cargo to be offloaded or redistributed. Careful, accurate planning can avoid such costly delays.

B. Loading Vehicles

1. Store high density loads (that is, tracked vehicles) in lower holds. This helps keep GM in the safe range. As a general rule of thumb, 2/3 of the cargo weight should be below the waterline.

2. Lower holds must be filled with heavy cargo to avoid running out of GM before they cube or weigh out.

3. Maintain at least 6 inches between vehicles for clearance.

4. Check weight limitations of each deck (see Appendix B).

5. Make sure lumber is placed under steel treads to avoid metal-to-metal contact.

6. Avoid loading equipment athwartship.

C. Securing Vehicles

1. Make sure transmissions are in neutral and parking brakes are set.

2. Use crossed chains to optimize lateral restraint.

3. Secure all gun tubes and turrets.

4. Blocking is not required for military vehicles on ramps. The vehicle's tiedown provisions are adequately designed to withstand dynamic forces in excess of those that could be imposed by ship motion.

NOTE

It is normal practice to double lash or use the next larger lashing size on vehicles secured on ramps. Also, it is normal practice to double lash all vehicles stowed in the outboard row on the weather deck.

5. Place chain hooks point down through the shackle or tiedown provision (see illustration below).



Proper hook placement for lifting and lashing vehicles.

6. Make sure shackles, chains, loadbinders, turnbuckles, and any other part of the tiedown assembly are comparable in strength. If a 70,000-pound chain is attached to a 35,000-pound shackle, the effective strength of the lashing *assembly* will only be 35,000 pounds.

D. General

1. Lashings should be checked periodically to ensure they remain taut throughout the voyage.

2. Equipment stowed on the weather deck typically experiences the most severe accelerations because of ship motion. Therefore, the lashing capacities and angles shown in the following sections should be strictly adhered to on the weather deck. Equipment stowed in the lower holds will experience relatively low accelerations, so strict adherence is not as critical. For example, if the 25 degree angle criteria discussed later cannot be met because of the location and number of available deck fittings, angles between 15 and 60 degrees may be acceptable below the weather deck.

3. Lashings on fast sealift and large medium speed roll-on/roll-off (RORO) ships are color coded. Red lashings are rated at 10,000 pounds; blue lashings are 35,000-pound capacity; and the silver lashings are rated at 70,000 pounds.

4. Blocking and bracing is not required on ships with adequate deck fittings to accommodate the tiedown patterns shown in the following sections. However, for ships with few or no deck fittings, blocking may be the only means of securing the cargo. Appendix C addresses proper blocking and bracing procedures for such instances.

5. Make sure vehicles, shelters, and trailers are not loaded beyond their rated capacities. Overloads exceed the tested design limits of lifting/tiedown provisions and other structural members. This could pose a safety risk during transit.

The following is a checklist to follow when loading and lashing vehicles.

Load and Tiedown Checklist

- Ensure deck capacity is adequate prior to loading (see Appendix B).
- Face vehicles in the same direction (do not load athwartship).
- Leave at least 6 inches between vehicles.
- Make sure parking brakes are set and transmission is in neutral.
- Ensure all lashings are crossed and achieve approximately a 25 degree angle with the deck.
- Use symmetrical tiedown patterns.
- Pull chain tight and attach hook, point down.
- Tighten chain further with appropriate device.
- Make sure chain is not kinked, twisted, or binding.
- Do not secure chains to axles or springs unless the procedure is indicated in a specific illustration.
- Strike lashing with hammer or breaker bar and retighten as necessary.

NOTE

When tying down helicopters, tighten the chain or strap only enough to remove slack; over tightening of chains or straps can result in structural damage to the helicopter.

Section III. Lashing Hardware

This section describes the lashing hardware and general tiedown requirements for roll-on/roll-off (RORO) and breakbulk vessels in the Ready Reserve Force (RRF), Maritime Security Program (MSP), Voluntary Intermodal Sealift Agreement (VISA) and under control of the Military Sealift Command (MSC). However, to keep instructions simple, we used only two categories of ships: fast sealift ships/large, medium speed RORO ships (FSS/LMSR) and “Other” ships. The “Other” category applies to all ships other than the FSS and LMSR classes. The FSS and LMSR were treated separately because of their relative size and stability under storm sea conditions.

Page 3-3 shows some of the various types of lashing gear that are available on the RORO ships. Breakbulk ships do not usually have lashing gear, so you may use blocking (see Appendix C), wire rope, turnbuckles, or shipper supplied chains of the appropriate strength and number. No matter what lashing gear is used, the actual tiedown procedure will depend on four things: strength of the lashing assembly; strength of the deck fitting; weight of the vehicle being restrained; and the angles of the lashing relative to the vehicle and the deck.

We optimized the angles for lashing military vehicles to get the best use of the available lashing gear. Pages 3-4 through 3-6 show the recommended angles for lashing equipment. The *actual* angle of the lashing chain will be determined by the placement of the vehicle to be lashed and the relative location of the deck fittings. When you have a choice of several deck fittings, use the one that most closely results in the angles given on pages 3-4 through 3-6. If you cannot get close to the angles shown, use the next higher lashing size, or add four more lashings.

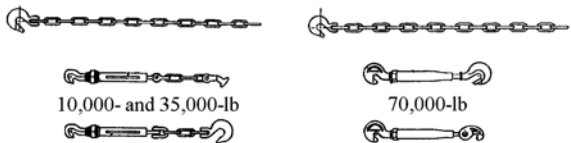
In the vehicle lashing sections, the lashing shown is meant to represent whatever lashing gear is available. You may have to use multiples of lashing gear to get the strength shown for a particular vehicle.

In some cases, a single line in an illustration may actually represent two separate lashings. Tables 3-1 and 3-2 give the strength capabilities of various lashing gear on FSS/LMSR and other ships, respectively. These tables can be used to determine the lashing required for any item based on the item's weight. For heavier vehicles, use the strongest lashing gear available. However, if a table or diagram requires 70,000-pound strength, but only 35,000-pound gear is available, use twice as many 35,000-pound devices as the number of 70,000-pound devices required.

NOTE

When using multiple lashings, always use the same size and type. If you mix types or sizes, the strengths will not add effectively, and the lashings may fail.

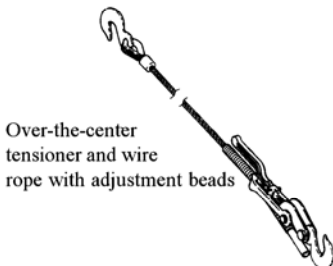
The lashing requirements and diagrams documented herein are based on sea state 7 conditions (between 25 and 40 foot seas depending on wind speed) and are necessarily conservative to account for the possibility of encountering rough seas. They apply to all ships listed in the Integrated Computerized Deployment System (ICODES). Therefore, this is a general guide that illustrates the maximum number of lashings that should be applied to safely secure equipment in stormy seas. However, in all matters of lashing onboard ships, the Master of the ship, as the person legally responsible for all activities onboard his/her ship, is the final approval authority. Frequently, the anticipated voyage will encounter lesser seas such that the actual required lashing size and number may be significantly lower. In such cases, the Master may appropriately determine that the requirements documented herein are overly conservative based on specific ship and/or voyage conditions. SDDCTEA is available to provide specific technical support on a case-by-case basis. For such support, contact Mr. Gary Horton at DSN 770-5765 or (618) 220-5765; Mr. John Newman at DSN 770-5263 or (618) 220-5765; or toll free at 1-800-722-0727.



Turnbuckle and chain (requires wrench - adjustable jaw, Crescent-type)



Over-the-center tensioner and chain



Over-the-center tensioner and wire rope with adjustment beads



Lever tensioner and chain

Vehicle Lashing Assemblies



Flush cloverleaf



D-ring

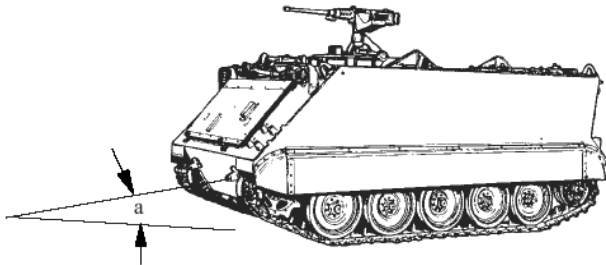


Raised cloverleaf

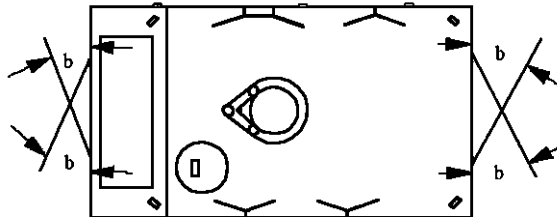
Deck Fittings

Types of lashing hardware on various RORO ships.

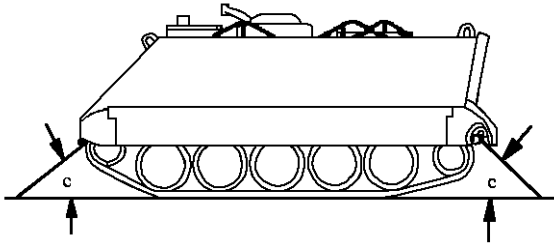
Angle a is the true angle between the deck and the lashing chain (or wire rope), measured on a plane perpendicular to the deck. Angles b and c are illustrated below.



Angle b is the projected angle between the front or rear edge of the vehicle (perpendicular to the vehicle's and ship's centerline) and the lashing chain (or wire rope), as viewed from above.

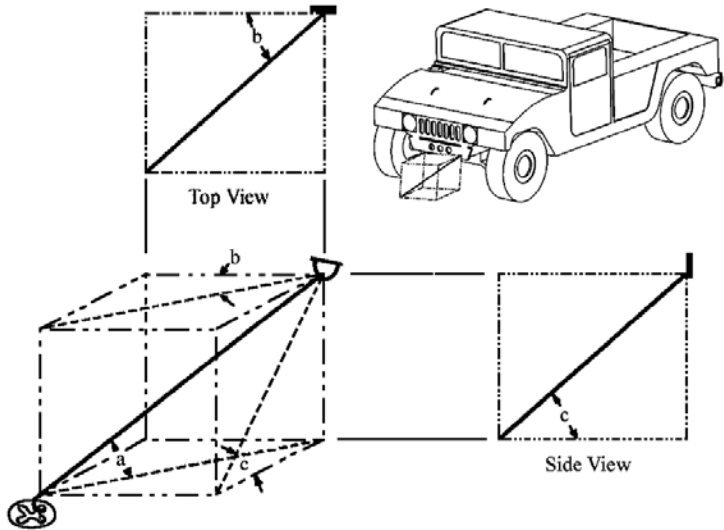


Angle c is the projected angle between the deck and the lashing chain (or wire rope), as viewed from the side (on a plane parallel to the ship's centerline).



Angle	FSS/LMSR	Other ships
a	25 degrees	25 degrees
b	35 degrees	40 degrees
c	39 degrees	36 degrees

Ideal tiedown angle



3-D View from Front

Ideal tiedown angle, continued

Table 3-1. FSS/LMSR Lashing Requirements.

For FSS/LMSR Only

Vehicle Weight	Lashing Strength	Total Number of Lashings Required
Up to 8,930 lb	5,000 lb	4
Up to 17,860 lb	10,000 lb	4
Up to 25,180 lb	14,100 lb	4
Up to 30,360 lb	17,000 lb	4
Up to 62,510 lb	35,000 lb	4
Up to 125,020 lb	70,000 lb	4
Up to 250,040 lb	70,000 lb	8

For FSS/LMSR Only – Metric

Vehicle Weight	Lashing Strength	Total Number of Lashings Required
Up to 4 050 kg	2 250 kg	4
Up to 8 100 kg	4 550 kg	4
Up to 11 420 kg	6 400 kg	4
Up to 13 770 kg	7 700 kg	4
Up to 28 350 kg	15 900 kg	4
Up to 56 710 kg	31 750 kg	4
Up to 113 420 kg	31 750 kg	8

Table 3-2. Other Ship Lashing Requirements.**For Other Ships Only**

Vehicle Weight	Lashing Strength	Total Number of Lashings Required
Up to 5,260 lb	5,000 lb	4
Up to 10,530 lb	10,000 lb	4
Up to 14,850 lb	14,100 lb	4
Up to 17,900 lb	17,000 lb	4
Up to 36,860 lb	35,000 lb	4
Up to 73,720 lb	70,000 lb	4
Up to 147,450 lb	70,000 lb	8

For Other Ships Only - Metric

Vehicle Weight	Lashing Strength	Total Number of Lashings Required
Up to 2 390 kg	2 250 kg	4
Up to 4 780 kg	4 550 kg	4
Up to 6 740 kg	6 400 kg	4
Up to 8 120 kg	7 700 kg	4
Up to 16 720 kg	15 900 kg	4
Up to 33 440 kg	31 750 kg	4
Up to 66 880 kg	31 750 kg	8

Section IV. Lashing Wheeled Vehicles

This section provides guidance on lashing wheeled vehicles. Throughout this section, lashing requirements are based on a universal four-lashing pattern - two fore and two aft. This is practical as long as the required gear is available.

If required lashing gear is not available, Table 4-1 may be used to determine alternate tiedown requirements. It applies to all of the illustrations and shows the lashing requirements for wheeled vehicles based on vehicle weight ranges and known lashing strengths. For example, if a diagram requires four 70,000-pound lashings, but only 35,000-pound lashings are available, Table 4-1 can be used to determine the required number - in this case, eight 35,000-pound chains versus four 70,000-pound chains.

Table 4-1. Lashing Requirements for Wheeled Vehicles.

FSS/LMSR		
Vehicle Weight	Lashing Strength	Total Number of Lashings Required
Up to 8,930 lb	5,000 lb	4
Up to 17,860 lb	10,000 lb	4
Up to 25,180 lb	14,100 lb	4
Up to 30,360 lb	17,000 lb	4
Up to 62,510 lb	35,000 lb	4
Up to 125,020 lb	70,000 lb	4
Up to 250,040 lb	70,000 lb	8
Other Ships		
Up to 5,260 lb	5,000 lb	4
Up to 10,530 lb	10,000 lb	4
Up to 14,850 lb	14,100 lb	4
Up to 17,900 lb	17,000 lb	4
Up to 36,860 lb	35,000 lb	4
Up to 73,720 lb	70,000 lb	4
Up to 147,450 lb	70,000 lb	8

Note that in some cases, diagrams are shown for unique vehicles and in others for vehicles that illustrate generic lashing procedures. For example, page 4-26 illustrates a heavy road grader so that the dunnage requirement for the grader blade is not overlooked. Page 4-13, on the other hand, is a generic cargo truck that applies to all 2-1/2- and 5-ton trucks. This approach helps reduce the size and complexity of the pamphlet.

