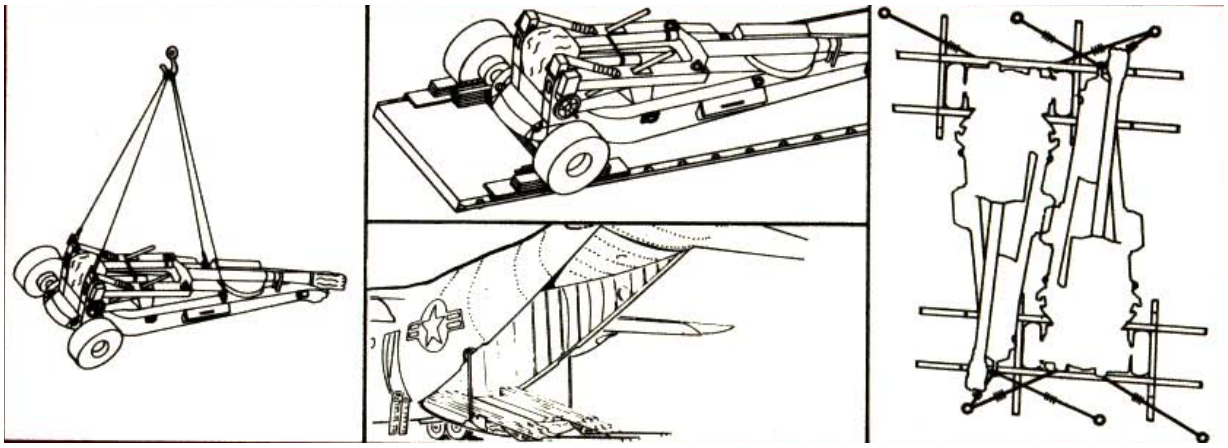


Technical Manual

Transportability Guidance

Transporting the Howitzer, Medium,

Towed, 155-MM, M198

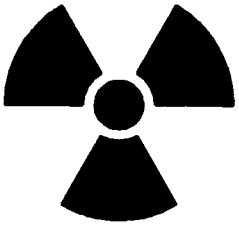
(NSN 1025-01-026-6648)

By

Air, Highway, Water and Rail

Headquarters, Department of the Army **September 1979**

WARNING
RADIOACTIVE MATERIALS



Items containing radioactive tritium gas are identified by a radioactive warning label.

These items are designed so as to preclude a health hazard; however, in the event that they are not illuminated, or there is evidence of breakage, the local radiation protection officer (RPO) must be notified. If a radioactive source is broken, open doors or windows (if inside) and evacuate the room or area for one-half hour. If it is suspected that skin contact has been made with any contaminated area, immediately clean the skin with lukewarm water and nonabrasive soap.

Change)
)
No. 2)

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 1 September 1987

TRANSPORTABILITY GUIDANCE
TRANSPORTING THE HOWITZER, MEDIUM
TOWED, 155-MM, M198 BY
AIR, HIGHWAY, WATER AND RAIL

This change updates the Dimensions, Weight, and Volume Table on page 2-1 and adds procedures for using the M198 Air Transportability Kit to Chapter 3. TM 55-1025-211-14, 1 September 1979, is changed as follows:

1. New or changed material is indicated by a vertical bar in the margin.

2. Remove old pages and insert new pages as indicated below:

Remove pages	Insert pages
1-1, 1-2	1-1, 1-2
2-1, 2-2	2-1, 2-2
3-5	3-5, 3-6
A-1, A-2	A-1, A-2

3. File this sheet in front of the manual for reference purposes.

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General. United States Army
The Adjutant General

DISTRIBUTION:

To be distributed in accordance with DA Form 12-40R and DA Form 12-34B, Requirements for Transportability Guidance; Howitzer, Medium, Towed, 155-MM, M198.

Change)
)
No. 1)

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 25 January 1984

**TRANSPORTABILITY GUIDANCE
TRANSPORTING THE HOWITZER, MEDIUM
TOWED, 155-MM, M198 BY
AIR, HIGHWAY, WATER AND RAIL**

This change provides procedures for transporting M198 Howitzers equipped with narrow tires and wheels by C-130 aircraft. TM 55-1025-211-14, September 1979, is changed as follows:

1. New or changed material is indicated by a vertical bar in the margin.
2. Remove old pages and insert new pages as indicated below:

Remove pages	Insert Pages
3-5	3-5

3. File this change in front of the publication for reference purposes.

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

Official:

ROBERT M. JOYCE
Major General, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-34B requirements for TM 55-Series: Transportability Guidance, Guns, Howitzer, and Rifles and DA Form 12-40A, Organizational Maintenance requirements for Howitzer, 155-MM, Towed, M198.

TECHNICAL MANUAL

NO. 55-1025-211-14

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC
1 September 1979

TRANSPORTABILITY GUIDANCE

TRANSPORTING THE HOWITZER, MEDIUM, TOWED, 155-MM, M198 (NSN 1025-01-026-6648)

BY

AIR, HIGHWAY, WATER, AND RAIL

Table of Contents
page

Table of Contents
continued

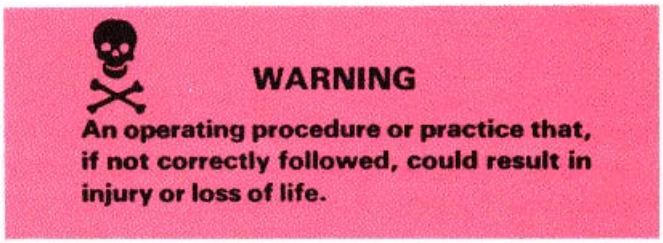
CHAPTER 1

Introduction

Scope: This manual provides instructions for the safe transport of the M198 towed howitzer by air, highway, rail, and water. These instructions are applicable in CONUS as well as for worldwide transport.

Purpose: This manual is primarily for use by personnel who will be directly involved in the hands-on loading for transport of the M198 howitzer. It is also intended for use by transportation officers and others responsible for the safe and efficient transport of the M198 howitzer.

Warnings, Cautions, and Notes: Warnings, cautions, and notes are used throughout this manual to emphasize important or critical guidance. They are used for the following conditions.



CAUTION

An operating procedure or practice that, if not strictly observed, could result in damage to or destruction of equipment.

NOTE

An operating procedure or condition that must be emphasized.

PREPARING THE HOWITZER FOR TRANSPORT

Except for tactical highway towing and tactical transport on C-5 aircraft, the howitzer will be transported in the stowed position with the gun tube locked in the stowage bracket. Wire-tie the pin that locks the gun tube stowage bracket so that the pin cannot come out during transit. Remove and stow all loose equipment.

FEEDBACK

Users of this manual are asked to recommend changes and submit comments for its improvement. Comments should be prepared on DA Form 2028-2 (Recommended Changes to Equipment Technical Manuals) and forwarded to Commander, Military Traffic Management Command Transportation Engineering Agency, ATTN: MTT-TRA (C. Henderson), PO Box 6276, Newport News, Virginia 23606-0276 (electrically transmitted messages should be addressed to: CDRMTMCTEA FT EUSTIS VA/MTT-TRA/). For your convenience, a DA Form 2028-2 is included in the back of this manual.

CHAPTER 2

General Description

Scope: This chapter provides a general description of the Howitzer, Medium, Towed, 155-mm, M198, including drawings, dimensions, and weight. This information is essential to the successful transportation of the M198 howitzer by any of the transport modes.

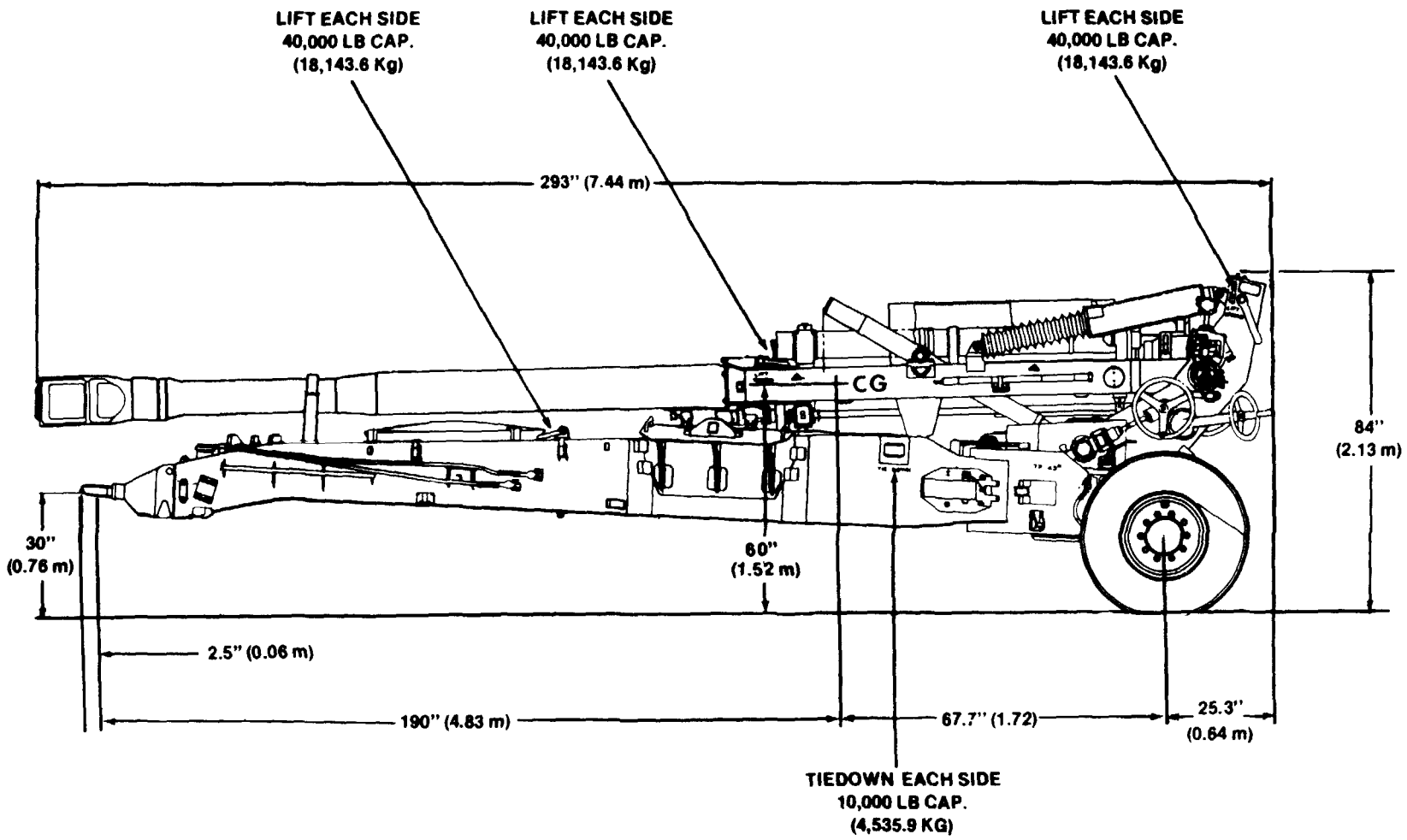
Description: The Howitzer, Medium, Towed, 155-mm, M198, also referred to in this manual as the howitzer, is a single-axle, carriage-mounted weapon. It is towed by the 5-ton cargo truck, M813 or M813A1, or by an M939-series truck. TM 55-2320-260-15-1 contains transportability guidance for the M813 and M813A1 cargo trucks. TM 55-2320-272-14-1 contains transportability guidance for M939-series trucks.

Dimensions, Weight, and Volume: Metric equivalents are given in parentheses after dimensions or other measurements.

Model: M198
National stock number: 1025-01-026-6648
Line item number: K57821
Type classification: Standard

Length	492.5 inches (12.51 ml
Length, reduced*	293.0 inches (7.44 m)
Width, wide tires	110.0 inches (2.79 m)
Width, narrow tires	100.0 inches (2.54 m)
Height	84.0 inches (2.13 ml
Volume, reduced*	1,550.7 cubic feet (43.90 m3)
Axle weight	12,250 pounds (5566.6 kg)
Weight on pintle	3,500 pounds (1587.6 kg)
Total weight	15,750 pounds (7144.2 kg)
Tire pressure, wide tires	45 psi
Tire pressure, narrow tires	110 psi

*Short stow configuration (muzzle over trails) with muzzle brake installed.


LIFT EACH SIDE
40,000 LB CAP.
(18,143.6 Kg)
LIFT EACH SIDE
40,000 LB CAP.
(18,143.6 Kg)
LIFT EACH SIDE
40,000 LB CAP.
(18,143.6 Kg)
293" (7.44 m)
CG
84"
(2.13 m)
30"
(0.76 m)
60"
(1.52 m)
2.5" (0.06 m)
190" (4.83 m)
67.7" (1.72)
25.3"
(0.64 m)
TIEDOWN EACH SIDE
10,000 LB CAP.
(4,535.9 KG)

CHAPTER 2
General Description

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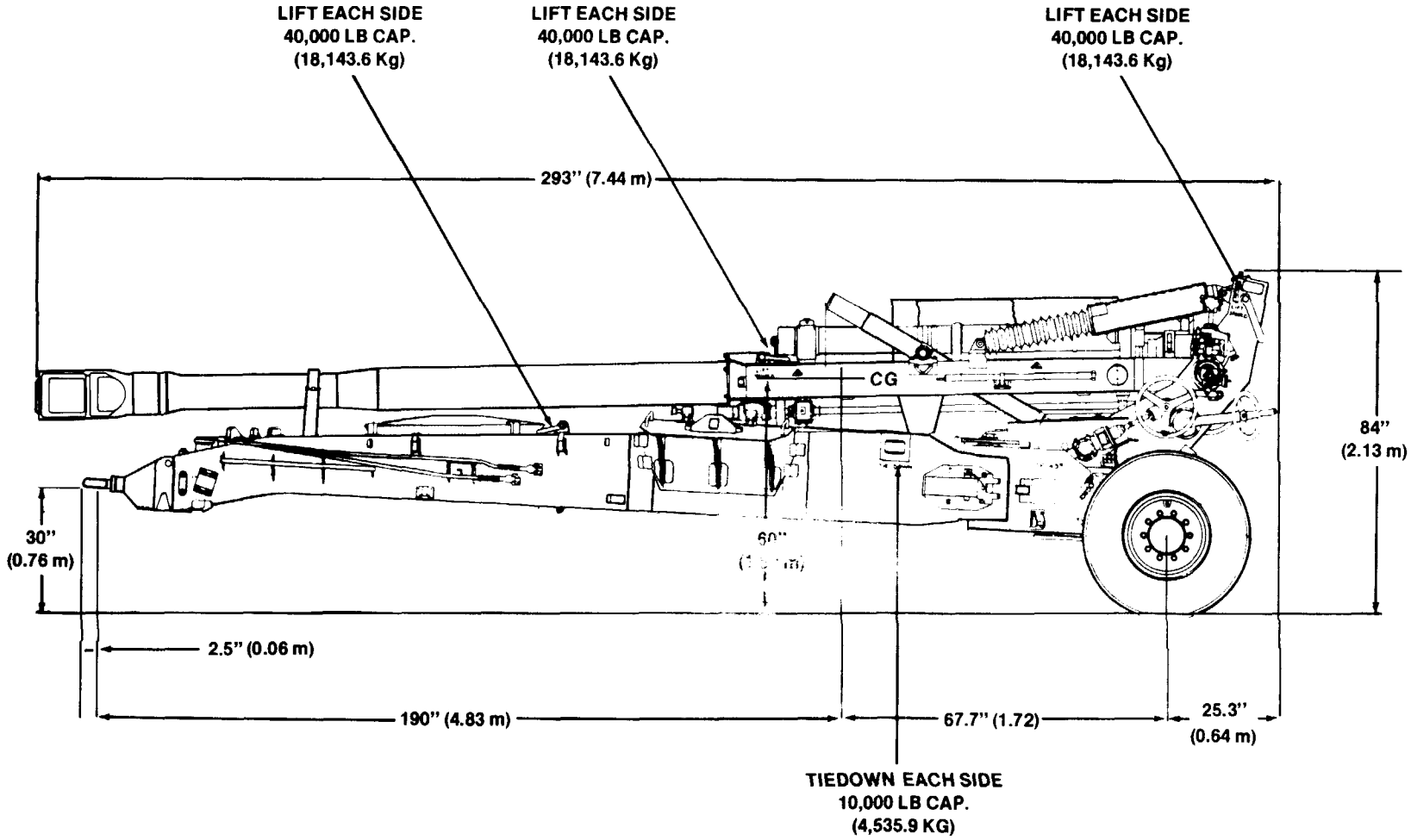
Description: The Howitzer, Medium, Towed, 155-mm,M198, also referred to in this manual as the howitzer, is a single axle, carriage-mounted vehicle. It is towed by the 5-ton cargo truck, M813 or M813A1. TM 55-2320-260-15-1 contains transportability guidance for the M813 and M813A1 cargo truck.

Dimensions, Weight, and Volume: Metric equivalents are given in parentheses after dimensions or other measurements.

Model: M198
NSN: 1025-01-026-6648
Line Item Number: K57821
Type Classification: Standard

Length	**492.5 inches (12.51 m)**
Length reduced*	**293.0 inches (7.44 m)**
Width	**110.0 inches (2.79 m)**
Height	**84.0 inches (2.13 m)**
Volume reduced*	**1,550.7 cubic feet (43.90 m3)**
Axle weight	**11,600 pounds (5,261.6 kg)**
Weight on pintle	**3,880 pounds 1,759.9 kg)**
Total weight	**15,480 pounds (7,021.5 kg)**
Tire pressure	**45 psi**

***Short stow configuration (muzzle over trails) with muzzle brake installed.**


LIFT EACH SIDE
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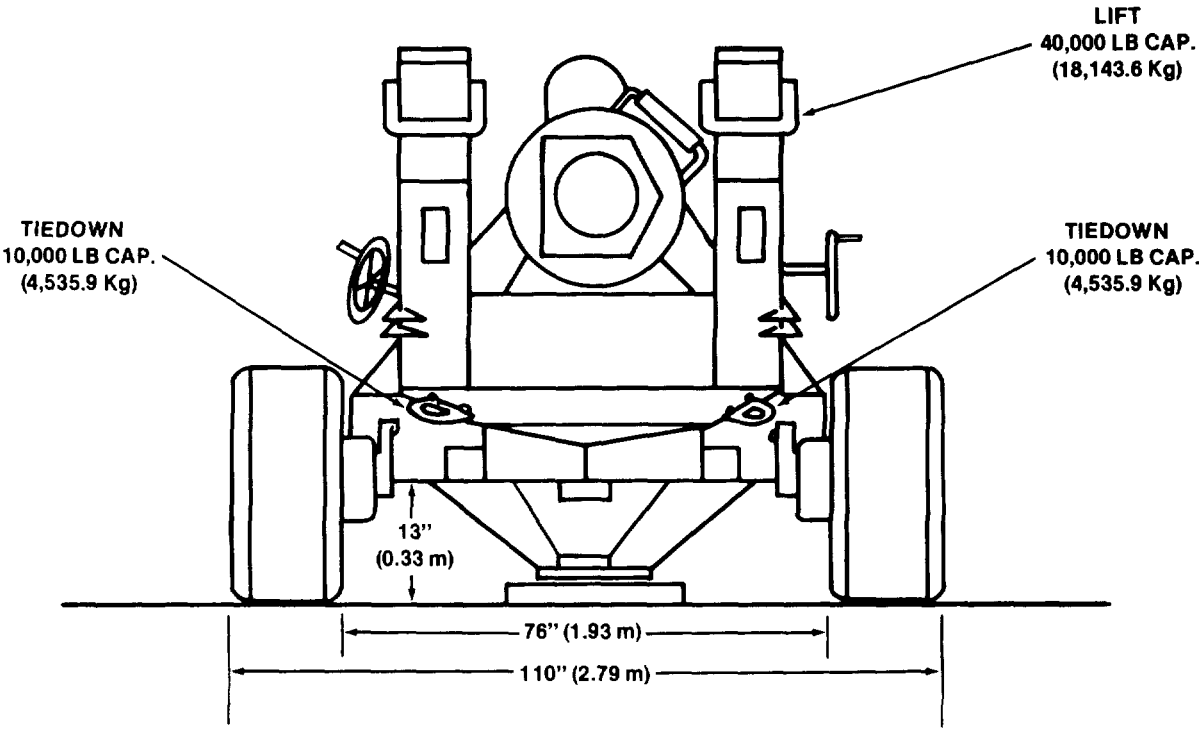

LIFT
40,000 LB CAP.
(18,143.6 Kg)
TIEDOWN
10,000 LB CAP.
(4,535.9 Kg)
TIEDOWN
10,000 LB CAP.
(4,535.9 Kg)
13"
(0.33 m)
76" (1.93 m)
110" (2.79 m)

CHAPTER 3

Transporting the M198 Howitzer by Air

NOTE: If ammunition or explosives are to be transported with the howitzer, the shipper must notify the aircraft commander.

Section I.

US ARMY AIRCRAFT

The howitzer can be transported externally by Army helicopter. For detailed instructions, refer to TM 55-450-11, TM 55-450-12 and TM 55-450-18.

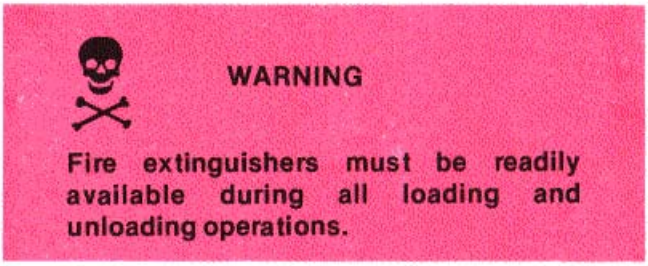
Section II.

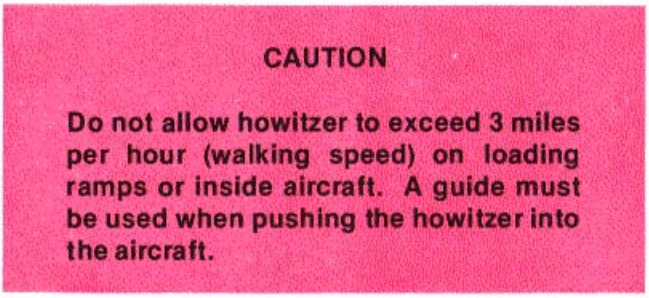
US AIR FORCE AIRCRAFT

NOTE: The M198 howitzer is certified for transport in USAF aircraft in accordance with TB 55-45/AFP 76-19, dated Sep 1978, as follows:

Towed configuration	**C-5 aircraft**
Stowed configuration	**C-130, C-141, C-5 aircraft**

SAFETY





GENERAL

The howitzer can be shipped in the USAF C-5, C-141, or C-130 aircraft. Procedures are given for each of the aircraft. All lumber must be furnished by the shipper. Loads in Air Force aircraft must be restrained for at least 3g's forward (Ig equals the weight of the howitzer). This must be increased to 8g's forward restraint when passengers or nuclear weapons cargo are carried forward of other cargo. Loads shown in this chapter are restrained to 3g's forward. The aircraft loadmaster will provide instructions if 8g restraint is required. Additional cargo may be loaded to take advantage of the maximum allowable load of the aircraft.

