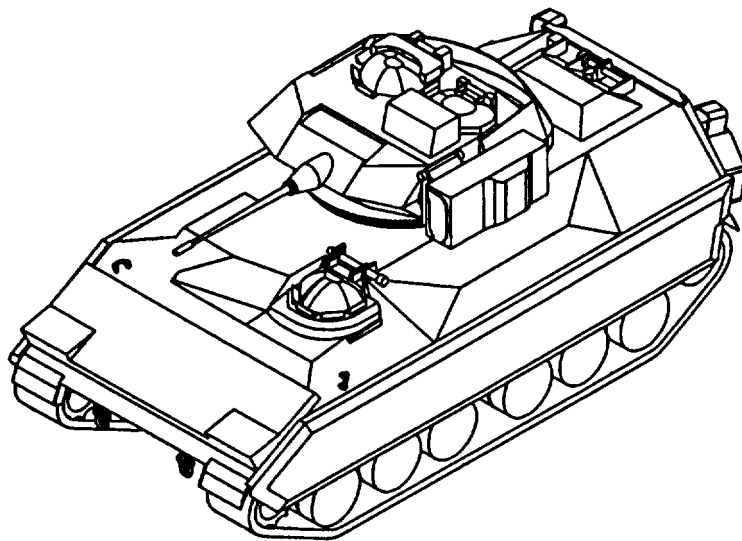


TRANSPORT GUIDANCE TECHNICAL MANUAL



**BRADLEY FIGHTING VEHICLE SYSTEM (BFVS)
INFANTRY, M2, M2A1, AND M2A2
CAVALRY, M3, M3A1, AND M3A2**

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**HEADQUARTERS, DEPARTMENT OF THE ARMY
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HEADQUARTERS
 DEPARTMENT OF THE ARMY
 WASHINGTON, DC, 1 November 1992

TRANSPORT GUIDANCE
 Bradley Fighting Vehicle System
 Infantry, M2, M2A1, and M2A2
 Cavalry, M3, M3A1, and M3A2

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*This manual supersedes TM 55-2360-252-14, dated 18 June 1986.

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CHAPTER 1

INTRODUCTION

Section 1. GENERAL

1-1. Purpose and Scope

This manual is for transportation officers and other personnel responsible for safe transport of Bradley Fighting Vehicle Systems (BFVS), infantry, M2, M2A1, M2A2; BFVS, cavalry, M3, M3A1, M3A2; and the 75K BFVS (product improvement of M2A2/M3A2). It provides transportability guidance for safe shipping and receiving of the BFVS. It includes significant technical and physical characteristics of the vehicles as well as safety requirements for worldwide movement by various modes of transportation. The BFVS weight varies from 50,000 pounds to 75,000 pounds; however, all BFVS should be secured as shown in the following chapters. Tiedown configurations for all modes of transport, unless otherwise noted, are based on the 75,000-pound gross vehicle weight.

1-2. Related Publications

Additional information on transport procedures can be found in:

- MTMCTEA Pamphlet 55-19, *Tiedown Handbook for Rail Movements*
- MTMCTEA Pamphlet 55-20, *Tiedown Handbook for Highway Movements*
- MTMCTEA Pamphlet 56-1, *Surface Transportation, Marine Terminal Lifting Guidance*
- MTMCTEA Pamphlet 70-1, *Transportability for Better Strategic Mobility*
- FM 55-65, *Strategic Deployment by Surface Transportation*
- TM 38-236/AFR 71-8, *Preparation of Freight for Air Shipment*
- TM 38-250/AFR 71-4 *Preparation of Hazardous Materials for Military Air Shipment*
- TM 9-2350-252-10-2 *Operator's Manual for Infantry Fighting Vehicle; M2, M2A1, and Cavalry Fighting Vehicle; M3, M3A1*
- TM 9-2350-284-10-1 *Operator's Manual for Infantry Fighting Vehicle; M2A2, and Cavalry Fighting Vehicle; M3A2, Hull*
- TM 9-2350-284-10-2 *Operator's Manual for Infantry Fighting Vehicle; M2A2, and Cavalry Fighting Vehicle; M3A2, Turret*
- USAREUR Regulation 55-8, *Loading and Securing Military Wheeled and Tracked Vehicles on European Railcars*
- USAREUR Regulation 55-1, *United States Army Motor Vehicle Operations on Public Roads*

- AR 55-162, *Permits for Oversize, Overweight, or Other Special Military Movements on Public Highways in the United States*
- AR 55-228, *Transportation by Water of Explosives and Hazardous Cargo*
- 46 CFR, *Code of Federal Regulations, Title 46*
- 49 CFR, *Code of Federal Regulations, Title 49*

1-3. User Comments

MTMCTEA encourages users of this manual to submit comments and recommended changes for its improvement on DA Form 2028 (Recommended Changes to DA Publications and Blank Forms) or on a marked copy of a page or pages of the manual. Forward these suggestions to Director, Military Traffic Management Command Transportation Engineering Agency, ATTN: MTTE-TRT, 720 Thimble Shoals Blvd-Suite 130, Newport News, VA 23606-2574. Address electronically transmitted messages to DIR MTMCTEA FORT EUSTIS VA//MTTE-TRT//. This command will furnish a reply.

1-4. Definitions

The following definitions will be used throughout this manual:

- a. *Bolt-on Armor*. Armor tiles that are "bolted on" to the hull upper glacis, hull sides, and portions of the turret to provide protection against shape charged munitions. The tiles incorporate innovative advancements in armor technology that may include reactive (explosive) armor.
- b. *CONUS*. Continental United States.
- c. *OCONUS*. Outside the Continental United States.
- d. *CG*. Center of Gravity.
- e. *Curb Weight (CW)*. Total weight of operational vehicle including fuel, all system fluids, and vehicle basic issue items (BII). CW does not include crew weight.
- f. *Gross Vehicle Weight (GVW)*. Total weight of the operational vehicle, including fuel, all system fluids, BII, ammunition, crew, infantrymen, and any other associated support items of equipment attached to, contained in, or projected as payload for the vehicle.
- g. *NATO*. North Atlantic Treaty Organization.
- h. *RORO*. Roll on.hell off.
- i. *Sweatboards*. Lumber running horizontally and mounted in hangers along the skin of the

ship, to protect cargo from contact with moisture or sweat condensing on the interior of the hull; also termed sweatbattens.

j. Working Load Limit (WLL). The maximum load that can be applied to a chain or wire rope while maintaining the required factors of safety.

1-5. Warnings, Cautions, and Notes

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

Section II. SAFETY

1-6. General

Safety requirements for individual transport modes are in the corresponding chapters and appear as Warnings, Cautions, or Notes. General safety considerations and precautions for all modes of transport, including self-delivery, are as follows:

a The driver must:

- (1) Be qualified to operate the vehicle.
- (2) Ensure all loose items have been secured before operating the vehicle. (Check TM 9-2350-252-10-2, M2/M2A1 and M3/M3A1; and TM 9-2350-284-10-2, M2A2 and M3A2 for instructions.)
- (3) Fully close the hatch cover and ensure the turret lock is engaged and the turret power switch is off when operating the vehicle.
- (4) Remain with the vehicle while the engine is running.
- (5) Bring the vehicle to a complete stop before the vehicle enters or leaves a building.
- (6) Not operate the vehicle in an enclosed area, unless proper ventilation for engine combustion and removal of exhaust gases is available and operating.
- (7) Allow the vehicle to coast to a stop when a track is thrown. The brakes may be applied if absolutely necessary.
- (8) Fully close the hatches when transporting or towing the vehicle.
- (9) Have a ground guide when operating the vehicle in reverse or within 20 feet of another vehicle or a building.

*****WARNING*****

The M13A1 air filter unit will not protect

Section III. EQUIPMENT DESCRIPTION

1-7. General

The BFVS have no unusual characteristics that require special consideration for temperature,

*****WARNING*****

Instructions that must be followed to prevent serious injury to or death of personnel.

****CAUTION****

Instructions that must be followed to prevent damage to or destruction of equipment.

Note

An operating procedure or condition that must receive special attention.

the user against carbon monoxide poisoning.

b. Personnel are prohibited from (not allowed to be):

- (1) Mounting or dismounting the moving vehicle.
- (2) Riding in or on the vehicle outside the crew area.
- (3) Smoking in or on the vehicle, or within 50 feet of a refueling area.
- (4) Entering or exiting the turret, unless the turret lock is engaged and the turret power and drive switches are off.
- (5) Being on or near the vehicle while the turret is traversing.
- (6) Being at the engine exhaust area during or immediately after engine operations.

*****WARNING*****

Contact with the engine exhaust area during or immediately after engine operations can cause severe burns.

*****WARNING*****

If the bolt-on armor is reactive, safety permits and procedures similar to those used when transporting ammunition will be required. Bolt-on armor will be transported in accordance with the Code of Federal Regulations, Titles 46 and 49.

NOTE

Regulations and/or transportation procedures normally associated with vehicles containing diesel fuel will apply.

atmospheric pressure, or humidity variations occurring during transport. This section contains descriptions, photographs, and relative transportability data for the individual vehicles.

1-8. M2/M2A1

The M2/M2A1 (fig 1-1) is a fully tracked, lightly armored vehicle with cross-country mobility and vehicular-mounted firepower. It has a crew of three (driver, gunner, and commander) and transports six infantrymen. (The M2A1 can transport seven infantry men.) The vehicle can cross over a wide variety of terrain, including swimming across a water obstacle. The primary armament is an externally powered 25-mm automatic gun, M242, mounted on a two-man turret. Secondary armament consists of a 7.62 coaxial machinegun, M240C, and a TOW missile system with a two-tube launcher. Supplementary armament consists of six 5.56-mm firing port weapons, M231. This vehicle has the capability to deliver rapid, accurate, and effective fire against personnel, armored vehicles, and low-speed aircraft.

1-9. M3/M3A1

The M3/M3A1 vehicle (fig 1-1) is designed for scouts. It is a modified version of the M2/M2A1, having a crew of three and transporting two observers. It is equipped with the same two-man turret and primary and secondary armament as the M2/M2A1, but it has plugged firing ports and no supplementary armament. This vehicle has a larger ammunition capacity, which improves the scout's ability to obtain needed information on strength, deployment, and operation areas of enemy forces because they can remain in the sector longer. From the exterior, the M2/M2A1 and the M3/M3A1 appear identical.

1-10. M2A2 and M3A2

The M2A2 and M3A2 vehicles (fig 1-2) are product

improvements to the M2/M2A1 and M3/M3A1 vehicles. These improvements are a 600-horsepower diesel engine and additional bolt-on armor (not shown in fig 1-2). The side firing ports and associated supplementary weapons on the M2/M2A1 are deleted from the M2A2.

1-11. 75K BFVS

The 75K BFVS allows for product improvements to the M2A2 and M3A2. The product improvements are not specified here, but they are expected to increase the weight of the M2A2 and M3A2 from 67,282 pounds and 67,312 pounds, respectively, to approximately 75,000 pounds.

1-12. Technical Data

The following general data and performance characteristics are for all BFVS:

Performance:	
Land speed	38 mph (61 km/h)
Water speed.	4 mph (6.4 km/h)
Fuel capacity.	175 gal (662 l)
Cruising range	250 miles (400 km)
Slope.	60 percent
Side slope	40 percent
Trench crossing.	100 in. (2.54 m)
Vertical obstacle.	36 in. (0.91 m)
Turning radius	pivot to infinite

The characteristics and data shown in tables 1-1 and 1-2 apply to the model number shown. Left side and front view drawings (figs 1-3 and 1-4) provide data for determining the loadability of the vehicles for various transport modes.

1-13. Reduced Configuration

Instructions for preparing the BFVS for each mode of transport appear in the respective chapters.

Table 1-1, M2 Series Comparison

Characteristics	M2	M2A1	M2A2
Curb Weight (pounds)	42,435.0	43,132.0	53,247.0
Operational Weight (pounds)	49,987.0	50,617.0	67,282.0
C-141 Leading Weight (pounds)	44,000.0	44,000.0	44,000.0
Operational Length (inches)	258.0	258.0	258.0
Operational Height (inches)	117.0	117.0	119.2
Reduced Height (inches)	103.7	103.7	103.9
Operational Width (inches)	126.0	126.0	131.0
Reduced Width (inches)	117.0	117.0	117.0
Ground clearance (inches)	18.0	18.0	17.5
Curb Weight Ground Pressure (psi)	6.5	6.6	8.2
Operational Ground Pressure (psi)	7.7	7.8	10.4

Table 1-1. M2 Series Comparison-Continued

Characteristics	M2	M2A1	M2A2
Track Width (inches)	21.0	21.0	21.0
Track Area (square inches)	6,500.0	6,500.0	6,500.0
Angle of Approach (degrees)	30.0	30.0	30.0
Angle of Departure (degrees)	35.0	35.0	35.0
Operational Area (square feet)	225.8	225.8	234.4
Reduced Area (square feet)	209.6	209.6	209.6
CG above ground (inches)	47.1	47.1	50.0
CG from centerline of the drive sprocket (inches)	93.7	93.7	109.3
CG from front edge of vehicle (inches)	106.1	106.1	118.8
CG from right side of vehicle (inches)	62.3	62.3	62.3

Table 1-2. M3 Series Comparison

Characteristics	M3	M3A1	M3A2
Curb Weight (pounds)	41,963.0	42,502.0	53,157.0
Operational Weight (pounds)	49,246.0	50,190.0	67,312.0
C-141 Loading Weight (pounds)	44,000.0	44,000.0	44,000.0
Operational Length (inches)	258.0	258.0	258.0
Operational Height (inches)	117.0	117.0	119.2
Reduced Height (inches)	103.7	103.7	103.9
Operational Width (inches)	126.0	126.0	131.0
Reduced Width (inches)	117.0	117.0	117.0
Ground clearance (inches)	18.0	18.0	17.5
Curb Weight Ground Pressure (psi)	6.5	6.6	8.2
Operational Ground Pressure (psi)	7.5	7.7	10.3
Track Width (inches)	21.0	21.0	21.0
Track Area (square inches)	6,500.0	6,500.0	6,500.0
Angle of Approach (degrees)	30.0	30.0	30.0
Angle of Departure (degrees)	35.0	35.0	35.0
Operational Area (square feet)	225.8	225.8	234.4
Reduced Area (square feet)	209.6	209.6	209.6
CG above ground (inches)	47.1	47.1	50.0
CG from centerline of drive sprocket (inches)	93.6	93.6	109.3
CG from front edge of vehicle (inches)	106.1	106.1	118.8
CG from right side of vehicle (inches)	62.3	62.3	62.3



Figure 1-1. Fighting Vehicle, Infantry, M2/M2A1 or Fighting Vehicle, Cavalry, M3/M3A1.

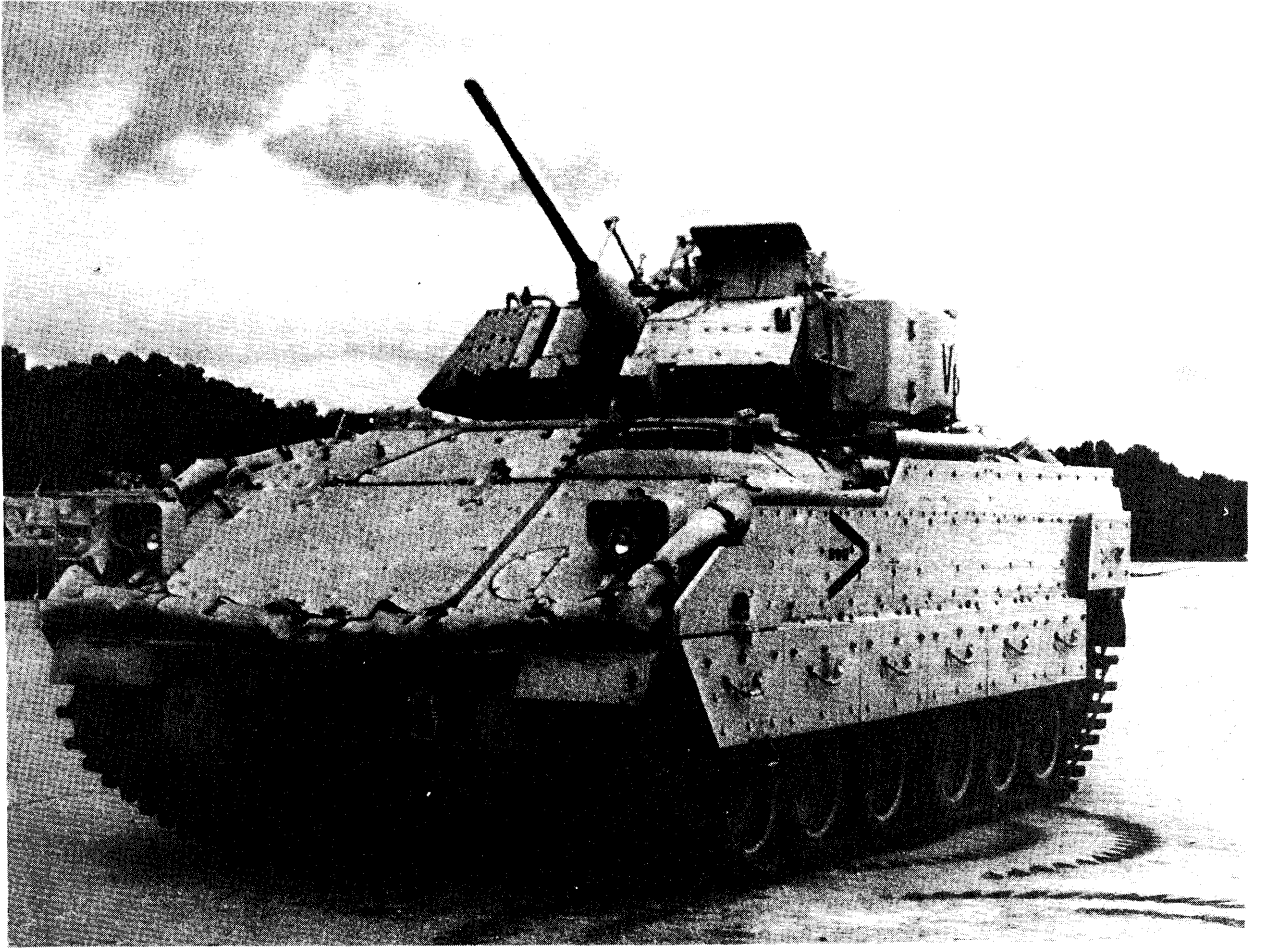
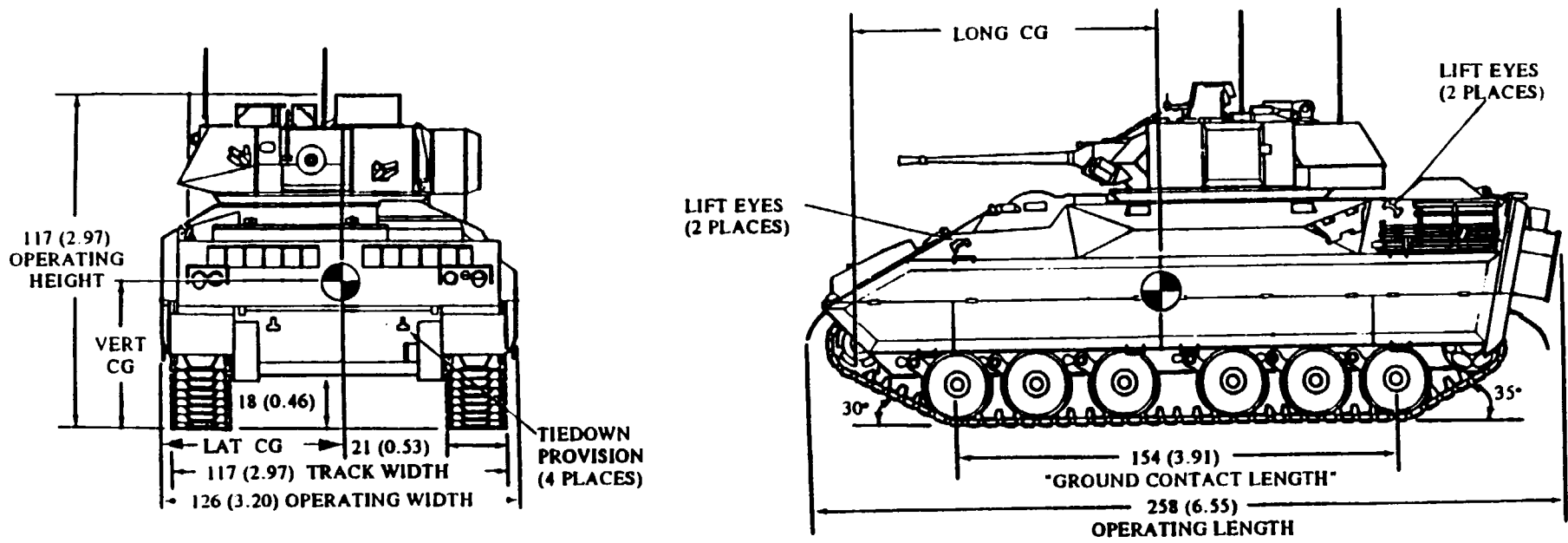


Figure 1-2. Fighting Vehicle, Infantry, M2A2 or Fighting Vehicle, Cavalry, M3A2.