Table 4-2 lists wheeled vehicles covered in this handbook.

Table 4-2. Wheeled Vehicles (Lashing).

Model	Item	Curb Weight (lb)	Gross Weight (lb)	Page
	Rough Terrain Forklift, Variable Reach	27,100	N/A	4-9
IHMEE	Interim High Mobility Engineer Excavator	25,480	N/A	4-10
LAV-25	Light Armored Vehicle	24,100	28,420	4-11
M10A	Trk, Forklift, 10,000 lb, RT	36,315	N/A	4-12
M35A1/2	Trk, Cargo, 2-1/2-ton, WWN	13,720	18,720	4-13
M49A2C	Trk, Tank, Fuel, 2-1/2-ton, WWN	14,860	19,180	4-13
M50A3	Trk, Tank, Water, 2-1/2-ton, WWN	15,150	19,400	4-13
M51A2	Trk, Dump, 5-ton, WWN	22,665	32,663	4-13
M52	Trk, Tractor, 5-ton	17,948	N/A	4-13
M62	Trk, Wrecker, Med, WWN	32,270	N/A	4-13
M63	Trk, Chassis, 5-ton, WWN	18,934	N/A	4-13
M109A3	Trk, Van, Shop, 2-1/2-ton, WWN	15,800	20,800	4-13
M246A2	Trk, Wrecker, Med, WWN	32,990	N/A	4-13
M275A2	Trk, Tractor, 2-1/2-ton, WWN	12,645	N/A	4-13
M291A1D	Trk, Van, Exp, 2-1/2-ton	25,572	N/A	4-13
M342A2	Trk, Dump, 2-1/2-ton, WWN	15,775	20,775	4-13
M543A2	Trk, Wrecker, Med, WWN	34,250	N/A	4-13
M621B	Tractor-scraper, wheeled	64,950	N/A	4-14
M813	Trk, Cargo, 5-ton	21,020	31,020	4-13
M813A1	Trk, Cargo, 5-ton, WWN	21,120	31,120	4-13
M814	Trk, Cargo, 5-ton, WWN	23,540	33,540	4-13
M815	Trk, Bolster, Log, 5-ton, WWN	21,040	31,040	4-13
M816	Trk, Wrecker, 5-ton, WWN	35,050	N/A	4-13
M817	Trk, Dump, 5-ton, WWN	23,755	33,755	4-13
M818	Trk, Tractor, 5-ton, WWN	20,165	N/A	4-13
M819	Trk, Wrecker, 5-ton, WWN	35,065	N/A	4-13
M820	Trk, Van, Expansibile, 5-ton	28,185	33,195	4-13
M820A2	Trk, Van, Expansibile, 5-ton	30,195	35,195	4-13

Table 4-2. Wheeled Vehicles (Lashing), continued

Model	Item	Curb Weight (lb)	Gross Weight (lb)	Page
M821	Trk, Stake, 5-ton, WWN	28,880	38,880	4-13
M911	Trk, Tractor, HET, 22-1/2-ton	39,952	N/A	4-13
M915	Trk, Tractor, Line Haul, 14-ton	18,500	N/A	4-13
M915A1	Trk, Tractor, Line Haul, 25-ton	18,900	N/A	4-13
M915A2	Trk, Tractor, Line Haul, 25-ton	18,680	N/A	4-13
M916	Trk, Tractor, LET	24,000	N/A	4-13
M916A1	Trk, Tractor, LET	27,740	N/A	4-13
M917	Trk, Dump, 20-ton	34,080	74,080	4-13
M918	Trk, Bituminous, 22-1/2-ton	29,839	74,839	4-13
M919	Trk, Concrete, Mixer, 22-1/2-ton	37,540	82,540	4-13
M920	Trk, Tractor, MET, 20-ton	26,200	N/A	4-13
M923	Trk, Cargo, 5-ton	21,770	32,070	4-13
M923A1	Trk, Cargo, 5-ton, WWN	23,275	33,275	4-13
M923A2	Trk, Cargo, 5-ton, WWN	20,930	30,930	4-13
M924	Trk, Cargo, 5-ton	21,370	31,370	4-13
M924A1	Trk, Cargo, 5-ton, WWN	23,175	33,175	4-13
M925	Trk, Cargo, 5-ton	22,750	32,750	4-13
M925A1	Trk, Cargo, 5-ton, WWN	23,275	33,275	4-13
M925A2	Trk, Cargo, 5-ton, WWN	22,030	32,030	4-13
M926	Trk, Cargo, 5-ton	22,470	32,470	4-13
M926A1	Trk, Cargo, 5-ton, WWN	23,175	33,175	4-13
M927A1	Trk, Cargo, 5-ton, WWN	26,135	36,135	4-13
M927A2	Trk, Cargo, 5-ton, WWN	23,790	33,790	4-13
M928A1	Trk, Cargo, 5-ton, WWN	26,135	36,135	4-13
M928A2	Trk, Cargo, 5-ton, WWN	24,890	34,890	4-13
M929	Trk, Dump, 5-ton	23,990	33,990	4-13
M929A1	Trk, Dump, 5-ton, WWN	26,165	26,165	4-13
M930	Trk, Dump, 5-ton	25,090	35,090	4-13
M930A1	Trk, Dump, 5-ton, WWN	26,165	36,165	4-13
M931	Trk, Tractor, 5-ton	20,510	N/A	4-13

Table 4-2. Wheeled Vehicles (Lashing), continued.

Model	Item	Curb Weight (lb)	Gross Weight (lb)	Page
M931A1	Trk, Tractor, 5-ton, WWN	22,240	N/A	4-13
M931A2	Trk, Tractor, 5-ton, WWN	19,895	N/A	4-13
M932	Trk, Tractor, 5-ton, WWN	21,150	N/A	4-13
M932A2	Trk, Tractor, 5-ton, WWN	20,995	N/A	4-13
M934	Trk, Van, Expansibile, 5-ton	28,440	38,440	4-13
M934A1	Trk, Van, Expansibile, 5-ton	29,280	34,280	4-13
M935A1	Trk, Van, Expansibile, 5-ton	31,280	36,280	4-13
M936	Trk, Wrecker, 5-ton, WWN	37,600	N/A	4-13
M936A1	Trk, Wrecker, 5-ton, WWN	38,155	N/A	4-13
M966	Trk, Tow Missile, (HMMWV)	5,269	8,128	4-15
M977	Trk, Cargo, 10-ton	35,500	60,000	4-16
M978	Trk, Tank, Fuel (HEMTT)	34,920	60,000	4-16
M983	Trk, Tractor, 10-ton (HEMTT)	38,660	N/A	4-16
M984	Trk, Wrecker, 10-ton (HEMTT)	42,215	N/A	4-16
M984A1	Trk, Cargo, 10-ton (HEMTT)	53,000	63,000	4-16
M985	Trk, Cargo, 10-ton (HEMTT)	38,271	60,000	4-16
M996	Trk, Amb, 2-liter (HMMWV)	5,800	8,600	4-15
M997	Trk, Amb, 1-1/4-ton (HMMWV)	5,800	8,600	4-15
M998	Trk, Utility, 3/4-ton (HMMWV)	7,400	7,700	4-15
M1008	Trk, Cargo, 1-1/4-ton (CUCV)	5,950	9,200	4-15
M1008A1	Trk, Utility, 1-1/4-ton (CUCV)	5,950	9,200	4-15
M1009	Trk, Utility, 1-1/4-ton (CUCV)	5,200	6,700	4-15
M1010	Trk, Amb, 1-1/4-ton (CUCV)	7,475	9,555	4-15
M1025	Trk, Armt, 1-1/4-ton (HMMWV)	6,104	8,200	4-15
M1026	Trk, Utility, 1-1/4-ton (HMMWV)	6,237	8,333	4-15
M1028	Trk, Cargo, 1-1/4-ton (CUCV)	5,750	9,350	4-15
M1028A2	Trk, Utility, 1-1/4-ton (CUCV)	6,120	10,120	4-15
M1035	Trk, Amb, 1-1/4-ton (HMMWV)	5,297	7,900	4-15
M1036	Anti-tank missile system(HMMWV)	6,200	8,200	4-15
M1037	Trk, Cargo, 1-1/4-ton (HMMWV)	5,484	8,660	4-15

Table 4-2. Wheeled Vehicles (Lashing), continued.

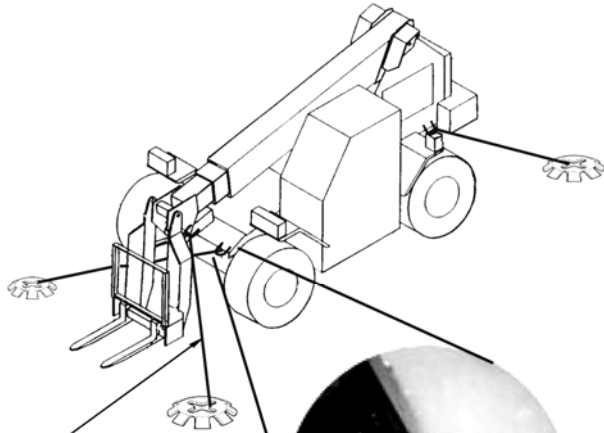
Model	Item	Curb Weight (lb)	Gross Weight (lb)	Page
M1038	Trk, Utility, 1-1/4-ton (HMMWV)	5,591	7,833	4-15
M1042	Trk, Shelter, 1-1/4-ton (HMMWV)	5,617	8,660	4-15
M1043	Trk, Armt, 1-1/4-ton (HMMWV)	7,673	8,473	4-15
M1044	Trk, Armt, 1-1/4-ton (HMMWV)	7,803	8,600	4-15
M1045	Trk, TOW, 1-1/4-ton (HMMWV)	7,549	8,149	4-15
M1046	Trk, TOW, 1-1/4-ton (HMMWV)	7,679	8,729	4-15
M1070	HET Tractor	40,999	N/A	4-13
M1074	PLS Truck w/flatrack	55,010	88,000	4-17
M1075	PLS Truck w/flatrack	49,520	82,960	4-17
M1076	PLS Trailer w/flatrack	16,530	49,520	4-19
M1078	LMTV, Cargo	18,137	23,137	4-11
M1079	LMTV, Van	19,879	24,879	4-11
M1081	LMTV, Cargo, A/D	19,379	24,379	4-11
M1083	MTV, Cargo, wwn	21,473	31,474	4-11
M1083	MTV, Cargo	20,497	30,497	4-11
M1084	MTV, Cargo, w/MHE	24,510	34,510	4-11
M1085	MTV, Long Cargo	22,978	32,978	4-11
M1086	MTV, Long Cargo, w/MHE	26,076	36,076	4-11
M1088	MTV, Tractor	19,251	N/A	4-11
M1089	MTV, Wrecker	33,810	N/A	4-11
M1090	MTV, Dump	23,082	33,082	4-11
M1093	MTV, Cargo, A/D	22,653	32,654	4-11
M1094	MTV, Dump, A/D	24,296	34,296	4-11
M1097	HHV, HMMWV Heavy Variant	5,600	10,001	4-15
M1113	Trk, Utility, Expanded Capacity (HMMWV)	6,400	11,500	4-20
M1114	Armt Carrier, Expanded Capacity (HMMWV)	9,800	12,100	4-20
M1117	Armored Security Vehicle (ASV)	12,428	12,428	4-11

Table 4-2. Wheeled Vehicles (Lashing), continued.

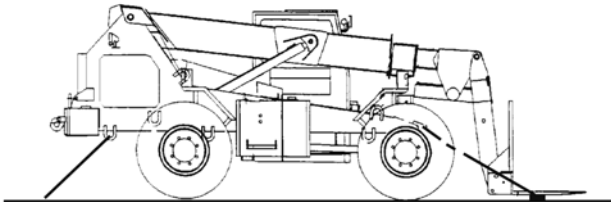
Model	Item	Curb Weight (lb)	Gross Weight (lb)	Page
M1120	Heavy Expanded Mobility Tactical Trk (HEMTT)	35,300	57,300	4-17
M1126	Stryker Infantry Carrier Vehicle with Slat Armor	35,574	40,836	4-21
M1127	Stryker Reconnaissance Vehicle with Slat Armor	39,574	44,836	4-21
M1128	Stryker Mobile Gun System with Slat Armor	36,403	40,168	4-21
M1129	Stryker Mortar Carrier with Slat Armor	40,403	44,168	4-21
M1130	Stryker Commander's Vehicle with Slat Armor	37,311	43,172	4-21
M1131	Stryker Fire Support Vehicle with Slat Armor	41,754	47,172	4-21
M1132	Stryker Engineering Squad Vehicle with Slat Armor	38,807	41,923	4-21
M1133	Stryker Medical Evacuation Vehicle with Slat Armor	42,807	45,923	4-21
M1134	Stryker Anti-Tank Guided Missile with Slat Armor	36,614	39,243	4-21
M1151	Trk, Utility, Expanded Capacity (HMMWV)	40,614	43,243	4-21
M1152	Trk, Utility, Expanded Capacity (HMMWV)	36,364	38,743	4-21
MT250	Crane, Truck-Mounted, 25-ton	40,364	42,743	4-21
MT300	Crane, Truck-Mounted, 35-ton	36,425	42,166	4-21
MW24C	Loader, Scoop, Wheel	40,425	46,166	4-21
		37,480	39,720	4-21
		41,480	43,720	4-21
		38,959	41,478	4-21
		42,959	45,478	4-21
		7,460	11,500	4-20
		6,400	11,500	4-20
		65,800	N/A	4-22
		69,910	N/A	4-22
		26,540	N/A	4-12

Table 4-2. Wheeled Vehicles (Lashing), continued.