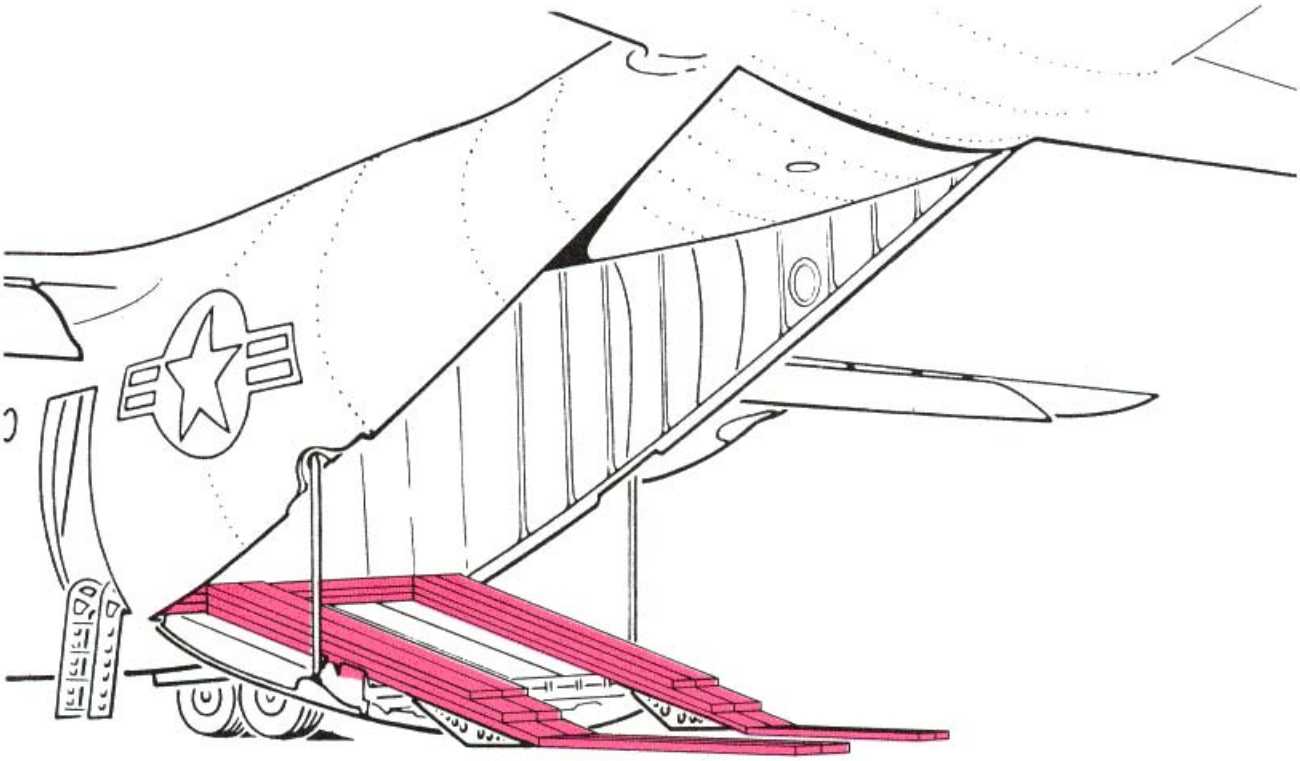
TRANSPORTING THE HOWITZER BY C-130

Material Required

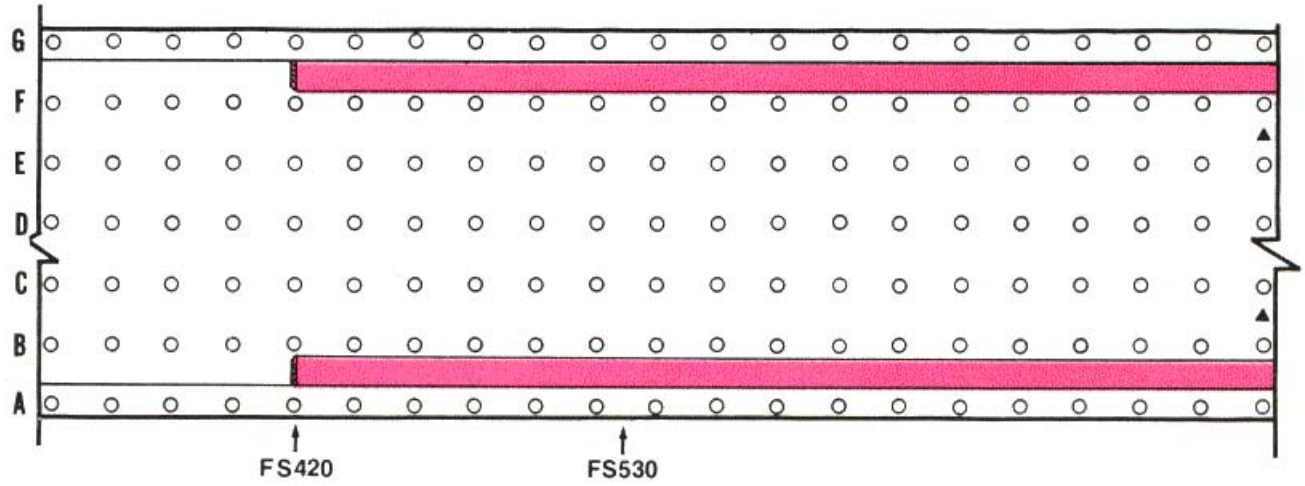
Lumber, 2- x 12-inch (rough-cut) 556 linear feet.
M-35 2-112-ton truck with front bumper-mounted pintle.
3-ton capacity hydraulic jack.
The lumber should be cut to size in advance.

CAUTION

Because of axle loads when using a front bumper-mounted pintle, ONLY an M-35 2-1/2-ton truck will be used for loading or unloading the howitzer. Heavier trucks will overload the aircraft loading ramp.



Place two rows of lumber from the ground to the top of the aircraft ramp, spaced to match the howitzer wheels. Each row should be approximately 24 inches wide, 5.25 to 5.5 inches thick, and 17 feet long. The required thickness can be obtained with three pieces of 2-inch-thick undressed lumber, one on top of the other. Shoring at the foot (ground level) of the ramp should be stair-stepped for easy transition to the 5.25 inch level.



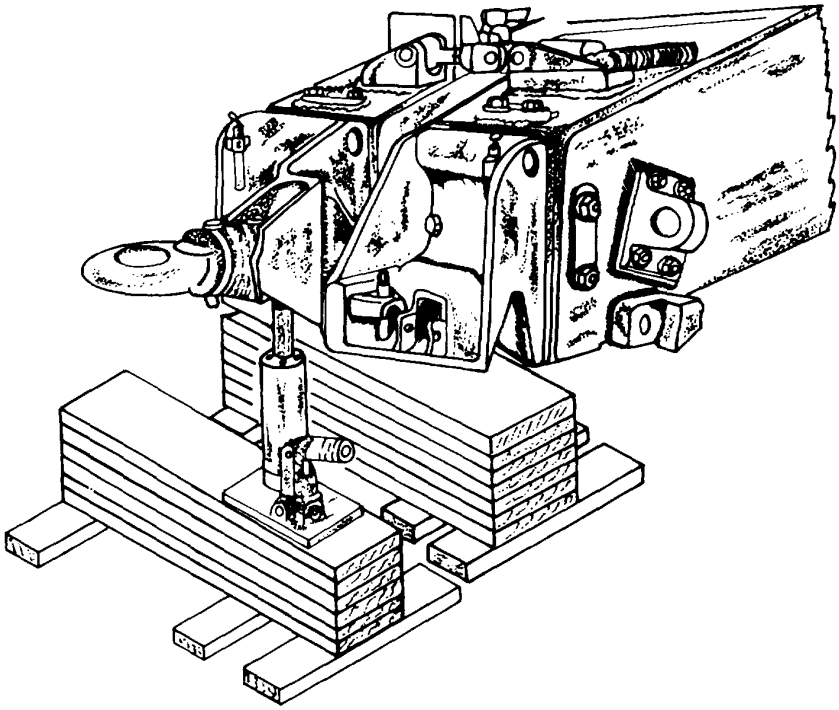
SYMBOL O INDICATES 10,000 POUND TIEDOWN FITTING.

Place two more rows of lumber from the top of the aircraft ramp to flight station 420 inside the aircraft, spaced to match the howitzer wheels. Each row should be approximately 12 inches wide, 5.25 inches thick and 27 feet long, again using three pieces of 2-inch thick lumber cut-to-length for each row.

Push the howitzer into the aircraft until the center of gravity of the howitzer is opposite flight station 530 on the aircraft.

Set handbrakes on the howitzer.

Install safety chains according to instructions from the aircraft load master so that the howitzer will not move when it is disconnected from the truck.



The trails of the howitzer also must be supported on shoring, and this will require 40 pieces of 2x 12-inch by4foot lumber.

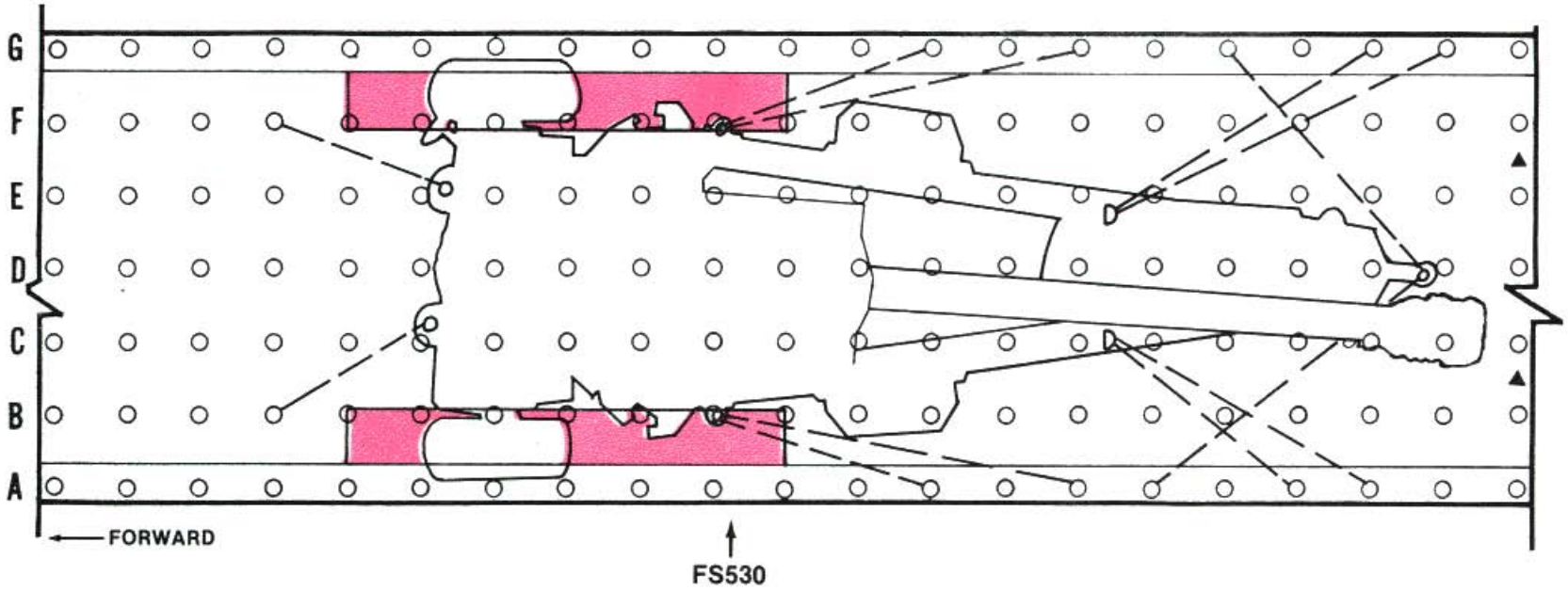
Move two pieces of lumber that was used as rolling shoring to the C-130 treadways on each side of the towing lunette and use to support the blocking under the jack and the trails.

Build up one stack of the 4-foot pieces under the solid part of the lowing lunette to support the hydraulic jack.

Place another stack of the 4-foot lumber pieces under the trails, near the jacking point. This stack will be used to support the trails during flight.

Put the jack under the base of the howitzer towing lunette and begin jacking. Place additional pieces of the 4-foot shoring under the trails as they are raised. When the truck can be disconnected, back it out of the way.

Lower jack until trails rest on shoring and remove jack.



SYMBOL ○ INDICATES 10,000 POUND TIEDOWN FITTING.

TRANSPORTING THE HOWITZER EQUIPPED WITH NARROW TIRES AND WHEELS BY C-130

Material Required

Lumber, 2- x 12-inch rough-cut, 160 linear feet, cut into 40 pieces of about 4-foot lengths.

M-35 2-1/2-ton truck with front bumper-mounted pintle.

3ton-capacity hydraulic jack.

Howitzers equipped with narrow tires and wheels can be loaded between the C-130AIA324-4A dual rails. Rolling and parking shoring are not required. Other loading procedures (page 3-3), including procedures for support of the howitzer trails, are unchanged.

SECURE THE LOAD
Standard or Narrow Tires and Wheels

Secure the howitzer with 10,000-pound-capacity tiedowns aboard the aircraft.

Unload by reversing the loading steps.

TRANSPORTING THE HOWITZER BY C-141

Material Required

Lumber, 2- x 12-inch rough-cut, 184 linear feet.

M-35 2-1/2-ton truck with front bumper-mounted pintle.

3ton-capacity hydraulic jack.

Place two pieces of 2by 12-inch by 6-foot lumber between flight stations 678 and 998 inside the aircraft, spaced to match the howitzer wheels. This lumber is parking shoring for the howitzer wheels to rest on during flight. Push the howitzer into the aircraft until the wheels are on the parking shoring.

Support the howitzer trails by use of the procedures described for the C-130 (page 3-3); use two pieces of 2by 12-inch by 6-foot lumber on the treadways to support the blocking under the jack and the trails.

SECURE THE LOAD

Secure the howitzer with 10,000-lb- or 25,000-lb-capacity tiedowns aboard the aircraft.

TRANSPORTING THE HOWITZER BY C-5

When the situation requires, the howitzer may be towed on board the C-5 in the tactical tow position. If it is left attached to the prime mover, no shoring, is required. If the howitzer is to be transported in the stowed position, support the trails by use of the procedures described for the C-141. No parking shoring is needed.

SECURE THE LOAD

Secure the howitzer with 25,000-pound-capacity tiedowns aboard the aircraft.

THE M198 HOWITZER AIR TRANSPORTABILITY KIT

NOTE: The air transportability kit is designed to reduce the time required to load and unload the howitzer and to support the howitzer trails during transport by USAF cargo aircraft.

Materiel Required

Lumber, 2- x 12-inch x a-foot, about 20 pieces

Jackstand Assembly, NSN 1025-01-210-3687

Lunette Hitch Assembly, NSN 1025-01-210-3688

When the howitzer is to be loaded into a C-130, use a 2-1/2-ton truck or an M237 forklift to push the howitzer into the aircraft and position the howitzer center of gravity at flight station 530. Set the handbrakes on the howitzer. Install safety chains, according to the loadmaster's instructions, so that the howitzer will not move when it is disconnected from the vehicle.

Place the jackstand under the left howitzer spade bracket. Orient the jackstand so that the "AFT" marking on the base is toward the rear of the aircraft. Hold the crank handle and rotate the jackscrew until the yoke almost touches the left spade bracket. Align the yoke so that the pin through the left spade bracket will enter the hole in the center of the yoke. Turn the crank handle until the yoke is properly and firmly seated. Continue cranking until the howitzer trails are elevated and the lunette is clear of the bottom plate of the hitch assembly or pintle hook.

Place safety shoring under the howitzer trails. Remove the pin from the hitch assembly or disconnect the pintle hook and back the truck or forklift out of the aircraft. Ensure that the howitzer is safely supported by the jack, and remove the safety shoring. Lower the jack until the yoke is seated firmly on the jack housing.

SECURE THE LOAD

Secure the howitzer with 10,000or 25,000-poundcapacity tiedowns aboard the aircraft (page 3-4) or as directed by the loadmaster.

Unload the howitzer by reversing the loading steps.

CHAPTER 4

Transporting the M198 Howitzer by Highway

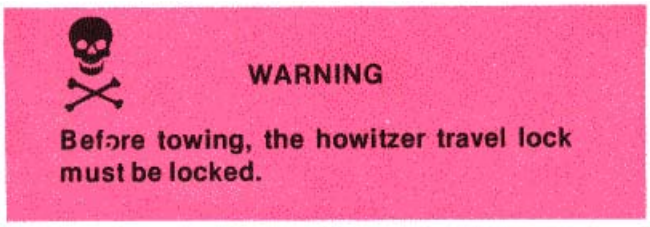
Section I

GENERAL

HIGHWAY MOVEMENT

Highway movement in CONUS is subject to all safety laws, rules, and regulations that apply to commercial carriers. In oversea areas, movement is governed by theater and local regulations.

TOWING



Except in tactical situations, towing in the tactical tow configuration is not recommended. The howitzer length of 492.5 inches (12.5 m) and width of 110 inches (2.79 m) exceeds the allowable limit for trailers in most states and will require special permits. See AR 55-162.

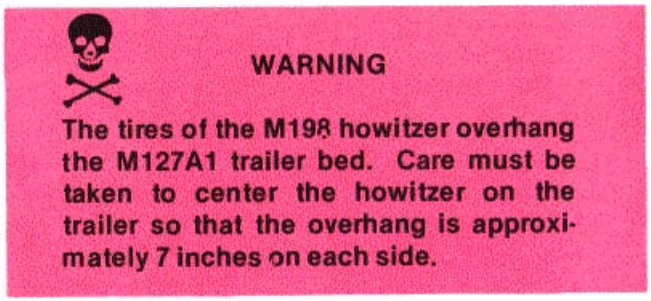
Section II

TRANSPORT WITH WHEELS ON BY SEMITRAILER

NOTE: All blocking and tiedown material, except chain load hinders, must be furnished by the shipper.

The M198 howitzer, in the stowed position, can be transport on semi-trailers, such as the M127AI, without removing the howitzer wheels. Since the width of the howitzer exceeds 96 inches, approval for highway transport must be obtained, as outlined in AR 55-162. For movement by commercial highway transport, refer to AR 55-355.

SAFETY



WARNING

Loading should not be done on slopes of more than 10 percent or with a tractor-to-trailer offset angle of more than 5 degrees. Do not load on steep grades.

Personnel must be cautioned not to walk under items being lifted.

Lifting eyes and shackles should be inspected to insure that they are complete and not damaged.

All lifts should have at least two tag lines attached to control the swing of the howitzer.

Wire tie the pin that locks the gun tube stowage bracket in such a way that the pin cannot come out during transit.

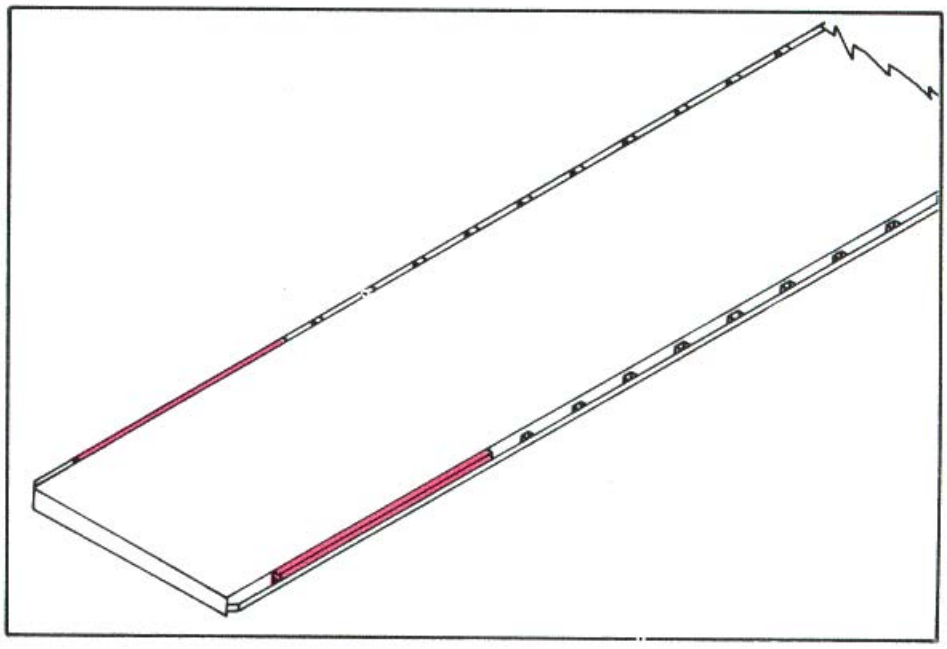
Remove and stow all loose equipment.

PREPARE THE TRAILER

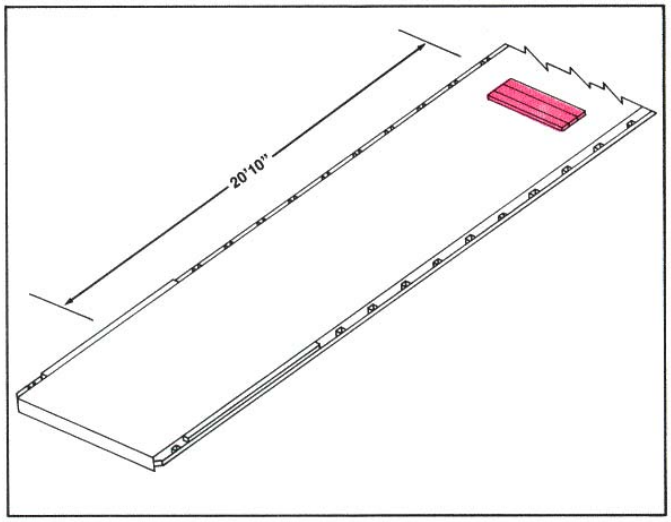
Materials Required for Trailer With Chain and Load Binders

Lumber, 2- x 4-inch	**16 linear feet**
Lumber, 2- x 6-inch	**14 linear feet**
Nails, 12d	**21**

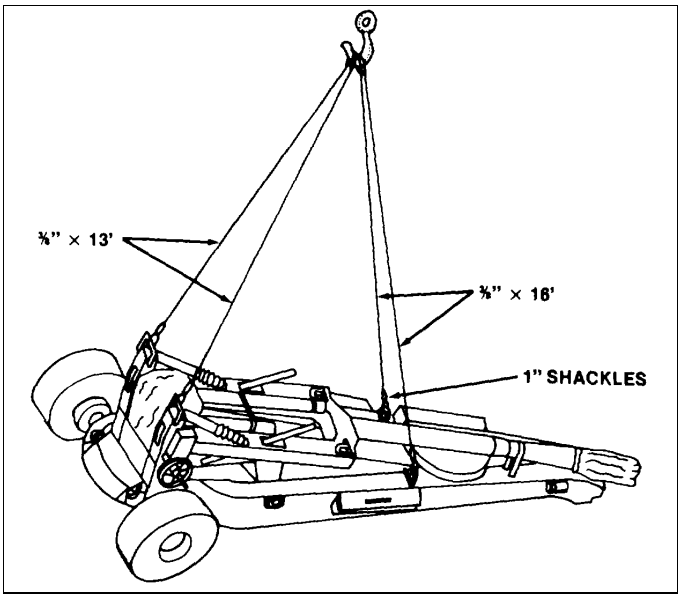
If the trailer stake pockets and rub rail are not flush with the trailer deck, cut two pieces of 1-114by 4-inch by 8foot lumber to use as fillers. Place filler strips on the rub rails if required to form a surface level with the trailer deck, centered under the spot where the howitzer wheels will be.



NOTE:
The howitzer may be put on the trailer with the tube pointing forward or to the rear.



