

TECHNICAL MANUAL

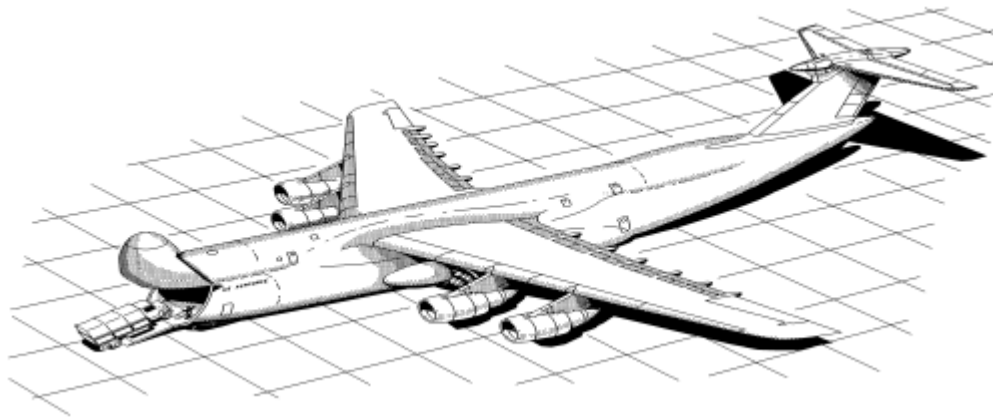
LOADING INSTRUCTIONS MANUAL

USAF SERIES

C-5M

AIRPLANES

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PREV

FOREWORD

PURPOSE.

The purpose of this foreword is to provide supplemental administrative information not contained in Chapter 1.

LIST OF RELATED PUBLICATIONS.

A list of publications referred to in this manual is given below. Refer to the current issue of the following Indexes of Technical Publications for the latest publication dates of technical orders: TO 0-1-1-1, Numerical Index and Requirement Table – General Technical Orders; and TO 0-1-35, Numerical Index of Technical Publications Ground Handling, Support and Air Base Operation Equipment Publications.

List of Related Publications	
Number	Title
TO 1C-5M-1	Flight Manual, C-5M Airplanes
TO 1C-5M-1CL-4	Loadmaster's Abbreviated Flight Crew Checklist
TO 1C-5M-2-2	Airframe
TO 1C-5M-5-1	Basic Weight Checklist
TO 1C-5M-5-2	Loading Data Manual
TO 1C-5M-9CL-1	Flight Crew Checklist, Loadmaster On/Off Loading Procedures
TO 1C-5M-9-2	Supplemental Loading Instructions Manual, Specific Procedures
TO 00-25-172	Ground Servicing of Aircraft and Static Grounding/Bonding
TO 1-1B-50	Basic Technical Order for USAF Aircraft Weight and Balance
AFMAN 24-204_IP	Preparing Hazardous Materials for Military Air Shipments
TO 37C2-8-1-127	Liquid Oxygen/Nitrogen Overboard Vent System

APPLICABILITY.

This manual provides coverage for C-5M airplanes.

- [A]** Text and illustrations designated by this symbol are applicable only to C-5M airplanes which were converted from C-5A airplanes.
- [B]** Text and illustrations designated by this symbol are applicable only to C-5M airplanes which were converted from C-5B airplanes.

ACRONYMS AND ABBREVIATIONS.

ADS	Aerial Delivery System	FS	Fuselage Station
AMC	Air Mobility Command	GSA	General Services Administration
ATOC	Air Terminal Operations Center	LEMAC	Leading Edge of MAC
BL	Butt Line	LSA	Load Shift Arm
CB	Center of Balance	LSW	Load Shift Weight
CG	Center of Gravity	MAC	Mean Aerodynamic Chord
CGFA	CG from Front Axle	PLF	Pounds per Linear Foot
CGFE	CG from Front End	RS	Ramp Station
CRW	Contingency Response Wing	SCM	Space Cargo Mission
ETIMS	Enhanced Technical Information Management System	WL	Water Line

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CHAPTER 1

INTRODUCTION

1.1 PURPOSE.

The purpose of this manual is to provide cargo handling personnel with sufficient information and data to load, secure, and offload all types of cargo efficiently and safely and to explain the restrictions governing these operations. Specific procedures pertaining to ground functions, and the Space Cargo Mission (SCM) airplanes are contained in supplemental manuals.

1.2 SCOPE.

This manual contains descriptions and physical characteristics of cargo items and the handling equipment used. Procedures are included for preloading, loading, postloading, preflight, and off loading for general types of cargo. This manual includes procedures pertaining to ground functions only.

1.2.1 Serialization. When it becomes necessary in this manual to differentiate among airplanes, reference will be made to the Air Force serial number.

C-5M Serialization		
Source Airplane Model	AF Serial Number	Contract End Item
C-5A	AF69-024	055
C-5A (SCM)	AF68-213	016
	AF68-216	019
C-5B	AF83-1285	0082
	AF84-0060 — AF84-0062	0084 – 0086
	AF85-0001 — AF85-0010	0087 – 0096
	AF86-0011 — AF86-0026	0097 – 0112
	AF87 0027 — AF87-0045	0113 – 0131

1.2.1A Applicability. This manual provides coverage of C-5M and C-5M (SCM) airplanes. For C-5M (SCM) airplanes also refer to the TO 1C-5M-1-2. Text and illustrations without the following applicability symbols apply to all series airplanes.

- A** Text and illustrations designated by this symbol are applicable only to C-5M airplanes which were converted from C-5A airplanes.
- B** Text and illustrations designated by this symbol are applicable only to C-5M airplanes which were converted from C-5B airplanes.
- S** Text and illustrations designated by this symbol are applicable only to C-5M (SCM) airplanes.
- ES** Text and illustrations designated by this symbol are applicable only to C-5M aircraft except C-5M (SCM) airplanes.

1.2.1.1 Deleted.

1.2.1.2 Deleted.

1.3 PERMISSIBLE OPERATIONS.

This manual takes a positive approach and normally states only what you can do. Unusual operations or configurations are prohibited unless specifically covered herein. Clearance from higher headquarters must be obtained before any questionable operation, which is not specifically permitted in this manual, is attempted. Waivers shall be obtained through appropriate command channels from AFLCMC/WLSA, 235 Byron St., Suite 19A, Robins AFB, GA 31098-1670, before any operation is attempted that exceeds the limits contained in this manual.

1.3.1 Damaged Equipment. Loadmasters shall only load damaged equipment (e.g., damaged helicopters or vehicles missing major components, nose gear, main gear, etc.) after they receive specific nonstandard loading procedures outlined in an Air Force certification letter from ASC/ENFC at Wright-Patterson AFB.

1.4 HOW TO BE ASSURED OF HAVING LATEST DATA.

Refer to Enhanced Technical Information Management System (ETIMS) or the AF TO Catalog for current status of flight manuals, safety supplements, operational supplements, and flight crew checklists. If you are not coming from a.mil site, you must use the TO 0-1-CD-1 to obtain catalog information. Also, check the flight manual cover page, the title block of each safety and operational supplement, and the latest status page contained in the manual or the latest safety or operational supplement. Clear up all discrepancies before flight.

1.5 ARRANGEMENT.

This manual is divided into six chapters.

1.5.1 Chapter 1 – INTRODUCTION. This chapter presents the purpose, scope, arrangement of the manual, and the type of aircraft, series, and model designation.

1.5.2 Chapter 2 – DESCRIPTION OF AIRPLANE FEATURES. This chapter presents a general description of the cargo compartment, including profile and cross sections, cargo loading ramps, entrances and exits, cargo floor, roller conveyors and guides, restraint rails, tiedown fittings, seat and litter provisions, cargo loading aids, and storage provisions for all cargo loading aids and tiedown devices. This chapter also describes emergency provisions, cargo doors, visor door, cargo loading aids, airplane kneeling system, troop compartment, stairways, and special mission kits.

1.5.3 Chapter 3 – AIRPLANE CONFIGURATION. This chapter contains instructions and procedures for preparing the airplane for loading, installation of cargo tiedown devices, and connection of the cargo compartment vents. Operational procedures are included for the following systems and components:

- Logistics cargo restraint rails and roller conveyors

1.5.4 Chapter 4 – GENERAL PROCEDURES. This chapter is divided into five sections which provide specific information and procedures for load planning, charts and graphs, load methods and restraint, winching procedures, and loadmaster on/off loading procedures.

1.5.5 Chapter 5 – EMERGENCY PROCEDURES. This chapter describes all ground preparation required for cargo emergency procedures.

1.5.6 Chapter 6 – SPECIFIC PROCEDURES. This chapter has been replaced by supplemental manual TO 1C-5M-9-2, Supplemental Loading Instructions Manual, Specific Procedures. TO 1C-5M-9-2 contains all necessary instructions relative to preloading, loading, postloading, preflight, and offloading procedures for cargo which, due to physical characteristics, cannot be handled in accordance with the general procedures of Chapter 4 and therefore requires special handling.

1.6 SAFETY AND OPERATIONAL SUPPLEMENTS.

Safety Supplements are issued as an expeditious means of reflecting safety information when hazardous or safety conditions exist. These supplements contain operational, precautionary, and restrictive instructions that affect safety and safety modifications. Operational Supplements are issued as an expeditious means of reflecting information when mission essential operational procedures are involved. Supplements are issued electronically or by printed copy (formal) depending upon the urgency. Interim supplements are usually formalized and replaced with a new number within 40 days. Formal printed supplements are identified by red letters SS for Safety Supplements and black letters OS for Operational Supplements printed around the borders of the title pages. All supplements use the same numbering system; however, a Safety Supplement can also be identified by the SS preceding the number. Operational Supplement numbers are preceded by a single S. Current supplements must be complied with. A Loading Instructions Manual and Supplement Status page is furnished with each formal safety and operational supplement to help you to be constantly aware of the status of all supplements. Since these status pages can only be as current as the associated publications, it is also necessary to refer to the appropriate index. File your supplements in reverse numerical order in front of the manual; i.e., put the latest supplement on top, regardless of whether it is a Safety or Operational Supplement.

1.7 CHECKLIST.

The loading manual contains an amplified checklist for on/off loading general cargo and vehicles. This checklist is in Chapter 4, Section V. An abbreviated checklist containing these checks is issued as a separate technical order. See the list of effective pages in this manual and the latest status page for current applicable checklists. Whenever a supplement affects the checklist, a replacement checklist page will normally be included in the supplement.

1.8 HOW TO GET INDIVIDUALLY ASSIGNED COPIES.

Each loadmaster is entitled to individually assigned copies of the loading manuals, supplements, and checklists. Check with your TO distribution office; it is their job to fulfill your technical order requests.

1.9 MANUAL BINDERS.

Loose leaf binders and sectionalized tabs are available for use with your manual and checklists. They are obtained through local purchase procedures and are listed in the General Services Administration (GSA) Supply Catalog (FSN 7510, Office Products). Check with your supply personnel for assistance in securing these items.

1.10 DEFINITIONS.

1.10.1 Word Usage. The following definitions apply to the use of the words shall, should, may, and will:

Shall:	Used to express a provision that is binding or mandatory.
Should:	Used to express a nonmandatory provision. Can be construed as a preferred method of accomplishment.
May:	Used to express a nonmandatory provision. Can be construed as a suggested means of accomplishment.
Will:	May be used as a declaration of purpose. It may be necessary to use in cases where simply futurity is required.

1.10.2 Warnings, Cautions, and Notes. Warnings, cautions, and notes are used in this manual to emphasize important or critical instructions. The following definitions apply to warnings, cautions, and notes found throughout the manual.

WARNING

- Operating procedures, techniques, etc., which could result in personal injury and/or loss of life if not carefully followed.
- Bullets are used to indicate multiple warnings.

CAUTION

- Operating procedures, techniques, etc., which could result in damage to equipment if not carefully followed.
- Bullets are used to indicate multiple cautions.

NOTE

- An operating procedure, technique, etc., which is considered essential to emphasize.
- Bullets are used to indicate multiple notes.

1.10.3 Change Symbols. Text changes or additions on each new page are indicated by a vertical line, opposite the text line changed. Changes to existing illustrations are indicated by a miniature hand pointing to each changed area. New illustrations or new sheets added to an existing illustration have no change hands.

1.10.4 Use of Capital Letters. Control or switch positions and placarded names of items are identified by the use of capital letters. Example: Place the RAMP OPERATE switch in the OPEN position.

1.11 YOUR RESPONSIBILITY TO LET US KNOW.

Every effort is made to keep this manual current. Review conferences with operating personnel and constant review of accident and flight test reports, assure inclusion of the latest data in the manual. We cannot correct an error unless we know of its existence. In this regard, it is essential that you do your part. Comments, corrections, and questions regarding this manual, or any phase of the flight manual program, are welcome. These should be forwarded on AF Form 847 as directed by AFI 11-215 through your command headquarters: Aircrew Standardization/Evaluation to AFLCMC/WLSA, 235 Byron St., Suite 19A, Robins AFB, GA 31098-1670. Critical Hazard Reports should be submitted via message to HQ AMC SCOTT AFB IL//A3V// with information addressee of AFLCMC/WLSA, 235 Byron St., Suite 19A, Robins AFB, GA 31098-1670.

CHAPTER 2

DESCRIPTION OF AIRPLANE FEATURES

2.1 AIRPLANE FEATURES.

2.1.1 Airplane Design. The C-5 airplane is designed for long range transportation of troops and cargo. The airplane is an all metal, high swept-back wing, T-tail design, powered by four pylon-mounted CF-6 turbofan engines.

2.1.1.1 Some of the airplane special features include the following:

- Front and aft loading capability
- Landing gear kneeling system
- High flotation landing gear
- Forward and aft ramps which can be positioned for truck bed height or drive on/off loading
- Separate relief crew, courier, and troop compartments

2.1.2 General Airplane Features. The airplane is designed for forward and aft on/off loading. On/off loading is facilitated by the full width load bearing floors, forward hinged visor door, aft cargo doors and the landing gear kneeling system. Forward entry is made through the visor door and aft entry is made through the aft cargo doors for on/off loading of cargo. On/off loading can be accomplished directly from truck, or from the ground. Simultaneous on/off loading can be made through the forward and the aft ends of the airplane with the doors open and the ramps lowered.

2.1.2.1 General and palletized cargo, vehicles and outsize cargo can be secured and transported in the cargo compartment.

2.2 TYPICAL CARGO AND TROOP LOADS.

2.2.1 Troop Loads. Seventy-three troops and two loadmasters can be carried in the troop compartment. The two forward facing seats shall be occupied by the loadmasters.

2.2.2 Cargo Loads. For allowable cargo loads, refer to TO 1C-5M-1.

2.3 SEATING.

The airplane can provide a total of 95 seats. Seating arrangements in the various compartments are as follows:

- Troop compartment: 75 seats
- Flight station and relief crew or courier compartment: 20 seats

The student/instructor seat kit provides two additional seats in the flight station.

2.4 RELIEF CREW OR COURIER COMPARTMENT.

The relief crew or courier compartment provides seating, comfort provisions, galley facilities, oxygen provisions, and baggage facilities for 15 personnel (including the relief crew). Bunks are provided for crew rest.

2.5 CARGO AREA.

2.5.1 Cargo Compartment Envelope. (See Figure 2-1.) The cargo compartment extends from Fuselage Station (FS) 395 to FS 2131. The compartment, excluding the forward and aft cargo ramps, is a constant, cross-sectional shape extending from FS 511 to FS 1976. The cargo compartment height is reduced between FS 395 to FS 511 and FS 1976 to FS 2131 due to the upward inclination of the ramps when they are in the closed position.

2.5.1.1 Compartment Dimensions. The overall dimensions of the cargo compartment are shown in Figure 2-1. The cross-sectional views in this figure show the compartment dimensions and shape of the compartment between FS 511 and FS 1976.

Some dimensions may be critical for on/off loading specific types of cargo discussed in this manual. The aft on/off loading opening can be reduced depending upon the kneeled position of the airplane. The height of the cargo compartment opening is reduced to 114 inches when the pressure door, aft cargo ramp and doors are positioned for truck loading.

2.5.2 Cargo Compartment Electrical Outlets and Power Supply. (See Figure 2-2.) Seven 28-volt DC service receptacles and fourteen 115/200-volt AC, 400 Hz, 3-phase service receptacles are provided in the cargo compartment for operation of equipment that may be needed in the airplane. The Monitor 2 bus provides AC, 70-ampere power to the forward cargo winch compartment outlet and two forward buffet/lavatory unit outlets on the right side of the cargo compartment. In addition, this bus provides AC, 35-ampere power to four service outlets on the left side of the cargo compartment. The Monitor 3 bus provides AC, 70-ampere power to two aft buffet/lavatory unit outlets on the right side of the cargo compartment. In addition, this bus provides AC, 50-ampere power to the aft winch compartment and four service outlets on the right side of the cargo compartment. The Main DC bus No. 1 provides DC, 35-ampere power to four service outlets on the left side of the cargo compartment. The Main DC bus No. 2 provides DC, 35-ampere power to three service outlets on the right side of the cargo compartment. The following is a list of part numbers for service receptacles and plugs:

Type of Outlet	Part Number	
	Receptacle	Plug
Buffet, 115/200-VAC, 3-Ph	NSN-5935-00-853-2537	NSN-5935-00-201-8373
Service, 28-VDC	NSN-4820-00-216-9048	NSN-5935-00-259-0823 or NSN-5935-00-522-2577
Service, 115/200-VAC, 3-Ph	MS3100R18-10S	NSN-5935-00-199-2622 or NSN-5935-00-199-2623
Winch, 115/200-VAC, 3-Ph	NSN-5935-00-853-2537	NSN-5935-00-201-8373

2.5.3 Cargo Compartment Interphone and Public Address Facilities. Refer to TO 1C-5M-1 for interphone and public address systems operating instructions.

2.5.4 Troop Jump Signal Lights. Troop jump signal lights, consisting of a red and a green light, are installed on the left and the right sides of the cargo compartment at the left and right troop door areas. There are two sets of lights on each side of the cargo compartment; one set is located at FS 1844 and Water Line (WL) 195 and the other at FS 1844 and WL 220. The lights are controlled by two JUMP SIGNAL switches on the navigator Aerial Delivery System (ADS) control panel and by two JUMP SIGNAL switches on the copilot side console. Light brilliance is controlled by a TROOP JUMP, DIM-BRT toggle switch on the loadmaster aft control panel on the left side of the cargo compartment.

2.5.5 Cargo Compartment Lighting. (See Figure 2-3.) The cargo compartment is provided with lights for general illumination, floodlighting of the forward and aft ramp areas, and emergency exit. The lights (except emergency exit) are controlled from the loadmaster forward and aft control panels.

2.5.6 Cargo Compartment Vents. (See Figure 2-4.) Seven overboard vents are provided in the cargo compartment for overboard venting of fumes and vapors. The vents are for connection to items of cargo carried in the airplane requiring cryogenic venting, or to exhausts of vehicles or internal combustion engines that may be operating in the cargo compartment. The cryogenic vents are on the left side of the cargo compartment at FS 734, FS 1219, and FS 1779, all at WL 200. The exhaust vents are on the right side of the cargo compartment at FS 594, FS 734, FS 1219, and FS 1779, all at WL 200.

2.5.6.1 Each vent consists of a tube extending through the sidewall of the cargo compartment, a sealing plug, and a coupling. In use, the sealing plug is removed from the vent tube and the coupling is used to secure a cryogenic vent nozzle to the vent tube. When not in use, the coupling secures the sealing plug inside the vent tube to prevent loss of air during pressurized flight. The sealing plug is attached to a chain at each vent for easy accessibility. When not in use, the three cryogenic vent nozzles are stored in the LH stowage box at FS 1774. An exhaust nozzle, which can be inserted through the right side vent tube, is stowed at each of the right side vents. When installed, the nozzles direct the exhaust of engines into the airstream away from the side of the fuselage.

2.5.7 Cargo Compartment Floor. (See Figure 2-5.) The cargo compartment floor consists of a series of flush-fitting, interlocking, stiffened aluminum panels that extend from FS 511 to FS 1976. The usable floor is 121 feet, 2 inches long and 19 feet wide and is a full-width, load-bearing structure; extending from FS 517 to FS 1971. Recessed coves, for the support and stowage of the roller conveyors and the inboard logistics rails, run the entire length of the floor. There are 304 tiedown locations designed for maximum flexibility. The individual 25,000-pound capacity tiedowns are recessed into the floor panels at a regular spacing of 40 inches between FS 664 and FS 1064, and between FS 1724 and FS 1964. The tiedowns between FS 1064 and FS 1724 follow an irregular pattern of between 30 and 50 inches. The tiedowns between FS 524 and FS 604 also follow an irregular pattern of 54 to 34 inches. A continuous line of ball studs is recessed into the cargo floor for installation of

the ADS rails. The ball studs are located at left and right Butt Line (BL) 55.9 and follow the same spacing as the cargo tiedowns.

2.5.8 Cargo and Ramp Floor Limitations. (Refer to Chapter 4, Section II.)

2.5.9 Cargo Floor Configuration – Logistics Cargo. (See Figure 2-6.) For loading and for transport of logistics cargo, the cargo floor should be prepared as shown in the referenced figure and in accordance with the applicable following paragraph:

2.5.9.1 For receiving palletized cargo, the roller conveyer assemblies are installed with the rollers facing upward and the inboard logistics rails are rotated up to the open position.

2.5.9.2 To receive all other cargo, the roller conveyor assemblies are installed with the rollers facing down in the roller coves and inboard logistics rails are rotated to the closed positions, flush with the floor surface.

2.5.10 Cargo Compartment Walkways and Safety Walks. (See Figure 2-7.) Full length interior walkways are provided along each side of the cargo compartment. The walkways are positioned 15 inches above the cargo floor and provide an unobstructed aisle for personnel movement both in flight and on the ground.

2.6 FORWARD AND AFT RAMP.

2.6.1 Cargo Loading Ramps and Extension. (See Figure 2-8, Figure 2-9, and Figure 2-12 through Figure 2-18.)

2.6.2 Forward and Aft Ramp. Forward and aft cargo loading capability is provided by the forward ramp, the forward ramp extension and toes, and the aft ramp and the pressure door (when used as the aft ramp extension for drive-in loading). The forward ramp, ramp extension, and toes are controlled from GROUND CONTROL, RAMP SELECT, RAMP OPERATE, and RAMP ADJUST switches on the forward loadmaster control panel, on the left side of the cargo compartment. The aft ramp and the pressure door are controlled from the GROUND CONTROL, RAMP SELECT, RAMP OPERATE, RAMP ADJUST, and PRESS DOOR switches on the LH aft loadmaster control panel, on the left side of the cargo compartment. When the pressure door is used as the ramp extension for drive-in loading, the toes must be manually locked in the deployed position. They are manually unlocked for stowing. They lock in the stowed position automatically as the pressure door moves to the closed position.

2.6.3 Forward Ramp, Ramp Extension, and Toes. (See Figure 2-12 and Figure 2-14.) The forward ramp, ramp extension and toes are an integral part of the airplane and form the forward loading platform. The ramp extension and toes, and the ramp are hinged together and operate as one unit during the opening and the closing operations. They are hydraulically actuated through linear actuators. Support jacks incorporated in the ramp extension support the extension during loading operations. In the stowed position, the jack pads face downward and support the ramp extension during drive-in loading operations. The jacks are manually deployed for support of the ramp extension for truck loading. The jacks are manually retracted and stowed inside the extension structure. Four ground support pads are incorporated in the forward end of the ramp for support of the ramp during drive-in loading operations in the forward kneel position. The pads are automatically deployed when the ramp is opened and stowed when the ramp is closed. In the closed position, the ramp extension and toes stow in the vertical position inside the fuselage. A door in the center of the ramp extension allows entrance to the visor door area for visual inspection of the visor door locks. Provisions for the installation of the cargo winch are included in a compartment below the ramp floor.

2.6.3.1 Truck Loading Position. When opening to the truck loading position, the ramp extension lowers until its floor is level with the ramp floor. The ramp then unlocks and lowers until its floor is level with the cargo compartment floor, at which point the ramp stops moving. The loading height can be adjusted, to compensate for different truck heights, by operating the RAMP ADJUST switch (Figure 2-25) to raise or to lower the ramp to the desired height. The ramp extension jacks are manually deployed by an outside crew member on command from the loadmaster. The closing operation is the reverse of the opening operation.

2.6.3.2 Drive-In Position. When opening to the drive-in position, the ramp extension lowers and the toes extend until the extension floor is level with the ramp floor; at this point the toes are fully extended and the ramp support pads are fully deployed. The ramp then unlocks and lowers until the ramp support pads contact the ground, at which point the ramp stops moving (forward kneel only). The ramp closing operation is the reverse of the opening operation.

2.6.3.3 Ramp Locks. Mechanical indication that the ramp locks are fully engaged and locked, with the ramp closed, is given by two colors showing from the sidewall at each lock position. (See Figure 2-13.) Electrical indication that the ramp locks are fully engaged and locked, with the ramp closed, is given when the RAMP LH and RH lights go off on the LH forward loadmaster door lock indicator panel.

2.6.3.4 Manual Locking Pins. A manual locking pin is provided for insertion through airplane structure and the bellcrank at each of the eight hook positions on the forward ramp. When inserted, these locking pins will prevent unlocking of the ramp. Each locking pin has a yellow streamer attached to the handle of the pin. The locking pins are stowed by inserting them in holes in the top of an open recessed stowage container located near the loadmaster forward cargo door and ramp control panel. The holes are sized to fit the shaft of the pin. When a pin is inserted through a hole, it is retained by the ball-detents. Should a ball-detent, spring, or other internal part of the pin fail, the pin will fall into the tray in the bottom of the stowage container. This action indicates an unsafe locking pin.

2.6.4 Forward Ramp and Ramp Extension Floor Configuration – Logistics Cargo. (See Figure 2-6.) For loading logistics cargo, the forward ramp and extension floor should be prepared as shown in the referenced figure and in accordance with the applicable following paragraph:

2.6.4.1 The inboard rails on the ramp extension are an integral part of a reversible access door in the extension floor. The door is removed, reversed, and reinstalled with the guide rails facing up, in the pallet loading position. The A-frame section of the rail is hinged forward and locked to the extension floor; then the rail aligner panel is installed between the fixed rails and the ramp inboard rails to bridge the gap between the extension and ramp rails.

2.6.4.2 To receive all other cargo, the roller conveyor assemblies are installed with the rollers facing down in the roller coves and the inboard rails on the ramp, and the forward inboard rails on the extension are rotated to the down, closed position flush with the floor. The access door in the extension floor (that includes the aft inboard rails) is reversed and installed with the rails down inside the extension with the door flush with the floor.

2.6.5 Forward Cargo Ramp Extension and Toes. The forward ramp extension and toes form part of the forward cargo loading platform. They provide loading capability but not cargo carrying capability. No cargo tiedown rings are provided. Both the extension and toes are similar in basic construction and hinge together to form one complete assembly.

2.6.6 Forward Ramp Floor Panels. (See Figure 2-14.) The forward ramp floor panels are similar in construction to the fuselage floor panels. They consist of skin panels reinforced by I-section beams and angle stiffeners, with coves for support of the roller conveyor assemblies and for receiving the inboard logistic rails. Cargo tiedown rings for the attachment of cargo tiedown devices are recessed in the floor panels.

2.6.7 Forward Ramp and Extension Logistics Rails and Detent Mechanisms. (See Figure 2-15 and Figure 2-16.) Two pairs of logistics rails are provided on both the ramp and the ramp extension. Each pair of rails consists of inboard and outboard assemblies. The rails on the ramp extension act only as a guide for cargo during on/off loading operations. The rails on the ramp act as a guide during on/off loading operations and also provide in-flight restraint for palletized cargo.

2.6.7.1 The outboard rails on the ramp extension consist of a left and right fixed rail assembly. The rails are angled to the outboard (loading) position and the forward end of each rail is curved in the same direction to provide easy alignment of pallets into the rail system. Each of the rails is supported by four support fittings attached to the ramp extension. Rail bridges are provided to bridge the gap between the forward ramp extension and ramp outboard rails. In the installed position, they provide a smooth transition between the ramp extension and ramp for palletized cargo as it is on/off loaded. On the [A] conversions the bridges are stowed on the flanges of the outboard rails. On the [B] conversions the bridges are permanently installed. Rail tongues at the forward and aft end of the rail bridge provide hinge points between the ramp extension and the ramp outboard rails to allow for adjustment of the ramp and extension for loading.

2.6.7.2 The inboard rails are an integral part of a reversible access door assembly installed in the ramp extension floor. The door assembly consists of the door, two fixed parallel rails, an A-frame rail, and a rail aligner panel. The fixed rails are permanently attached to the door and form the aft rails. The A-frame is hinged to the forward end of the aft rails and forms the forward rail. The rail aligner panel bridges the gap between the fixed rails and the ramp inboard rails.

2.6.7.3 For loading palletized cargo the reversible access door is removed, reversed, and reinstalled with the rails facing up. On the [A] conversions and some [B] conversions the strap holding the A-frame rail in its stowed position is released; the frame is hinged forward and its forward end is locked to the extension floor with a lock-unlock device that is a part of the frame. The rail aligner panel is then removed from its stowed position on the door, and is installed between the ramp extension fixed rails and the ramp inboard rails. Slots on the forward end of the ramp rails accommodate bolts on the aft end

of the aligner panel to secure the aft end of the panel to the ramp rails. The forward end of the panel is then attached to support fittings on the aft end of the access door with quick-disconnect pins provided with the panel. On some [B] conversions the permanently installed frame is hinged forward with its forward end locked to the extension floor with a lock-unlock device that is part of the frame. The hinged rail aligner panel is then rotated back and interlocked by slots to the inboard rail.

2.6.7.4 The outboard rails on the ramp consist of an extruded aluminum rail with a mechanically actuated retractable detent and a mechanically actuated retractable lip. The detent moves to the open or closed position when the control mechanism handle on the rail is actuated to the fore or aft position. The detents provide restraint for palletized cargo during flight. The retractable lip is a spring-loaded device that hinges to the loading or locked positions. In the loading position, the retractable lip accommodates the tipping motion of pallets during loading operations. In the locked position, the lip provides vertical restraint of the pallets during flight.

2.6.7.5 The inboard rails on the forward ramp are hinged to the ramp floor. They hinge down flush with the floor for on/off loading of vehicular or skid-mounted cargo. The rails hinge up for loading palletized cargo. They are held in the pallet loading position by links and spring cartridges. Retractable lip detents in the rails provide in-flight restraint for palletized loads. The retractable lip detents are mechanically operated from a control handle recessed flush with the rail.

2.6.8 **Aft Cargo Ramp.** (See Figure 2-17.) The aft ramp is an integral part of the airplane. In the open position it forms part of the cargo aft loading platform and in the closed position it is a part of the fuselage pressure structure. The ramp provides both cargo loading and cargo carrying capability. Provisions for the installation of the cargo winch are included in a compartment below the ramp floor. Restraint rails, and roller conveyor assemblies that provide for easy loading of palletized cargo and restraint of the cargo during flight, are incorporated in the ramp floor. Ground support pads are provided to support the aft end of the ramp during drive-in loading operations in the aft kneel loading position. (Shoring under the pads may be required in some conditions.) The pads are automatically deployed when the ramp opens and are stowed when the ramp closes. The ramp is hydraulically actuated and is controlled from toggle switches on the loadmaster aft control panel on the left side of the cargo compartment.

2.6.8.1 **Truck Bed Position.** When opening to the truck bed position the pressure door locks into its upper hinges and the door lower actuators retract unlocking the lower end of the door from the aft ramp, and the ramp moves down until its floor is level with the cargo compartment floor. At this point the pressure door rises to its overhead position and locks in place. The loading height of the ramp can be adjusted to compensate for different truck bed heights by operating the RAMP ADJUST switch. In operation to the closed position, the ramp (if it has been adjusted to an angle above the level of the cargo compartment floor) will move down level with the cargo compartment floor. At this point, the pressure door will unlatch from its overhead position and will lower to its closed position; the ramp will then close and lock.

2.6.8.2 **Drive-In Loading Position.** When opening to the drive-in loading position, the ramp unlocks from the fuselage and moves down (with the pressure door connected) until its ground pads contact the ground or the ramp actuators bottom out. The pressure door then moves down to its drive-in position. The closing operation is the reverse of opening.

2.6.8.3 **Airdrop Position.** When opening to the airdrop position (after the pressure door is open), the ramp and the center cargo door unlock and move simultaneously; the ramp down to its ADS position, and the center cargo door up to its overhead position. The closing operation is the reverse of the opening operation.

2.6.8.4 **Ramp Locks.** Mechanical indication that the ramp locks are fully engaged and locked, with the ramp closed, is given by two colors showing from the sidewall at each lock position. (See Figure 2-18.)

Electrical indication that the ramp locks are fully engaged and locked, with the ramp closed, is given when the RAMP NOT LKD lights go off on the loadmaster aft control panel on the left side of the cargo compartment.

2.6.8.5 **Manual Locking Pins.** A ramp manual locking pin is provided for insertion at each of the 14 hook positions on the aft ramp. When inserted, these locking pins will prevent unlocking of the ramp. Twelve of the manual locking pins are inserted through airplane structure and the bellcrank at each hook position. The other two pins are inserted through airplane structure and pass forward of the bellcrank at the number four hook position on each side of the airplane. (See Figure 2-18.)

Each locking pin has a yellow streamer attached to the handle of the pin. The locking pins are stowed by inserting them in holes in the top of an open, recessed stowage container located near the loadmaster aft cargo door and ramp control panel. The holes are sized to fit the shaft of the pin. When a pin is inserted through a hole, it is retained by the ball-detents. Should a ball-detent, spring, or other internal part of the pin fail, the pin will fall into the tray in the bottom of the stowage container. This action indicates an unsafe locking pin.

2.6.9 Aft Ramp Floor Configuration – Logistics Cargo. (See Figure 2-6.) For loading and for transport of logistics cargo, the ramp floor should be prepared as shown in the referenced figure and in accordance with the applicable following paragraph.

2.6.9.1 To receive palletized cargo, the roller conveyor assemblies are installed with the rollers facing up. The forward section of the inboard logistics rails are rotated to the open position while the aft section of the rails are left closed, flush with the ramp floor. Then the aft inboard logistics A-frame rail assembly is removed from its stowed position against the fuselage sidewall and is installed on the ramp floor as the aft inboard section of the logistics rails. The outboard rails are positioned in the outboard (loading) position. After all pallets are loaded on the cargo floor, the A-frame rail assembly is removed and stowed prior to loading ramp pallets. The aft inboard section of the rails are then rotated to their open position and the pallets are locked in place with the detents in these rails. The aft outboard rails are then moved inboard to the closed position.

2.6.9.2 To receive all other cargo, the roller conveyor assemblies are installed with the rollers facing down in the roller coves in the floor panels, and the inboard logistics rails are rotated to the closed position, flush with the floor surface.

2.6.10 Aft Cargo Ramp Floor Panels. (See Figure 2-19.) The aft ramp floor panels consist of skin panels reinforced by I-section beams and angle stiffeners, with coves for stowage and support of logistic roller conveyor assemblies and inboard logistics rails. Cargo tiedown rings and ball studs are recessed in the ramp floor. The tiedown rings are used for tiedown of cargo. The ball studs are the attachment points for the quick-release couplings of the ADS guide rails when the rails are installed in the airplane.

2.6.11 Aft Cargo Ramp – Logistics Rails and Detent Mechanisms. (See Figure 2-20.) Two pairs of logistics rails and detent mechanisms are provided on the aft ramp. Each pair of rails consists of inboard and outboard rail and detent mechanisms. The outboard rails consist of two sections, a forward fixed rail and a movable aft rail. The inboard rails are similar in construction to those in the cargo compartment and hinge to the open and closed position.

2.6.11.1 The forward section of the outboard rail is permanently attached to the ramp floor and understructure and acts only as a guide rail during on/off loading of palletized cargo. Part of the detent mechanism control for the aft section of outboard rail is attached to the forward rail.

2.6.11.2 The aft section of the outboard rail consists of an extruded aluminum rail with a retractable lip, detent mechanism, and two quick-release couplings for attaching the rail to the ramp floor. The aft section of rail is hinged to the forward section of rail and can be manually operated to the closed position against a pallet to provide restraint or to the open position to provide a funnel effect for lateral repositioning of a misaligned pallet during cargo handling operations. The rail is capable of being moved inboard 6 inches and outboard 2 inches.

2.6.11.3 Rail connectors are provided to bridge the gap between the cargo compartment and aft ramp outboard rails. There are two connectors (a forward and aft connector) for the left and right side rails. They are permanently attached to the rails, one to the aft end of the cargo compartment rail and the other to the forward end of the ramp rail. They are joined together (through a curved slot in the forward connector) by a nut, bolt, and washer. The curved slot allows operation of the ramp to any open or closed position without removal of the connectors. The connectors provide a smooth transition for palletized cargo as it is on/off loaded.

2.6.11.4 The inboard logistics rails are similar in construction and operation to the inboard logistics rails in the cargo compartment. The rails are hinged to the ramp floor and hinge down to the closed position, flush with the ramp floor for on/off loading of vehicular or skid mounted or general cargo. The rails are held in the closed or open position by links and spring cartridges. Retractable lip detents incorporated in the aft section of the rails provide in-flight restraint of palletized cargo. The retractable lip detents are mechanically operated from a control handle recessed flush with the rail.

2.6.11.5 An A-frame rail assembly is provided as loose equipment and is used as the aft inboard rail for on/off loading palletized cargo. It supplements the existing forward inboard rails and when installed, extends from Ramp Station (RS) 55 to RS 156. The A-frame is a ladder configuration with converging side rails braced by transverse members. It is comprised of two assemblies hinged together so as to fold in half for handling and stowage.

2.6.11.6 For loading palletized cargo the existing aft inboard rails are hinged down flush with the ramp floor and the A-frame rail assembly is installed in their position. The assembly is locked to the floor by two T-bolt locking devices on the assembly which engage with receptacles in the floor at RS 96 and RS 137 and a spring-loaded locking device that locks into the tiedown ring at RS 54. The existing forward inboard rails are then opened for the loading operation. After all the pallets are loaded on the cargo floor, the A-frame is removed from the ramp floor, folded and stowed. The assembly is stowed against the left sidewall between FS 2024 and FS 2044, WL 220 and 234. The existing aft inboard rails are then opened and the pallets on the ramp are locked into position with the detents in the rails.

2.6.12 Winch Cable Wear Strips. Stainless steel wear strips are incorporated into the cargo floor and the forward and aft cargo ramp hinge shrouds at the ramp hinge areas. They help prevent damage to the cargo floor (when the ramp floor is below the level of the cargo compartment floor) by the winch cable during winching operations.

2.6.13 Roller Conveyor System – Logistics Cargo. (See Figure 2-6 and Figure 2-21.)

2.6.14 Description of Roller Conveyor System – Logistics Cargo. Four rows of logistics roller conveyor assemblies are provided in the coves in the cargo floor between each set of logistics rails. When the roller conveyor assemblies are stowed with the rollers facing down, a flush floor is provided for on/off loading vehicular and skid-mounted cargo. When the roller conveyor assemblies are installed with the rollers facing up, a continuous roller conveyor system is provided for easy on/off loading of palletized cargo. The conveyors are capable of accommodating Type HCU-6/E pallets.

2.6.14.1 Standard primary roller conveyor assemblies are provided on the forward ramp, the cargo compartment floor, and part of the aft ramp floor. Each of the roller conveyor assemblies consists of a series of aluminum rollers housed in an aluminum channel. The rollers run on bearings installed in each end of the rollers. Finger holes in the channel members provide access for unlatching and lifting the conveyor out of its cove. The rollers are 1.68 inches in diameter and 1.85 inches wide. When the conveyor is turned upright, the rollers project 1.50 inches above the floor level. The rollers are spaced on approximate 5.30-inch centers.

2.6.14.2 Teeter roller conveyor assemblies are provided at the forward and the aft ends of the forward ramp, the forward and aft ends of the cargo compartment floor, and at the forward end of the aft ramp. They are basically similar in construction to the primary roller conveyor assemblies. The teeter rollers used in the aft ramp and forward ramp are single segment rollers of the same basic diameter as the omnidirectional rollers. The remainder of the teeter rollers each are comprised of three segments, all of which are similar to the primary rollers.

2.6.14.3 Omnidirectional roller conveyor assemblies are provided on the forward ramp extension and most of the aft ramp. These rollers permit pallets to be moved in any direction to align the pallets for entry into the rail system. Each of the conveyor assemblies consists of a series of four pairs of rollers. Each pair of rollers is comprised of two separate supports which house eight barrel rollers (four in each support). The barrel rollers are held in their respective supports by shafts. The supports are locked together to form and to operate as one unit. The rollers run on Teflon-impregnated bearings installed in the supports. Finger holes in the channel provide access for unlatching and for lifting the conveyor from out of its cove.

2.6.14.4 All primary roller conveyor assemblies on the cargo floor, except those which include teeter rollers, are fully interchangeable. The teeter rollers are interchangeable across the floor at their respective locations.

2.6.15 Roller Conveyor System Latches – Logistics Cargo. (See Figure 2-21.) The logistics roller assemblies in both the deployed (palletized cargo loading position) and the stowed position are attached to the coves in the cargo floors by a series of fixed and moveable, spring loaded latch assemblies. The latches are permanently installed in the cargo floor roller coves. Each of the moveable latch assemblies consists of a clevis attached to the cove structure and a spring loaded latch hook. The moveable latches are released through a hole in the adjacent conveyor and a finger hole is provided so that the conveyor can be lifted out of its cove.

2.7 CARGO COMPARTMENT LOGISTICS RAIL.

Two sets of logistics rails are provided in the cargo compartment. Each set consists of inboard and outboard rail assemblies which run the entire length of the cargo compartment. They are installed symmetrically about the airplane centerline and will accommodate two rows of Type HCU-6/E pallets (one row to each set of rails), with the 108-inch pallet dimension positioned across the floor width.

2.7.1 Cargo Compartment Outboard Logistics Rails. (See Figure 2-22.) The outboard logistics rails are installed as a permanent part of the airframe structure, except in the area of the troop doors. In the area of the troop doors, a section of the rail is removable, to accommodate passenger loading. The major portion of the rails consists of a constant, extruded angle section attached directly to the inner chine cap, which is a part of the airplane permanent structure. The rails provide both vertical and side restraint. A manually operated retractable lip is included as a part of the forward and aft sections of the rail. The lip accommodates the tipping motion of the pallets as they are loaded into the cargo compartment from non-coplanar surfaces.

2.7.2 Cargo Compartment Outboard Logistics Rails Restraint Mechanism. (See Figure 2-23.) Restraint mechanisms are provided as part of the outboard rail installation. The mechanisms consist of a series of two-position control handles which are recessed into the sidewall of the cargo compartment above the walkway at each lock position. They control the

detents in the rails through a telescopic control when the handles are actuated. Movement of the control handle to the down position will cause the detent jaws to spread apart until the overcenter mechanism locks the detent into the pallet indent. Moving the control handle to the up position will close the jaws and unlock the detent from the pallet indent. Visual inspection of the engagement and disengagement of the detents is accomplished through cutouts in the horizontal lips of the rails from the side walkway on the outboard side of the palletized cargo.

2.7.3 Cargo Compartment Inboard Logistics Rails. (See Figure 2-22.) The inboard rails are attached to continuous hinges in the cargo rail coves near the center line of the airplane. The rails hinge up to the open position for loading and transporting of palletized cargo. They hinge down, flush with the cargo floor surface, for loading and transporting of skid mounted or general cargo and vehicular cargo. The rails are retained in the open or the closed position by overcenter compression spring devices attached to the rails and the rail coves.

2.7.4 Cargo Compartment Inboard Rails Restraint Detents. (See Figure 2-22.) Restraint detents are provided as an integral part of the inboard rail assemblies. The detents are hinged, spring-loaded, manually operated mechanisms. For on/off loading, the detents are opened by manually unlocking the spring-loaded positive lock and then rotating the detents to their full inboard (open) position to ensure the detents clear the inboard side of the rails. A spring device holds the detents in the open position. After the pallets are loaded into the airplane and are locked in place with the outboard logistics rails detents, the inboard rail detents are rotated to their full outboard (closed) position until the spring-loaded positive lock snaps in place, locking the detent into the pallet indent.

2.7.4.1 These devices are located on 80-inch centers, maximum, to assure that one detent is always engaged in each side of any pallet regardless of position. Longitudinal restraint on both sides of the pallet prevents cocking and possible damage to the system. The detent spacing allows pallets to be placed at any fore and aft location on the cargo floor in increments of 10 inches. If a pallet is located between two detents, both are closed to assure restraint in both longitudinal directions by entrapment of the pallet. The inboard and outboard detents provide restraint at load factors of 3.0g. forward and 1.5g. aft.

2.7.5 Cargo Compartment Inboard Rail Retractable Lip. (See Figure 2-22.) Retractable lips are an integral part of the inboard rail assemblies. The lip or detent combination is a manually operated mechanism which is held open by a spring and closed by a positive spring-loaded lock. The lip is opened by pushing the actuating rod, releasing the positive lock, and rotating the lip inboard from the rail. When open, the unit forms a surface flush with the vertical surface of the adjacent rail and acts as a guide rail, permitting a more positive pallet alignment. The lip is closed by rotating outboard until flush with the back of the adjacent rail. The spring-loaded operating rod then locks the mechanism automatically.

2.7.6 Cargo Compartment and Forward and Aft Ramp Inboard Logistics Rail Connectors. (See Figure 2-15, Figure 2-16, and Figure 2-22.) Rail connectors are provided to bridge the gap between the forward and aft ramp and cargo compartment inboard logistics rails. In the installed position they provide a smooth transition between the ramps and the cargo compartment for palletized cargo as it is on/off loaded. The forward ramp/cargo compartment connectors stow on the forward ramp outboard logistics rails. The aft ramp/cargo compartment connectors stow in clips against the cargo compartment sidewall under the walkway.

2.8 CARGO COMPARTMENT ENTRANCES AND EXITS.

There are three exterior doors normally used for entrance into and exit from the cargo compartment. There are also two interior ladders. The exterior doors are the crew entry door and ladder located on the left side of the cargo compartment, and the troop doors, located one on each side of the cargo compartment. All three entrance doors can be opened from the inside and the outside of the airplane. The two interior ladders are the flight station ladder located at the forward end of the cargo compartment, opposite the crew entrance doorway, and the troop compartment ladder near the aft end of the cargo compartment near the troop doors.

2.8.1 Crew Entry Door and Ladder. The door is on the left side of the airplane between FS 488 and FS 524. The door is 36 inches wide and 75 inches high.

2.8.2 Troop Doors. The doors are on the left and the right side of the cargo compartment between FS 1844 and FS 1884. Each door is 36 inches wide and 72 inches high.

2.8.3 Flight Station Ladder. (See Figure 2-24.) The flight station ladder is located in line with the crew entrance doorway between FS 488 and FS 524.

2.8.4 Aft Cargo Doors. (See Figure 2-9.)

2.8.5 Pressure Door and Toes. (See Figure 2-8.)

2.8.6 Forward Cargo Opening Dimensions. (See Figure 2-10.)

2.8.7 Visor Door. (See Figure 2-11.)

2.8.8 General Description of Visor Door. The visor door is a dome-shaped metal structure constructed of honeycomb sandwich material. In the closed position, it forms the nose portion of the fuselage and the forward pressure closure of the fuselage when the airplane is pressurized. When open it provides access to the cargo compartment for on/off loading of cargo. The radome and the support structure for radar components are an integral part of the door structure. The door is hydraulically operated to the open and the closed positions, by hydraulic motor driving a chain transmission over a track in the visor door. The visor door can be stopped in any position during the opening and the closing operations. The visor door can be operated to the open and the closed positions in sequence with the forward ramp and the forward ramp extension, or independently from switches on the loadmaster forward LH control panel. The visor door is held in the closed and locked position by a series of hydraulic locks located on the fuselage cab top and the canted frame at FS 488, which engage with conical fittings and yokes on the aft frame of the visor door. The door is automatically stopped and held in position by a dual, spring-loaded, hydraulically operated brake in the door actuator, when the VISOR OPERATE switch is placed in the OFF position.