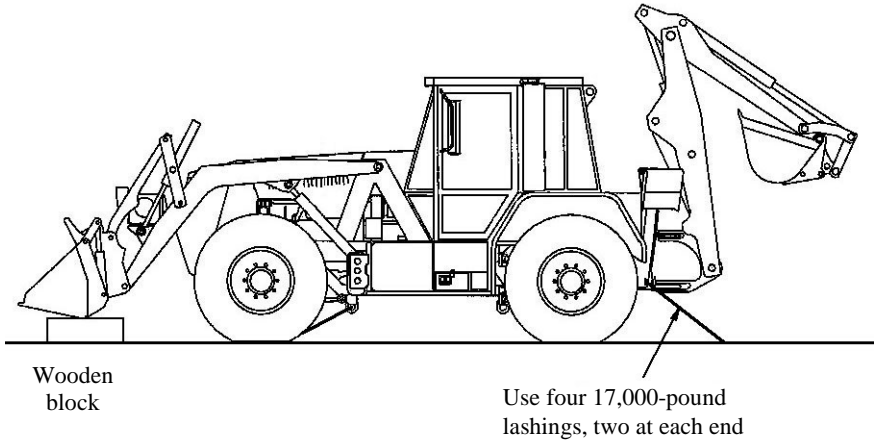
Model	Item	Curb Weight (lb)	Gross Weight (lb)	Page
RTCH	Rough Terrain Container Handler	118,040	N/A	4-23
RT240	Rough Terrain Container Handler (RTCH) Kalmar	118,000	N/A	4-24
SEE	Small Emplacement Excavator	15,920	N/A	4-25
130G	Grader, road, heavy	31,900	N/A	4-26
7-1/2-ton	Crane, Rough Terrain	24,230	N/A	4-27



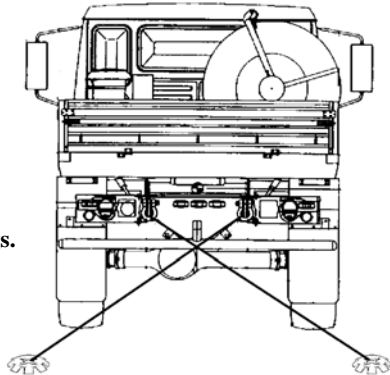
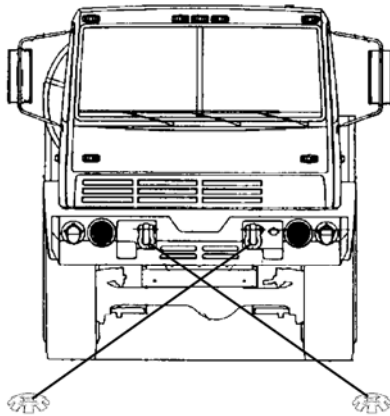
Use four 35,000-pound lashings, two at each end.



Variable reach rough terrain forklift, 6,000-pound.



Interim High Mobility Engineer Excavator.

**NOTE**

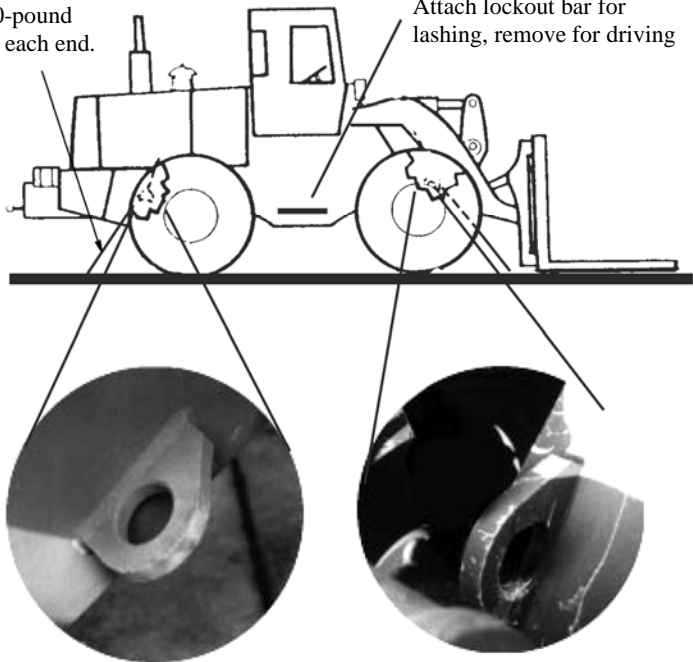
Refer to Table 4-1,
page 4-2, for strength
and number of lashings.

Other similar lashings: LAV-25, M1078, M1079, M1081, M1083, M1084, M1085, M1086, M1088, M1089, M1090, M1093, M1094, M1117 (ASV)

Family of medium tactical vehicles (FMTV).

Use four 35,000-pound lashings, two at each end.

Attach lockout bar for lashing, remove for driving



CAUTION

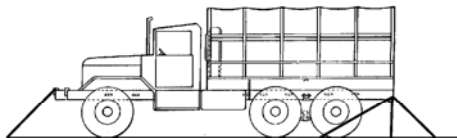
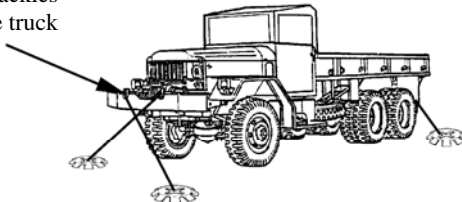


For a vehicle like this, where the tiedown would touch part of the vehicle that is not the tiedown provision, it is better not to cross the tiedowns.

Other similar lashings: MW24C

Rough terrain forklift truck (M10A) 10,000-pound.

You may lash either the upper or lower shackles on the front of the truck

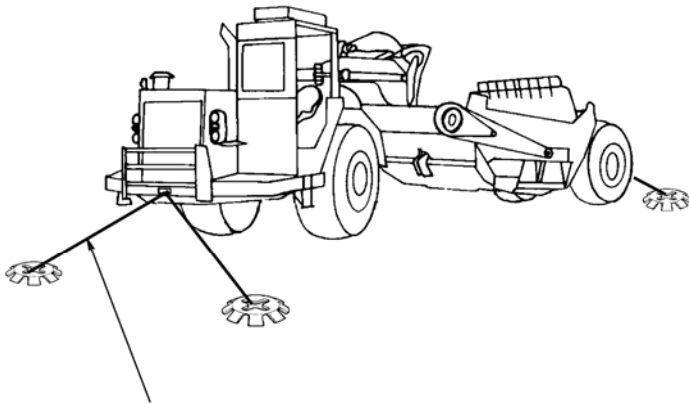


Do not wrap chain around bumperette.
Lash to the shackle inside the bumperette.

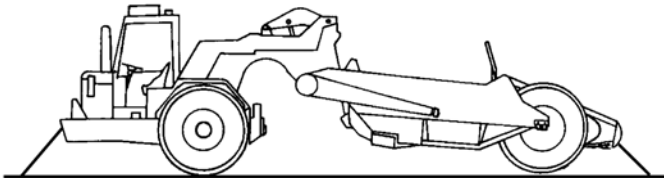
NOTE

Refer to Table 4-1, page 4-2, for strength and number of lashings.

Trucks, 2-1/2, 5, 14, 20, 22-1/2, and 25-ton.



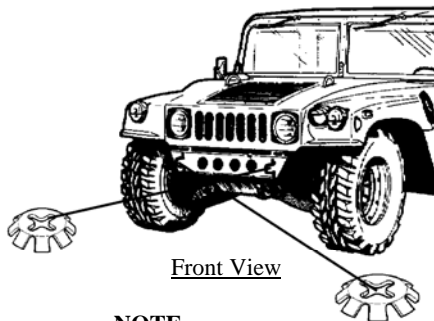
Use four 70,000-pound lashings, two at each end



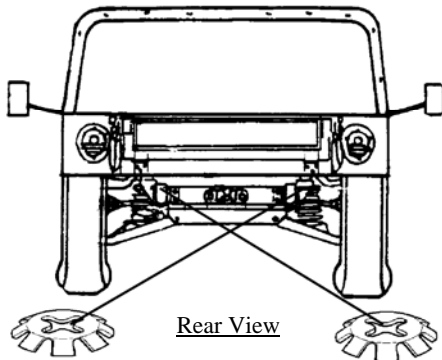
NOTE

Attach lockout bar for lashing, remove for driving.

Tractor-scraper, wheeled, M621B.

**NOTE**

Refer to Table 4-1, page 4-2, for strength and number of lashings.

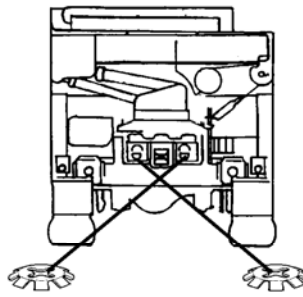


Other similar lashings: M966, M997, M998, M1008, M1008A1, M1009, M1010, M1025, M1026, M1028, M1028A2, M1035, M1036, M1037, M1038, M1042, M1043, M1044, M1045, M1046, M1097

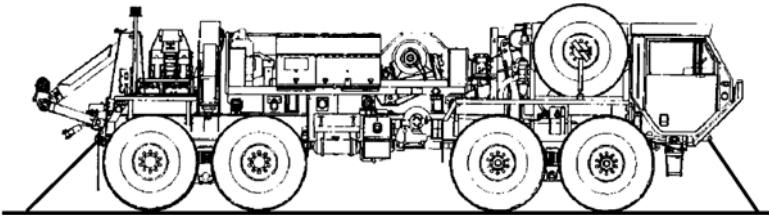
High mobility multipurpose wheeled vehicle (HMMWV).



Front View



Rear View



Side View

NOTE

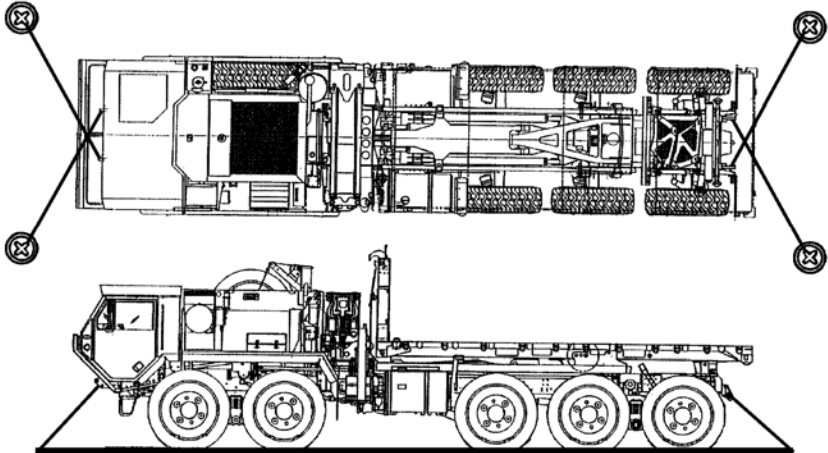
Refer to Table 4-1, page 4-2, for strength and number of lashings.

Other similar lashings: M977, M978, M983, M984, M984A1, and M985.

Heavy expanded mobility tactical truck (HEMTT).

FSS/LMSR - Four 70,000-pound lashings, two at each end.

Other Ships - Four/eight 70,000-pound lashings, two at each end up to 73,720 pounds, four at each end if over 73,720 pounds.



NOTE

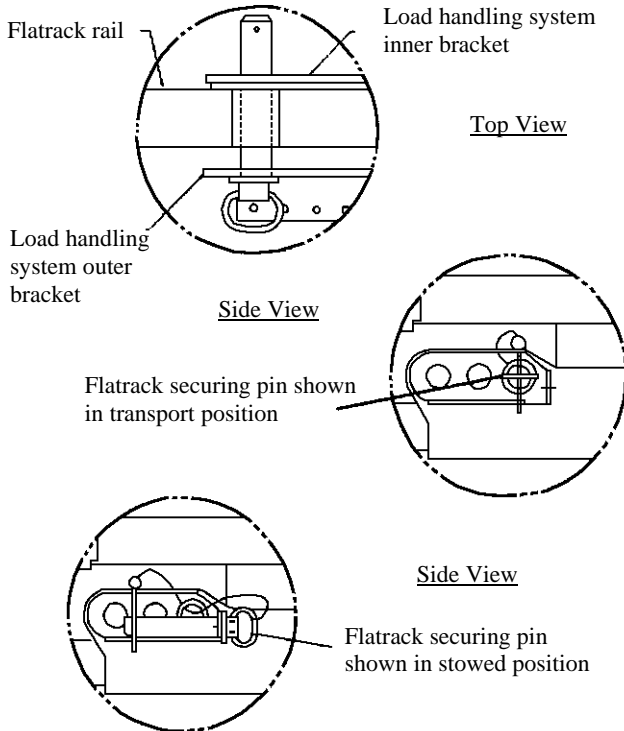
See page 4-18 for details.

Other similar lashings: M1120 HEMTT

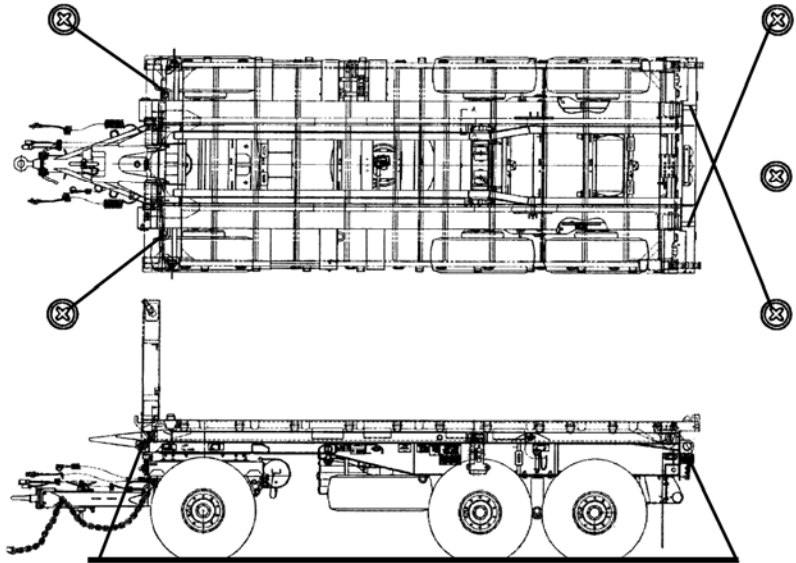
M1074/M1075 PLS truck with flatrack.

NOTE

Shippers must ensure the flatrack is secured to the truck using the two securement pins prior to lifting to prevent the flatrack from shifting.



M1074/M1075 PLS truck with flatrack, continued.



NOTE

See page 4-18 for pin procedure and refer to table 4-1, page 4-2, for strength and number of lashings.

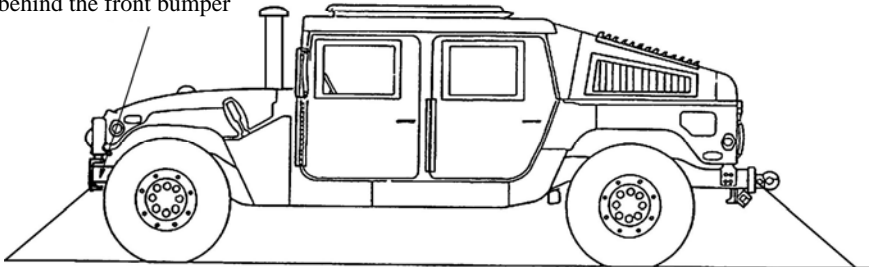
CAUTION



Raise trailer tongue and secure with straps provided with trailer after trailer is in position.