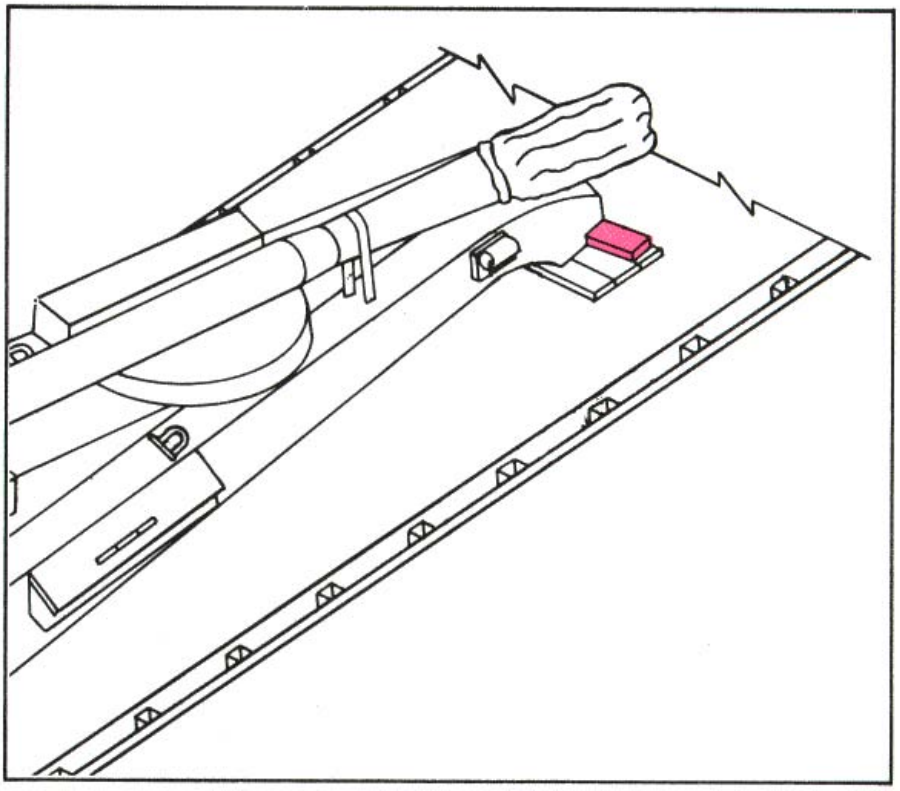
Make a support platform for the trails using three pieces of 2-by 6-by 48-inch lumber. Place the support platform in the center of the trailer deck with the front edge approximately 20 feet 10 inches from the center line on which howitzer wheels will rest. Nail the platform to the trailer deck, using five 12d nails though each piece.



If the trailer is equipped with chains and load binders, no further preparation is required. Lift the howitzer onto the trailer with a crane of at least 8-ton capacity, centering the wheels over the filler strips, with the trails resting on the support platform. Lifting points on the howitzer in the stowed position are the four lifting eyes of 40,000 pound-capacity each. They are located on top of each trail and on each side of the top carriage.

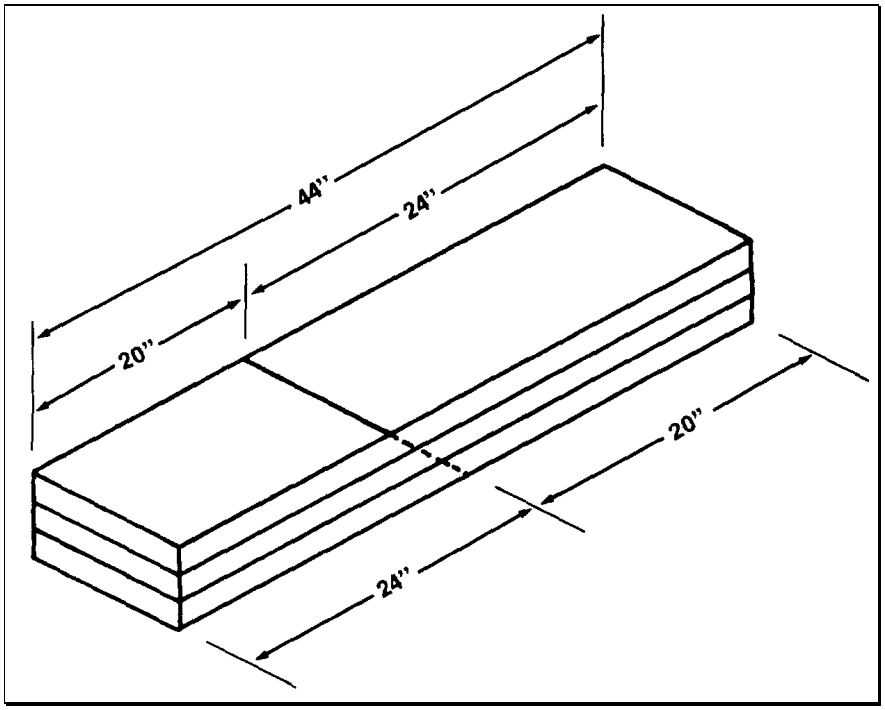
When the howitzer is in place, set and wire tie the handbrakes. Secure the howitzer with chain tiedowns to each side and rear howitzer tiedown point and with two chain tiedowns to the howitzer lunette. Tighten the chains with load binders. Cut two side blocks of 2 by 6 by 10 Inch lumber. Place one block against each side of the trails and nail to the support platform with three 12d nails.

If the trailer is not equipped with chains and load binders, blocking and tiedown material will be needed.



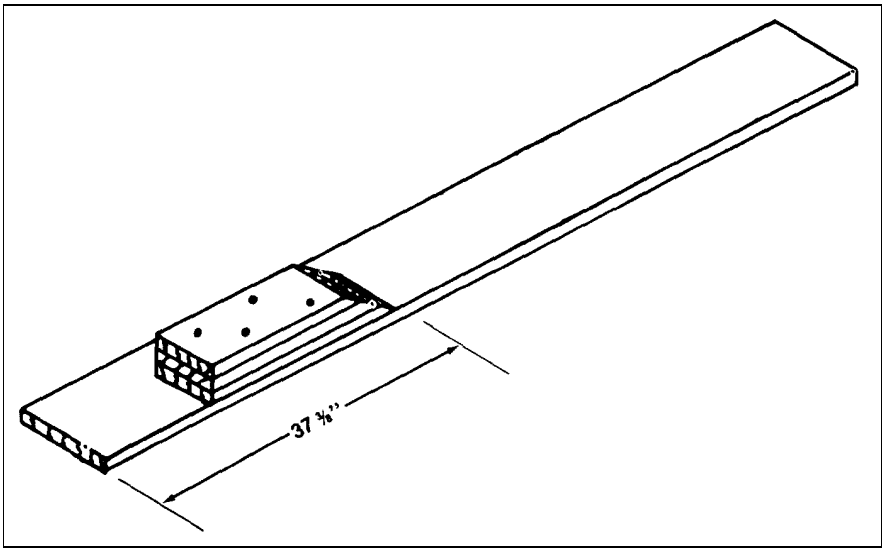
Materials Required For Trailer Without Chains and Load Binders	
Lumber, 2-x 4-inch	58 linear feet
Lumber, 2-x 6-inch	30 linear feet
Lumber, 2-x 8-inch	22 linear feet
Lumber, 2-x 12-inch	16 linear feet
Nails, 10d	22
Nails, 12d	125
Nails, 20d	24
Wire rope, 1/2-inch	75 feet
Thimbles, open-type, 1/2-inch	12
U Bolt clips, 1/2-inch	36
Waterproof paper or burlap	As required

BUILD CHOCK BLOCKS



Build two wheel chock-block assemblies, starting with two pieces of 2 by 12-inch by 8 foot lumber as a base. Cut 6 pieces of 2 by 8 by 44-inch lumber. Make two stacks of three pieces each and cut so that four chock blocks with about 45 degree angles can be made.

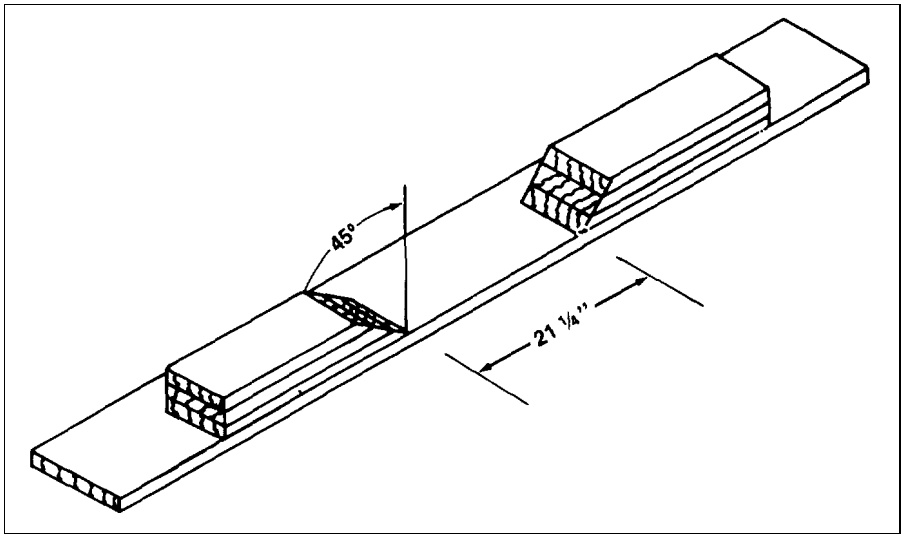
NOTE:
Stagger the nailing pattern so that a nail will not be driven into or right beside a nail in a lower piece.



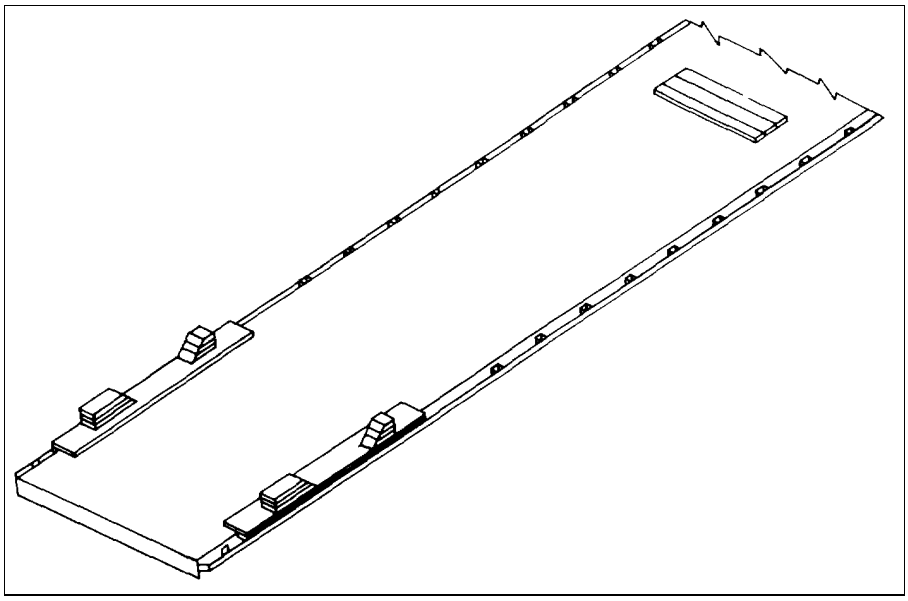
Place the bottom piece on the 2 by 12-inch by 8-foot base so that the 45 degree angle is toward the center of the base and 37-3/8 inches from the end. Nail to the base with four 10d nails. Nail each additional piece to the piece below with four 20d nails.

Nail the next stack of three pieces at the other end of the base with the-45 degree angle facing the center. Place so that the space between the two blocks is 21-114 inches wide.

Two of these assemblies will be required, one for each howitzer wheel.

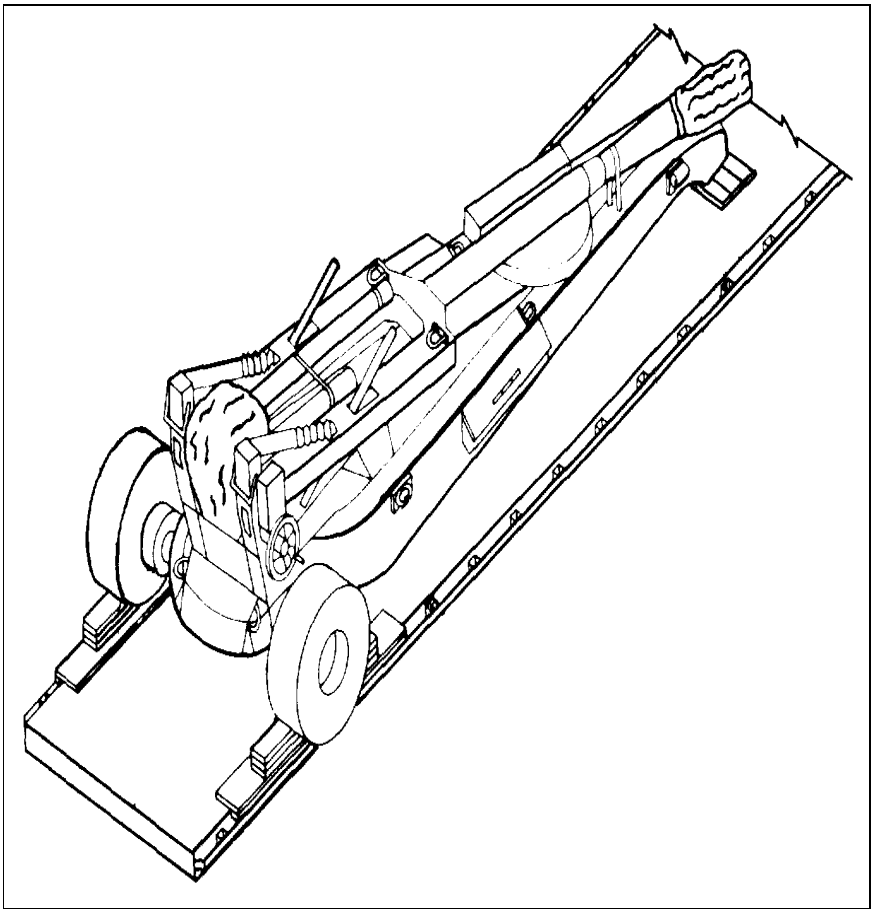


Place the wheel-block assemblies on the trailer deck flush with the outside edge and over the filler strips. Nail to the deck with nine 12d nails and to the filler strip with five 10d nails.



LOAD THE HOWITZER

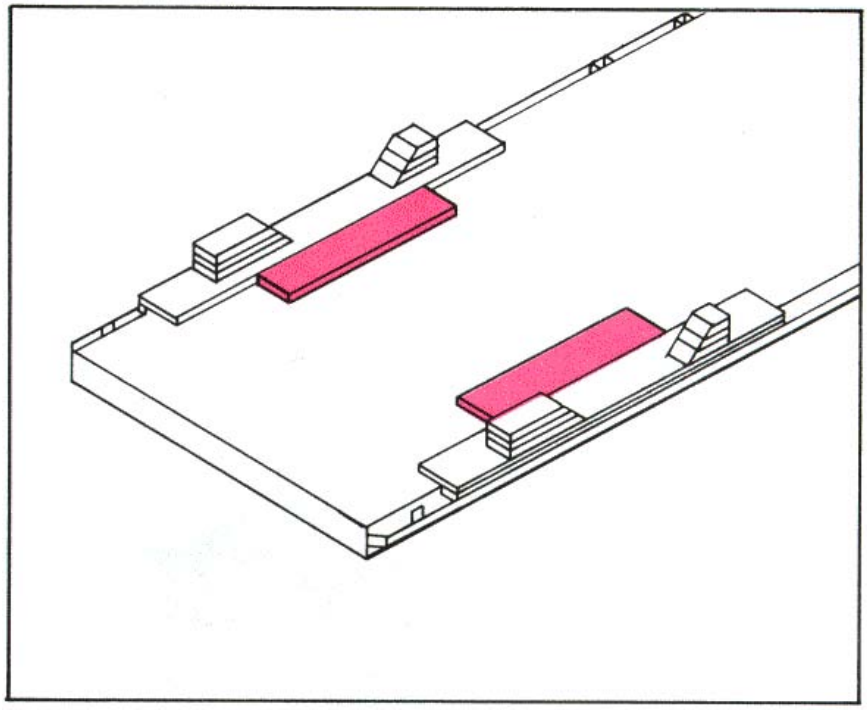
Lift the howitzer onto the trailer using a crane of at least 8-ton capacity. Lifting points on the howitzer in the stowed position are the four lifting eyes of 40,000 pound capacity each, located on top of the trails and on each side of the top carriage.



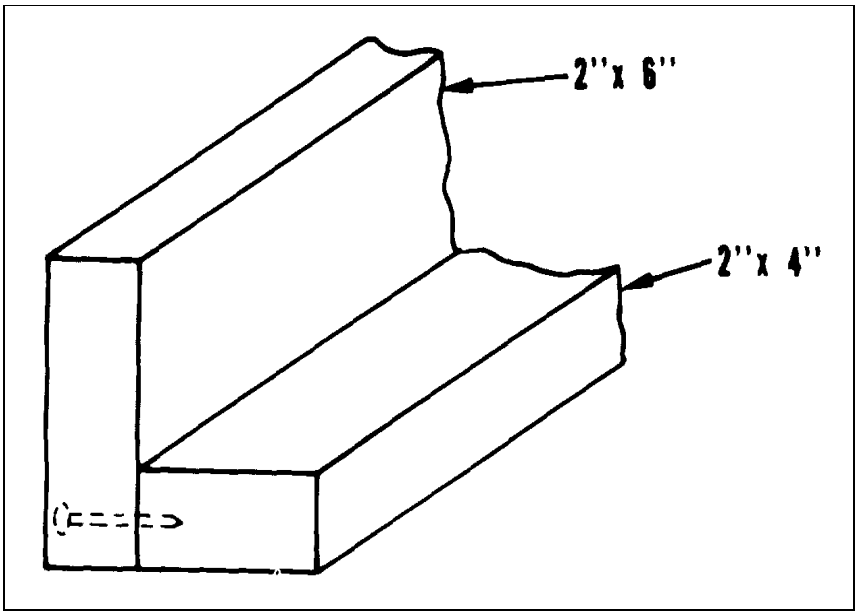
Center the howitzer on the trailer with the wheels in the wheel-block assemblies and the trails resting on the support platform. Set and wire tie the howitzer handbrakes.

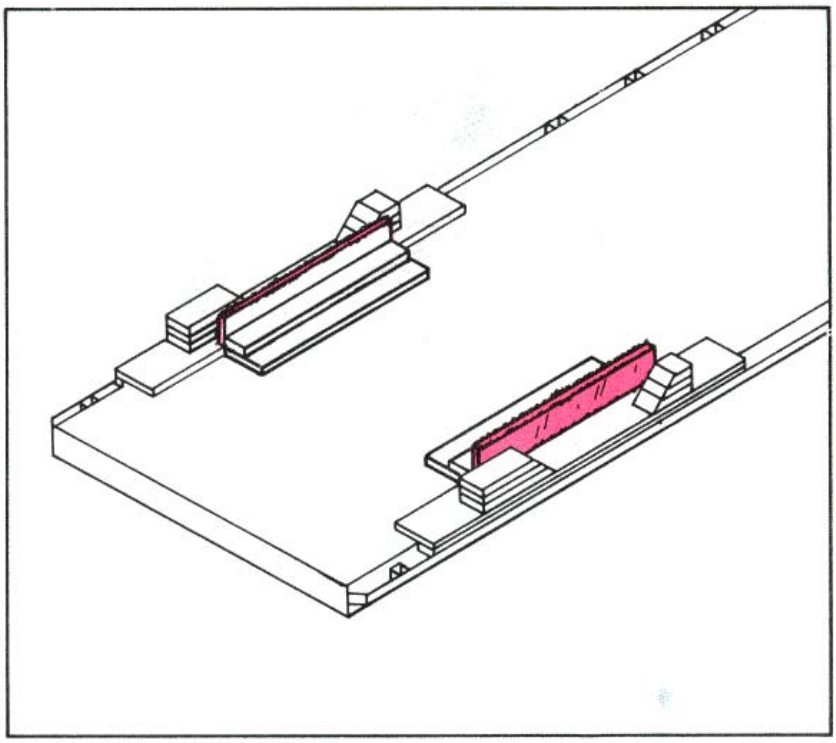
SECURE THE LOAD

Center a piece of 2 by 6 by 48-inch lumber inside each howitzer wheel and against the base of the chock block assemblies. Nail to the trailer deck with five 12d nails. These pieces are used as risers to raise the side blocks to the proper height.



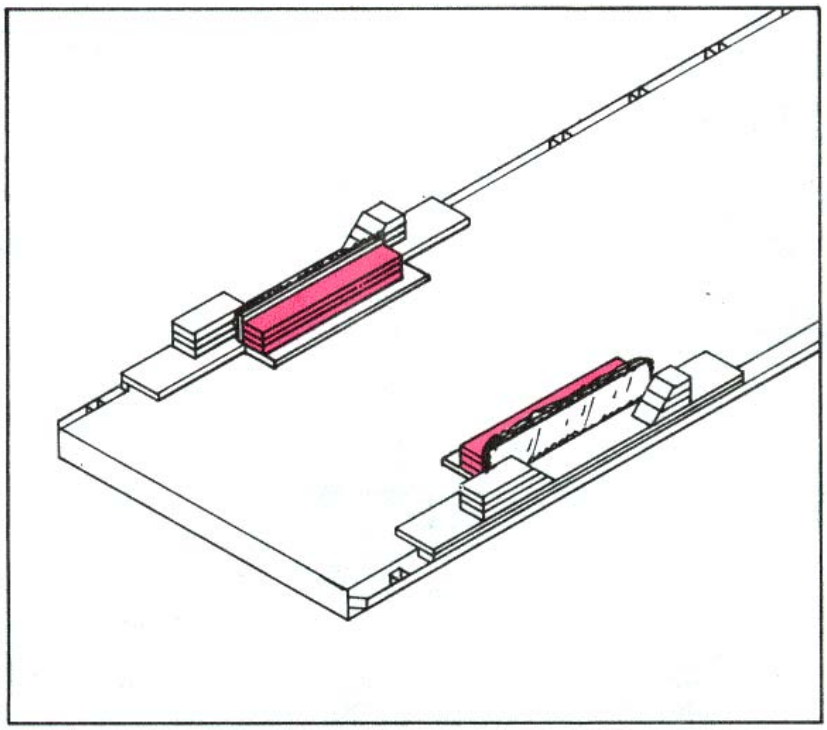
Cut two pieces of 2 by 6 by 48-inch lumber and six pieces of 2 by 4 by 48-inch lumber for the side blocks. Build two side blocks for blocking against the inside of the wheels, using the following steps. Nail one of the 2 by 6 inch pieces to the edge of one of the 2 by 4-inch pieces with five 12d nails.





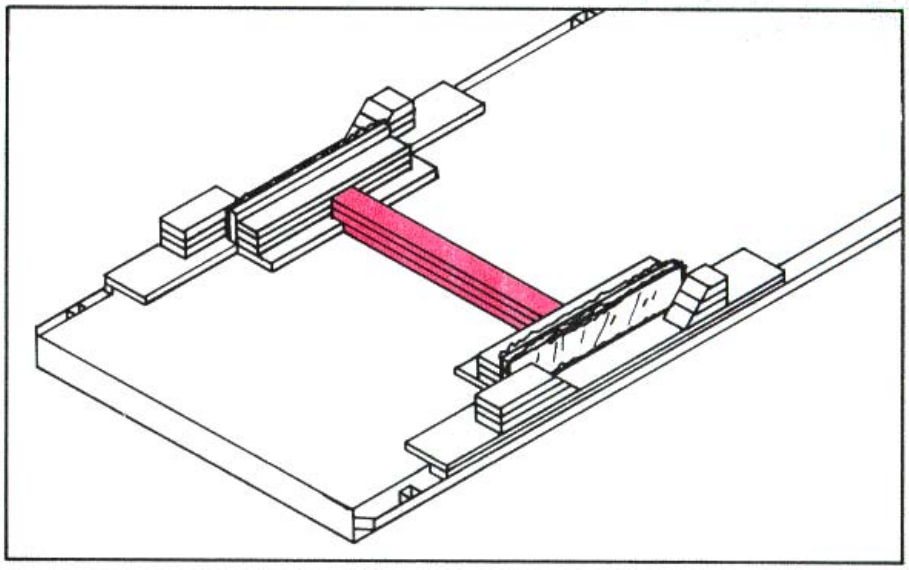
Place a piece of 10 by 48-inch waterproof paper or burlap between the 2 by 6-inch lumber and the howitzer tire and nail the 2 by 4-inch piece to the riser with five 12d nails.