2.9 CONTROL PANELS – DOOR, RAMPS AND CARGO WINCH.

2.9.1 Copilot Cargo Doors and Air Deflector Control Panel. (See Figure 2-25.) The copilot cargo doors and air deflector control panel is located on the right side of the flight station. The PARATROOP AIR DEFLECTOR ARM switch on the panel controls the arming of the PARATROOP AIR DEFL switch on the LH aft loadmaster control panel. The CARGO DOORS ARM switches on the panel control the arming of the cargo door control switches on the loadmaster panels.

2.9.2 LH Forward Loadmaster Control Panel. (See Figure 2-25.) The LH forward loadmaster control panel is located on the left side of the cargo compartment. Control switches on the panel control the operation of the visor door, the forward ramp and the forward ramp extension for drive-in and truck loading and off loading of cargo.

2.9.3 LH Aft Loadmaster Control Panel. (See Figure 2-25.) The LH aft loadmaster control panel is located on the left side of the cargo compartment. Switches on the panel control ground operation of the aft cargo doors, ramp, ADS doors and paratroop air deflectors. The control panel contains NOT LKD/BYPASS indicators to indicate lock status of the following doors and hatches.

- AFT WINCH COMPT HATCH
- **B** AFT BILGE ACCESS HATCH
- TROOP SERVICE DOOR
- HORIZ STAB ACCESS DOOR
- RAMP (LH AND RH)
- PRESSURE DOOR (LH AND RH)
- LH SIDE DOOR
- CENTER DOOR
- RH SIDE DOOR
- PERSONNEL DOORS (LH AND RH)

2.9.4 Forward Loadmaster ADS Control Panel. (See Figure 2-25.) The forward loadmaster ADS control panel is located on the left side of the cargo compartment at FS 584. A switch on the panel controls the operation of the aft ramp and the center cargo door for airdrop of cargo, after the pressure door has been opened and raised to its overhead position. The panel also includes lights that indicate the position of the ADS doors, and the arming and release of the extraction parachute mechanism.

2.9.5 Forward Loadmaster Door Locks Status Panel. (See Figure 2-25.) The forward loadmaster door lock status panel is located on the left side of the cargo compartment between FS 524 and FS 544. The control panel contains NOT LKD/BYPASS indicators to indicate lock status of the following doors and hatches.

- VISOR LH
- CREW DOOR
- VISOR UPPER
- RAMP TO FUSELAGE LH
- FWD UNDERFLOOR COMPT DOOR
- **[B]** FWD BILGE ACCESS HATCH
- RAMP TO FUSELAGE RH
- VISOR RH
- VISOR/RAMP

2.9.6 **[A]** Cargo Winch Remote Control Panel. (See Figure 2-26.) The cargo winch remote control panel is located on the right side of the cargo compartment at FS 1904. The panel provides the means of selecting electrical power to the forward or aft cargo winch compartments for winch operation. The cargo winch can be operated directly from the panel. The mode switch on the panel can be selected for remote operation of the winch using the cargo winch remote control grip assembly located at FS 1215.

2.9.6.1 The three-position CARGO WINCH CONTROL SELECT switch on the panel is used to select electrical power to the forward or aft winch compartments. Placing the switch to FWD provides electrical power to the forward winch compartment. Placing the switch to AFT provides electrical power to the aft winch compartment. The OFF position removes electrical power from the selected compartment.

2.9.6.2 The two-position CARGO WINCH CONTROL MODE switch on the panel is used to select winch speed. Placing the switch to FAST sets up the fast speed. Placing the switch to SLOW OR REMOTE sets the winch up for slow speed operation of the winch from the controls on the panel, or provides electrical power to the CARGO WINCH PENDANT CONTROL DISCONNECT receptacles on the left and right side of the compartment at FS 1208 and FS 1231 respectively for remote operation of the winch using the cargo winch remote control grip assembly.

2.9.6.3 The three-position (center off) CARGO WINCH CONTROL OPERATE switch is used to operate the winch. Placing and holding the switch to WIND or UNWIND operates the winch in its installed location (forward or aft winch compartment) position, provided the CARGO WINCH SELECT switch is in the applicable select position.

2.9.7 **[B]** Cargo Winch Remote Control Panel. (See Figure 2-26.) The cargo winch remote control panel is located on the right side of the cargo compartment at FS 1904. The panel contains two selector switches and two receptacles. The left selector switch is used to select either the forward or aft pendant location for controlling winch operation. The right selector switch is used to select either the forward or aft winch compartments as the location for winch operation. The left receptacle is used for winch pendant plug in and the right one is used for interphone plug in. Electrical power to the winch is controlled by the winch remote control pendant. (See Figure 2-36.)

2.9.8 Flight Station Ladder Controls. (See Figure 2-24.)

2.10 CARGO LOADING AIDS.

Certain items of equipment are provided as cargo loading aids on the airplane. Some of this equipment is an integral part of the airplane structure and other items are stowed as loose equipment in the cargo compartment.

2.10.1 Cargo Tiedown Chains and Devices.

2.10.1.1 There are 75 MB-1 Tiedown Chains and Device that are rated at 10,000 pounds. (See Figure 2-27.) The device consists of an adjustable hook, tensioning grip, chain lock, and quick-release lever. The chain is 9 feet long.

2.10.1.2 There are 75 MB-2 Tiedown Chains and Device that are rated at 25,000 pounds (See Figure 2-27.) The device consists of an adjustable hook, tensioning grip, chain lock, and quick-release lever. The chain is 9 feet long.

2.10.1.3 There are 50 AF Type CGU-1/B Cargo Tiedown Devices that can be used to tie down light weight cargo loads. (See Figure 2-28.) These devices have a rated ultimate capacity of 5,000 pounds. They consist of a ratchet/hook, nylon webbing, and a flat tiedown hook assembled together to form one unit. The extended length of the devices is 19.5 feet.

2.10.2 Forward Ramp Extension Toes. (See Figure 2-12 and Figure 2-29.)

2.10.3 Pressure Door Toes. (See Figure 2-8 and Figure 2-30.)

2.10.4 Snatch Blocks. (See Figure 2-31.) Three snatch blocks are provided as loose equipment on the airplane. The rated capacity of the snatch blocks is 15,000 pounds. The maximum cable size that can be used with the snatch blocks is 3/8-inch diameter. These snatch blocks may be snapped into any tiedown ring on the cargo compartment floor or ramps in order to redirect the cable pull as necessary to accommodate the various modes of winch operation. When snatch blocks are used during winching operations, shoring shall be placed between the snatch block hook and the tiedown ring pan receptacle. This will prevent damage to the cargo floor during the winching operations.

2.10.5 Snatch Block Clevis. (See Figure 2-32 and Figure 2-33.) A clevis (MS70087-1) is stowed on the lifting plate of the cargo winch. The clevis is used to connect the snatch block to an MB-2 chain or a doubled MB-1 chain when a double line is required for winching.

2.10.6 **A** Cargo Winch. (See Figure 2-32.) The cargo winch can be installed in either of the compartments provided in the forward or aft ramps. Access to the compartments is provided by the winch compartment access hatches. (See Figure 2-12 and Figure 2-17.) The 3/8-inch diameter cable exits through a single exit sheave, rather than a level wind mechanism. The exit sheave provides 360 degrees of rotation and positions the 175 feet of usable cable approximately three-quarter inch above the cargo floor surface. A friction device incorporated into the sheave keeps the sheave aligned with the direction of cable pull and prevents the sheave from becoming misaligned when the load is removed from the cable and the cable is slack. The sheave must be manually repositioned for different directions of pull. The winch cable hook can be swiveled through 360 degrees. The winch is powered by a 400 Hz, AC motor through a planetary speed reducer driving a double capstan. The winch power cables connect to electrical outlets in the winch compartment. Mobility rollers and mobility handles on the winch provide ease of movement and handling between the winch installation points and also provide for easy installation of the winch.

2.10.6.1 In operation the winch provides two-speed operation with a 6,500-pound pull at 30 feet per minute and a 2,000-pound pull at 100 feet per minute. Selection of speed is done manually with automatic shift from high to low when the cable load exceeds 2,000 pounds. The winch cable is fed to the storage drum through a level wind feature. The winch cable is stowed under a minimum load to increase the life of the cable and prevent entanglement of the cable.

2.10.7 **A** Winch Remote Control Grip Assembly. (See Figure 2-35.) The winch remote control grip assembly is provided for remote operation of the cargo winch during cargo loading. The assembly consists of a molded pistol-type grip that includes two toggle switches and a squeeze-type switch for operation of the winch. An integral 85-foot long extension cord provides the means of connecting the assembly to the winch power supply receptacle in the cargo compartment. A flanged area around the toggle switches and a trigger guard over the trigger switch guard against inadvertent operation of the switches. No interphone or public address capability is included in this assembly.

2.10.7.1 A two-position switch is provided for selection of winch speed. Placing the switch to SLOW or FAST selects the desired winch speed.

2.10.7.2 A three-position WIND/OFF/UNWIND switch is provided to select the winch wind or unwind operation. Placing the switch to WIND or UNWIND and squeezing the trigger switch provides wind or unwind operation of the winch.

2.10.7.3 A trigger switch is provided to operate the winch. Squeezing the switch will operate the winch. Releasing the switch will stop the winch. The switch will not operate the winch if the WIND/OFF/UNWIND select switch is in the OFF position.

2.10.7.4 To operate the winch using the remote control grip assembly, the assembly must be connected to the CARGO WINCH PENDANT CONTROL DISCONNECT receptacle on the left or right side of the cargo compartment at FS 1208 or FS 1231 respectively. Then the CARGO WINCH CONTROL MODE switch on the cargo winch control panel on the right side of the compartment at FS 1904 is placed to SLOW OR REMOTE. The select switches on the grip assembly are then selected for the desired mode of winch operation and the trigger switch is squeezed to operate the winch.

2.10.8 **B** Cargo Winch. (See Figure 2-33.) The cargo winch can be installed in either of the compartments provided in the forward or aft ramps. Access to the compartments is provided by the winch compartment access hatches. (See Figure 2-12 and Figure 2-17.) The winch is electrically controlled and hydraulically operated. Electrical power is provided from main DC bus No. 2 and hydraulic power is provided by hydraulic system No. 1 or No. 4. Normally system No. 1 provides hydraulic power for the forward winch compartment and system No. 4 provides hydraulic power for the aft winch

compartment. Two manual hydraulic selector valves are located on the right side of the cargo compartment at FS 604 and FS 1620 (See Figure 2-36.). The selector valves can be manually positioned to provide No. 1 hydraulic system power to the aft winch compartment or No. 4 hydraulic system power to the forward winch compartment. Hydraulic and electrical connections for the winch are located in the forward and aft winch compartments. The winch cable stowage drum contains 250 feet of usable cable. The cable is directed evenly onto the storage drum by a level wind assembly during winch operations. During cable reel out, the hydraulic motor will shut off when two and a half to three and a half wraps of cable remain on the drum. During cable reel in, the hydraulic motor will shut off when all cable has been retrieved except for 17 to 23 inches as measured from the top of the winch. The exit sheave positions the cable approximately three-fourths of an inch above the cargo floor surface during winching operations. The sheave friction device keeps the sheave aligned with the direction of cable pull and prevents the sheave from becoming misaligned when the load is removed from the cable. The sheave must be manually repositioned for different directions of cable pull. The winch contains mobility rollers and handles to aid in moving the winch between compartments.

2.10.8.1 The winch control system provides a reversible drive and variable, high speed and low speed operation. The speed range is variable from 15 to 0 feet per minute with 7,500 pounds cable load in the low speed mode of operation. The speed range is variable from 100 to 0 feet per minute with 2,000 pounds cable load in the high speed mode of operation. The hydraulic drive motor will stall at a load of 9,000 pounds with 2,900 PSI differential pressure across the motor. The cable brake is capable of holding a maximum static cable load of 10,000 pounds without slippage in the event of operating power interruption. When power is reapplied and reel-in is commanded, there should be no tendency for the cable to reel-out provided the cable load does not exceed 9,000 pounds. The cable brake is capable of stopping and holding the cable within a distance of 10 inches from no-load to maximum load and at all speed ranges. The cable brake is applied and released by operating the winch remote control pendant thumbwheel control. The cable brake is automatically applied if hydraulic or electrical power is interrupted to the winch.

2.10.9 **[B] Winch Remote Control Pendant.** (See Figure 2-36.) Two pendants are provided with the airplane. One pendant is stowed in the retainer on the left side of the cargo compartment at FS 1208 and one pendant is stowed at the right hand control panel. Electrical plug-ins for the pendant cable are provided on the right and left sides of the cargo compartments at FS 1231 and FS 1208 and the cargo winch remote control panel at FS 1904. The electrical plug-in at FS 1231 has a pendant selector switch for selecting either RH or LH pendant location. The cargo winch remote control panel contains selector switches for selecting FWD or AFT pendant and FWD or AFT winch. The pendant receives 28 VDC through the CARGO WINCH SELECTOR circuit breaker on the flight engineer circuit breaker panel No. 5. The pendant contains a POWER and SPEED switch and a WINCH thumbwheel control. When the POWER switch is placed to ON, a circuit is completed to close the forward or aft winch power relay as appropriate. When the winch power relay closes, a circuit is made to energize the forward or aft hydraulic servo valve as appropriate. The hydraulic servo valve, when energized, permits hydraulic pressure from system No. 1 or No. 4 to be routed to the winch hydraulic control module to drive the hydraulic motor. The SPEED switch selects HI or LOW winch speed operation. The thumbwheel control is used to control winch speed and direction. The thumbwheel control is spring loaded to the neutral position and when released from either the IN or OUT direction, it will return to the neutral position. The winch cable brake is applied when the POWER switch is OFF, operating power is interrupted or the thumbwheel control is in neutral or released to neutral. Moving the thumbwheel control from neutral releases the winch cable brake and starts winch operation. Winch speed increases as the thumb-wheel control is moved from the neutral position.

2.10.10 Cargo Winch Sling. A cargo winch sling is stowed in a sling pouch attached to the winch. (See Figure 2-32 and Figure 2-33.) The sling is used with a folding ladder, pulley, and lug-all hoist for extracting and installing the winch out of or into the forward or aft winch compartment.

2.10.11 Heavy Cargo Winch Assembly. The heavy cargo winch assembly consists of a housed, single wrap cable drum driven through a manually controlled simple planetary gear box. It includes an AC electric motor, level wind mechanism assembly, operating control box with 75 feet of electrical cable, and a snatch block for double line cable operation. The winch is operated by 200 VAC, 400 Hz, 3 phase power. In the event of a power failure, a hand crank is provided for emergency manual operation. The older winches provide two-speed operation with single line pull loads of 5,000 pounds at 18 feet per minute or 15,000 pounds at 6 feet per minute. The winch will automatically stop whenever the cable tension exceeds 5,000 pounds in the Fast (F) load mode. The reconfigured winch contains only a single speed operation of 15,000 pounds at 6 feet per minute. Some reconfigured winches retain two-speed operation. All heavy cargo winches weigh approximately 792 pounds and are provided with a 205 foot length of 9/16-inch diameter steel cable. Refer to paragraph titled Portable Heavy Cargo Winch Operation in Chapter 4, Section IV for electrical connection of the winches.

2.10.11A [A] Dual Powered Winch. (See Figure 2-32.1) The dual powered winch (DPW) can be installed in either of the compartments provided in the forward and aft ramps. Access to the compartments is provided by the winch compartment access hatches (see Figures 2-12 and 2-17). The 3/8 inch diameter synthetic cable exits the winch through the sheave assembly mounted above the top frame. The sheave assembly provides 360 degrees of rotation and positions the 250 feet of usable cable approximately three-quarters of an inch above the cargo floor surface. The sheave assembly must be manually

positioned for the desired direction of pull. The DPW is powered by a brushless DC motor through a gearbox driving a loaded drum on which the synthetic cable is wound. The winch electrical power cables connect to electrical outlets in the winch compartment. The total weight of winch is 514 pounds.

2.10.11A.1 The dual powered winch controller provides reversible and variable speed operation. Speed is controlled using the thumbwheel on the winch pendant. The speed range is variable from 0 to 33 feet per minute with a maximum operating load of 7,500 pounds. The winch will automatically slow the speed when the temperature of the electronics approaches the maximum allowed. The winch synthetic cable is fed to the loaded drum through a level wind system and the cable is stowed on the drum.

2.10.11A.2 **A** Dual Powered Winch Pendant Assembly. (See Figure 2-36.1) The dual powered winch pendant assembly is provided for remote operation of the winch during cargo loading. One pendant assembly is provided with each dual powered winch. The assembly consists of an ergonomic grip and an integrated faceplate. The faceplate contains a center thumbwheel, a power on/off toggle switch. The thumbwheel is used to select operation in or out, as well as to control speed in or out. When the thumbwheel is released it springs back to center and the winch stops. The power on/off toggle switch turns the entire dual powered winch on or off. An 85 foot long pendant cable assembly provides the means of connecting the assembly to the winch power supply receptacle in the cargo compartment. Two guards on either side of the thumbwheel and an integral hood that covers the faceplate guard against inadvertent operation of the switches.

2.10.11A.3 To operate the winch using the winch pendant, the winch pendant cable must be connected to the CARGO WINCH PENDANT CONTROL DISCONNECT receptacle on the left or right side of the cargo compartment at FS 1208 or FS 1231 respectively. Then the CARGO WINCH CONTROL MODE switch on the cargo winch control panel on the right side of the compartment at FS 1904 is placed to SLOW OR REMOTE. The winch pendant power switch and thumbwheel are then used to operate the winch in the desired direction and at the desired speed.

2.10.11A.4 **B** Dual Powered Winch. (See Figure 2-33.) The dual powered winch can be installed in either of the compartments provided in the forward and aft ramps. Access to the compartments is provided by the winch compartment access hatches (see Figures 2-12 and 2-17). The dual powered winch can be operated either electrically or hydraulically, and is installed with both electrical power and hydraulic power available simultaneously. Electrical power is provided from main DC bus No. 2 and hydraulic power is provided by hydraulic system No. 1 or No. 4. Normally system No. 1 provides hydraulic power for the forward winch compartment and system No. 4 provides hydraulic power for the aft winch compartment. Two manual hydraulic selector valves are located on the right side of the cargo compartment at FS 604 and FS 1620. (See Figure 2-36). The selector valves can be manually positioned to provide No. 1 hydraulic system power to the aft winch compartment or No. 4 hydraulic system power to the forward winch compartment. Hydraulic and electrical connections for the winch are located in the forward and aft winch compartments.

2.10.11A.5 The 3/8 inch diameter synthetic cable exits the winch through the sheave assembly mounted above the top frame. The sheave assembly provides 360 degrees of rotation and positions the 250 feet of usable cable approximately three-quarters of an inch above the cargo floor surface. The sheave assembly must be manually positioned for the desired direction of pull. The winch is powered by a hydraulic motor through a gearbox driving a loaded drum on which the synthetic cable is wound. During cable reel out, the winch controller will sense when all usable cable is out and will automatically stop the winch when eight wraps of synthetic cable remain on the drum. During cable reel in, the winch controller will sense when all usable cable has been retrieved and the integral cable swaged button hits the cable in switch. Mobility wheels and handles on the top frame provide for ease of movement and handling between the winch installation points and provide for easy installation of the winch.

2.10.11A.6 The dual powered winch controller provides reversible and variable speed operations. Speed is controlled using the thumbwheel on the winch pendant. The speed range is variable from 0 to 33 feet per minute with a maximum operating load of 7,500 pounds. However, in the electric mode, the winch controller will automatically slow the speed when the temperature of the electronics approaches the maximum allowed. The electric motor brake is used in both electrical and hydraulic operation. The brake is capable of holding a maximum static cable load of 10,000 pounds without slippage in the event of operating power interruption. When power is reapplied and reel in is commanded, operation resumes. The brake is capable of stopping and holding the cable within a distance of 10 inches from no load to maximum load and at all speed ranges. The brake is applied and released by operating the pendant thumbwheel. The brake is automatically applied if hydraulic or electrical power is interrupted to the winch, and in hydraulic mode the brake will only release when a minimum of 1100 psi of hydraulic pressure is available to the hydraulic manifold. The winch synthetic cable is fed to the loaded drum through a level wind system and the cable is stowed on the drum.

2.10.11A.7 **B** Dual Powered Winch Pendant Assembly. (See Figure 2-36.) The dual powered winch pendant is provided for remote operation of the winch during cargo loading. The pendant consists of an ergonomic grip with an integrated faceplate. The faceplate contains a center thumbwheel, a power on/off toggle switch. The thumbwheel is used to command operation and control speed in or out. The thumbwheel is spring-loaded and when released it returns to the neutral position, stopping the winch. The power on/off toggle switch turns the dual powered winch on or off. When the power switch is turned on, a circuit is closed to the forward or aft winch power relay. When the winch power relay closes, the forward or aft hydraulic servo valve is energized. When energized, the hydraulic servo valve permits hydraulic pressure from system No. 1 or No. 4 to be routed to the winch hydraulic control module to drive the hydraulic motor. An 85 foot long pendant cable provides the means of connecting the pendant to the winch power supply receptacle in the cargo compartment. Two guards on either side of the thumbwheel and an integral hood that covers the faceplate guard against inadvertent operation of the switches.

2.10.11A.8 One winch pendant is provided with each dual powered winch. One pendant is stowed in the retainer on the left side of the cargo compartment at FS 1208 and one pendant is stowed at the right hand control panel. Electrical plug ins for the pendant cable are provided on the right and left sides of the cargo compartments at FS 1231 and FS 1208 and the cargo winch remote control panel at FS 1904. The electrical plug in at FS 1231 has a pendant selector switch for selecting either RH or LH pendant location. The cargo winch remote control panel contains selector switches for selecting FWD or AFT pendant and FWD or AFT winch. The pendant receives 28 VDC through the CARGO WINCH SELECTOR circuit breaker on the flight engineer circuit breaker panel No. 5.

TOC

LOI

CH 1

CH 2

CH 3

CH 4

CH 5

CH 6

PREV

2.10.12 Ground Support Pads – Forward Ramp. (See Figure 2-29.)

2.10.13 Forward Ramp Extension Support Jacks. (See Figure 2-29.)

2.10.14 A Stabilizing Struts – Aft Fuselage.

NOTE

The aft fuselage stabilizer struts were installed on airplanes AF66-8303 through AF69-011. Stowage provisions are retained on AF69-012 through AF70-467.

(See Figure 2-37.) For airplanes on a mission that requires the aft stabilizer struts, two stabilizer struts are provided (one on each side of the aft fuselage). They provide stabilization of the airplane during on/off loading operations with the aft cargo ramp in the truck loading position. The struts are located at FS 1964 below WL 140 on the right and the left sides of the fuselage. The struts consist of a large ground bearing pads attached with quick-release pins to telescoping struts. The telescoping strut is comprised of an outer tube and an inner sliding tube. The inner sliding tube allows for mechanical adjustment of the strut to accommodate for uneven ground surface. Ledges on the outer diameter of the inner sliding tube prevent rotation of the strut during deployment, by engaging with stops on the inside of the outer tube. Height adjustment of the strut is accomplished by screwing in or out on the upper or the lower adjustment points. When deployed and adjusted for height, the upper end of the strut seats against a support bracket attached to the fuselage structure, and the ground pad at the lower end rests on the ground.

2.10.15 Ground Support Pads – Aft Ramp. (See Figure 2-38.)

2.10.16 MA-1 Pry Bar. (See Figure 4-32.) A wheeled pry bar (Johnson Bar) type MA-1 can be used to assist in positioning of cargo provided the weight on the pry bar does not exceed 1,000 pounds. Multiple pry bars may be used to lift weights in excess of 1,000 pounds provided the weight per pry bar does not exceed 1,000 pounds.

2.10.17 Portable Utility Ladder. (See Figure 2-50 and Figure 2-51.)

2.10.18 Pallet Stops. (See Figure 2-44.) Four pallet stops are provided and are carried as loose equipment on the airplane. They consist of wedge-shaped brackets with a hard-rubber bumper and a spring-loaded handle that controls a locking pin. They are used as stops to prevent winched or pushed cargo pallets from overrunning the cargo floor and rolling out of the airplane during off loading operations. They are also used to stop pallets at any desired position on the cargo floor to provide space for vehicles or bulk cargo during loading operations. They attach to the tiedown rings in the cargo floor (with the ring raised to its vertical position) by moving the spring-loaded handle. When the handle is released, the locking pin engages in the cutout in the tiedown ring to lock the pallet stop in position. When pallet stops are used to stop moving pallets, they must be used in pairs. A single pallet stop may be used to chock a static pallet.

2.10.19 Cargo Pallet Couplers. (See Figure 2-45.) The cargo pallet coupler is a flat cast aluminum plate with integral parts and a locking T-bar. It is used for in-train coupling of cargo pallets when required to transport oversized cargo.

2.11 CARGO LOADING AIDS STOWAGE.

2.11.1 Snatch Block Stowage. (See Figure 2-46.)

2.11.2 Cargo Winch Stowage. (See Figure 2-34.)

2.11.3 MB-1 Tiedown Device Stowage. (See Figure 2-47.)

2.11.4 MB-2 Tiedown Device Stowage. (See Figure 2-47.)

2.11.5 MB-1 and MB-2 Tiedown Chain Stowage. (See Figure 2-48.)

2.11.6 AF Type CGU-1/B Cargo Tiedown Device Stowage. Four containers are provided for the stowage of CGU-1/B tiedown devices. Two containers are located on each side of the cargo compartment at FS 1024.

2.11.7 Forward Ramp Extension Support Jacks Stowage. (See Figure 2-29.)

2.11.8 Forward Ramp Extension Toes Stowage. (See Figure 2-29.)

2.11.9 Pressure Door Toes Stowage. (See Figure 2-8 and Figure 2-30.)

2.11.10 Pressure Door Upper Hinge Lock Blocks Stowage. The pressure door hinge lock blocks are stowed in the loose equipment locker at FS 1774, right side.

2.11.11 Forward Ramp Support Pads Stowage. (See Figure 2-29.)

2.11.12 Detent Locking Tee and Quick-Release Pin. Locking tees are provided to restrain pallets in the outboard logistics rail mechanism if a cable is missing or broken. The detent locking tees and quick-release pins will be locally manufactured in accordance with Figure 3-4 and installed in accordance with Figure 3-5. They will be stowed in the loose equipment locker on the left side of the cargo compartment at FS 1774.

2.11.13 Pallet Stop Stowage. The pallet stops are stowed in the loose equipment lockers on the left and right side of the cargo compartment at FS 1774.

2.12 COMPARTMENT PROVISIONS.

2.12.1 [A] Crew and Relief Crew or Courier Compartment Galley. (See Figure 2-39.) The galley that serves the crew and the relief crew or courier compartment is located on the right side of the airplane immediately forward of the courier compartment. The galley is a self-contained unit that includes stowage, refrigeration, and preparation facilities. The galley also contains its own water system stowed in two 7-gallon containers and its own waste disposal facilities.

2.12.2 [A] Crew, Relief Crew, or Courier Compartment Toilet. (See Figure 2-41.) Toilet facilities are provided for the crew and personnel carried in the relief crew or courier compartment. The toilet is located on the right side of the airplane immediately forward of the galley. The toilet is a recirculating type toilet with its utility supplemented by a urinal. The counter has a flush fitting wash basin with hot and cold water supplied by two 5-gallon water tanks. The water is heated by a heating unit under the wash basin. Other facilities provided in the toilet include a mirror, an electrical shaver outlet, two ash trays, a paper hand towel dispenser, a removable refuse container, three assist handles, ceiling lights, two RETURN TO SEAT advisory lights, and a portable oxygen bottle with mask. The toilet and the wash water tanks are serviced from outside the airplane through two separate service panels.

2.12.3 [B] Crew, Relief Crew, or Courier Compartment Galley. (See Figure 2-40.) The galley is essentially the same as the [A] conversions except water is supplied by a pressurized central potable water system. Provisions are included for a refrigerator and an ice chest igloo.

2.12.4 [B] Crew, Relief Crew, or Courier Compartment Toilet. (Airplanes Not Modified By TO 1C-5M-544) (See Figure 2-41.) The toilet is essentially the same as on [A] conversions except water is supplied to the lavatory by a pressurized central potable water system.

2.12.5 Crew, Relief Crew, or Courier Compartment Toilet. (Airplanes Modified by TO 1C-5M-544). (See Figure 2-42) Toilet facilities are provided for the crew and personnel carried in the relief crew or courier compartment. The toilet is located on the right side of the airplane immediately forward of the galley. The toilet is a vacuum type toilet. The counter has a flush fitting wash basin. Other facilities provided in the toilet include a mirror, an electrical shaver outlet, two ash trays, a paper hand towel dispenser, a removable refuse container, three assist handles, ceiling lights, two advisory RETURN TO SEAT annunciator lights, and a portable oxygen bottle with mask. The toilet is serviced from outside the airplane through a service panel.

2.13 AIRPLANE KNEELING SYSTEM – CARGO ON/OFF LOADING.

(See Figure 2-49 for detailed dimensions and angles.)

2.13.1 Landing Gear Hydraulic Kneeling System. Refer to TO 1C-5M-1 for kneeling system operation.

2.13.2 Forward Kneel – On/Off Loading Position. With the airplane in the forward kneel position, cargo can be loaded through the forward and aft ends of the airplane, using the truck or drive-in loading position.

2.13.3 Level Kneel – On/Off Loading Position. With the airplane in the level kneel position, cargo can be loaded through the forward and aft ends of the airplane using the truck or drive-in loading positions. With the airplane in the level kneel position, all the main landing gear oleos are bottomed out with no kneel collars installed, and the nose gear is partially retracted.

2.13.4 Aft Kneel – On/Off Loading Position. With the airplane in the aft kneel loading position, cargo can only be on/off loaded through the aft end of the airplane using the truck or drive-in loading position.

2.14 TROOP COMPARTMENT.

The troop compartment extends from FS 1383 to FS 2101 in the upper lobe of the airplane. There are 75 seats available along with the services required for transporting troops. Normal access to this compartment is provided by a ladder extending from the cargo floor area up to an entrance opening in the troop compartment floor at FS 1964.

2.14.1 Troop Compartment Floor. (See Figure 2-52.) The troop compartment floor is a permanent part of the airplane structure and consists of a series of panels supported by an underfloor structure of beams and stiffeners. The panels are bonded assemblies of aluminum core and face sheet sandwich construction. Installed on the top surface of the floor are the attachment fittings for the seats, lavatory, and galley units of the troop compartment removable kit. The floor extends from FS 1347 to FS 2101. A removable panel is incorporated in the floor at the stairwell opening in the floor at FS 1964. The panel is removed to provide a larger opening for hauling units of the removable kit up or down through the stairwell opening when the removable kit is to be installed or removed from the compartment. This panel incorporates a grill that allows an air passage between the troop compartment and the cargo compartment during pressurized flight.

2.14.2 Troop Compartment Electrical Outlets and Power Supply. (See Figure 2-59.)

2.14.3 Troop Compartment Permanently Installed Lighting. (See Figure 2-53.)

2.14.4 Troop Compartment Seating. (See Figure 2-54.)

2.15 TROOP COMPARTMENT ENTRANCES AND EXITS.

2.15.1 Troop Compartment Ladder and Stairwell. (See Figure 2-68.) A ladder is provided as a part of the troop compartment kit. It is located between FS 1964 and FS 2004, at the troop compartment stairwell. It provides the means of access from the cargo compartment to the troop compartment during flight or while on the ground. The ladder is removable so that major components of the removable troop compartment kit can be hoisted through the stairwell. In the up (stowed) position, the upper section of the ladder stows vertically inside the troop compartment above the stairwell, and the lower section against the cargo compartment roof.

2.15.2 Troop Compartment Service Door. The service door is on the left side of the troop compartment between FS 1844 and FS 1884.

2.16 SPECIAL MISSION KITS.

Removable kits are provided for special mission capability on the airplane. The kits, when installed, add greater operational flexibility to the airplane's overall capability. The kits are as follows:

- Troop Compartment Seat Kit
- Student/Instructor - Flight Station Seat Kit

2.16.1 Troop Compartment Seat Kit. (See Figure 2-54.) The troop compartment seat kit provides the components and the furnishings to seat 75 personnel. The kit also provides food and sanitation facilities, compartment lighting, interphone and public address facilities, modules containing pop-out oxygen masks and reading lights, and emergency escape equipment that includes escape slides, liferafts, an axe, and ropes. The majority of the seats are arranged in a six-abreast seating configuration (three seats on each side of the aisle) with a center dividing aisle.

2.16.1.1 Troop Compartment Kit Galley. (See Figure 2-55 and Figure 2-56.) The troop compartment kit includes a self-contained galley. When the galley is installed, it is located on the left side of the troop compartment between the stairwell and the aft bulkhead.

2.16.1.1.1 The galley contains two ovens, two dual temperature refrigerators, trays and storage compartments, a warming plate, a hot beverage unit, a waste container, and its own water system. (See Figure 2-57.)

2.16.1.1.2 **A** The galley water system has a capacity of 50 gallons of water. Power for the galley is received from the MONITOR AC BUS NO. 3.

2.16.1.1.3 **B** The galley water is supplied by the airplane pressurized potable water system. Water is plumbed to the coffee maker and the faucet.

2.16.1.2 Troop Compartment Kit Lavatory Units. (Airplanes Not Modified By TO 1C-5M-544). (See Figure 2-58.) Two lavatory units are provided as a part of the removable troop compartment kit. They are located on the right side of the compartment directly aft of the forward bulkhead. The lavatory units provide toilet facilities for 75 personnel for a period of 15 hours. Each of the units includes a flushing recirculating toilet, a wash basin with cold water, an electric shaver outlet, a paper towel dispenser, a toilet roll holder, an assist handle, lighting, an oxygen mask dropout container, and a RETURN TO SEAT advisory light. The units include their own water supply, waste storage, and ground servicing outlets.

2.16.1.3 Troop Compartment Kit Lavatory Units. (Airplanes Modified by TO 1C-5M-544) (See Figure 2-58.) Two lavatory units are provided as a part of the removable troop compartment kit. They are located on the right side of the compartment directly aft of the forward bulkhead. The lavatory units provide toilet facilities for 75 personnel for a period of 15 hours. Each of the units includes a vacuum toilet, a wash basin, an electric shaver outlet, a paper towel dispenser, a toilet roll holder, an assist handle, lighting, an oxygen mask dropout container, and an advisory RETURN TO SEAT annunciator light. The units include their own waste storage.

2.16.1.4 Troop Compartment Kit Lighting. (See Figure 2-60.) The troop compartment kit provides lights for general illumination of the compartment, emergency exit lights, and individual lights for reading.

2.16.1.5 Troop Compartment Interphone and Public Address Systems. (See Figure 2-61.)

2.16.1.6 Troop Compartment Chime. A single-tone chime is installed in the trim to the right of the troop compartment public address system amplifier control panel. When the SEAT BELTS switch on the pilot overhead panel is placed to ON, the chime sounds. The chime may be sounded more than once by alternately placing the switch to ON, then to OFF. The chime receives 28-volt AC power from the AFT MAIN AC BUS NO. 3.

2.16.1.7 Troop Compartment Kit Accessory Modules. (See Figure 2-62.) Accessory modules are provided as a part of the removable troop compartment kit. Each of the modules contains dropout oxygen masks, individual reading lights, environmental ducting, and oxygen lines and electrical cables. A removable access panel is included in each of the modules for ready access for connecting/disconnecting the environmental ducting, and oxygen and electrical connections.

2.16.1.8 Troop Compartment Kit Emergency Escape Slide Assemblies. (See Figure 2-63.)

2.16.1.9 Troop Compartment Kit Liferaft Assemblies. (See Figure 2-64.)

2.16.1.9.1 Each of the liferaft assemblies consists of a two-piece carrying case, an inflatable liferaft, two independent compressed air systems (comprising of an air reservoir and an air aspirator), a mooring lanyard, a case splitting cable, and two inflation lanyards synchronized to actuate the inflation valves of the two compressed air reservoirs. Each assembly also includes a manually erected canopy, a sea anchor, boarding stirrup, boarding ramp, boarding handles, heaving lines, an outer lifeline, inner grasp handles, survivor lights, a hand pump, and a survival kit.

2.16.1.9.2 The survival kit is an integral part of the liferaft assemblies. The kit has a carrying case with carrying handles, and contains a survival manual, first aid kits, distress signals, desalter kits, a bailing bucket, signalling mirror, survival rations, distillation kits, water containers, sunburn preventive, wrist compasses, lipsticks, sponges, a fishing kit, receiver/transmitter, repair kit, an adapter pump, and a knife. The kit is tied to the outer lifeline of the liferaft assembly.

2.16.1.10 Troop Compartment Kit Oxygen System. (See Figure 2-62.)

2.16.1.11 Troop Compartment Kit Portable Oxygen Bottle Assembly. (See Figure 2-65.) Two portable oxygen bottle assemblies are provided as part of the troop compartment kit. One oxygen bottle assembly is located on the wall of each lavatory unit.

2.16.1.11.1 The oxygen bottle is a combined assembly consisting of an oxygen cylinder, a regulator, a recharger valve, an oxygen mask and supply hose, a stowage bag for the mask, and a carrying harness.

2.16.1.11.2 The oxygen bottle assembly is equipped with a continuous flow or pressure demand regulator that will supply oxygen for emergency use. It can be recharged with oxygen from the airplane oxygen system by connecting it to either the oxygen recharger assembly on the aft wall of the lavatory at FS 1458 or the recharger assembly on the right side of the compartment at FS 1964.

2.16.1.12 Troop Compartment Kit Fire Extinguishers. Five fire extinguishers are provided as a part of the troop compartment kit.

2.16.1.13 Troop Compartment Kit Coat Closet. (See Figure 2-66.)

2.16.1.14 Troop Compartment Kit Lavatory Oxygen System. (See Figure 2-65.)

2.16.1.15 Troop Compartment Kit Bulkhead Guard. A guard is provided as a part of the troop compartment kit. The guard protects the bulkhead at FS 1383 from damage which may occur when troops are carried in the troop compartment. The guard consists of a series of extruded channel and angle members attached together to form a frame of horizontal and vertical construction. The guard is installed just aft of the bulkhead at FS 1389. It attaches to the compartment floor at WL 314 and to the trim structure at WL 363.

2.16.1.16 Troop Compartment Kit Stairwell Guard. (See Figure 2-67.) A guard rail assembly, installed around the periphery of the stairwell in the troop compartment floor, is provided with the troop compartment kit. The guard rail acts as a safety guard around the stairwell to prevent the possibility of personnel in the troop compartment from falling through the stairwell opening.

2.16.1.16.1 The guard rail assembly consists of three guard rail sections, a gate, and a kick strip. Each of the guard rail sections is similar in construction, consisting of a welded tubular frame and a webbing of galvanized wire mesh covered with vinyl. The three sections of guard rail are joined together to form one 3-sided guard rail. The gate is a prefabricated tubular structure consisting of three horizontal members and one vertical member and a locking latch. A metal kick strip installed between the sides of the guard rail assembly completes the assembly and acts as a closure between the rail and the floor.

2.16.1.17 Troop Compartment Kit Auxiliary Refuse Containers. (See Figure 2-67.)

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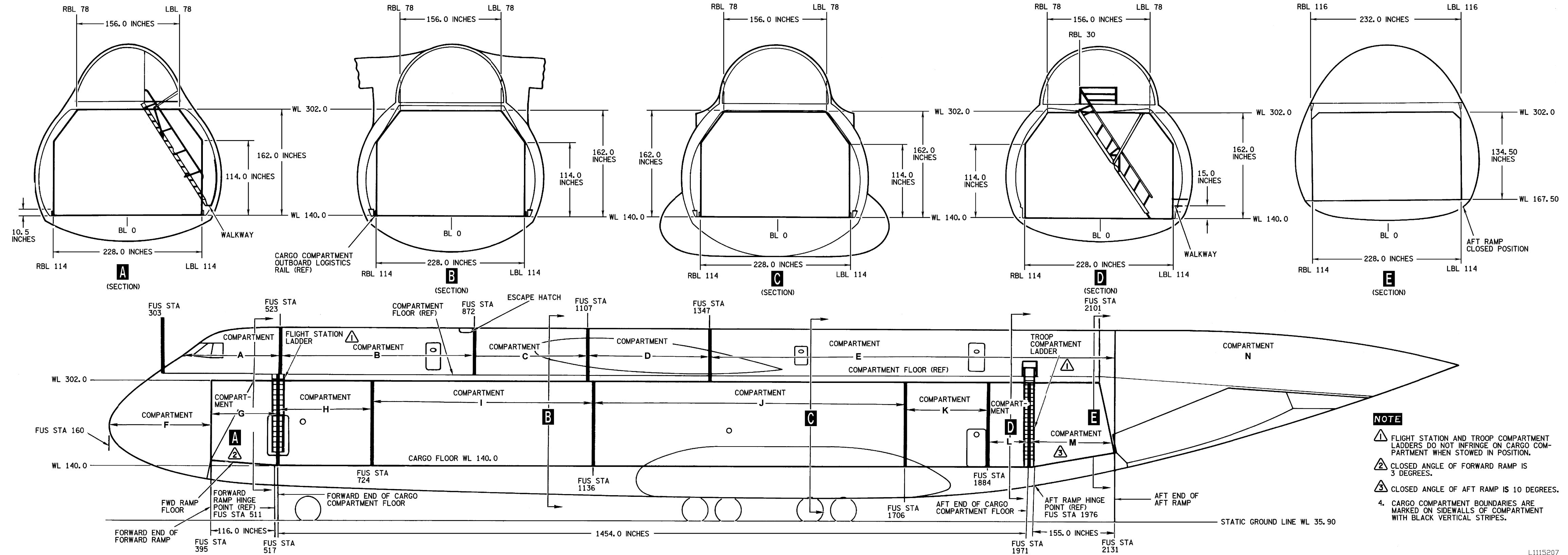
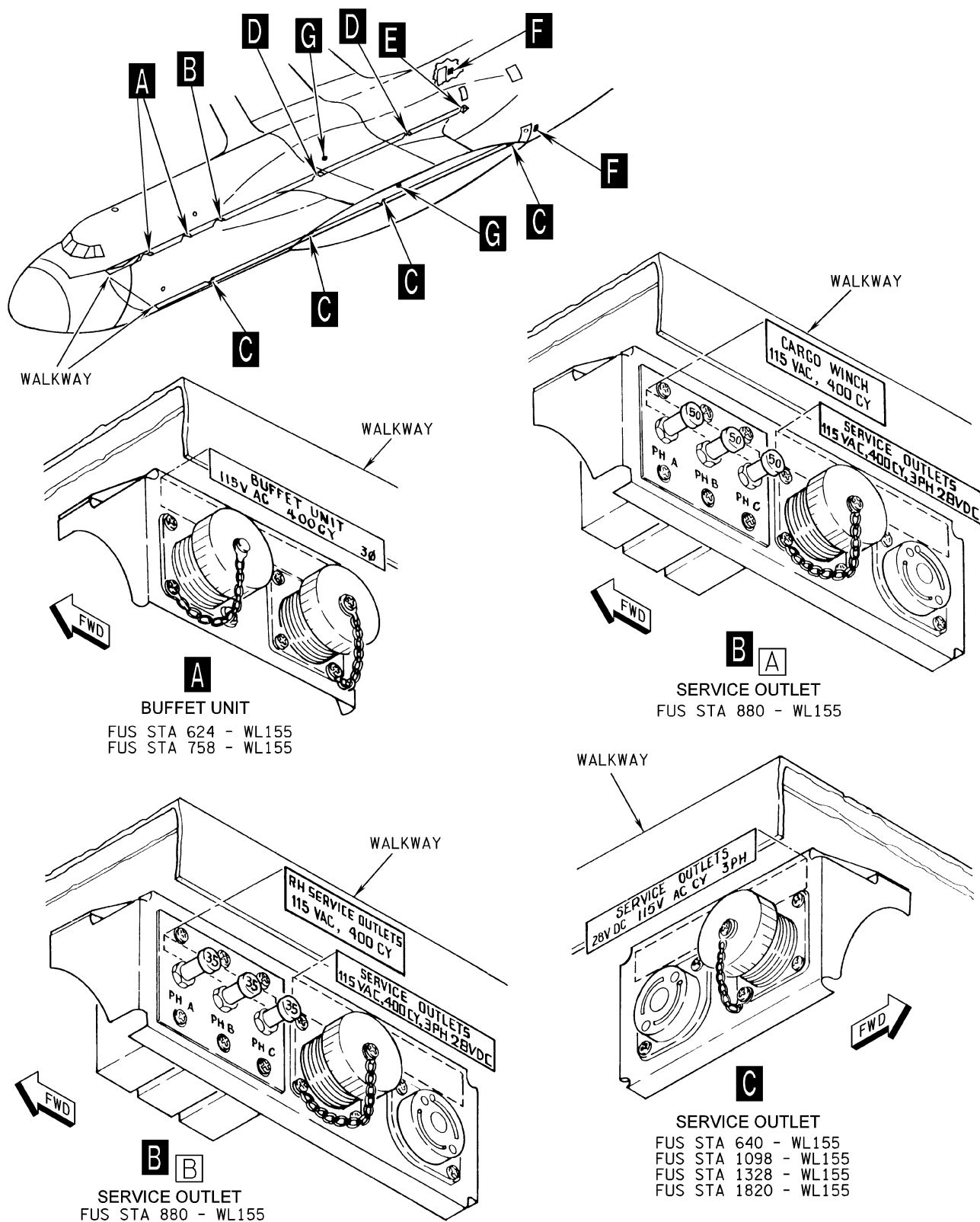


Figure 2-1. Cargo Compartment Envelope

L1115207



L1115208

Figure 2-2. Cargo Compartment Electrical Outlets (Sheet 1 of 2)