M1076 PLS trailer with flatrack.

Front tiedowns are located
behind the front bumper

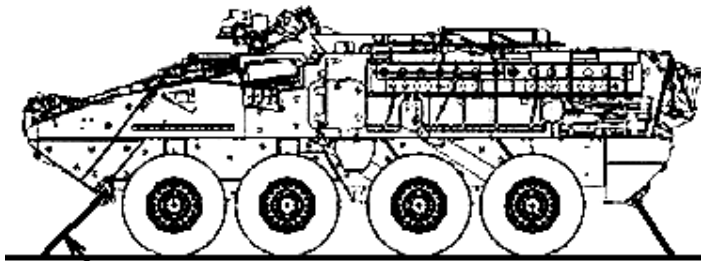


NOTE

Refer to Table 4-1, page 4-2, for strength and number of lashings.

Other similar lashings: M1113, M1151, M1152

M1114 Utility Truck, Expanded Capacity (HMMWV)



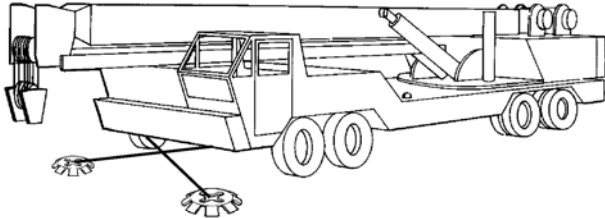
Use four 35,000-pound lashings, two at each end

NOTE

The tiedown is the same with or without armor.

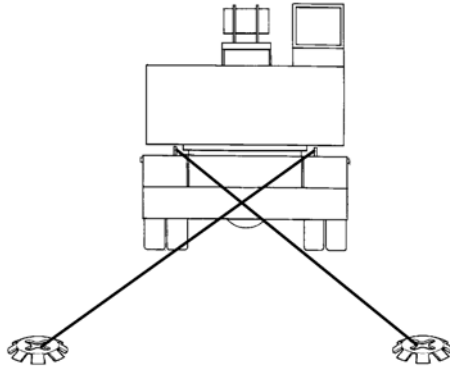
Other similar lashings: M1127, M1128, M1129, M1130, M1131, M1132, M1133, M1134.

M1126, Stryker, Infantry Carrier Vehicle



NOTE

Refer to Table 4-1, page 4-2, for strength and number of lashings.

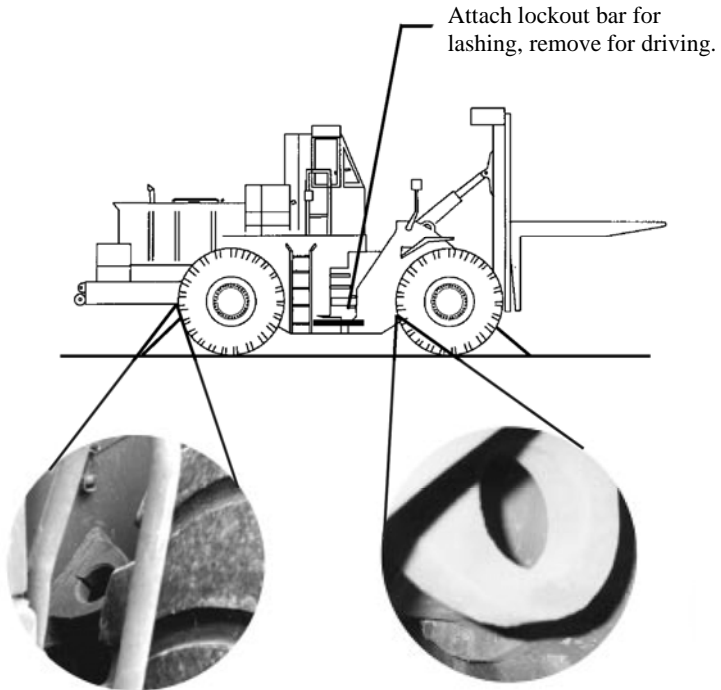


Other similar lashings: 25-ton and 40-ton cranes

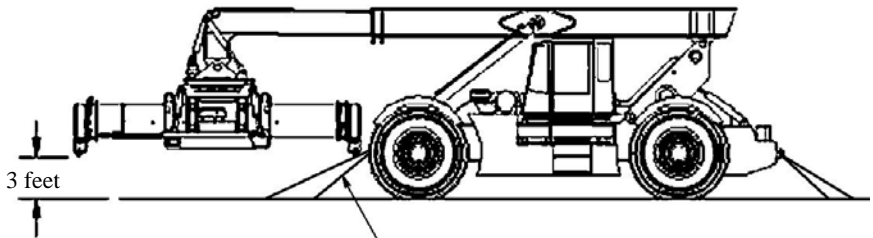
Crane, truck, mounted, hydraulic, 35-ton, MT-300

FSS/LMSR - Four 70,000-pound lashings, two at each end.

Other Ships - Eight 70,000-pound lashings, four at each end.



Rough terrain container handler (RTCH).



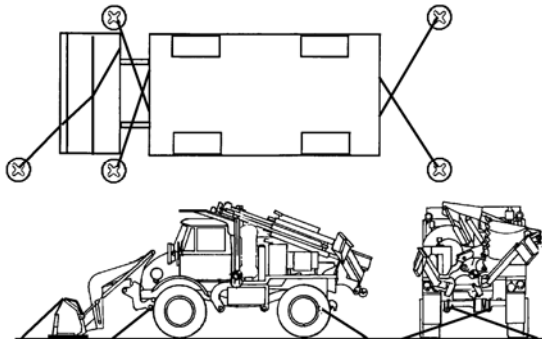
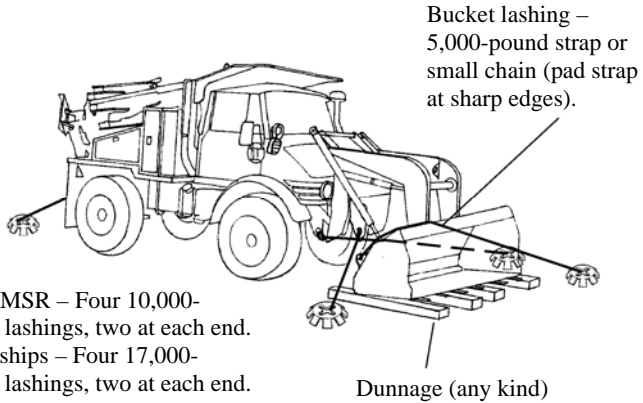
Use eight 70,000-pound lashings, two at each end.

CAUTION



The top handler is NOT lashed down for marine transport

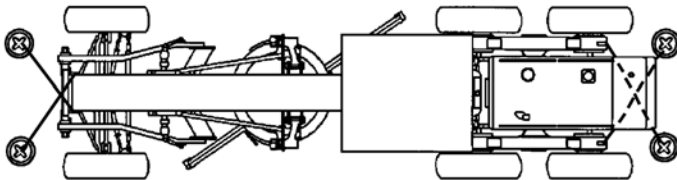
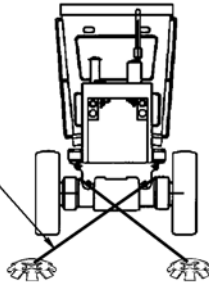
RT240 Rough Terrain Container Handler (RTCH) Kalmar



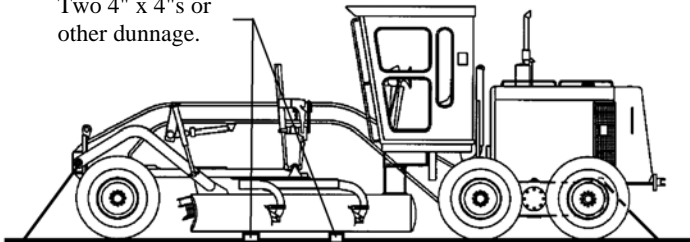
Other similar lashings: High Mobility Entrencher (HME) and High Mobility Material Handler (HMMH)

Small emplacement excavator (SEE).

Use four 35,000-pound lashings, two at each end.



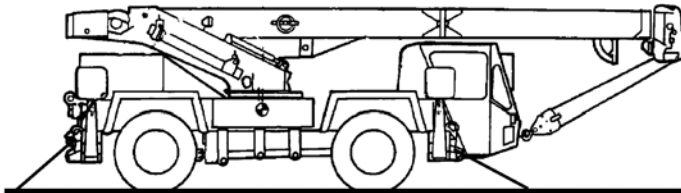
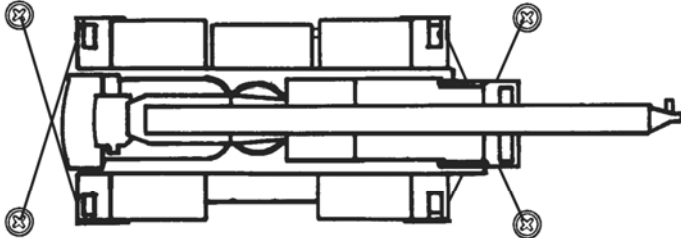
Two 4" x 4"s or other dunnage.



Grader, road, heavy, 130G MIL, 32,000 pound.

FSS/LMSR - Four 14,100-pound lashings, two at each end.

Other Ships - Four 35,000-pound lashings, two at each end.



Crane, 7-1/2-ton, rough terrain, Koehring.

Section V. Lashing Trailers

This section provides guidance that applies to lashing trailers. Whenever possible, trailers should be towed aboard ship by, and stowed with, their prime movers as shown on page 5-10. Likewise, fifth-wheel semitrailers should always be coupled to their prime mover when stowed (see page 5-10). In both cases, the trailer and prime mover should be lashed as if they were separate, using Table 5-1 to determine the number and strength of the lashings required. This eliminates the need for blocking under the lunette or kingpin.

When semitrailers are stowed without their prime mover, they must be placed on a stanchion. If the semitrailer is not loaded, the landing legs may be used instead of a stanchion. See page 5-5 for details. The stanchion should be centered under the kingpin. Place shoring under the landing legs, and lower them until they make contact with the shoring. Plywood cut slightly larger than the landing leg works well.

If a trailer is loaded without its prime mover, a front support will be required if the trailer is loaded or used as a machinery platform such that equipment is in danger of tipping over (see page 5-16). If a front support is not required, plywood or similar blocking should be placed under the tow bar to prevent metal-to-metal contact with the deck as shown on page 5-6.

The diagrams in this section typically show trailers that illustrate generic lashing procedures. For example, page 5-6 applies to all one and two-axle trailers.

Table 5-2 lists trailers addressed in this handbook.

Table 5-1. Lashing Requirement for Trailers.

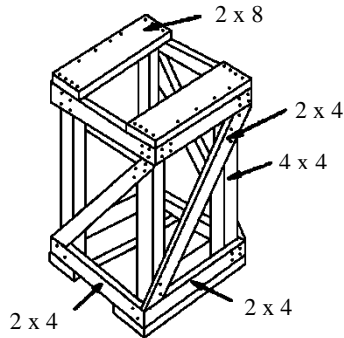
FSS/LMSR		
Vehicle Weight	Lashing Strength	Total Number of Lashings Required
Up to 8,930 lb	5,000 lb	4
Up to 17,860 lb	10,000 lb	4
Up to 25,180 lb	14,100 lb	4
Up to 30,360 lb	17,000 lb	4
Up to 62,510 lb	35,000 lb	4
Up to 125,020 lb	70,000 lb	4
Up to 250,040 lb	70,000 lb	8
Other Ships		
Up to 5,260 lb	5,000 lb	4
Up to 10,530 lb	10,000 lb	4
Up to 14,850 lb	14,100 lb	4
Up to 17,900 lb	17,000 lb	4
Up to 36,860 lb	35,000 lb	4
Up to 73,720 lb	70,000 lb	4
Up to 147,450 lb	70,000 lb	8

Table 5-2. Trailers (Lashing).

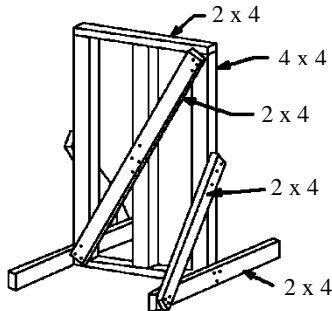
Model	Item	Curb Weight (lb)	Gross Weight (lb)	Page
M101A2	Trlr, Cargo, 3/4-ton	1,280	2,780	5-6
M105A2	Trlr, Cargo 1-1/2-ton	2,750	5,750	5-6
M107A1/A2	Trlr, Tank, Water, 1-1/2-ton	2,280	5,280	5-6
M116A2	Trlr, Cargo, 3/4-ton, 2 wheel	740	2,780	5-6
M118A1	Semitrlr, Stake, 6-ton	8,060	20,090	5-8
M119A1	Semitrlr, Van, Cargo, 6-ton	8,140	20,470	5-8
M127A1C	Semitrlr, Stake, 12-ton	13,840	36,840	5-8
M128A1C	Semitrlr, Van, Cargo, 12-ton	15,220	39,220	5-8
M129A2C	Semitrlr, Van, Supply, 12-ton	15,400	39,400	5-8
M131A4	Semitrlr, Fuel, 5000 Gal.	12,900	36,165	5-9
M146	Semitrlr, Van, Shop, 6-ton	7,300	19,330	5-8
M149A2	Trlr, Tank, Water, 1-1/2-ton	2,730	6,062	5-6
M172A1	Semitrlr, Lowbed, 15-25-ton	16,600	16,600	5-10
M270A1	Semitrlr, Lowbed	17,500	17,500	5-10
M310	Trlr, Cable, Reel, 3-1/2-ton	2,950	9,950	5-6
M313	Semitrlr, Van, Expand, 6-ton	15,350	27,350	5-8
M332	Trlr, Ammo/Gen Cargo, 1-1/2-ton	2,875	5,875	5-6
M349A1	Semitrlr, Van, Refr, 7-1/2-ton	8,750	23,750	5-8
M373A2	Semitrlr, Van, Electronic, 6-ton	9,430	21,430	5-8
M416A1	Trlr, Cargo, 1/4-ton Semitrler, Van, Shop, 6-ton	670	1,170	5-6
M447	Semitrlr, Van, Shop, 6-ton	13,080	25,080	5-8
M747	Semitrlr, Lowbed, HET, 60-ton	31,000	71,000	5-11
M777	Lightweight, 155mm Howitzer	9,400	9,400	5-12
M870A1	Trlr, Lowbed, 40-ton	16,500	96,500	5-10
M871	Semitrlr, Flatbed, 22-1/2-ton	15,900	60,900	5-13
M871A1	Semitrlr, Flatbed, 22-1/2-ton	15,630	61,630	5-13
M871A3	Semitrlr, Flatbed	17,600	45,000	5-13
M872	Semitrlr, Flatbed, 22-1/2-ton	17,400	84,600	5-13

Table 5-2. Trailers (Lashing), continued.