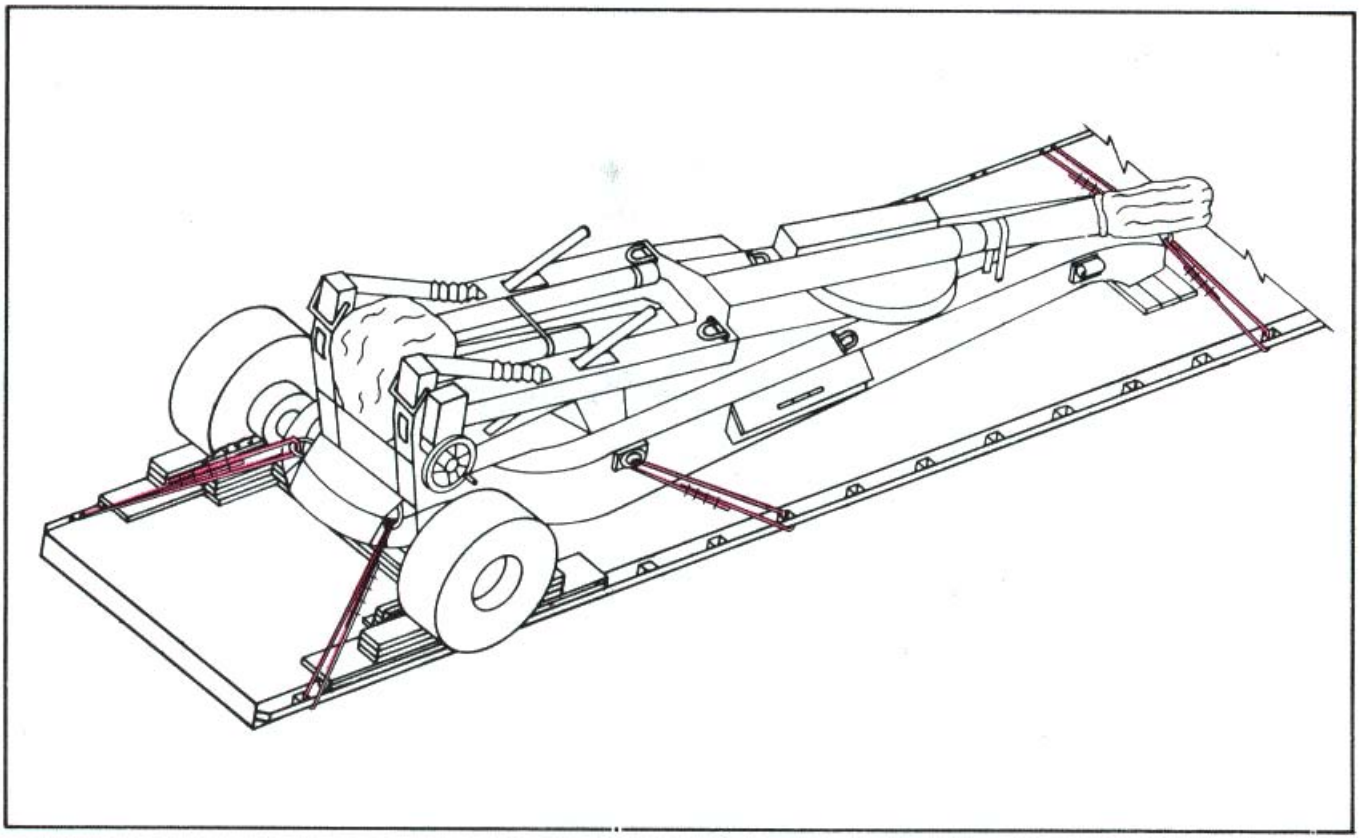
The waterproof paper or burlap protects the tire and should extend from under the 2 by 6 inch rubbing strip to 2 inches above the rubbing strip.



Nail two more 2 by 4 by 48 inch pieces of lumber to the bottom piece with five 12d nails through each piece. Fabricate and install another side block inside the other wheel.

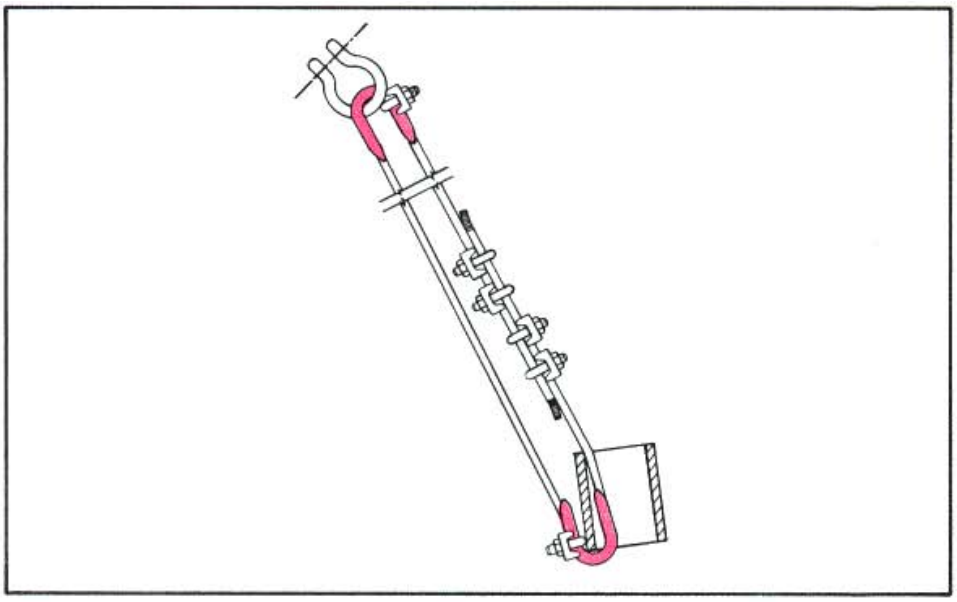
Cut three pieces of lumber 2 by 4-inch by length cut-to-fit for use as a spanner brace between the wheel side blocks. Fit one piece between the two risers and nail to the trailer deck with twelve 12d nails. Fit the other two pieces between the 2 by 4 inch side blocks and nail them to the bottom spanner with twelve 12d nails through each piece.





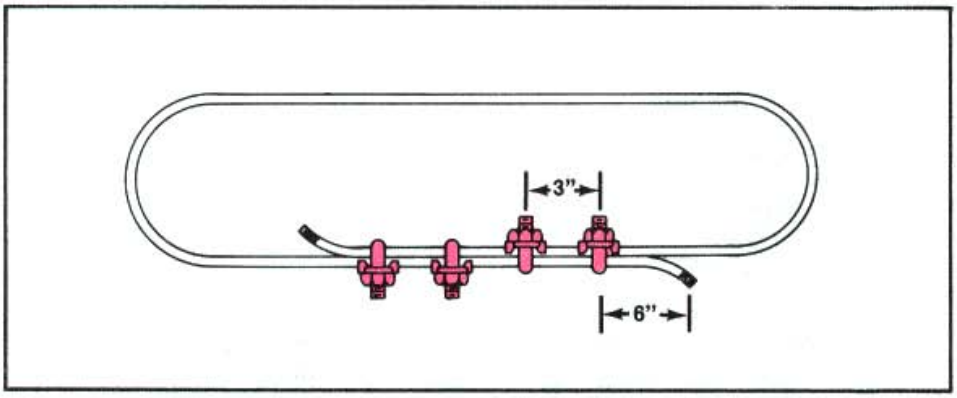
Tie the howitzer to the trailer with 112-inch wire rope. A total of six tiedowns are required. Attach one to each of the two rear tiedown points, one to each of the two side tiedown points, and two to the towing lunette.

Form a complete loop with the wire rope through the trailer stake pocket and the tiedown point on the howitzer. The angle between the trailer deck and the wire rope tiedowns on the rear and sides of the howitzer should be as close to 45 degrees as possible. The wire rope ends should overlap at least 21 inches.

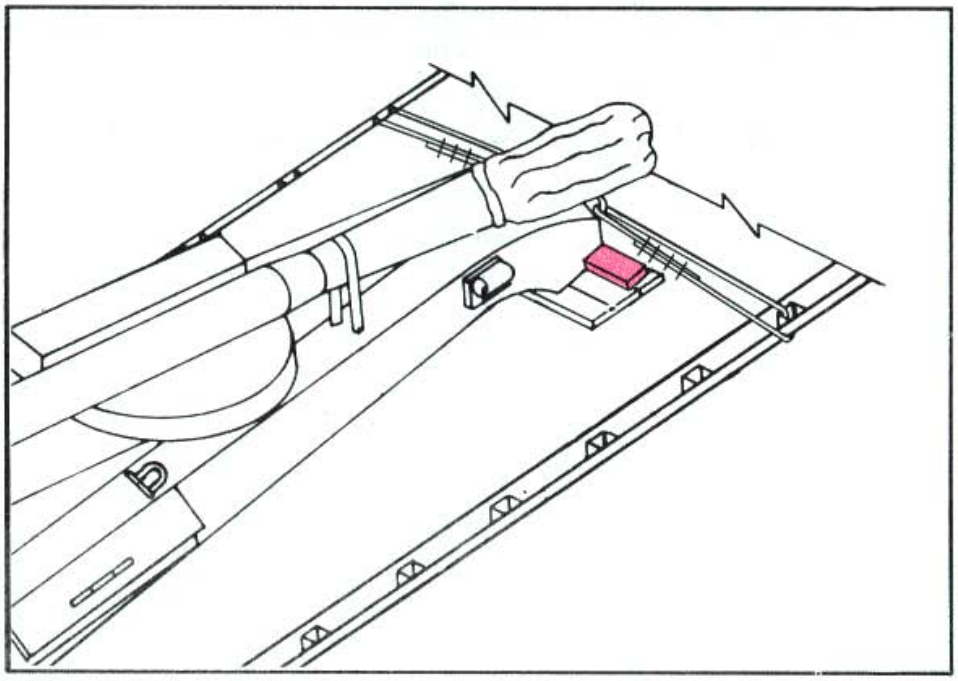


Place standard 112-inch open-type thimbles at each place where the wire rope contacts the trailer stake pocket and the howitzer tiedown points, except that no thimbles are required at the howitzer lunette. Secure the thimble to the wire rope with a 112-inch U-bolt clip.

Tension the wire rope enough to cause moderate depressing of the howitzer by using two cable grippers and an appropriate size of come-along mechanical hoist.



Secure the ends of the wire rope at the overlap area with four 112-inch U-bolt clips, spaced 3 inches apart, none closer than 6 inches from the ends of the wire rope.



Tighten the U-bolt clip nuts enough to prevent slippage of the wire rope. After the U-bolt nuts have been tightened initially, the "U side of each clip must be struck several times with a hammer to insure proper seating. The nuts must then be re-tightened.

After the tiedowns have been tightened, cut two side blocks of the 2 by 6 by 10-inch lumber. Place one piece against each of the trails and nail to the support platform with three 12d nails each.

Section III
TRANSPORT WITH WHEELS OFF BY SEMITRAILER

REMOVE HOWITZER WHEELS

Remove the howitzer wheels and replace the wheel lug nuts on the wheel bolts. Tighten the nuts and tape or wire tie in such a manner that they will not work loose during transit.

PREPARE THE TRAILER

If the trailer is not equipped with chain load binders, blocking and tiedown material will be needed.

Materials Required

Lumber, 2-x 4-inch	6 linear feet
Lumber, 2-x 6-inch	142 linear feet
Nails, 10d	102
Nails, 12d	84
Nails, 20d	84
Wire rope, 1/2-inch	60 feet
U-bolt clips, 112-inch	22
Thimbles, open-type, 1/2-inch	6
Steel strapping, 1-114x .035 inch	17 feet
Seals for 1-114-inch strapping	5
Waterproof paper or burlap	as required

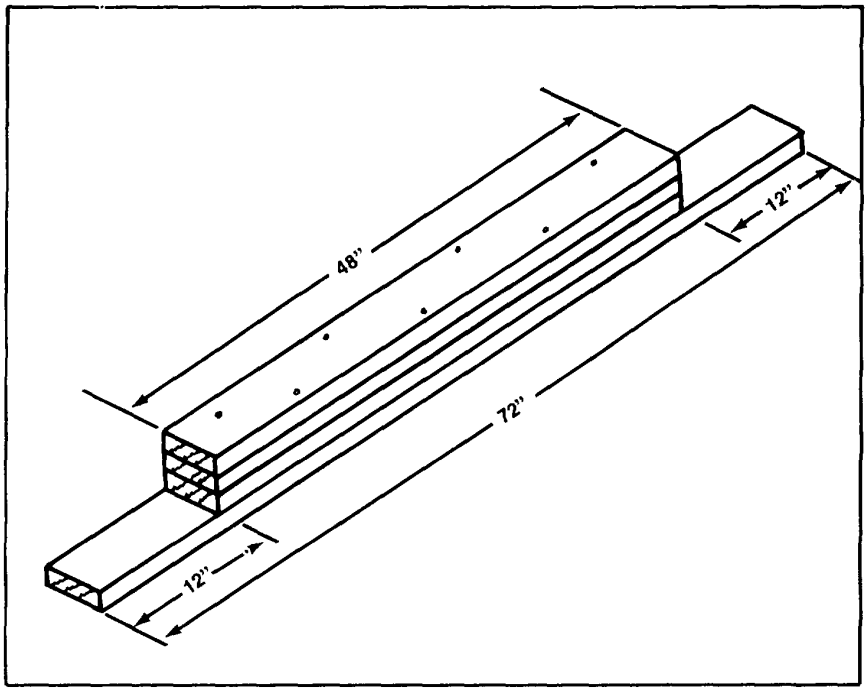
Before loading the howitzer on the trailer, a base support assembly and a riser assembly must be built and nailed to the trailer deck.

BUILD THE BASE SUPPORT ASSEMBLY

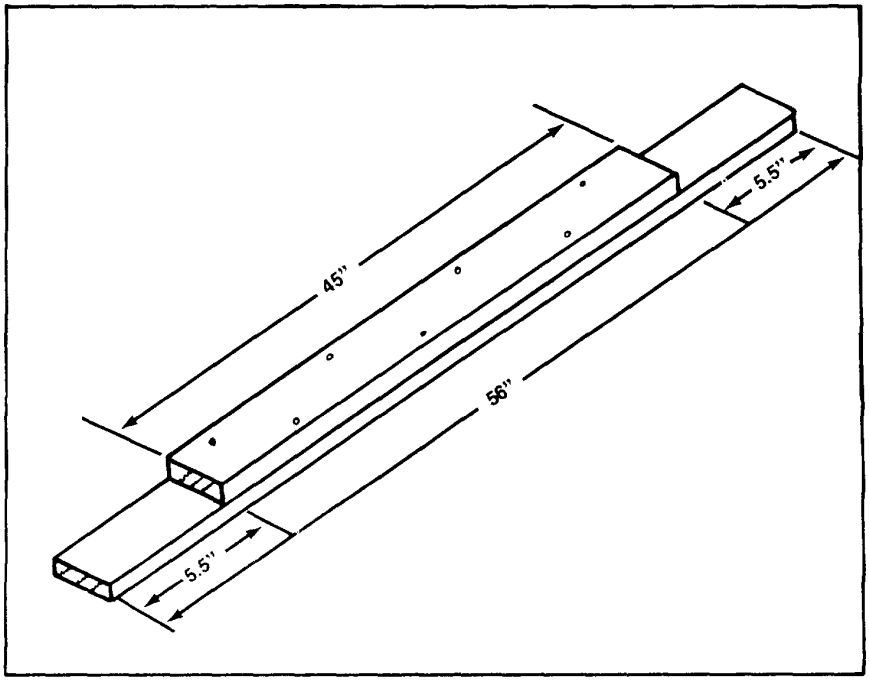
Cut two pieces of 2 by 6 by 72-inch lumber; ten pieces 2 by 6 by 48-inch; two pieces 2 by 6 by 45 inch; two pieces 2 by 6 by 37-inch; and two pieces 2 by 6 by 56 inch.

Use the following steps to assemble these 18 pieces which make up the base support assembly:

NOTE:
Stagger the nailing pattern so that a nail will not be driven into or right beside a nail in a lower piece

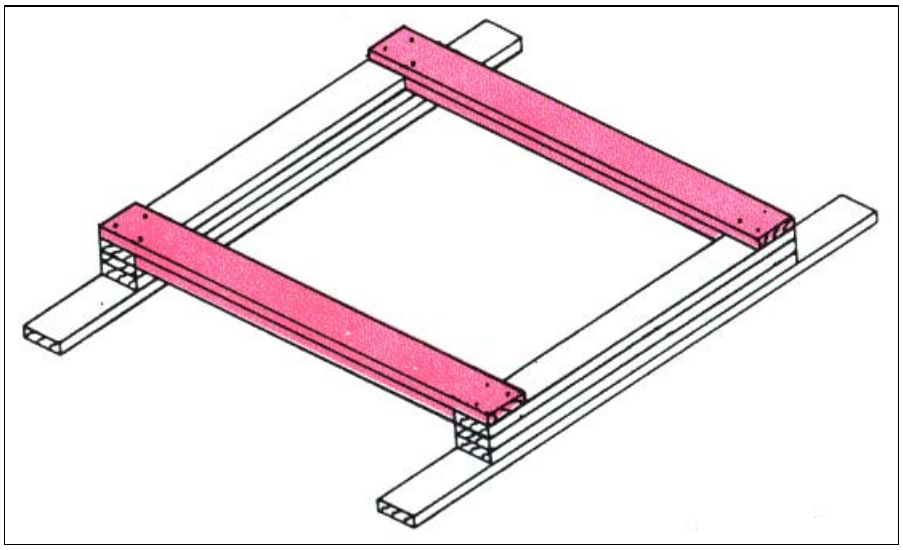


Nail three of the 48-inch-long pieces to each of the two 72-inch-long pieces, using seven 10d nails through each piece.

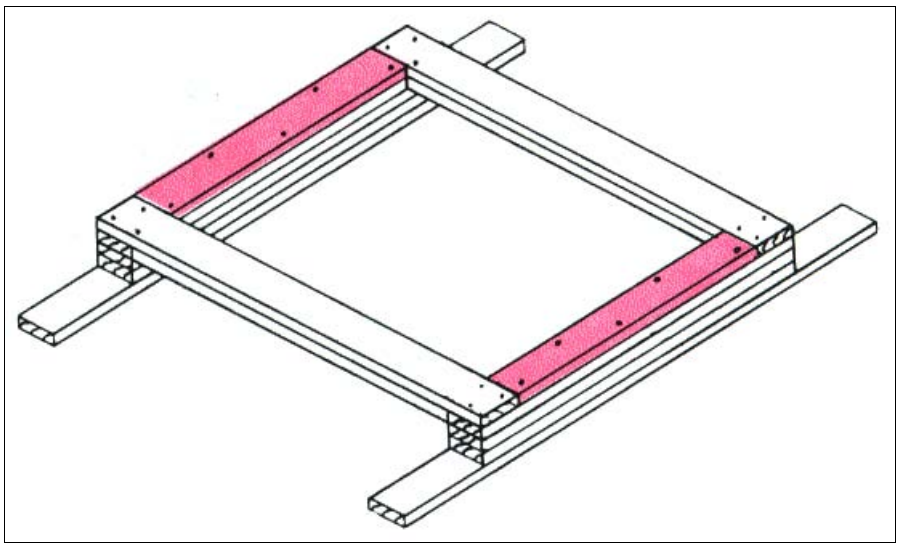


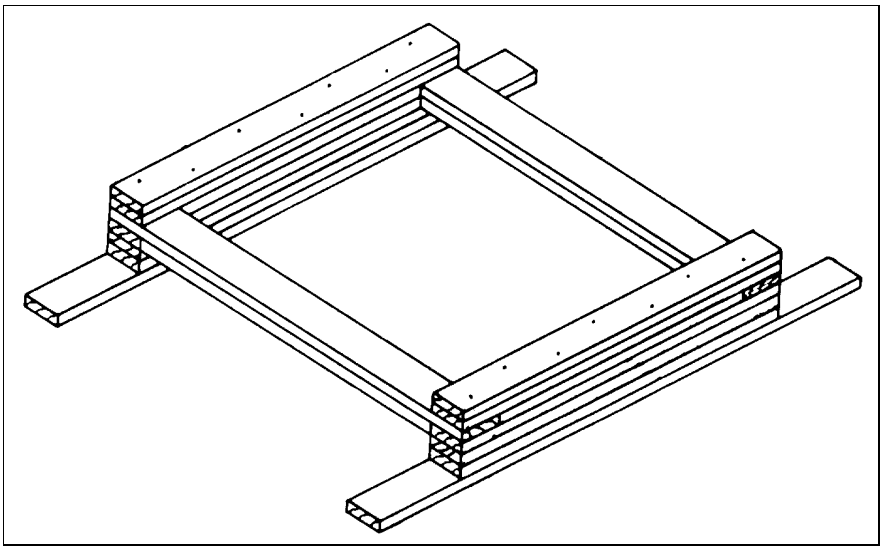
Nail one of the 45-inch-long pieces to each of the two 56-inch-long pieces with five 10d nails through each.

Using the 45-inch-long pieces as spacers, and the 56-inch-long pieces as tie pieces, tie the two partially completed supports together by nailing with three 10d nails at each end.

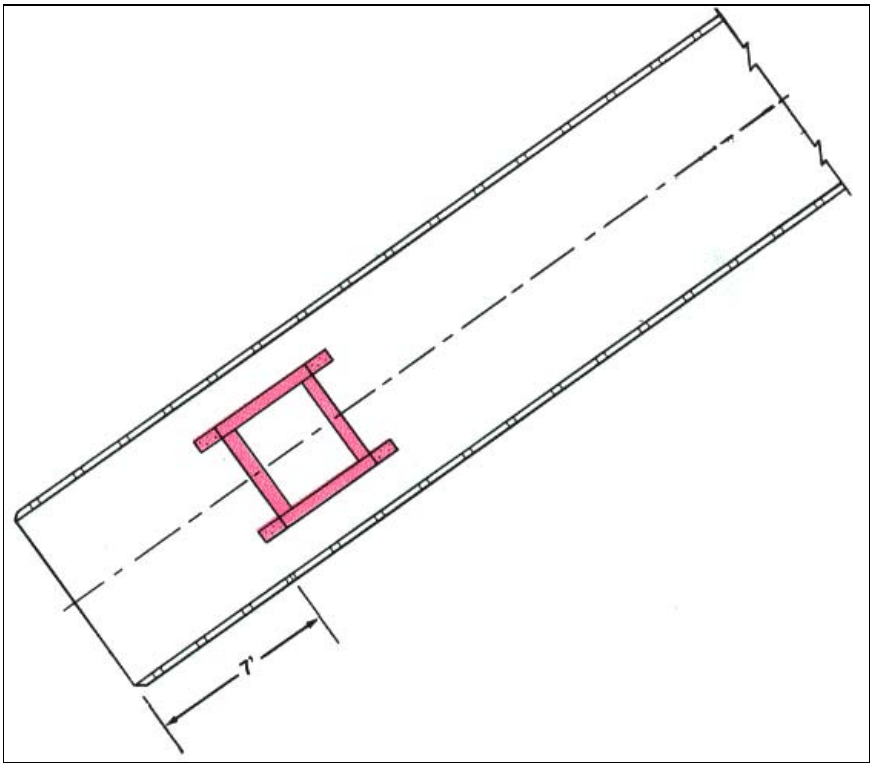


Nail two pieces of 2 by 6 by 37-inch-long lumber between the ends of the tie pieces with five 10d nails through each.