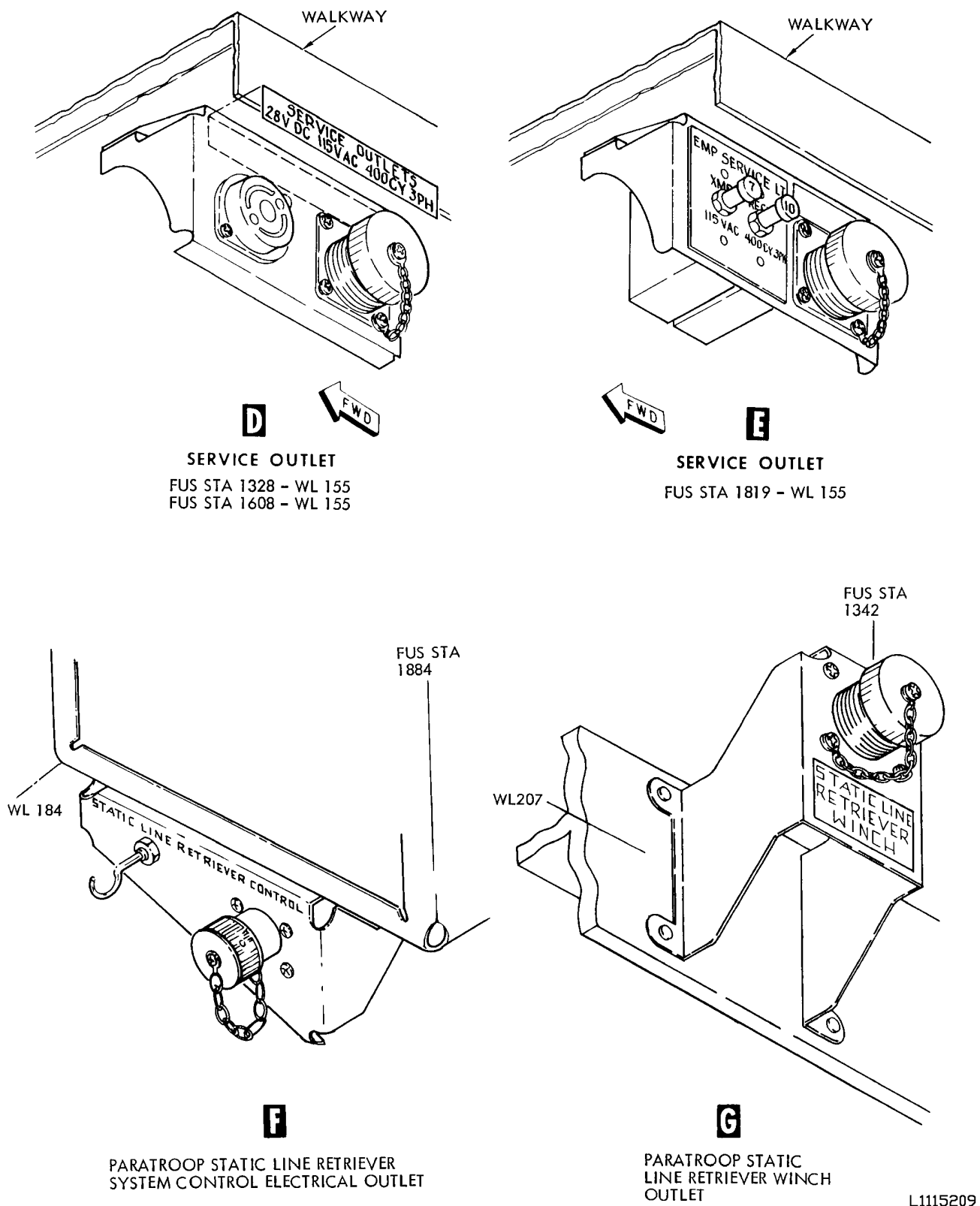
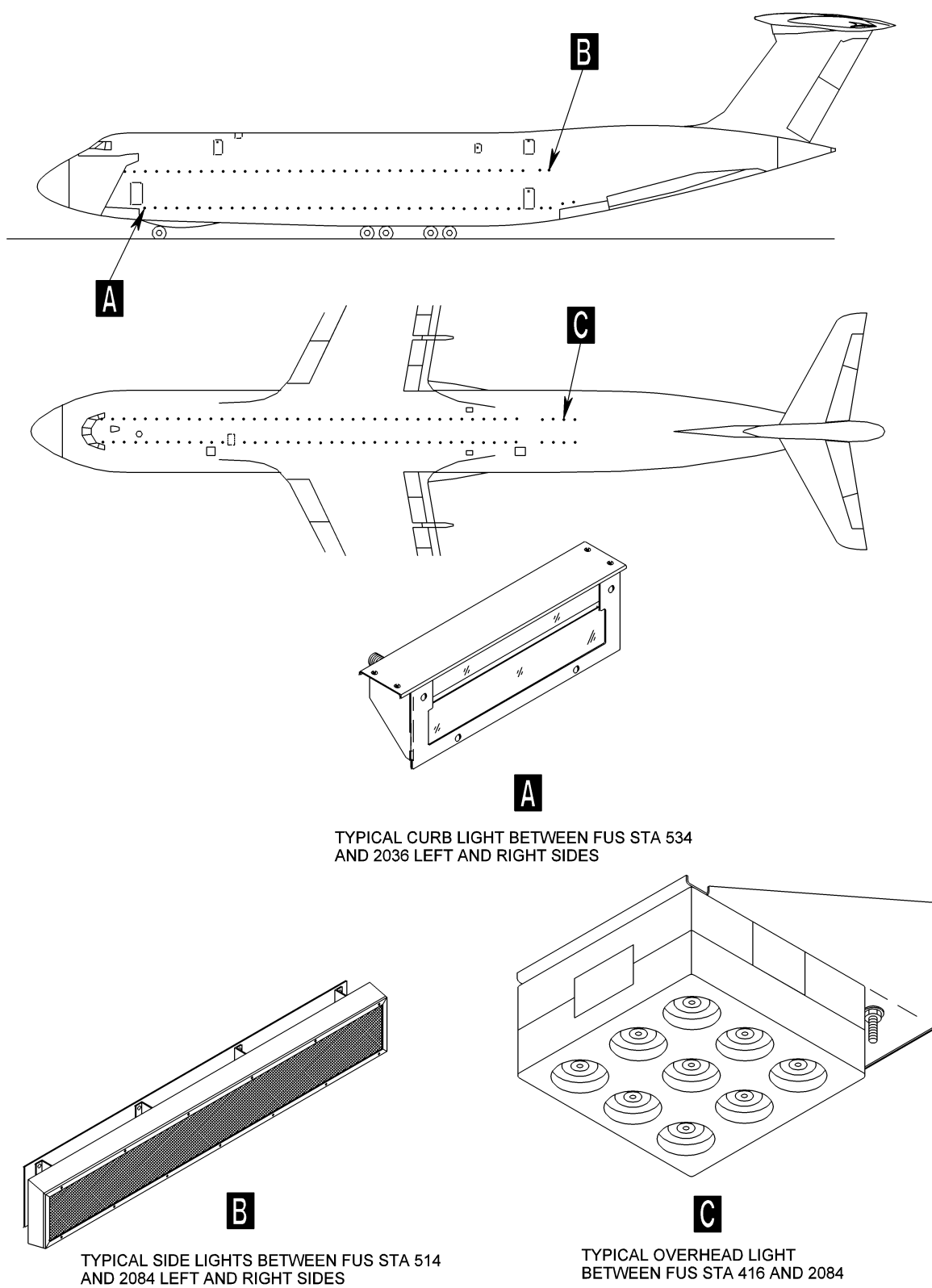
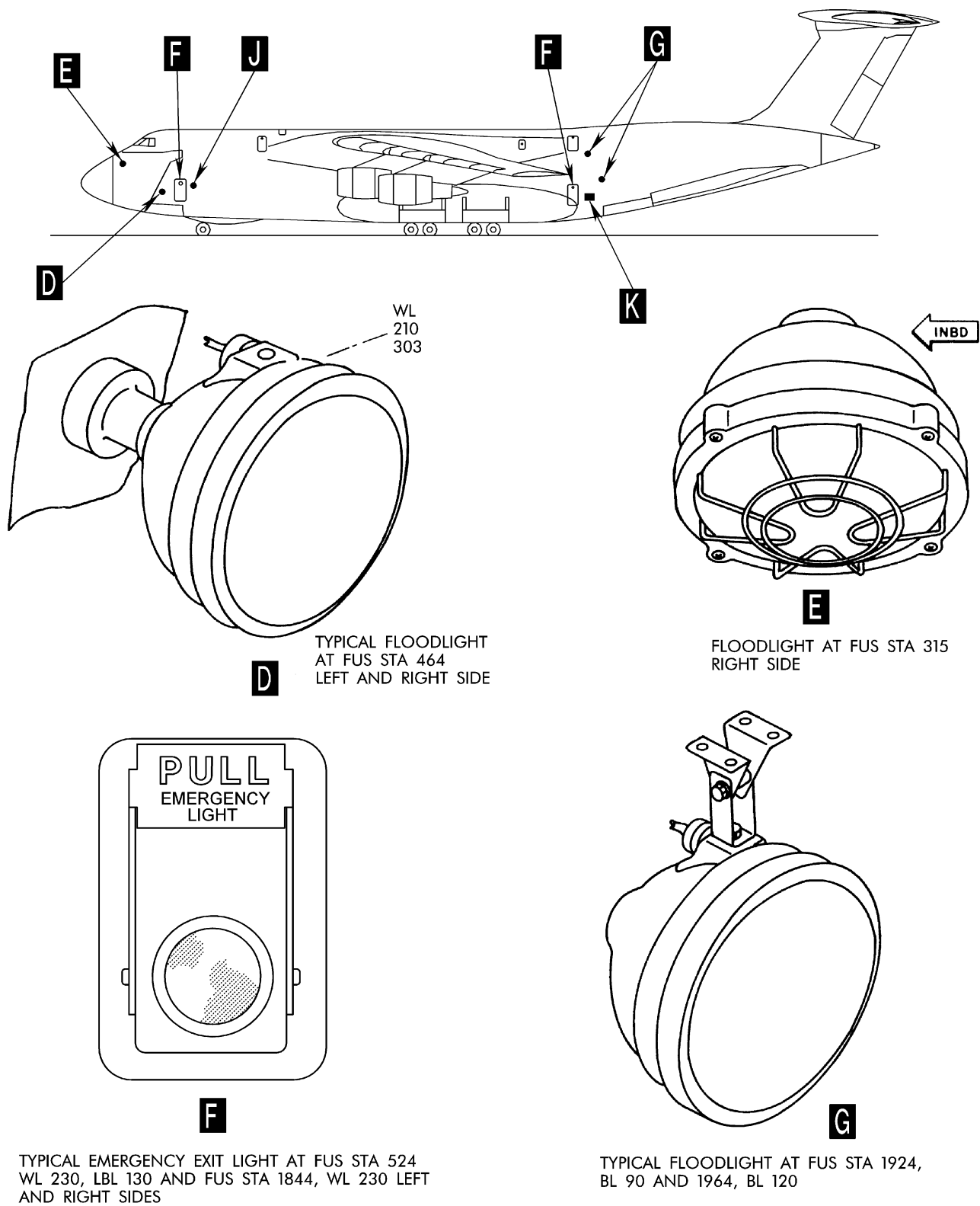


Figure 2-2. Cargo Compartment Electrical Outlets (Sheet 2)



L1115210

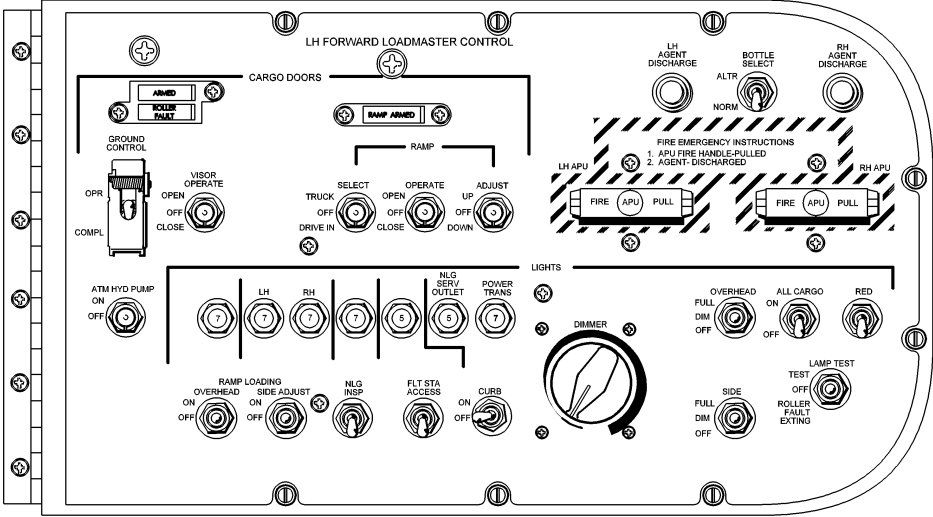
Figure 2-3. Cargo Compartment Lighting (Sheet 1 of 3)



L1115211

Figure 2-3. Cargo Compartment Lighting (Sheet 2)

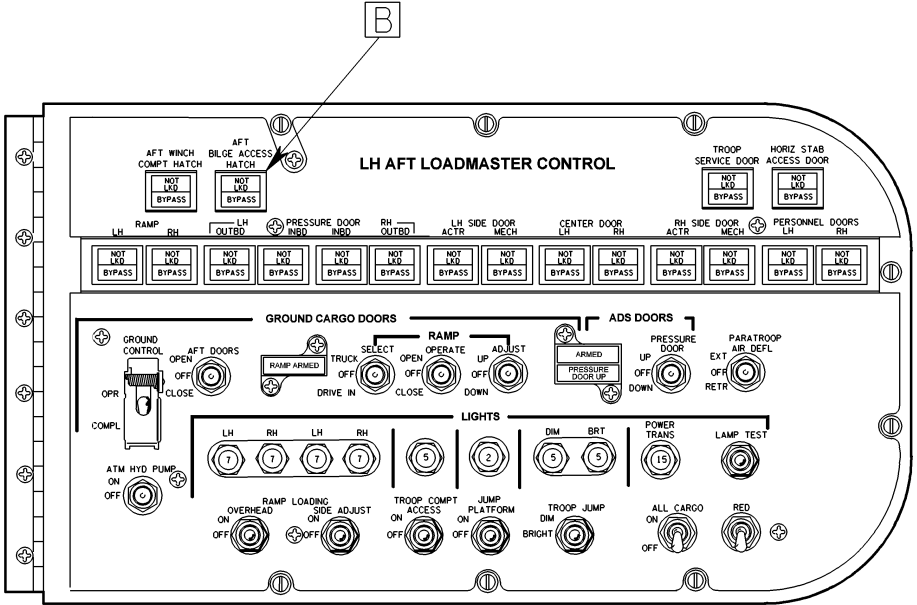
CAUTION INSURE RAMP
LOCK PINS ARE REMOVED FROM
LOCKS BEFORE OPERATING RAMP



J

FORWARD LOADMASTER CONTROL PANEL
(FUS STA 544 LEFT SIDE)

CAUTION INSURE RAMP
LOCK PINS ARE REMOVED FROM
LOCKS BEFORE OPERATING RAMP



K

AFT LOADMASTER CONTROL PANEL
(FUS STA 1904 LEFT SIDE)

L1115212

Figure 2-3. Cargo Compartment Lighting (Sheet 3)

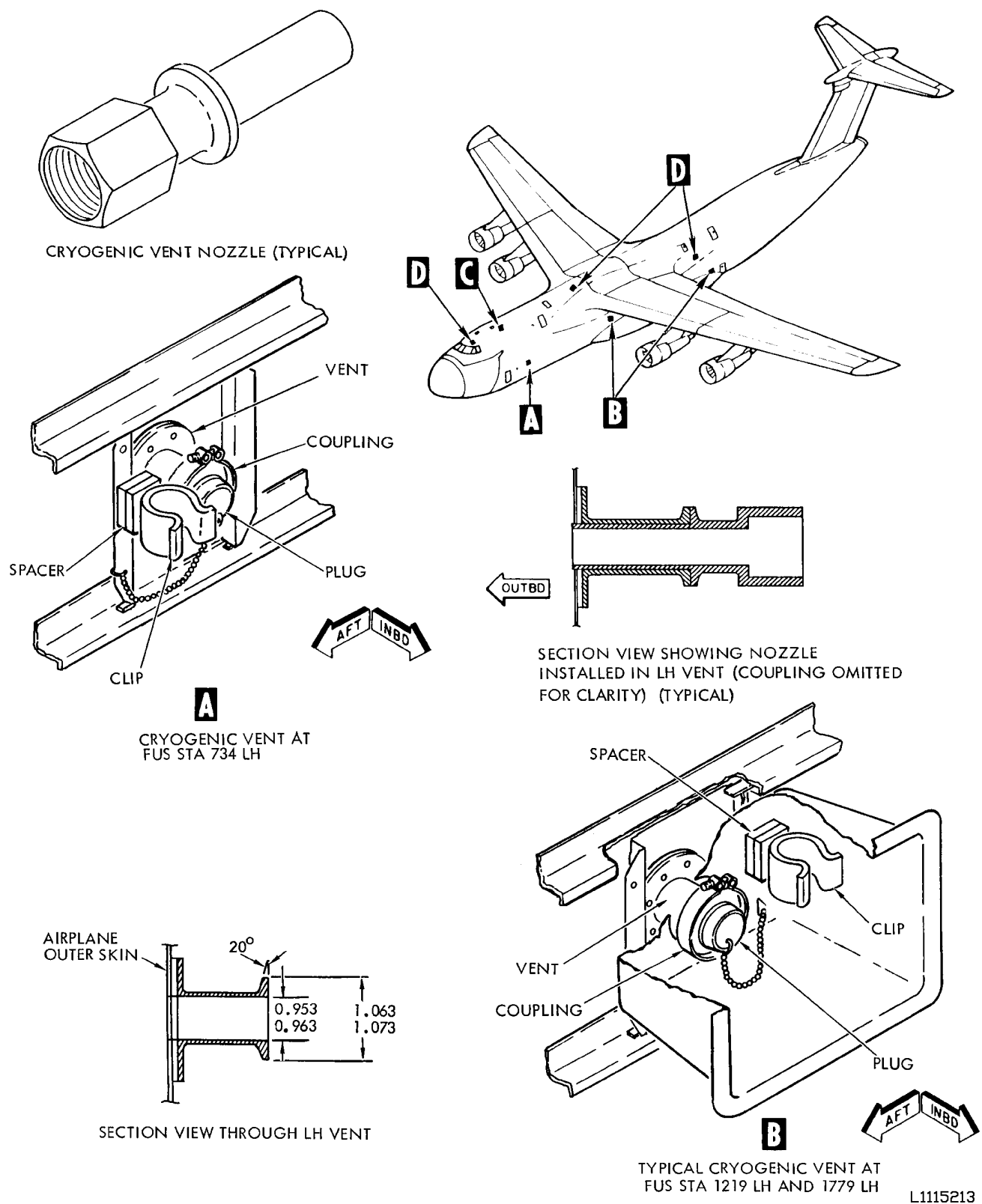
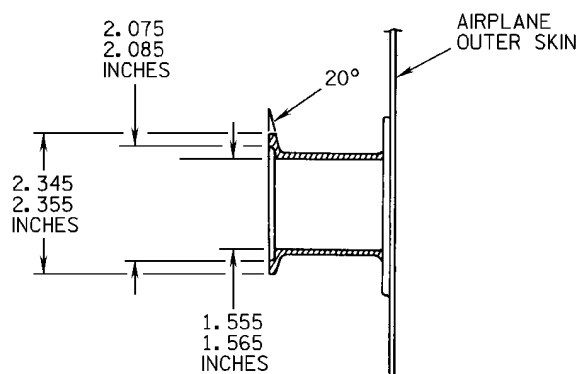
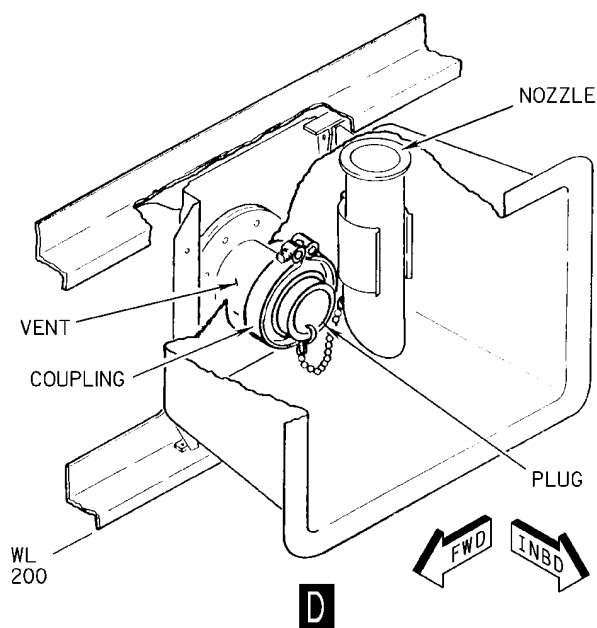
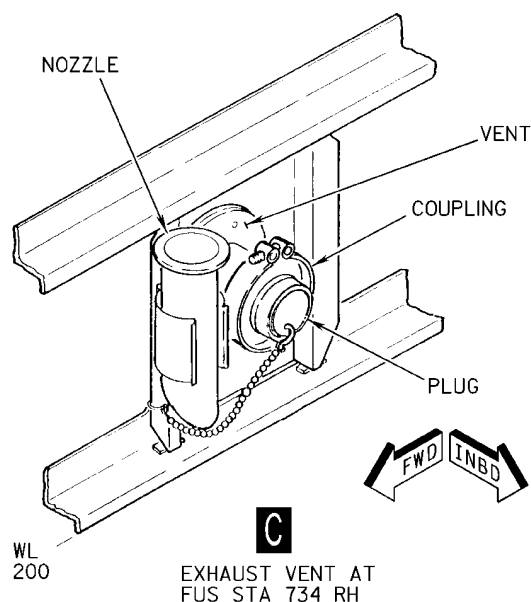
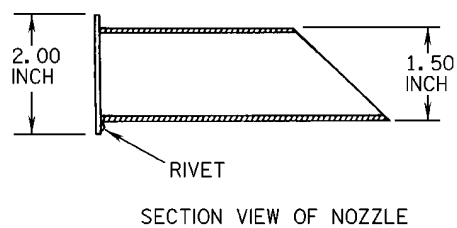


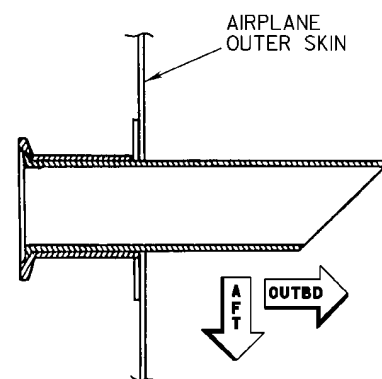
Figure 2-4. Cargo Compartment Vents (Sheet 1 of 2)



SECTION VIEW THROUGH RH VENT



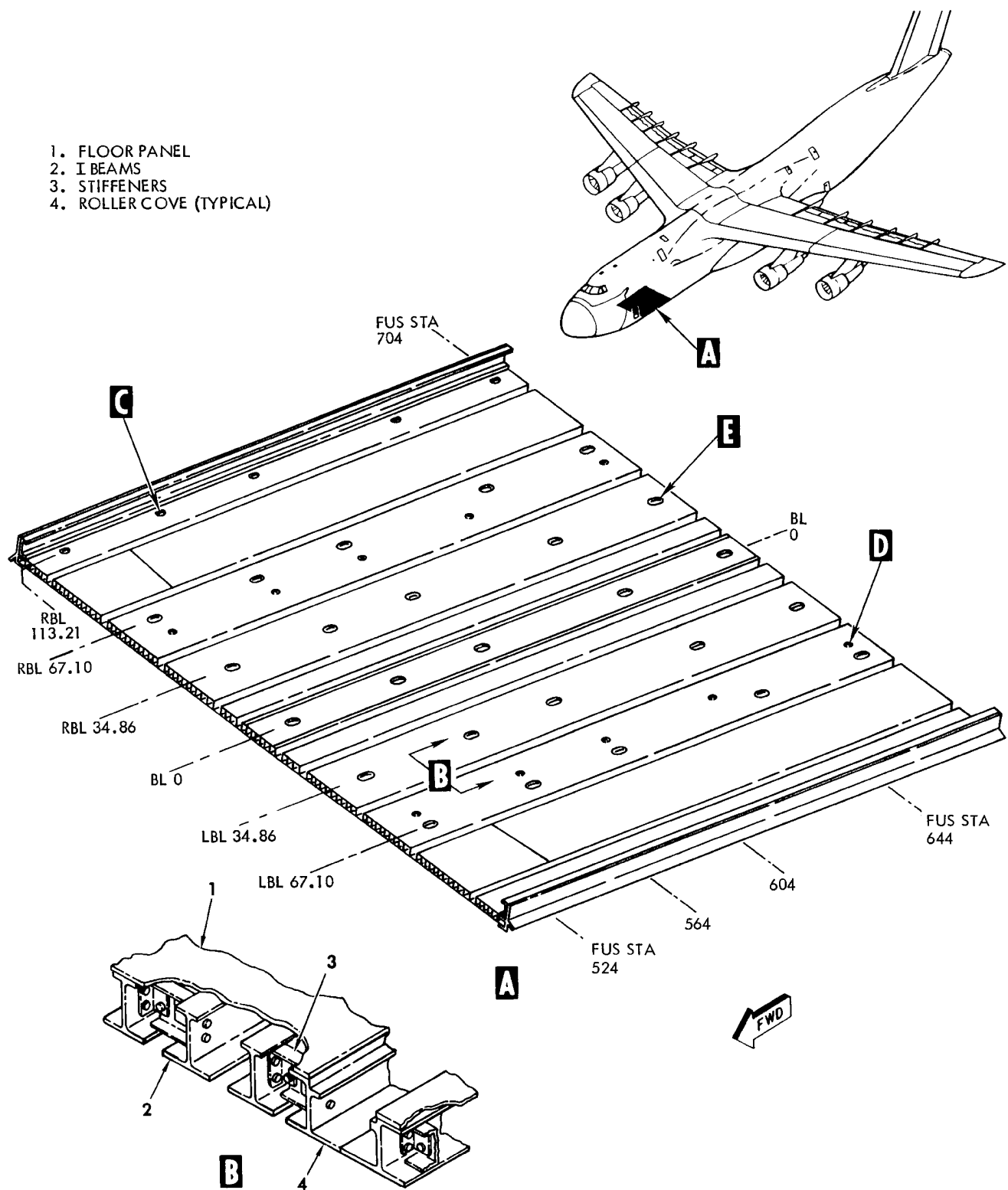
SECTION VIEW OF NOZZLE



SECTION VIEW SHOWING NOZZLE INSTALLED IN RH VENT

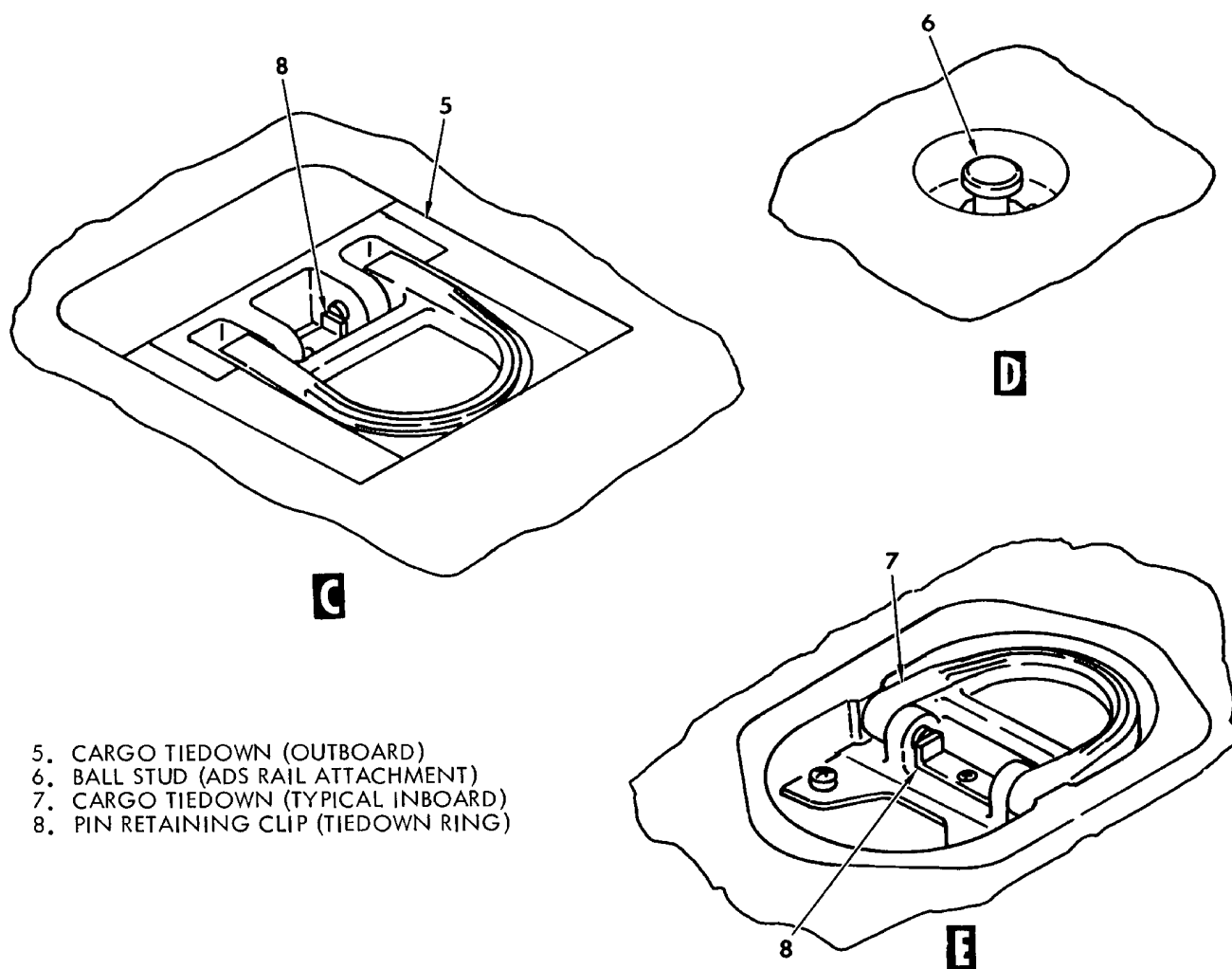
L1115214

Figure 2-4. Cargo Compartment Vents (Sheet 2)



L1115215

Figure 2-5. Cargo Compartment Floor Section (Typical) (Sheet 1 of 2)



L1115216

Figure 2-5. Cargo Compartment Floor Section (Typical) (Sheet 2)

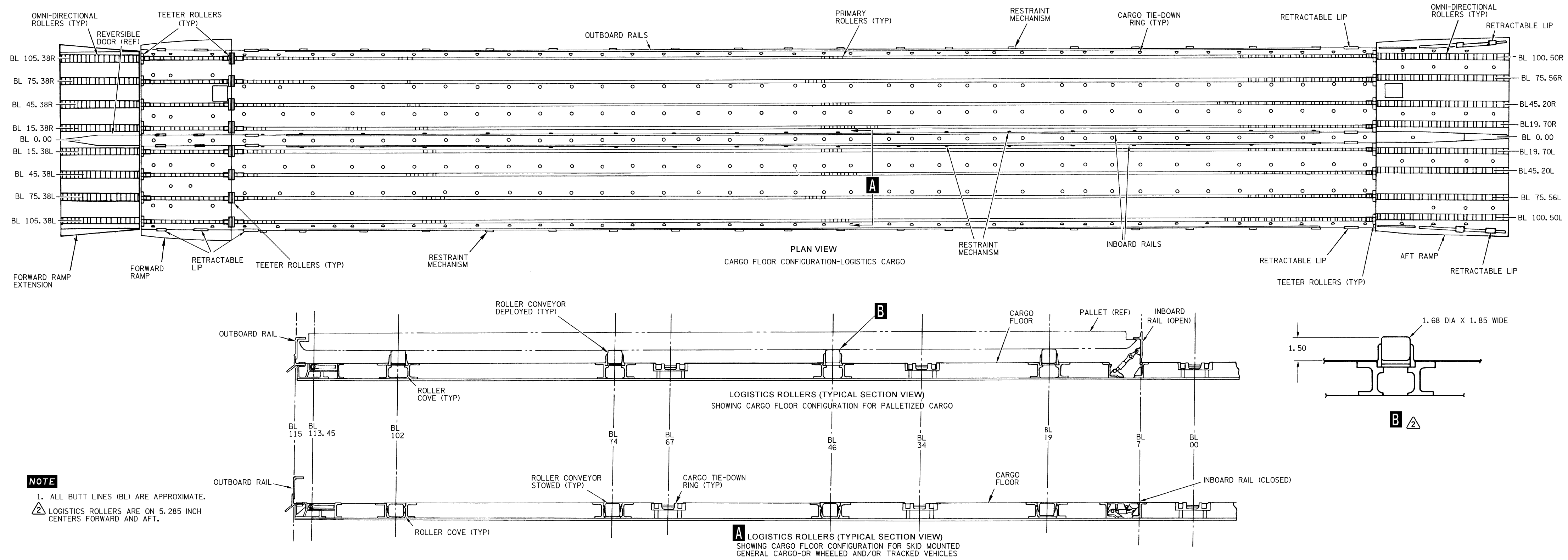


Figure 2-6. Cargo Floor Configuration – Logistics Cargo

L1115217

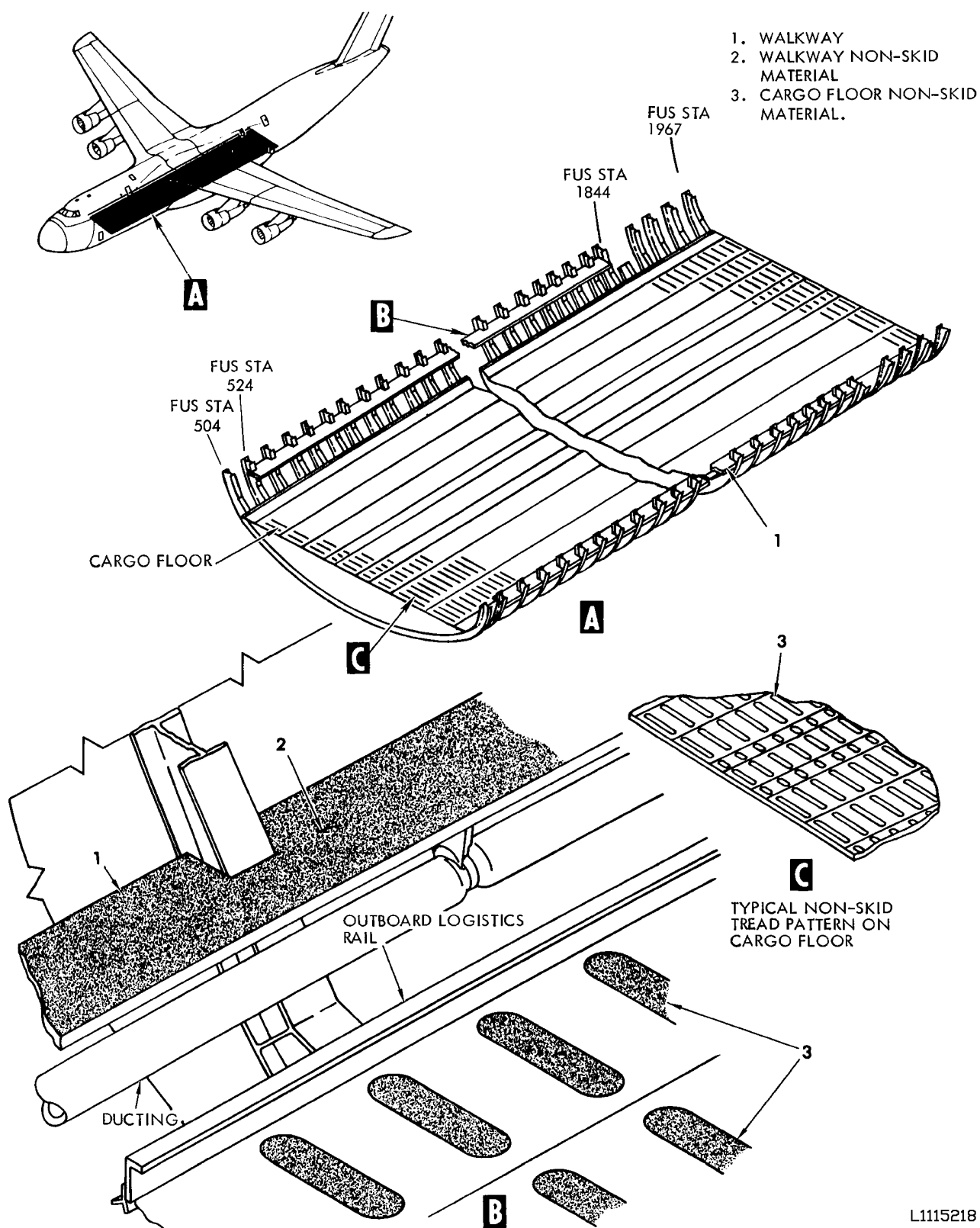
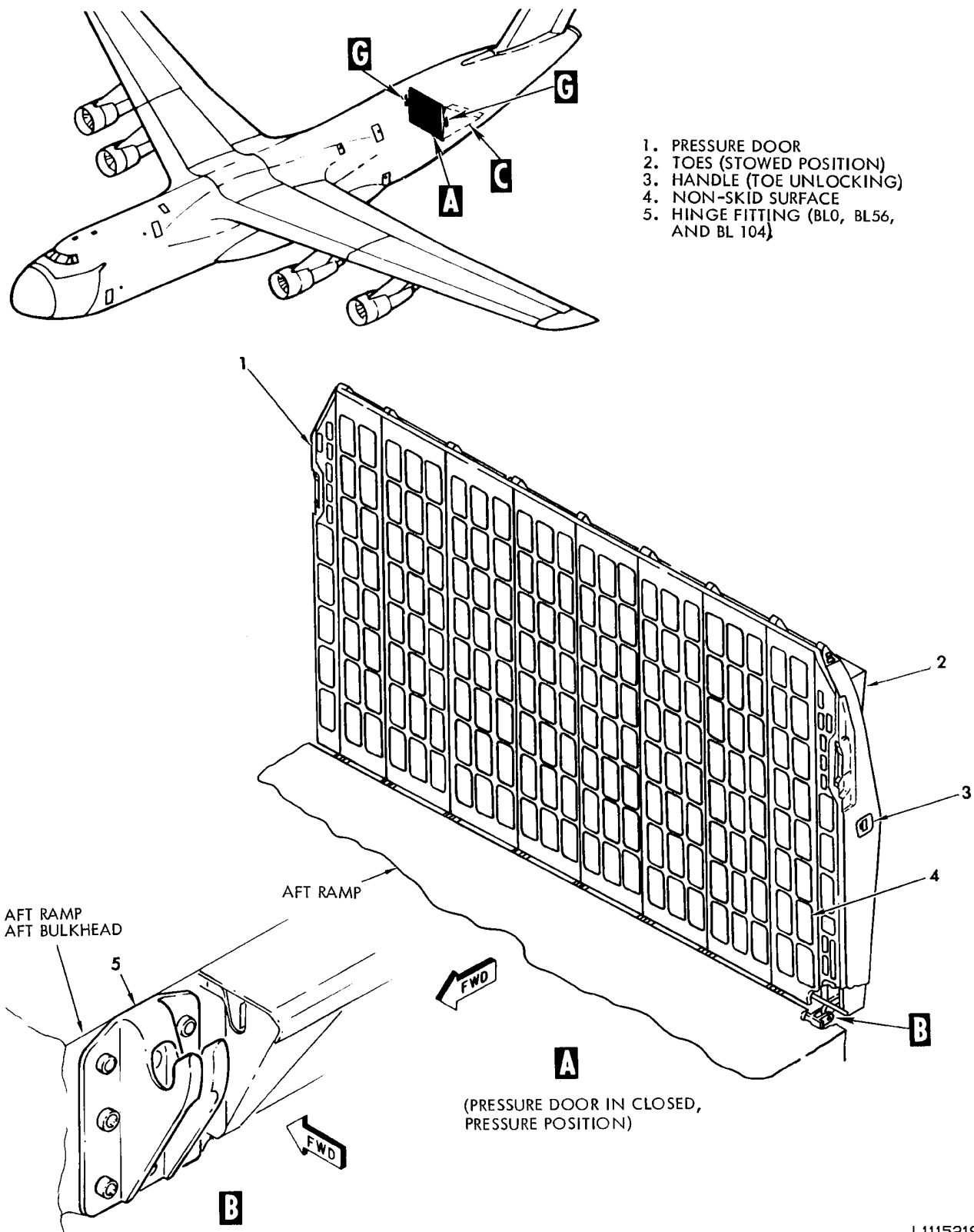


Figure 2-7. Cargo Compartment Walkways and Safety Walks

L1115218



L1115219

Figure 2-8. Pressure Door and Toes (Sheet 1 of 3)

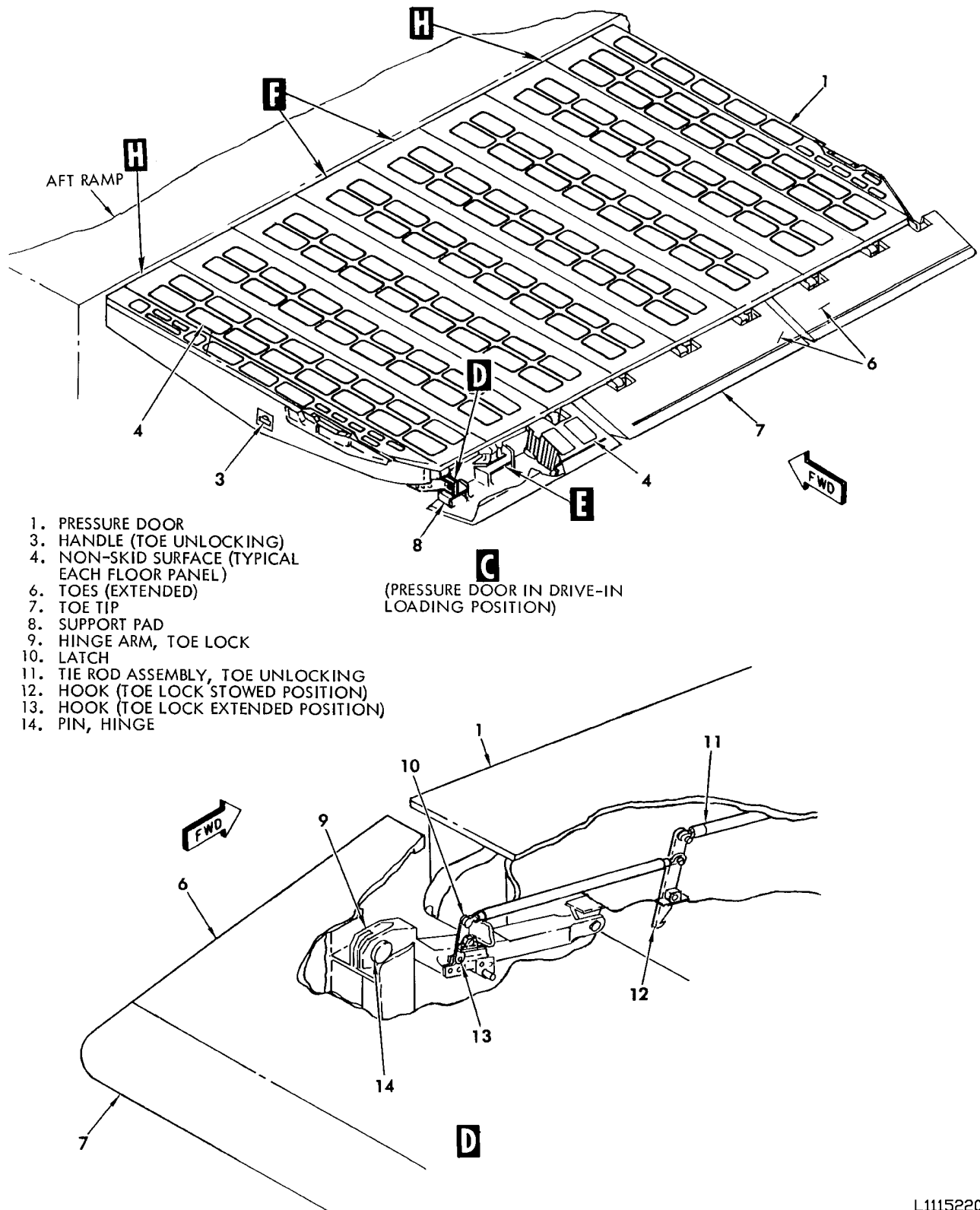
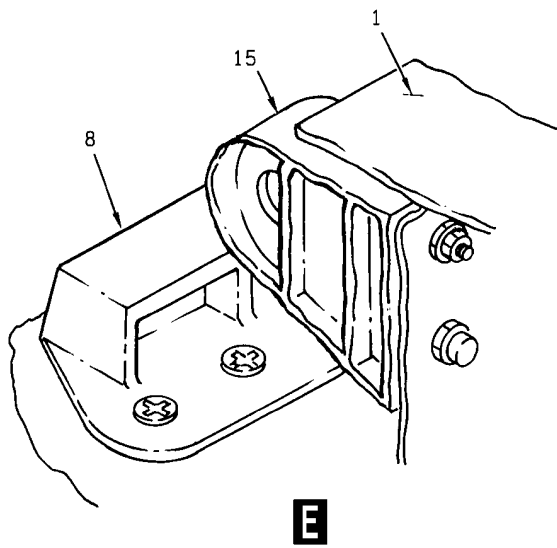
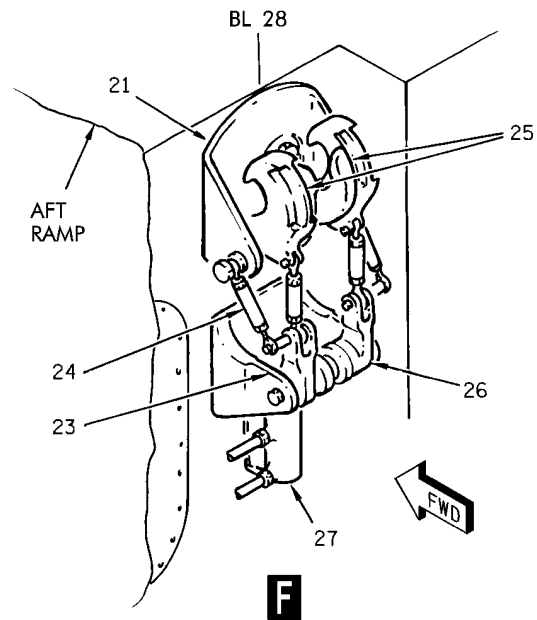
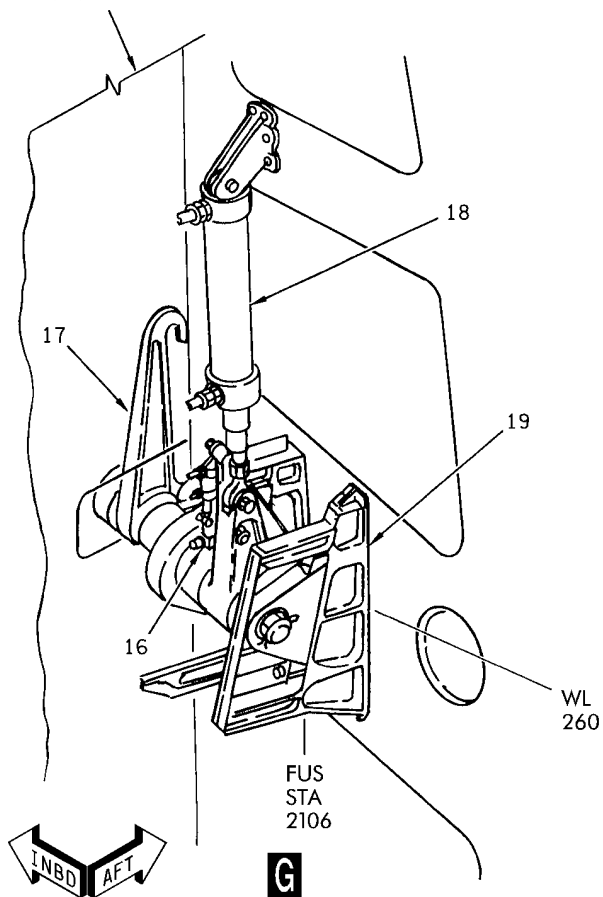


Figure 2-8. Pressure Door and Toes (Sheet 2)

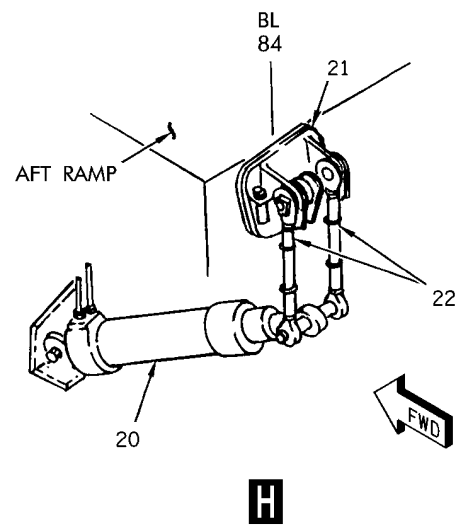
L1115220



AFT FUSELAGE
SIDE WALL
STRUCTURE



1. PRESSURE DOOR
8. SUPPORT PAD
15. FITTING
16. HINGE SELECTOR ACTUATOR
17. UPPER HINGE HOOK
18. UPPER HINGE ACTUATOR
19. SUPPORT FITTING
20. LOWER HINGE ACTUATOR
21. RAMP HINGE FITTING
22. IDLER ARMS, LOWER HINGE
23. BRACKETS
24. LINKS
25. HOOKS
26. BELLCRANK
27. ACTUATING CYLINDER