Model	Item	Curb Weight (lb)	Gross Weight (lb)	Page
M872A1	Semitr, Flatbed, 34-ton	19,240	86,440	5-13
M902	PATRIOT Launcher Trlr	35,000	58,500	5-14
M967	Semitr, fuel, 5000 Gal.	13,000	46,950	5-9
M967A1	Semitr, fuel, 5000 Gal.	13,000	46,950	5-9
M967A2	Semitr, fuel, 5000 Gal.	16,700	48,200	5-9
M969	Semitr, fuel, 5000 Gal.	15,000	48,950	5-9
M969A1	Semitr, fuel, 5000 Gal.	15,000	48,950	5-9
M969A2	Semitr, fuel, 5000 Gal.	16,500	50,450	5-9
M969A3	Semitr, fuel, 5000 Gal.	17,600	52,300	5-9
M970A1	Semitr, fuel, 5000 Gal.	15,210	15,210	5-9
M970A2	Semitr, fuel, 5000 Gal.	16,810	16,810	5-9
M989A1	Trlr, (HEMAT)	10,650	10,650	5-15
M1000	Semitr, HET	50,400	100,400	5-11
M1048	Trlr, MTSS, 6-1/2-ton	7,940	19,940	5-16
M1061	Trlr, Flatbed, 5-ton	5,850	15,000	5-6
M1061A1	Trlr, Gen. Purp, 5-ton	5,850	15,000	5-6
M1073	Trlr, Flatbed, 7-1/2-ton	6,640	20,255	5-6
M1082	FMTV 2-1/2-ton Trlr	6,860	11,500	5-6
M1095	FMTV 5-ton Trlr	9,202	20,000	5-6
M1098	Semitr, fuel, 5000 Gal.	16,810	55,810	5-9
M1112	400 Gallon Water Trlr	3,945	11,200	5-6
HP15T	Trlr, Flatbed, Tilt Deck, 15-ton	8,000	38,000	5-6
PU-732/M	Trlr, Power Unit	N/A	6,080	5-6
	ISO container on chassis	10,710	52,000	5-17



Center Under Kingpin



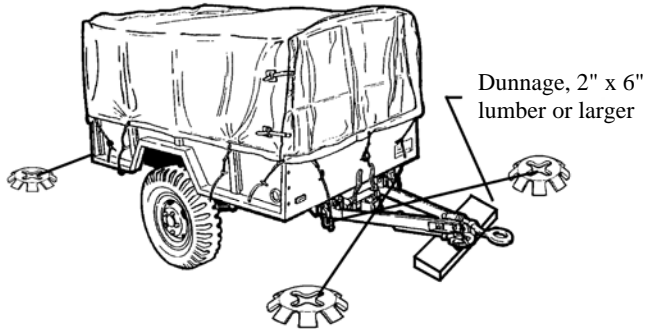
Place Against Back Side of Kingpin

NOTES

These are nominal dimensions and are in inches.

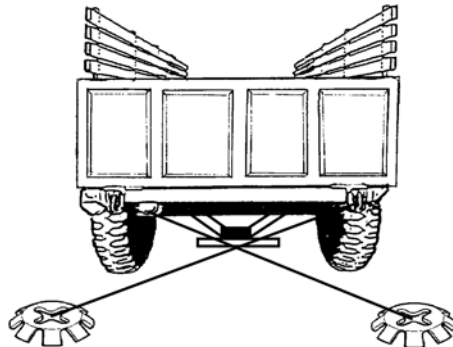
Lengths may vary depending on the height of the kingpin.

Semitrailer stanchions.

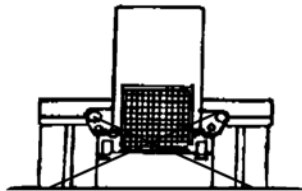
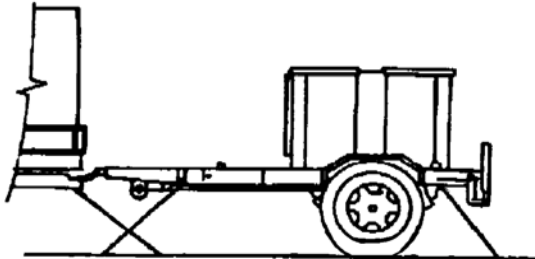


NOTE
Refer to Table 5-1, page 5-2,
for strength and number of
lashings.

WARNING
Do not allow tiedowns
to pinch hoses or wires.
Run lashings under trailer
tongue if necessary.



One- and two-axle trailers.

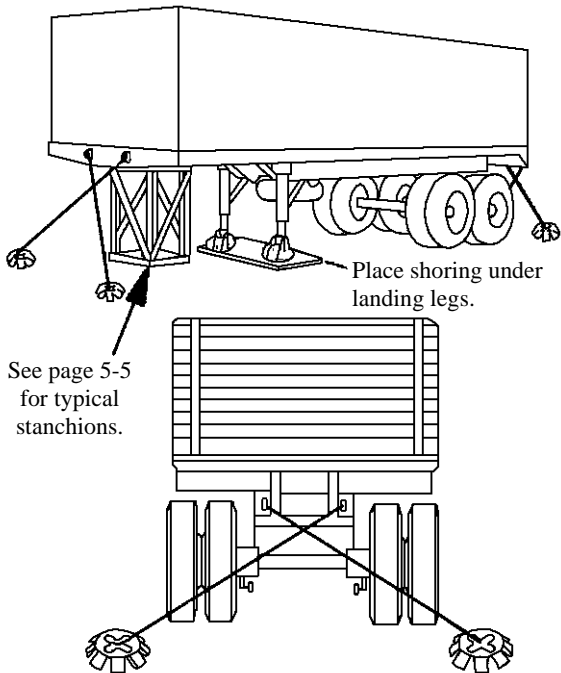


NOTE

Attach lashings to the trailer as if it were being secured separately.

Refer to Table 5-1, page 5-2, for strength and number of lashings.

One- and two-axle trailers coupled to vehicles.



NOTE
Refer to Table 5-1,
page 5-2, for strength and
number of lashings.

Other similar lashings: M118, M119, M127, M128, M129, M146, M269, M270, M349, M373, M447, and one- and two-axle semitrailers in general.

Semitrailers

Empty:

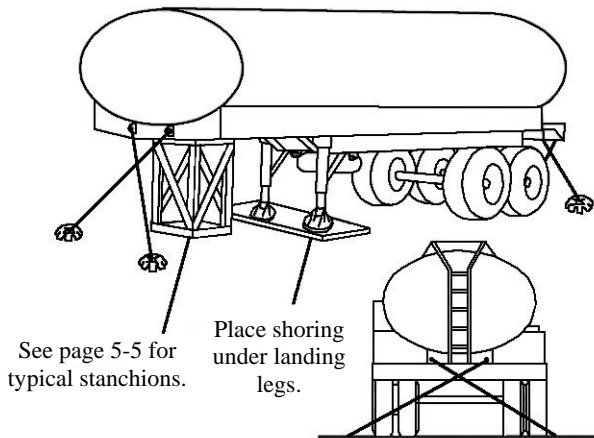
FSS/LMSR - Four 10,000-pound lashings, two at each end.

Other Ships - Four 17,000-pound lashings, two at each end.

Full:

FSS/LMSR - Four 35,000-pound lashings, two at each end.

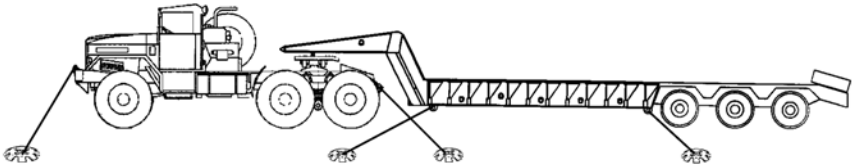
Other Ships - Four 70,000-pound lashings, two at each end.



Other similar lashings: M967, M967A1, M967A2, M969, M969A1, M969A2, M969A3, M970A1/A2, M1071, M1098.

Tanker semitrailer, M131A4

Leave tractor and semitrailer coupled together and lash as if they were separate. See page 5-11 for the semitrailer.



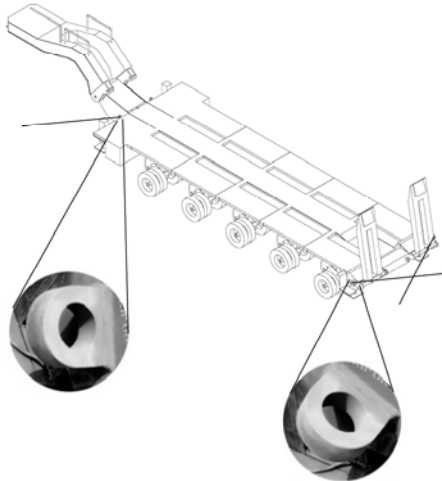
NOTE

Refer to Table 5-1, page 5-2, for strength and number of lashings.

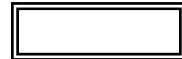
Other similar lashings: M172A1, M270A1

M870A1 Trailer, Lowbed, 40-ton

NOTE
Refer to Table 5-1,
page 5-2, for strength and
number of lashings.



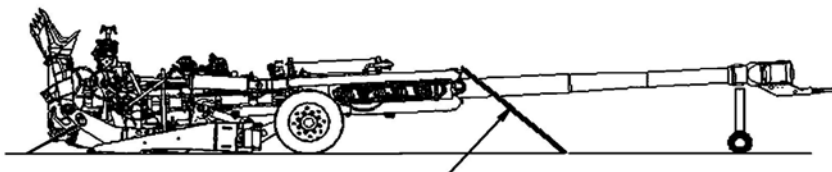
CAUTION



The M1000 is restricted to a 50,500-pound payload. Also, ensure the hydraulic fifth wheel is in the locked position.

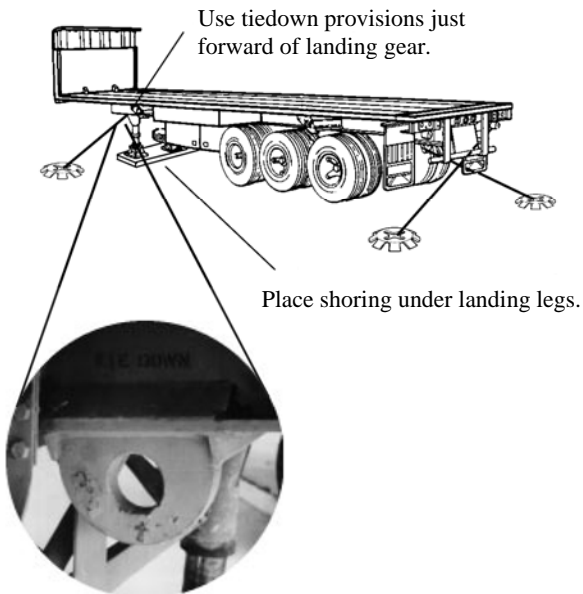
Other similar lashings: M747

M1000 semitrailer HET.



Use four 10,000-pound lashings.

M777, lightweight, 155mm howitzer



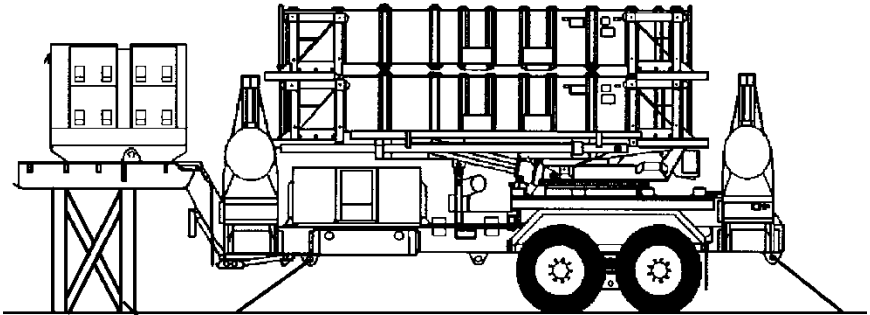
NOTES

Refer to Table 5-1, page 5-2, for strength and number of lashings.

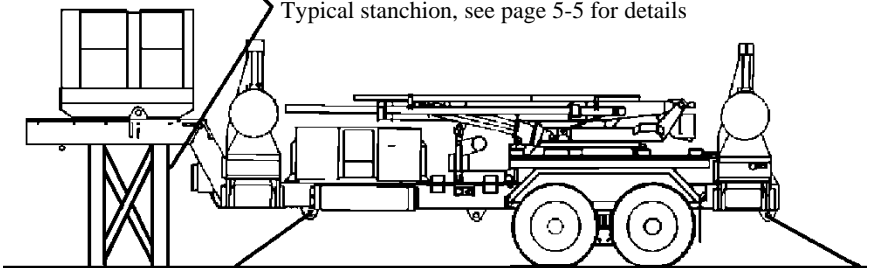
If the semitrailer is loaded, use a stanchion as shown on page 5-5.

Other similar lashings: M871 and flatbed semitrailers in general

Flatbed semitrailer, 34-ton, M872.



With missiles



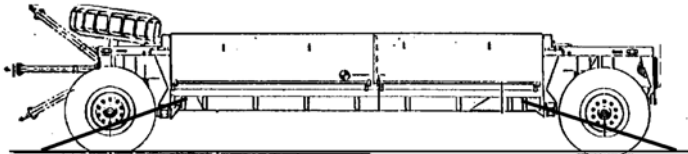
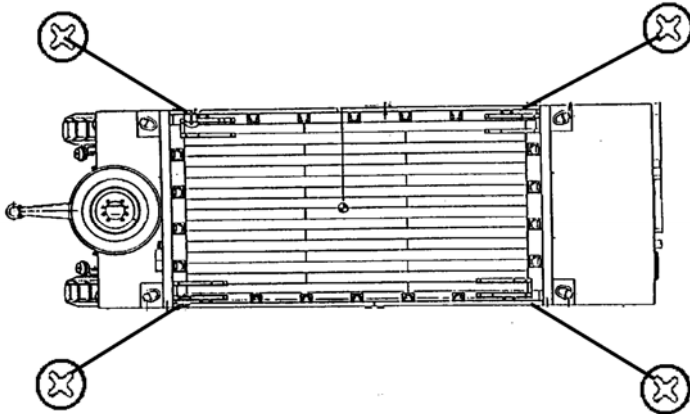
Typical stanchion, see page 5-5 for details

Without missiles

NOTE

Refer to Table 5-1, page 5-2, for strength and number of lashings

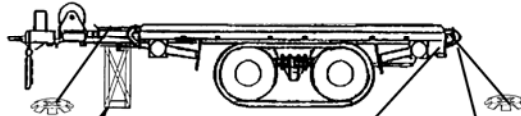
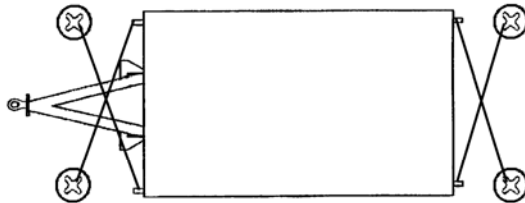
M902, PATRIOT launcher trailer.