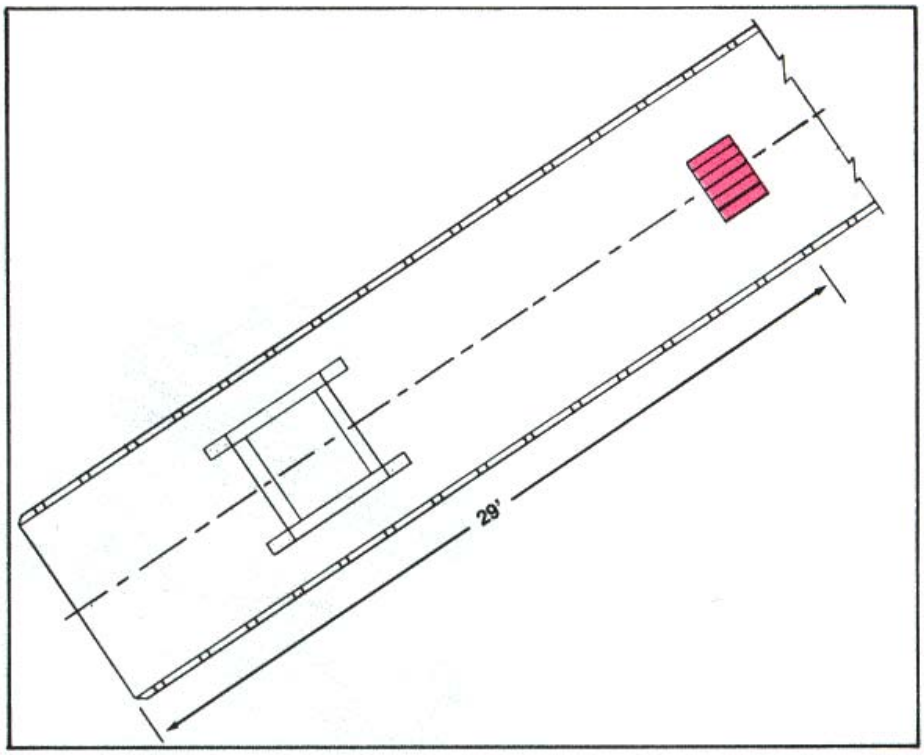
To complete the base support assembly, nail two more 2 by 6 by 48-inch pieces of lumber on top of each side with seven 10d nails.



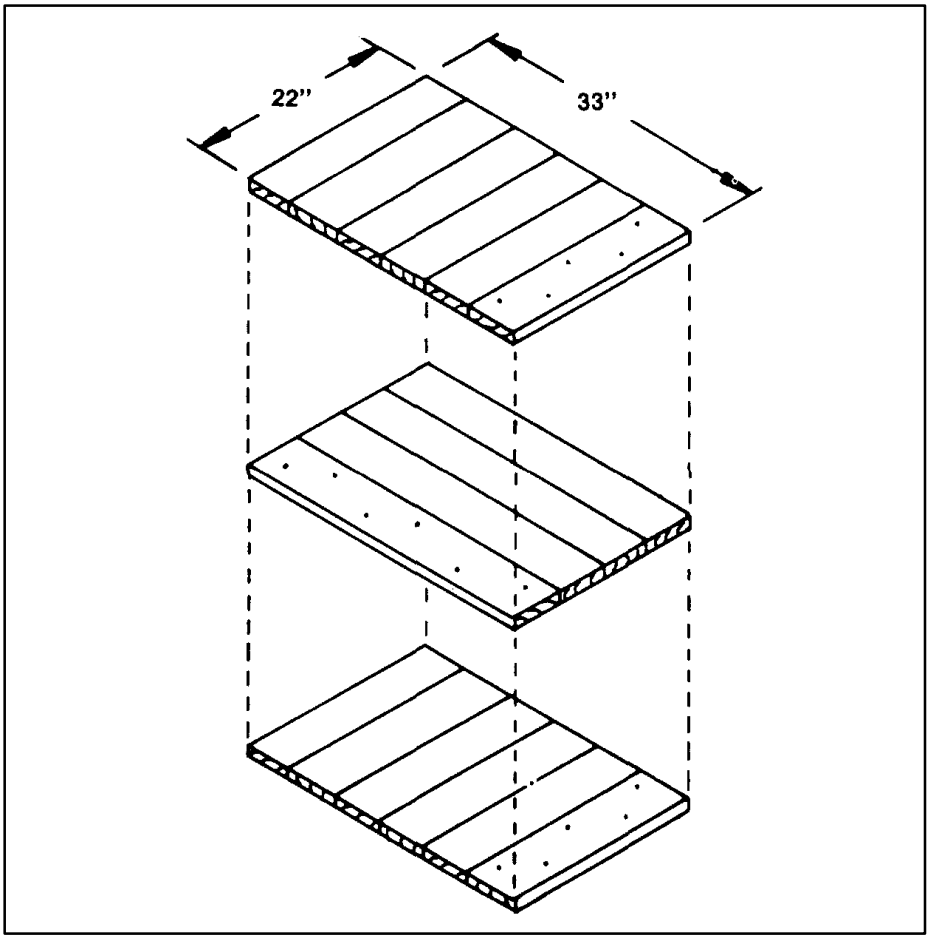
Position the base support assembly seven feet from the rear end of the trailer deck, centered on the center line of the deck, and nail to the deck with four 12d nails through each end of each bottom piece of lumber.

BUILD THE RISER ASSEMBLY

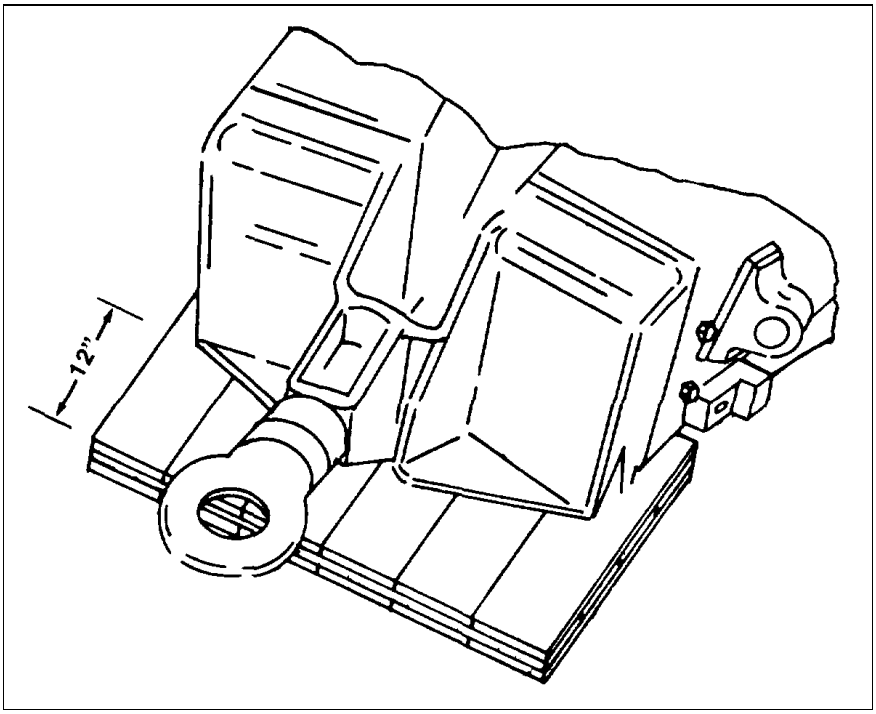
Cut twelve pieces of 2 by 6 by 22 inch lumber and four pieces of 2 by 6 by 33-inch lumber. Center on the center line of the trailer and nail six of the 22-inch-long pieces to the trailer deck with five 12d nails through each piece. Locate the forward edge of these pieces 29 feet from the rear end of the trailer deck.



Nail the four pieces of 33-inch long lumber crossways to the lower pieces with six 20d nails through each piece. To complete the riser assembly, nail the other six 22-inch-long pieces on top with five 20d nails through each piece.

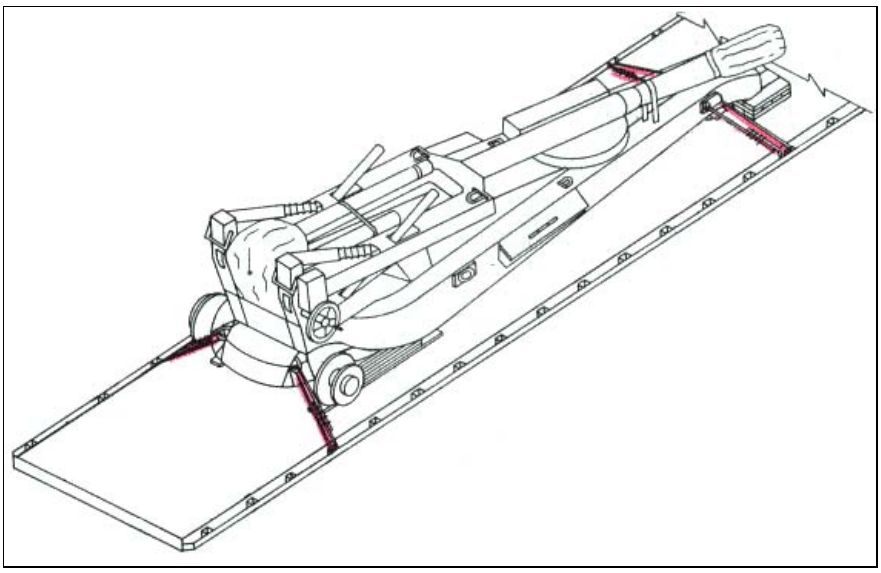


LOAD THE HOWITZER



Lift the M198 howitzer onto the trailer using a crane of at least 8-ton capacity. Position the howitzer by centering it across the width of the trailer and in the base support assembly and the riser assembly. Position the howitzer fore and aft by placing the end of the trails 12 inches from edge of the riser assembly.

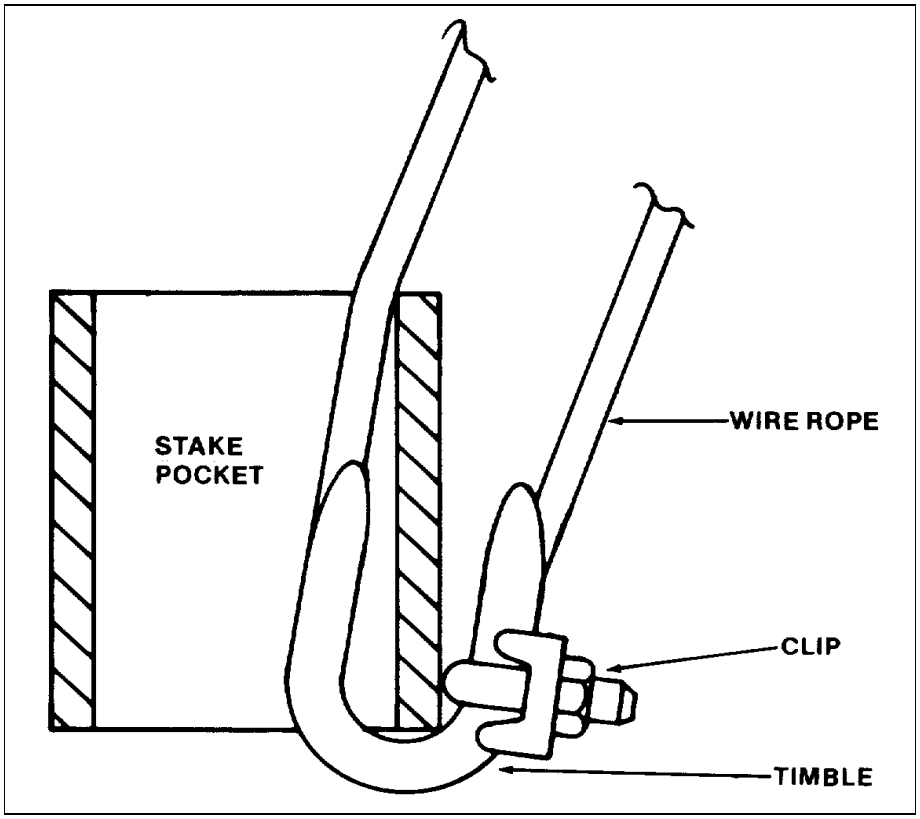
SECURE THE LOAD



Tie the howitzer to the trailer with 1/2-inch wire rope. A total of four tiedowns are required. Attach one to each of the two rear tiedown points and one to each of the two weapon support brackets.

Form a complete loop with the wire rope through the trailer stake pocket and the tie down point on the howitzer. The angle between tie trailer deck and the wire rope tiedowns should be as close. to 45 degrees as possible. The wire rope ends should overlap at least 21 inches.

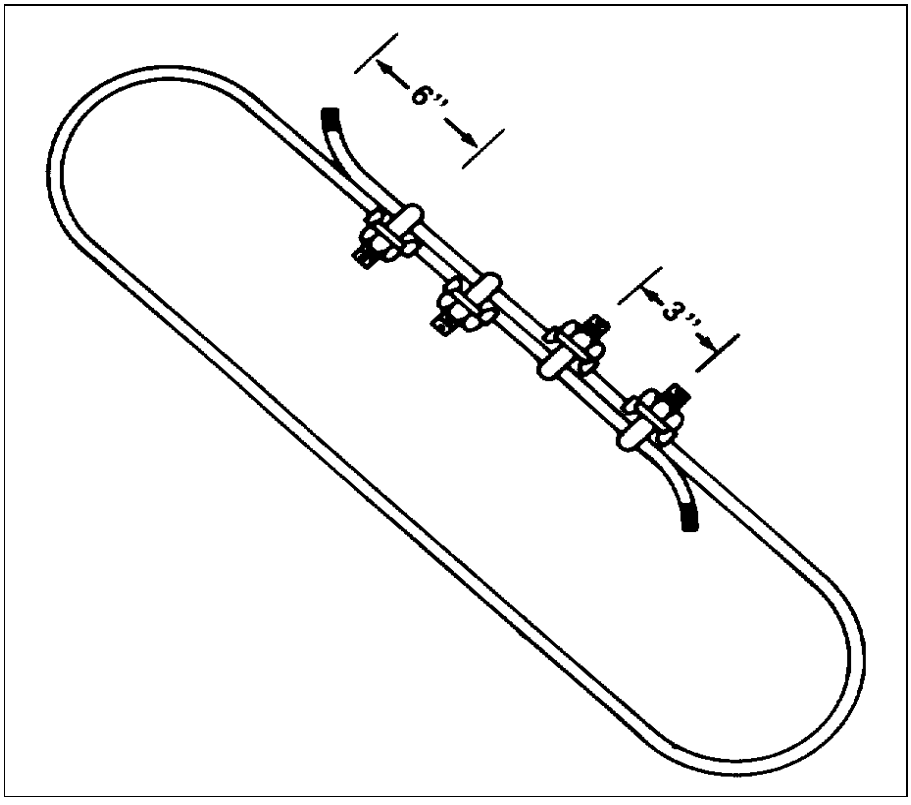
Place standard 1/2-inch open-type thimbles at each place where the wire rope contacts the trailer-stake pocket and where the wire rope contacts the rear tiedown points on the howitzer. Secure the thimbles to the wire rope with a 1/2-inch U-bolt clip.

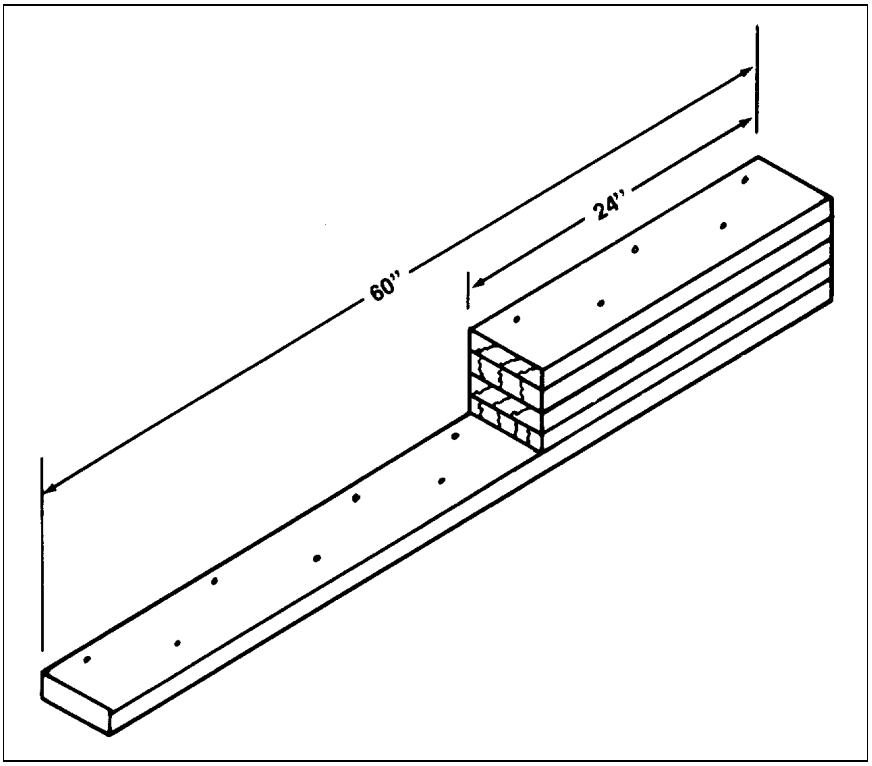


Tension the wire rope until taut by using two cable grippers and an appropriate size of come-along mechanical hoist.

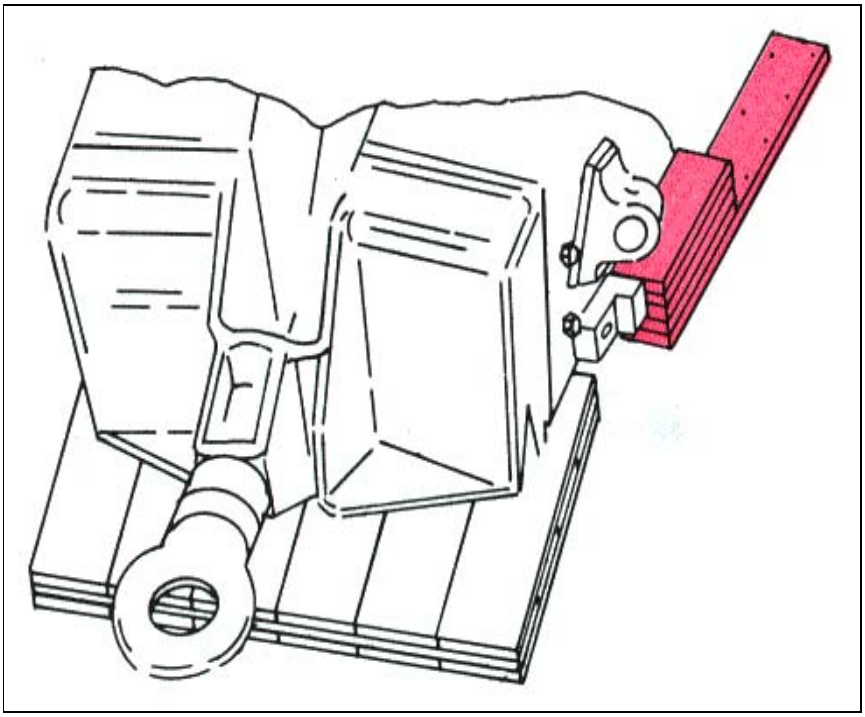
Secure the ends of the wire rope at the overlap area with four 1/2-inch U-bolt clips, spaced 3 inches apart, none closer than 6 inches from the ends of the wire rope.

Tighten the U-bolt clip nuts enough to prevent slippage of the wire rope. After the U-bolt clip nuts have been tightened initially, the "U" side of each clip must be struck several times with a hammer to insure proper seating. The nuts must be then be re-tightened.

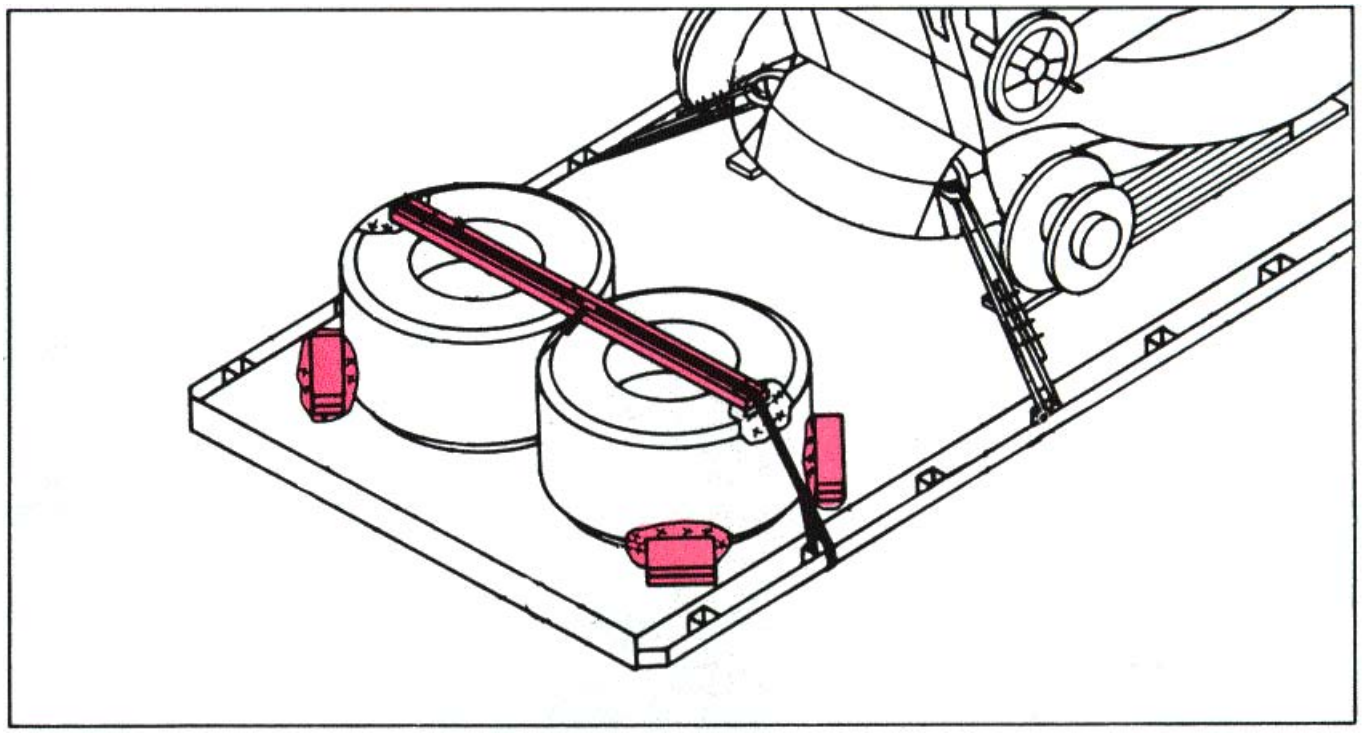




Build two blocking assemblies out of two pieces of 2 by 6 60-inch lumber and eight pieces of 2 by 6 by 24-inch lumber. Nail four 24 inch-long pieces to each of the 60-inch-long pieces with five 10d nails through each 24 inch piece.



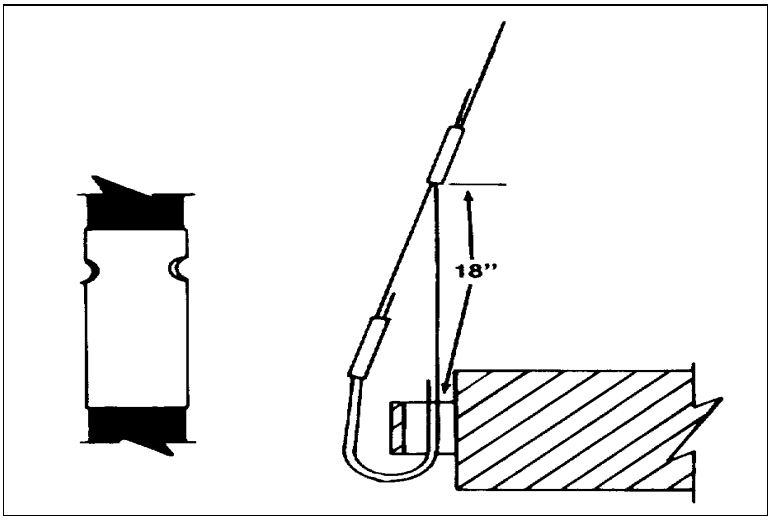
Position a blocking assembly against the plunger assembly slot on each side of the howitzer trails and nail each assembly to the trailer deck through the 60 inch long piece with seven 20d nails.