L1115221

Figure 2-8. Pressure Door and Toes (Sheet 3)

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LOI

CH 1

CH 2

CH 3

CH 4

CH 5

CH 6

PREV

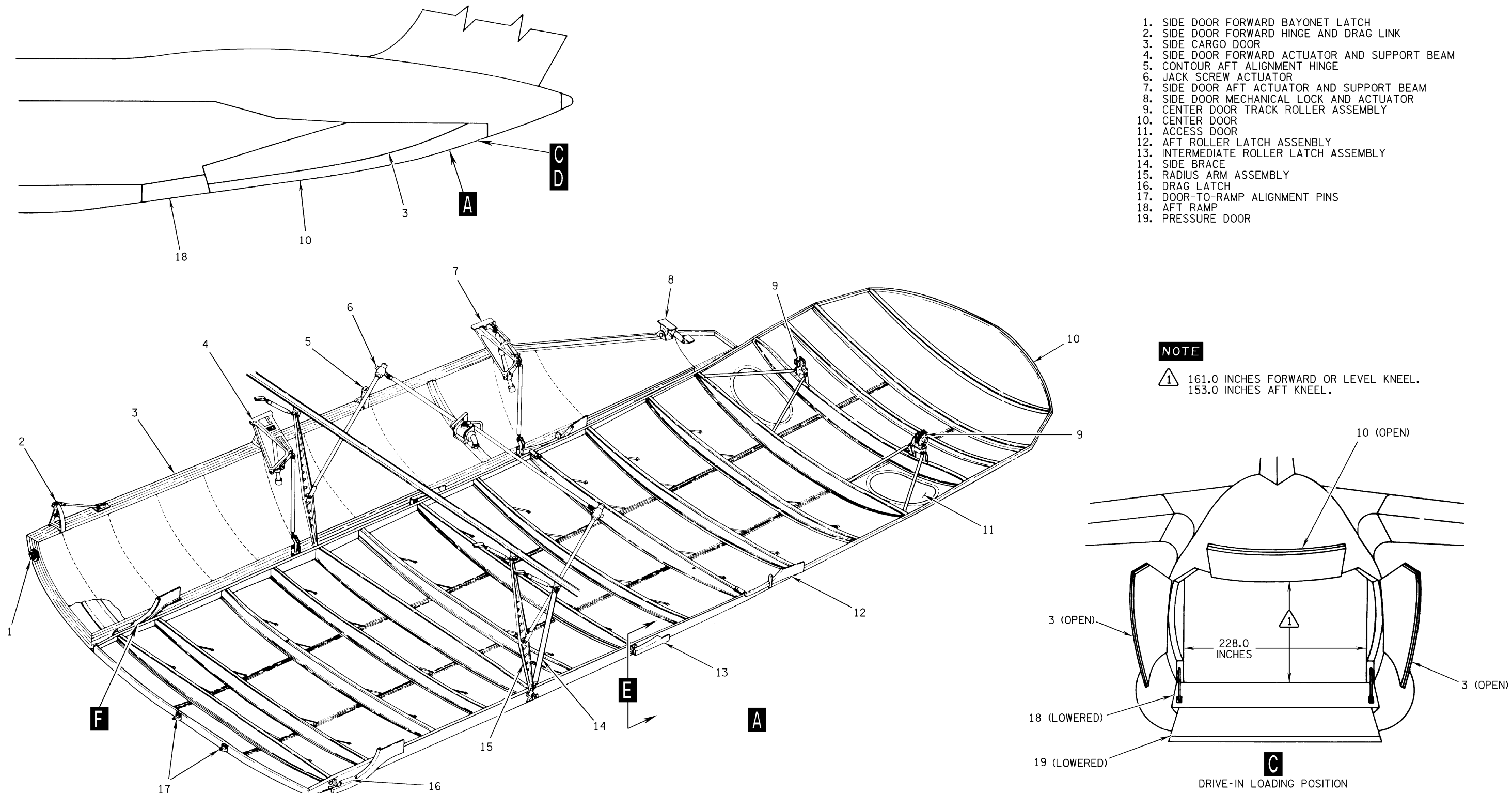
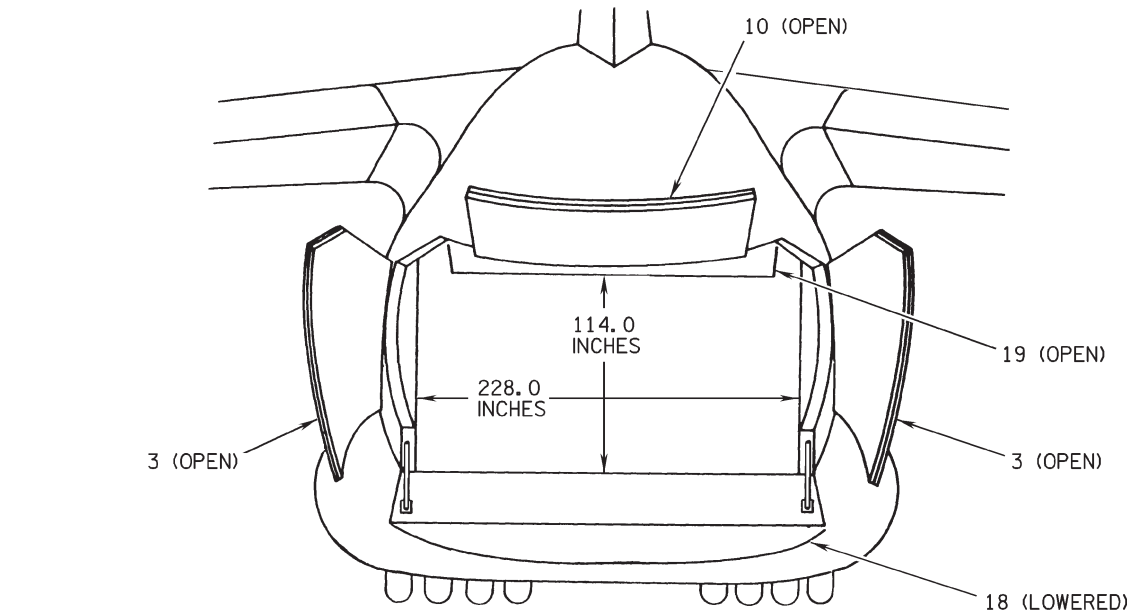
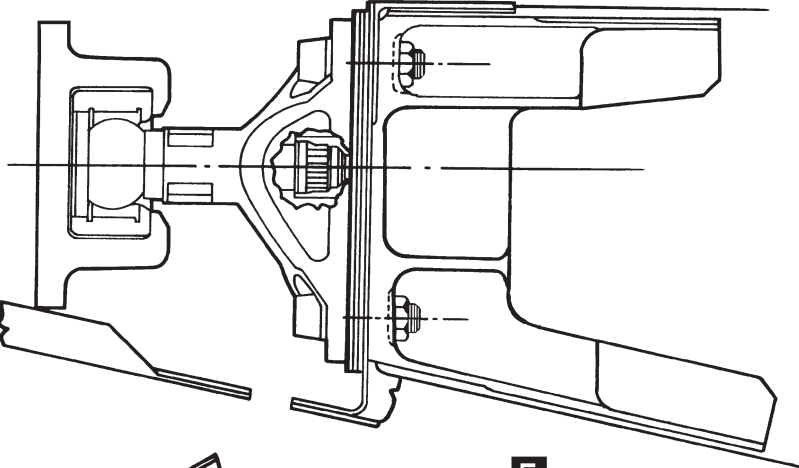


Figure 2-9. Aft Cargo Doors (Sheet 1 of 2)

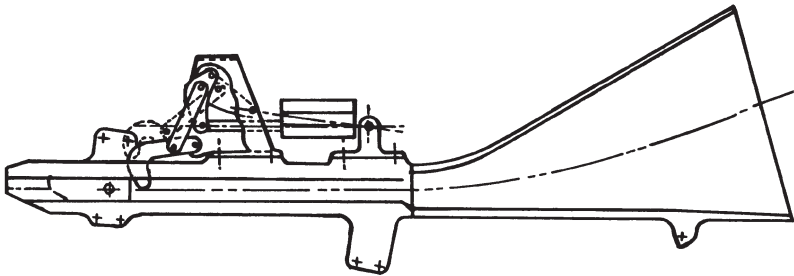


D
TRUCK LOADING POSITION

- 3. SIDE CARGO DOOR
- 10. CENTER DOOR
- 18. AFT RAMP
- 19. PRESSURE DOOR



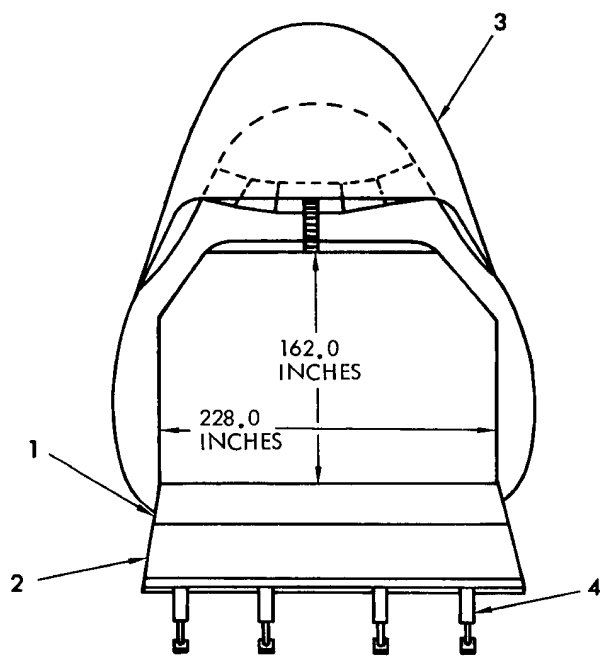
E
(SECTION)
SIDE TO CENTER DOOR TRACK
AND DRAG LATCH



F
CENTER TO SIDE DOOR SLIDE BLOCK ASSEMBLY

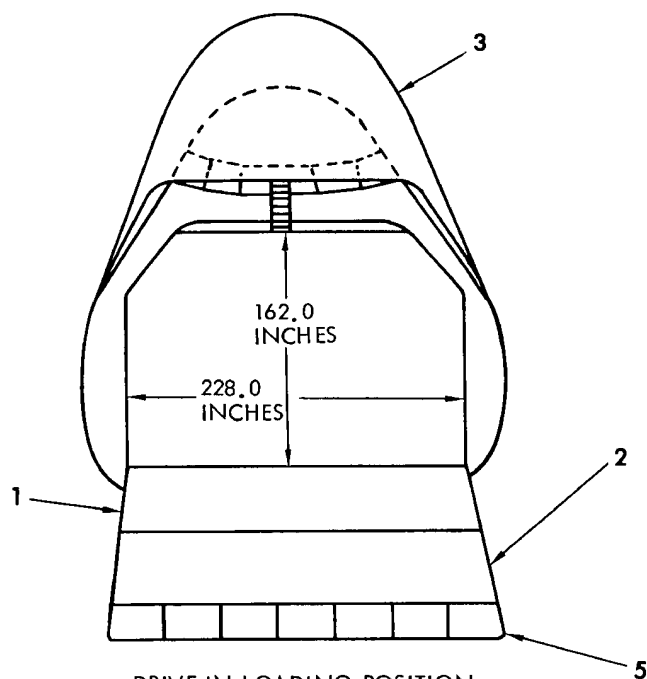
L1115223

Figure 2-9. Aft Cargo Doors (Sheet 2)



TRUCK LOADING POSITION

1. FORWARD RAMP
2. FORWARD RAMP EXTENSION
3. VISOR
4. FORWARD RAMP EXTENSION
SUPPORT JACKS
5. FORWARD RAMP EXTENSION
TOES



DRIVE IN LOADING POSITION

L1115224

Figure 2-10. Forward Cargo Opening Dimensions

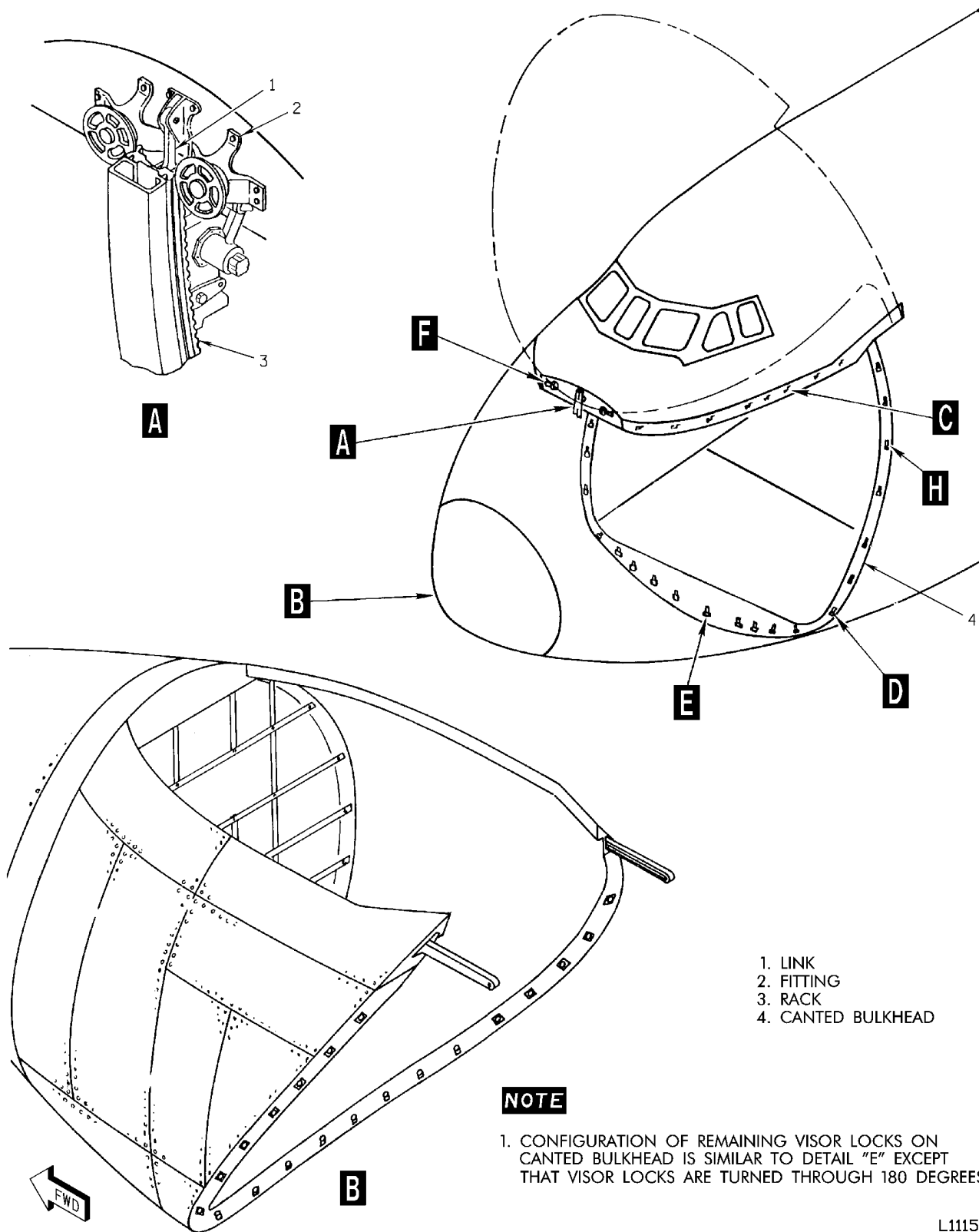
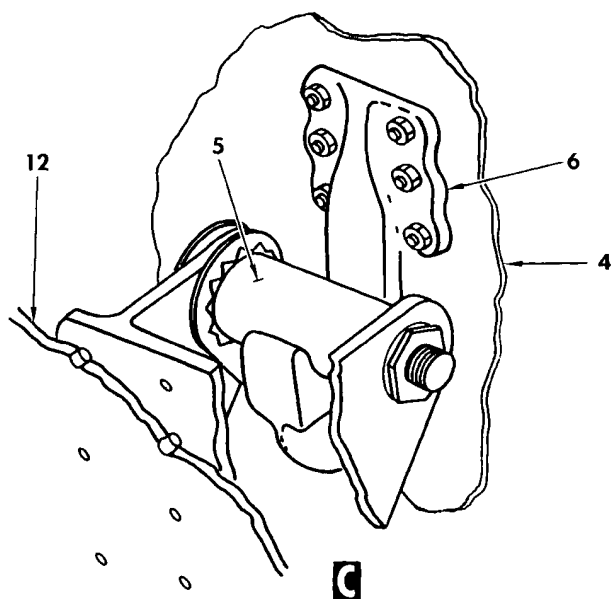
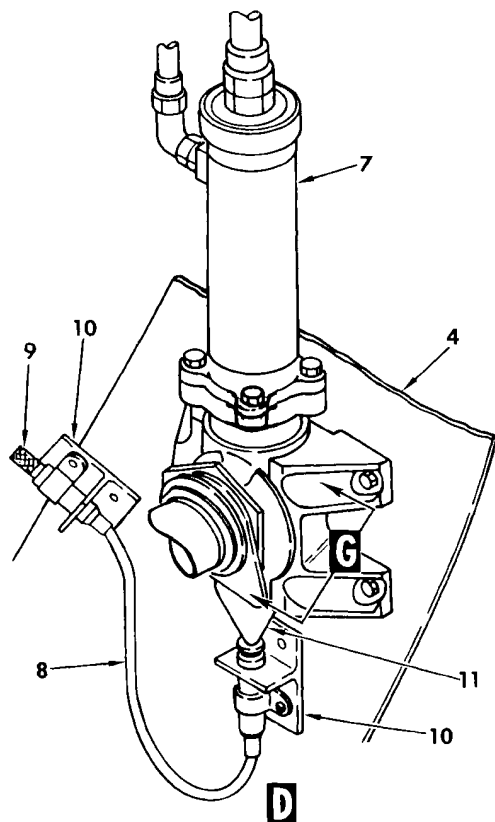


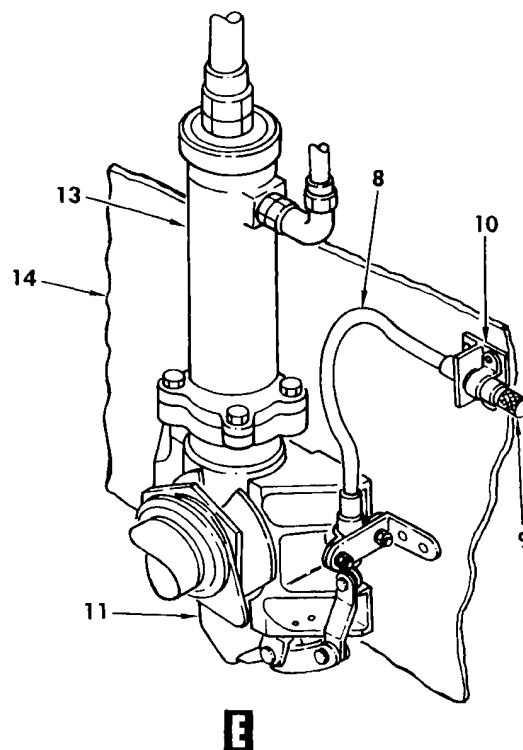
Figure 2-11. Visor Door and Radome (Sheet 1 of 3)



- 4. CANTED BULKHEAD
- 5. ECCENTRIC SPOOL
- 6. HOOK FITTING
- 7. VISOR HYDRAULIC LOCK
(FORWARD FUSELAGE CANTED BULKHEAD)
- 8. INDICATOR CONDUIT
- 9. INDICATOR
- 10. CONDUIT BRACKET
- 11. ACTUATOR LOCK PIN (PISTON)
- 12. VISOR SIDE BULKHEAD
- 13. VISOR HYDRAULIC LOCK,
(RAMP CANTED BULKHEAD)
- 14. RAMP CANTED BULKHEAD



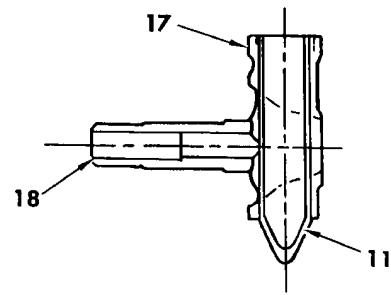
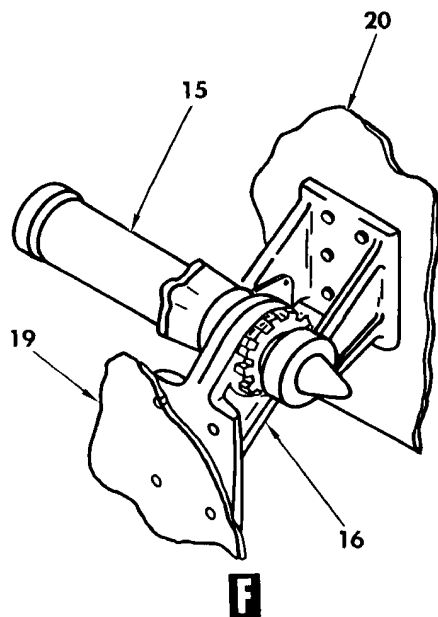
VISOR LOCK AND LOCK VISUAL INDICATOR ON CANTED BULKHEAD, TYPICAL AT LEFT AND RIGHT BL 122, 128, 133, AND 134. LOCKED POSITION SHOWN.



VISOR LOCK AND LOCK VISUAL INDICATOR ON CANTED BULKHEAD, TYPICAL AT LEFT AND RIGHT BL 0, 26, 52, AND 78. LOCKED POSITION SHOWN.

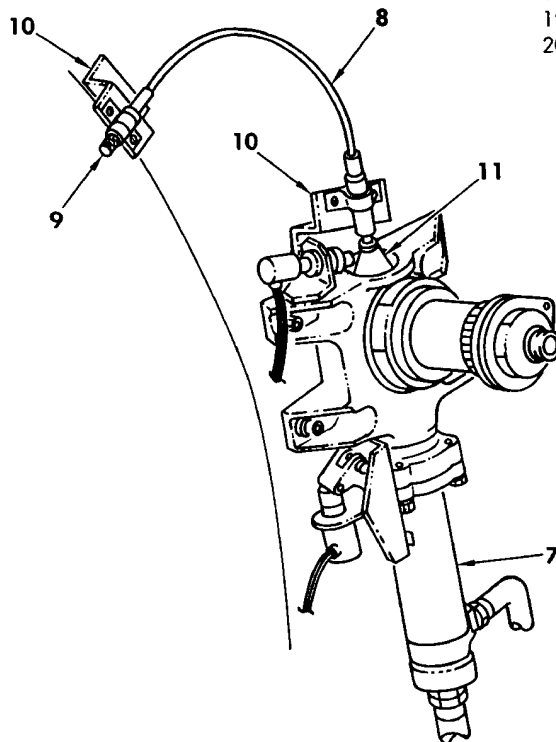
L1115226

Figure 2-11. Visor Door and Radome (Sheet 2)



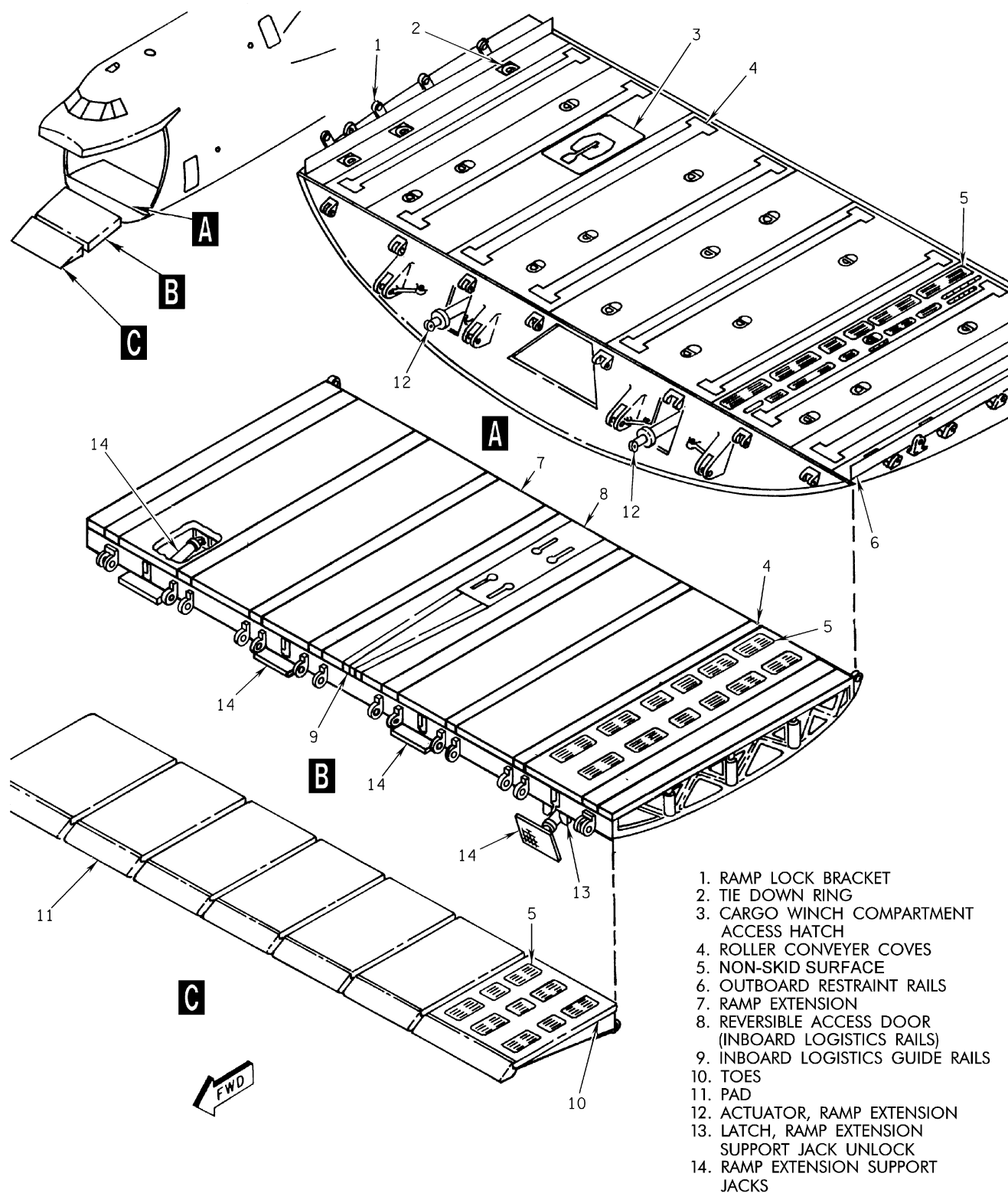
SECTION

- 7. VISOR HYDRAULIC LOCK (FORWARD FUSELAGE CANTED BULKHEAD)
- 8. INDICATOR CONDUIT
- 9. INDICATOR
- 10. CONDUIT BRACKET
- 11. ACTUATOR LOCK PIN (PISTON)
- 15. VISOR DOOR LOCK (FORWARD BULKHEAD)
- 16. VISOR FITTING
- 17. LOCK RECEPTACLE
- 18. LOCK PIN
- 19. VISOR BULKHEAD
- 20. FUSELAGE BULKHEAD



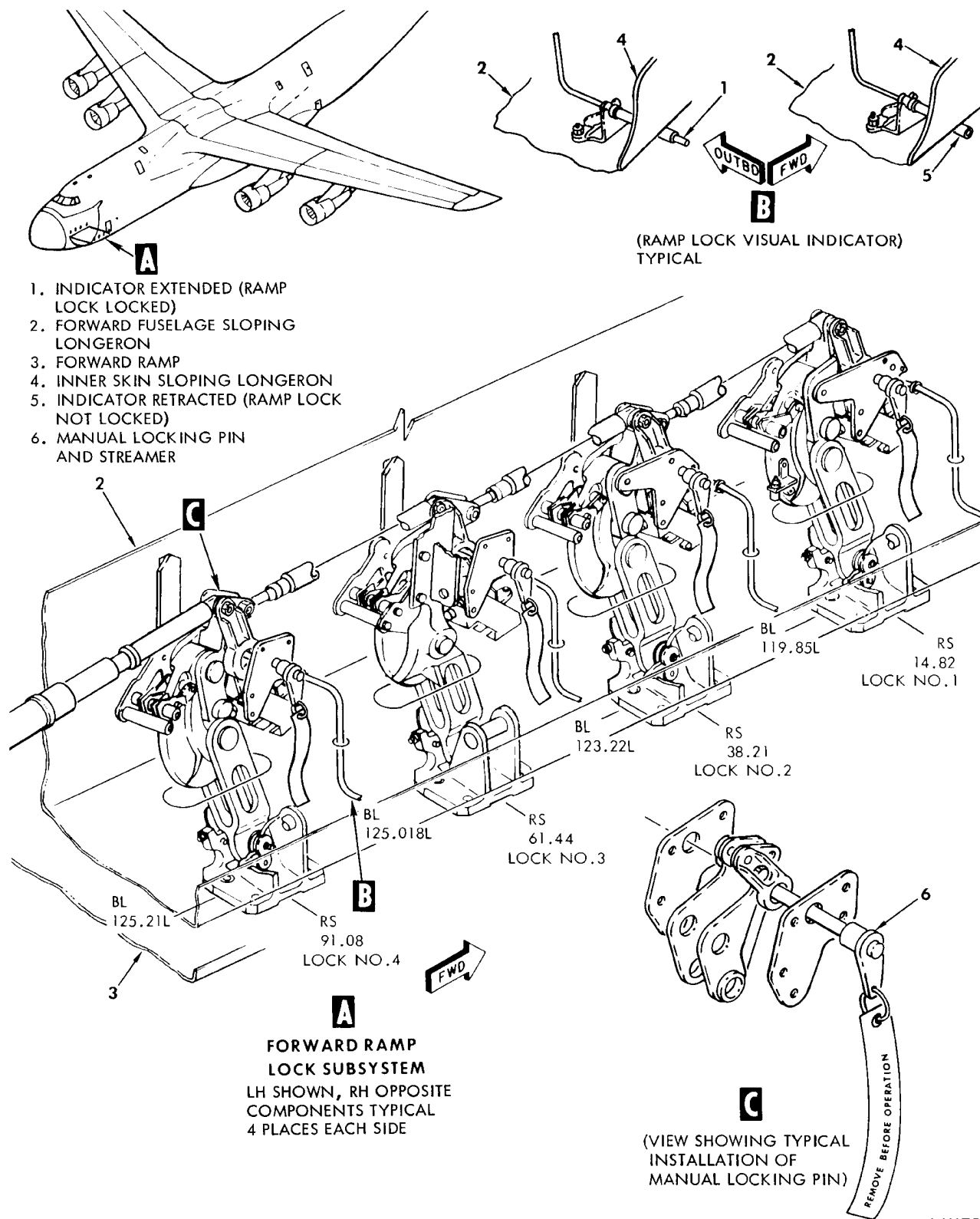
L1115227

Figure 2-11. Visor Door and Radome (Sheet 3)



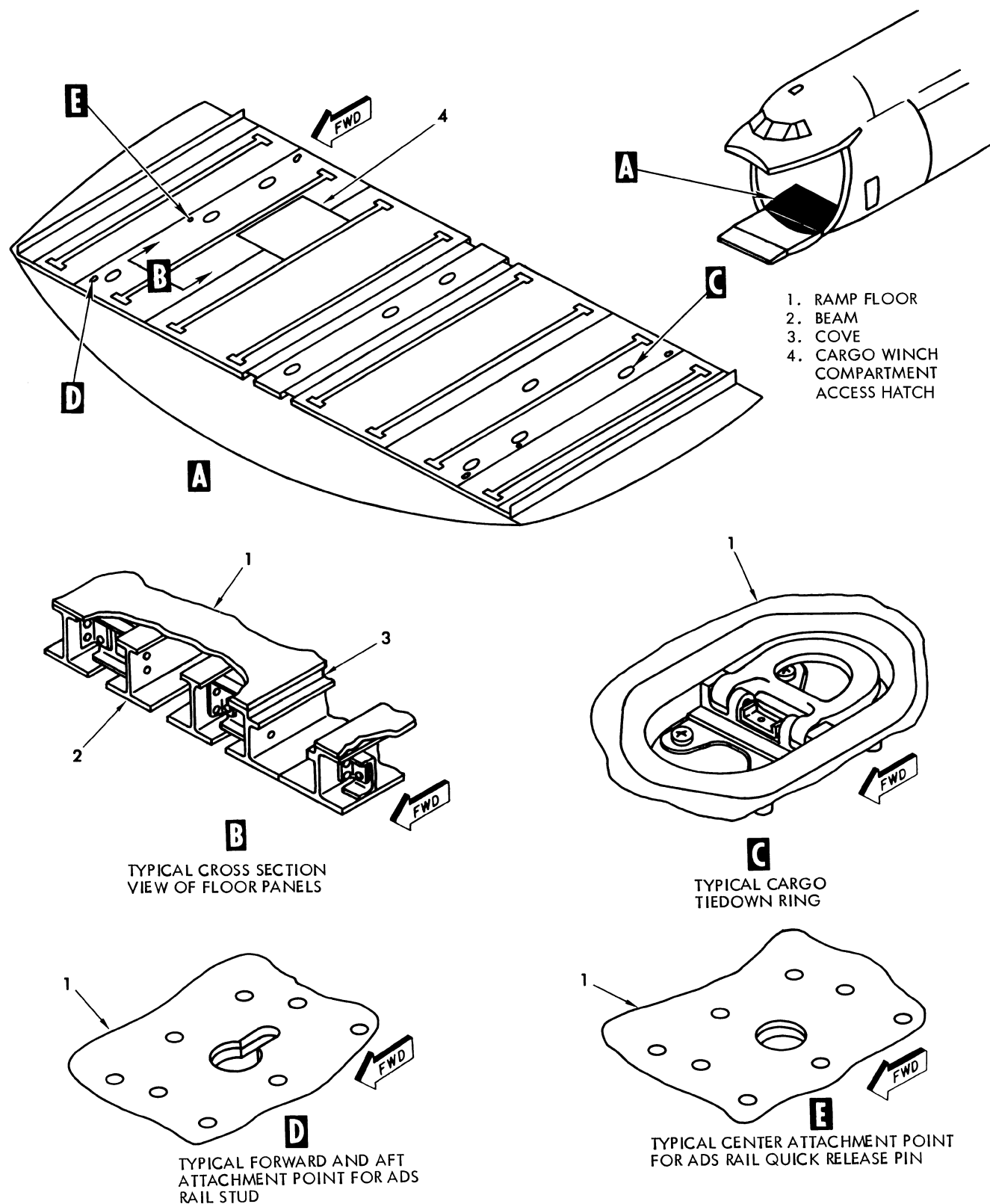
L1115228

Figure 2-12. Forward Cargo Ramp, Ramp Extension and Toes



L1115229

Figure 2-13. Forward Ramp Locks



L1115230

Figure 2-14. Forward Cargo Ramp Floor Panels

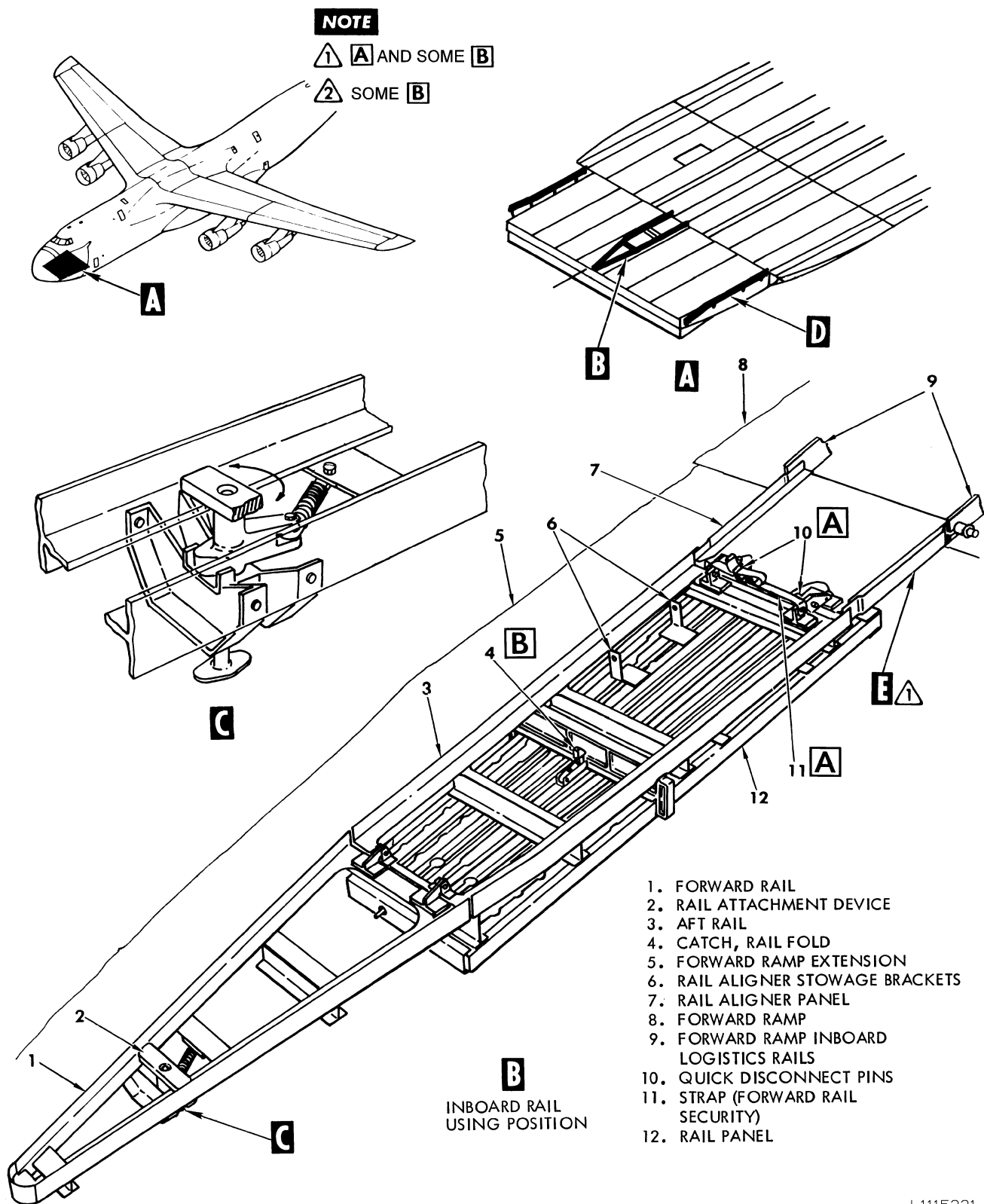
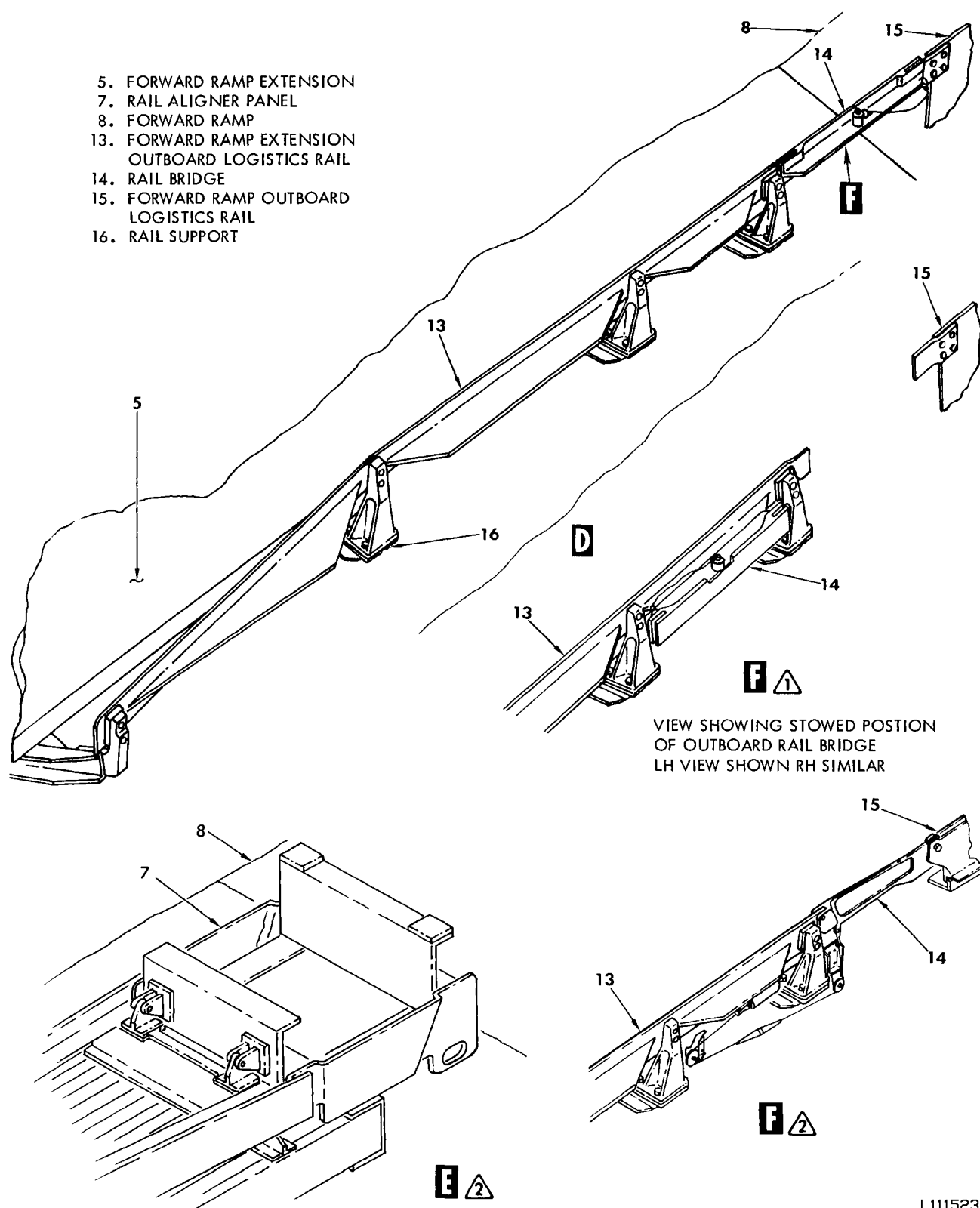


Figure 2-15. Forward Ramp Extension Logistics Rails and Detent Mechanisms (Sheet 1 of 2)



L1115232

Figure 2-15. Forward Ramp Extension Logistics Rails and Detent Mechanisms (Sheet 2)