NOTE

Refer to Table 5-1, page 5-2, for strength and number of lashings.

M989A1, heavy expanded mobility ammunition trailer (HEMAT).



See page 5-5 for typical stanchion.

The hook shown in the provision is securing equipment to the trailer.

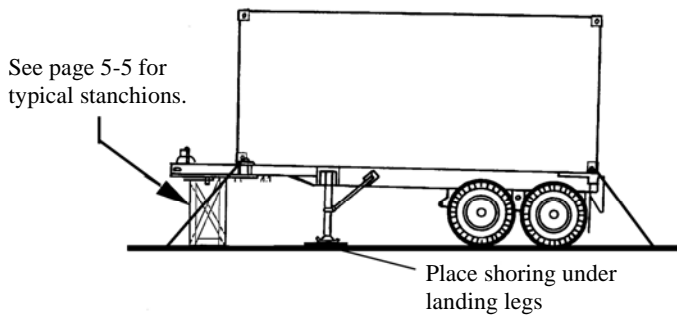
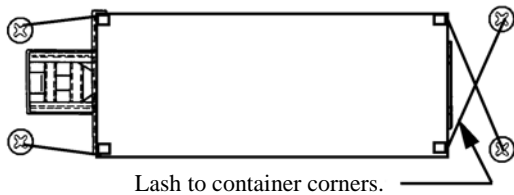


NOTE

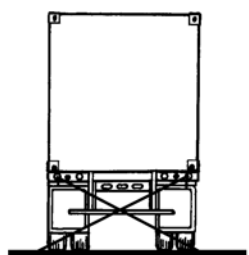
Refer to Table 5-1, page 5-2, for strength and number of lashings.

Other similar lashings: M1061, M1061A1, M1073, HP15T, M989

M1048, trailer, TSS.



NOTE
Refer to Table 5-1,
page 5-2, for strength
and number of
lashings.



ISO container or shelter on chassis.

Section VI. Lashing Tracked Vehicles

This section provides guidance on lashing tracked vehicles. Throughout this section, lashing requirements are based on the universal four-lashing pattern - two fore and two aft. However, eight or more lashings may be required, depending on the vehicle weight and available lashing strength. For example, an M1 tank combat loaded to 137,360 pounds would require eight 70,000-pound lashings or sixteen 35,000-pound lashings. Table 6-1 should be used to determine the actual number of lashings required for a given vehicle weight.

Note that in some cases, diagrams are shown for unique vehicles and in others for vehicles that illustrate generic lashing procedures. For example, page 6-5 illustrates the D7 Caterpillar tractor with blade and ripper so that shoring requirements are not overlooked. Page 6-10, on the other hand, is a generic medium tracked vehicle representing the M113 family and similar vehicles. This approach helps reduce the size and complexity of the pamphlet.

Note that tracked vehicles are typically classified as high density loads. Therefore, they are usually stowed below the weatherdeck to help optimize the ship's trim and stability by keeping the ship's overall center of gravity as low as possible (combats the tendency to roll). This will likely ensure that these vehicles will not experience the full effect of the load factors described in Appendix A. Based on these observations, Table 6-1 is considered to be conservative to the extent that lashing requirements shown therein should not be exceeded.

Table 6-2 lists the tracked vehicles included in this handbook.

Table 6-1. Lashing Requirements for Tracked Vehicles.

FSS/LMSR		
Vehicle Weight	Lashing Strength	Total Number of Lashings Required
Up to 8,930 lb	5,000 lb	4
Up to 17,860 lb	10,000 lb	4
Up to 25,180 lb	14,100 lb	4
Up to 30,360 lb	17,000 lb	4
Up to 62,510 lb	35,000 lb	4
Up to 125,020 lb	70,000 lb	4
Up to 250,040 lb	70,000 lb	8
Other Ships		
Up to 5,260 lb	5,000 lb	4
Up to 10,530 lb	10,000 lb	4
Up to 14,850 lb	14,100 lb	4
Up to 17,900 lb	17,000 lb	4
Up to 36,860 lb	35,000 lb	4
Up to 73,720 lb	70,000 lb	4
Up to 147,450 lb	70,000 lb	8

Table 6-2. Tracked Vehicles (Lashing).

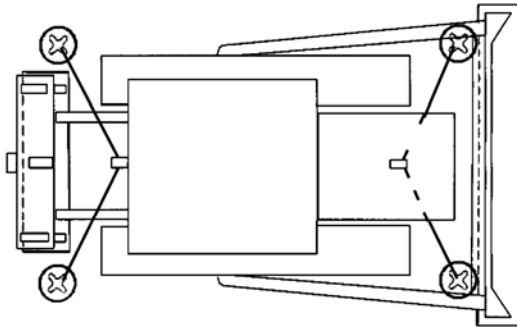
Model	Item	Curb Weight (lb)	Gross Weight (lb)	Page
D7	Caterpillar Tractor, with blade and ripper	38,196	52,450	6-5
M1	Tank, Combat	N/A	123,000	6-6
M1A1	Tank, Combat	125,000	135,200	6-6
M1A2	Tank, Combat	128,600	137,400	6-6
M2	Vehicle, Infantry Fighting	N/A	47,000	6-8
M2A1	Vehicle, Infantry Fighting	43,132	50,617	6-8
M2A2	Vehicle, Infantry Fighting	53,247	67,282	6-8
M2A3	Vehicle, Infantry Fighting	64,858	73,000	6-8
M2A6	Bradley Linebacker	64,858	73,000	6-8
M3	Vehicle, Infantry Fighting	N/A	48,450	6-8
M3A1	Vehicle, Infantry Fighting	42,502	50,190	6-8
M3A2	Vehicle, Infantry Fighting	53,157	67,213	6-8
M88A1E1	Vehicle, Recovery	110,000	112,000	6-6
M9	Earthmover, Armored Combat	36,000	54,000	6-9
M106A2	Carrier, Mortar, 107-mm	25,044	26,876	6-10
M109A6	Howitzer, 155-mm, Med, SP	56,000	64,200	6-11
M110A2	Howitzer, 8-in., Hvy, SP	55,800	62,500	6-11
M113A1	Carrier Personnel	21,887	25,007	6-10
M113A3	Carrier Personnel	23,880	27,180	6-10
M125A2	Carrier, Mortar, 81-mm	23,424	25,256	6-10
M270	Mult. Launch Rocket System (MLRS)	46,000	56,200	6-8
M548A1/A3	Carrier, Cargo, 6-ton	15,322	28,290	6-10
M577A2	Carrier, Command Post	24,142	25,813	6-10
M728	Vehicle, Cbt Engr, Full Track	N/A	117,400	6-6
M901A1	Vehicle, Cbt, Improved TOW	N/A	26,000	6-10
M992	Vehicle, Field Arty Ammo Spt	46,500	58,500	6-11
M992A1	Carrier, Ammo	46,800	57,000	6-11
M992A2	Carrier, Ammo	42,600	63,600	6-11

Table 6-2. Tracked Vehicles (Lashing) continued.

Model	Item	Curb Weight (lb)	Gross Weight (lb)	Page
M1015A1	Carrier, Full Track	17,390	26,785	6-10
M1059	Carrier, Smoke Gen.	23,700	24,400	6-10
M1068A3	Carrier Command Post	23,398	27,130	6-10

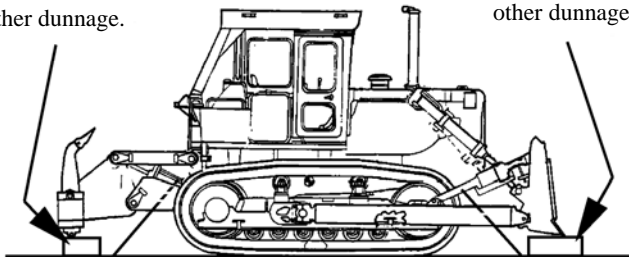
FSS/LMSR - Four 35,000-pound lashings, two at each end.

Other Ships - Four 70,000-pound lashings, two at each end.

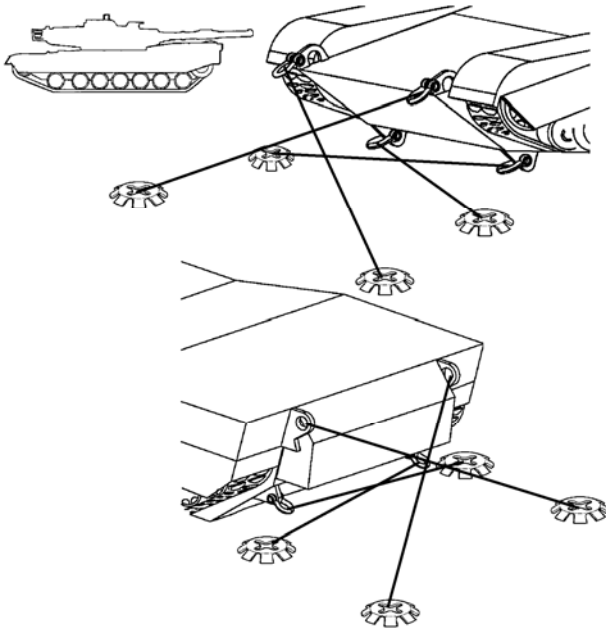


Two 4" x 4"s or
other dunnage.

Two 4" x 4"s or
other dunnage.



D7 Caterpillar tractor with blade and ripper

**NOTES**

See page 6-7 for information on the proper and alternate shackles.

See Table 6-1, page 6-2 for required number of lashings.

Other similar lashings: M1A1, M1A2, M88A1, M88A1E1, M728

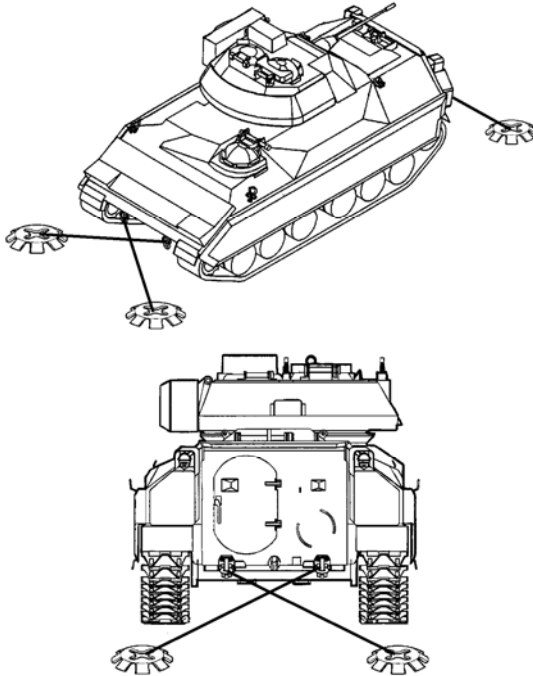
M1 tank, combat.

Shackles for Lashing M1 Series Vehicles

The tank must have six shackles, each with a minimum working load limit (WLL) of 14 short tons.

The special rail transport shackles (1-1/2-inch size with 1-3/8-inch diameter pin) are suitable. The rail transport shackle is not marked but is easily recognized by its large bar size (1-1/2-inch diameter) and small screw pin (1-3/8-inch diameter).

The Bradley shackle may also be used, WLL 21-ton, NSN 4030-01-187-0964, part number 12328579.

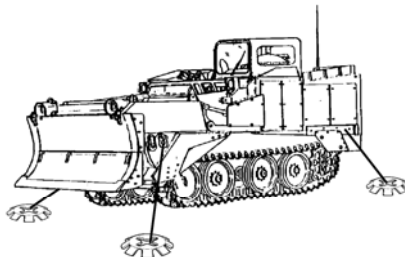


NOTE

See Table 6-1, page 6-2, for required number of lashings.

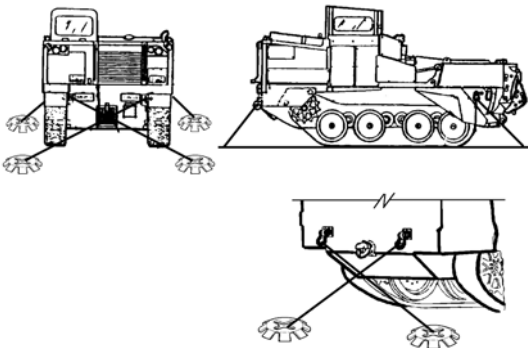
Other similar lashings: M2A1, M2A2, M2A3, M2A6, M3A1, M3A2

M2 and M3, Bradley fighting vehicle (BFV).



FSS/LMSR – Four 35,000-pound lashings, two at each end.

Other Ships – Four 70,000-pound lashings, two at each end.

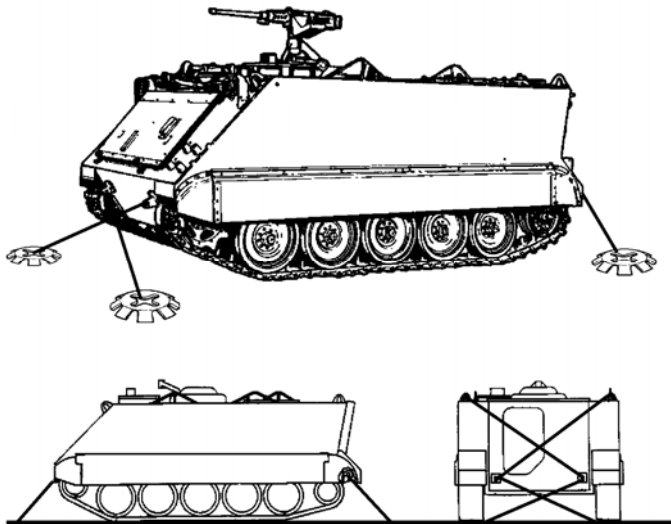


NOTE

The blade must be raised when tied down properly

Other similar lashings: M270, M270A1

M9, Earthmover, armored combat (ACE).