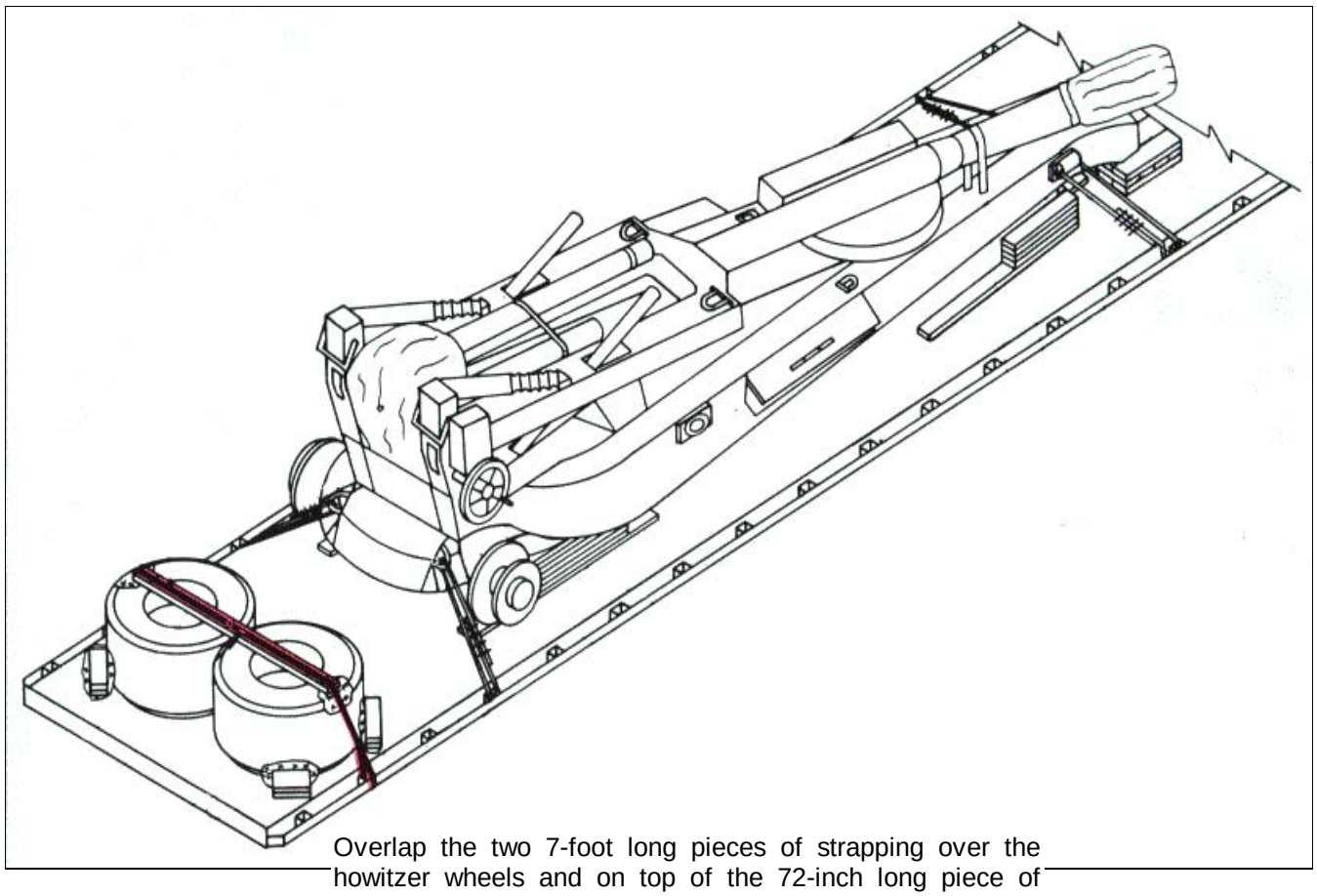


Load the howitzer wheels in the area to the rear of the Howitzer. Cut eight pieces of 2 by 6 by 12-inch lumber to be used as wheel blocks. Place a piece of waterproof paper or burlap underneath each block and against the tire to protect the tire. The paper or burlap should extend from underneath the block to 2 inches above the block. Place one piece of 2 by 6 by 12-inch lumber against the tire and nail to the trailer deck with three 12d nails. Nail the second piece to the first piece with three 12d nails.

Block the tires in four places. Lay a piece of 2 by 4 by 72. inch lumber across the wheels with waterproof paper or burlap underneath at points where the lumber contacts the tires.

Secure the wheels to the trailer deck with two pieces of 1-1/14-inch by .035-Inch by 7 foot long steel strapping. Loop one piece of strapping through the trailer stake pocket on each side of the trailer, with a pad of 18-inch long strapping between the long strap and the stake pocket. Attach the pad to the strap with one seal, crimped once. Complete the loop by installing one seal, crimped once, about 18 inches above the stake pocket.





Overlap the two 7-foot long pieces of strapping over the howitzer wheels and on top of the 72-inch long piece of lumber, tighten and join with a seal. This seal requires two pairs of crimps.

Secure the strapping to the 72-inch piece of lumber at three places with wire or staples.

CHAPTER 5

Transporting the M198 Howitzer by Water

Section I.

GENERAL

SCOPE: The M198 howitzer can be transported by a variety of inland waterway cargo carriers, including barges and lighters, and by all seagoing cargo vessels. This chapter prescribes the materials and guidance required to prepare, lift, and tie down the howitzer. The methods described in this chapter for lifting and securing the howitzer are suggested procedures. Other methods of handling and stowage may be used, provided they will insure safe delivery without damage.

SAFETY

If ammunition is to be transported, the carrier must be notified. Compliance with AR 55-228, paragraph 2-7, and CFR 46 part 146 is mandatory.

Ship's equipment and gear should be inspected before being used.

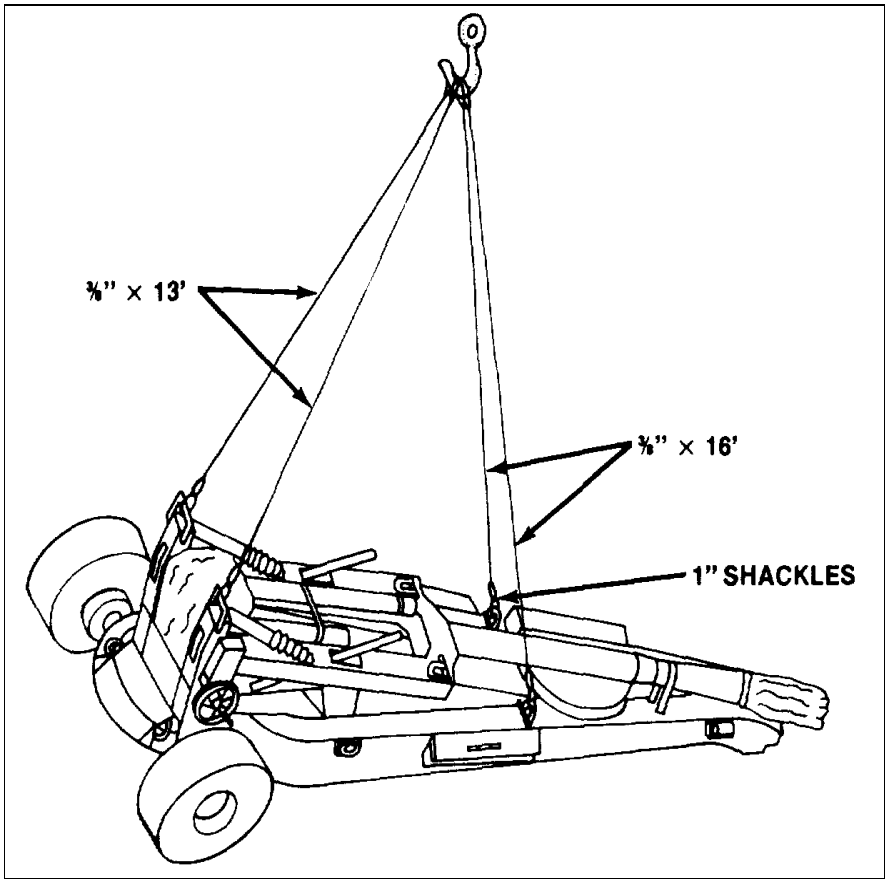
Stevedore slings and other items used in loading and off loading operations should be inspected for condition and capacity (8-ton minimum).

Lifting eyes and shackles should be inspected to insure that they are complete and not damaged.

All lifts should have at least two tag lines attached to control the swing of the howitzer.

LIFTING

Correct lifting points on the howitzer in the stowed position are the four lifting eyes of 40,000-pound capacity each. They are located on top of each trail and on each side of the top carriage.



STOWAGE

Whenever possible, howitzers should be stowed below deck. Good stowage means having howitzers placed as close together as practicable with minimum spacing between outer howitzer and the ship sweat boards (approximately 4 to 6 inches). All unattached parts should be protected and properly identified as to location or disposition during shipment. Howitzer wheels should be blocked in front, rear and on both sides so they cannot move in any direction. Wheel blocks should be braced to bulkheads, stanchions, and other howitzer wheel blocks. Lash howitzers with steel wire rope or chains to bulkheads, stanchions, or padeyes.

LOAD THE HOWITZER

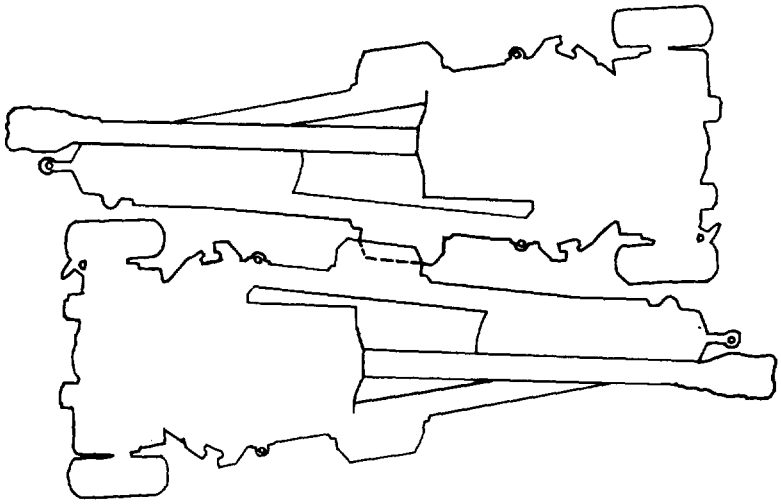
Howitzers will be loaded on vessels in the stowed position. They can be loaded aboard break-bulk freighters, C3 and C4 cargo vessels, special purpose vessels (such as roll-on/roll-off and LASH or SEABEE), and the current Army lighterage fleet, including the LARC-LX or larger. Container ships can transport the howitzer as deck cargo, and standard Army barges can be used to transport the

howitzer in sheltered or inland waterways. The howitzer can be loaded aboard seagoing vessels by shoreside or floating cranes or by ship's gear of at least 8-ton capacity. They can be towed aboard roll-on/roll-off vessels and vessels with suitable ramps.

Section II

TRANSPORT BY GENERAL CARGO VESSEL

NOTE: For the purpose of illustration, howitzers are shown loaded in a general-cargo vessel. Two howitzers are shown to illustrate multiple loading.



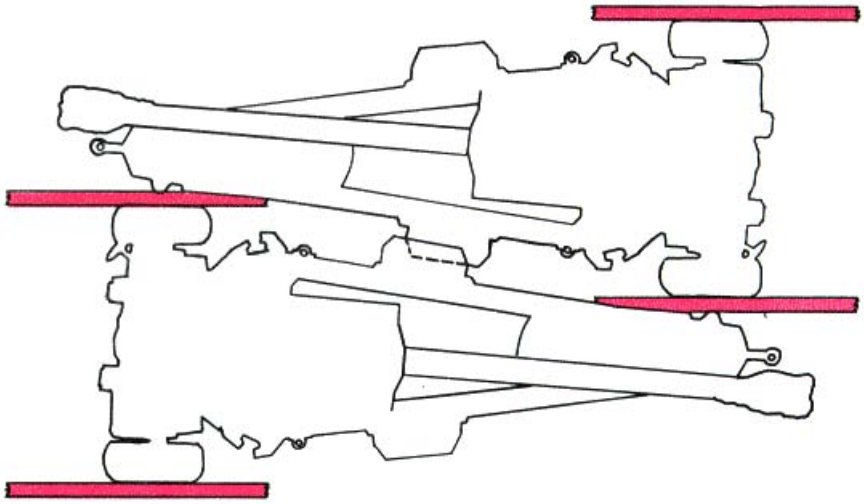
Place howitzers side-by-side, head-to-tail, with the spades overlapping.

Materials Required for Blocking and Tiedown in General-Cargo Vessel*

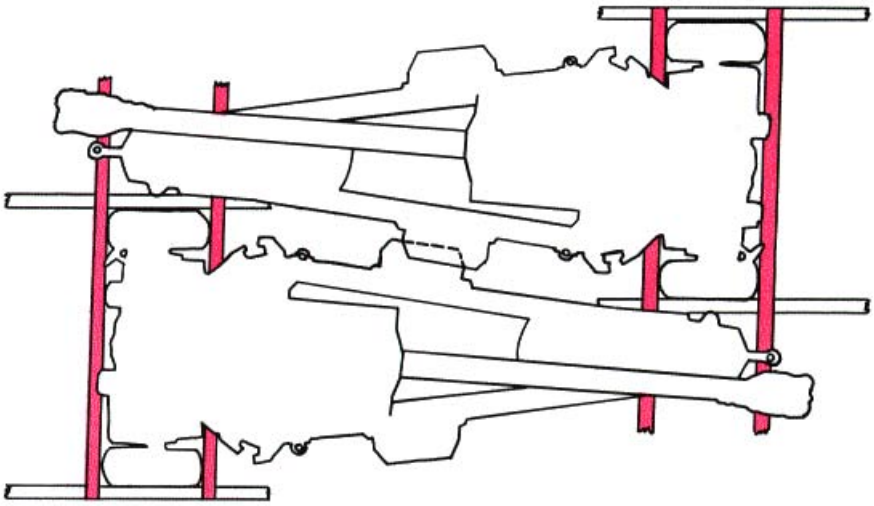
Lumber, 4 x 4-inch	70 linear feet
Nails, 50d	32
Nails, 20d	40
Steel wire rope, 518-inch	120 feet
Thimbles, open-type, 518-inch	4
U bolt clips, 518-inch	36

*** NOTE: List of materials is for securing two howitzers and is approximate.**

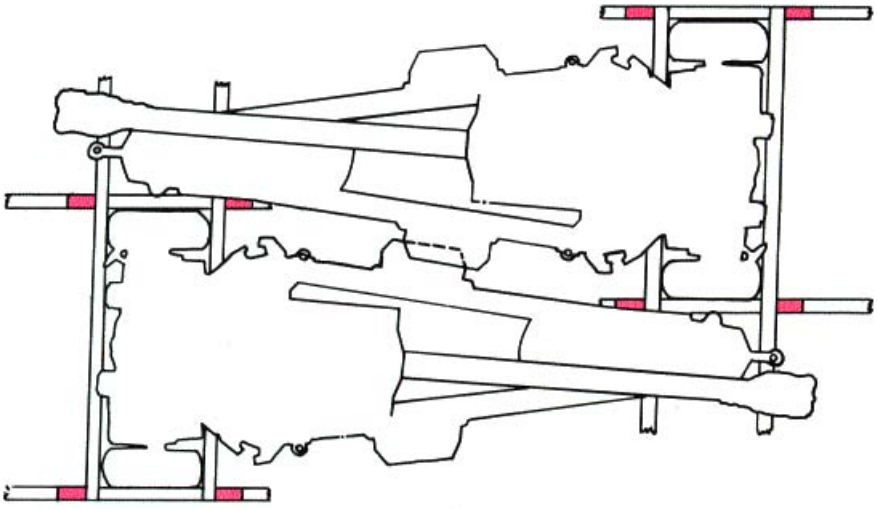
SECURE THE LOAD



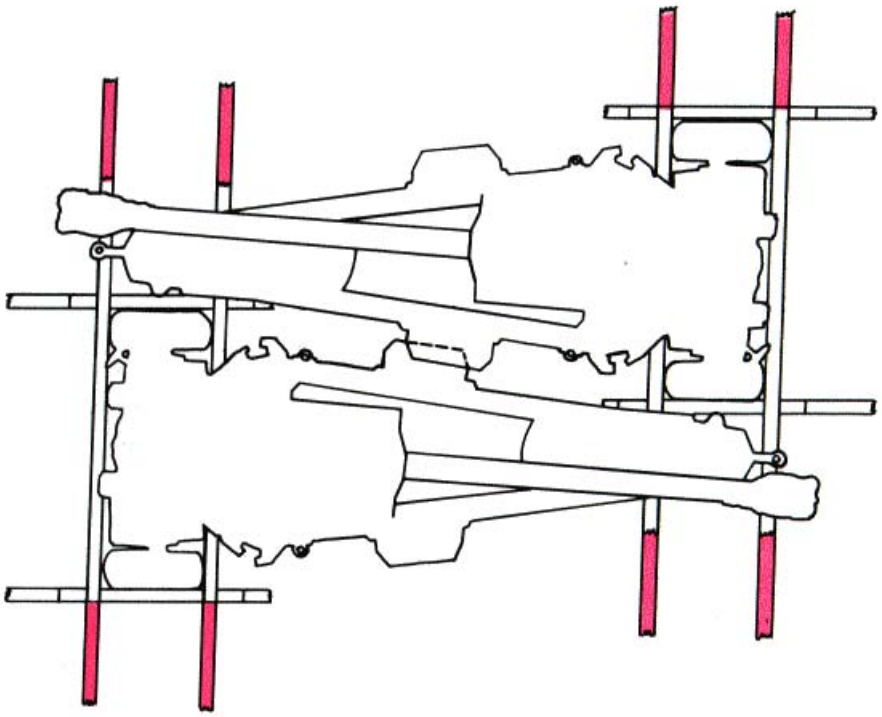
Cut four pieces of 4-by 4-by approximately 66-inch-long lumber for side blocking. Locate one piece against the outside of each howitzer wheel.



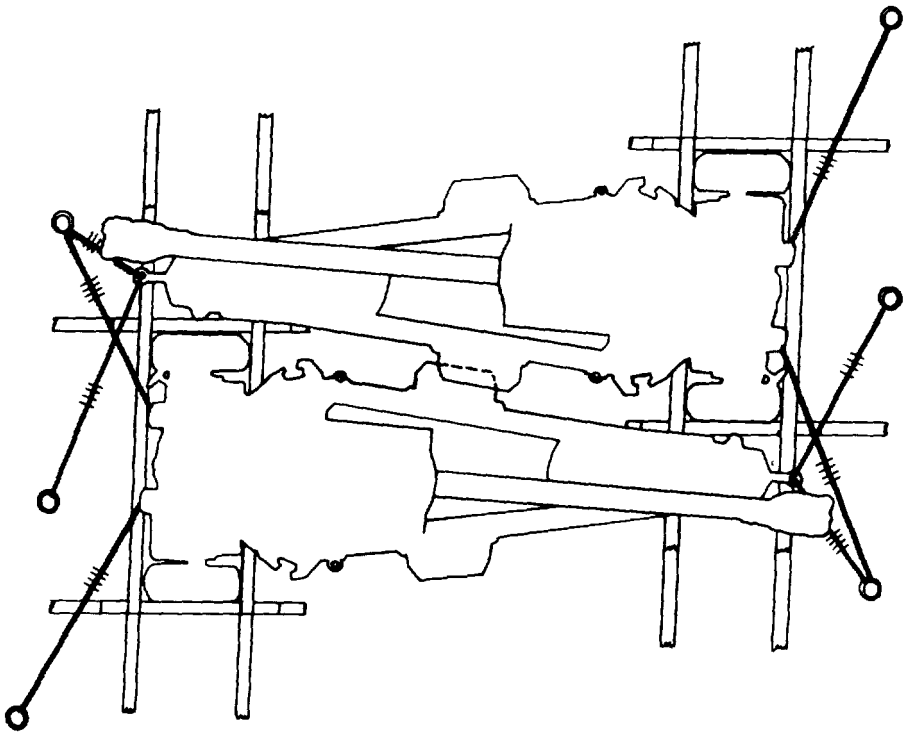
Cut four pieces of 4- by 4- by approximately 110-inch-long lumber, and lay a piece on the top of side blocking and against front and rear of tires. Nail at each place where the top piece crosses the bottom piece with two 50d nails.



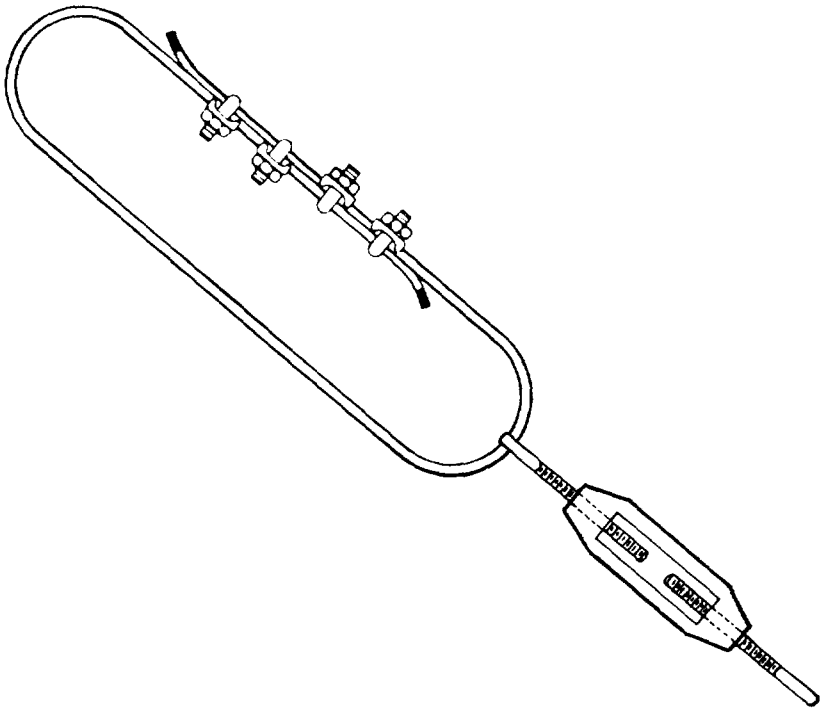
Cut 8 backup blocks of 4- by 4- by 18-inch lumber. Place one block against the top piece where it crosses the bottom piece near each tire. Nail the backup block to the bottom piece with two 50d nails.