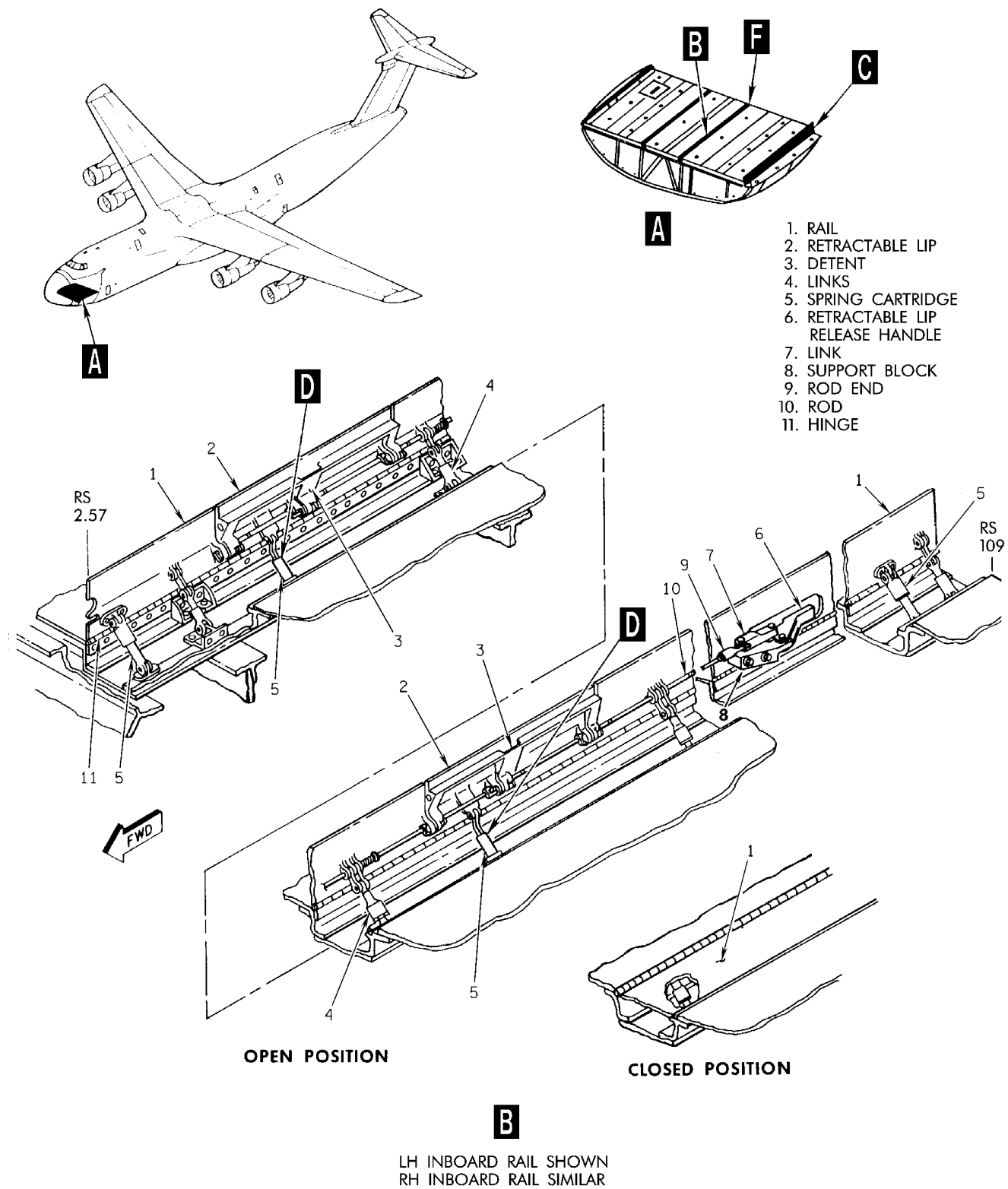
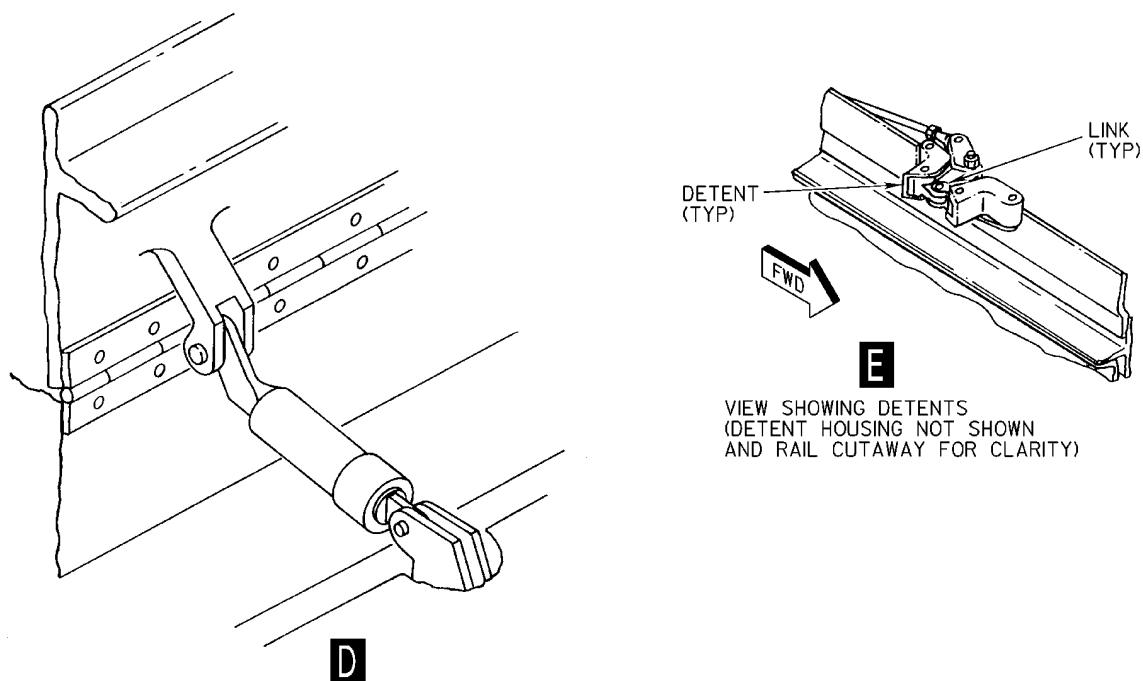
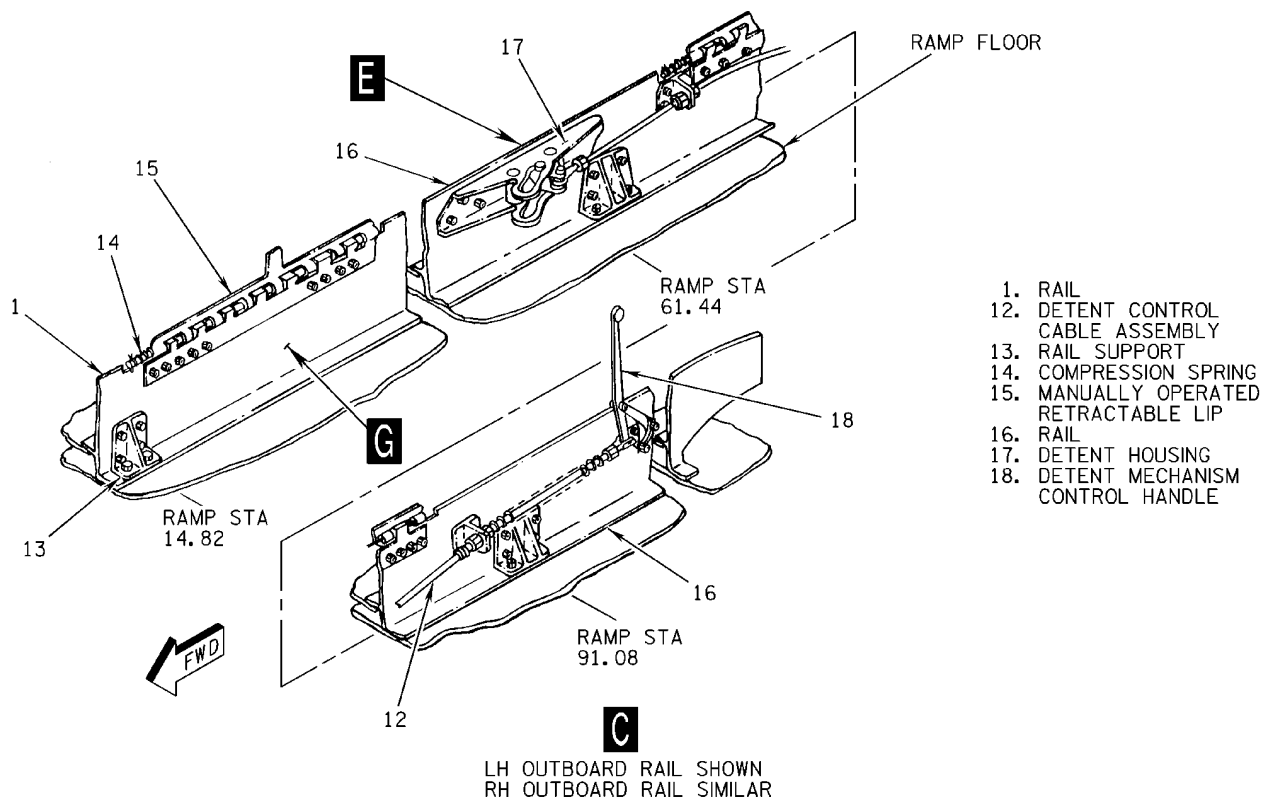
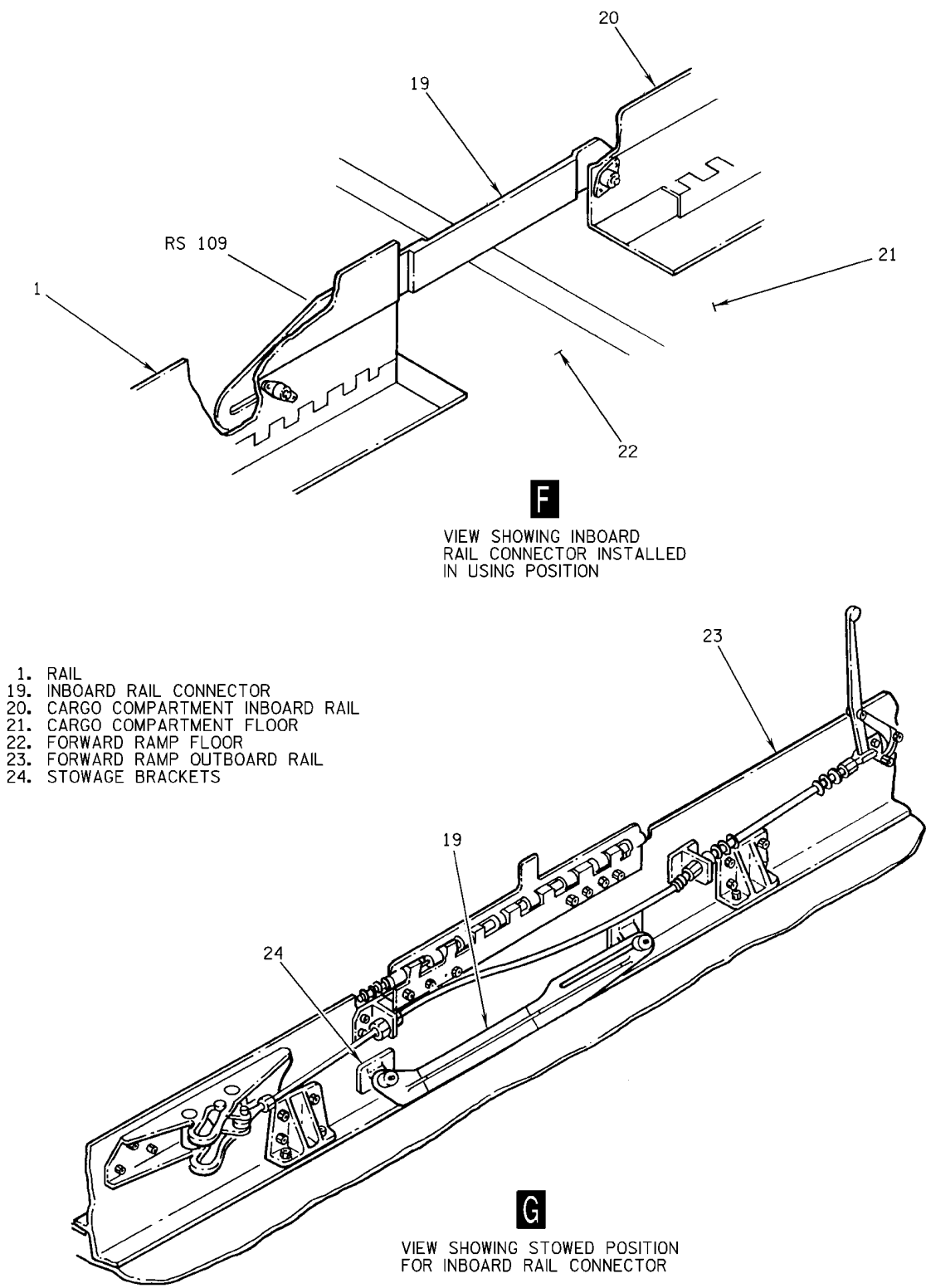


Figure 2-16. Forward Ramp Logistics Rails and Detent Mechanisms (Sheet 1 of 3)



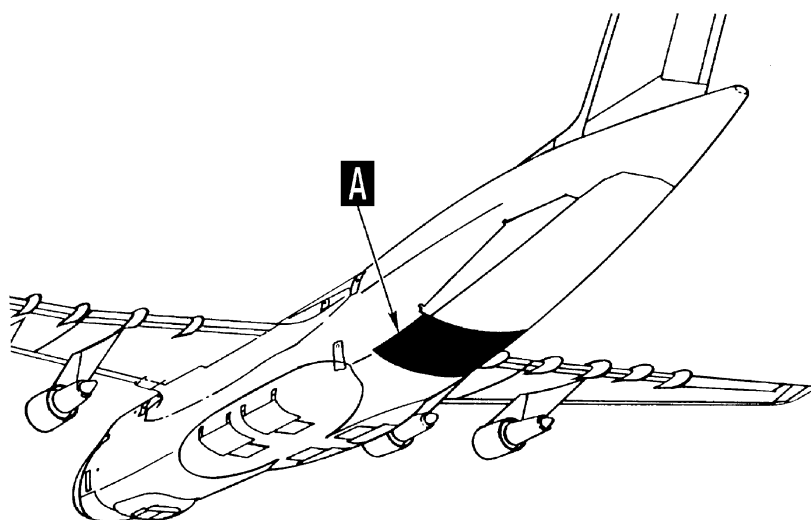
L1115234

Figure 2-16. Forward Ramp Logistics Rails and Detent Mechanisms (Sheet 2)



L1115235

Figure 2-16. Forward Ramp Logistics Rails and Detent Mechanisms (Sheet 3)



1. NON-SKID SURFACE
2. INBOARD LOGISTICS RAILS (SHOWN CLOSED)
3. ROLLER CONVEYOR COVE
4. OUTBOARD LOGISTICS RAIL
5. BRACKET CARGO RAMP LOCK
6. RAMP ACTUATOR FITTING
7. PRESSURE DOOR HINGES
8. PRESSURE DOOR LOWER ACTUATOR
9. SUPPORT PAD GROUND LOADING (SHOWN IN STOWED POSITION)
10. CARGO WINCH COMPARTMENT ACCESS HATCH

NOTE

RAMP STATIONS ARE BASED ON RAMP FLOOR AT 10° ANGLE TO HORIZONTAL (WL 140), RAMP CLOSED POSITION.

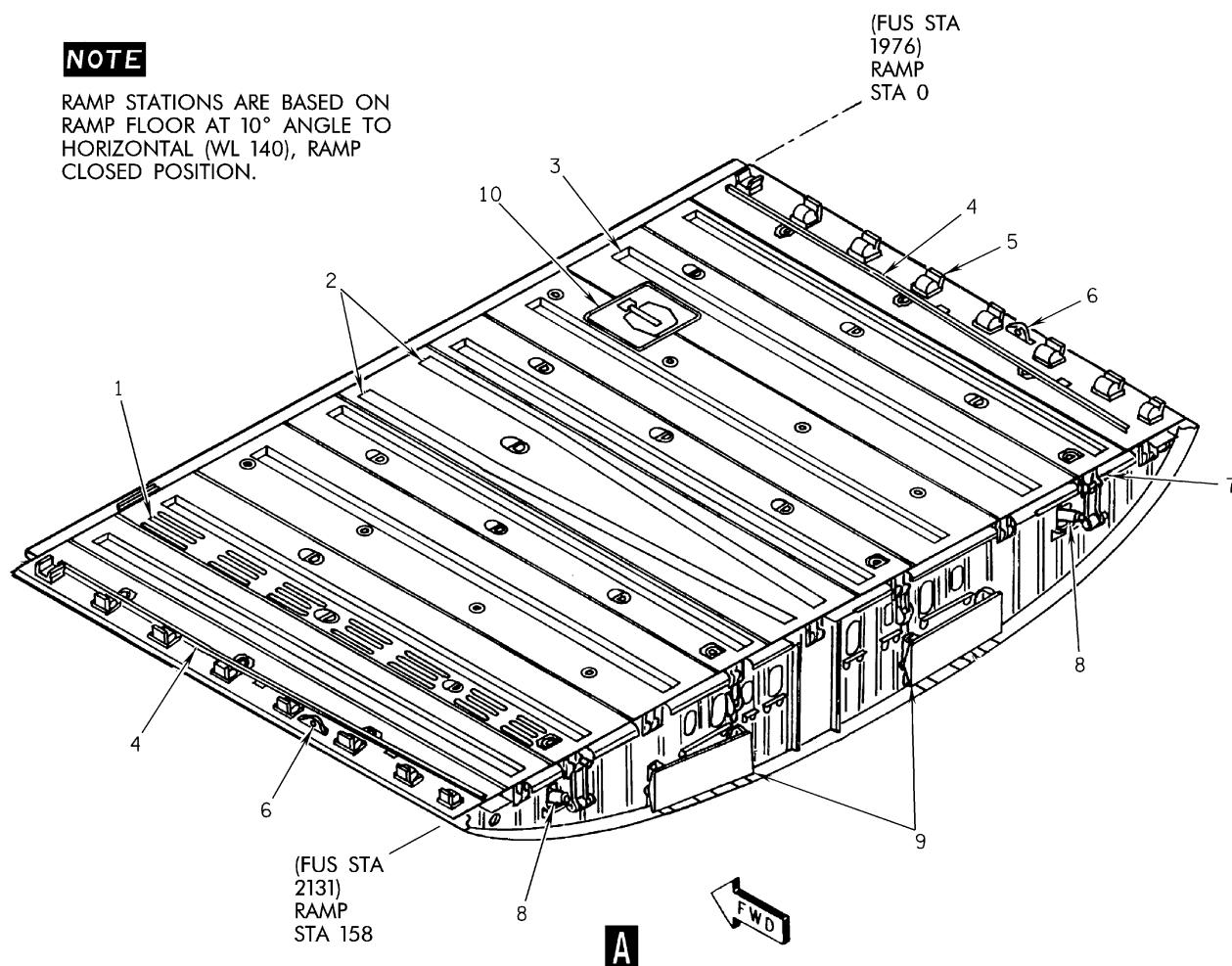
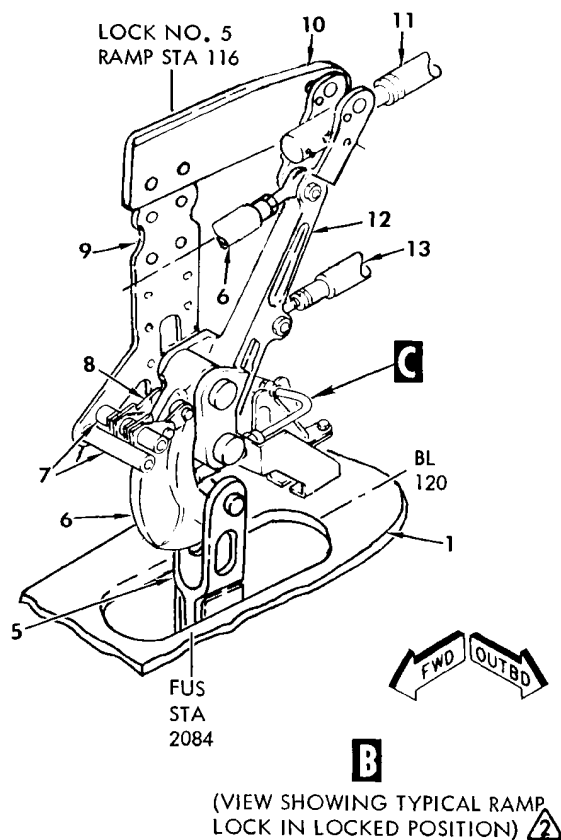
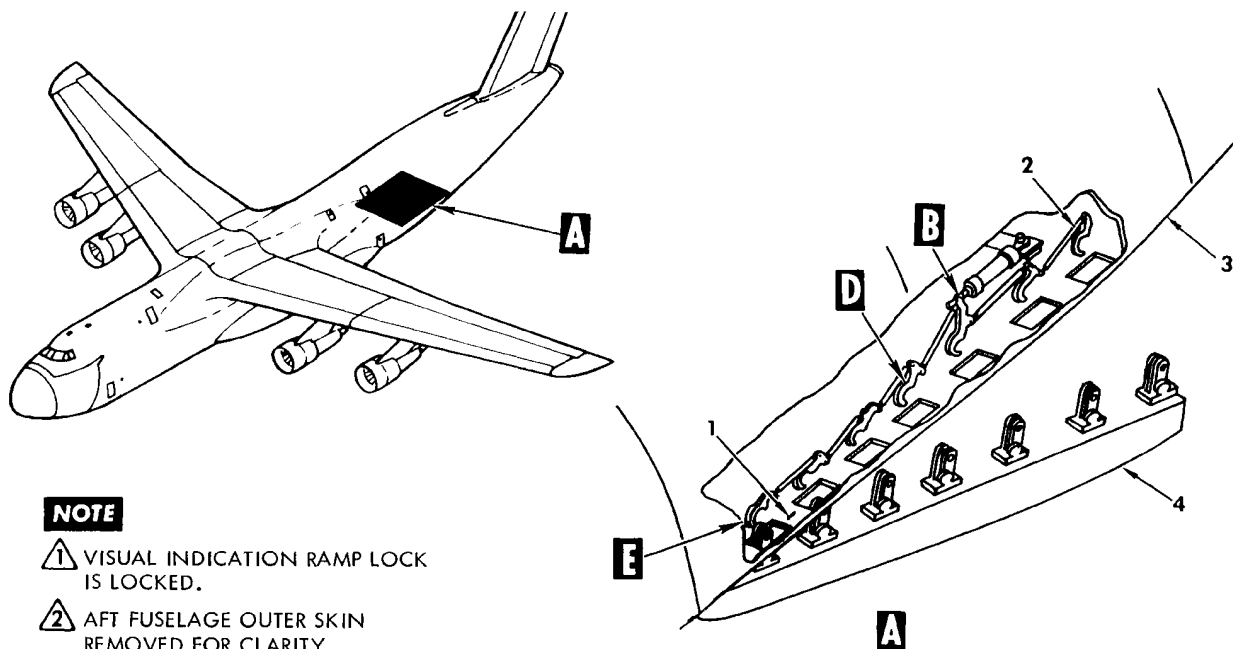


Figure 2-17. Aft Cargo Ramp

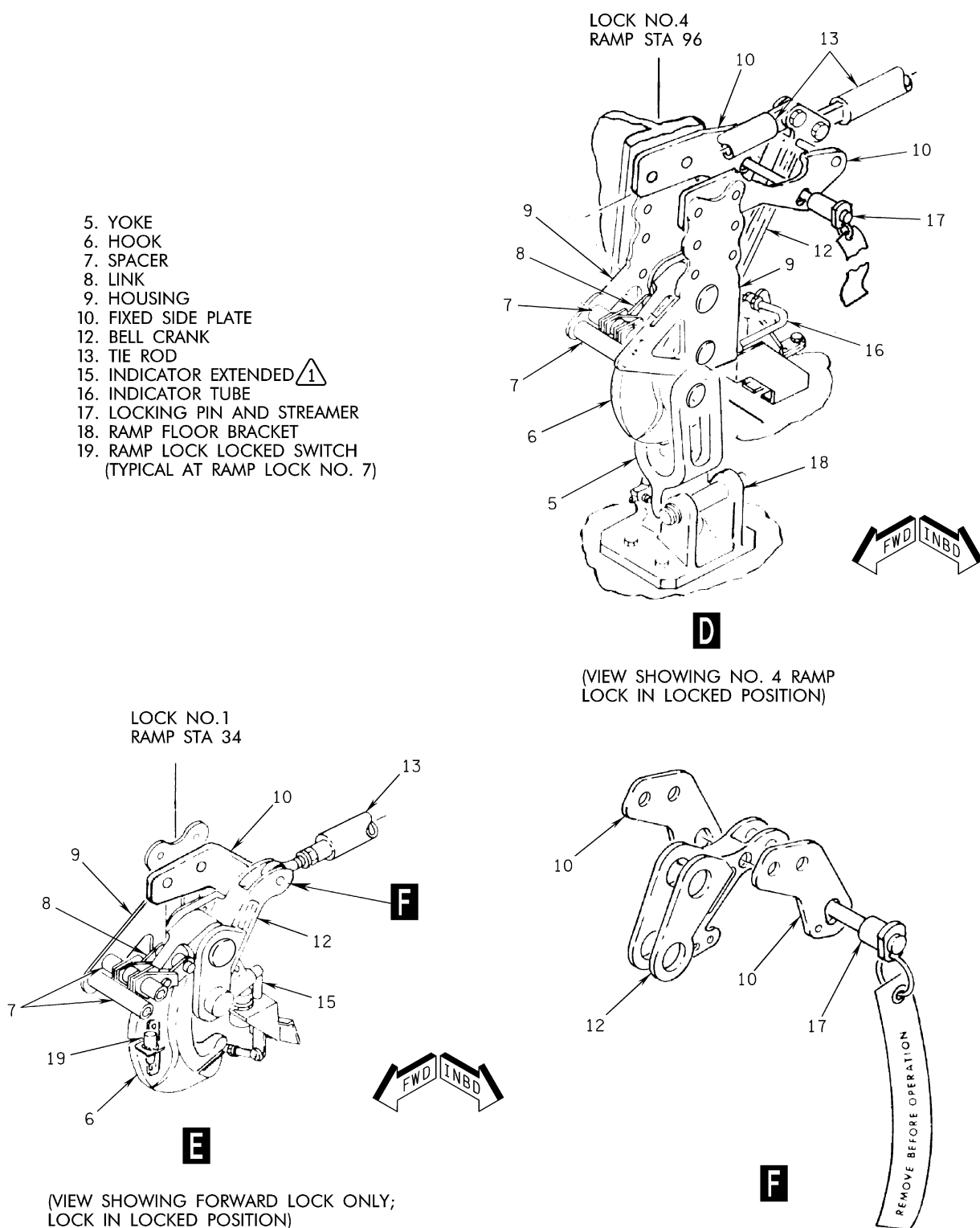
L1115236



1. AFT FUSELAGE SLOPING LONGERON
2. RAMP LOCK MECHANISM
3. AFT FUSELAGE INNER SKIN
4. AFT RAMP
5. YOKE
6. HOOK
7. SPACER
8. LINK
9. HOUSING
10. FIXED SIDE PLATE
11. LOCK ACTUATOR
12. BELLCRANK
13. TIE ROD
14. INNER SKIN SLOPING LONGERON
15. INDICATOR EXTENDED **A**
16. INDICATOR TUBE

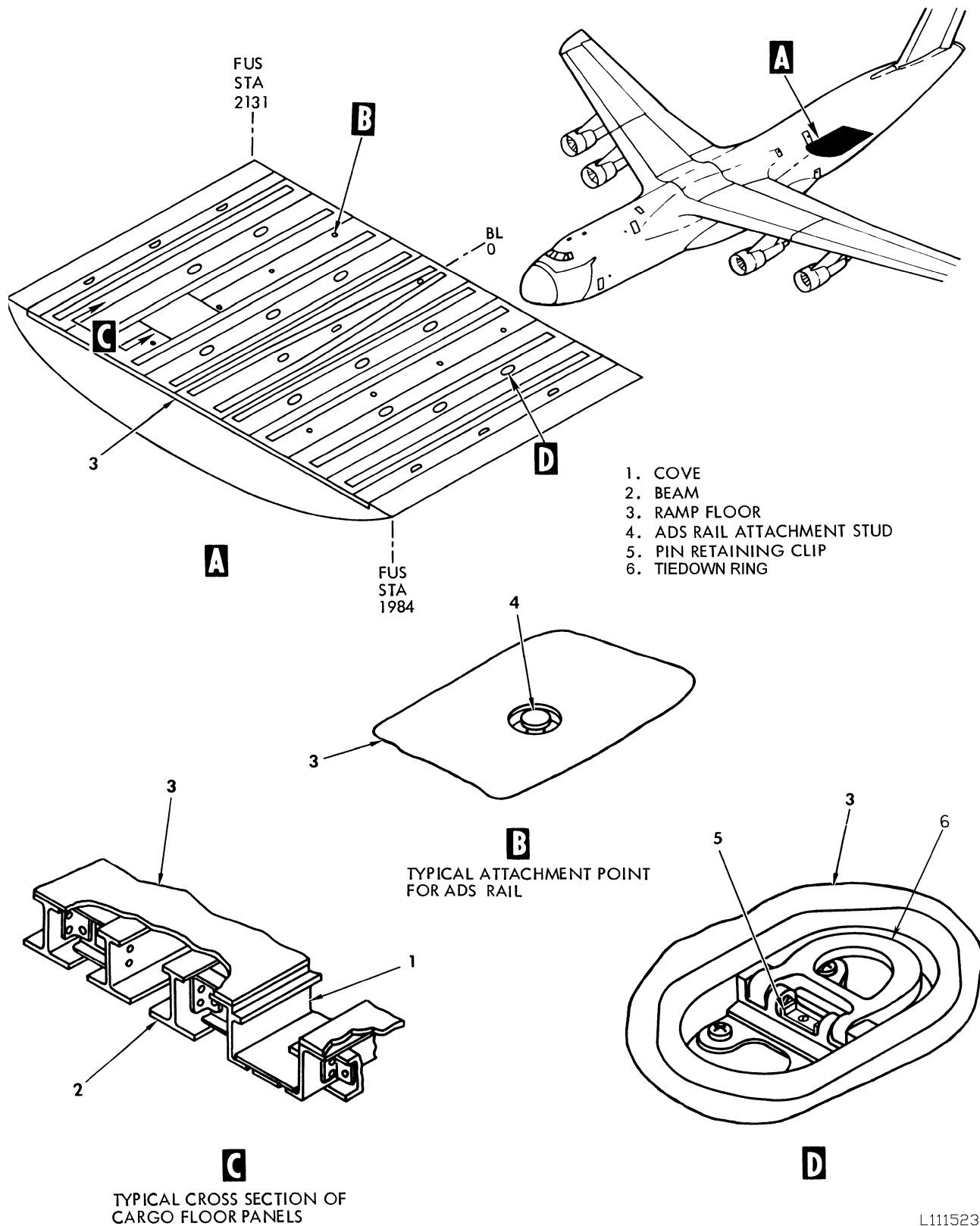
L1115237

Figure 2-18. Aft Ramp Locks (Sheet 1 of 2)



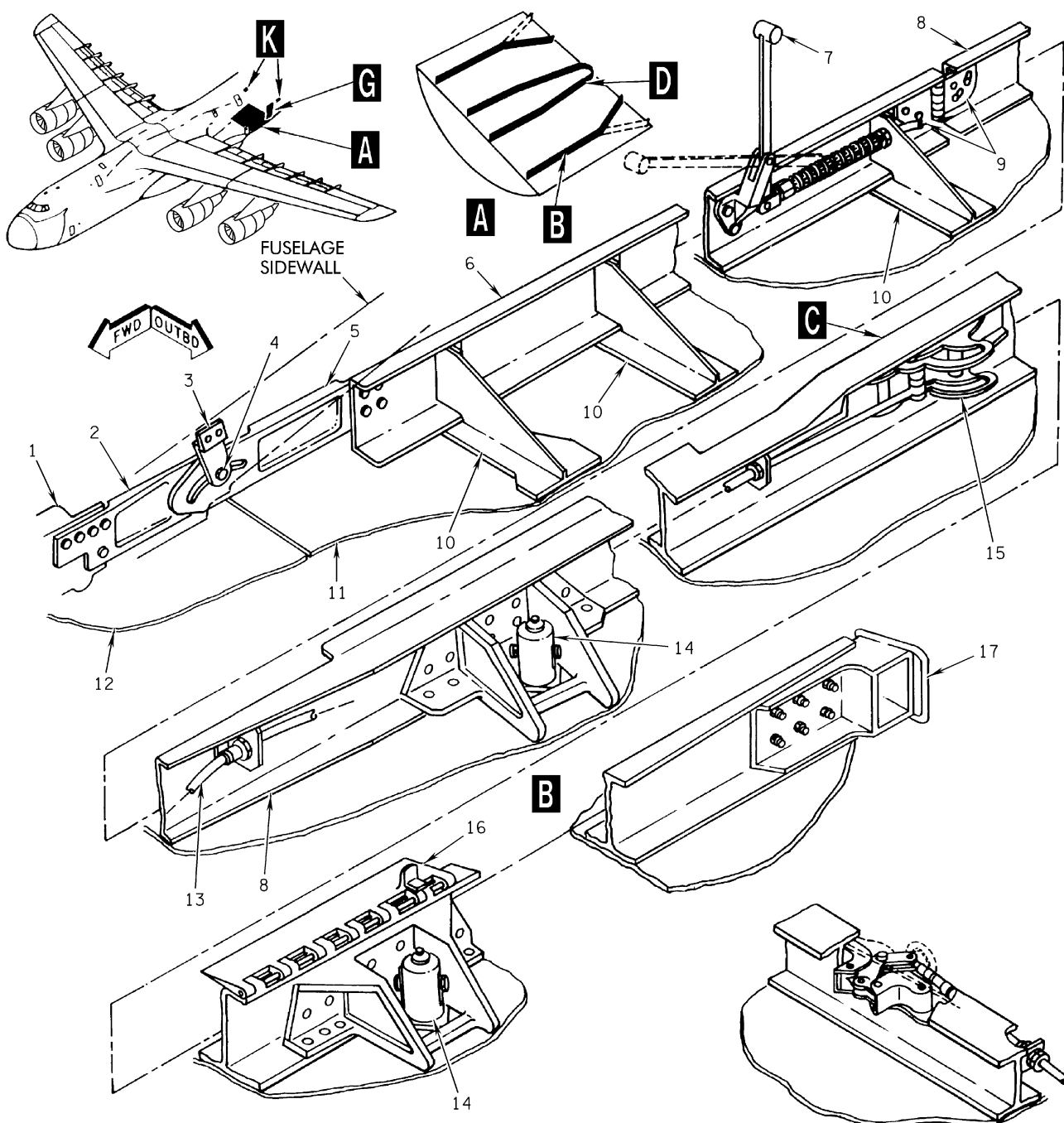
L1115238

Figure 2-18. Aft Ramp Locks (Sheet 2)



L1115239

Figure 2-19. Aft Cargo Ramp Floor Panels

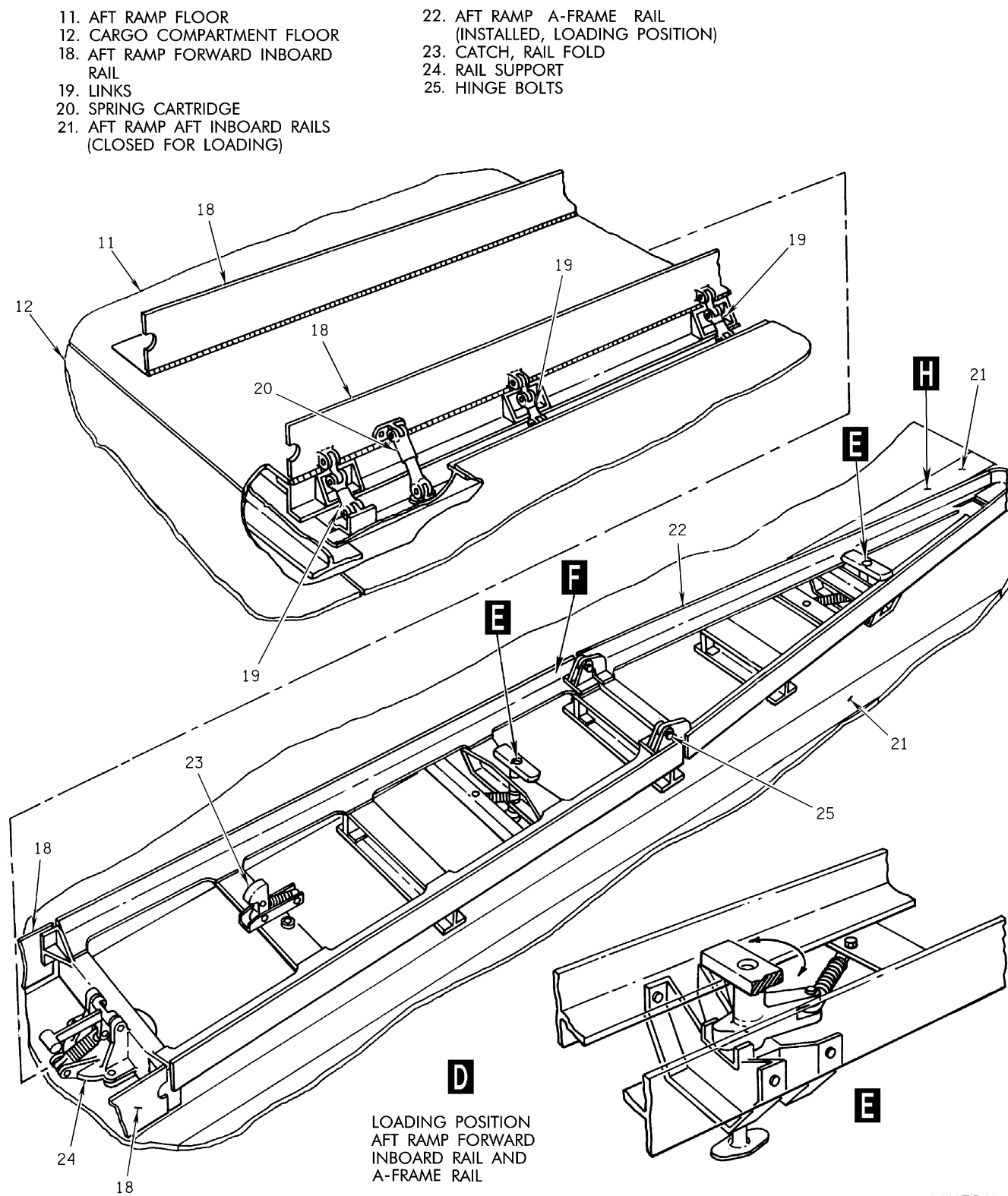


1. CARGO COMPARTMENT OUTBOARD RAIL	9. HINGE
2. FORWARD RAIL CONNECTOR	10. BRACKETS, RAIL BRACING
3. BRACKET	11. AFT RAMP FLOOR
4. CONNECTING HARDWARE	12. CARGO COMPARTMENT FLOOR
5. AFT RAIL CONNECTOR	13. TELEFLEX CONTROL
6. AFT RAMP FORWARD RAIL	14. QUICK-RELEASE COUPLING
7. DETENT MECHANISM CONTROL HANDLE	15. DETENT MECHANISM
8. AFT RAMP AFT RAIL	16. RETRACTABLE LIP
	17. BUMPER

C
VIEW SHOWING TYPICAL DETENT ASSEMBLY (RAIL CUTAWAY FOR CLARITY)

L1115240

Figure 2-20. Aft Cargo Ramp Logistics Rails and Detent Mechanisms (Sheet 1 of 4)



L1115241

Figure 2-20. Aft Cargo Ramp Logistics Rails and Detent Mechanisms (Sheet 2)

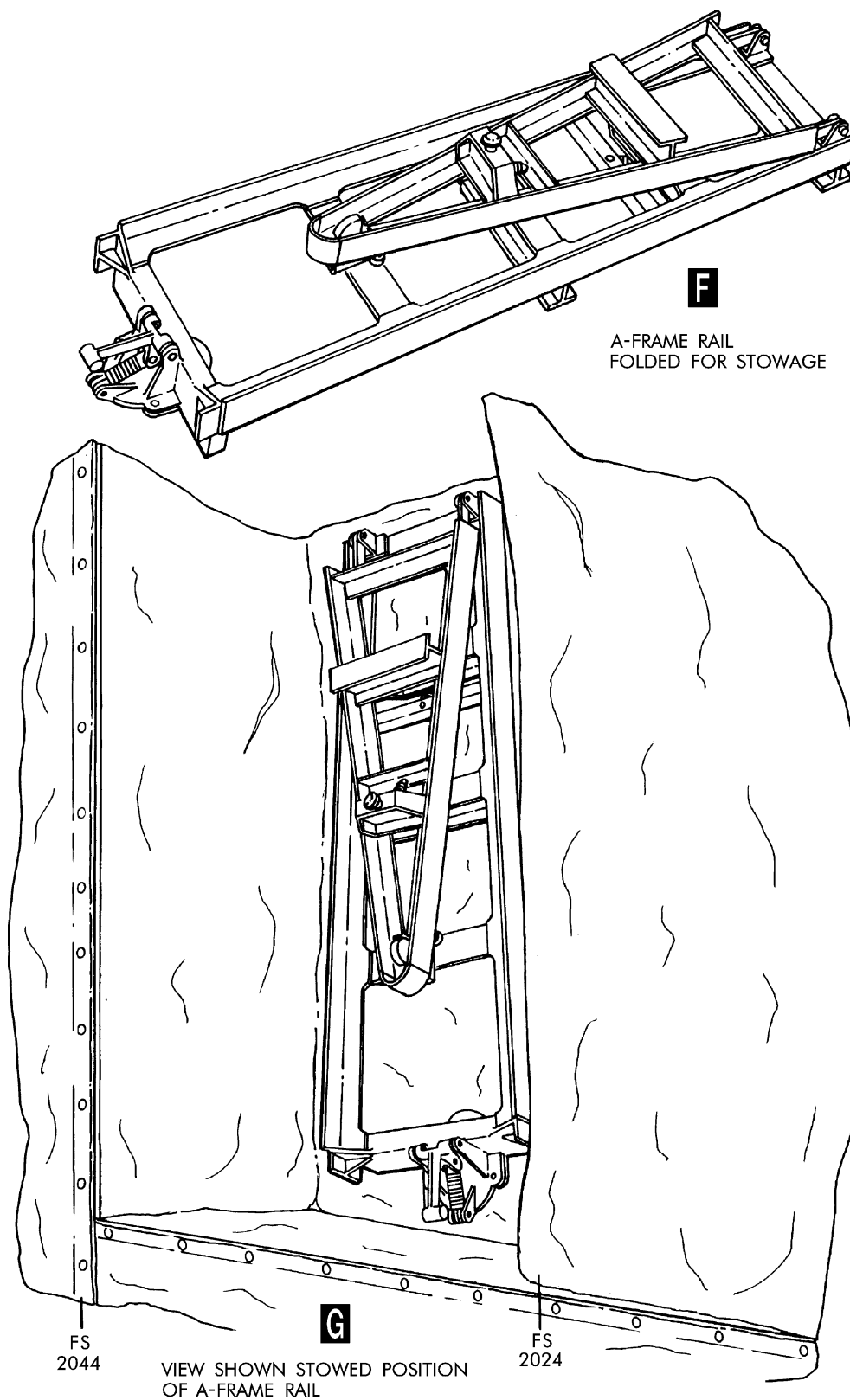


Figure 2-20. Aft Cargo Ramp Logistics Rails and Detent Mechanisms (Sheet 3)

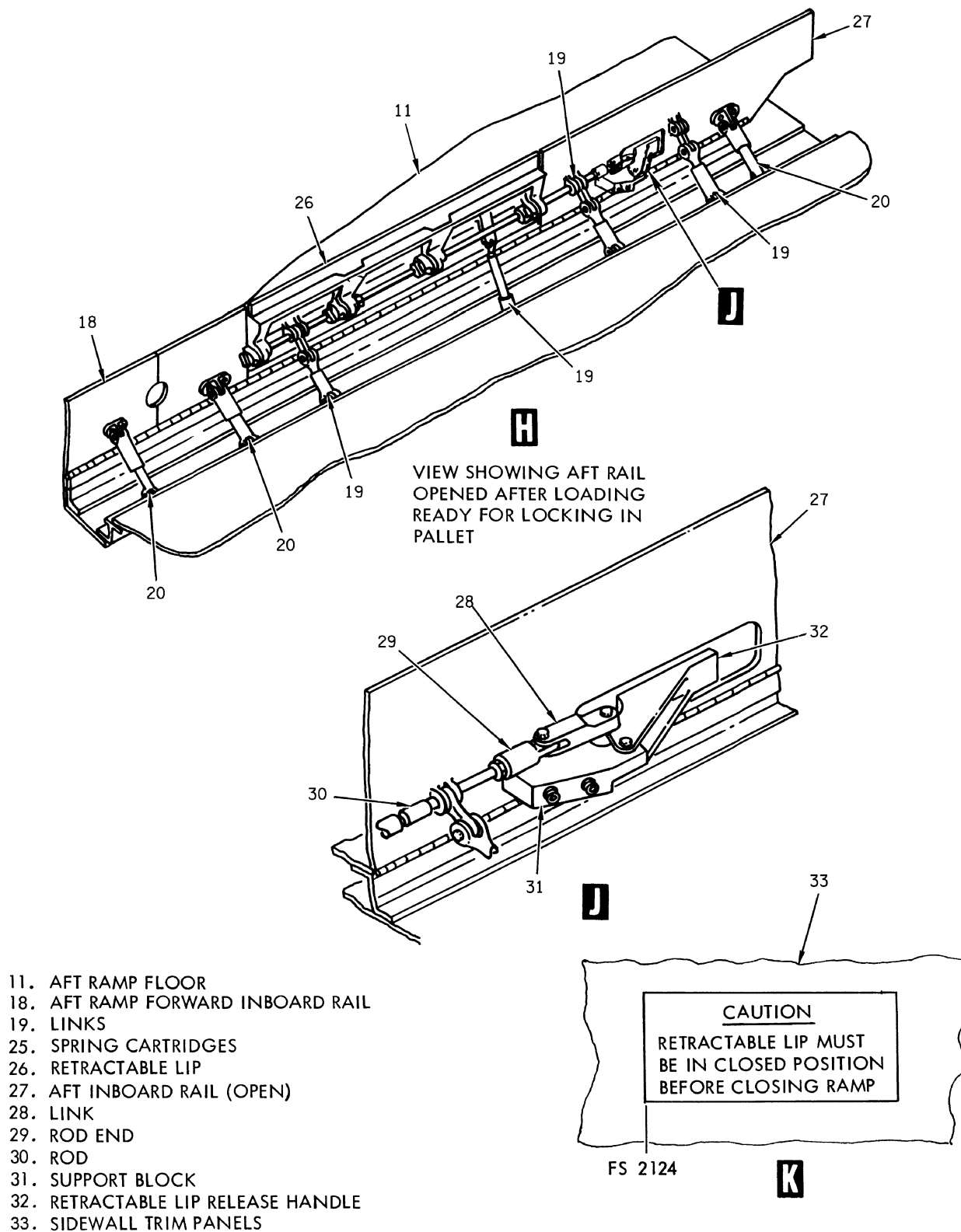


Figure 2-20. Aft Cargo Ramp Logistics Rails and Detent Mechanisms (Sheet 4)

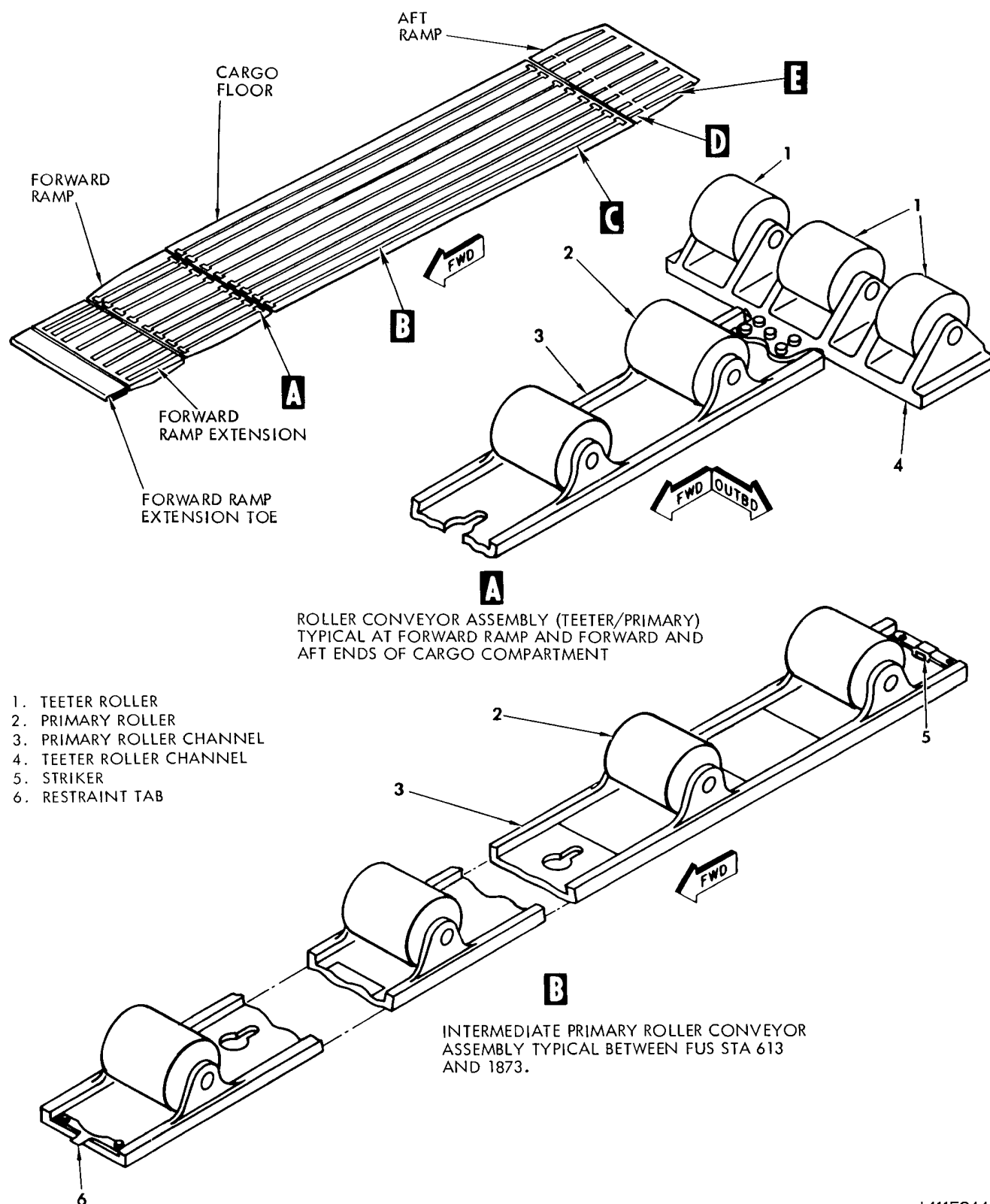
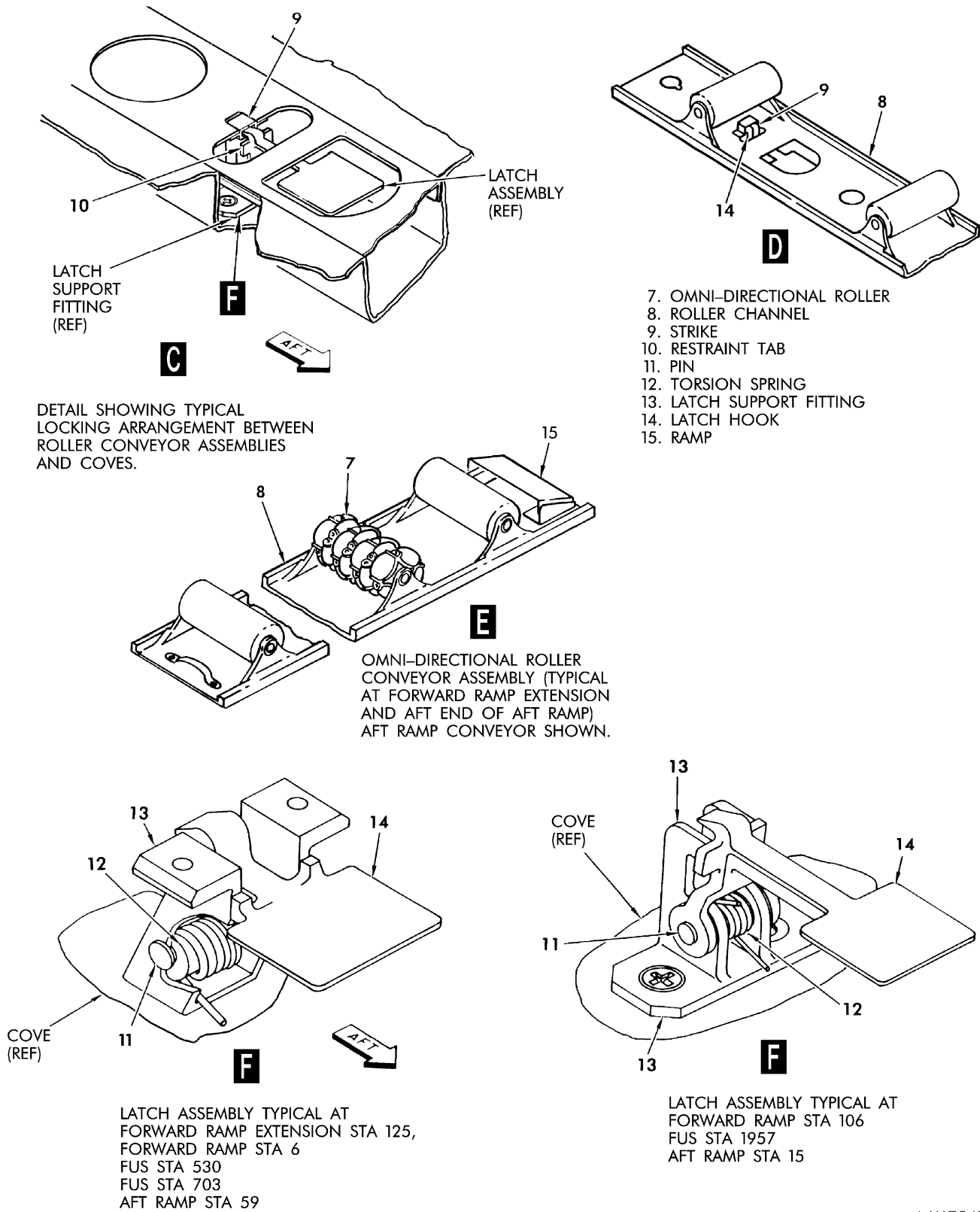