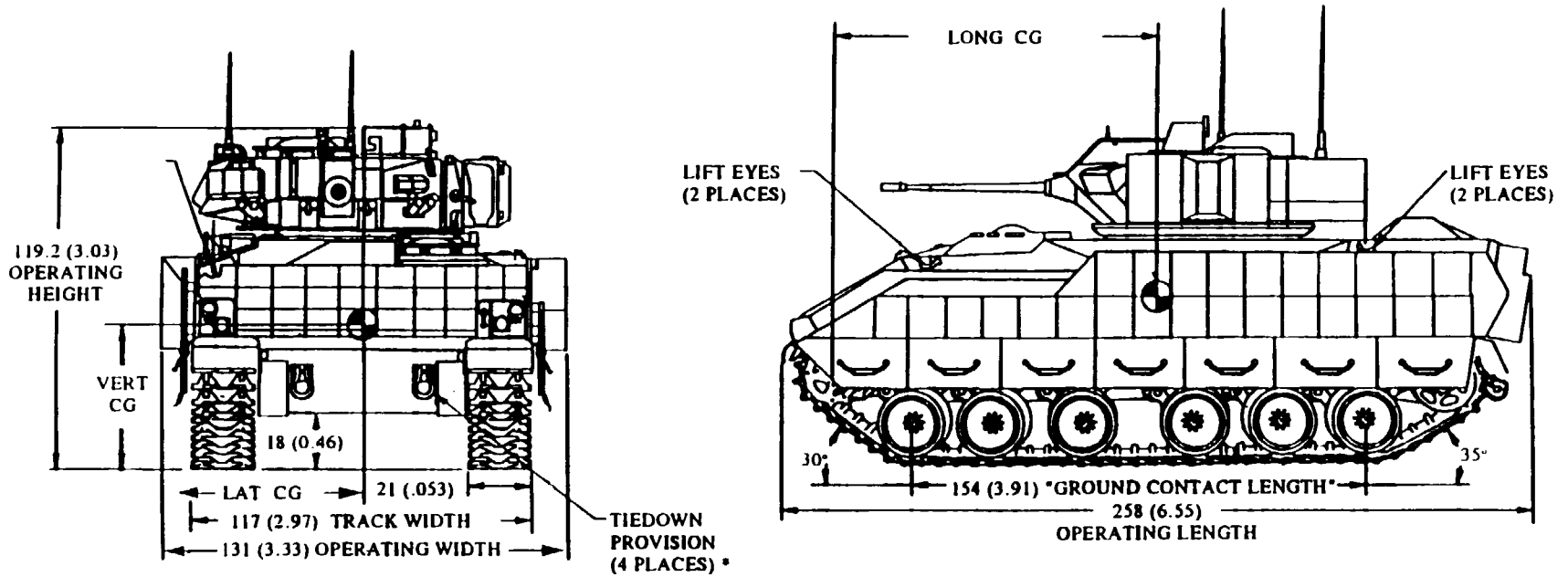


NOTE: DIMENSIONS IN INCHES (METERS)

CG LOCATION

	M2	M3	M2A1	M3A1
LATERAL CG	62.3 (1.58)	62.3 (1.58)	62.3 (1.58)	62.3 (1.58)
VERTICAL CG	47.1 (1.20)	47.1 (1.20)	47.1 (1.20)	47.1 (1.20)
LONGITUDINAL CG	93.7 (2.38)	93.6 (2.38)	93.7 (2.38)	93.6 (2.38)

Figure 1-3. Left side and front views of the M2/M2A1 and M3/M3A1 vehicles.



NOTE: DIMENSIONS IN INCHES (METERS)

* ALL M2A2 AND M3A2 VEHICLES HAVE TWO ADDITIONAL TIEDOWN PLATES ON REAR OF VEHICLES. TWO ADDITIONAL FRONT TIEDOWN PROVISIONS ARE SCHEDULED FOR PRODUCTION CUT-IN IN MAY 1993.

THE 75K BFVS WILL HAVE THE TWO ADDITIONAL TIEDOWN PLATES ON THE REAR OF THE VEHICLE AND THE TWO ADDITIONAL FRONT TIEDOWN PROVISIONS.

CG LOCATION

	M2A2	M3A2	75K BFVS**
LATERAL CG	62.3 (1.58)	62.3 (1.58)	60.3 (1.53)
VERTICAL CG	50.0 (1.27)	50.0 (1.27)	51.1 (1.30)
LONGITUDINAL CG	109.3 (2.78)	109.3 (2.78)	108.1 (2.75)

** PRODUCT IMPROVEMENTS MAY AFFECT THE CG LOCATION.

Figure 1-4. Left side and front views of the M2A2, M3A2, and 75K BFVS.

CHAPTER 2

HIGHWAY TRANSPORT

Section 1. GENERAL

2-1. General

The BFVS are highway transportable on semitrailers of adequate capacity. All the BFVS require highway permits for oversized cargo. AR 55-162 gives additional guidance on permits in CONUS.

Dimensional and weight restrictions in foreign countries are more restrictive than those in the United States. Foreign highway authorities will require permits for highway transport where vehicles exceed the legal limits. USAREUR Regulation 55-1 gives additional guidance for highway movement in U.S. Army Europe areas. The transportation movements officer (TMO) can provide further

guidance for highway transport in foreign countries. Permit requirements will vary depending on local regulations and conditions, but in general the shipper must:

- u. Submit DD Form 1266 (Request for Special Hauling Permit) to the installation transportation officer (ITO) 2 weeks before the planned movement.
- b. Be aware that travel may be restricted to daylight hours on normal workdays.
- c. Be prepared to use WIDE LOAD signs, amber lights, and escorts.
- d. Determine if blanket permits are available for specific prime movers, such as a heavy-equipment transporter (HET).

Section II. SELF-DELIVERY

2-2. Self-Delivery

The BFVS are considered self-deliverable only under appropriate tactical situations. Although the

tracks have rubber pads, these vehicles cannot move over paved public highways without specific approval, as outlined in FM 55-65.

Section III. MOTOR VEHICLE TRANSPORT

CAUTION

2-3. Prime Mover Selection

The BFVS can be transported over highways on specific semitrailers. The variety of semitrailers is limited by the weight and dimensions of the BFVS. When selecting a semitrailer, the shipping unit must consider the proposed route and local availability of oversized vehicle permits. An evaluation of available military semitrailers is given in table 2-1.

If the M2A2fM3A2 bolt-on armor is reactive, highway permits may require its removal before transport. If it is not reactive, a permit could also require its removal, to reduce the vehicle's width and/or weight.

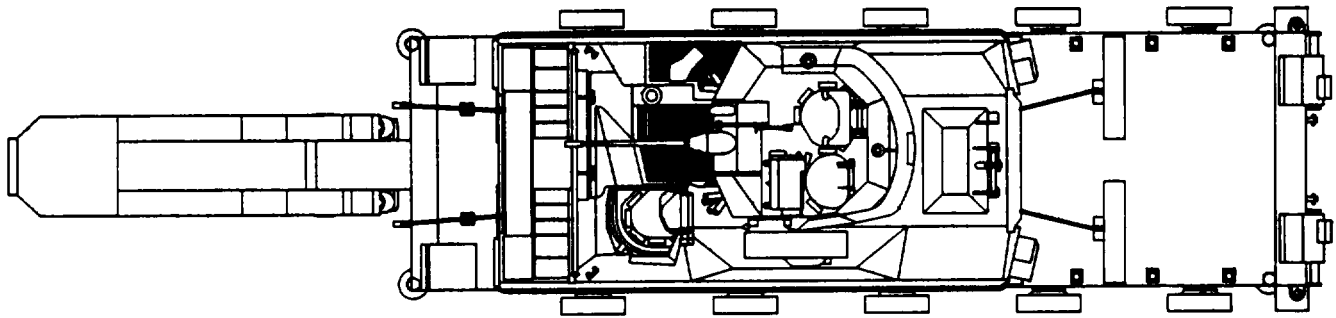
Table 2-1. Evaluation of Semitrailers

Semitrailers	Load Rating (STON)	Comments
M1000 HET	70	Suitable, but is large.
M747 HET	60	Suitable.
M870 Low Bed	40	Suitable.
M870A1 Low Bed	40	Suitable.
M872 Flat Bed	34	Not suitable, is too high.
M172A1 Low Bed	25	Undesirable, but usable when BFVS weight is reduced.
M871 Flat Bed	22.5	Not suitable, is too narrow and too high.
M127A2C Stake	12	Not suitable, is too small.
M345 Flat Bed	10	Not suitable, is too small.

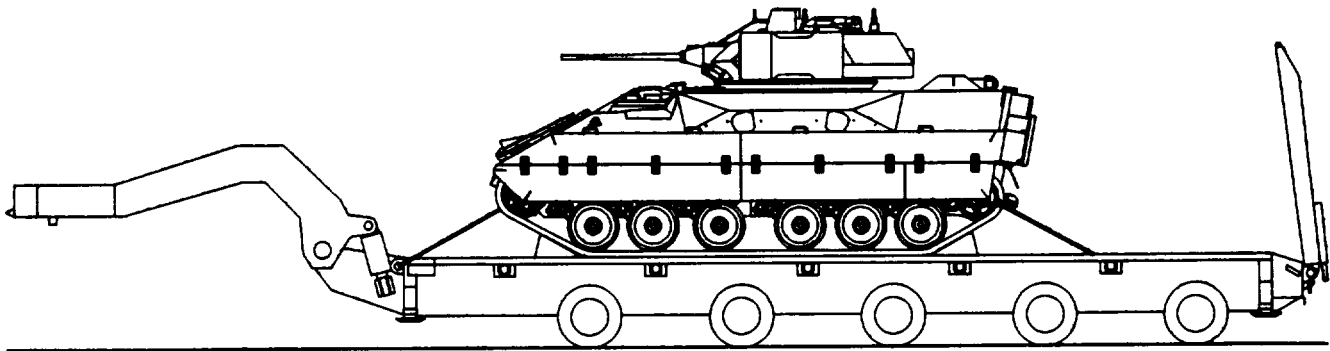
The recommended truck tractor and semitrailer combinations are:

- a. M911 truck tractor/M747 semitrailer.

- b. M920 truck tractor/M870A1 semitrailer.
- c. M746 truck tractor/M747 semitrailer.
- d. M920 truck tractor/M870 semitrailer.

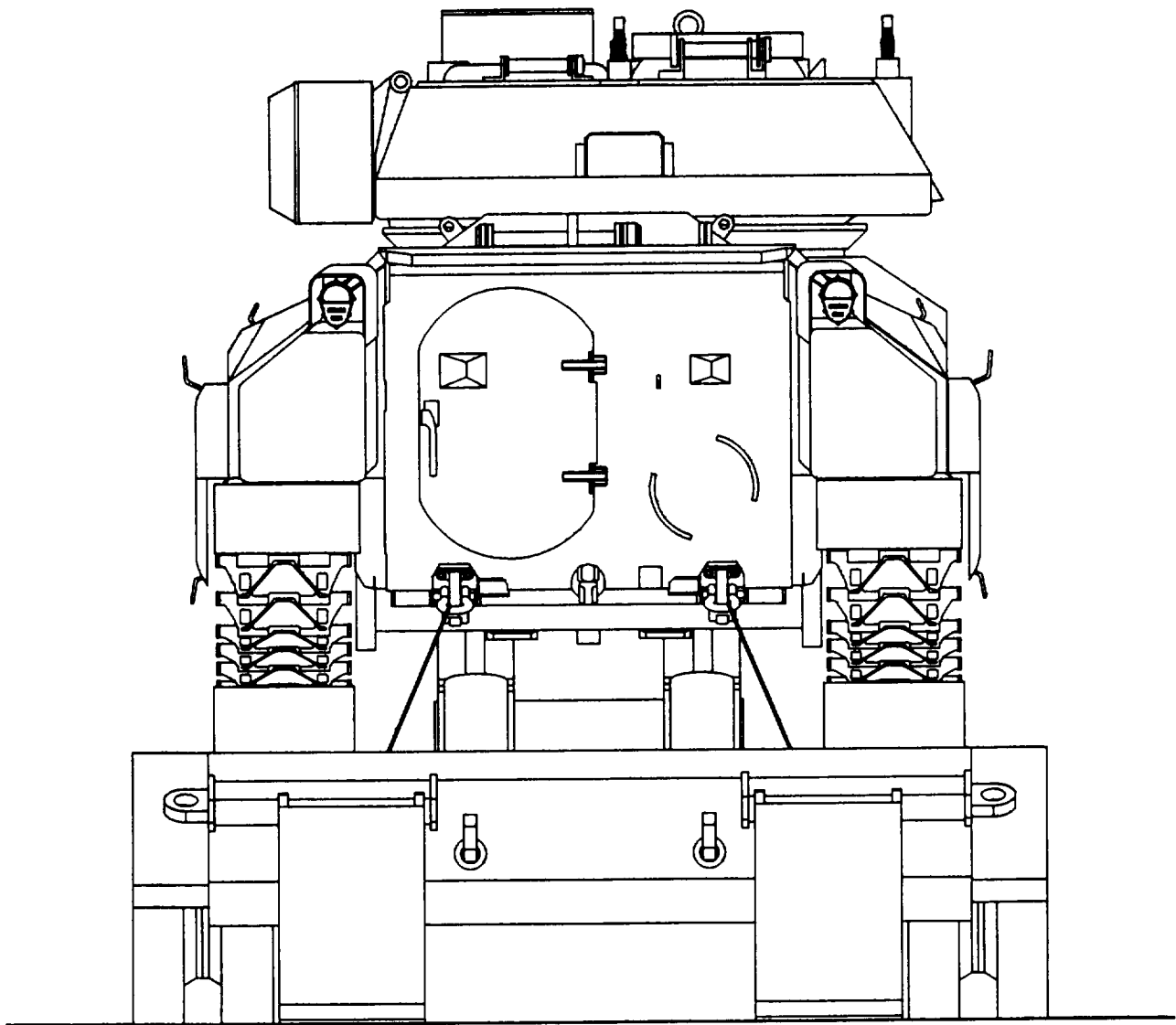


PLAN VIEW



SIDE VIEW

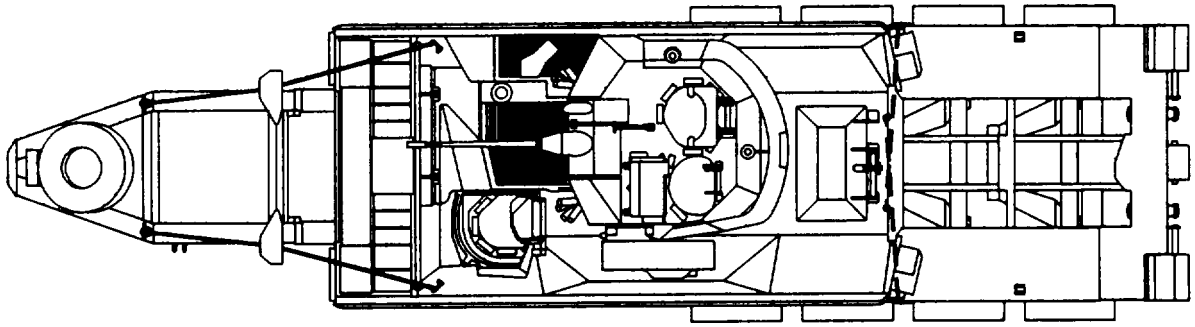
Figure 2-1. Tiedown configuration of the BFVS on the M1000 semitrailer.



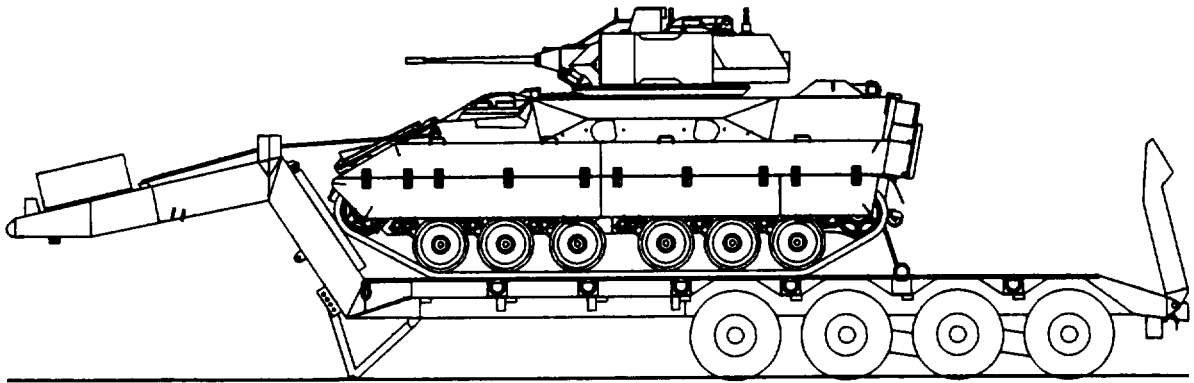
REAR VIEW

- ATTACH CHAINS AS SHOWN. DO NOT USE THE SPROCKET, FINAL DRIVE, IDLER, OR TRACKS AS TIEDOWN POINTS.
- USE THE CHAINS THAT ARE BII FOR THIS SEMITRAILER (NSN NOT YET AVAILABLE).
- USE THE LOAD BINDERS THAT ARE Bii FOR THIS SEMITRAILER (NSN NOT YET AVAILABLE).

Figure 2-1. Tiedown configuration of the BFVS on the M1000 semitrailer-Continued

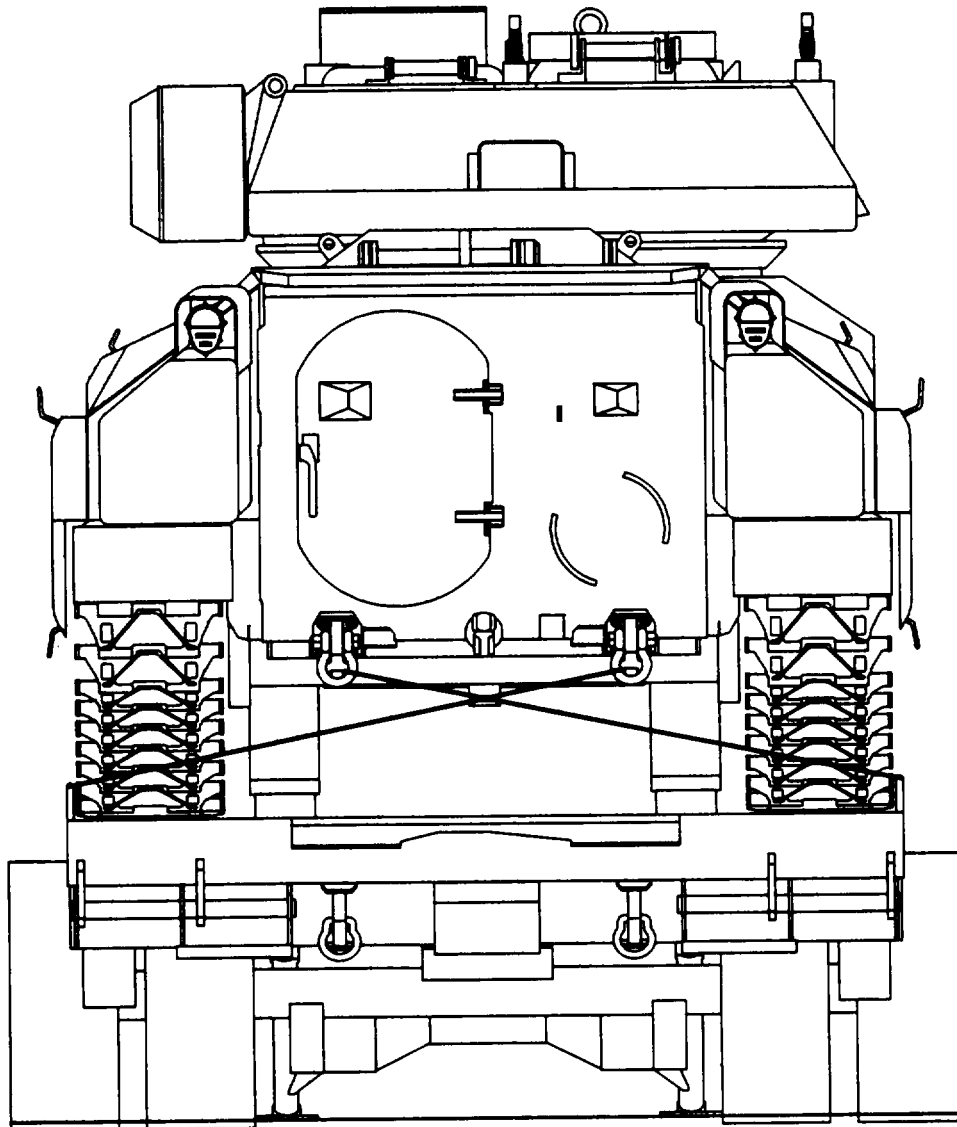


PLAN VIEW



SIDE VIEW

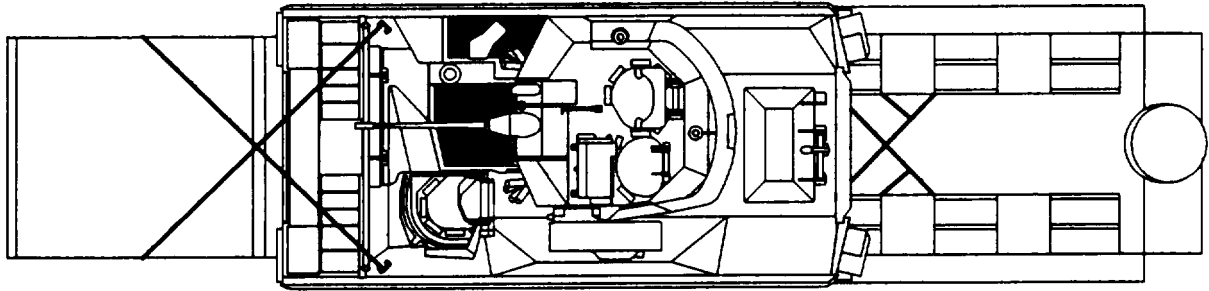
Figure 2-2, Tiedown configuration of the BFVS on the M747 semitrailer.



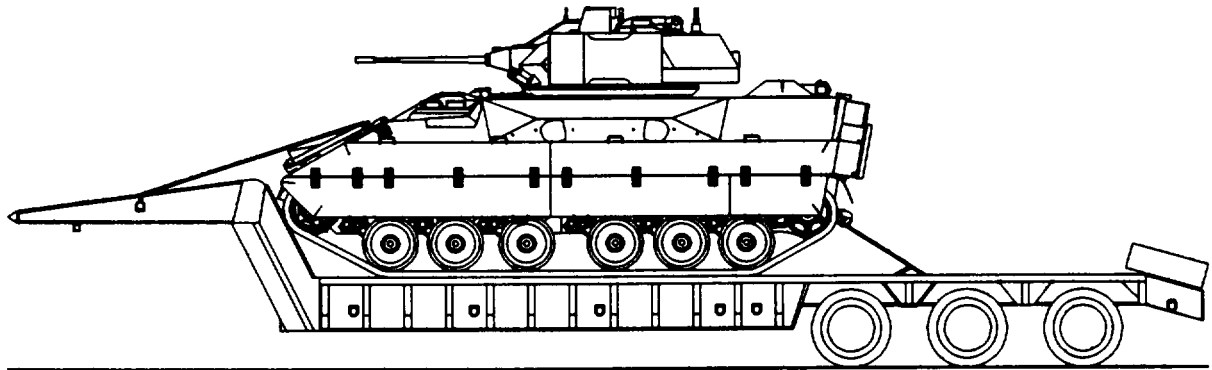
REAR VIEW

- ATTACH CHAINS AS SHOWN. DO NOT USE THE SPROCKET, FINAL DRIVE, IDLER, OR TRACKS AS TIEDOWN POINTS.
- USE 3/4-INCH X 12-FOOT CHAINS WITH 25,200-POUND WLL THAT ARE BII FOR THIS SEMITRAILER (NSN 4010-00-449-6573).
- USE 3/4-INCH LOAD BINDERS WITH 24,000-POUND WLL THAT ARE BII FOR THIS SEMITRAILER (NSN 3990-00-401-1503).