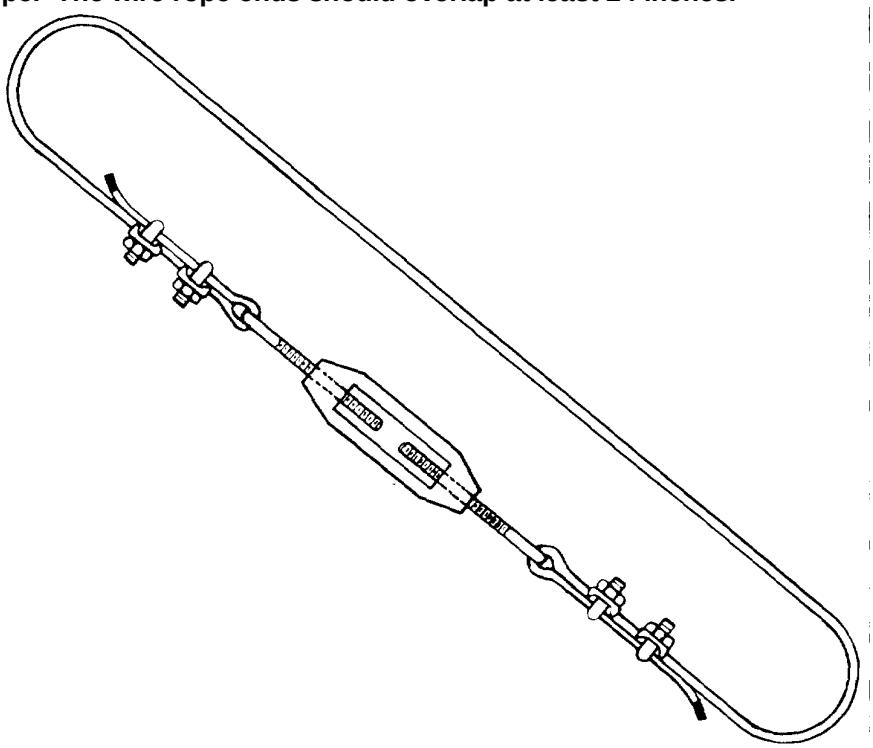
Cut 4- by 4- inch by length-to fit lumber, and use as bracing against the ship's structure and other cargo. Nail in place with 20d nails.



Tie down the howitzers with 5/8-inch steel wire rope and 3/4-inch tumbuckles. A total of four tiedowns to each howitzer Is required. Attach one to each of the two rear tiedown points and two to the towing lunette. The angle between the ship's deck and the tiedowns should be as close to 45 degrees as possible. Two types of tiedowns may be used.



Wire loop with suspended tumbuckle. One end of the tumbuckle is attached to the ship's padeye or other deck fitting with a shackle. Run the wire rope through the other eye of the tumbuckle. Overlap and secure the ends of the wire rope at the overlap with four U-bolt clips, placed 3-3/4 inches apart, and a minimum of 6 inches from the ends of the wire rope. The wire rope ends should overlap at least 24 inches.



Complete loop. Form complete loop by securing the ends of the 5/8-inch wire rope to the eyes of the 3/4-inch tumbuckle. Allow at least 12 inches overlap on each end of the wire rope for two 518-inch U-bolt clips. Outside U-bolt clip should be placed at least 6 inches from overlapped ends of wire rope.

Tighten the U-bolt clip nuts enough to prevent slippage of the wire rope. After the U-bolt clip nuts have been tightened initially, the "U" side of each clip must be struck several times with a hammer to insure proper seating. The nuts must then be retightened. Close the tumbuckle to the desired tension.

Section III.

TRANSPORT BY SPECIAL-DESIGN VESSEL

Seatrain/trailer vessels, roll-on/roll-off ships, landing ships, and attack cargo ships are equipped with patented lashing gear and pre-positioned fittings in the deck. The use of such equipment is adequate, and additional blocking and bracing is not required. For movement by LASH or SEABEE barges or similar lighterage, the howitzers must be blocked and braced. When they are transported extended distances over rough seas, howitzers loaded aboard landing craft and amphibious lighters should be lashed, blocked and braced.

CHAPTER 6

Transporting the M198 Howitzer by Rail

Section I.

GENERAL

The M198 howitzer can be transported by rail without sectionalization or major disassembly. Most flatcars in use will carry at least two howitzers, depending on the length of the car. If the howitzers are to be loaded on the center line of the flatcar, the flatcar deck must be at least 10 feet wide. If the howitzers are to be loaded at an angle on the car, the deck must be at least 10 feet 6 inches wide. Additional cargo may be transported with the howitzers.

Section II.

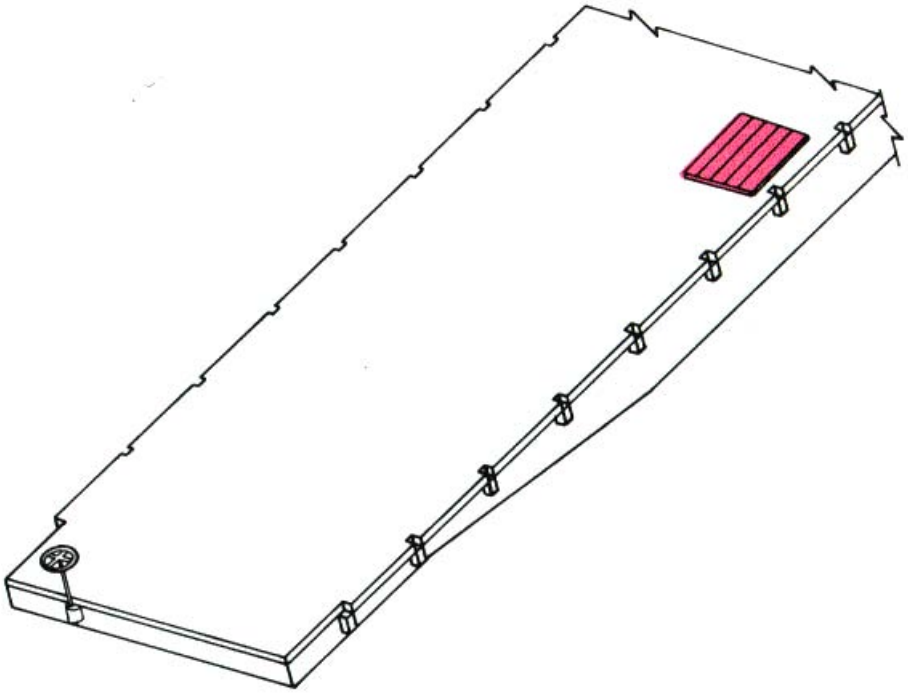
TRANSPORT ON CONUS GENERAL-PURPOSE FLATCARS

Material Required for General-Purpose Flatcar

Lumber, 2- x 4-inch	24 linear feet
Lumber, 2- x 6-inch	43 linear feet
Lumber, 2- x 12-inch	48 linear feet
Nails, 10d	144
Nails, 12d	10
Nails, 30d	84
Nails, 40d	32
Nails, 60d	16
Steel wire rope, 5/8-inch	97 feet
Thimbles, standard, open-type	10
U-bolt clips, 5/8-inch	38
Waterproof paper or burlap	As required

NOTE: All blocking and tiedown material must be furnished by the shipper.

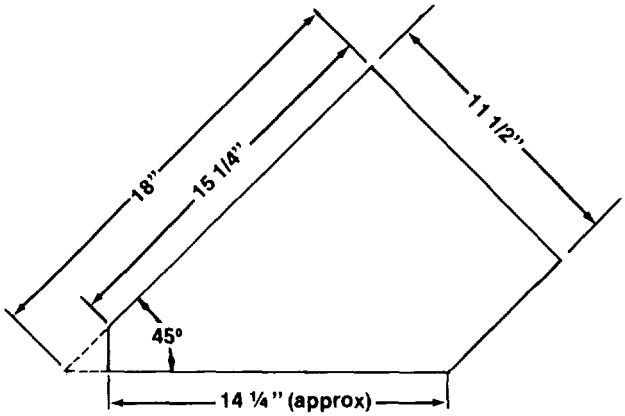
PREPARE THE FLATCAR



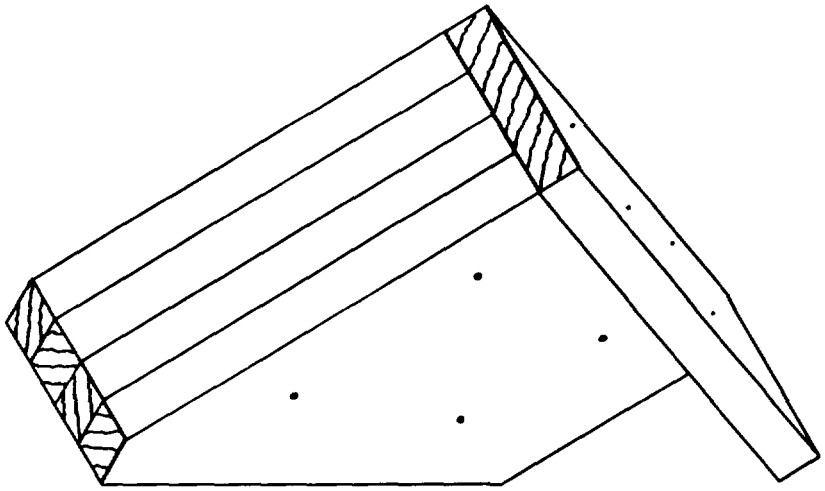
Make a support platform of five pieces of 2by 6by 36inch lumber for the howitzer trails. Decide where the trails will rest and nail the platform to the flatcar deck at that location. Use three 30d nails through each piece of lumber. Locate the platform on the center line of the flatcar if only one howitzer is to be shipped. The platform may be placed to the side if two howitzers are to be shipped on the same flatcar. This section illustrates the howitzer loaded at an angle so that another howitzer could be loaded on the same flatcar.

NOTE: Always stagger the nailing pattern so that a nail will not be driven onto or right beside a nail in a lower piece.

BUILD CHOCK BLOCKS



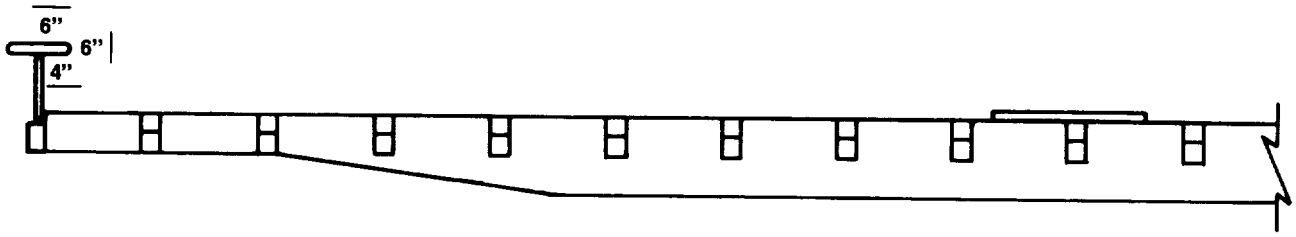
Build eight chock blocks for the howitzer wheels. Each block is made from four pieces of 2-by 12-inch lumber cut like this:

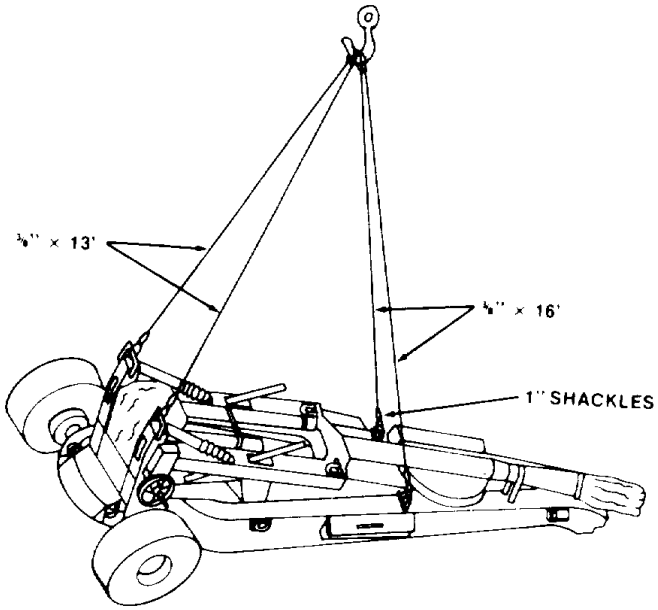


Nail the four pieces together with four 10d nails through each piece. Next, nail a 2-by 6-by 18-inch face piece to the four pieces with four 10d nails like this:

LOAD THE HOWITZER

NOTE: A minimum clearance of 6 inches above, in back of, and on each side of, and 4 inches underneath the flatcar brake wheel is required by Association of American Railroads rules.





The howitzer can be placed in the tiedown position on the flatcar by a crane of at least 8-ton capacity. It can also be towed or pushed onto the flatcar if a suitable ramp is available.

SAFETY

CAUTION

Do not allow howitzer to exceed 3 miles per hour during loading or unloading.

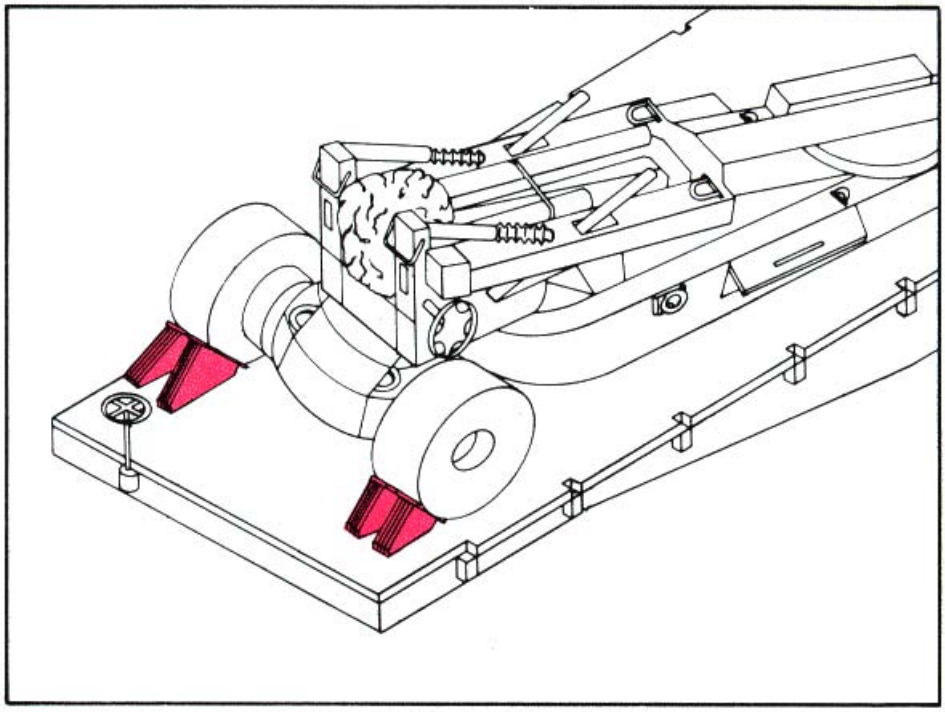
Personnel must be cautioned not to walk under items being lifted.

Lifting eyes and shackles should be inspected to insure that they are complete and not damaged.

All lifts should have at least two tag lines attached to control the swing of the howitzer.

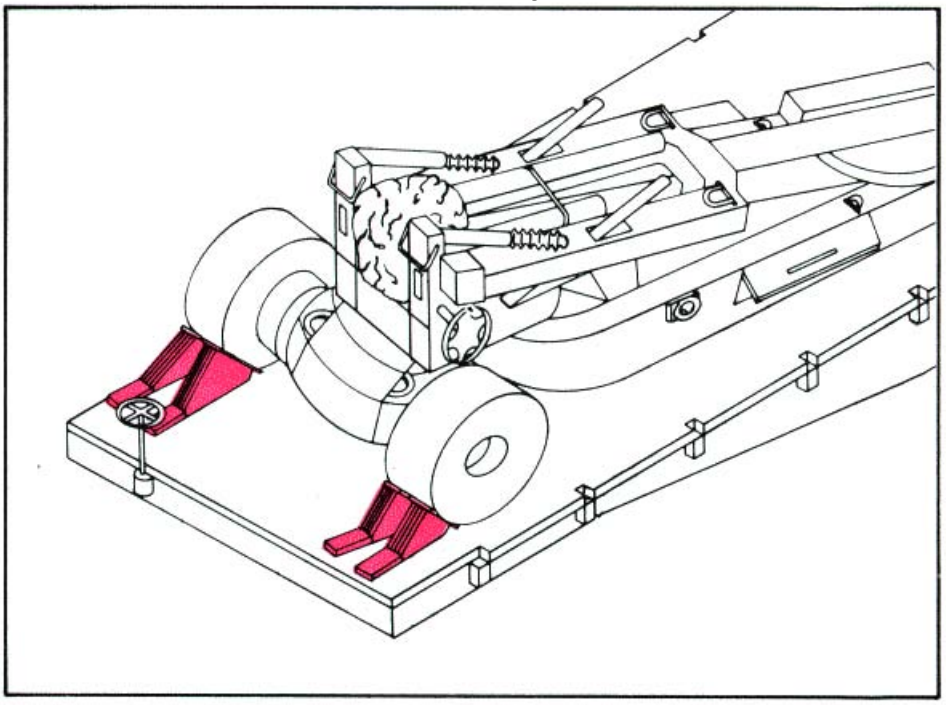
After the howitzer is properly located on the flatcar, set and wire tie the howitzer handbrakes.

SECURE THE LOAD



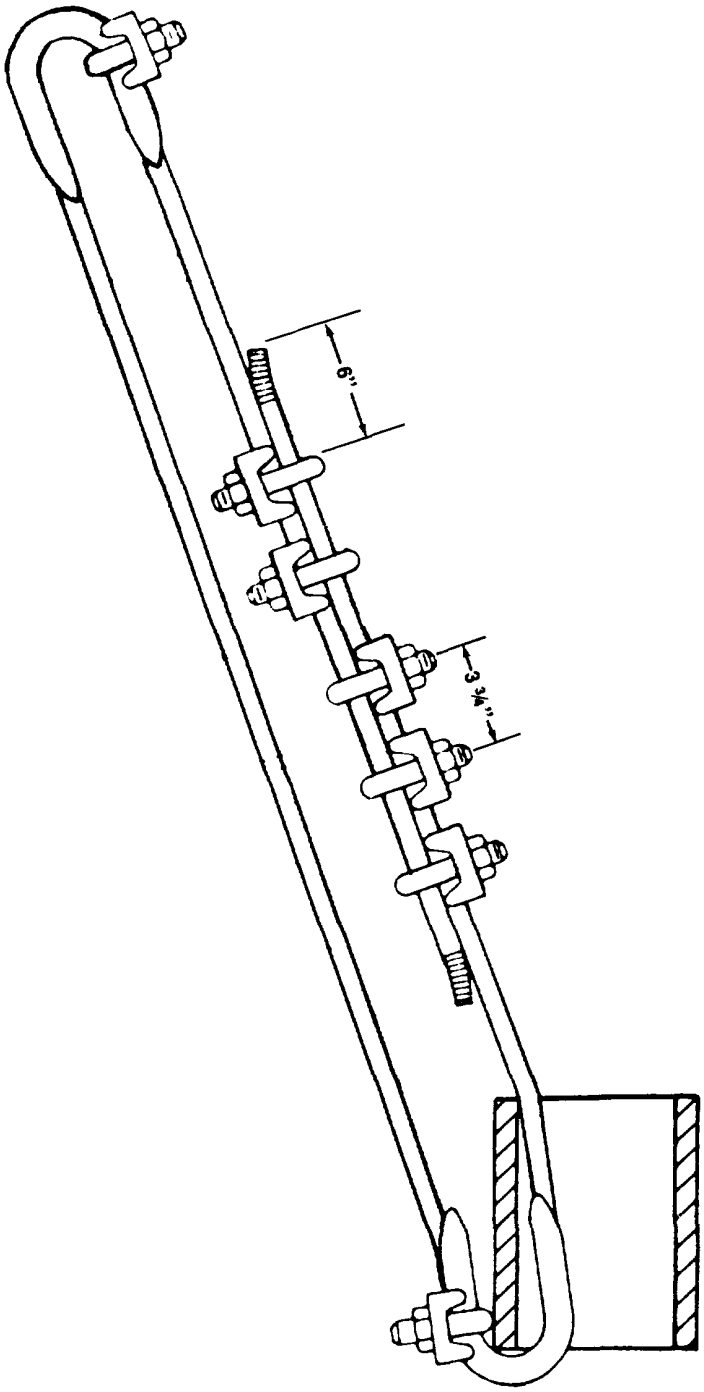
Cut eight pieces of 2- by 6- by 12-inch lumber to use as backup pieces for the chock blocks. When the howitzer is in place on the flatcar, place two chock blocks tightly against the rear of each tire, with the face plates against the tire. Nail the chock block to the deck with two 60d nails through the heel (back) of each block, and toenail through the sides of the blocks with two 40d nails on each side.

NOTE: When two chock blocks are placed side-by-side, only the first one can be toenailed on both sides. Toenail the second block on one side only.

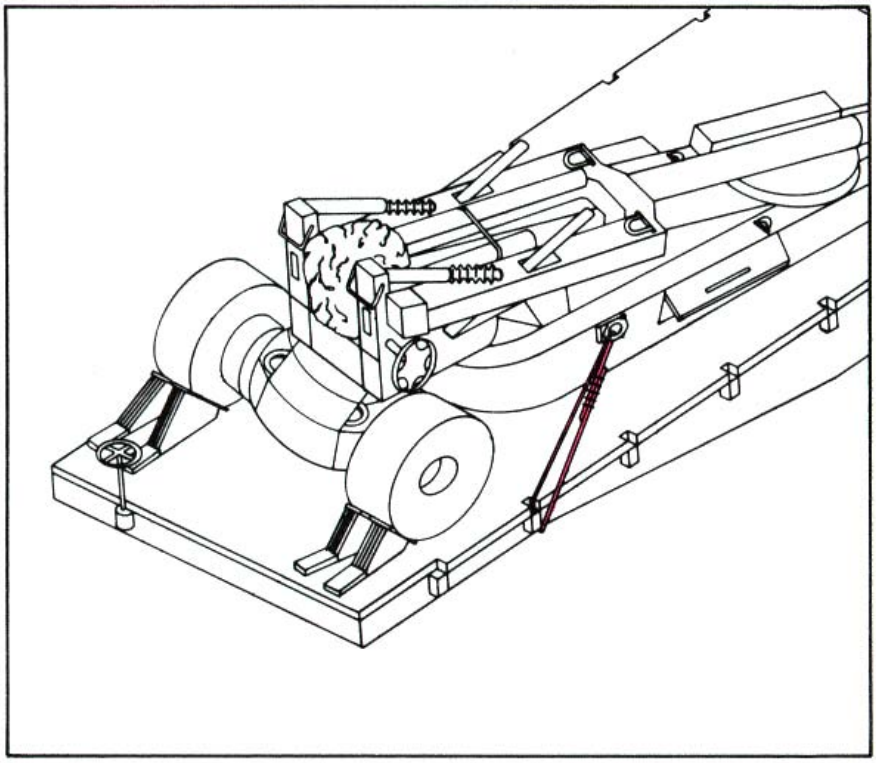


Next, position a 2-by 6-by 12inch backup piece tightly against each chock block and nail each one to the flatcar deck with three 30d nails.

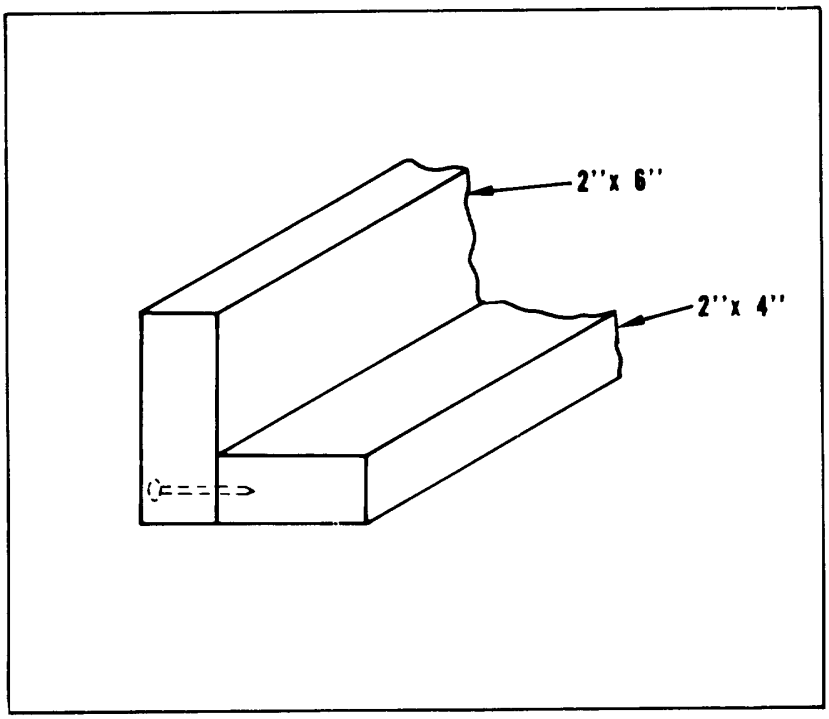
Tie the howitzer to the flatcar with 5/8-inch steel wire rope. A total of six tiedowns are required. When installing wire rope tiedowns, form a complete loop through the flatcar stake pocket and the tiedown point on the howitzer. The wire rope ends should overlap at least 28 inches. Place standard 5/8 inch open-type thimbles at each place where the wire rope contacts the flatcar stake pocket and the howitzer tiedown points, except that no thimbles are required at the howitzer lunette. Secure the thimble to the wire rope with a 5/8-inch U-bolt clip. Each wire rope loop should be tensioned enough to cause moderate depression of the howitzer by using two cable grippers and an appropriate size come-along mechanical hoist. Secure the ends of the wire rope at the overlap areas with five 5/8-inch U-bolt clips at the side tiedowns and four 5/8-inch U-bolt clips at the lunette tiedowns. The clips are spaced 3-3/4inches apart, and no closer than 6 inches from the ends of the wire rope.