**CAUTION**

**Do not remove wire rope restraint from ramp door on M577s and M1068s.
This is a safety precaution for rail transport.**

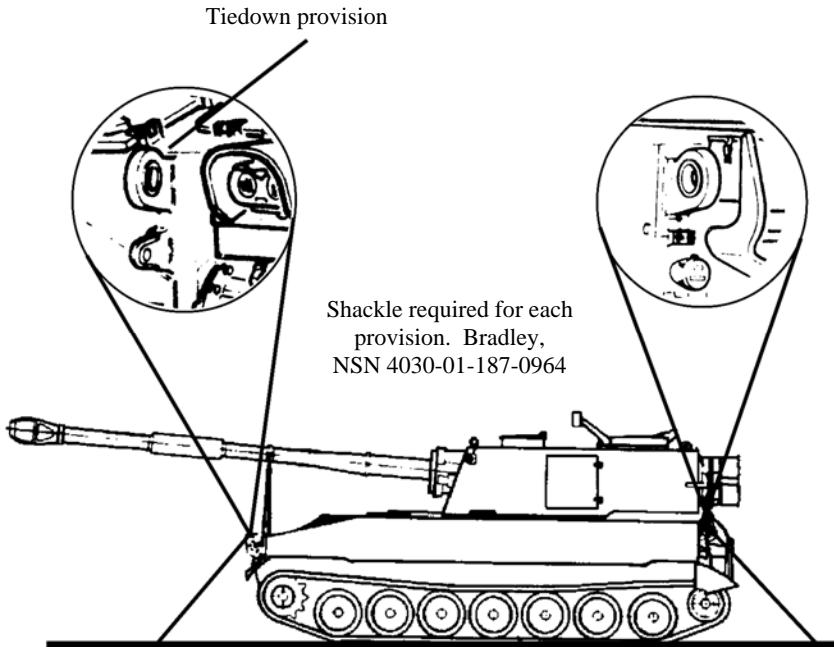
NOTE

For the A3 models, use the plate provisions mounted on the hull of the vehicle.

See Table 6-1, page 6-2, for required number of lashings.

Other similar lashings: M106A2, M113A2, M113A3, M125A2, M548A1/A3, M577A2, M677, M730A2, M741A1, M901A1, M981, M1015A1, M1059, M1064, and M1068A3

M113A1 carrier, personnel.

**NOTE**

See Table 6-1, page 6-2, for required number of lashings.

Other similar lifts: M110A2, M992, M992A1, M992A2, M109A2-A5

M109A6, howitzer, 155 mm, medium, full-tracked.

Section VII. Lashing Watercraft

Sea barge (SEABEE) vessels provide the flexibility of moving large watercraft vessels quickly, easily, and efficiently.

Planning and Lashing

1. Stow Planning - A detailed load and tiedown plan should be developed for loading watercraft onto SEABEE vessels. This plan should include all blocking, bracing, lashing, and any cargo limitations for the equipment.

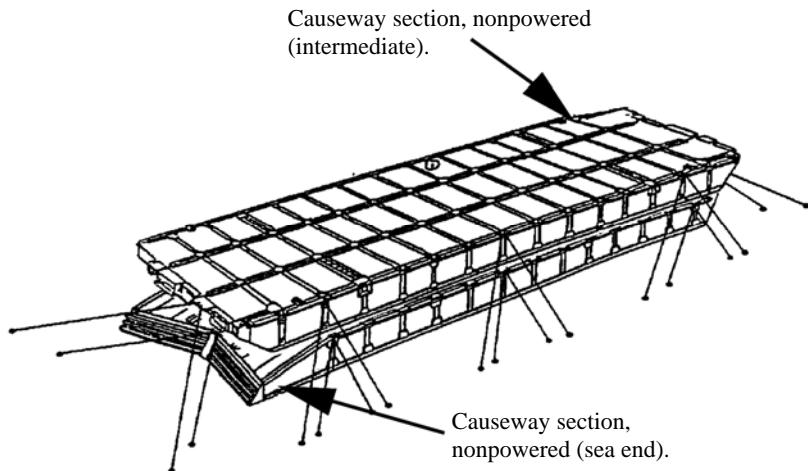
2. Lashings - Lashings must be stored on each deck of the ship, or a forklift must be provided to prestage and move lashings from the weather deck to the desired locations.

Table 7-1. Watercraft (Lashing).

Model	Item	Curb Weight (lb)	Gross Weight (lb)	Page
CSNP	Causeway sections	136,000	N/A	7-3
LARC-LX	Lighter, amphibious resupply cargo 60-ton	197,000	317,000	7-4
LCU	1600-class landing craft, utility	660,000	1,360,000	7-5
LCM-8	Landing craft, mechanized	134,400	254,400	7-6
Mark V	Special Operations Craft	90,000	119,000	7-7

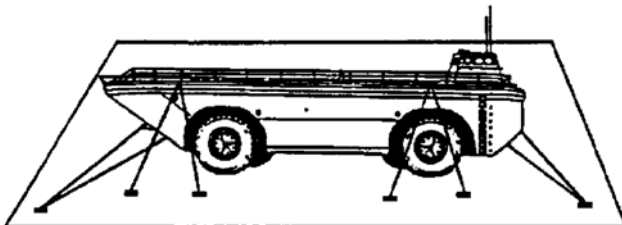
**Table 7-2. SEABEE Ship Lashing Requirements.
Number of 70K-Pound Lashings Required.**

CRAFT TYPE	UPPER DECK			MAIN DECK			LOWER DECK		
	PER SIDE	PER END	TOTAL	PER SIDE	PER END	TOTAL	PER SIDE	PER END	TOTAL
LCU-1600	12	6 ^A	34	-	-	-	-	-	-
LCM-8	6	4	16	6	2	16	6	2	16
LARC-LX	4 ^B	5	14	4	4	16	4 ^B	5	14
CSNP	6	2	16	6	2	16	6	2	16
CSNP ^C	12	4	32	12	4	32	12	4	32
Legend: A. 6 Lashings on the stern end 4 Lashings on the bow end B. One side only C. Refers to double-stacked causeways									



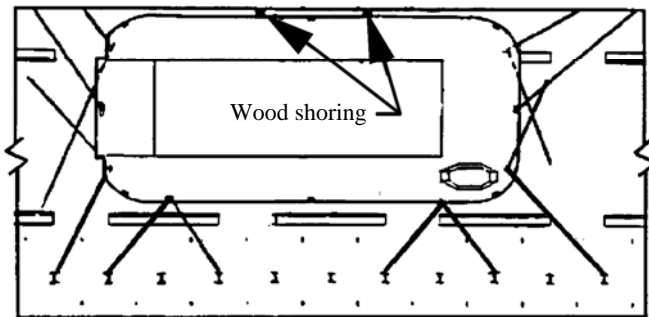
Thirty-two 70,000-pound cable lashings required with 35,000-pound chain tiedown assemblies and 2-inch turnbuckles with 24-inch takeup. Shackles, rings, and so forth as required.

***Causeway section, nonpowered (CSNP), intermediate,
and causeway section, nonpowered (CSNP), sea end.***



Fourteen 70,000-pound cable tiedown lashings required with 35,000-pound chain tiedown assemblies and 2-inch turnbuckles with 24-inch takeup. Shackles, rings, and so forth as required.

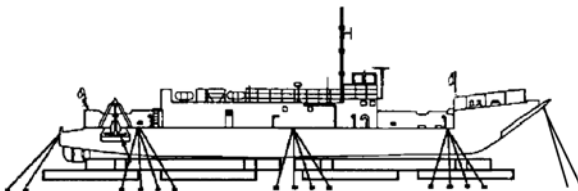
Starboard Side of Ship



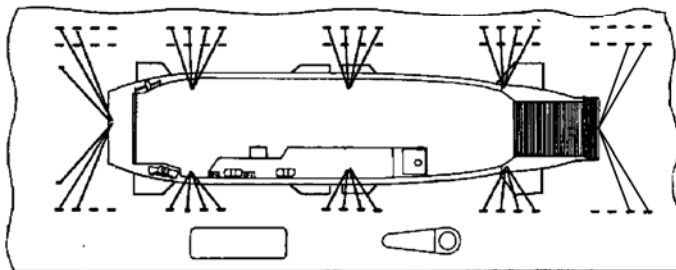
NOTE

Stowed against side of ship.

*Lighter amphibious resupply cargo-60 tons
(LARC-LX) typical tiedown stowage position.*

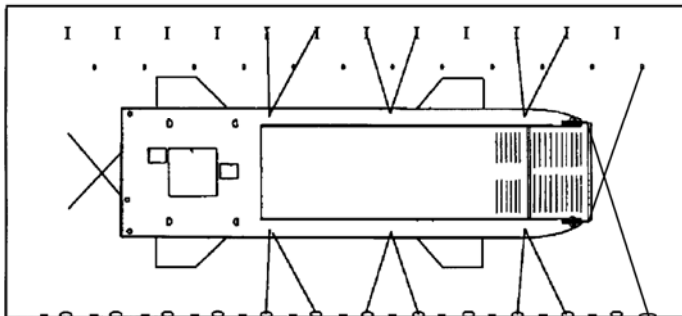
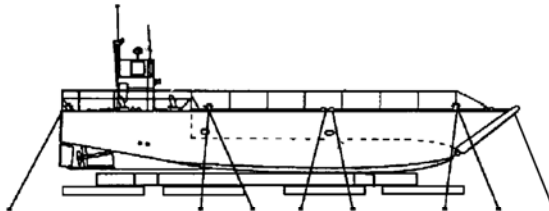


Thirty-four 70,000-pound cable lashings required with 35,000-pound chain tiedown assemblies and 2-inch turnbuckles with 24-inch takeup. Shackles, rings, and so forth as required.



Side of Ship

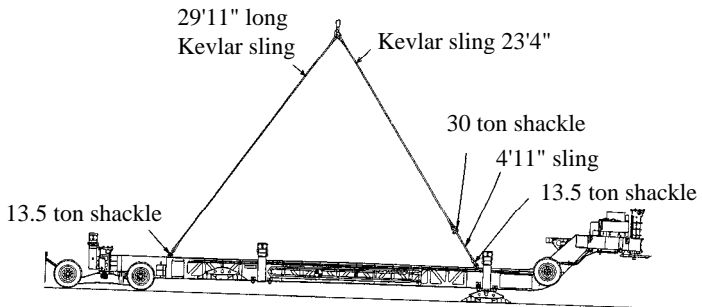
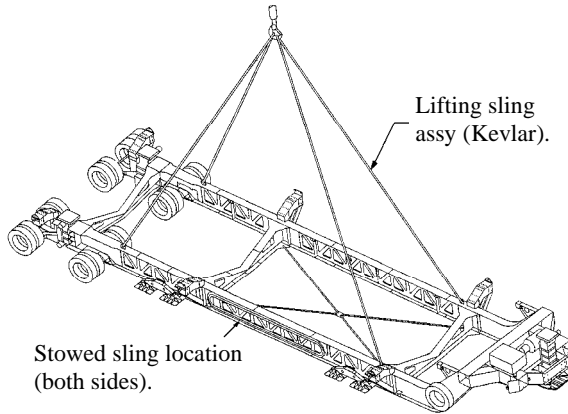
Landing craft utility (LCU)-1600 typical tiedown.



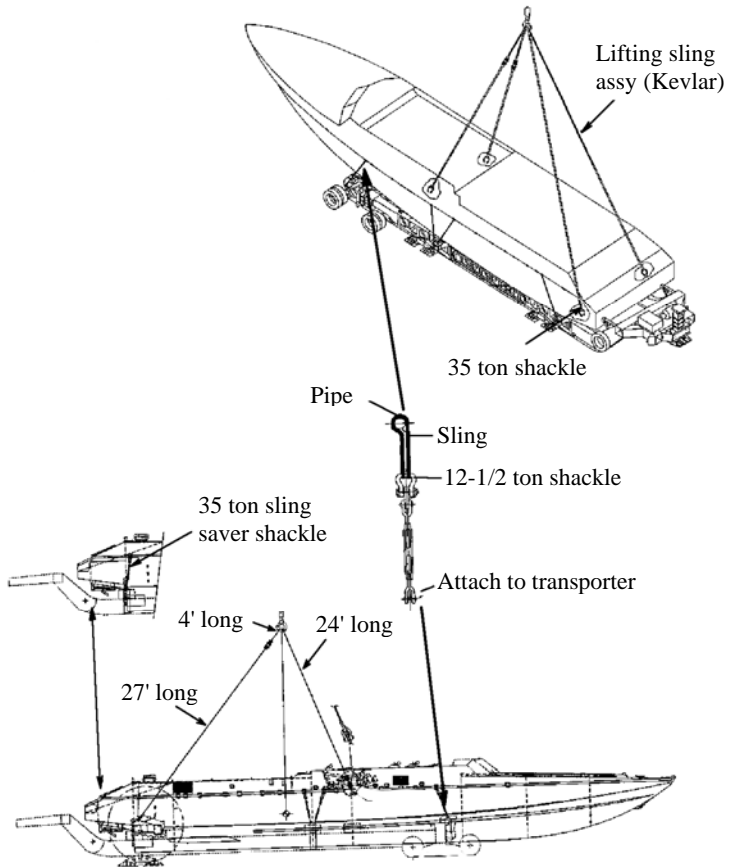
Side of Ship

Sixteen 70,000-pound cable lashings required with 35,000-pound chain tiedown assemblies and 2-inch turnbuckles with 24-inch takeup. Shackles, rings, and so forth as required.

Landing craft mechanized (LCM)-8 typical tiedown.

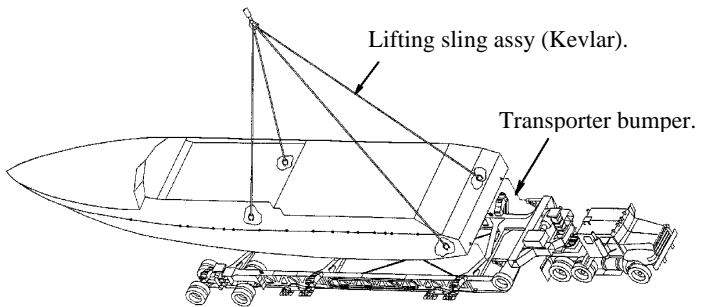
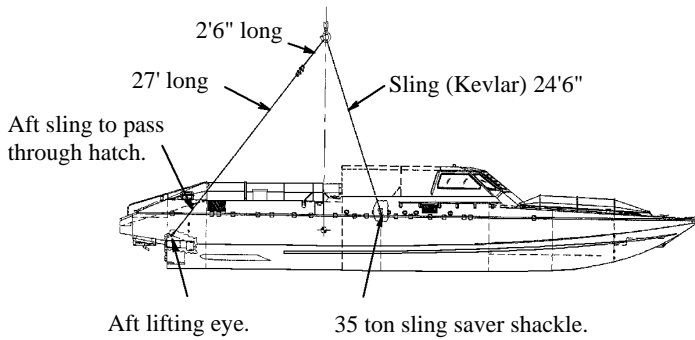


Mark V trailer



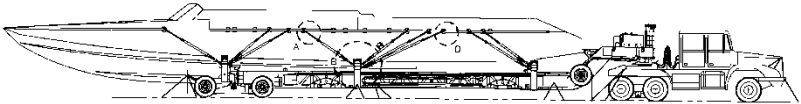
Craft/transporter lift

Mark V.