Figure 2-2. Tiedown configuration of the BFVS on the M747 semitrailer—continued

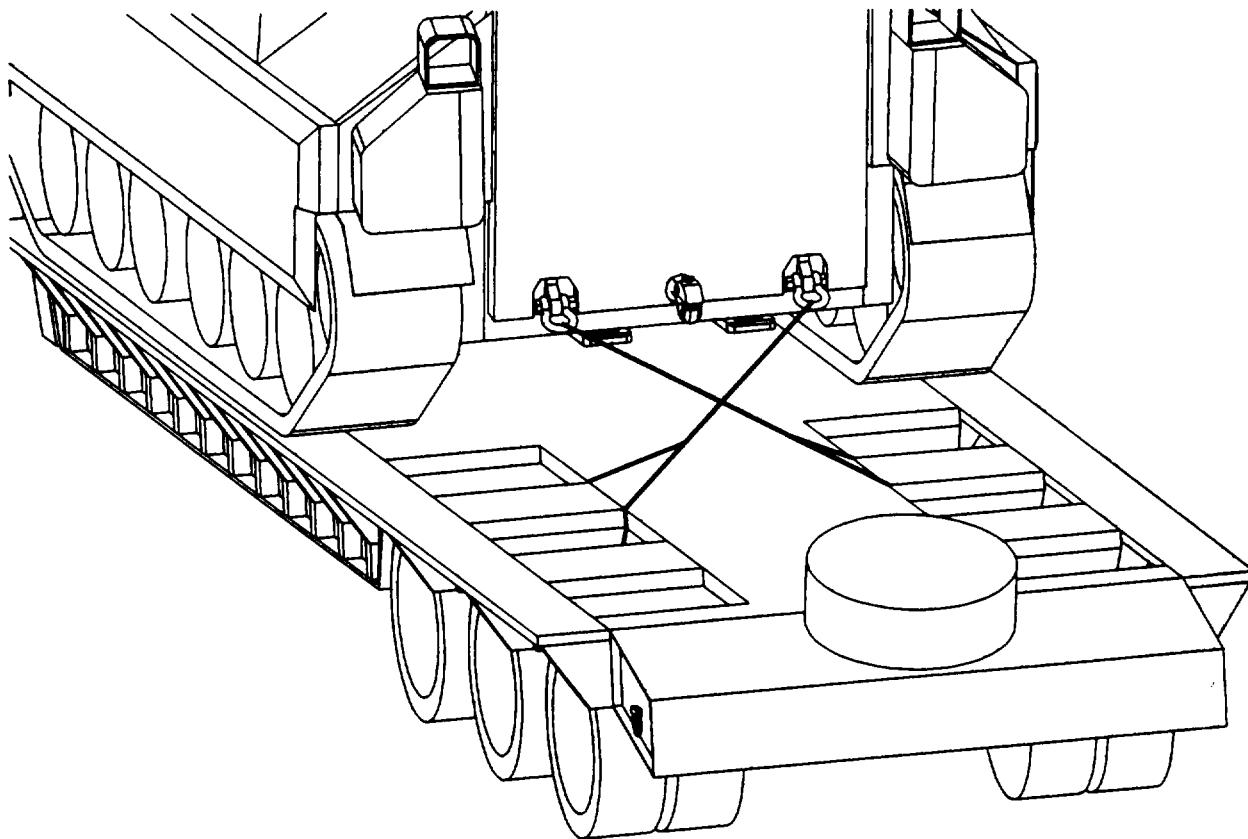


PLAN VIEW



SIDE VIEW

Figure 2-3. Tiedown configuration of the BFVS on the M870 semitrailer.

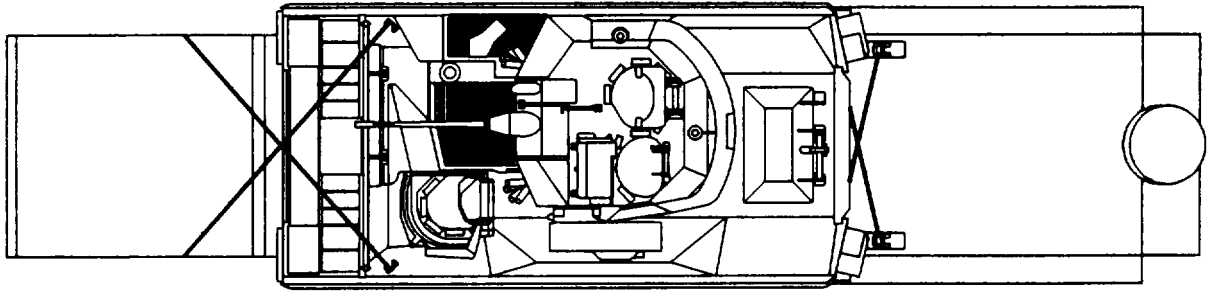


REAR VIEW

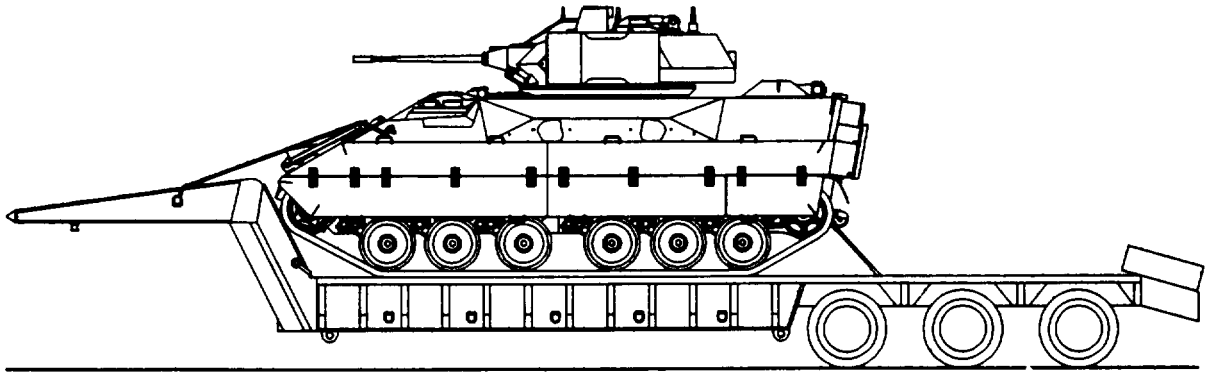
ATTACH CHAINS AS SHOWN. DO NOT USE THE SPROCKET, FINAL DRIVE, IDLER, OR TRACKS AS TIEDOWN POINTS.

- **USE 3/8-INCH X 14-1/2-FOOT CHAINS WITH 6,600-POUND WLL THAT ARE BII FOR THIS SEMITRAILER (NSN 4010-00-443-4845).**
- **USE 3/8 - 1/2-INCH, TYPE 4, LOAD BINDERS WITH 9,200-POUND WLL THAT ARE BII FOR THIS SEMITRAILER (NSN 3990-01-213-1746).**

Figure 2-3. Tiedown configuration of the BFVS on the M870 semitrailer—Continued

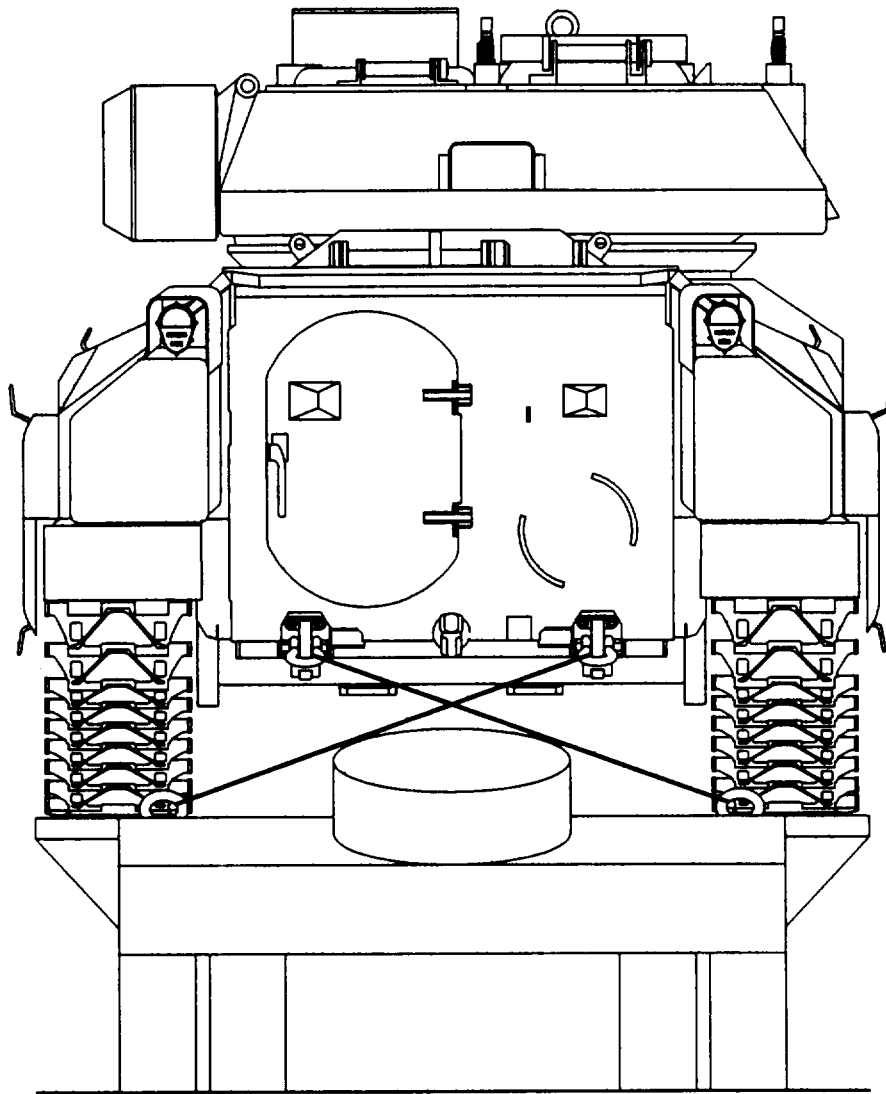


PLAN VIEW



SIDE VIEW

Figure 2-4. Tiedown configuration of the BFVS on the M870A1 semitrailer- Continued.



REAR VIEW

- ATTACH CHAINS AS SHOWN. DO NOT USE THE SPROCKET, FINAL DRIVE, IDLER, OR TRACKS AS TIEDOWN POINTS.
- USE 3/8-INCH X 14-1/2-FOOT CHAINS WITH 6,600-POUND WLL THAT ARE BII FOR THIS SEMITRAILER (NSN 4010-00-443-4846).
- USE 3/8 - 1/2-INCH, TYPE 4, LOAD BINDERS WITH 9,200-POUND WLL THAT ARE BII FOR THIS SEMITRAILER (NSN 3990-01-213-1746).

Figure 2-4. Tiedown configuration of the BFVS on the M870A1 semitrailer-Continued.

2-4. Vehicle Preparation

BFVS preparations for highway transport include:

- a. Removing external antennas and the 25-mm gun barrel (optional).
- b. Securing all loose items.
- c. Closing hatches.
- d. Locking the turret.
- e. Placing gun elevating mechanism in the neutral position.
- f. Emptying fuel tank to one-fourth of its capacity.
- g. Removing all trash and mud from the vehicle tracks,
- h. Checking for fluid leaks and repairing defects,
- i. Inspecting engine, brakes, and tiedown provisions and repairing any defects.
- j. Securing the battery.

2-5. Semitrailer Preparation

a. *M1000 Semitrailer*: The curbing must be adjusted to receive the BFVS tracks.

b. *M747 Semitrailer*: The curbing must be adjusted to receive the BFVS tracks. Position curbing inboard, row 1, locations A, B, C, and F.

c. *M870 and M870A1 Semitrailers*: The outriggers should be extended, and the outrigger planking should be moved from the storage area in the center of the semitrailer to the outrigger extensions.

*****WARNING*****

Loading should not be conducted on surfaces with side or lateral slopes larger than 10 percent. The tractor-semitrailer offset angle should not be greater than 5 percent.

*****WARNING*****

Avoid loading on a severe downward grade, to prevent the payload from rolling forward on the semitrailer.

*****WARNING*****

No one should be on the semitrailer bed during loading operations.

2-6. Loading and Tiedown Procedures

a. Place the BFVS in the tiedown position on the semitrailer. Use a crane of adequate capacity, or drive or winch it onto the semitrailer, provided suitable ramps are available. (See para 4-4 for lifting procedures.)

b. Position the BFVS on the semitrailer, using the semitrailer's cargo plate as guidance, or the figure in this text corresponding to the semitrailer being used. If no cargo data plate is present and a corresponding figure is not in this text, position the vehicle so that its weight is evenly distributed over the tractor and semitrailer axles.

c. Put the transmission in neutral.

d. Set the parking brake.

e. Install chains and load binders in locations shown in the figure corresponding to the type of semitrailer being used. The size and type of chains and load binders are specified on the corresponding figures. A detail of a chain tiedown configuration, using a loadbinder, is shown in figure 2-5.

****CAUTION****

Do not use the sprocket, idler, tracks, or final drive assemblies as tiedown points for the BFVS.

NOTE

During CONUS movement, the prime mover of the BFVS is governed by the same safety requirements as commercial carriers.

NOTE

An appropriate substitution of chains can be made in accordance with appendix A, "Chain Tiedown Calculations." If chains are not available, wire rope should be used. See paragraph 3-5 for materials and instructions.

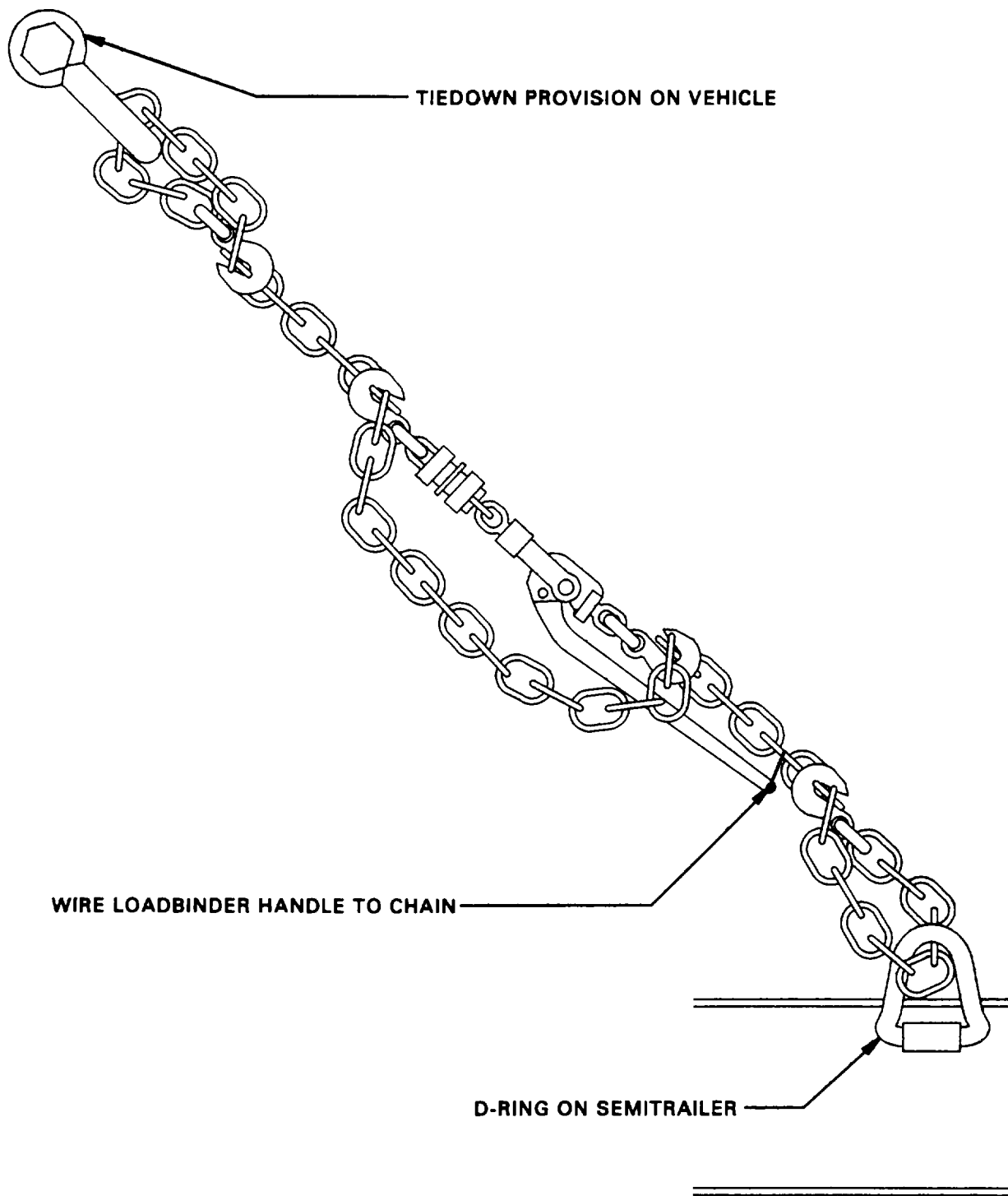


Figure 2-5. Detail of chain tiedown configuration using a loadbinder.

CHAPTER 3

RAIL TRANSPORT

Section 1. GENERAL

3-1. General

The BFVS are rail transportable in CONUS, Canada, and Mexico on most railcars. NATO railways classify the BFVS as an exceptional transport item because of the overall dimensions and the GVW. The BFVS must be cleared for rail transport on an

individual basis with the railroad authorities of the host nation. The railroad authorities may require special routing and provisions.

NOTE

Additional cargo may be transported with the vehicles if approved by the activity offering the equipment for transport.

Section II. RAIL LOADING

3-2. Railcar Selection

The BFVS are transportable on a variety of railcars. Table 3-1 presents characteristics of com-

monly available military and commercial railcars with comments about transporting the BFVS on each railcar.

Table 3-1. Evaluation of Railcars

RailCar	Features	Comments
DODX 140-TON	68 ft long, 10.5 ft wide, 140-ton, steel deck, cushioned, ½-inch chain WLL 13,750 lb	Suitable.
DODX 100-TON	54 ft long, 10.5 ft wide, 100-ton, wood deck, standard, no chain tiedowns provided	Suitable.
HTTX	60 ft long, 10.2 ft wide, 73-ton, wood deck, cushioned, ½-inch chain WLL 13,750 lb	Suitable.
ITTX	89 ft long, 8.5 ft wide, 70-ton, steel deck, cushioned, ½-inch chain WLL 9,000 lb	Not Recommended. Suitable when side rails are removed.
MTTX	60 ft long, 10.5 ft wide, 74-ton, wood deck, cushioned, no chain tiedowns provided	Suitable.
OTTX	60 ft long, 10.5 ft wide, 72-ton, wood deck, cushioned, ½-inch chain WLL 9,000 lb	Suitable.
TTDX	89 ft long, 8.5 ft wide, 74-ton, steel deck, cushioned, ½-inch chain	Not Suitable. Railcar does not allow overhang.

Note: Other general purpose flatcars can be used provided they are at least 8 feet wide and allow overhang on the sides. Flatcars with permanently attached side rails must be at least 10 feet wide. The flatcar must have at least a 40-ton capacity.

NOTE

If the railcar is not chain equipped, the shipping unit is responsible for providing chains or wire rope for tiedown.

3-3. Vehicle Preparation

BFVS preparations for rail transport include:

- a. Removing external antennas.
- b. Removing the bolt-on side armor for the M2A2 and M3A2 if it is reactive. The reactive bolt-on armor should be palletized for transport.
- c. Removing the gun barrel and securing it inside the vehicle (optional).
- d. Securing all loose items.
- e. Locking the turret.

f. Placing gun elevating mechanism in the neutral position.

g. Removing all trash and mud from the vehicle tracks.

h. Checking for fluid leaks and repairing any defects.

i. Inspecting the engine, brakes, and tiedown provisions, and repairing any defects.

j. Disconnecting the battery.

h Closing and locking all hatches to protect vehicle from pilferage.

NOTE

Bolt-on armor can be removed to reduce vehicle width.

****CAUTION****

Use railcar and ground guides when loading or unloading the BFVS.

****CAUTION****

Do not allow the BFVS to exceed 3 miles per hour (walking speed) during loading or unloading operations.

3-4. Loading Procedures

Place the BFVS onto the railcar with a crane of adequate capacity, or drive it onto the railcar if a suitable ramp or bridge is available. (See para 4.4 for lifting procedures.) Once the vehicle is in position, set the parking brake, and put the transmission in neutral.

3-5. Tiedown Procedures

Rail tiedown of the BFVS is dependent on the type

Table 3-2. Tiedown Material Options for Railcar Types

Type of Railcar	Options
Cushioned Wood Deck	all 1-11
Cushioned Steel Deck	1, 3, 6, 7, 10, 11
Standard Wood Deck	1, 4, 8

Table 3-3. Tiedown Option Descriptions

Option	Materials
1	16 wire rope tiedowns, 4 chock blocks, and 6 wheel blocks
2	16 wire rope tiedowns, and 4 chock blocks
3	16 wire rope tiedowns, and 6 wheel blocks
4	12 1/2-inch, 13,750-pound WLL chains, 4 chock blocks, and 6 wheel blocks
5	12 1/2-inch, 13,750-pound WLL chains, and 4 chock blocks
6	12 1/2-inch, 13,750-pound WLL chains, and 6 wheel blocks
7	16 1/2-inch, 13,750-pound WLL chains
8	20 3/8-inch, 9,000-pound WLL chains, 4 chock blocks, and 6 wheel blocks
9	20 3/8-inch, 9,000-pound WLL chains, and 4 chock blocks
10	20 3/8-inch, 9,000-pound WLL chains, and 6 wheel blocks
11	24 3/8-inch, 9,000-pound WLL chains

NOTE

The shipping unit is responsible for providing blocking materials.