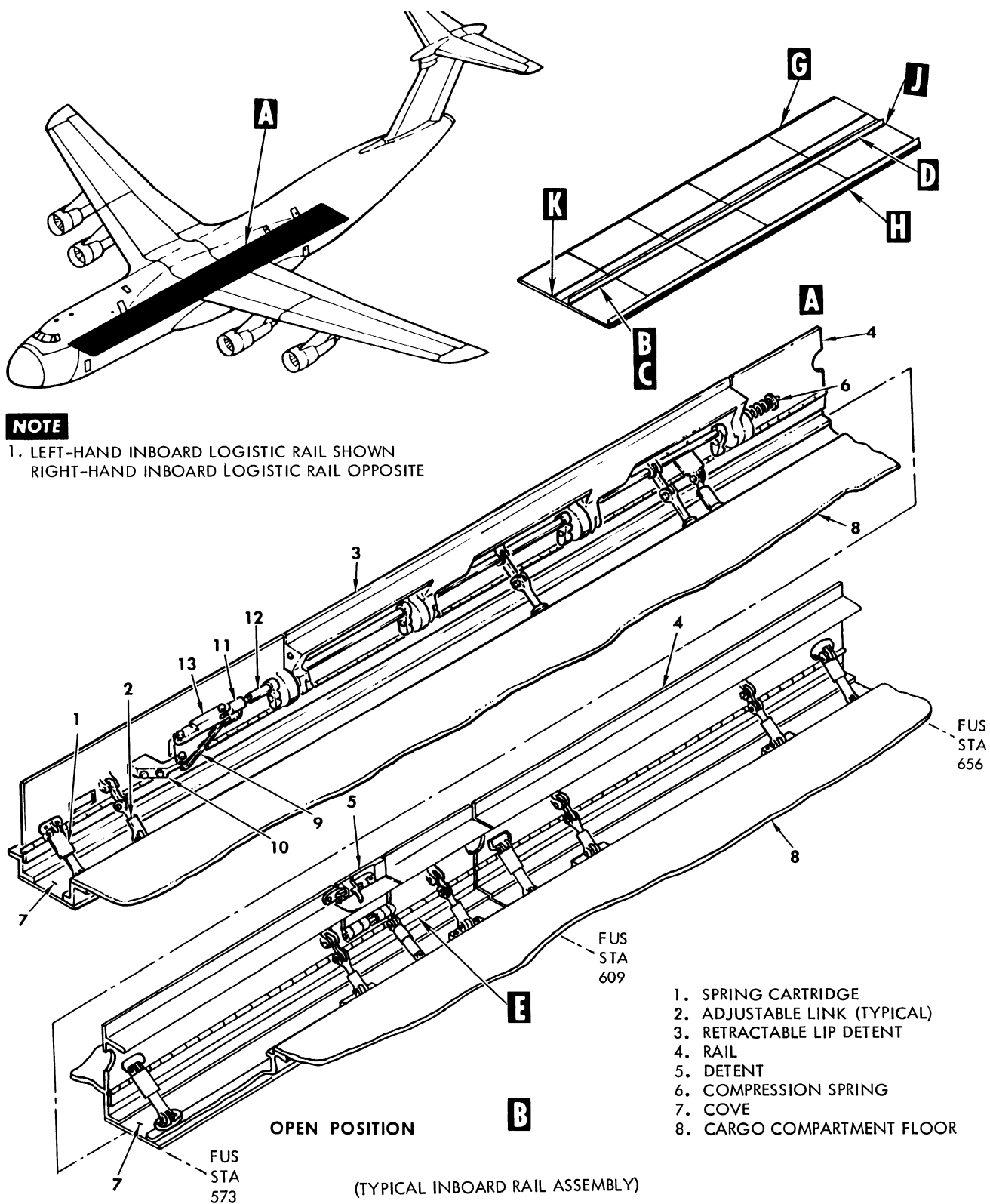
Figure 2-21. Roller Conveyor System - Logistics Cargo (Sheet 1 of 2)

L1115244



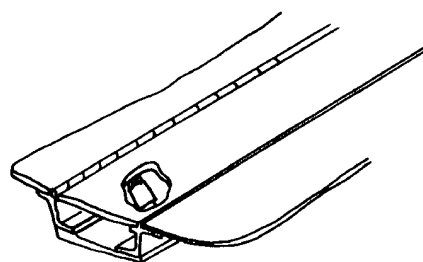
L1115245

Figure 2-21. Roller Conveyor System - Logistics Cargo (Sheet 2)



L1115246

Figure 2-22. Cargo Compartment Logistics Rails (Sheet 1 of 5)

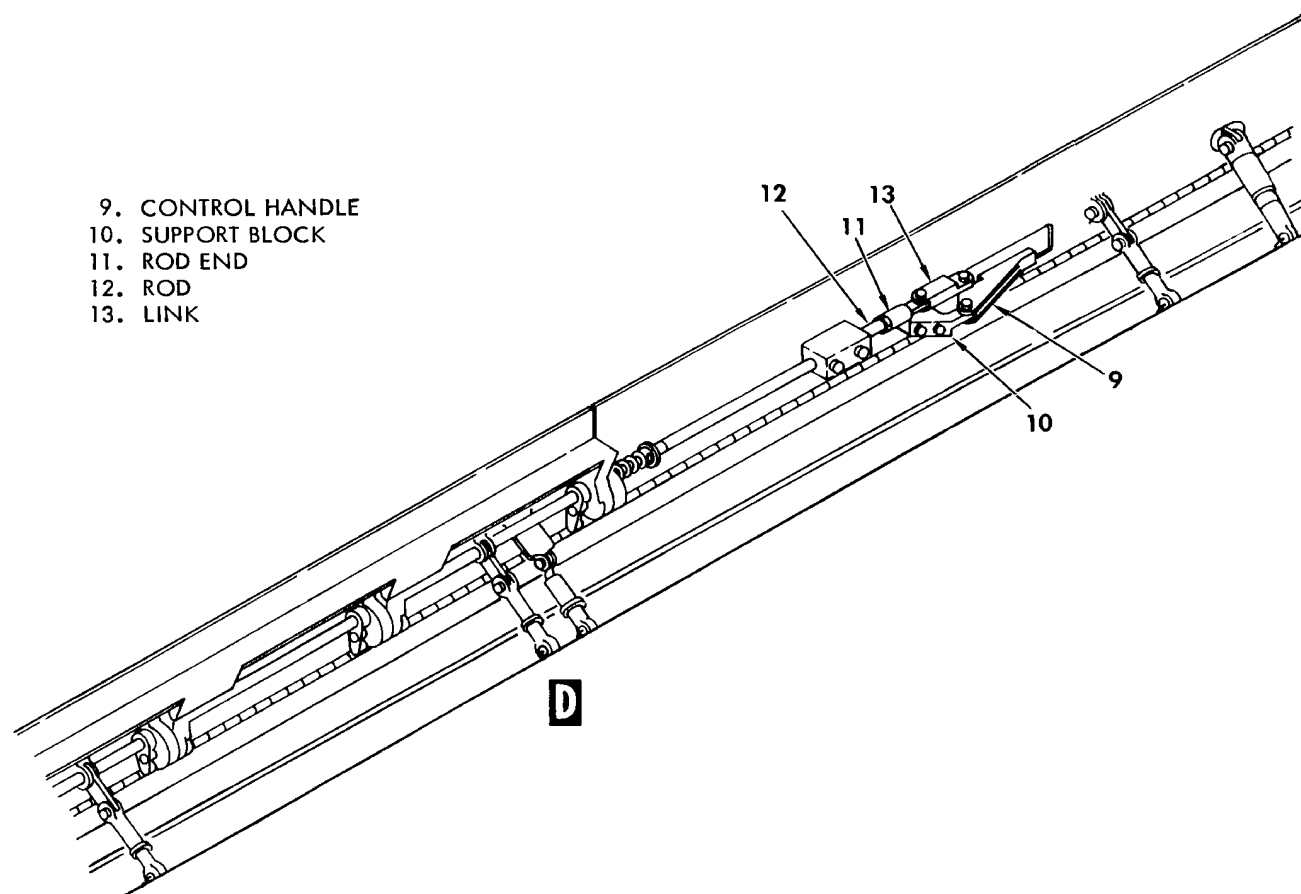


CLOSED POSITION

C

NOTE

2. LEFT-HAND INBOARD LOGISTIC RAIL SHOWN,
RIGHT-HAND INBOARD LOGISTIC RAIL OPPOSITE.



- 9. CONTROL HANDLE
- 10. SUPPORT BLOCK
- 11. ROD END
- 12. ROD
- 13. LINK

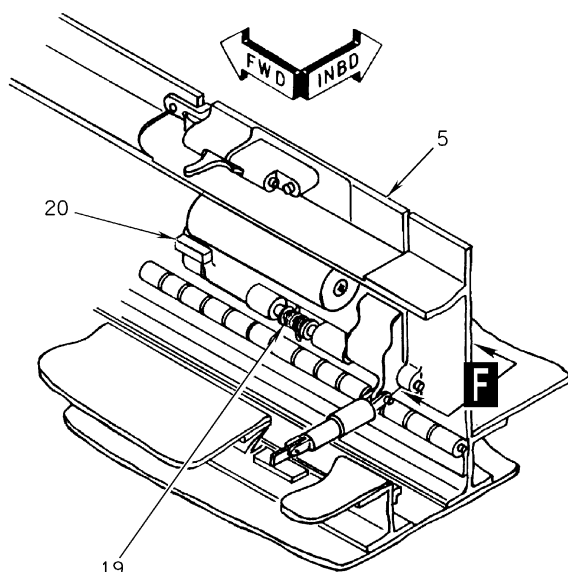
D

L1115247

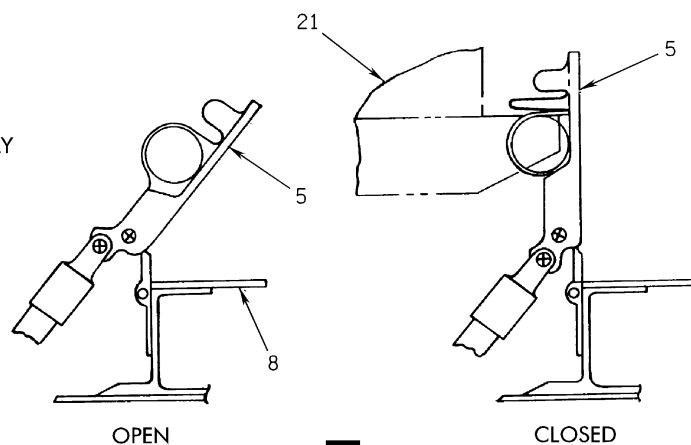
Figure 2-22. Cargo Compartment Logistics Rails (Sheet 2)

CAUTION

DETENTS SHALL BE MANUALLY ROTATED TO THEIR FULL OPEN POSITION BEFORE ON/OFF LOADING. FAILURE TO COMPLY COULD DAMAGE THE DETENTS AND RAILS IF PALLET IS PUSHED AGAINST THE PARTIALLY CLOSED DETENTS.

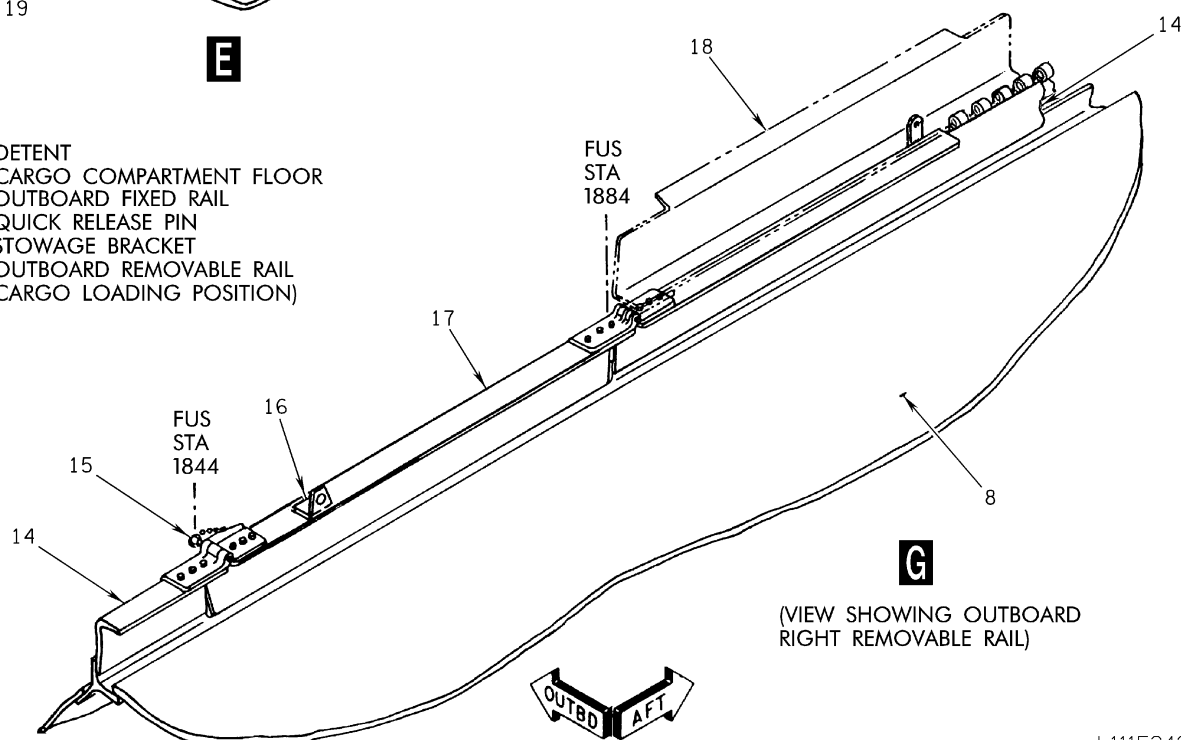
**E**

- 5. DETENT
- 8. CARGO COMPARTMENT FLOOR
- 14. OUTBOARD FIXED RAIL
- 15. QUICK RELEASE PIN
- 16. STOWAGE BRACKET
- 17. OUTBOARD REMOVABLE RAIL (CARGO LOADING POSITION)

**F**

(SECTION VIEW OF DETENT)

- 18. OUTBOARD REMOVABLE RAIL (RETRACTED POSITION)
- 19. TORSION SPRING
- 20. STOP
- 21. PALLET

**G**

(VIEW SHOWING OUTBOARD RIGHT REMOVABLE RAIL)

Figure 2-22. Cargo Compartment Logistics Rails (Sheet 3)

L1115248

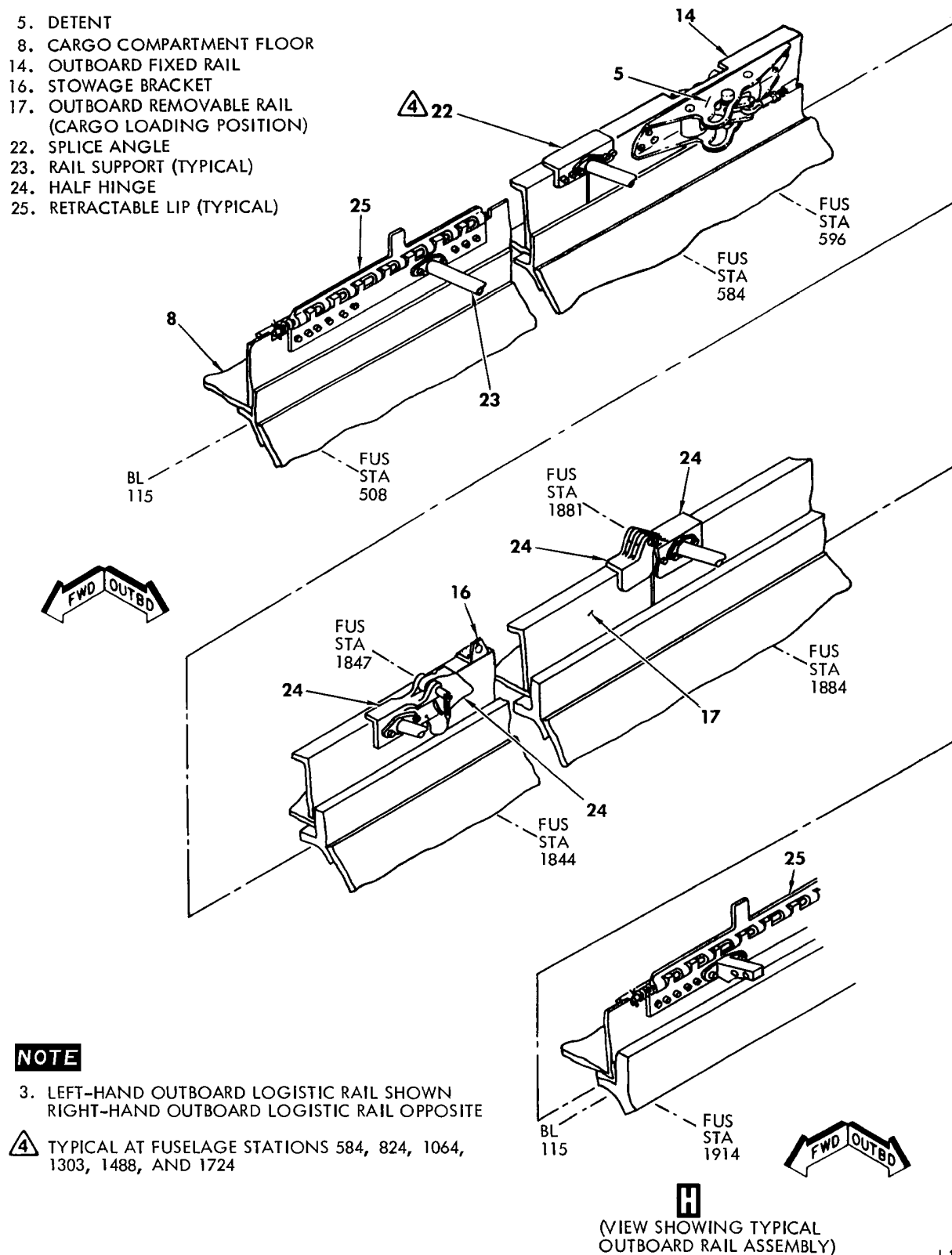
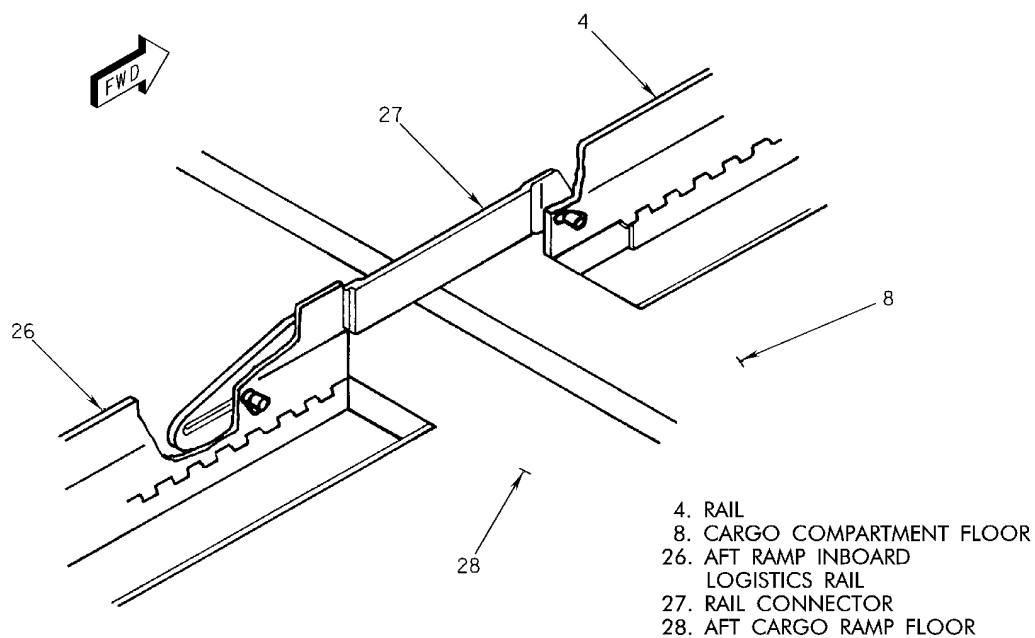


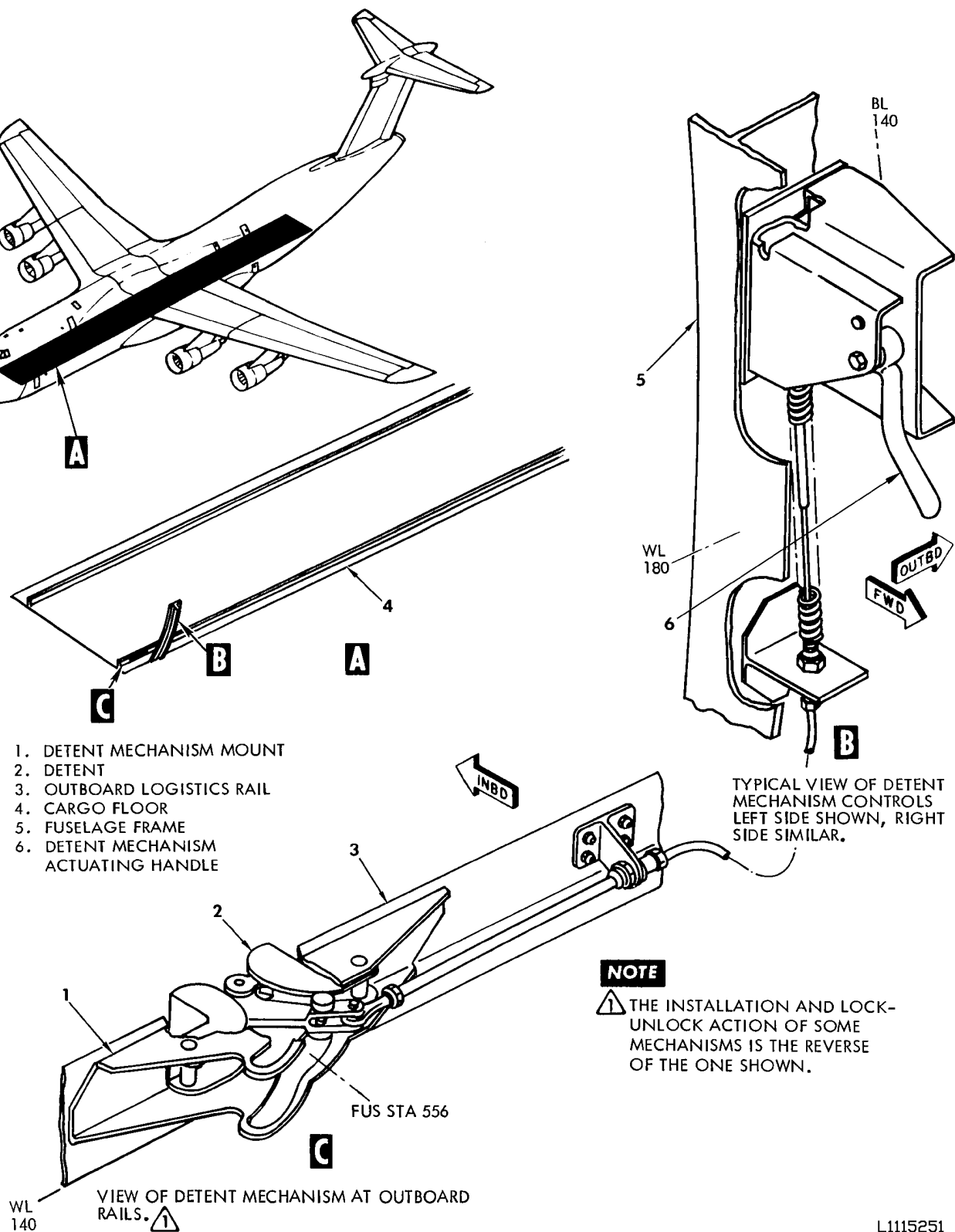
Figure 2-22. Cargo Compartment Logistics Rails (Sheet 4)

**J**

VIEW SHOWING INBOARD RAIL
CONNECTOR INSTALLED IN
USING POSITION

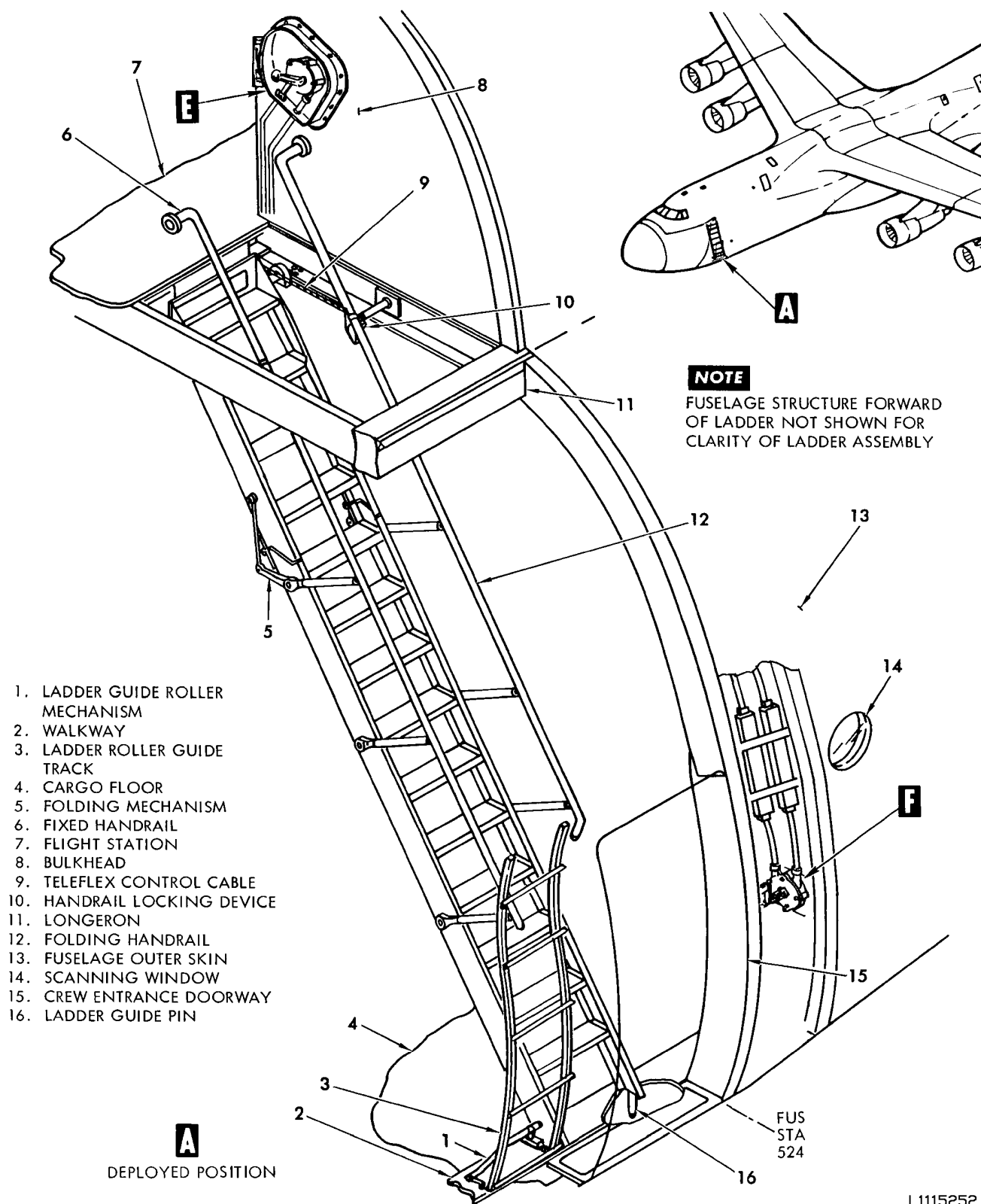
L1115250

Figure 2-22. Cargo Compartment Logistics Rails (Sheet 5)



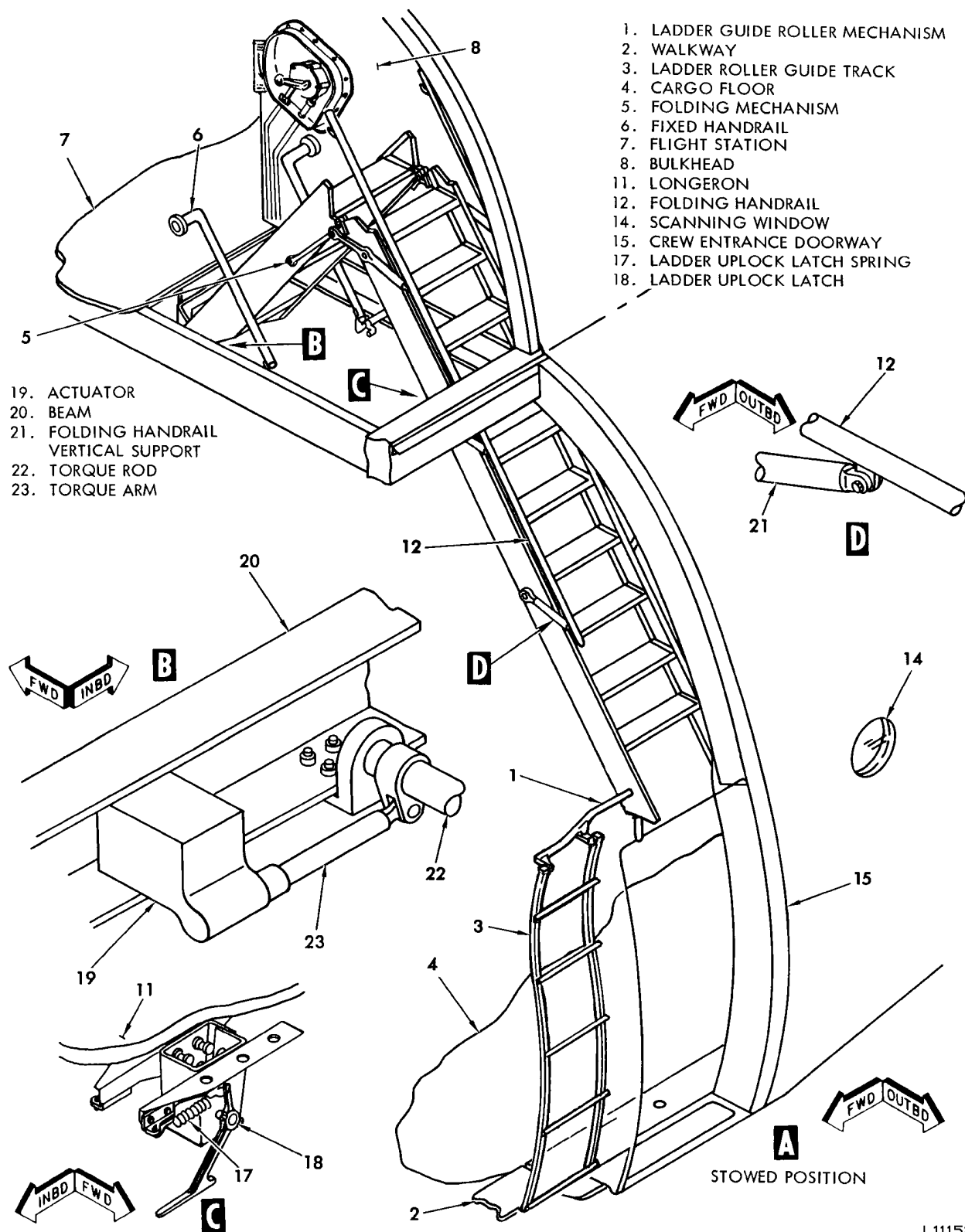
L1115251

Figure 2-23. Cargo Compartment Outboard Logistics Rails Restraint Mechanisms



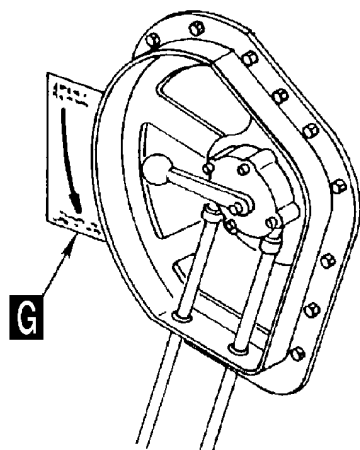
L1115252

Figure 2-24. Flight Station Ladder and Controls (Sheet 1 of 3)

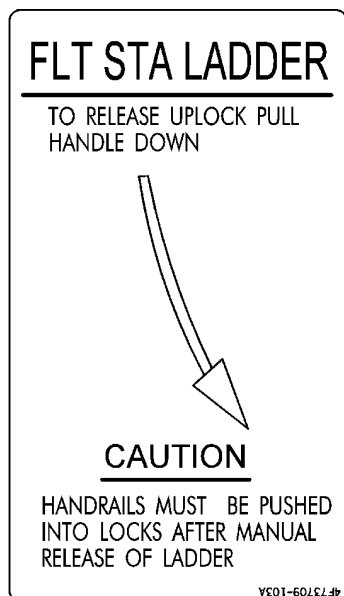


L1115253

Figure 2-24. Flight Station Ladder and Controls (Sheet 2)

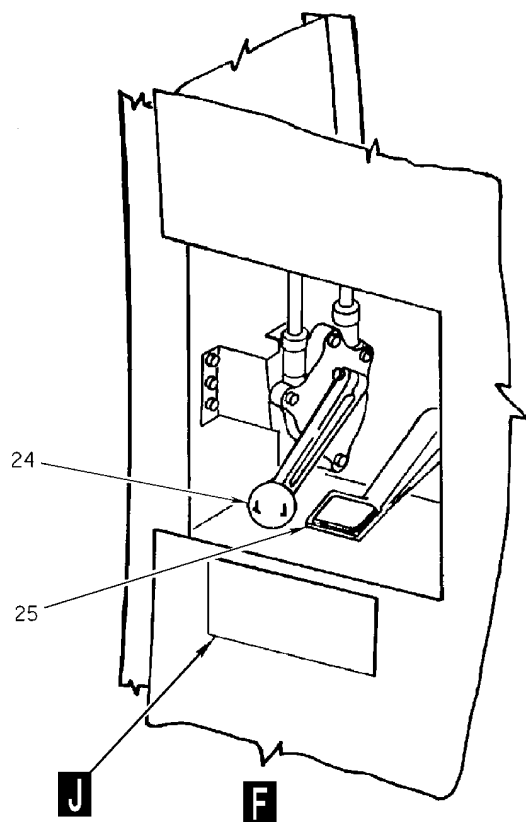


E
LADDER CONTROL
FLIGHT STATION

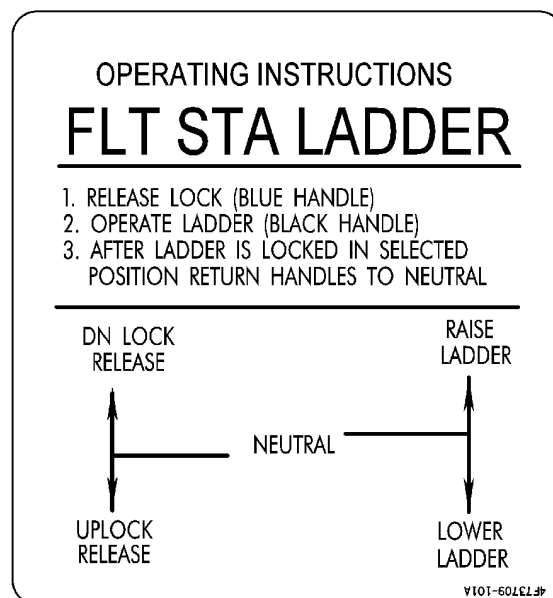


G

24. LOCK RELEASE HANDLE (BLUE)
25. LADDER OPERATE HANDLE (BLACK)



F
LADDER CONTROL
CARGO COMPARTMENT



J

L1115254

Figure 2-24. Flight Station Ladder and Controls (Sheet 3)

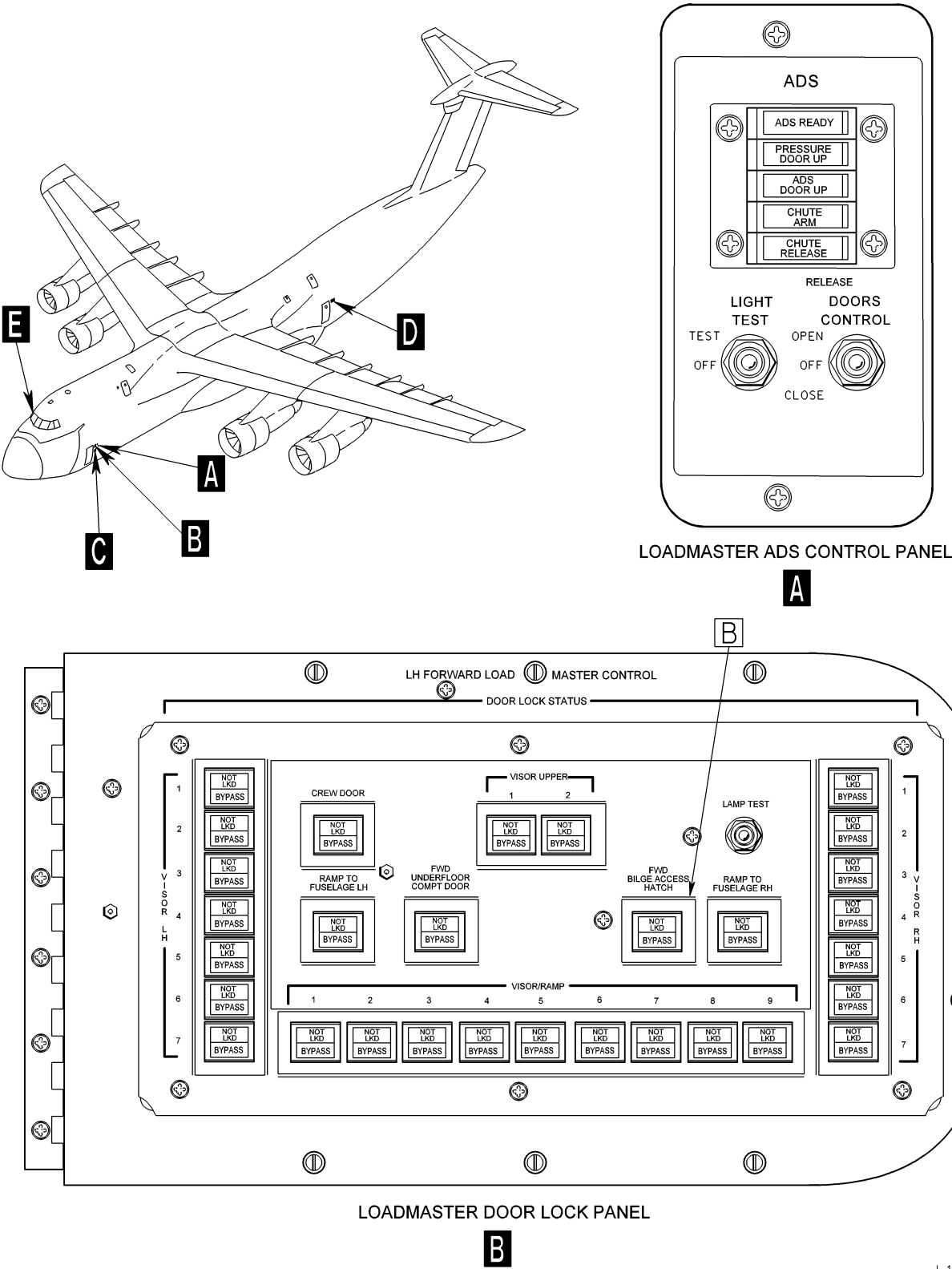
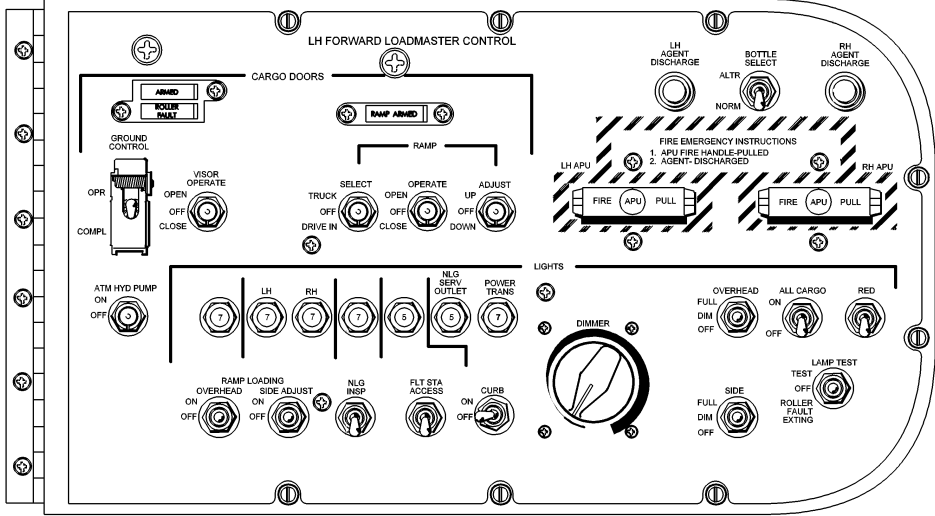


Figure 2-25. Control Panel – Cargo Doors and Ramps (Sheet 1 of 3)

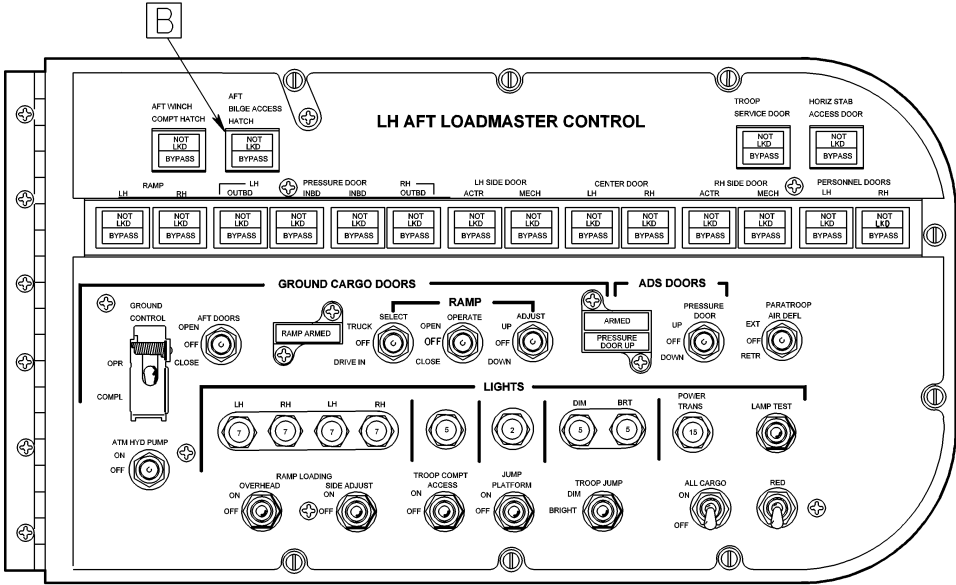
CAUTION INSURE RAMP
LOCK PINS ARE REMOVED FROM
LOCKS BEFORE OPERATING RAMP



C

FWD LOADMASTER CONTROL PANEL

CAUTION INSURE RAMP
LOCK PINS ARE REMOVED FROM
LOCKS BEFORE OPERATING RAMP

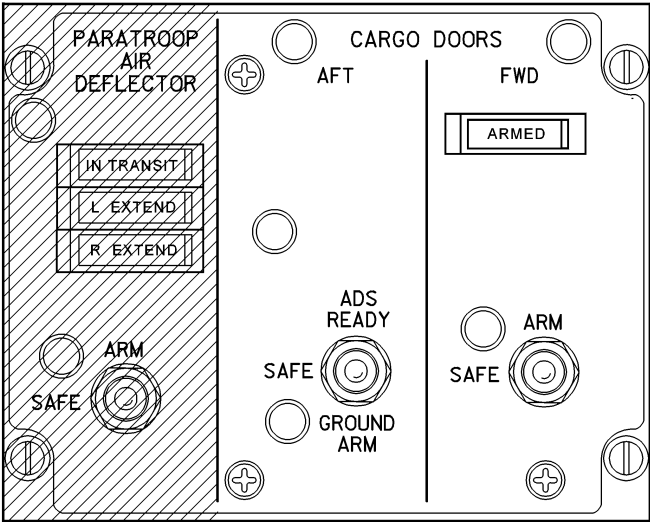


D

LH AFT LOADMASTER CONTROL PANEL

Figure 2-25. Control Panel – Cargo Doors and Ramps (Sheet 2)

L1115256



E

COPILOTS DOOR ARMING
CONTROL PANEL

L1115257

Figure 2-25. Control Panel – Cargo Doors and Ramps (Sheet 3)