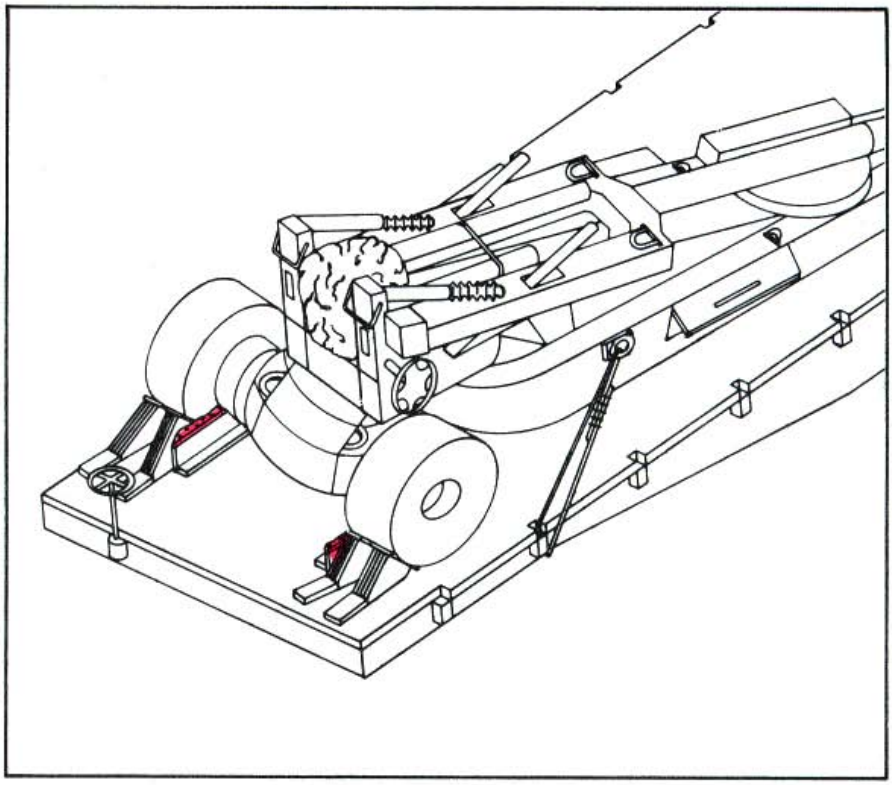
Tighten the U-bolt clip nuts to a torque of 135 to 150 footpounds. If a torque wrench is not available, the proper torque can be obtained by using box-end, open-end, or socket wrenches that have 24-inch handles. After the U-bolt clip nuts have been tightened initially, the "U" side of each clip must be struck several times with a hammer to insure proper seating. The nuts must then be retorqued.



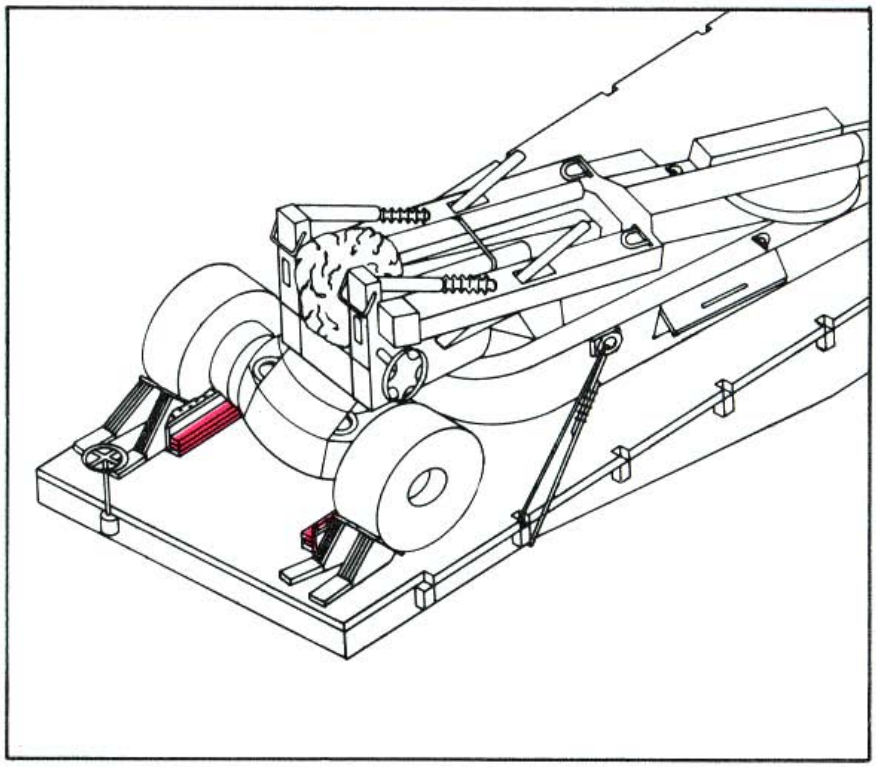
Loop the first two wire rope tiedowns from the tiedown provisions on the sides of the howitzer carriage to a stake pocket near the howitzer tires. Select a stake pocket that will result in a tiedown angle as near to 45 degrees as possible. Tighten these two tiedowns, making sure that the howitzer tires are pulled tight against the rear chock blocks.



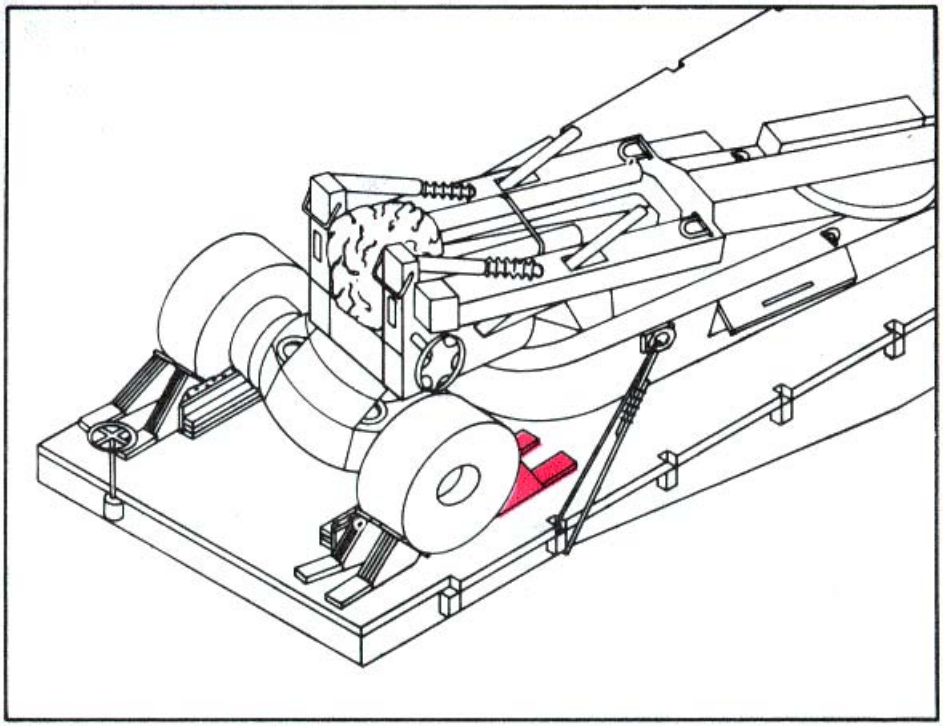
Cut two pieces of 2- by 6- by 48-inch lumber and six pieces of 2- by 4- by 48-inch lumber for the side blocks. Build two side blocks for blocking against the inside of the wheels, using the following steps. Nail one of the 2- by 6- inch pieces to the edge of one of the 2- by 4- inch pieces with five 12d nails.



Place a piece of waterproof paper or burlap between the 2- by 6- inch side block and the tire, and place against the inside of the wheel. Nail to the flatcar deck through the 2- by 4-inch piece with five 30d nails.

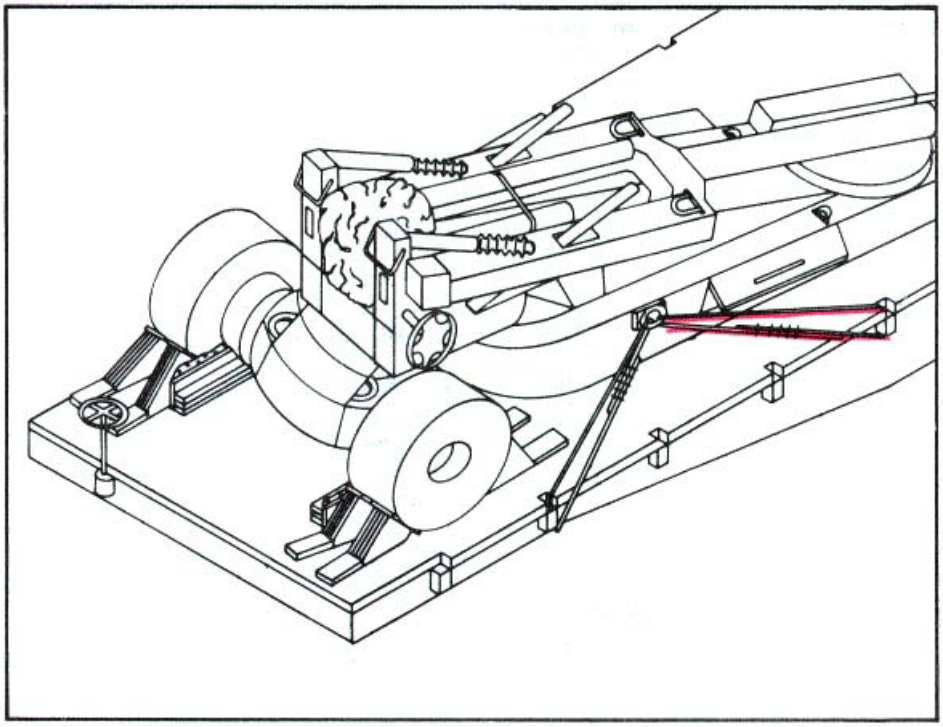


The waterproof paper or burlap protects the tire and should extend from under the side block to about 2 inches above it. Nail two more 2- by 4-inch pieces on top of the bottom piece with five 30d nails through each piece.

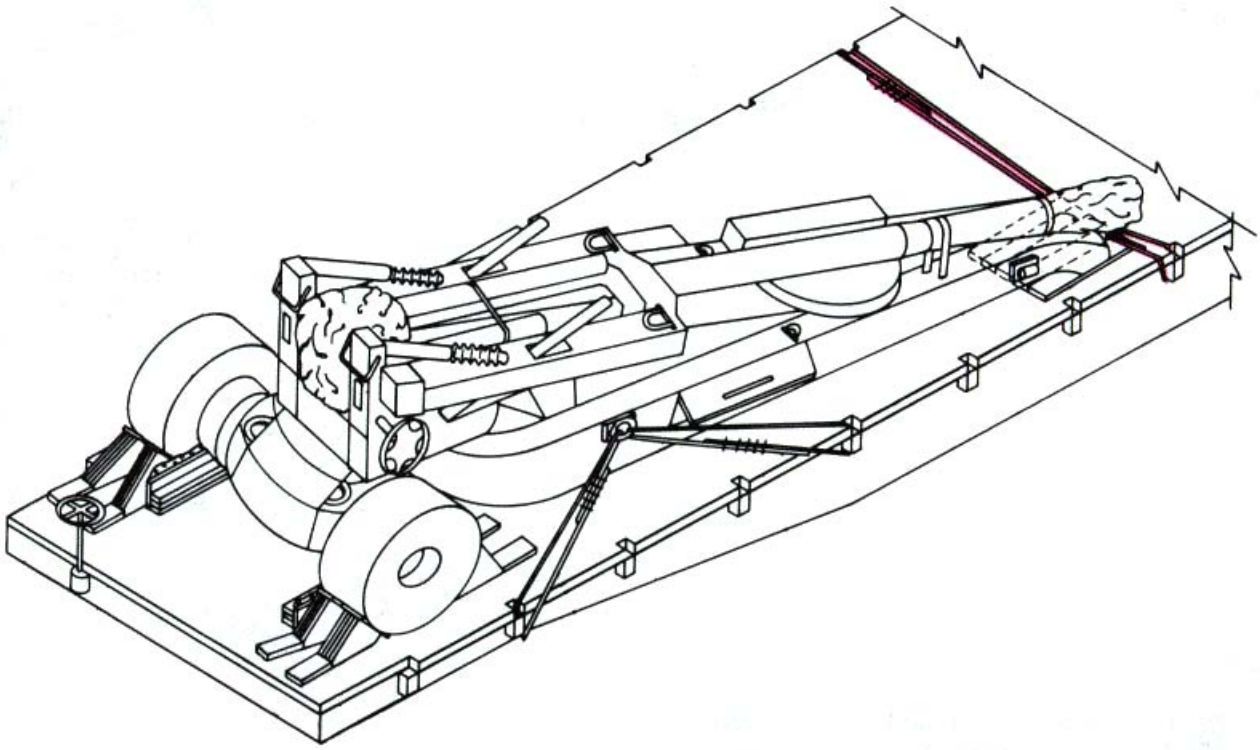


Place the other four chock blocks, two against the front of each tire, and nail to the flatcar deck. Drive two 60d nails through the heel (back) of each chock block, and toenail through the sides of the blocks with two 40d nails on each side.

NOTE: When two chock blocks are placed side-by-side, only the first one can be toenailed on both sides. Toenail the second block on one side only.



Install the second pair of steel wire rope tiedowns. Form loops from the tie-down provisions on each side of the howitzer carriage to the flatcar stake pockets. Select a stake pocket that will result in a tiedown angle as near to 45 degrees as possible. This will be about the third stake pocket forward of where the first two tiedowns are located. Install thimbles and U-bolt clips, tighten the tiedown and torque the U-bolt clip nuts.



Loop the third pair of steel wire rope tiedowns from the howitzer lunette to the next stake pockets forward of the lunette. Install thimbles only at the point where the tiedowns contact the stake pockets. Tighten the tiedowns, install the U-bolt clips and torque the U-bolt clip nuts.

Section III.

TRANSPORT ON CONUS HTTX SPECIAL-PURPOSE FLATCARS

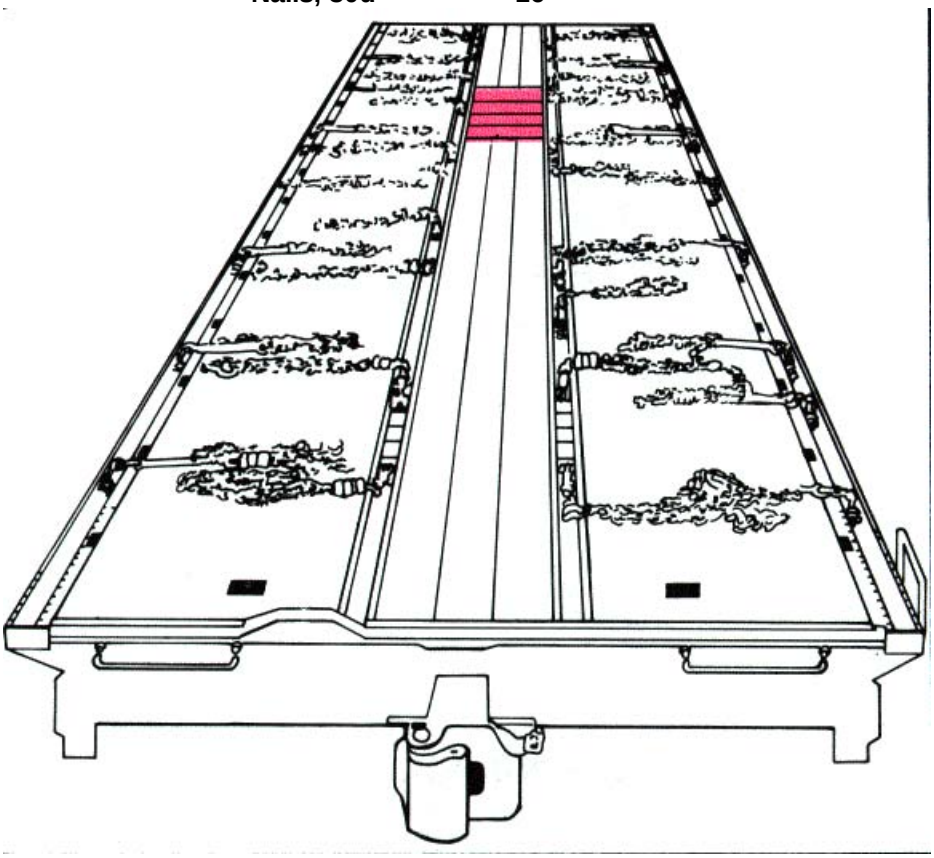
GENERAL

CONUS HTTX special-purpose flatcars are equipped with heavy-duty tiedown anchors and chain assemblies in channels along each side of the car and along the center sill. If such a car is to be used to transport the howitzer, the chain assemblies are all that is required to secure the howitzer.

The howitzer must be in the stowed position with the gun tube locked in the stowage bracket. Wire tie the pin that locks the stowage bracket so that the pin cannot come out during transit. Remove and stow all loose equipment.

PREPARE THE FLATCAR

Materials Required for HTTX or similar Special. Purpose Flatcar
Lumber, 2- x 8-inch 12 linear feet
Nails, 30d 16



Before loading the howitzer, make a support platform for the trails using four pieces of 2- by 8- by 36-inch lumber. Decide where the trails will rest and center the platform on the railcar at that point. Nail the platform to the railcar deck crossways to the center line with four 30d nails through each piece.

LOAD THE HOWITZER

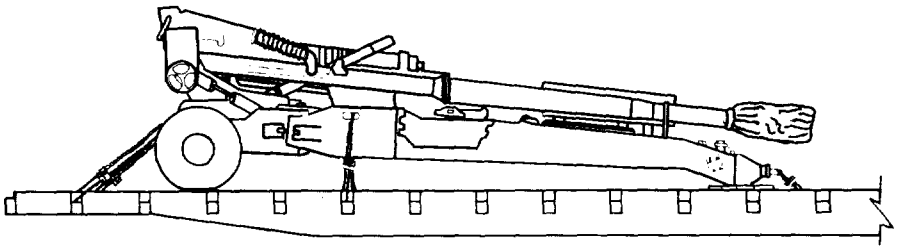
Lift the howitzer onto the flatcar with a crane of at least 8-ton capacity, or, if a suitable ramp is available, the howitzer can be towed or pushed onto the flatcar.

CAUTION

Do not allow the howitzer to exceed 3 miles per hour during loading or unloading.

After the howitzer is properly located on the railcar, set and wire tie the howitzer handbrakes.

SECURE THE LOAD



Attach the chain tiedowns from each side and rear howitzer tiedown point to the outside tiedown channels on the railcar. Attach two chain tiedowns from the howitzer lunette to the inside tiedown channels. Tighten the chains with turnbuckles.

Open hooks must be secured with wire over the opening to prevent the hook from becoming disengaged from the chain link to which it is attached. Turnbuckles used to tighten the chain must be wired to prevent them from turning unless the turnbuckles are equipped with self-locking devices

Section IV.

TRANSPORT ON FOREIGN RAILROADS

GENERAL

When loaded on flatcars of adequate capacity, the M198 howitzer can be transported without restriction within European countries that comply with the International Loading Gage; in most Middle East and South American countries; and in Australia, India, and Pakistan. Clearances vary from one country to the next and within a country, and evaluation of possible restrictions must be made on each shipment.

NOTE: Restrictions to rail shipment in foreign countries due to the narrow width of some flatcars can be overcome by removing the howitzer wheels.

EUROPEAN FLATCARS

The howitzer can be transported without disassembly on a number of European flatcars. The requirements for loading, blocking, and tiedown of the howitzer are essentially the same as within CONUS. Detailed guidance is contained in 4th Transportation Brigade Pamphlet number 55-2, dated 15 August 1977, titled Tiedown Guide for Rail Movements.

APPENDIX

REFERENCES

1. ARMY REGULATIONS (AR)

55-162	Permits for Oversize, Overweight, or Other Special Military Movements on Public Highways in the United States
55-228	Transportation by Water of Explosives and Hazardous Cargo
55-355	Military Traffic Management Regulation
70-47	Engineering for Transportability
746-1	Packaging of Army Material for Shipment and Storage

2. FIELD MANUAL (FM)

55-450-1	Army Helicopter External Load Operations

3. TECHNICAL BULLETIN (TB)

55-45 (AFP 76-19)	Certification of Military Equipment for Transport in Air Force Aircraft

4. TECHICAL MANUALS (TM)

9-1025-211-10	Operator's Manual (Crew) for Howitzer, Med, Towed: 155-MM, 198
38236 (AFP 71-8)	Preparation of Freight for Air Shipment
38-250 (AFR 71-4)	Packaging and Materials Handling: Preparation of Hazardous Materials for Military Air Shipment

5. AIR FORCE MANUALS (AFM)

TO 1C-5A-9	Loading Instructions, USAF Series C-5 Aircraft
TO 1C-130A-9	Loading Instructions, USAF Series C-130 Aircraft
TO 1C-141A-9	Loading Instructions, USAF Series C-141 Aircraft

A-5 Technical Orders (TO)

1C-5A-9	Loading Instructions, USAF Series C-5 Aircraft
1C-130A-0	Loading Instructions, USAF Series C-130 Aircraft
1C-141A-9	Loading Instructions, USAF Series C-141 Aircraft

NOTE: Air Force Technical Orders that have not bean integrated Into the Department of the Army publications system may be requisitioned through The Adjutant General Office In accordance with AR 310-71.

A-6 Other Publications

a. Code of Federal Regulations, Title 49 - Transportation, Parts 170-179
   Available from: Superintendent of Documents
   US Government Printing Office
   Washington, DC 20402

b. Association of American Railroads, Rules Governing the Loading of Commodities on Open-Top Cars and Trailers
   Section No. 1 - General Rules
   Section No. 6 - Rules Governing the Loading of Department of Defense Materiel on Open-Top Cars
   Available from: Association of American Railroads
   American Railroad Building
   50 F St, NW
   Washington, DC 20001

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Chief of Staff

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The Adjutant General

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To be distributed in accordance with DA Form 12-34B, Requirements for TM 55 Series: Transportability Guidance, Guns, Howitzers and Rifles and DA Form 12-40A, Organizational maintenance requirements for Howitzer, 155-IIM, Towed, M198.

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The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 dekagram = 10 grams = .35 ounce
1 hectogram = 10 dekagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	newton-meters	1.356	metric tons	short tons	1.102
pound-inches	newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

PIN: 044260-000