Table 3-4. Bill of Materials for Wire Rope

Item	Description
Wire Rope 320 feet	5/8-inch diameter, 6 x 19, IWRC, preformed, regular lay, Fed Spec RR-W-410D.
Cable Clamps 64	5/8-inch, Type I, single-saddled, steel, Fed Spec FF-C-45.
Cable Clamps 32	3/4-inch, Type I, single-saddled, steel, Fed Spec FF-C-45,
Thimbles 32	5/8-inch, Type HI, split oval construction (heavy open pattern), Fed Spec FF-T-276.

of railcar, materials available, and the weight of the vehicle. The M2/M3 and M2A1/M3A1 require four less wire rope or chain tiedowns than the other BFVS. Figures 3-1 and 3-2 show the tiedown patterns. Tables 3-2 and 3-3 determine the type of materials needed for tying down the BFVS. Tables 3-4 and 3-5 and figure 3-3 provide a list of materials and application of wire rope tiedowns (options 1 through 3). Table 3-6 provides a list of materials and application of chain tiedowns (options 4 through 11). Figure 3-4 provides construction and application instructions for chock blocks. Figure 3-5 provides construction and application instructions for wheel blocks. If the railcar is not chain-equipped, the shipping unit is responsible for providing blocking materials and chains or wire rope for tiedown.

Table 3-5. Procedures for Wire Rope Tiedown

Item	Procedure
Wire rope loops	Each tiedown is made from one piece of 5/8-inch wire rope. Cut length as required. (Need a maximum of 20 feet per tiedown.) Form a complete loop between BFVS tiedown provision and appropriate railcar stake pocket. The angle between the cables and trailer deck (viewed from the side) should be as close to 45° as possible. The wire rope ends must overlap at least 24 inches. Tension the wire rope by using two cable grippers and a 3-ton chain hoist or come-along.
Cable Clamps	Space clamps 3 3/4 inches apart. Use 5/8-inch cable clamps, and torque nuts alternately to about 95 foot-pounds.
Thimbles	Use thimbles to protect cable at sharp bends. Attach to cable with a 5/8-inch cable clamp.

****CAUTION****

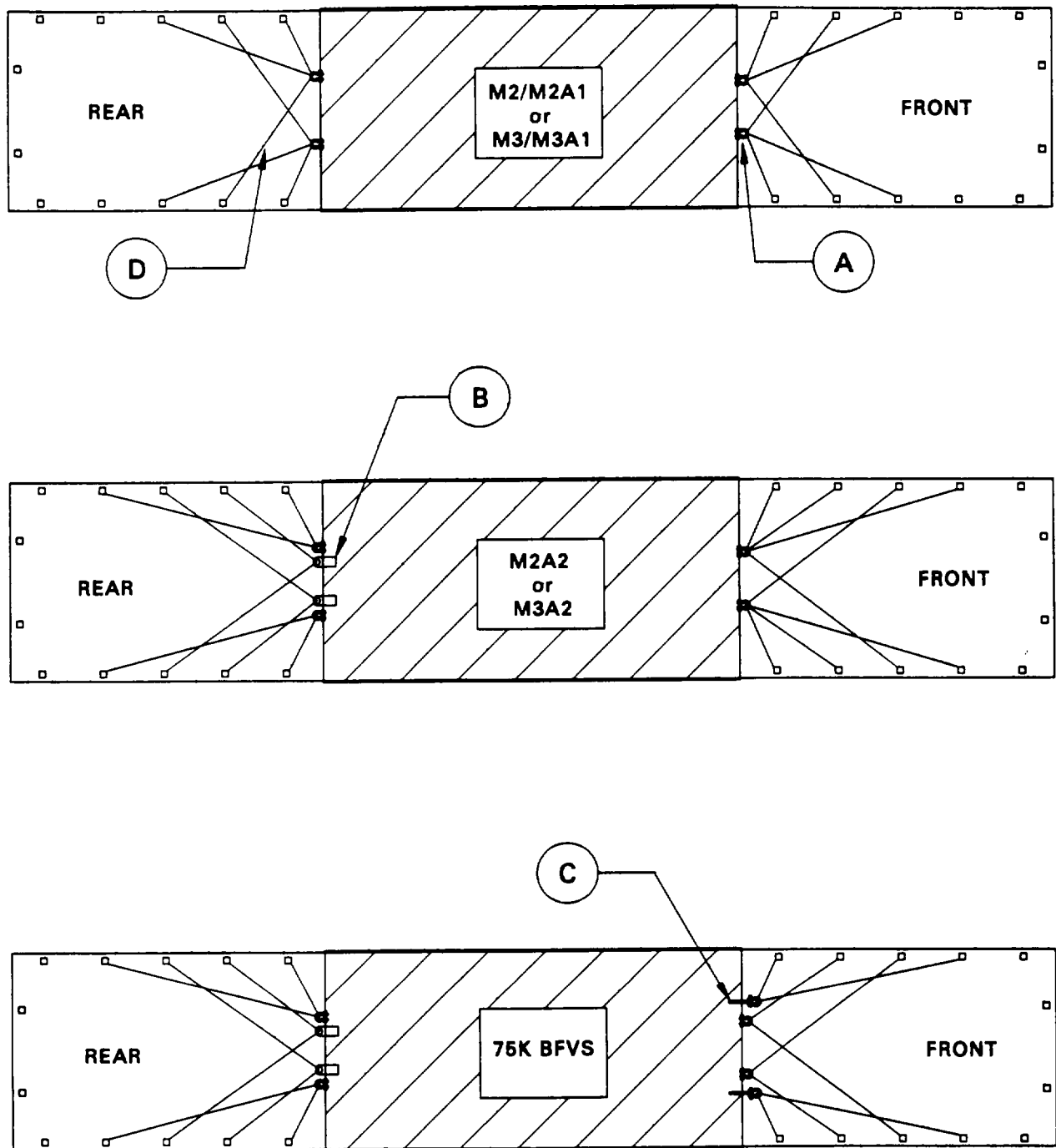
Do not use the sprocket, idler, tracks, or final drive assemblies as tiedown points on the BFVS.

NOTE

Cable clamp nuts must be torqued to at least 65 foot-pounds to develop full cable loop breaking strength of 36,800 pounds. To get the correct torque, apply torque alternately to both nuts.

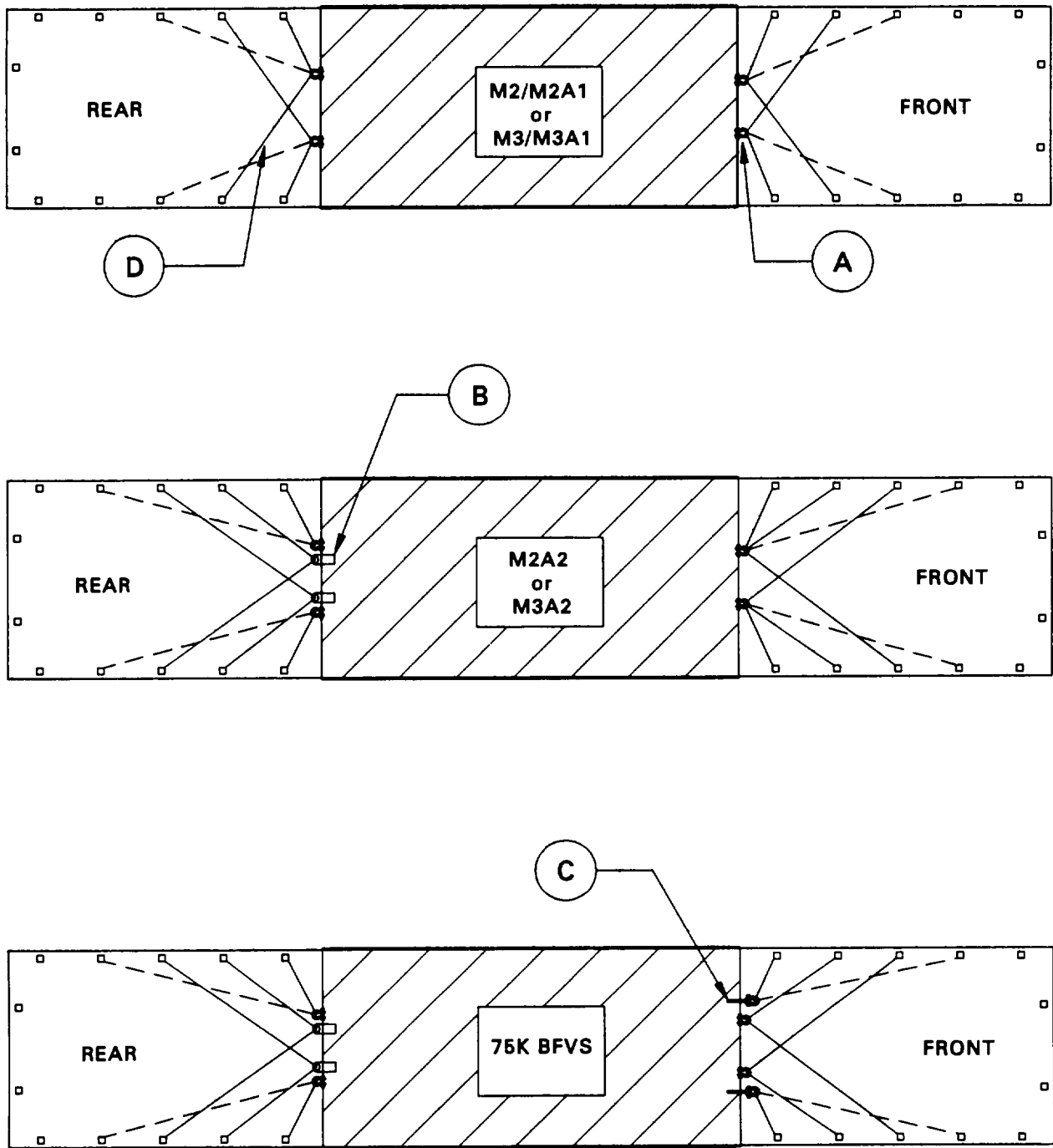
Table 3-6. Bill of Materials for Chain Tiedown

Item	Description
Chain Load Binders	1/2-inch chain (options 4 through 7): 1/2-inch diameter, 13,750 pounds minimum WLL 3/8- to 1/2-in, 13,750 pounds minimum WLL
Chain Load Binders	3/8-inch chain (options 8 through 11): 3/8-inch diameter, 9,000 pounds minimum WLL 3/8- to Winch, 9,000 pounds minimum WLL



- A - SHACKLE TIEDOWN POINT
- B - REAR TIEDOWN PLATE
- C - FINAL DRIVE TIEDOWN PLATE SHACKLE
- D - WIREROPE

Figure 3-1. Wire rope tiedown configuration of the BFVS on railcars.



- A - SHACKLE TIEDOWN POINT
- B - REAR TIEDOWN PLATE
- C - FINAL DRIVE TIEDOWN PLATE SHACKLE
- D - CHAIN

NOTE: DOTTED CHAINS ARE NOT REQUIRED WHEN USING WHEEL OR CHOCK BLOCKS ON A CUSHIONED RAILCAR.

Figure 3-2. Chain tiedown configuration of the BFVS on railcars.

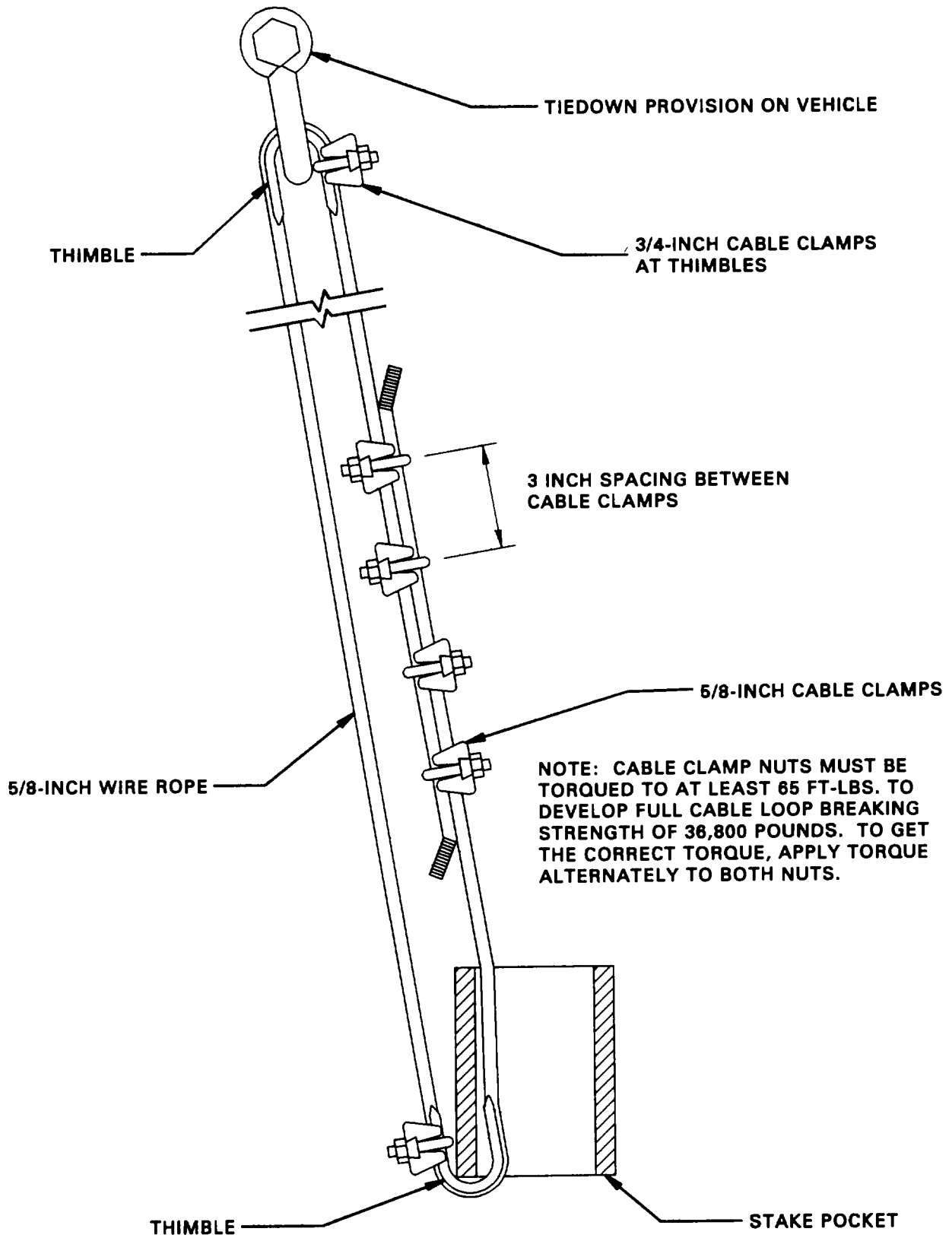
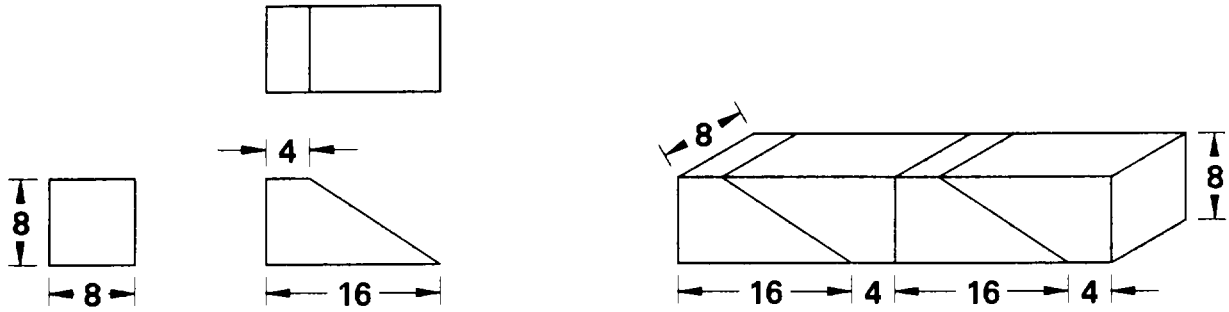
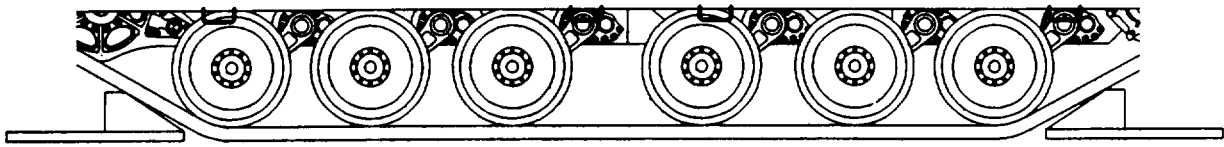
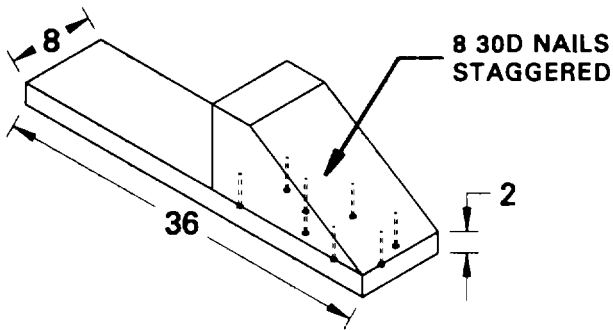


Figure 3-3. Detail of wire rope tiedown configuration.



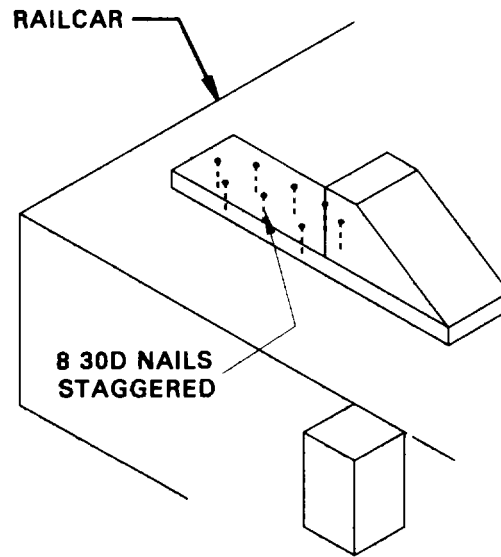
THE TRIANGULAR WEDGES CAN BE CUT FROM AN 8 X 8 AS SHOWN ABOVE.



NAIL THE TRIANGULAR WEDGES TO 36-INCH LONG 2 X 8'S USING 8 30D NAILS IN A STAGGERED PATTERN.

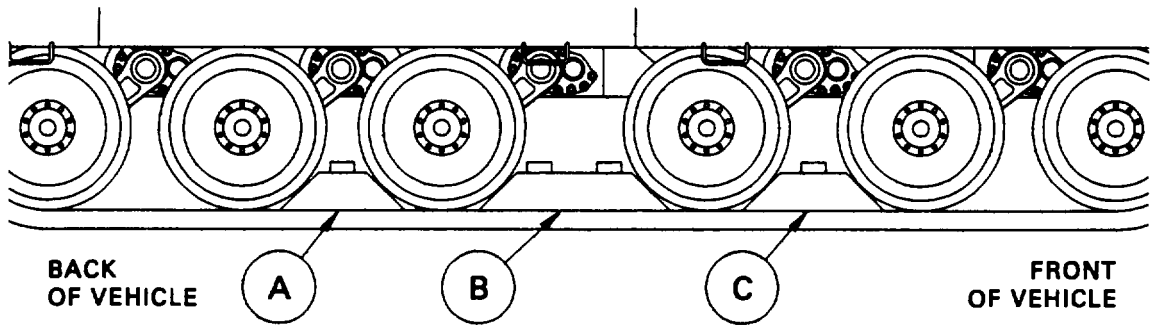
NOTE:

1. ALL LUMBER - DOUGLAS FIR, OR COMPATIBLE STRAIGHT GRAIN, FREE FROM MATERIAL DEFECTS PER FED SPEC MM-L-751.
2. DIMENSIONS IN INCHES.



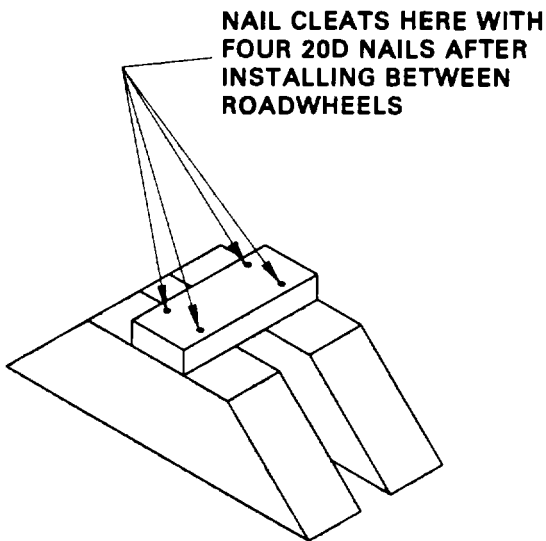
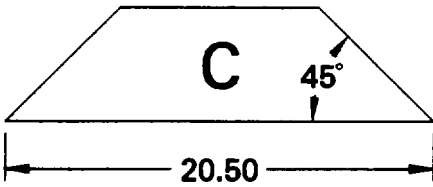
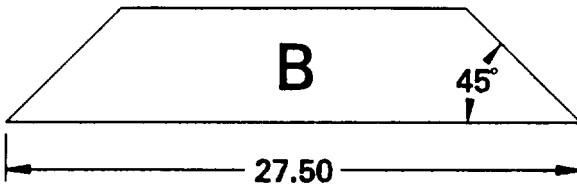
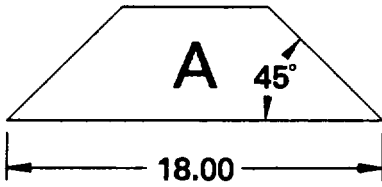
THE CHOCK BLOCKS CAN THEN BE SECURED TO A WOODEN-DECK RAILCAR USING 8 30D NAILS IN A STAGGERED PATTERN.

Figure 3-4. Chock block design.