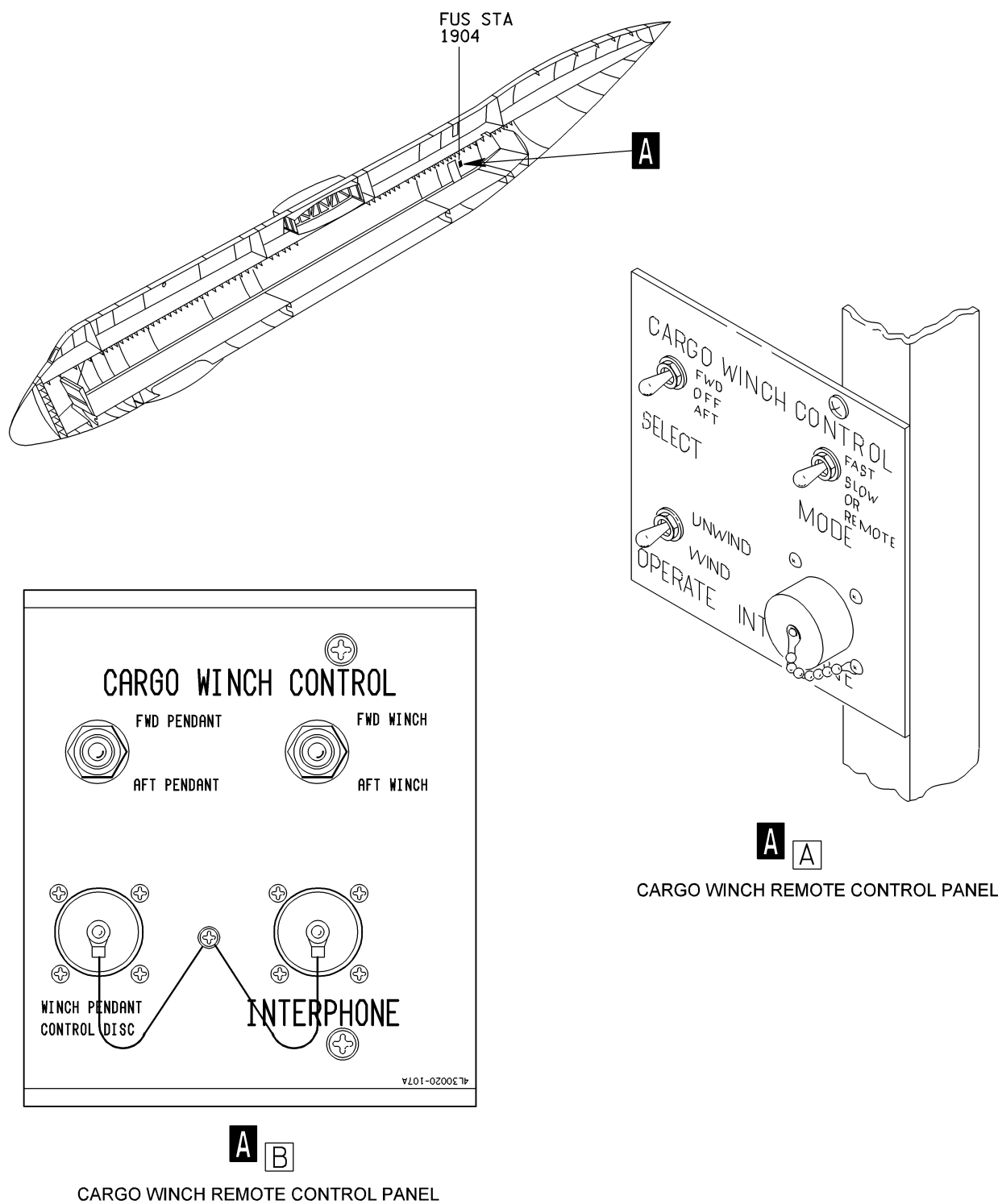


Figure 2-26. Cargo Winch Remote Control Panel

L1115258

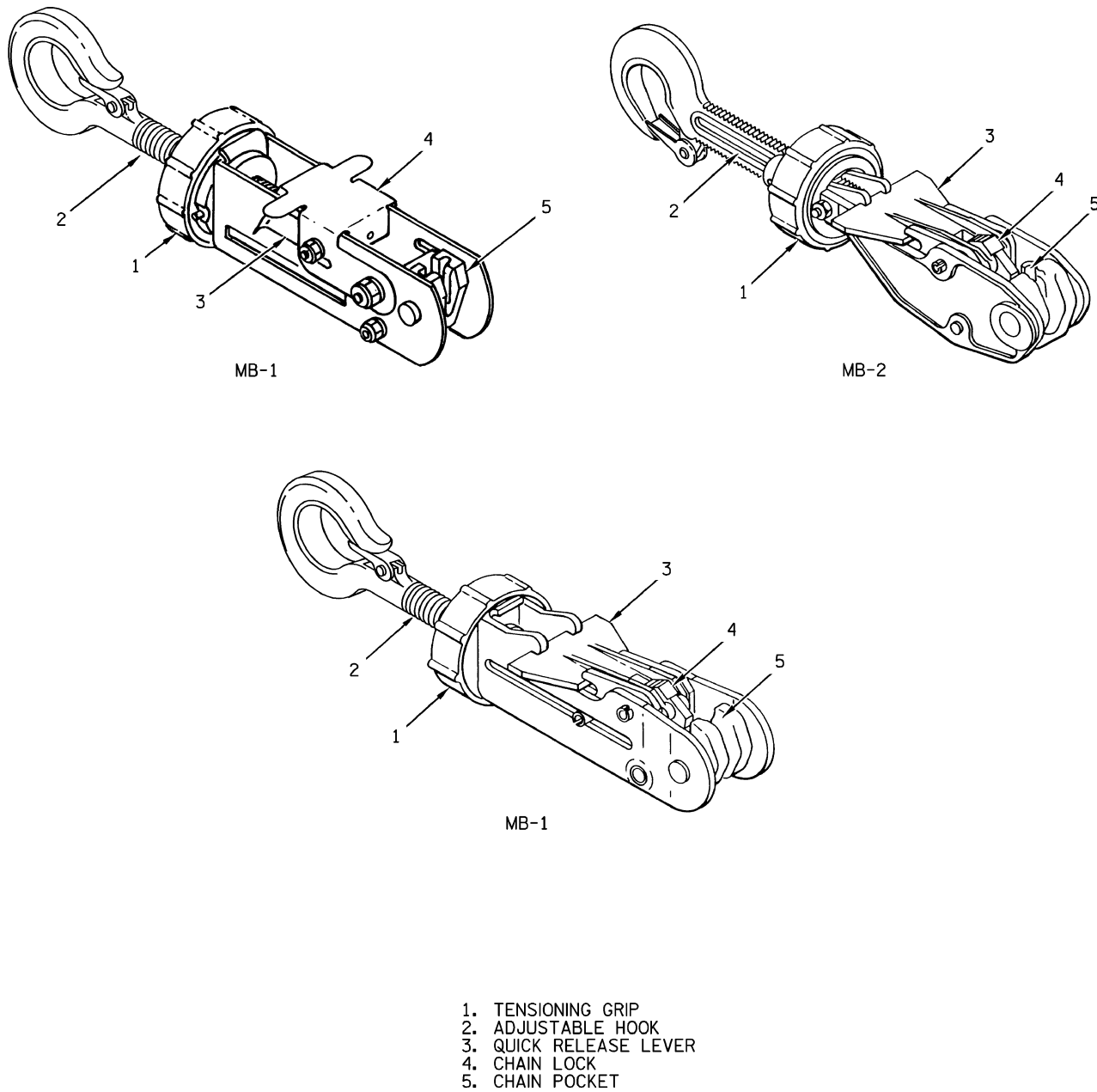


Figure 2-27. MB-1/MB-2 Tiedown Devices (Typical)

L1115259

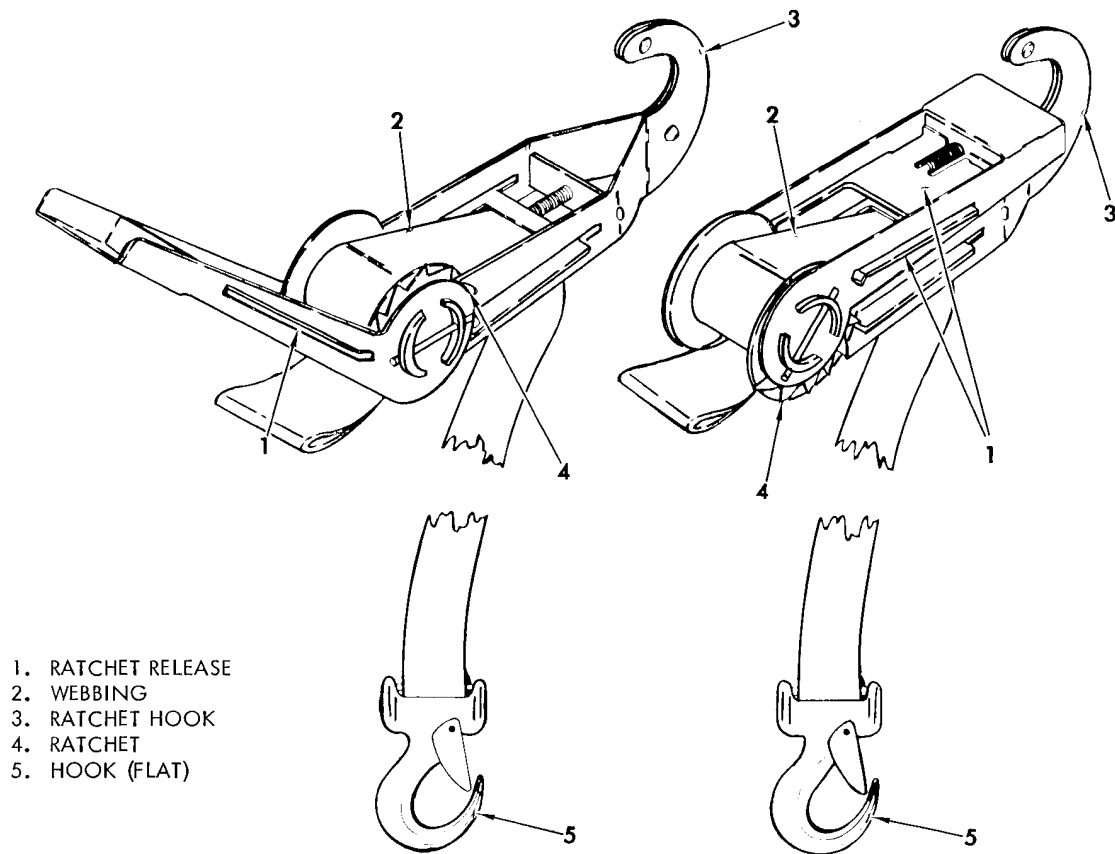


Figure 2-28. AF Type CGU-1/B Cargo Tiedown Devices

L1115260

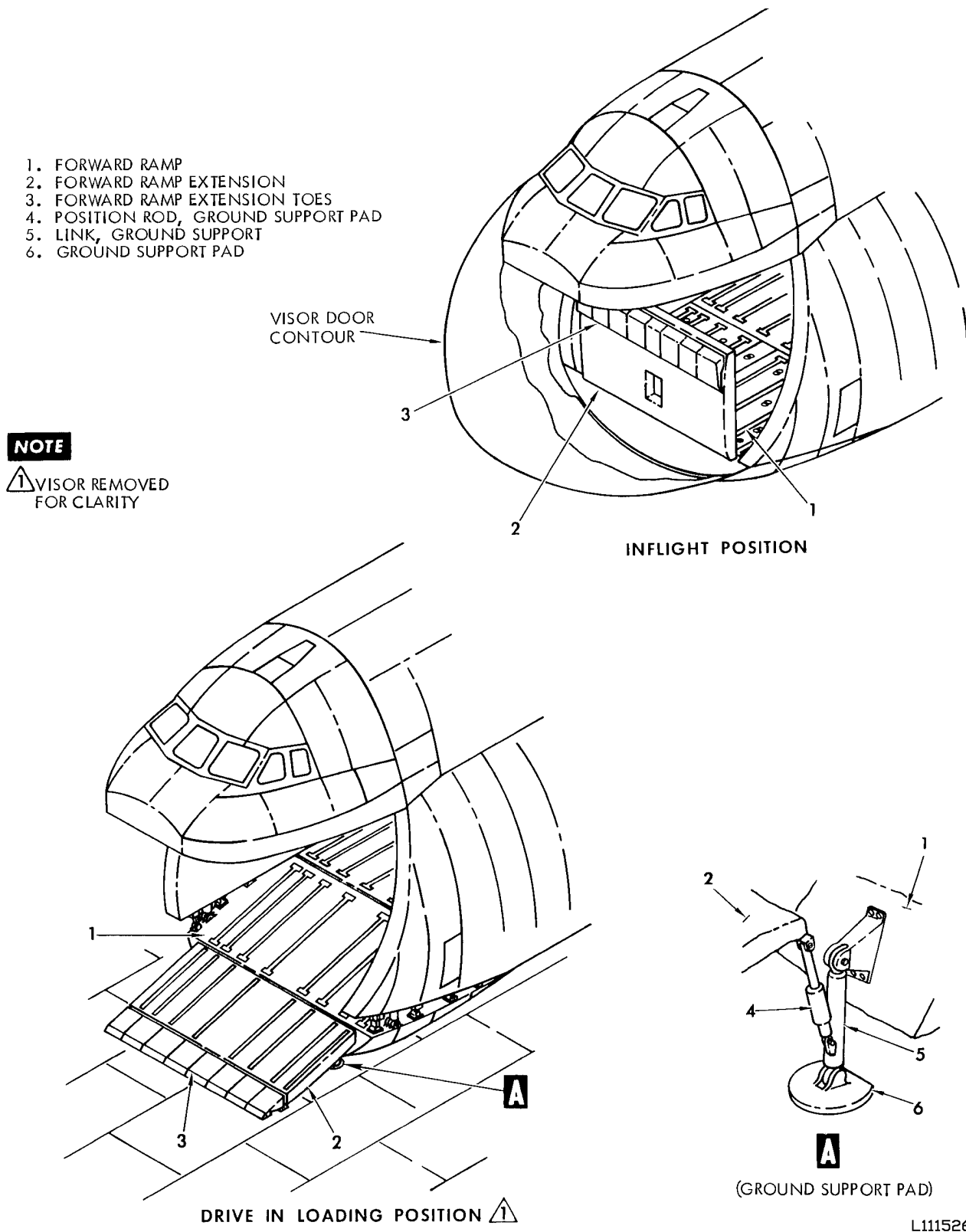
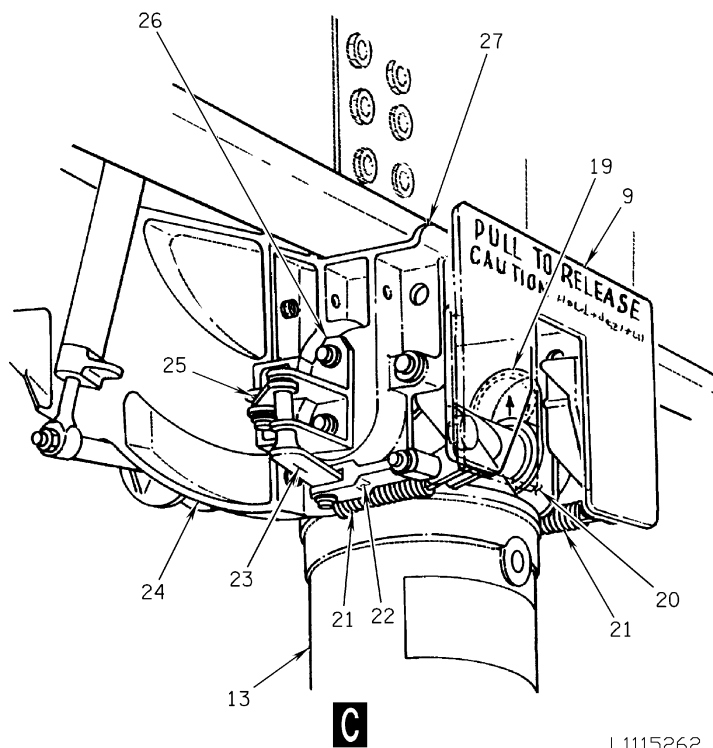
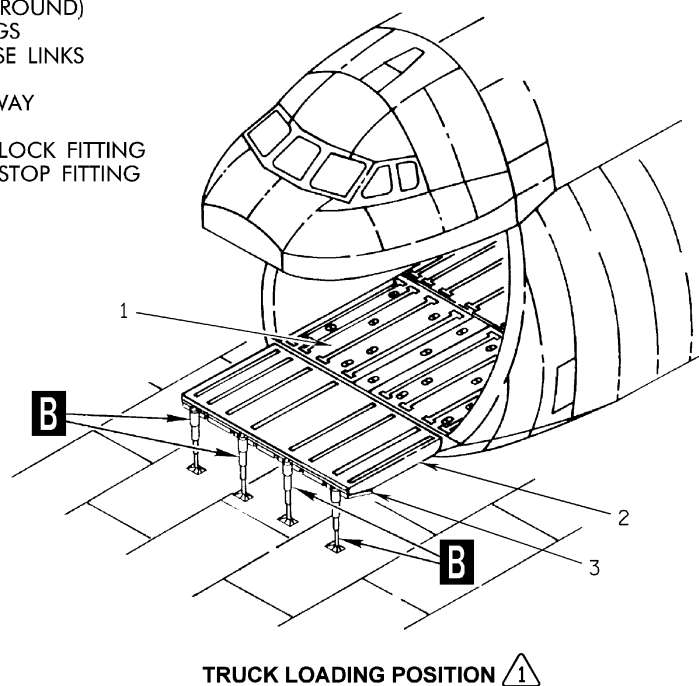
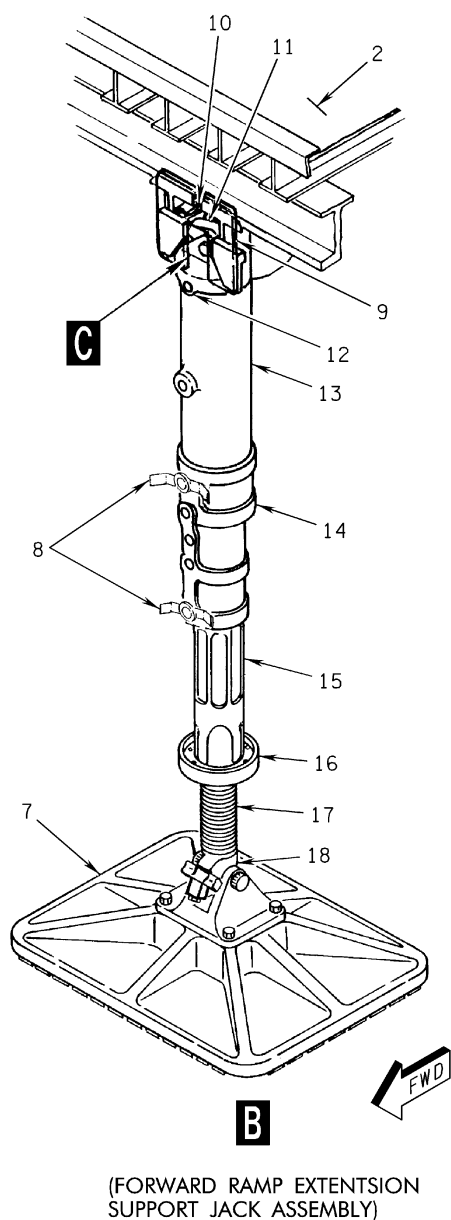


Figure 2-29. Forward Cargo Ramp, Ramp Extension, and Toes – In-flight and Loading Positions (Sheet 1 of 2)

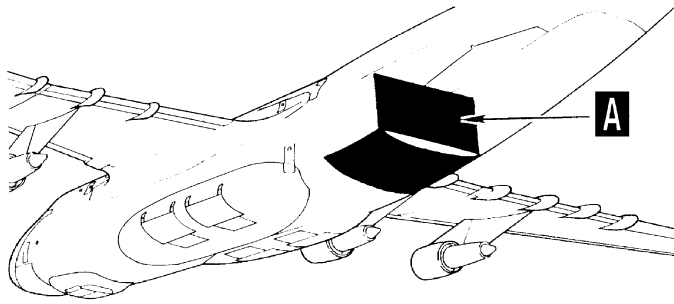
1. FORWARD RAMP
2. FORWARD RAMP EXTENSION
3. FORWARD RAMP EXTENSION TOES
7. SUPPORT JACK PAD
8. T-HANDLE BALL LOCK PIN
9. LATCH RELEASE HANDLE
10. TRACK
11. ROLLER ARM
12. END CAP
13. OUTER TUBE
14. OUTER TUBE EXTENSION
15. INNER TUBE
16. FINE ADJUSTMENT NUT
17. SCREW

18. FITTING
19. JACK BEARING (LOADING POSITION
JACK PAD RESTING FIRMLY ON GROUND)
20. JACK BEARING (JACK PAD NOT RESTING
ON GROUND)
21. SPRINGS
22. RELEASE LINKS
23. SHAFT
24. RACEWAY
25. LINK
26. JACK LOCK FITTING
27. JACK STOP FITTING

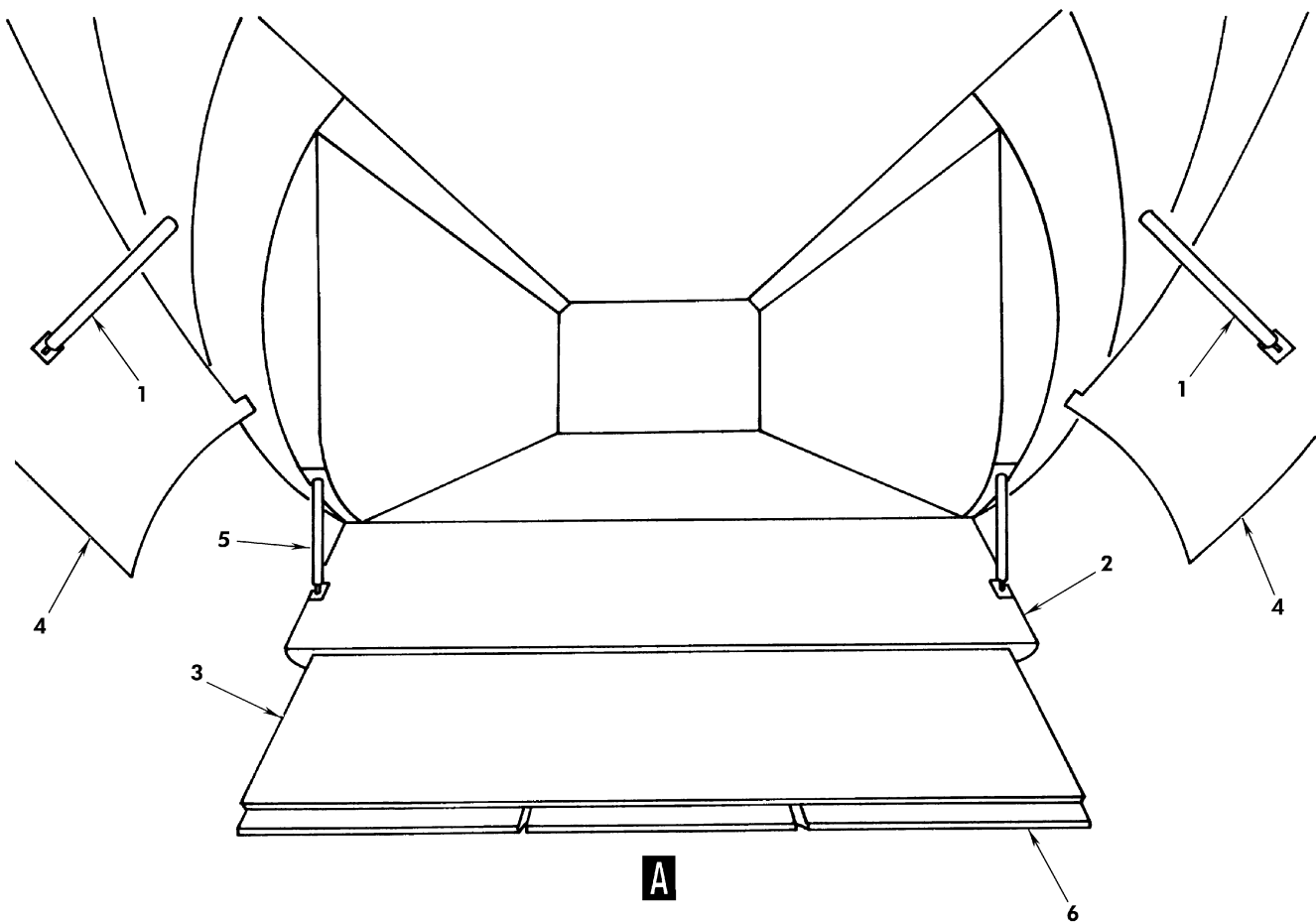


L1115262

Figure 2-29. Forward Cargo Ramp, Ramp Extension, and Toes – In-flight and Loading Positions (Sheet 2)



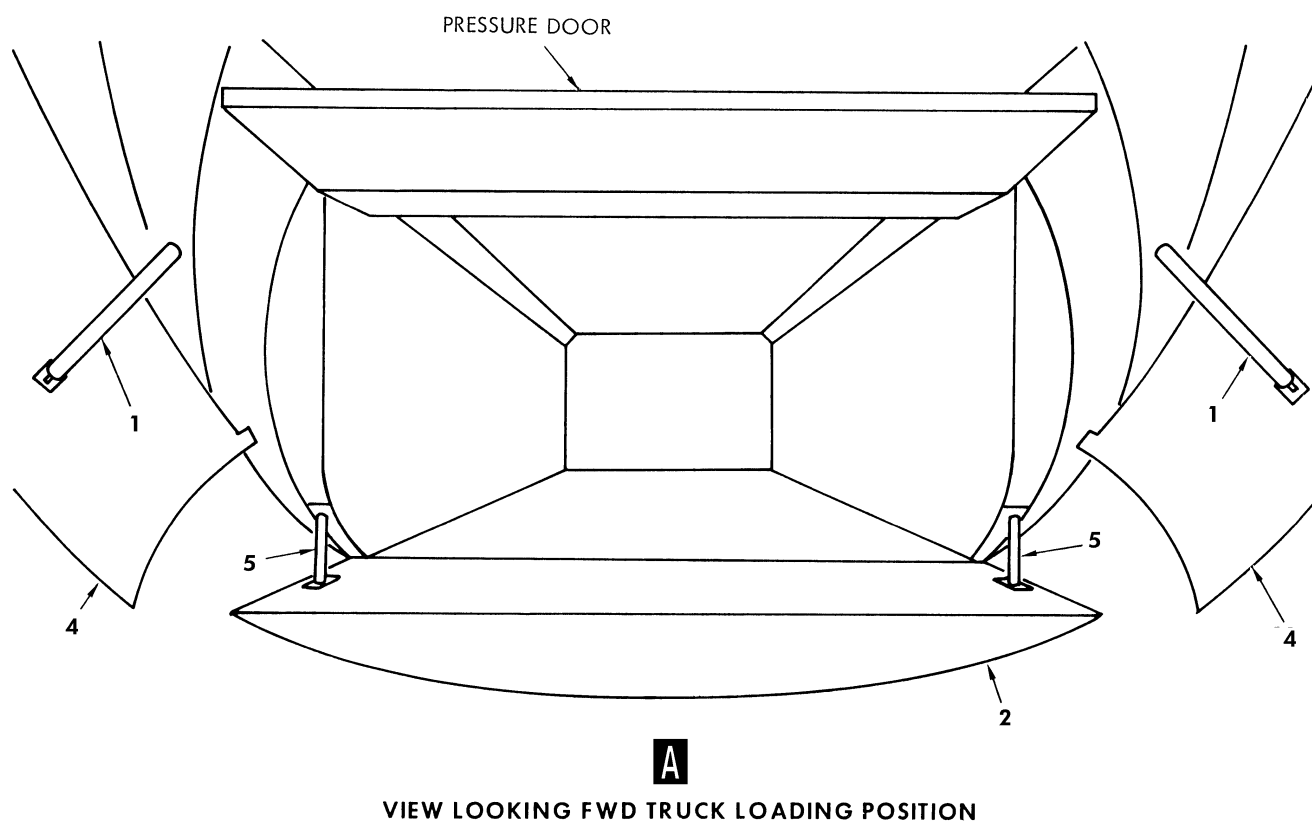
1. SIDE CARGO DOOR ACTUATING RODS
2. AFT RAMP
3. PRESSURE DOOR (RAMP EXTENSION POSITION)
4. SIDE CARGO DOORS (OPEN, TRUCK AND DRIVE-IN LOADING POSITION)
5. AFT RAMP ACTUATORS
6. PRESSURE DOOR TOES



VIEW LOOKING FWD DRIVE - IN LOADING POSITION

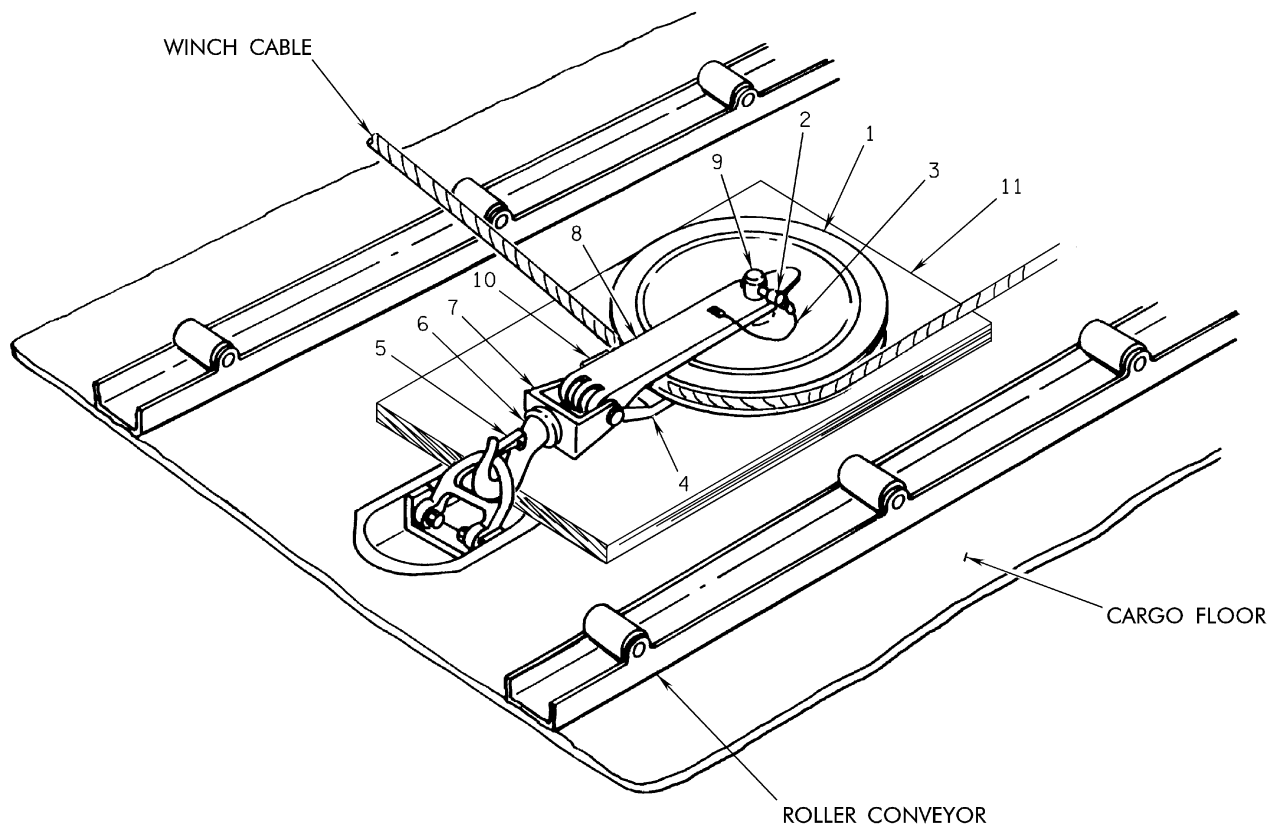
L1115263

Figure 2-30. Aft Cargo Ramp, Pressure Door, and Toes – Loading Positions (Sheet 1 of 2)



L1115264

Figure 2-30. Aft Cargo Ramp, Pressure Door, and Toes – Loading Positions (Sheet 2)



- 1. PULLEY
- 2. QUICK-RELEASE PIN
- 3. RETAINING CHAIN
- 4. SIDE ARM, LOWER
- 5. LATCH
- 6. HOOK
- 7. LINK
- 8. SIDE ARM, UPPER
- 9. PIN
- 10. STOP
- 11. SHORING

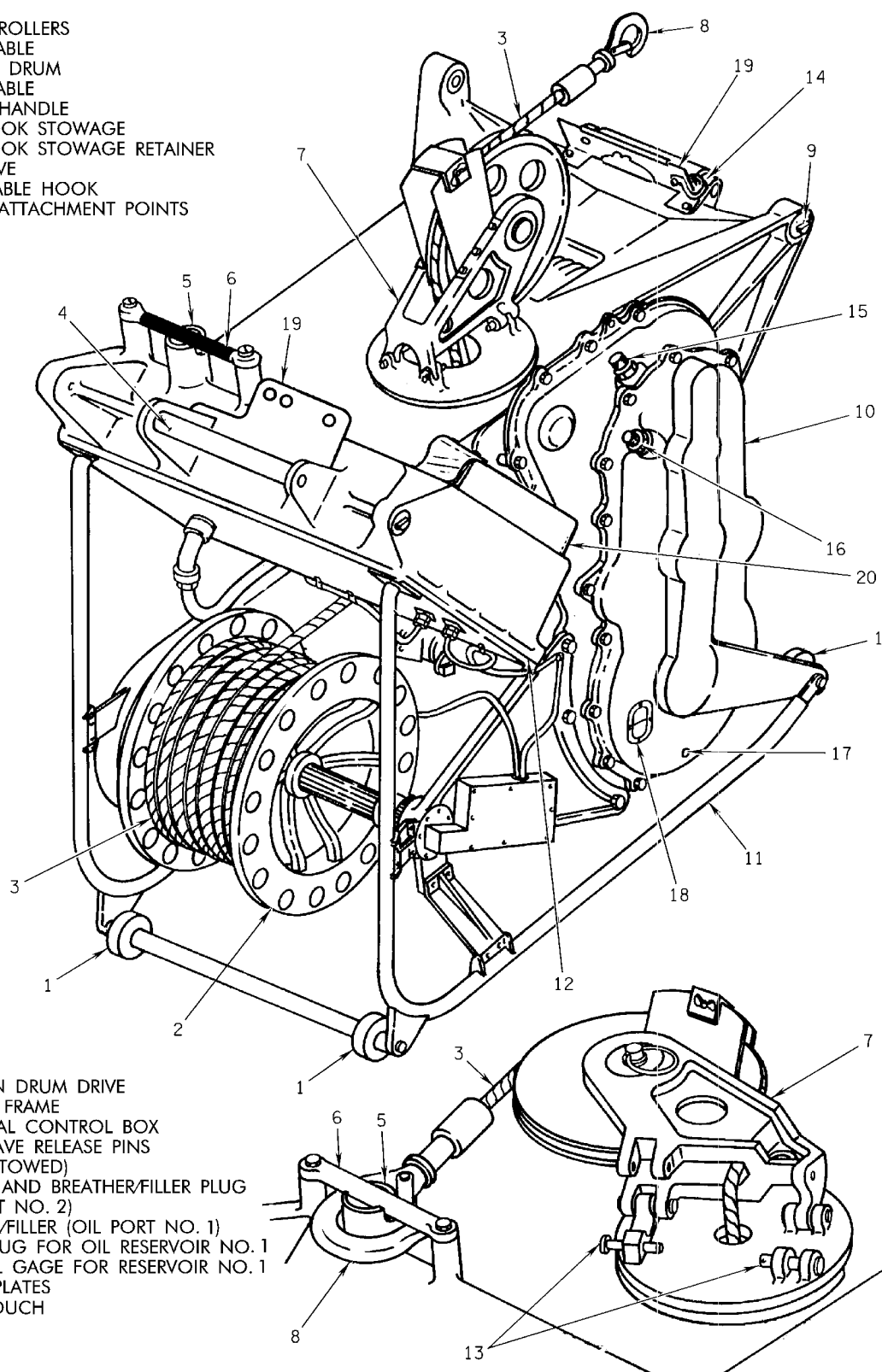
ROLLER CONVEYOR

CARGO FLOOR

L1115265

Figure 2-31. Snatch Block

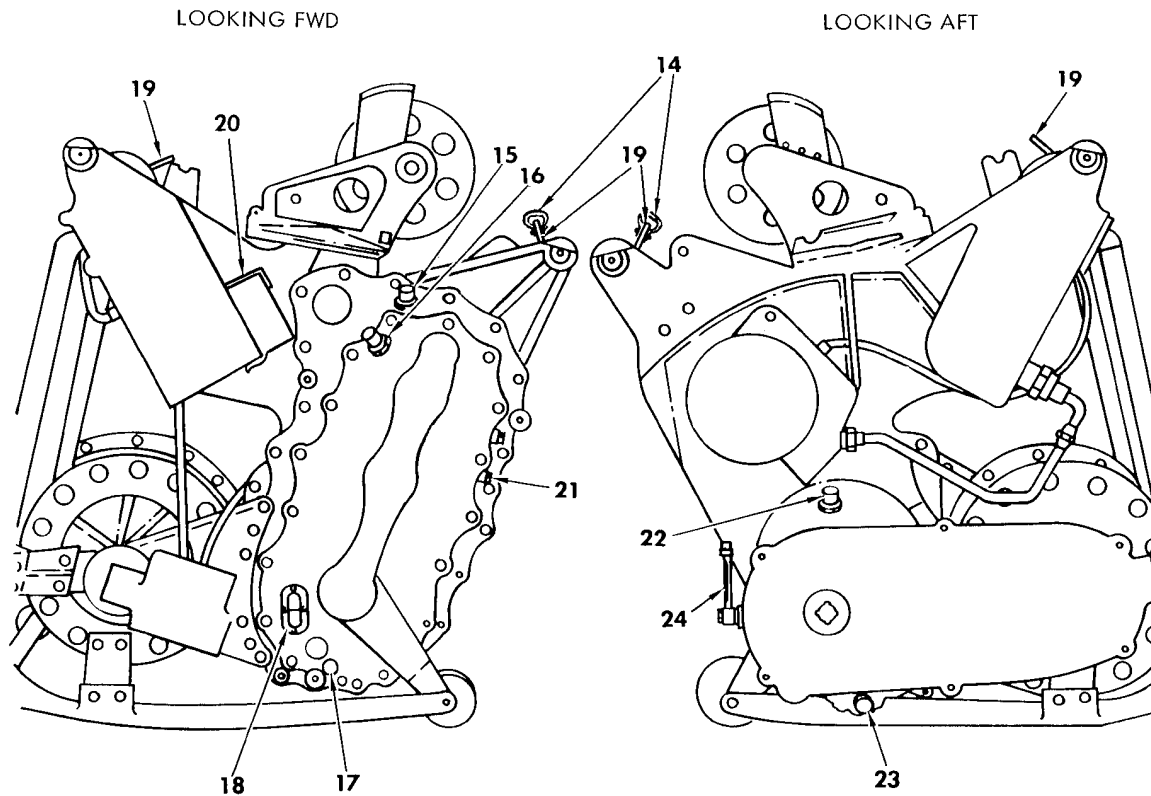
1. MOBILITY ROLLERS
2. WINCH CABLE STOWAGE DRUM
3. WINCH CABLE
4. MOBILITY HANDLE
5. CABLE HOOK STOWAGE
6. CABLE HOOK STOWAGE RETAINER
7. EXIT SHEAVE
8. SWIVEL CABLE HOOK
9. AIRPLANE ATTACHMENT POINTS



10. TRACTION DRUM DRIVE
11. SUPPORT FRAME
12. ELECTRICAL CONTROL BOX
13. EXIT SHEAVE RELEASE PINS
14. CLEVIS (STOWED)
15. DIPSTICK AND BREATHER/FILLER PLUG (OIL PORT NO. 2)
16. BREATHER/FILLER (OIL PORT NO. 1)
17. DRAIN PLUG FOR OIL RESERVOIR NO. 1
18. OIL LEVEL GAGE FOR RESERVOIR NO. 1
19. LIFTING PLATES
20. SLING POUCH

L1115266

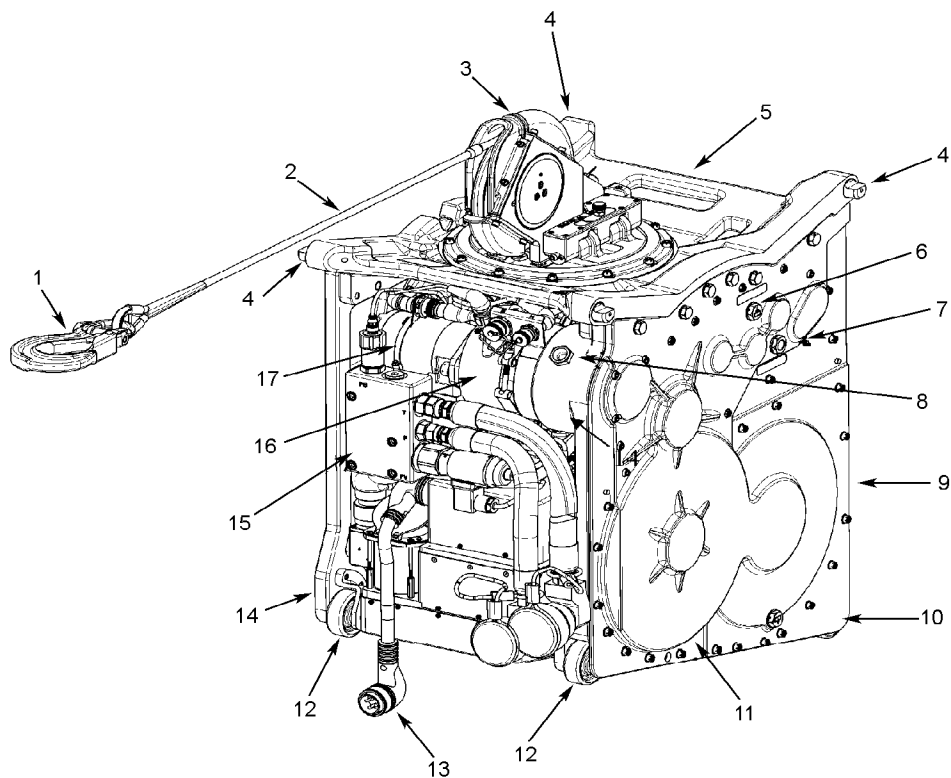
Figure 2-32. **A** Cargo Winch (Sheet 1 of 2)



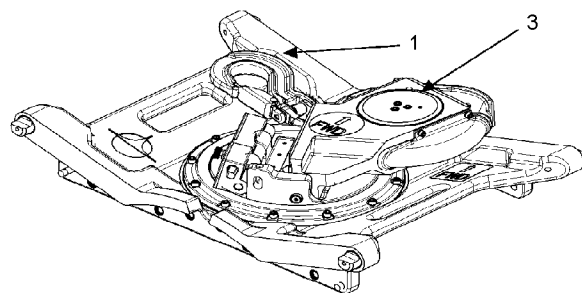
- 14. CLEVIS
- 15. DIPSTICK AND BREATHER/FILLER PLUG (OIL PORT NO. 2)
- 16. BREATHER/FILLER (OIL PORT NO. 1)
- 17. DRAIN PLUG FOR OIL RESERVOIR NO. 1
- 18. OIL LEVEL GAGE FOR RESERVOIR NO. 1
- 19. LIFTING PLATES
- 20. SLING POUCH
- 21. DRAIN PLUG FOR OIL RESERVOIR NO. 2
- 22. BREATHER/FILLER PLUG (OIL PORT NO. 3)
- 23. DRAIN PLUG FOR OIL RESERVOIR NO. 3
- 24. OIL LEVEL GAGE FOR RESERVOIR NO. 3

L1115267

Figure 2-32. **A** Cargo Winch (Sheet 2)

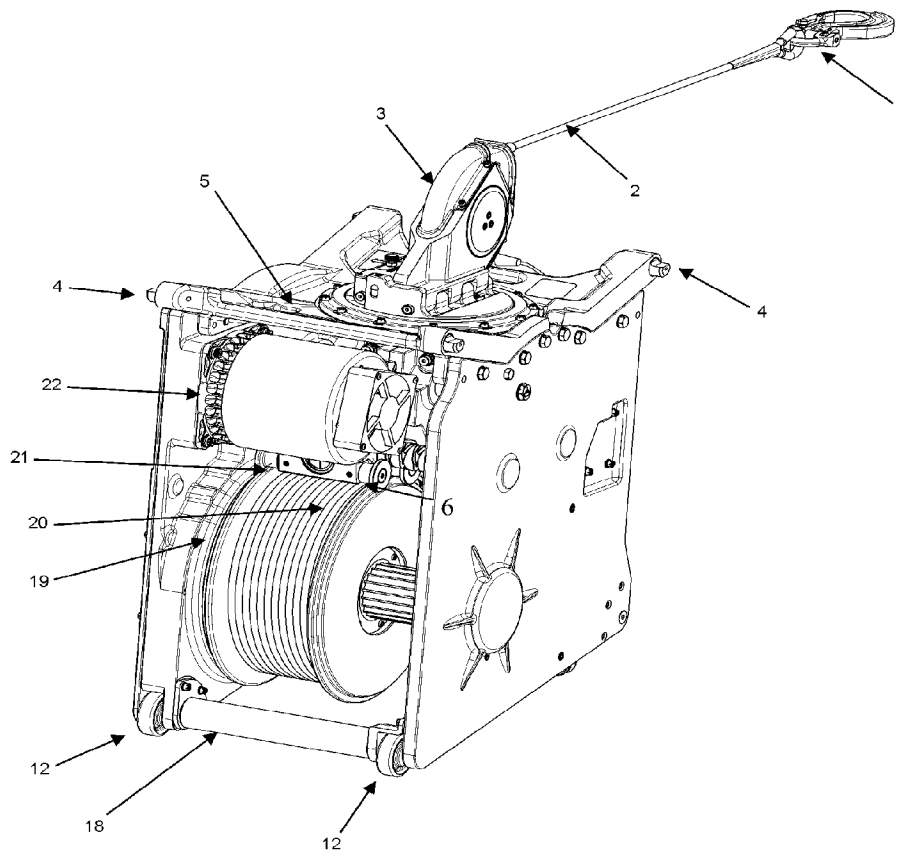


1. SYNTHETIC CABLE HOOK
2. SYNTHETIC CABLE
3. SHEAVE ASSEMBLY
4. SUPPORT PINS, AIRCRAFT ATCH POINTS
5. MOBILITY HANDLE
6. OIL FILL PLUG
7. LIQUID LEVEL SIGHT CAGE
8. BREATHER
9. LOADED DRUM
10. OIL DRAIN PLUG
11. LEVEL WIND GEARBOX ASSEMBLY
12. MOBILITY WHEEL
13. ELECTRICAL CONNECTOR
14. DRUM SUPPORT HOUSING ASSEMBLY
15. HYDRAULIC MANIFOLD
16. PRIMARY GEARBOX ASSEMBLY
17. ELECTRIC MOTOR