Mark V

Leave tractor and trailer coupled together
and lash as if they were separate.



12 chains per side
70,000-pound restraints required.

Mark V restraint on trailer

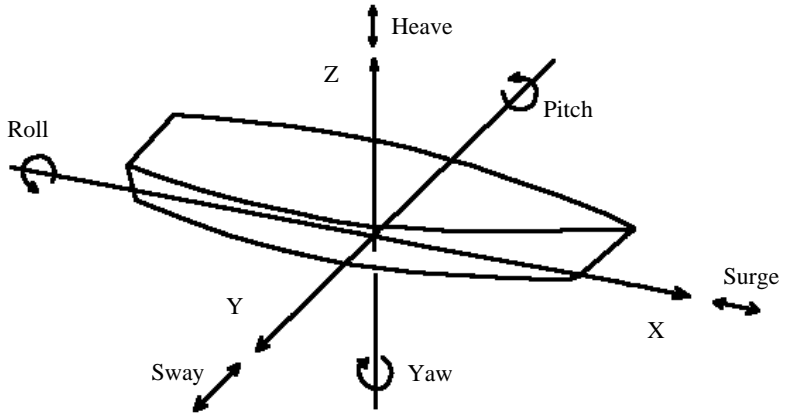
Appendix A

Cargo Restraint Criteria for Marine Transport: Development and Implementation

The lashing requirements tabulated in this reference are based on approved load factors and provide for safe equipment tiedown during storm sea conditions (sea state 7, between 25 and 40 foot seas depending on wind speed). When multiplied by the equipment's weight, the load factors give design loads that the equipment tiedown assembly must be able to withstand in the longitudinal, transverse, and vertical directions. Since the motion of a floating object has 6 degrees of freedom, both static and dynamic contributions were considered. Static contributions are dictated by the ship attitude, which include list, heel, and trim. Dynamic contributions include angular (roll, pitch, and yaw) and linear (surge, sway, and heave) motions. Page A-2 illustrates these motions. These contributions were combined with the components of the gravitational acceleration on the equipment to determine the net accelerations in the component directions (longitudinal, transverse, and vertical). Based on this approach, and the equations and data from DOD-STD-1399, load factors were calculated for two categories of ships.¹ The following summarizes these load factors for the FSS/LMSR and "Other" ships in the ICODES database:

Ship Type	Transverse Load Factor	Longitudinal Load Factor	Vertical Load Factor
FSS/LMSR	0.56	0.19	0.0
Other Ships	0.81	0.42	0.0

¹DOD-STD-1399 (Navy). *Interface Standard for Shipboard Systems*, Section 301A, *Ship Motion and Attitude*, 21 July 1986.



Conventional ship coordinate axes and ship motions.

NOTES

1. **Ship data was furnished by MSC and MARAD.**
2. **Load factors are based on sea state 7 conditions (between 29 and 40 ft seas).**
3. **Load factors were calculated IAW DOD-STD-1399, Section 301A, *Ship Motion and Attitude*.**
4. **Load factors were calculated at farthest stowage location from ship's center of gravity.**
5. **Load factors were based on a partially loaded ship with respect to the metacentric height.**

Once developed, the load factors on page A-1 became the foundation for the lashing requirements tabulated in this reference.

During a decision briefing to MSC and MARAD, the following load factor implementation plan was agreed to by consensus²:

1. Apply load factors simultaneously versus independently to account for each factor peaking at the same time.
2. Assume friction forces between equipment and deck are negligible (water and lubricant on deck).
3. Assume a 25° angle between deck and lashing.
4. Assume equipment center of gravity is in the geometric center.
5. Base lashing requirements on known lashing capacities and corresponding equipment weight ranges.

²MTMCTEA Decision Briefing at Washington Navy Yard, 12 Apr 94, subject: Implementation of Load Factors for Cargo Restraint During Marine Transport.

The following illustrates the tabulated lashing requirements for the FSS/LMSR and all "Other" vessels in the ICODES database. These tables appear throughout this reference.

For FSS/LMSR Only

Vehicle Weight	Lashing Strength	Total Number of Lashings Required
Up to 8,930 lb	5,000 lb	4
Up to 17,860 lb	10,000 lb	4
Up to 25,180 lb	14,100 lb	4
Up to 30,360 lb	17,000 lb	4
Up to 62,510 lb	35,000 lb	4
Up to 125,020 lb	70,000 lb	4
Up to 250,040 lb	70,000 lb	4

For FSS/LMSR Only – Metric

Vehicle Weight	Lashing Strength	Total Number of Lashings Required
Up to 4 050 kg	2 250 kg	4
Up to 8 100 kg	4 550 kg	4
Up to 11 420 kg	6 400 kg	4
Up to 13 770 kg	7 700 kg	4
Up to 28 350 kg	15 900 kg	4
Up to 56 710 kg	31 750 kg	4
Up to 113 420 kg	31 750 kg	4

For Other Ships Only

Vehicle Weight	Lashing Strength	Total Number of Lashings Required
Up to 5,260 lb	5,000 lb	4
Up to 10,530 lb	10,000 lb	4
Up to 14,850 lb	14,100 lb	4
Up to 17,900 lb	17,000 lb	4
Up to 36,860 lb	35,000 lb	4
Up to 73,720 lb	70,000 lb	4
Up to 147,450 lb	70,000 lb	4

For Other Ships Only – Metric

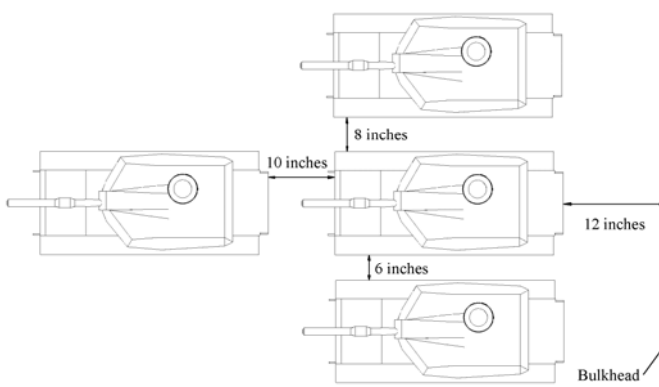
Vehicle Weight	Lashing Strength	Total Number of Lashings Required
Up to 2 390 kg	2 250 kg	4
Up to 4 780 kg	4 550 kg	4
Up to 6 740 kg	6 400 kg	4
Up to 8 120 kg	7 700 kg	4
Up to 16 720 kg	15 900 kg	4
Up to 33 440 kg	31 750 kg	4
Up to 66 880 kg	31 750 kg	4

Note: “Other” ships are all ships except FSS and LMSR.

Appendix B

Calculation of Required Deck Strength

1. Deck strength is often given in pounds per square foot (psf).
2. The required deck strength for a piece of equipment is based on its shadow area, including its share of any surrounding clear space.
3. To calculate the shadow area of a piece of equipment, multiply the length by the width. The length and width should include one-half of the spacing between the equipment and adjacent equipment and all the space between the equipment and a bulkhead.
4. To calculate the deck strength required, divide the weight of the equipment by the shadow area. The required deck strength should be equal to or less than the posted or known deck strength of the vessel.
5. The following example illustrates this concept (not to scale):



Given the following:

M1A2 length = 312 inches (excluding the gun barrel)

M1A2 width = 144 inches

M1A2 weight = 137,360 pounds

Calculate the shadow area:

Shadow area length = $312 + 12 + 10/2 = 329$ inches

$= 329 \text{ inches}/12 = 27.4$ feet

Shadow area width = $144 + 6/2 + 8/2 = 151$ inches

$= 151 \text{ inches}/12 = 12.6$ feet

Shadow area = $27.4 \times 12.6 = 345$ square feet

Calculate the required deck strength:

$137,360 \text{ pounds}/345 \text{ square feet} = 398 \text{ pounds per square foot (psf)}$

Compare the required deck strength to the actual deck strength:

The posted or known deck strength must be greater than or equal to 398 psf.

Appendix C

Recommended Blocking and Bracing Procedures

Under normal circumstances, blocking and bracing is not required for marine transport. Military vehicles, shelters, and trailers are equipped with tiedown provisions that are more than adequate to provide restraint under the worst sea conditions. An exception to this applies when lumber is placed under steel tracks to prevent metal-to-metal contact. However, the following circumstances could dictate that blocking and bracing are required to secure the equipment.

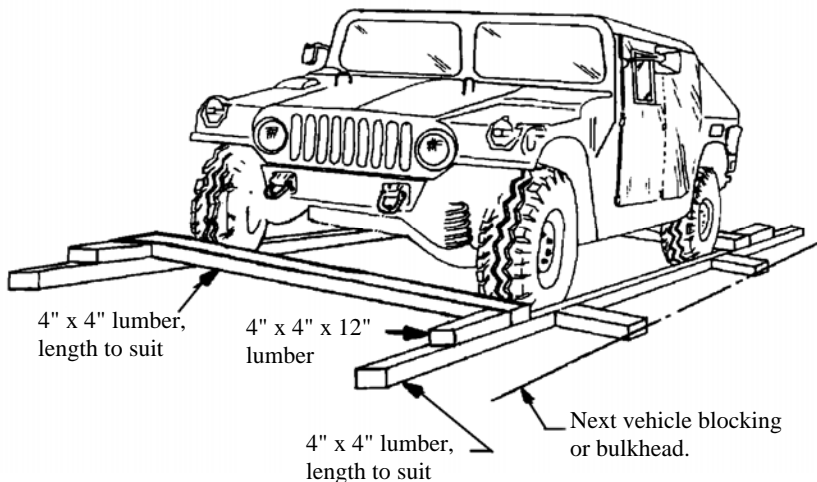
1. Deck fittings do not have adequate strength to restrain the equipment. In this case, blocking and bracing may be required to supplement the restraint provided by the lashings.

2. The ship is not equipped with deck fittings to accommodate lashing gear. When this occurs, blocking and bracing will be the only means to achieve restraint requirements.

3. The number and location of the deck fittings do not adequately accommodate standard lashing procedures. Again, blocking and bracing may be necessary to achieve the required restraint.

4. The ship has adequate deck fittings but is not equipped with lashing gear.

When the above situations arise, blocking may be the only means to secure the cargo. If this is the case, proper procedures are critical. Wheels must be chocked on all four sides and braced to the ship's bulkhead or each other as shown on page C-2. Failure to brace to the bulkhead defeats the purpose of the blocking since it leaves the entire assembly (vehicle and surrounding lumber) free to shift during transit.

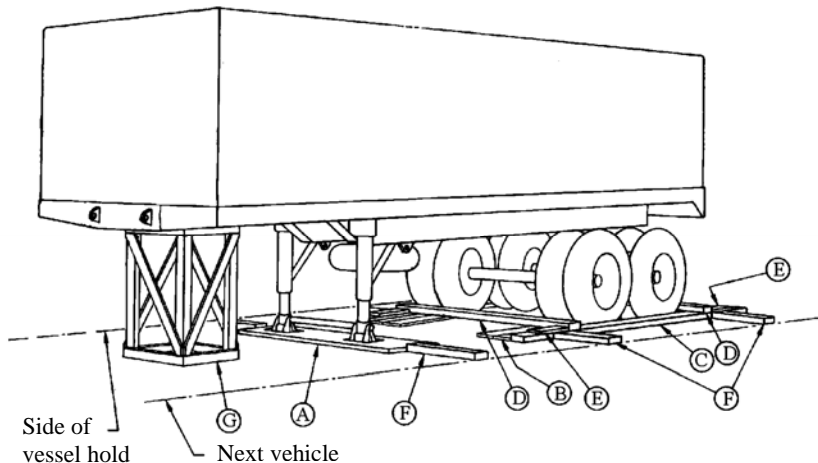
**NOTE**

**All longitudinal and lateral bracing
must be tied into other bracing or
braced to the side of the bulkhead.**

*Typical blocking and bracing of a
wheeled vehicle in a ship's hold.*

Whenever possible, trailers and semitrailers should remain attached to their respective prime movers and blocked and braced in accordance with the wheeled vehicle diagrams. This helps simplify the blocking and bracing requirements by eliminating the need for stanchions, front supports, and so forth. Page C-4 applies to trailers and semitrailers separated from their prime movers.

For tracked vehicles, refer to page C-5. In addition to the blocking and bracing shown, lumber may be required under the tracks to prevent metal-to-metal contact with the deck.

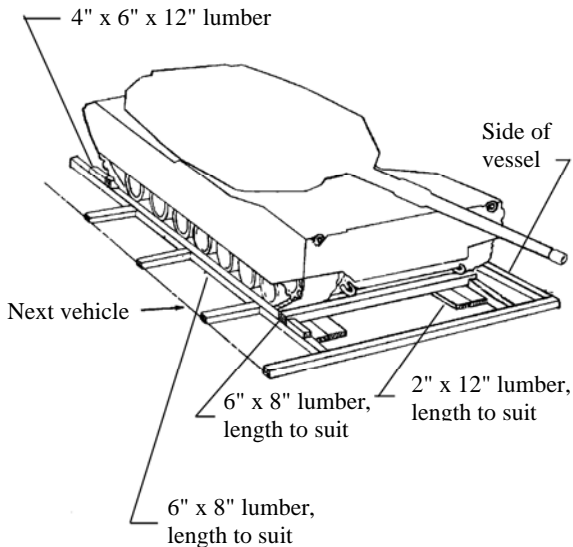


- A 2" x 12" x 72" lumber, under landing legs
- B 2" x 12" x 96" lumber, under wheels
- C 4" x 6" x 108" lumber
- D 4" x 6" x 108" lumber
- E 2" x 4" x 24" lumber
- F 4" x 6" lumber, length to suit
- G Typical stanchion, see page 5-5 for details

NOTE

All longitudinal and lateral bracing must be tied into other bracing or braced to the side of the bulkhead.

Typical blocking and bracing of a semitrailer in a ship's hold.



NOTE

All longitudinal and lateral bracing must be tied into other bracing or braced to the side of the bulkhead.

Typical blocking and bracing of a tracked vehicle in a ship's hold.