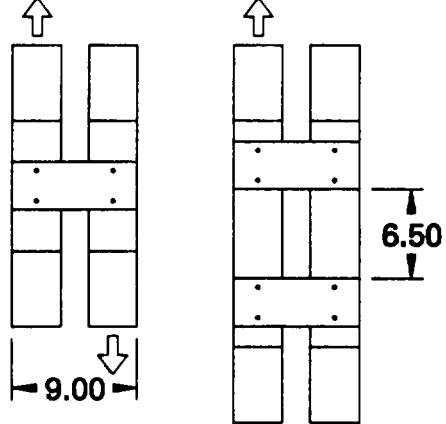


NOTE:

1. ALL LUMBER - DOUGLAS FIR, OR COMPATIBLE STRAIGHT GRAIN, FREE FROM MATERIAL DEFECTS PER FED SPEC MM-L-751.
2. LUMBER FOR BLOCKS, SIZE 4 X 6 NOMINAL.
3. LUMBER FOR TIE CLEATS, SIZE 2 X 4 NOMINAL.
4. DIMENSIONS IN INCHES.



OFF SET BLOCKS AS FAR AS POSSIBLE TO TOUCH ROAD WHEELS



BLOCKS A AND C - ONE CLEAT EACH

BLOCK B - TWO CLEATS

Figure 3-5. Wheel block design.

CHAPTER 4

MARINE TRANSPORT

Section I. GENERAL

4-1. General

The BFVS can be transported by a variety of inland waterway cargo carriers and lighters and by all seagoing cargo vessels. Shoring may be required to avoid metal to metal contact. Most marine vessels will have lashing/tiedown materials. If shoring is required or the vessel does not have tiedown materials, then the shipping unit is responsible for providing these materials. The ship must have suitable tiedown points such as D rings or chain lashing anchors.

When possible, the vehicle should receive the protection of below-deck stowage. In general, good stowage of vehicles means having them placed fore and aft, as close together as practical, with minimum spacing between outer vehicles and the sweatboards. If not shipped on the vehicle, the breakable parts, spare parts, and OEM (on equipment material) should be protected and properly identified as to location or disposition during shipment.

NOTE

The methods described in this chapter for

lifting and securing vehicles are the recommended procedures. Other methods of handling and stowing may be used, provided they will ensure safe delivery.

4-2. Safety

Besides the safety precautions in paragraph 1-6, the following safety measures will apply for marine transport.

a. The shipping unit will notify the marine vessel if ammunition or explosives are to be transported with the BFVS. Compliance with AR 55-228, paragraph 2-7 is required.

b. The BFVS and ammunition will be handled and stowed in accordance with the Code of Federal Regulations, Title 49, Transportation, subparts 176.76 and 176.905. The same regulations are also contained in Water Carrier Tariff No. 32 or the current issue of this tariff.

c. Fire extinguishers will be readily available during shiploading and unloading.

CAUTION

Ear protection (plugs) must be worn at all times when working in RORO ship holds.

Section II. SHIPLOADING

4-3. Vehicle Preparation

BFVS preparations for marine transport include:

- u. Removing external antennas and the 25-mm gun barrel (optional).
- b. Securing all loose items.
- c. Rotating the turret 3,200 roils (180°) if the vehicle is going to be lifted.
- d. Closing hatches.
- e. Locking the turret.
- f. Placing gun elevating mechanism in the neutral position.
- g. Emptying fuel tank to one-fourth of its capacity.
- h. Removing all trash and mud from the vehicle tracks.
- i. Checking for fluid leaks and repairing defects.
- j. Inspecting engine, brakes, and tiedown provisions, and repairing any defects.

4-4. Loading Procedures

When appropriate (such as RORO vessels), the

BFVS can be driven or towed onto the vessel. When lifting the BFVS, use a crane of adequate capacity. Ship and shore side cranes are usually rated in long tons (LT), 2,240 pounds, and/or metric tons (t), 1000 kilograms. To lift a BFVS, a crane and sling-set rated to at least 33.5 LT (34.0 t) is required. A typical lifting diagram for the BFVS is shown in figure 4-1.

Place the BFVS in the position indicated on the stow plan so that sufficient tiedown points are available. Put the transmission in neutral, and set the parking brake. Disconnect the battery.

CAUTION

The turret must be rotated 3200 roils (180°) before lifting the vehicle. If not, damage to the TOW missile launcher and turret bustle will occur.

4-5. Tiedown Procedures

The preferred tiedown pattern is four chains with a 75,000-pound minimum WLL, crossed and at an angle of 30" (fig 4-2). If the vessel is not equipped

TM 55-2350-252-14

with lashing/tiedown materials, the shipping unit is responsible for providing them. The location of the D rings (or chain lashing anchors) and the tiedown materials available will determine the actual tiedown pattern. The appendix A to ensure the adequate size and quantity of tiedowns.

*****WARNING*****

Do not walk under the vehicle when it is lifted.

NOTE

If adequate lashing is not available, use blocking.

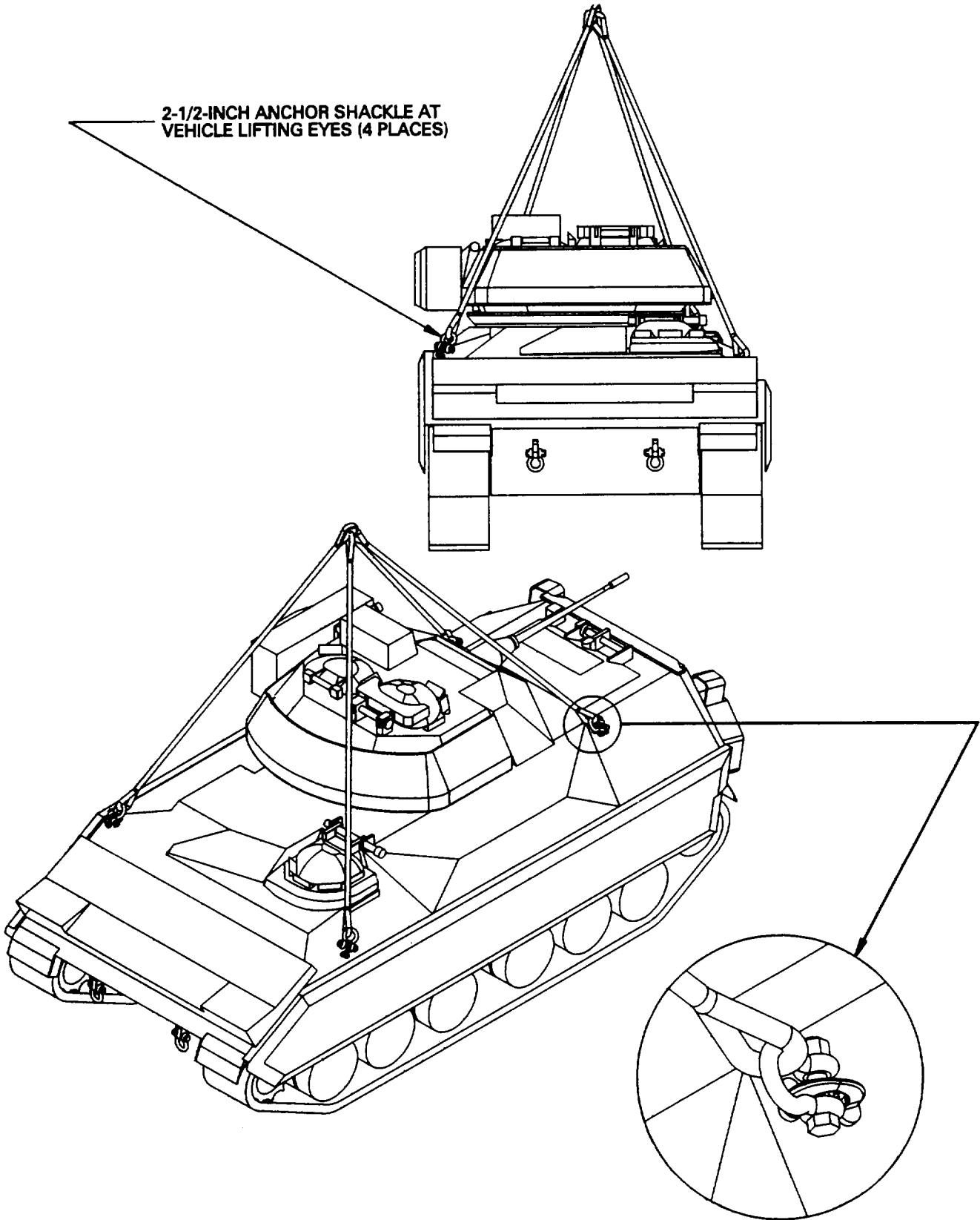


Figure 4-1. Lifting diagram for the BFVS using wire rope sling.

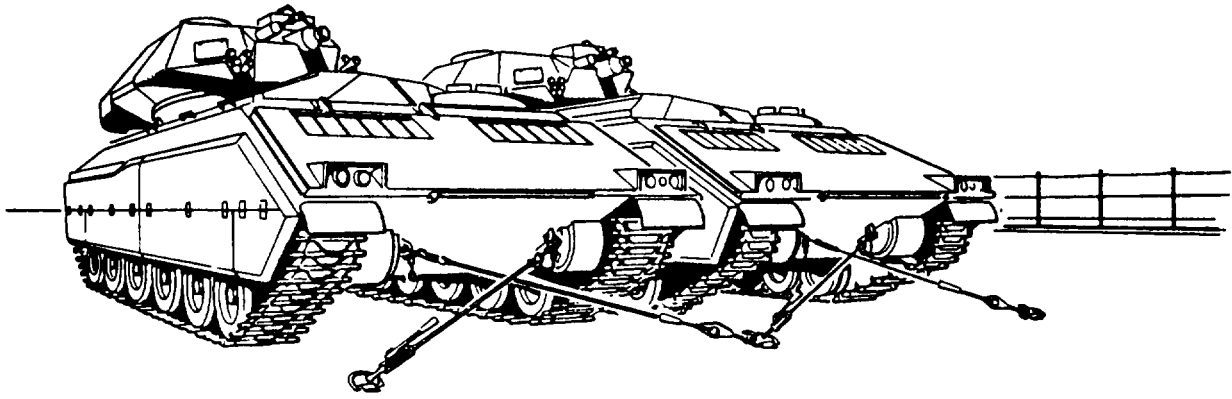


Figure 4-2. Preferred marine tiedown configuration for the BFVS.

CHAPTER 5

AIR TRANSPORT

Section I. GENERAL

5-1. General

The BFVS is air transportable on a C-5 and C-17 aircraft in its operational configuration and on a C-141 if reduced to 44,000 pounds GVW. The BFVS exceeds dimensional and/or weight limitations for all other aircraft. Variables such as weather, airfield characteristics, and distance to destination affect total cargo loads and operating ranges. TM 38-236/AFR 71-8 provides general guidance on total cargo loads and operating ranges. For specific guidance, contact the nearest Air Mobility Command (AMC) activity.

The shipping unit must ensure that the carrier is properly prepared for air transport before reaching the marshaling area. The shipping unit will assist the aircraft loadmaster/crew in loading and tying down the BFVS. It is the responsibility of the shipping unit to provide shoring material.

5-2. Safety

Besides the general safety notes in section 1-6, the following safety considerations and precautions apply for air transport:

Section II. TRANSPORT BY CARGO AIRCRAFT

5-4. USAF Cargo Aircraft

The BFVS is certified for airlift on the C-5, C-17, and C-141 aircraft.

5-5. US Army Aircraft

The BFVS exceeds weight and dimensional limitations for transport on US Army fixed-wing aircraft and US Army rotary-wing aircraft.

5-6. Civil Reserve Air Fleet (CRAF)

The BFVS exceeds weight and dimensional limitations for transport on all CRAF aircraft.

5-7. Preparations for Airlift

5-7.1. Preparation for Transport on C-5 and C-17 Aircraft

BFVS preparation for transport on C-5 and C-17 aircraft include:

- a. Removing external antennas.
- b. Removing the gun barrel and securing it inside the vehicle (optional).
- c. Securing all loose items.
- d. Locking the turret.

- a. Personnel must not refuel or otherwise service the BFVS within 50 feet of the aircraft.

- b. Personnel will wear ear protection (plugs) at all times while working on the flightline.

- c. Fire extinguishers will be readily available during aircraft loading and unloading operations.

- d. The vehicle maximum speed is 5 mph when within 25 feet of an aircraft. The maximum speed on loading ramps or inside an aircraft is 3 mph.

- e. The fuel tank will not be more than one-fourth full for transport on the C-141 aircraft and three-fourths full for transport on the C-5 aircraft.

- f. The driver must allow adequate time for the transmission fluid to warm prior to placing the transmission in gear. If the fluid is not warm, the vehicle may move forward when shifted into reverse.

5-3. Hazardous Material

The shipping unit must provide written notification before shipping dangerous or hazardous materials aboard military or Department of Defense (DOD) contract aircraft. Specific instructions can be found in TM 38-250/AFR 71-4 or in CFR 49.

- e. Placing gun elevating mechanism in the neutral position.

- f. Removing all trash and mud from the vehicle tracks.

- g. Checking for fluid leaks and repairing any defects.

- h. Inspecting the engine, brakes, and tiedown provisions, and repairing any defects.

- i. Disconnecting the battery.

- j. Closing and locking all hatches to protect vehicle from pilferage.

NOTE

Preparation for transport on C-17 aircraft could change as the aircraft comes into production.

Shoring is required when loading and offloading the BFVS. The shipping unit must provide the shoring in accordance with TO IC-5A-9.

The shipping unit will assist the aircraft loadmaster/crew in loading and tying down the BFVS. The USAF will provide the tiedown materials.

5-7.2. Preparation for Transport on C-141 Aircraft

a. Preparation for transport on C-141 aircraft is a difficult and time consuming task. It requires reducing the vehicle to a height of 103.7 inches, width of 117 inches, and GVW of 44,000 pounds. The 24th Infantry Division (Mechanized), Fort Stewart, Georgia, has developed a procedure for preparing the M2A2 for C-141B transport, The U.S. Air Force approved this procedure and MTMCTEA concurs. Their procedure appears in appendix D. The BFVS is straight-on loaded onto the C-141B aircraft from a semitrailer. Shoring is used to support the aircraft ramp while loading the BFVS. The top piece of shoring is modified to

fit against the aircraft ramp skid plate. Construction and application instructions are given in appendix E. The semitrailer used must have a deck height of 40 to 48 inches and a minimum capacity of 44,000 pounds. The 24th ID (M) uses the M172A1 semitrailer because it is also transportable on a C-141B aircraft. Upon arrival at the destination, a semitrailer must be available to unload the BFVS.

b. Shoring is required when loading and offloading the BFVS. The shipping unit must provide the shoring in accordance with TO IC-141B-9.

c. The shipping unit will assist the aircraft loadmaster/crew in loading and tying down the BFVS. The USAF will provide the tiedown materials.

APPENDIX A

CHAIN TIEDOWN CALCULATIONS

A-1. Introduction

The number of chains needed to safely transport a vehicle depends on the weight of the vehicle, the strength of the tiedown, the method of transport, and blocking and bracing. This appendix provides a conservative method of calculating the number of tiedown chains required to restrain a load. The following calculations do not account for blocking and bracing. The procedures given in the text are based on actual tiedown angles; while the following calculations are based on estimated angles. Therefore, the number of chains given in the text may be less than what you will calculate here.

A-2. General Rules

The following information is required:

a. *Vehicle Weight (VW)*—when preparing to load use the vehicle’s actual weight if possible; otherwise, use the GVW.

b. *Load Restraint Factor (LRF)*—the “G” (acceleration of gravity) loading factors that a vehicle can expect to see during military transport (table A-1).

c. *Tiedown Strength (TS)*—the strength of the weakest part (provision, chain, loadbinder, and so forth) of a tiedown assembly.

d. *Angle Effect (AE)*—the percent of tiedown strength available in each direction (lateral, longitudinal, and vertical) (table A-2).

Table A-1. Load Restraint Factors

Mode of Transport	Forward	Aft	Lateral	Vertical
Highway (semitrailer)	0.7	0.3	0.1	0.3
Rail*	3.0	3.0	2.0	2.0
Marine (Fast Sealift Ship)	0.3	0.3	0.9	0.2
Marine (other)	0.7	0.7	1.2	0.2
Air	3.0	1.5	1.5	2.0

*To approximate AAR rules, use LRF = 0.7 in these calculations.

Table A-2. Angle Effects

Mode of Transport	Angle	Forward	Aft	Lateral	Vertical
Highway (semitrailer)	45	0.50	0.50	0.50	0.71
Rail	45	0.50	0.50	0.50	0.71
Marine (Fast Sealift Ship)	30	0.75	0.75	0.43	0.50
Marine (other)	30	0.75	0.75	0.43	0.50
Air	30	0.75	0.75	0.43	0.50

The following steps will give the total number of chains required to be placed symmetrically about the vehicle.

Note: The LRF and AE are for the same mode of transport in the same direction.

1. Calculate the number of chains required for each direction.

$$\frac{(VW \times LRF)}{(TS \times AE)} = \text{number of chains}$$

2. Multiply the maximum number of chains calculated in step 1 by 2.
3. Round the number of chains calculated in step 2 to the next highest number divisible by 4.

A-3. Example Calculation

Problem: It is required to transport a tracked 43,000-pound GVW vehicle by semitrailer without blocking. The provisions are rated at 40,000 pounds, the chains have a 13,700-pound WLL, and the loadbinders have a 9,000 pound WLL.

Information required:

VW = 43,000 pounds

LRF - from table A-1

Forward = 0.7, Aft = 0.3, Lateral = 0.1, Vertical = 0.3

TS = 9,000 pounds (weakest part of the tiedown assembly)

AE - from table A-2

Forward = 0.50, Aft = 0.50, Lateral = 0.50, Vertical = 0.71

Step 1:

Forward Calculation: $\frac{(43,000 \times 0.7)}{(9,000 \times 0.50)} = 6.69$

Aft Calculation: $\frac{(43,000 \times 0.3)}{(9,000 \times 0.50)} = 2.87$

Lateral Calculation: $\frac{(43,000 \times 0.1)}{(9,000 \times 0.50)} = 0.96$

Vertical Calculation: $\frac{(43,000 \times 0.3)}{(9,000 \times 0.71)} = 2.02$

Step 2:

Maximum number was calculated in the forward calculation.

$6.69 \times 2 = 13.38$

Step 3:

13.38 is not divisible by 4, so round to 16, which is the next highest number divisible by 4.

Answer: Sixteen chains placed symmetrically about the vehicle are required to secure it for highway transport on a semitrailer without blocking.

A-4. General Notes

As a general rule, if proper blocking and bracing are used, the total number of chains can be reduced by four.

- a. Chain is generally rated by proof test load or about two times the working load limit.
- b. Load binders are generally marked with an ultimate breaking strength rating. Depending on the manufacturer, breaking strength is about three times the working load limit.

ASSEMBLY B

NSN REFERENCE TABLE

NSN	Highway Transport <i>Description</i>
	<i>Chains</i>
4010-00-449-6573	3/4-inch x12-foot, 25,200-pound WLL BII for the M747 semitrailer
4010-00-443-4845	3/8-inch x 14 1/2-foot, 6,600-pound WLL BII for the M870 and M870A1 semitrailers
	<i>Load Binders</i>
3990-00-401-1303	3/4-inch, 24,000-pound WLL BII for the M747 semitrailer
3990-01-213-1746	3/8- to 1/2-inch, type 4, 9,200-pound WLL BII for the M870 and M870A1 semitrailers
	Rail Transport <i>Description</i>
	<i>Wire Rope Tiedown Materials</i>
4010-00-763-9361	wire rope, 5/8-inch, 6 x 19 IWRC improved plow steel, 35,800-pound nominal breaking strength
4030-00-243-4441	cable clamps, 5/8-inch, type I, single-saddled, steel
4030-00-243-4442	cable clamps, 3/4-inch, type I, single-saddled, steel
4030-00-431-6058	thimbles, 5/8-inch, type III, split oval construction

**APPENDIX C
CONVERSION TABLES**

1. Common Metric Abbreviations

m = meter	kg = kilogram
dm = decimeter	km = kilometer
cm = centimeter	t = metric ton
mm = millimeter	

2. Linear Measure

1 mi = 1,609.35 m	1 km = 0.62137 mi
1 yd = 0.9144 m	1 m = 1.0936 yd
1 ft = 0.3048 m	1 m = 3.2808 ft
1 in = 0.0254 m	1 m = 39.3700 in
1 m = 10 dm = 100 cm = 1000 mm	

3. Surface Measure

1 sq yd = 0.8361 sq m	1 sq m = 1.196 sq yd
1 sq ft = 0.0929 sq m	1 sq m = 10.764 sq ft
1 sq in = 0.00065 sq m	1 sq m = 1,550 sq in

4. Cubic Measure

1 CU yd = 0.76455 cu m	1 cu m = 1.31 CU yd
1 Cu ft = 0.02831 cu m	1 cu m = 35.30 Cu ft
1 cu in = 0.000016 cu m	1 cu m = 61,023 cu in

5. Weight

1 STON = 907.185 kg	1 kg = 2.2046 lb
1 LTON = 1016 kg	1 t = 1,000 kg
1 lb = 0.45359 kg	1 t = 2,204.62 lb
1 STON = 2,000 lb	1 LTON = 2,240 lb

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

- a. Inches to centimeters - Multiply inches by 10 and divide by 4.
- b. Yards to meters - Multiply yards by 9 and divide by 10.
- c. Miles to kilometers - Multiply miles by 8 and divide by 5.
- d. Pounds to kilograms - Multiply pounds by 5 and divide by 11.

7. The following conversions are provided for guidance when procuring lumber, wire rope, or wire in areas that use the metric system. Lumber sizes are rounded off to the nearest 1/2 cm.

a. Lumber

2-in x 4-in x desired length = 5-cm x 10-cm x desired length

1-in x 6-in x desired length = 2.5-cm x 15-cm x desired length

6-in x 8-in x desired length = 15-cm x 20-cm x desired length

1-in x 12-in x desired length = 2.5-cm x 30-cm x desired length

(length normally expressed in ft or m)

b. Wire rope. Round off to next higher whole mm of available wire rope sizes.

3/8-in dia = 9.5-mm dia

1/2-in dia = 12.7-MM dia

5/8-in dia = 15.8-MM dia

3/4-in dia = 19.0-mm dia

7/8-in dia = 22.2-mm dia

1-in dia = 25.4-mm dia

1-1/4-in dia = 31.7-MM dia

1-1/2-in dia = 38.1-MM dia

c. Wire. No. 8 gauge annealed (11/64-in dia) = 4.37-mm dia. Round off to the next higher whole mm of available wire rope sizes.

APPENDIX D

BFVS DISASSEMBLY/REASSEMBLY PROCEDURES FOR C-141 TRANSPORT

D-1. Introduction

The BFVS may be transported on a C-141 aircraft if it does not exceed a height of 103.7 inches, a width of 117 inches, and a total weight of 44,000 pounds. To meet this requirement, several items must be removed from the M2, M2A1, M3, and M3A1 vehicles. Even more items must be removed from the M2A2 and M3A2 vehicles.

This appendix gives detailed guidance on how to meet the requirements for an M2A2 vehicle. These guidelines can be adapted to meet the requirements for the different BFVS and the operational needs of the military unit.

To deploy M2A2 vehicles on a C-141, significant disassembly of the vehicles is required. This document details the specific disassembly and assembly procedures. The Immediate Ready Company (IRC) Mechanized Infantry Platoon is to disassemble and reassemble the BFVS unsupported except for what they carry with them. For optimum efficiency, the infantry platoon leader should divide the platoon into three teams—two hull teams and a turret team. Except where noted, the teams perform their tasks at the same time. The platoon deploys with a 6,000-pound forklift and operator from the Mechanized Support Battalion Supply Company and two portable A-frames and chain hoists (which are themselves disassembled for deployment) and a 2.5-ton hydraulic jack per M2A2.

Once disassembled, the BFVS components are shipped on USAF 463L pallets, labeled A and B. The A pallet consists of components that are required to render the vehicle combat capable. The platoon could, in an emergency, fight the BFVS after assembling only the A pallet items. The B pallet consists mostly of the armor plates, along with the remainder of the items to make the BFVS complete. Components are stored on both pallets with the heaviest items toward the center and the other items distributed evenly around the pallet allowing a 2-inch margin around the edge. Hard to identify items are numbered both on the part removed and on the place it goes on the M2A2 with a permanent marker. These numbers appear in the text. Obvious items, such as hatches, are not numbered.

Wherever possible, the text has been augmented with photographs of the IRC soldiers carrying out

the tasks and line drawings from the manuals.

D-2. Disassembly

Note: Before beginning disassembly, refer to tables 1 and 2.

1. *Front hull armor plate (a three-person operation).* Using two people, loosen lower front hull armor 15/16-inch bolts. Remove lower front hull armor. Reinstall four each lower front hull armor bolts for stability. Then loosen upper left front hull armor plate bolts while one person holds center plate in place with feet. Remove upper left plate. Remove 15/16-inch bolts from center plate and remove left center plate. Repeat steps for right side.

2. *Mine armor plate.* Insert hydraulic jack under vehicle and raise the jack to stabilize mine armor plate. Remove 15/16-inch bolts. Lower jack with three people holding plate in place and roll jack and plate out from under vehicle.

3. *25-mm battle/feeder and receiver assembly.* Unlock barrel lock in front of feed assembly. Twist barrel in opposite direction of arrow and remove. For feeder and receiver assembly, adjust barrel elevation to position 25 roils. Unlock feed tray mechanism. Use a two-person lift and twist receiver in a counterclockwise motion. Align the slotted indents with receiver lugs and slide receiver out, using an upward and out motion. Secure in black box, using straps. Screw cover onto box.

4. *Air intake grill.* Using two people and a hoist, loosen 3/4-inch bolts. Remove grill, making sure not to damage rubber seal.

5. *Engine access cover.* Using a three-person lift and a hoist, remove two each 3/4-inch bolts from the engine access door and install lift and eye mount. Loosen 15/16-inch bolts and remove engine access door (during the lifting of the engine access door, be careful not to damage the outer seal).

6. *Side skirt armor.* Three people are required for this job. Two hold the skirt in place while the third loosens the 11/16-inch bolts. The skirt is then removed by the two people holding it.

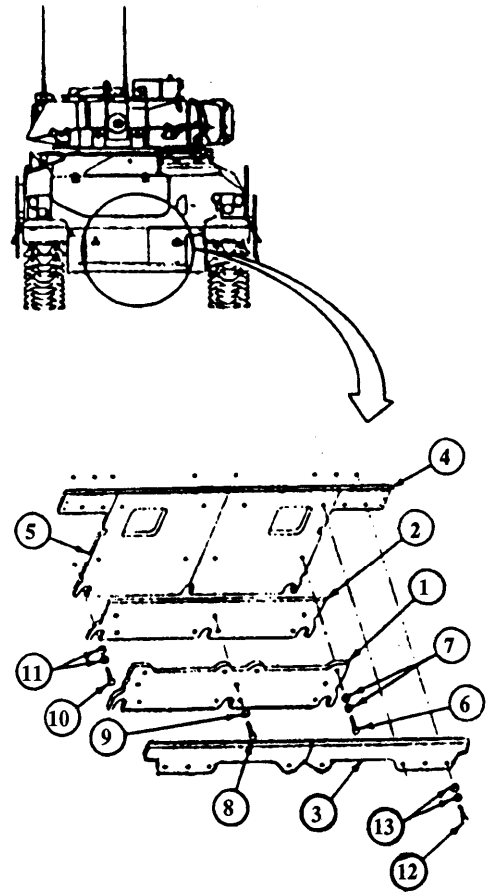
7. *Cargo hatch.* Using two guide people and a hoist, loosen 15/16-inch bolts and remove hatch slowly. Remove six each shims.

8. *Driver's hatch.* Using two guide people and a hoist, loosen three each 15/16-inch bolts and remove hatch slowly. Remove shims and spacers.

WARNING!



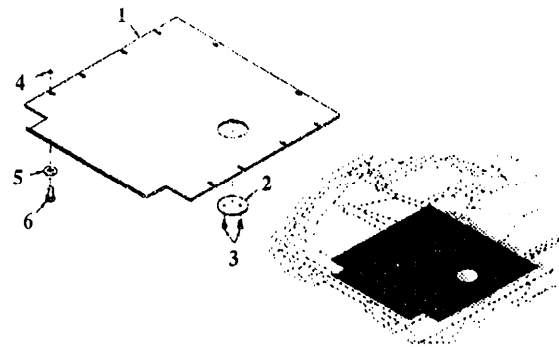
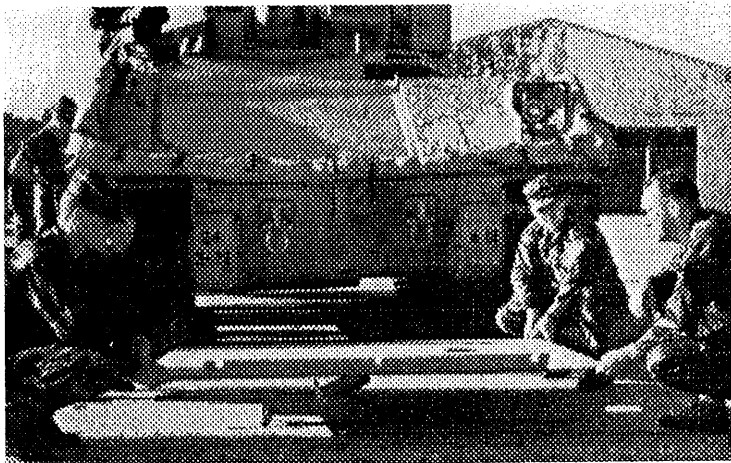
Lower front hull armor plate is heavy. It can fall and injure you if handled improperly. Be sure to have two helpers assist you when removing and replacing armor plate. Armor plate weighs 160 lbs. (72.7 kgs).



REMOVE LOWER ARMOR PLATES (1, 2, 3, and 5) FROM HULL. HAVE HELPERS ASSIST.

- a. Remove four screws (6) and eight washers (7) from armor plates (1 and 5) and hull.
- b. Remove seven screws (8), washers (9), and armor plate (1) from armor plate (2) and hull.
- c. Remove three screws (10), six washers (11), and armor plate (2) from hull.
- d. Remove 8 screws (12), 16 washers (13), and 6 armor plates (3, 4, and 5) from hull.

Figure D-1



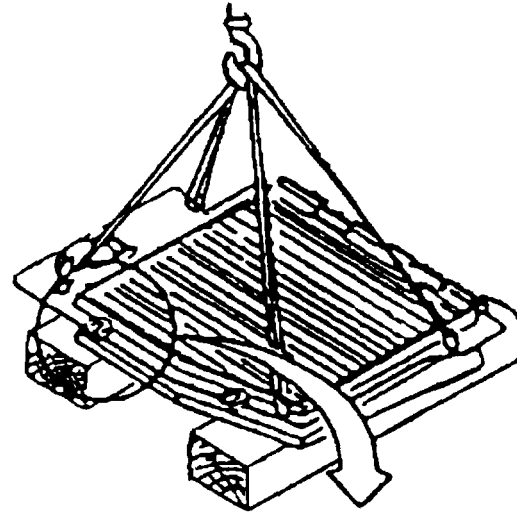
MINE ARMOR PLATE BEING REMOVED WITH 2-1/2 TON JACK

Figure D-2

- 9. *Gunner's and commander's hatch.* Using two guide people and a hoist, loosen the 3/4-inch bolts and remove hatch slowly. Remove box,
- 10. *Sponson boxes.* Disconnect electrical male and female connectors. Two people hold box in place, and one loosens 15 /16-inch bolts. Remove box,

- 11. *Front hull halfmoon armor.* Remove three each 3/4-inch bolts and remove plate.
- 12. *Headlight assemblies.* Loosen four each 9/16-inch bolts, disconnect electrical wires, and remove headlights,
- 13. *Maintenance platform.* Using a two-person lift,

**NOTE: 4 Lift Points
for air intake grill.**



CAUTION

Unprotected radiator can be damaged. If working near unprotected radiator, cover radiator with plywood cover.

IF NEEDED, PLACE PLYWOOD COVER (13) ON TOP OF RADIATOR (11).

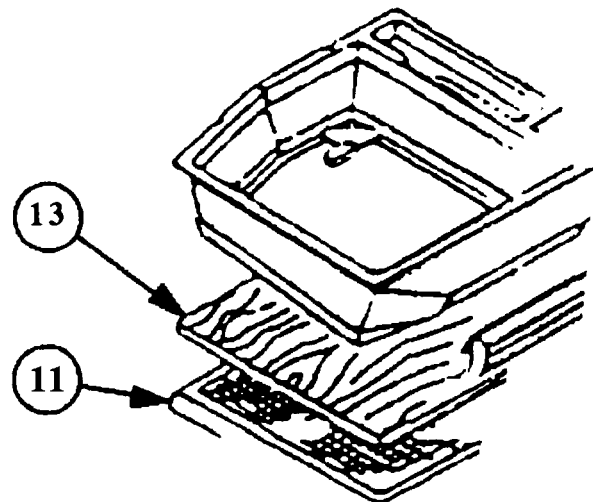


Figure D-3

loosen two each wing nuts and remove platform.

14. *Swim tripods.* Using two people, loosen straps and wing nuts and remove brackets.

15. *ISU ballistic cover.* Use a 12-inch adjustable wrench and disconnect two each cables. Remove five $\frac{3}{4}$ -inch screws. Using a two-person lift and a hoist, remove the cover.

16. *ISU.* Remove 14 $\frac{9}{16}$ -inch bolts. Using a two-person lift, remove ISU, being careful not to bump ISU, as this could knock it out of alignment or break the mirrors. Place in yellow ISU box and secure into position with bolts. Screw lid onto the ISU box. (Instructions for building an ISU box are given in table 3.)

17. *Backup and secondary sights.* Remove two each pins from secondary sight and remove sight. Then, remove four each allen head screws, three each $\frac{9}{16}$ -inch bolts, and backup sight tube assembly.

18. *Periscopes.* Remove $\frac{9}{16}$ -inch mounting bolts.

Take off each spacer and bracket and remove periscopes. Place eye covers over scopes.

19. *Matching unit.* Remove $\frac{9}{16}$ -inch bolts. Disconnect cables underneath matching unit and remove matching unit.

20. *Snub the vehicle:* Using railroad tie or like large piece of wood, run over each road wheel individually. Attach one each bracket, cable, and pin. Proceed until all 12 road wheels are snubbed.

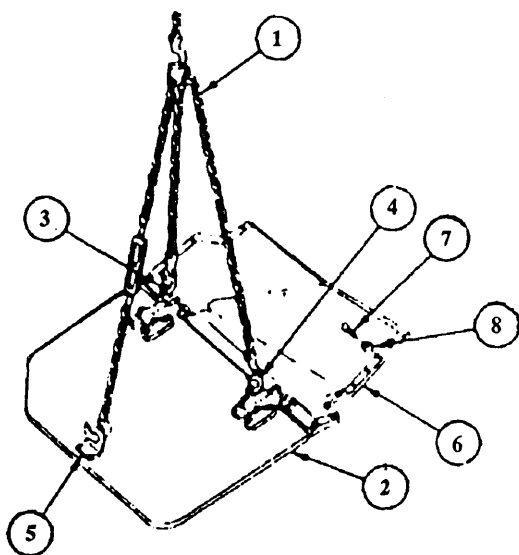
21. *Road wheels.* Using eight each 2 by 4's that are 6 inches long, place blocks in front of road wheels. Drive forward onto blocks. Remove $\frac{15}{16}$ -inch nuts and washers and remove road wheels. Reinstall nuts and washers with $\frac{15}{16}$ -inch deep well socket (so they do not get lost).

22. *Turret armor.* Using two or three people, remove $\frac{3}{4}$ -inch bolts and 8-mm allen head screws and remove turret armor. (Caution: Some plates are double plated and heavy!).

23. *Right side grenade launcher.* Loosen $\frac{3}{4}$ -inch

ATTACH TO ACCESS DOOR (2) AND LIFTING DEVICE. HAVE HELPER ASSIST.

- a. Install two shackles (3, 4) in two lifting eyes on access door (2).
- b. Install two non-adjustable legs of sling (1) to shackles (3, 4) on access door (2).
- c. Install adjustable leg of sling (1) on lifting eye (5).



WARNING!

Power unit bolted beam and access door can fall and injure you if not removed properly. Be sure lifting device is attached before screws are removed.

CAUTION:

Hydraulic parts can be damaged when supporting bolted beam assembly. Check that parts clear trestles before lowering bolted beam assembly. **DO NOT LOWER ON FLOOR.**

NOTE:

Screws are different lengths. Note proper lengths. Note proper location when removing screws. Some screws have multiple washers. Note number of washers with screws.

Figure D-4

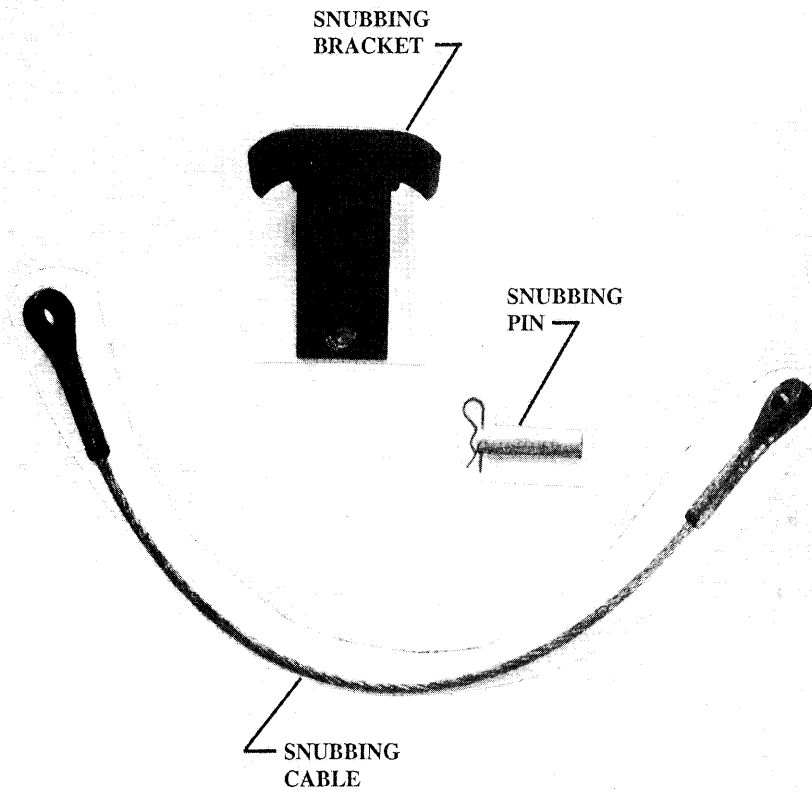
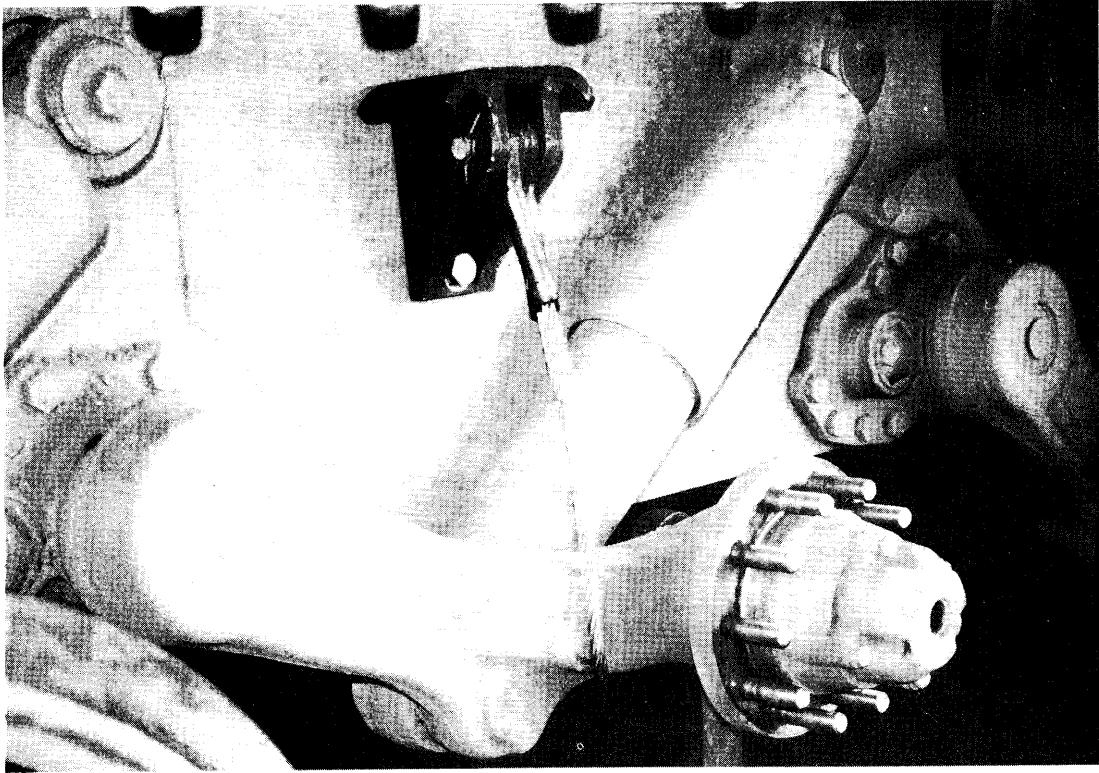
bolts. Loosen male to female ends and remove grenade launcher.

24. *Final drive half-moon plate* Remove four each

3/4-inch bolts and remove half-moon Plates

25. *Troop seats*. Remove pins and remove seats.

26. BII, Remove all BII and put in box.



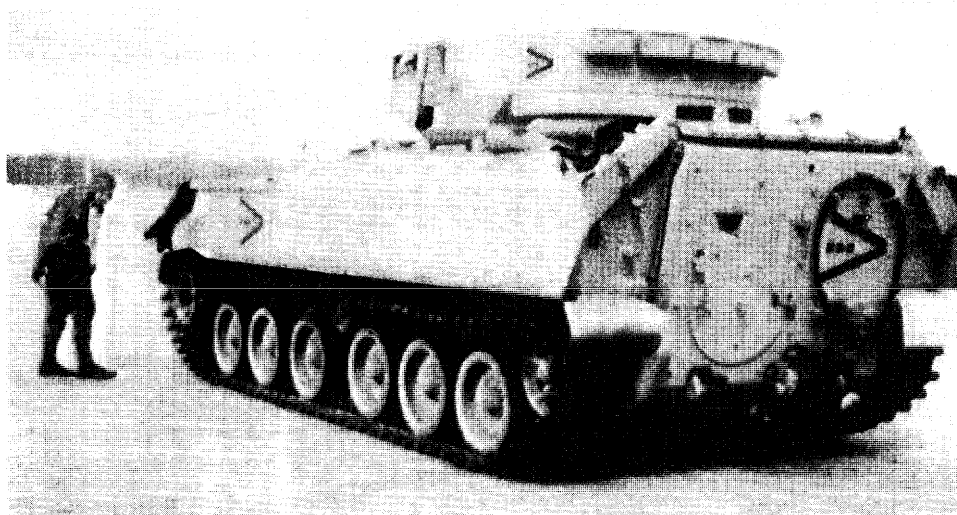
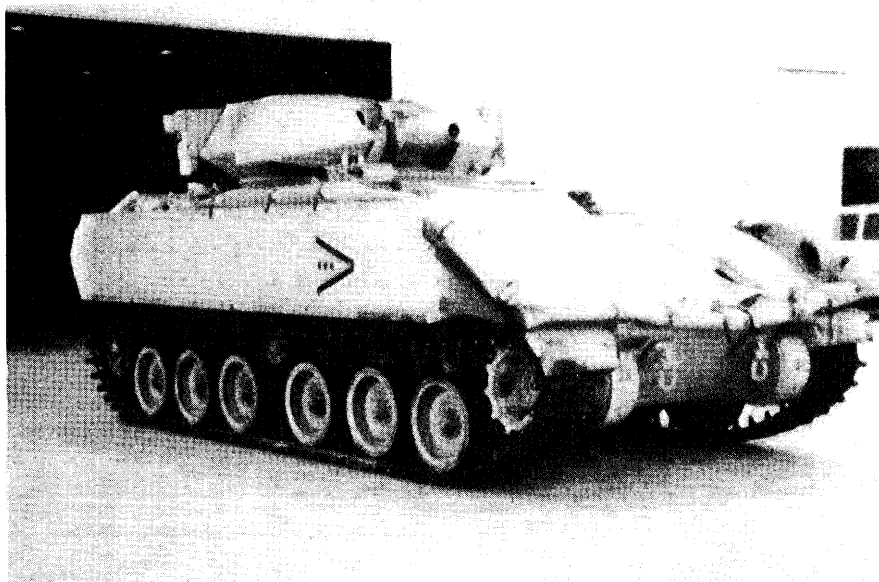
*Snubbing kit showing locally fabricated snubbing bracket, cable, and pin. (Alternate: restraining kit, part number 12307315.)
One kit per road wheel arm.*

Table 1. Disassembly/Reassembly Teams' Tasking

<i>Turret Team</i>	<i>Hull Team # 1</i>
25-mm gun assembly	Driver's hatch
Matching units	Cargo hatch
ISU	Engine access cover
ISU ballistic cover	Air intake grill
Gunner's and commander's hatch	Periscopes
Turret armor	Sponson boxes
Grenade launcher	Headlight assemblies
Backup and secondary sights	Swim tripods
Periscopes	Maintenance platform
	<i>Hull Team # 2</i>
	Road wheels
	Side armor
	Mine armor plate
	Lower front hull armor plates
	Front hull half-moon armor
	Troop seats
	BII
	Final drive half-moon plate

Table 2. Step-by-step Disassembly (Begin by placing 2 by 6-inch blocks under road wheels)

Component (Identifying Numbers)	Pallet
1. Front hull armor plates (300, 302, 303, 304, 305)	B
2. Mine armor plate (301)	B
3. 25-mm barrel and feeder and receiver assembly (306)	A
4. Air intake grill (307)	A
5. Engine access cover (308)	A
6. Side skirt armor (322-324, 326, 309-321)	B
7. Cargo hatch (327)	A
8. Driver's hatch	A
9. Gunner's and commander's hatch (329, 332)	A
10. Sponson boxes (330, 331)	B
11. Front hull half-moon armor (333, 334)	B
12. Headlight assemblies (335, 336)	B
13. Maintenance platform (337)	B
14. Swim tripods	B
15. ISU ballistic cover	B
16. ISU	A
17. Backup and secondary sights	A
18. Periscopes	A
19. Matching unit	A
20. Road wheels (center 4 each side)	A
21. Turret armor	B
22. Grenade launcher	B
23. Final drive half-moon plate	B
24. Troop seats	B
25. BII (after all steps are completed, snub vehicle)	A



Three views of the BFVS after disassembly and snubbing. Note compressed configuration and absence of external protrusions.

D-3. Palletizing M2A2 Components After Disassembly

1. Layout two each 463L aircraft pallets per M2A2, making sure that a 4-inch ground to pallet clearance is maintained to facilitate forklift use.
2. The placement of the load is set so that the heaviest items are centered flat and on the bottom. Stick the remaining pieces in the gaps and holes in a neat and orderly fashion, making maximum usage of all space available. Always ensure that a minimum of 2-inches is left between the edge of the load and the inner edge of the aircraft pallet. This permits aircraft personnel to walk around the edges of the pallets during flight and to recinch the load as necessary.
3. Lay a large sheet of plastic under the cargo netting and over the entire load of each pallet, making sure that the edges of the plastic are tucked in and under the edges of the load. This is not mandatory, but it does make the load more weather resistant.
4. To secure the load to the pallet, use one yellow (TOP) tiedown net and five tiedown straps on each pallet. The tiedown straps are arranged by laying two straps lengthwise and two straps widthwise, spread across evenly. The remaining strap is pulled around the diameter of the load and then all straps are cinched tightly.
5. When loading easily damaged items onto the pallets, either wrap or box them, or wrap and box them, and set them aside to be placed on top of remaining items to be palletized. When the item is very heavy or extremely flat (like the mine armor plate), it is to be placed on the bottom of the load, to reduce the effects and damages of being top-heavy and unbalanced. For example, the engine access cover has steel lines and rubber hoses for hydraulic lift assembly. These are easily damaged by crushing effects of loose or sliding armor plates. Therefore, the engine access cover needs to be placed on the bottom and shored with wood to protect the hydraulic lines.

D-4. Reassembly

Note: Before beginning reassembly, refer to tables 1 and 4.

1. Receiver and feeder assembly (a two-person operation). Unscrew all screws and take lid off black box containing the receiver and feeder assembly, Unhook straps inside box. With two people, one holding each end of the receiver and feeder assembly, take feeder and receiver out of the box, carry it into the turret of the M2A2, adjust the rails ring to 25 rails elevation, slide receiver in the direction, and align the slotted

indents with the receiver lugs and slide by using an upward and in motion.

2. 25-mm barrel (a two-person operation). Lift the barrel up, slide barrel into position, and twist barrel in the direction of the arrows. Once barrel is locked in place, check to see if barrel lock is locked by feeder assembly.
3. Matching unit (a one-person operation). Hook up ground wire, using a flat-tip screwdriver. Hook up coaxial cable. Using standard 9/16-inch screws, bolt down matching unit.
4. Road wheels (a two-person operation). Place six each 8-inch long 2 by 4 planks (taken from shoring used in aircraft) in front of road wheels. Drive the BFVS forward onto planks and unscrew bolts on road wheels. Put road wheels in place and screw bolts back in place, using a 15/16-inch deep well socket. Drive the BFVS off the boards.

****Note**

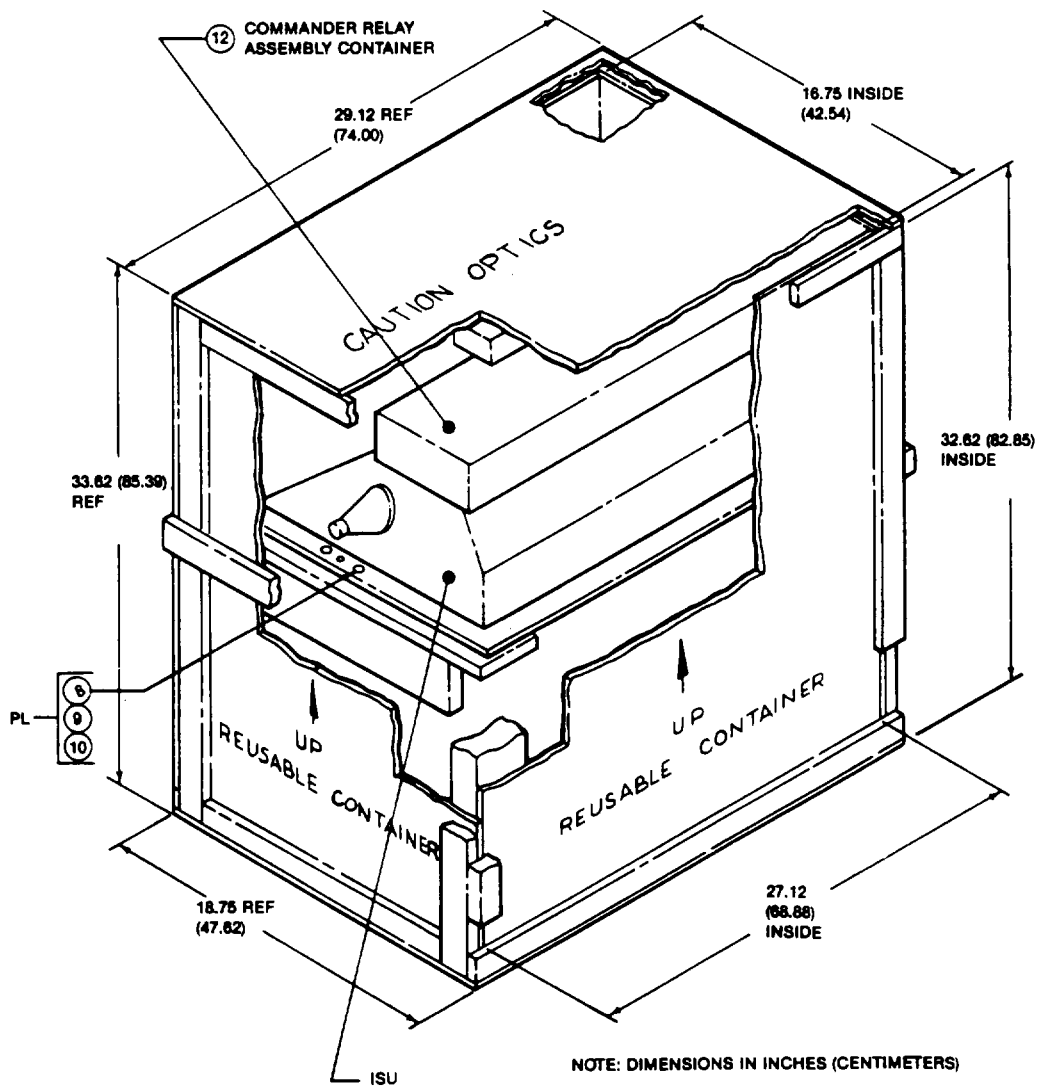
Unsnub the vehicle at this point by using railroad tie or like large piece of wood. Run over each road wheel individually, removing one each pin and clip, and remove cable. Proceed until all 12 road wheels are unsnubbed. This must be done between steps 4 and 14.

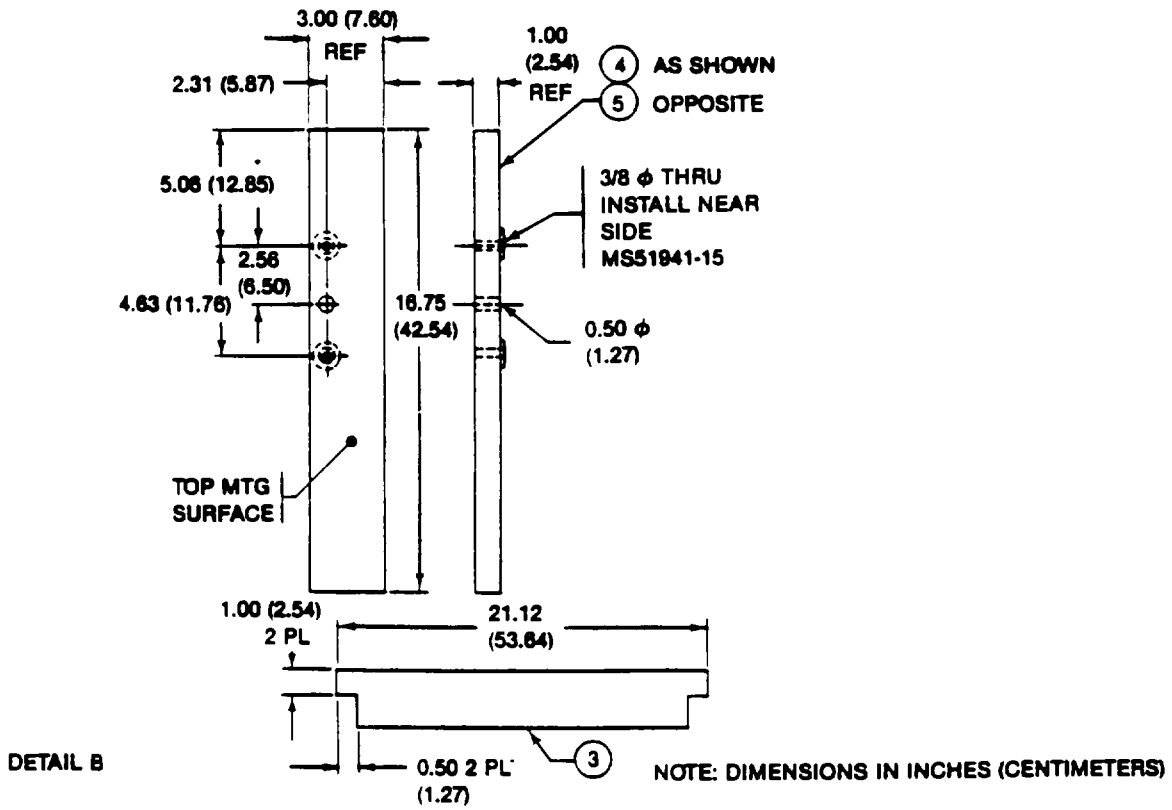
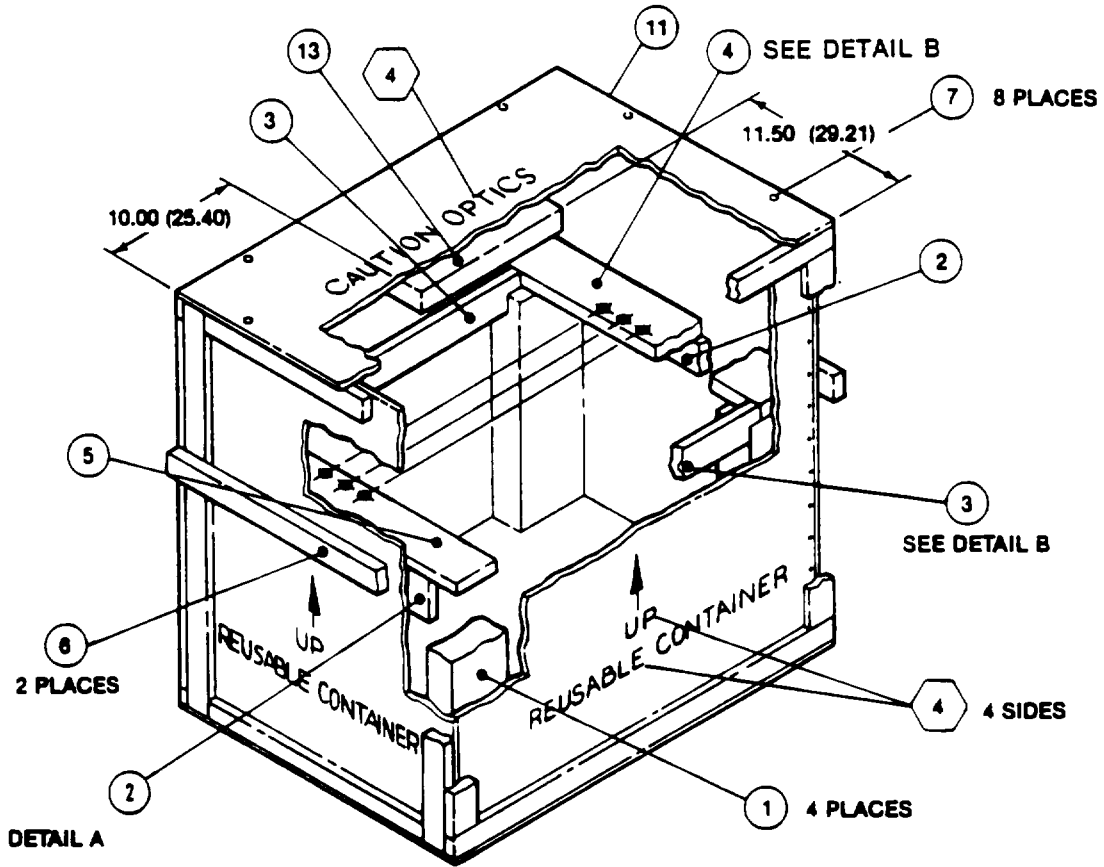
5. ISU and ballistic cover (a three-person operation). Unscrew all screws from the top of the yellow box containing the ISU, take lid off, and unscrew the four bolts holding the ISU in place. Take ISU out of yellow box. Using one person in turret to guide, slowly lower ISU into place. Using 9/16-inch wrench, tighten the 14 screws. (Caution: Be sure not to bump the ISU; it could be thrown out of alignment and the mirror could break.) For the ISU ballistic cover, using two guide people and the hoist, lower cover over ISU and align ballistic cover cables in proper places. Tighten cables with 12-inch adjustable wrench. Screw in and tighten the five 3/4-inch screws.
6. Drivers hatch (a two-person operation). Using two people as guides and the hoist, lower hatch into place. Using three 15/16-inch bolts, and shims plus spurs, tighten half way. Close hatch to make sure it locks, and finish tightening.
7. Gunner's and commander's hatch (a two-person operation). Using two people as guides and the hoist, lower hatch into place, placing shims under hatch, and then tighten the 3/4-inch bolts half way. Close hatch to ensure correct positioning, and complete tightening.
8. Cargo hatch (a two-man operation). Using two people as guides and the hoist, lower hatch into place. Use 15/16-inch bolts, spacers, and six each shims, tighten half way. Check hatch for placement, and complete tightening.

**Table 3. Application of Materials for Construction of Box for Integrated Sight Unit (ISU)
(Figures 4-2 and 4-3)**

Item No.	Required	Material
*1	4	Lumber, MIL-STD-731, Group I or II, 2 In. x 4 In. nom x 15 In.
*2	2	Lumber, MIL-STD-731, Group I or II 1 In. x 4 In. nom x 13 3/4 In.
*3	2	Lumber, MIL-STD-731, Group I or II, 1 in. x 4 In. nom x 21 1/8 in.
*4	1	Plywood, NN-P-530, 1 In. thk x 3 In. x 16 3/4 In.
*5	1	Plywood, NN-P-530, 1 in. thk x 3 in. x 16 3/4 In.
*6	2	Plywood, NN-P-530, 1 in. thk x 2 in. x 18 3/4 In.
7	16	Wood screw #10, 1 In. long
8	4	Hexagon head bolt, 3/8-16 UNC-2B x 2 In. long (MS90726-66)
9	4	Flat washer, 3/8 In. nom (MS27183-14)
10	4	Plate nut (MS51841-15)
11	1	Wood box, PPP-B-601, style 1, 27 1/8 In. long x 18 3/4 in. wide x 32 5/8 in. deep (Inside dimensions)
12	1	Commander relay assembly container: Wrap, MIL-A-121, Type II, Class 2, Grade A, 28 in. wide x 33 In. long (1 piece); Cushioning, PPP-C-843, quantity as required to fill all void areas of container; Container, PPP-B-636, Style RSC, Type CF, Grade W5C, Class Weather-resistant, 10 In. long x 6 In. wide x 28 in. deep (inside dimensions); Tape, for container sealing, PPP-T-60, Type III, Class 1, 2 in. wide x 33 in. long (2 pieces.)
13	1	Lumber, MIL-STD-731, Group I or II, 2 In. x 4 In. nom x 9 1/8 In.

* Nailing of lumber together and into container shall be per MIL-STD-1186.





ISU wooden box construction details.

Table 4. Pallet Load Plans

<i>Pallet A</i>	<i>Pallet B</i>
Air intake grill	Mine armor plate
Engine access cover with railroad tie	Side skirt armor
Receiver and feeder assembly in box	Lower front hull armor plates
Cargo hatch	Sponson boxes
Driver's hatch	Maintenance platform
ISU in box	Turret armor
Gunner's and Commander's hatches	Swim tripods
Road wheels	ISU ballistic cover
Bolt box	Grenade launcher
25-mm barrel	Front hull halfmoon armor
Litter	Final drive halfmoon armor
Each troop seats	Camouflage and poles box
MREs (six cases)	Troop seats
protective box:	
Sights	
Periscopes	
BII	
POL products:	
1 Gal GAA	
5 Qt GMD Turret	
1 Gal CLP	
3 Qt Hydraulic FRH	
4 Gal Antifreeze	
5 Qt 15/40 Oil	

9. Engine access cover (a three-person operation). Remove two each $\frac{3}{4}$ -inch bolts and put eye mount on door hatch. Using three people as guides and the hoist, guide engine access cover into position and tighten two each $\frac{3}{4}$ -inch bolts. Using 15/16-inch bolts, install armor and tighten bolts.

10. Air intake grill (a two-person operation). Using two people as guides and the hoist, guide grill into place (taking care to avoid damage to the rubber seal). Lower with hoist into place. Put four each $\frac{3}{4}$ -inch bolts on and tighten.

11. Turret armor (a minimum of two people on each piece). Place armor in positions with $\frac{3}{4}$ -inch bolts (or 8-mm allen head screws in some spots where armor is double plated). Be very careful, as armor is heavier than it looks.

12. Grenade launcher (a one-person operation). Place launcher into position. Tighten male to female ends and insert four each $\frac{3}{4}$ -inch bolts and tighten.

13. Mine armor plate (a three-person operation). Using a floor jack (provided) and a three-person lift, place armor plate onto jack. Roll jack under vehicle and raise until holes line up. Put 15/16-inch bolts in and tighten.

14. Final drive half-moon plate (a one-person operation). Put plates into position and tighten four

each $\frac{3}{4}$ -inch bolts (leaving one each bolt out of the left side for easy installment of front lower hull armor).

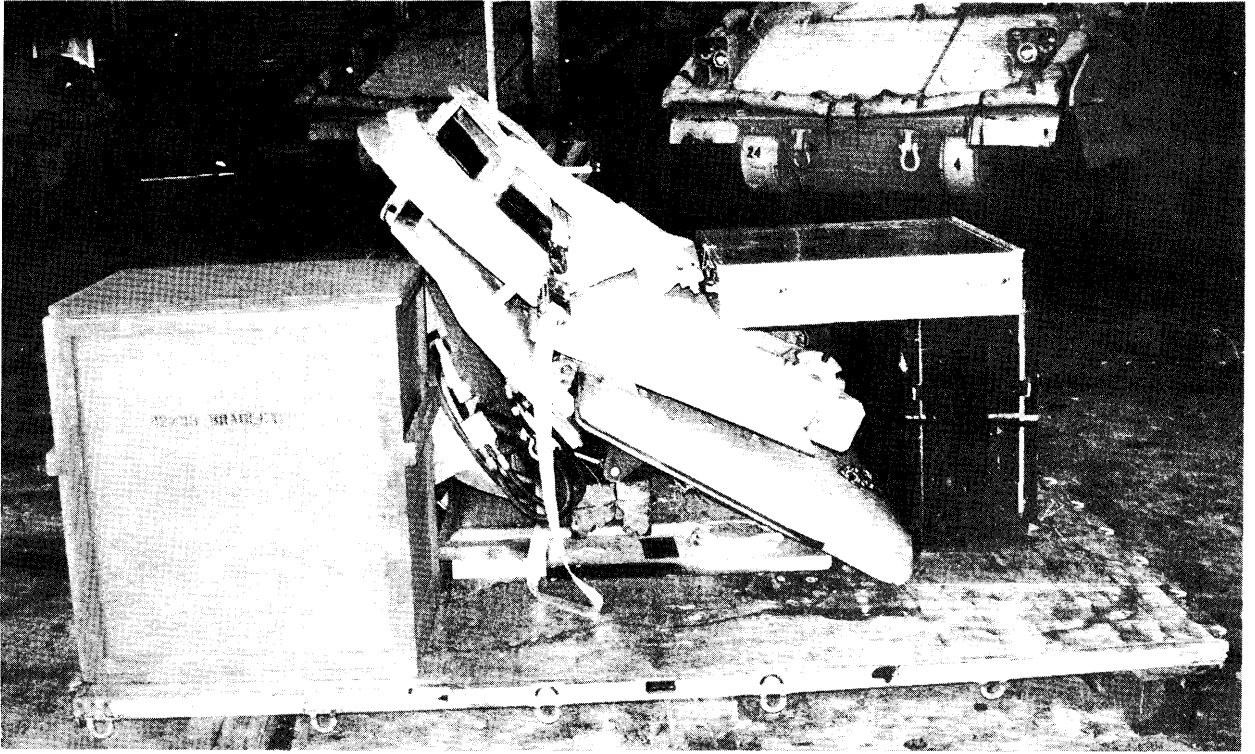
15. Lower front hull armor plate (a three-person operation). Using a three-person lift, place center left hull armor plate into position. One person positions plate with their feet, to allow the other person to put left side upper armor into position and put four each 15/16-inch bolts into place and tighten. Repeat steps for right side. Remove lower four each bolts and place lower front hull armor into place. Reinstall four each 15/16-inch bolts and tighten.

16. Side skirt armor (a two-person operation). Using a two-person lift, place each skirt into position. Use 11/16-inch bolts and tighten it down.

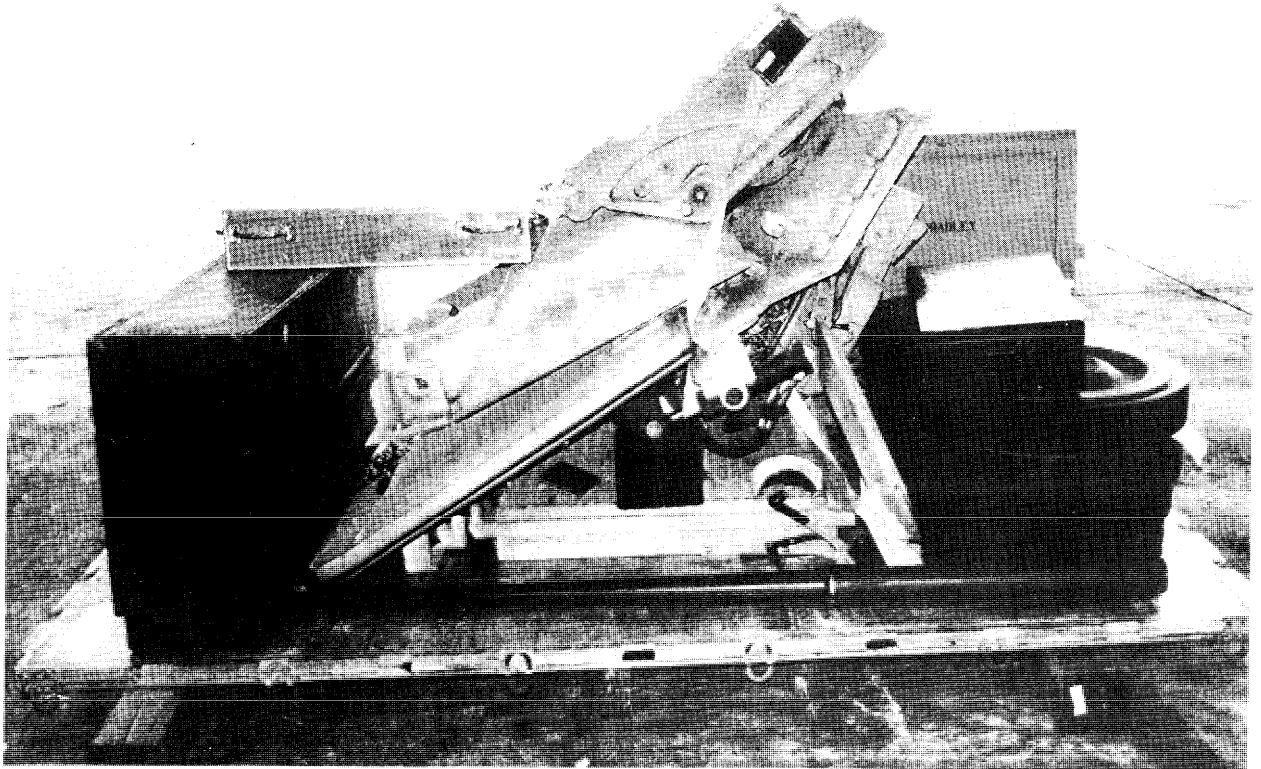
17. Periscopes (a one-person operation). Assemble velcro eye cover. Push periscope into place, place in bracket, and put spacer into place using 9/16-inch bolts. Tighten.

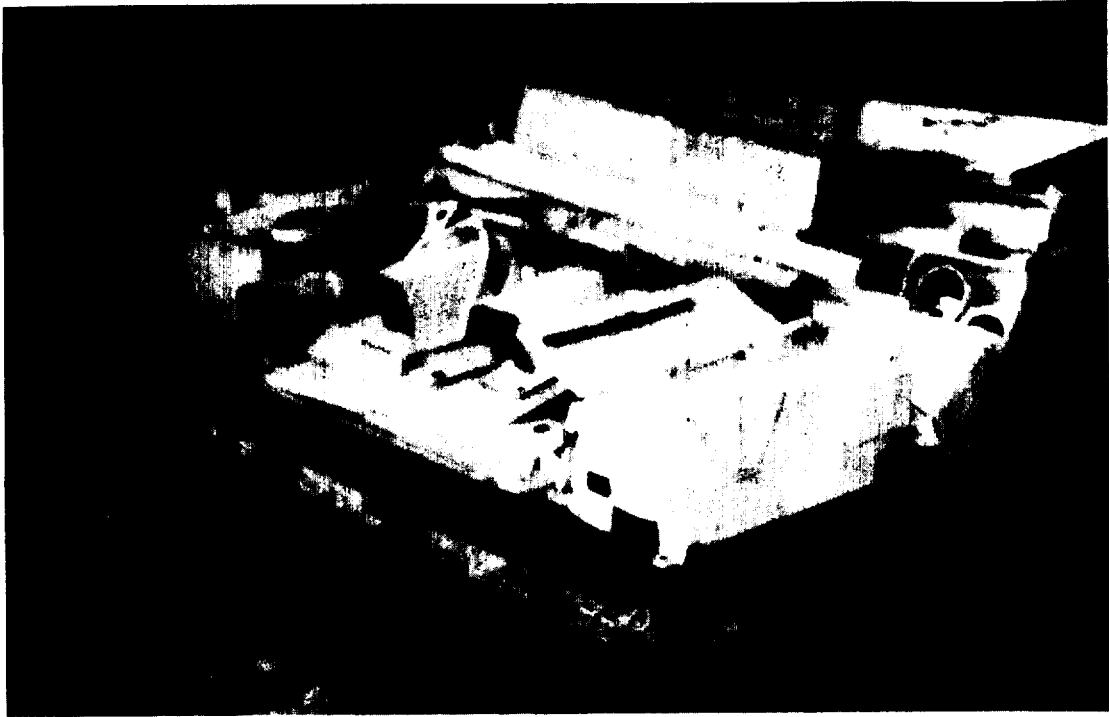
18. Backup sight and secondary sight (a one-person operation). Unwrap backup sight and place tube assembly into position. Tighten four allen head screws and three 9/16-inch bolts on top of turret. For the secondary sight, place sight up into position, and install two pins.

19. Front headlight assemblies (a one-person operation). Place headlights into position. Put four

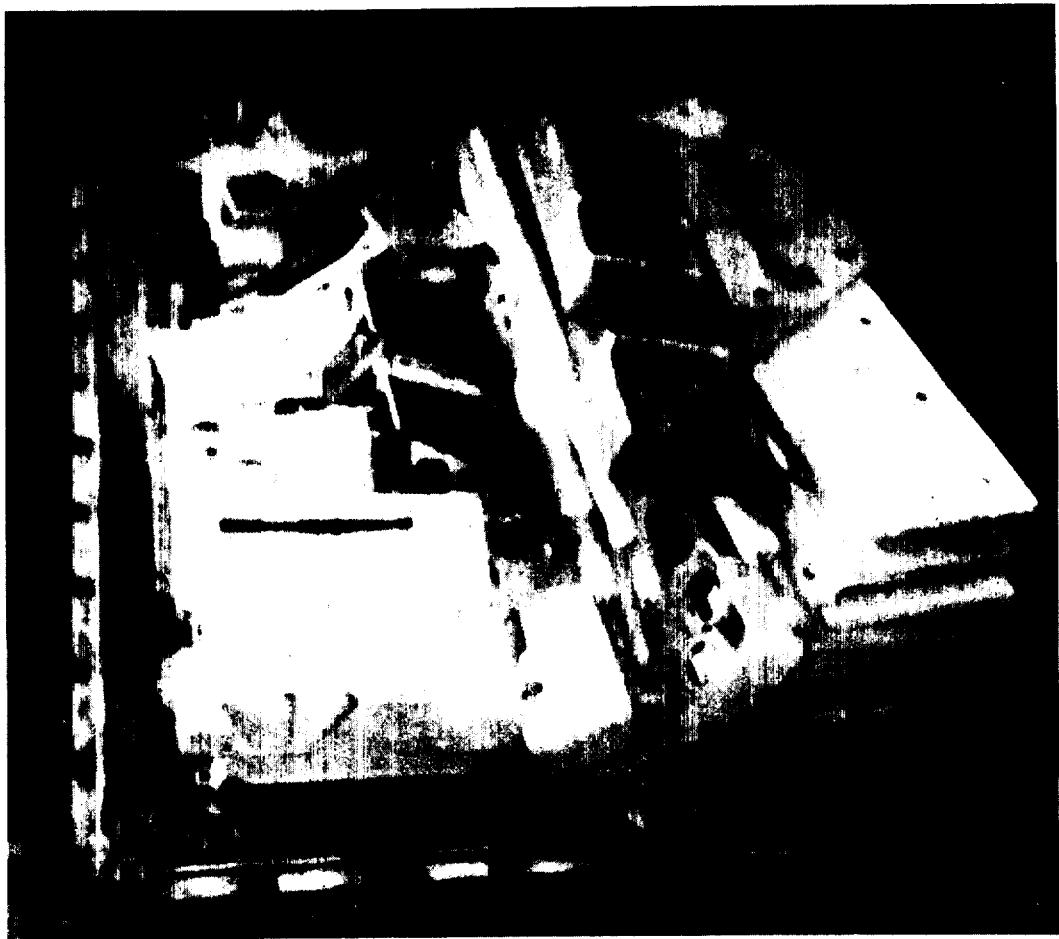


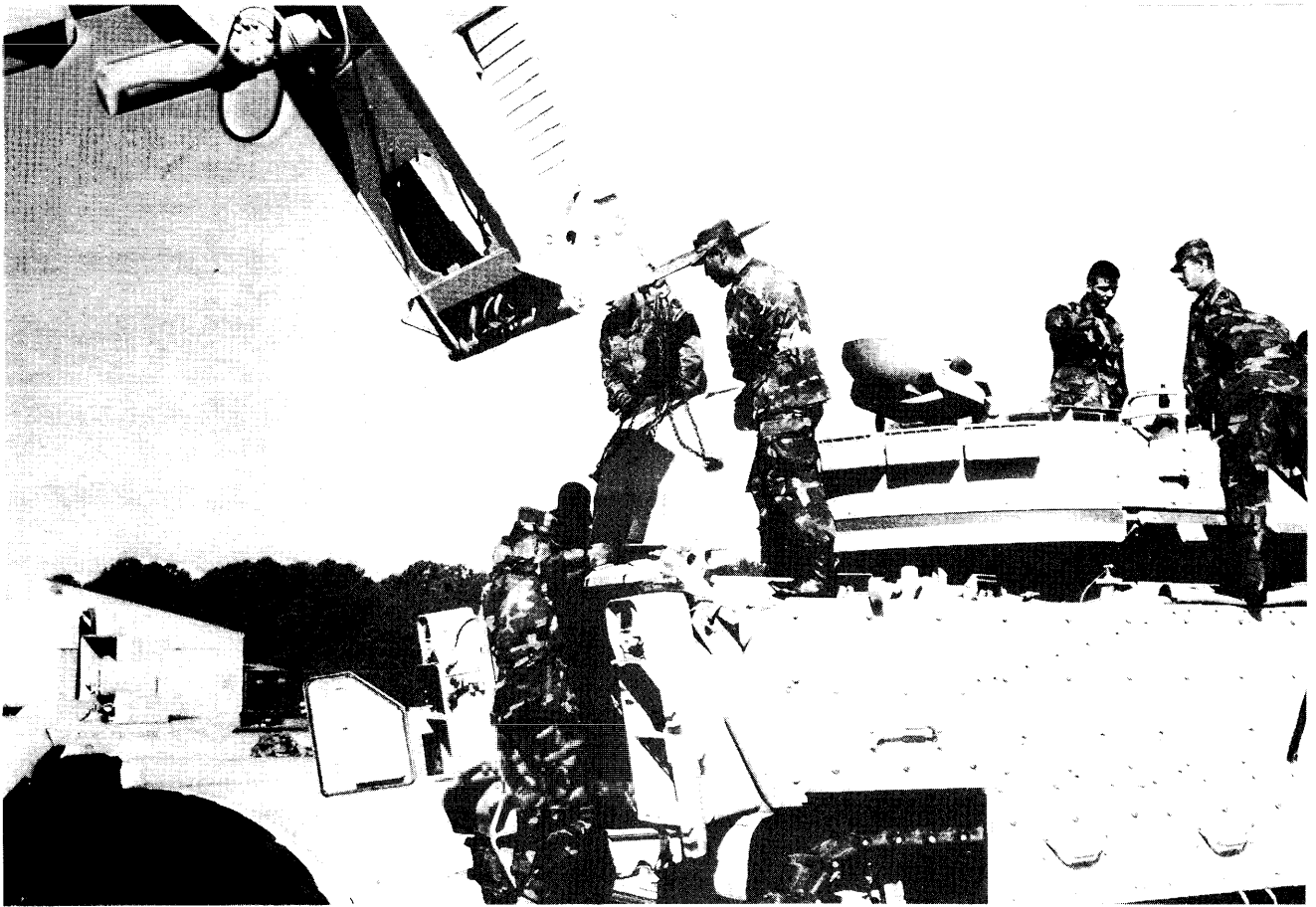
Two views of Pallet A. Note the silver box containing bolts, yellow box containing ISU, black box containing 25-mm gun receiver group, gun barrel on pallet, and stacking of engine access cover and cargo hatch on top of air intake grill to protect hydraulic lines on engine access cover.





Two views of Pallet B. Note the propensity of armor plates.





each 9/16-inch bolts in holes and tighten,
20. Rear sponson boxes (a two-person operation). Using a two-person lift, put box into position, while one person installs and tightens 15/16 inch bolts and connects male to female electrical wires, being sure to match label numbers.

21. Front hull half-moon armor. Using one-person, place armor into position. Use 3/4-inch bolts. Tighten.

22. Swim tripods, Using one person, place into bracket. Tighten straps and wing nuts.

23. Maintenance platform (a two-person operation). Using a two-person lift, place the platform into position, Tighten two wing bolts hand tight.

24. Troop seats, Place each seat into position. Slide pin into place,

25. BIL Unbox all BII and mount onto appropriate places.



6,000 Pound forklift lowers engine access cover into place, guided by IRC platoon soldiers. The A-frame can also be used to perform this operation.

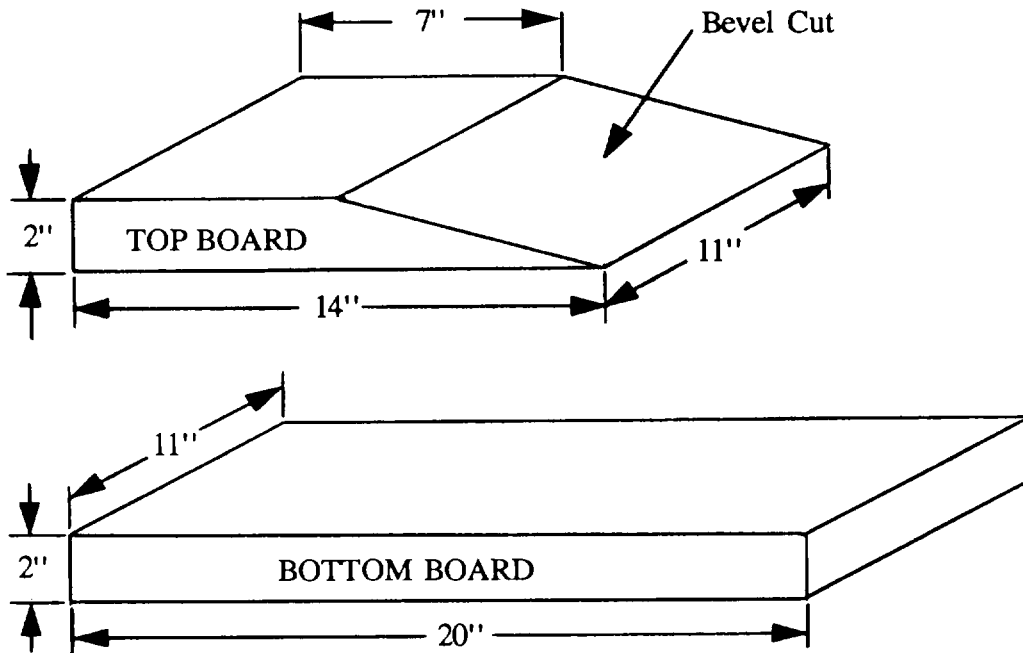
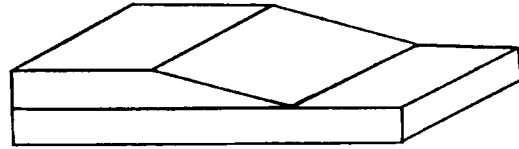
Table 5. Step-by-Step Reassembly (Begin by placing 2 by 6-inch blocks under road wheels)

Component (Identifying Numbers)	Pallet
1. Receiver and feeder assembly	A
2. 25-mm barrel/machinegun (306)	A
3. Matching unit	A
4. Road wheels	A
>Note: Unsnub the vehicle between steps 4 and 14	
5. ISU and ballistic cover	A/B
6. Driver's hatch	A
7. Gunner's and commander's hatch (329, 332)	A
8. Cargo hatch (327)	A
9. Engine access cover (308)	A
10. Air intake grill (307)	A
11. Turret armor	B
12. Grenade launcher	B
13. Mine armor plate (301)	B
14. Final drive half-moon plate	B
15. Lower front hull armor plate (300, 302-305)	B
16. Side skirt armor (322-324, 326, 309-321)	B
17. Periscopes	A
18. Backup sight and secondary sight	A
19. Front headlights (335-336)	B
20. Sponson boxes (330, 331)	B
21. Front hull half-moon armor (333-334)	B
22. Swim tripods	B
23. Maintenance platform (337)	B
24. Troop seats	B
25. BII	A

APPENDIX E

C-141 Ramp Shoring Kit Instructions

BEVEL CUT PEDESTAL SHORING



Start the bevel cut for the top board at the 7' mark.
Nail the top board to the bottom board using 6 each 10 penny nails.

TOP BOARD DIMENSIONS: 2" THICK X 11" W X 14" L.

BOTTOM BOARD DIMENSIONS: 2" THICK X 11" W X 20" L.

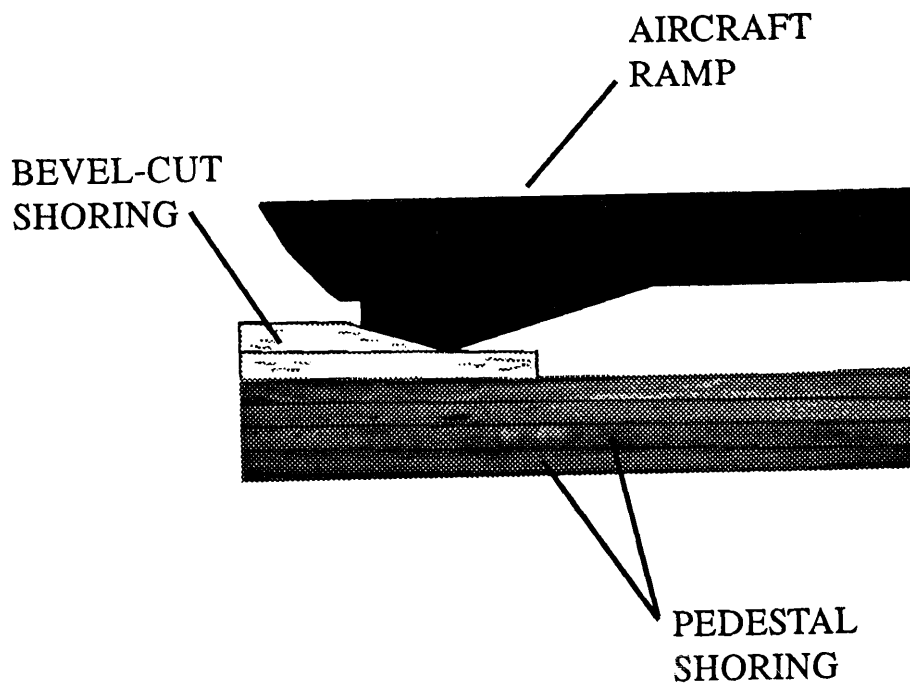
ALL DIMENSIONS ARE FOR COMMERCIAL GRADE LUMBER.

PAINT THE TOP AND BOTTOM OF EACH BOARD WITH A NON-SKID PAINT.

PAINT THE LAYER OF PEDESTAL SHORING DIRECTLY UNDER THESE TWO BOARDS WITH A NON-SKID PAINT.

THE SUGGESTED PAINT IS: "Walk Way Compound, "Common Non-Skid, Black, NSN 8010-00-641-0427.

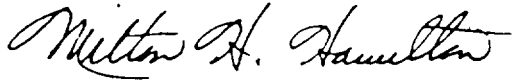
APPLICATION OF SHORING KIT



By Order of the Secretary of the Army:

GORDON R. SULLIVAN
General, United States Army
Chief of Staff

Official:



MILTON H. HAMILTON
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