L1701681

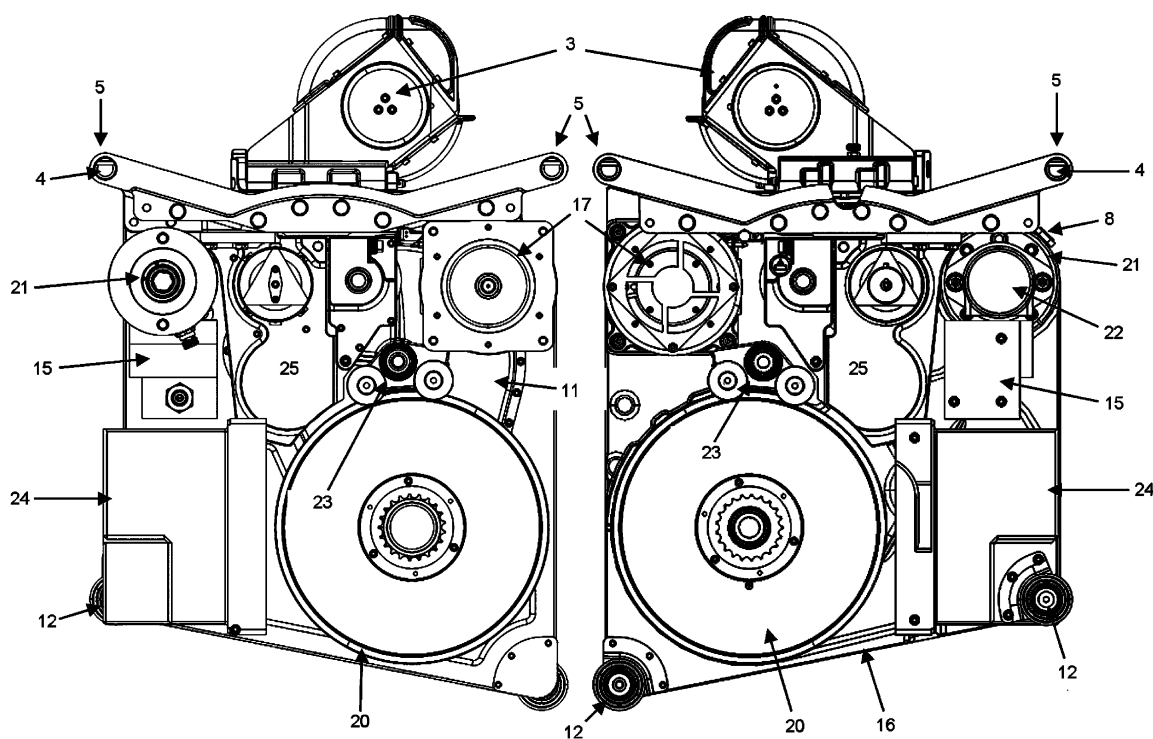
Figure 2-32.1. Dual Powered Winch (Sheet 1 of 3)



- 1. SYNTHETIC CABLE HOOK
- 2. SYNTHETIC CABLE
- 3. SHEAVE ASSEMBLY
- 4. SUPPORT PINS, AIRCRAFT ATCH POINTS
- 5. MOBILITY HANDLE
- 12. MOBILITY WHEEL
- 18. AXLE
- 19. PRIMARY GEARBOX ASSEMBLY
- 20. LOADED DRUM
- 21. ELECTRIC CLUTCH
- 22. HYDRAULIC MOTOR

L1701682

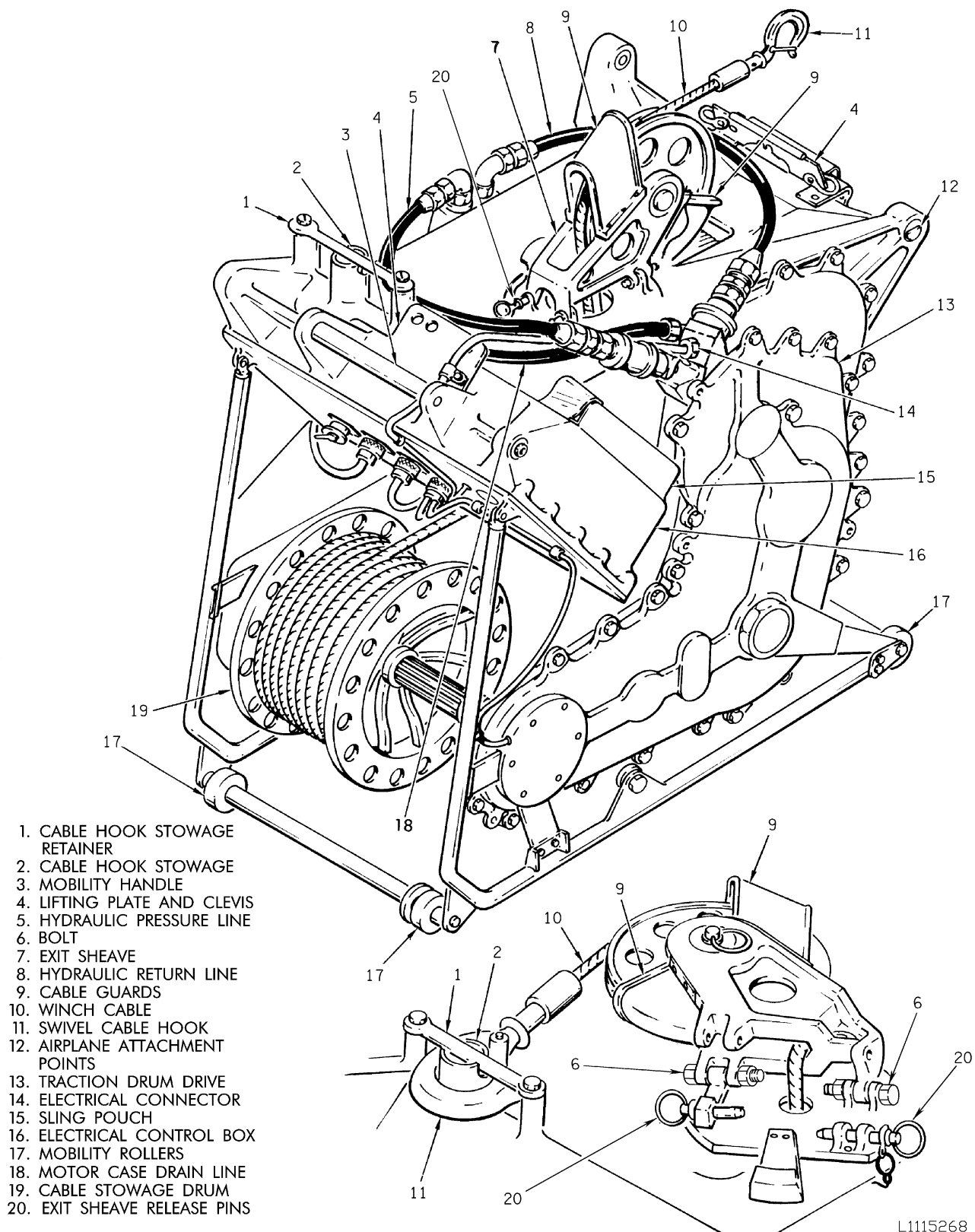
Figure 2-32.1. Dual Powered Winch (Sheet 2)

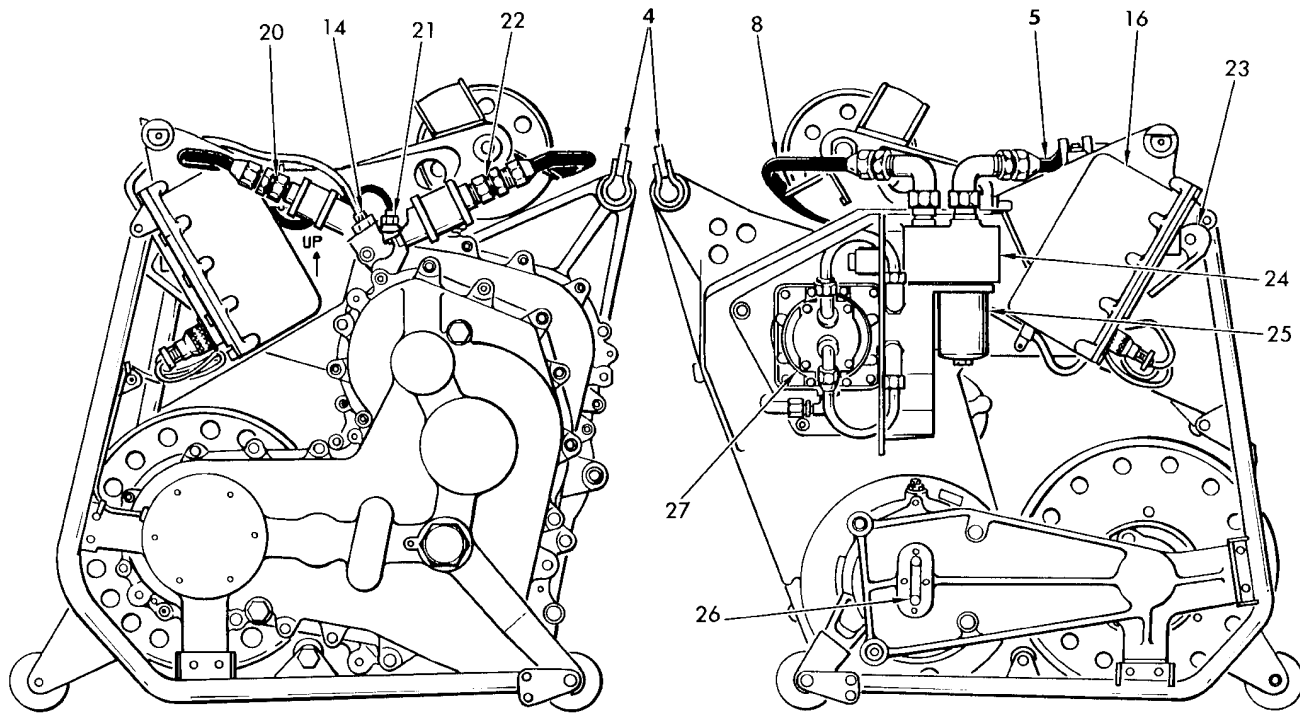


- 3. SHEAVE ASSEMBLY
- 4. SUPPORT PINS, AIRCRAFT ATCH POINTS
- 5. MOBILITY HANDLE
- 8. BREATHER
- 11. LEVEL WIND GEARBOX ASSEMBLY
- 12. MOBILITY WHEEL
- 15. HYDRAULIC MANIFOLD
- 16. PRIMARY GEARBOX ASSEMBLY
- 17. ELECTRIC MOTOR
- 20. LOADED DRUM
- 21. ELECTRIC CLUTCH
- 22. HYDRAULIC MOTOR
- 23. LEVEL WIND SYSTEM
- 24. MULTICONTROLLER
- 25. CABLE TENSIONER ASSEMBLY

L1701683

Figure 2-32.1. Dual Powered Winch (Sheet 3)

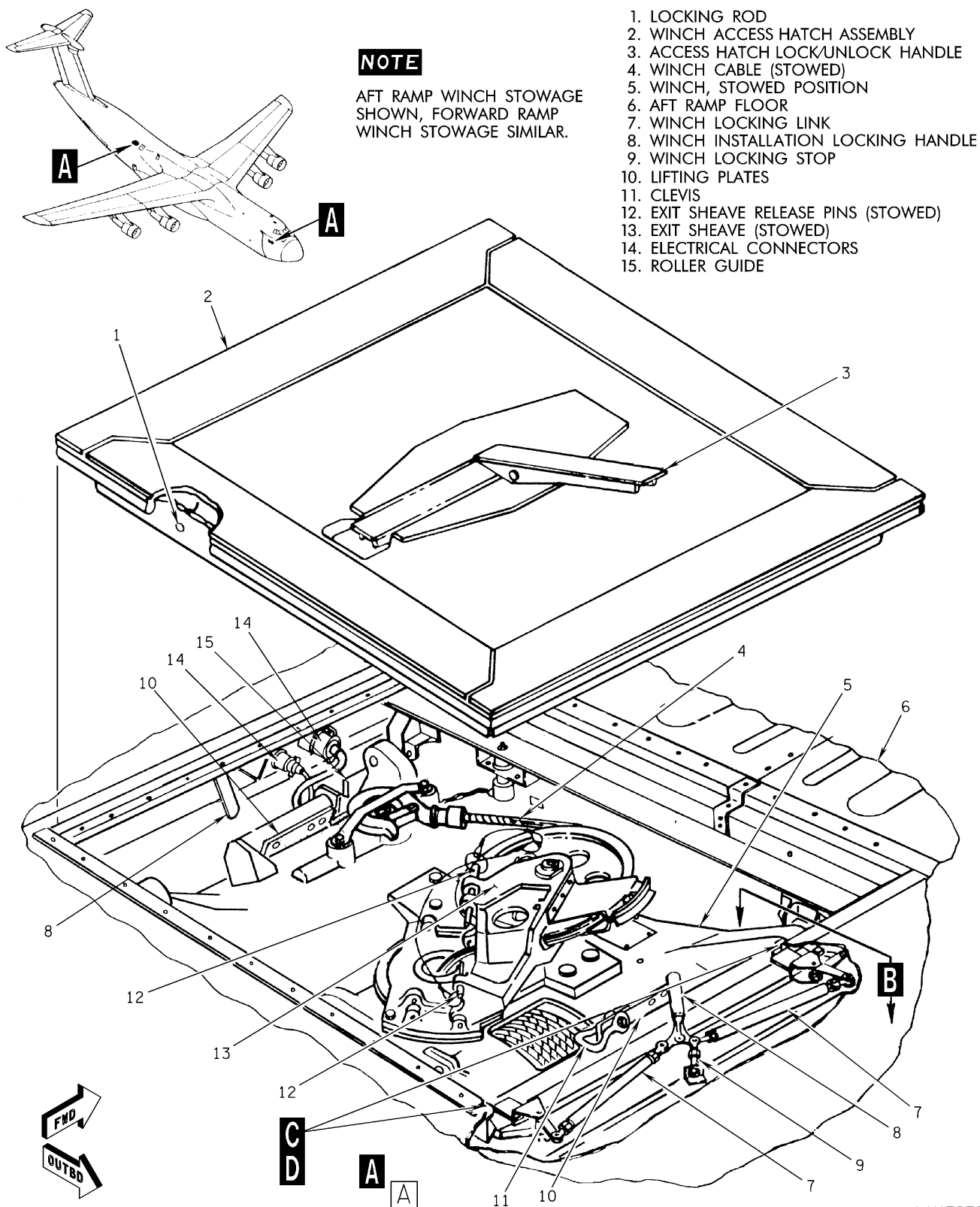
Figure 2-33. **B** Cargo Winch (Sheet 1 of 2)



- 4. LIFTING PLATE AND CLEVIS
- 5. HYDRAULIC PRESSURE LINE
- 8. HYDRAULIC RETURN LINE
- 14. ELECTRICAL CONNECTOR (STOWED)
- 16. ELECTRICAL CONTROL BOX
- 20. HYDRAULIC PRESSURE LINE CONNECTOR (STOWED)
- 21. MOTOR CASE DRAIN LINE CONNECTOR (STOWED)
- 22. HYDRAULIC RETURN LINE CONNECTOR (STOWED)
- 23. HYDRAULIC MOTOR DE-ENERGIZE CONTROL HANDLE
- 24. HYDRAULIC MANIFOLD
- 25. HYDRAULIC FILTER
- 26. OIL LEVEL GAGE
- 27. HYDRAULIC MOTOR

L1115269

Figure 2-33. **B** Cargo Winch (Sheet 2)



L1115270

Figure 2-34. Cargo Winch – Stowed Position (Sheet 1 of 3)

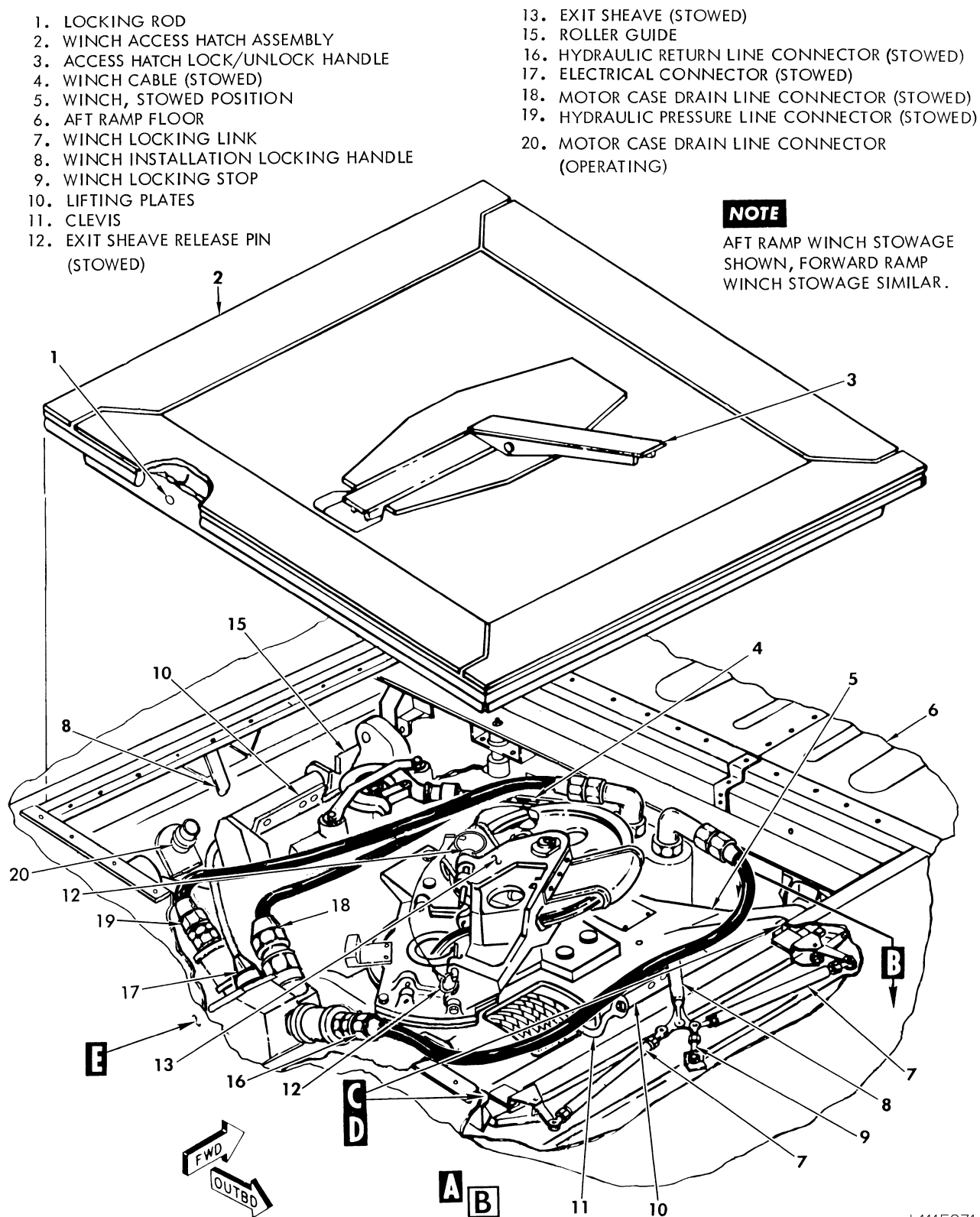
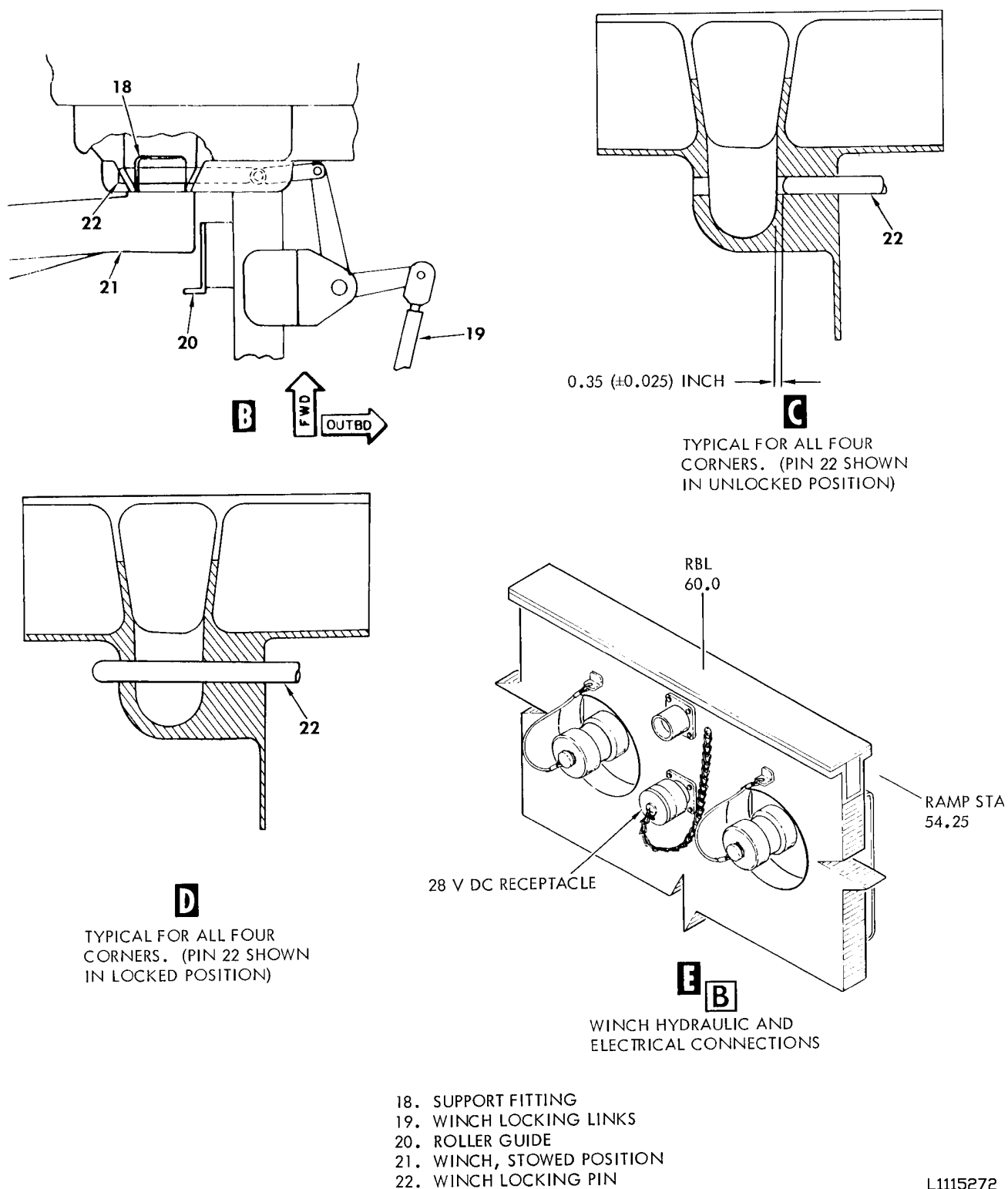


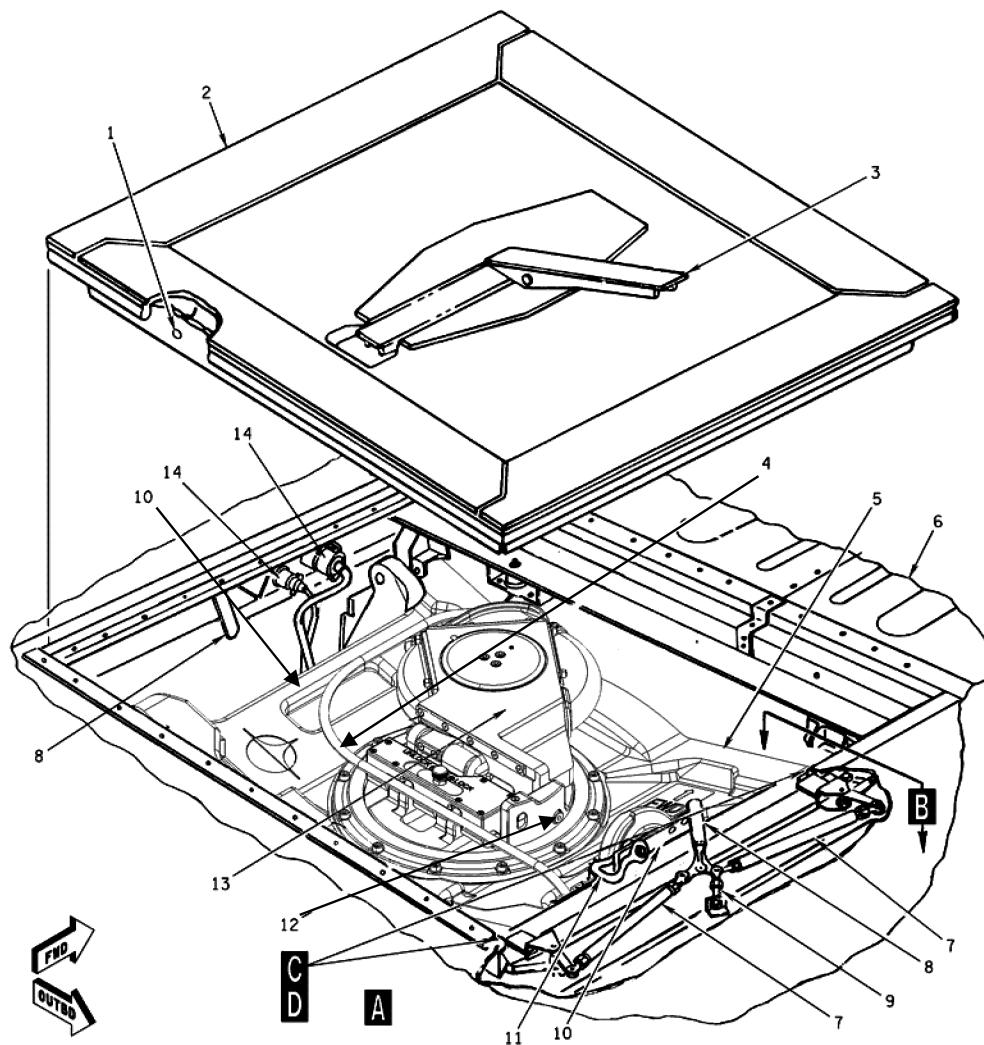
Figure 2-34. Cargo Winch – Stowed Position (Sheet 2)



L1115272

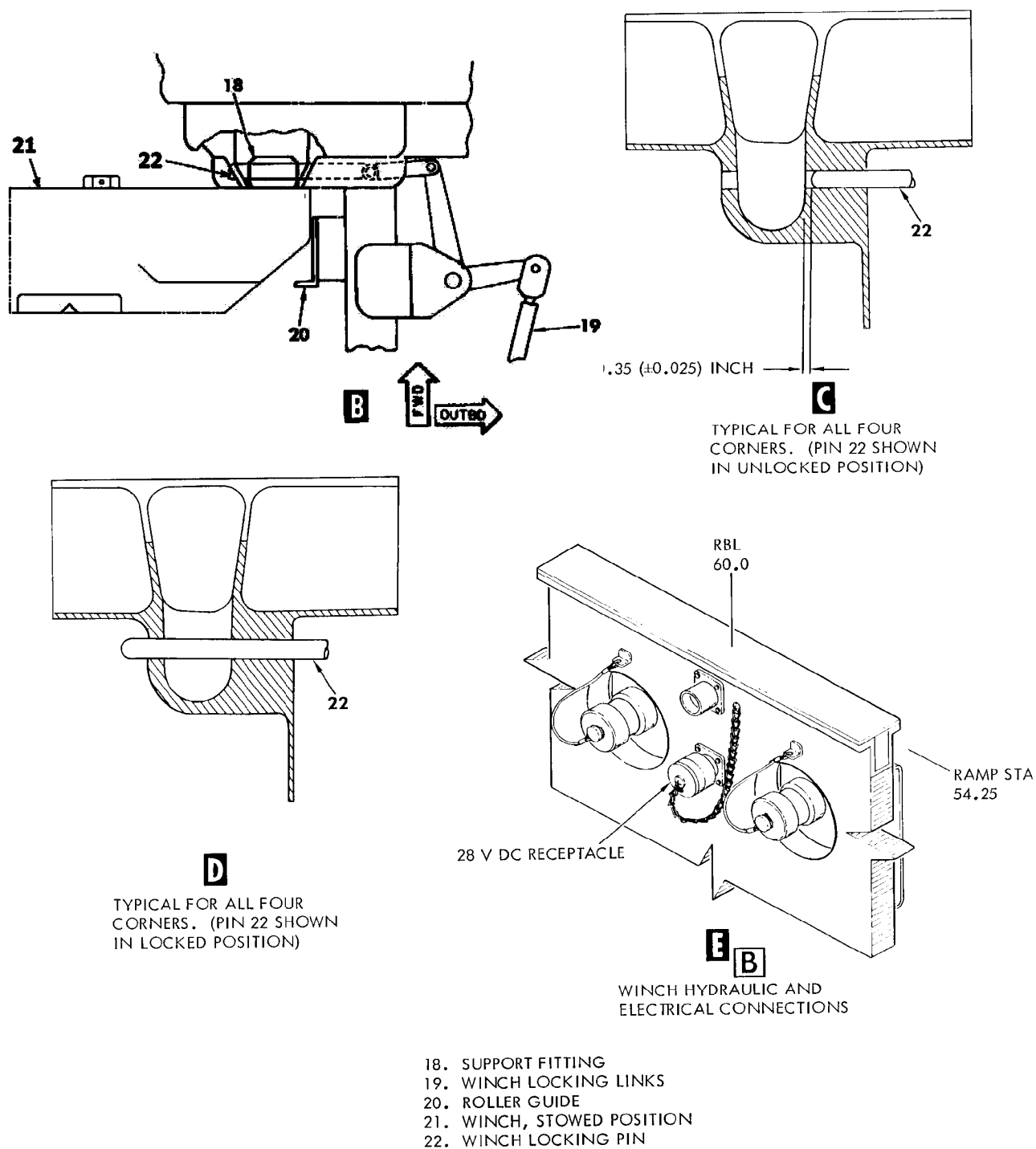
Figure 2-34. Cargo Winch – Stowed Position (Sheet 3)

1. LOCKING ROD	8. WINCH INSTALLATION LOCKING HANDLE
2. WINCH ACCESS HATCH ASSEMBLY	9. WINCH LOCKING STOP
3. ACCESS HATCH LOCK/UNLOCK HANDLE	10. WINCH MOBILITY HANDLE
4. WINCH CABLE STOWED	11. CLEVIS
5. WINCH, STOWED POSITION	12. SHEAVE ROD
6. RAMP FLOOR	13. SHEAVE ASSEMBLY STOWED
7. WINCH LOCKING LINK	14. ELECTRICAL CONNECTOR



L1701688

Figure 2-34.1. Dual Powered Winch – Stowed Position (Sheet 1 of 2)



L1701689

Figure 2-34.1. Dual Powered Winch – Stowed Position (Sheet 2)

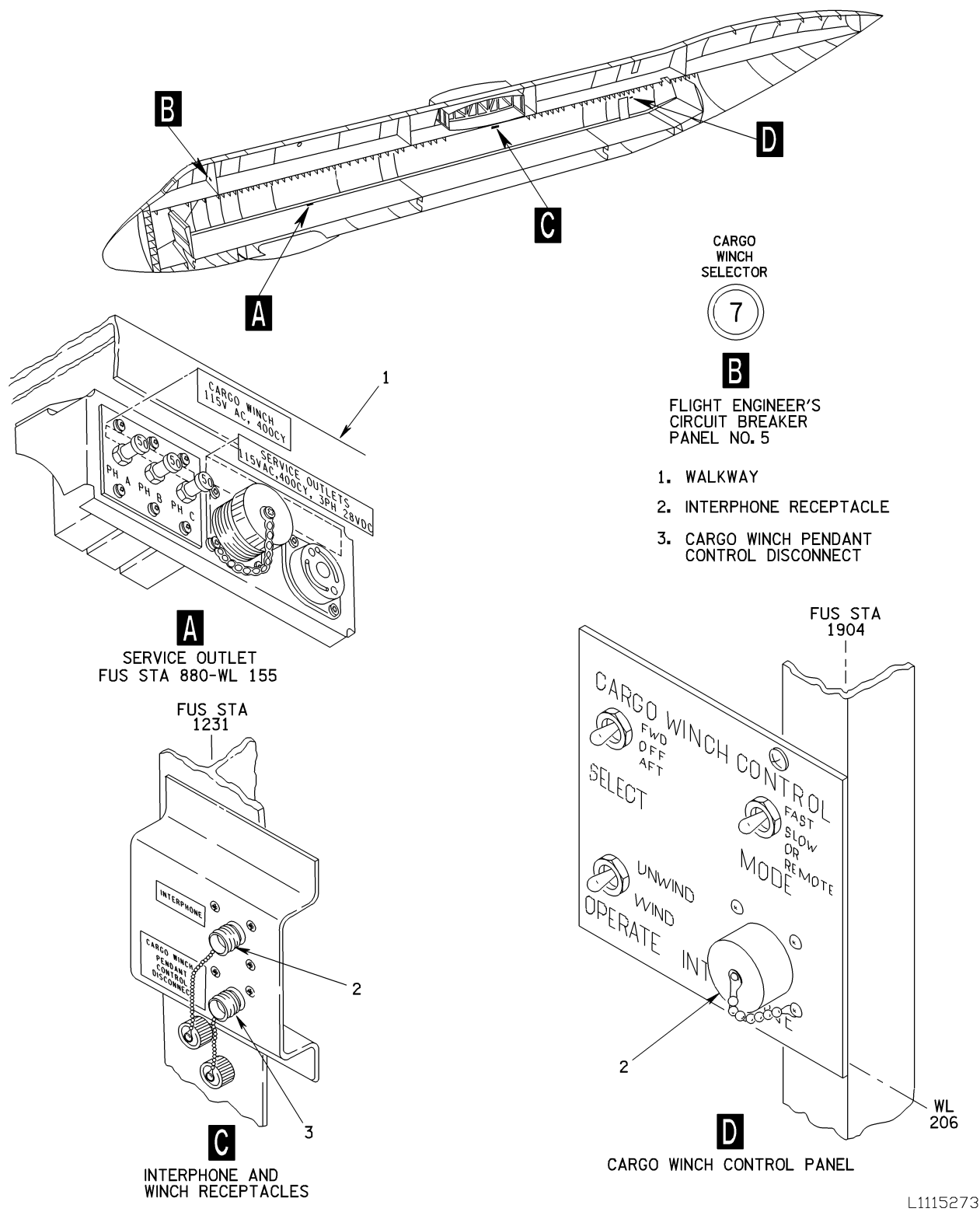
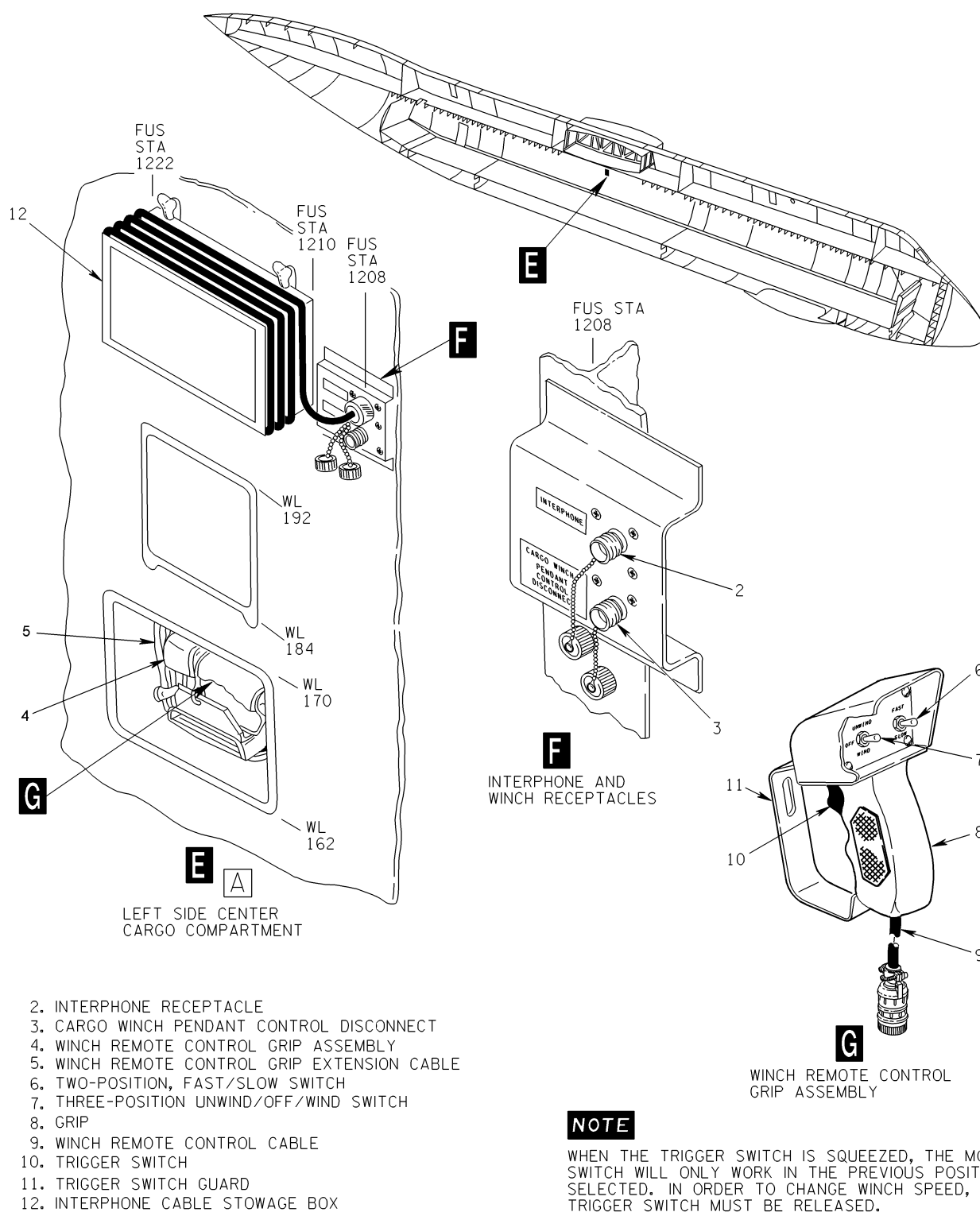
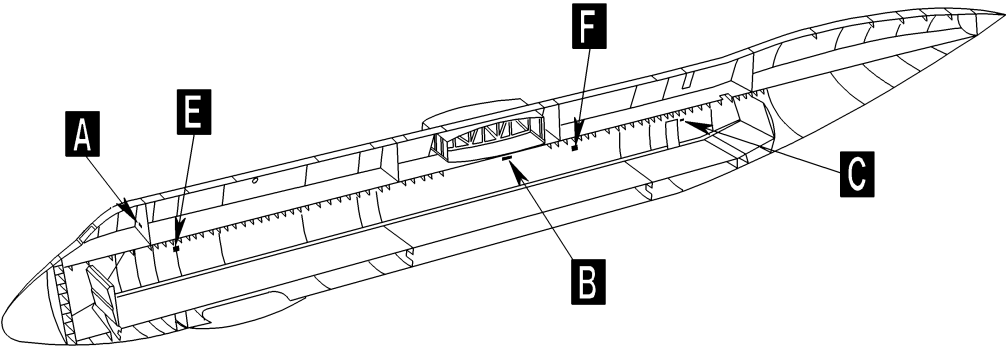


Figure 2-35. **A** Cargo Winch Controls (Sheet 1 of 2)



L1115274

Figure 2-35. **A** Cargo Winch Controls (Sheet 2)



NOTE

1 USED IN WINCH PENDANT CONTROL DISC RECEPTACLE ON AIRPLANES THAT HAVE CABLE ASSEMBLIES INSTALLED FOR ELECTRIC WINCH OPERATION.

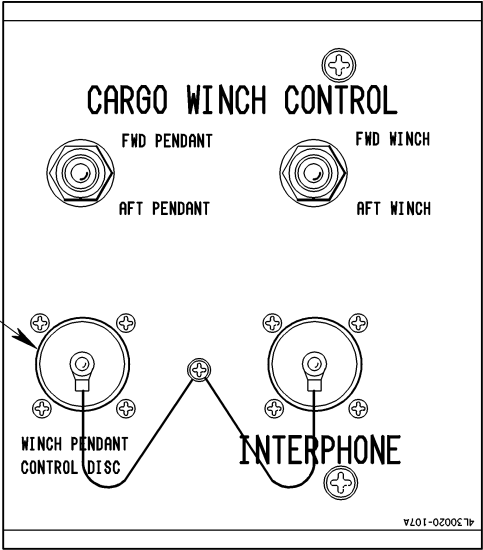
CARGO WINCH SELECTOR



A

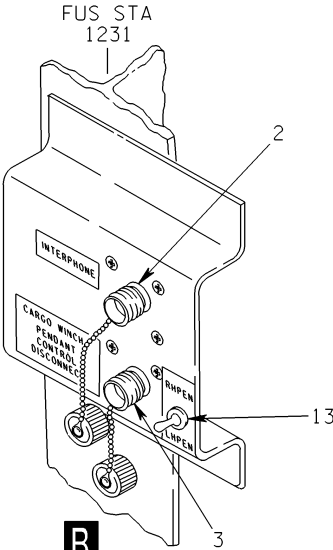
FLIGHT ENGINEER'S CIRCUIT BREAKER PANEL NO. 5

FUS STA 1904



C

CARGO WINCH CONTROL PANEL

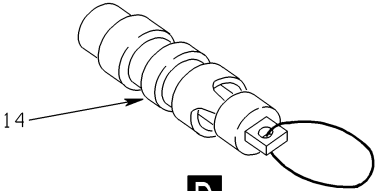


B

INTERPHONE AND WINCH RECEPTACLES AND PENDANT SELECT SWITCH

- 2. INTERPHONE RECEPTACLE
- 3. PENDANT CONTROL DISCONNECT
- 13. PENDANT SELECTOR SWITCH

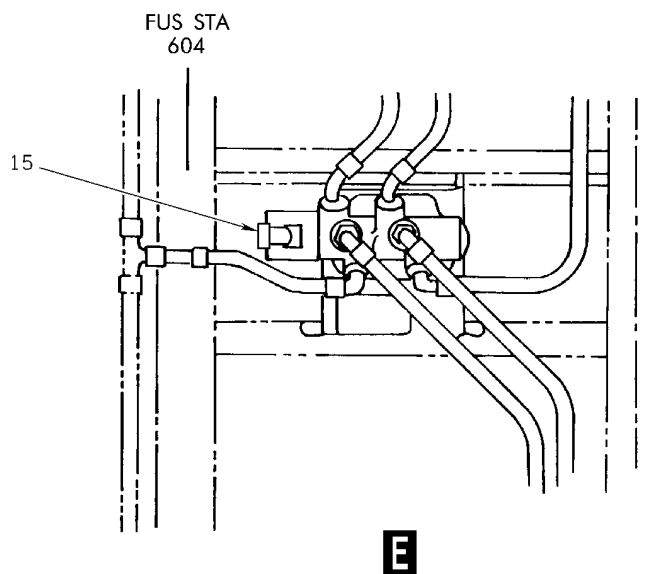
1 14. SHORTING PLUG ASSEMBLY



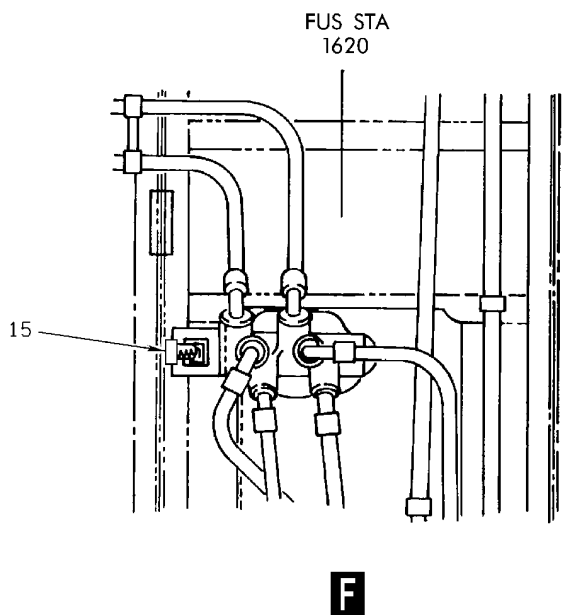
D

L1115275

Figure 2-36. **B** Cargo Winch Controls (Sheet 1 of 3)



15. MANUAL HYDRAULIC
SELECTOR VALVE



L1115276

Figure 2-36. **B** Cargo Winch Controls (Sheet 2)

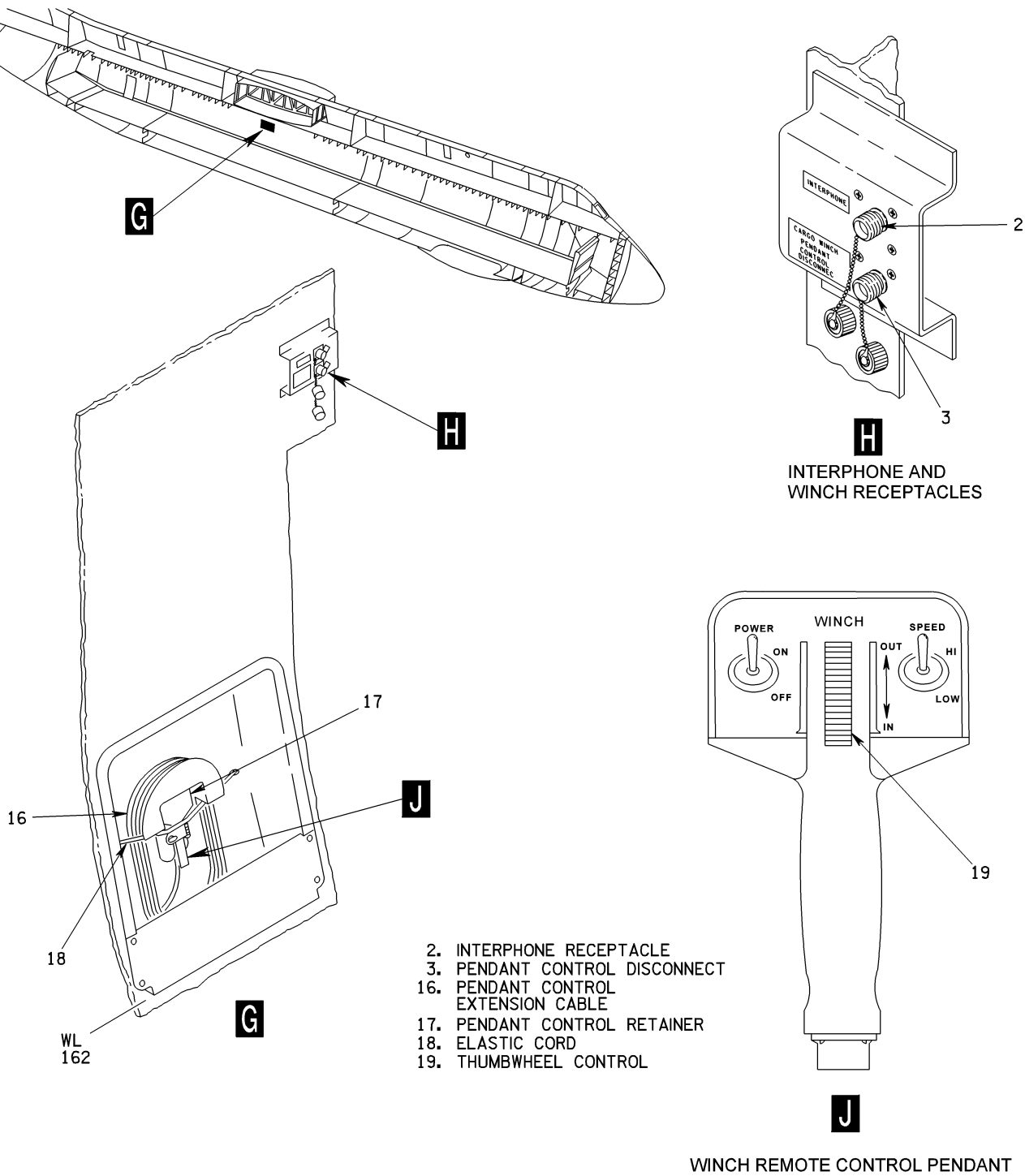
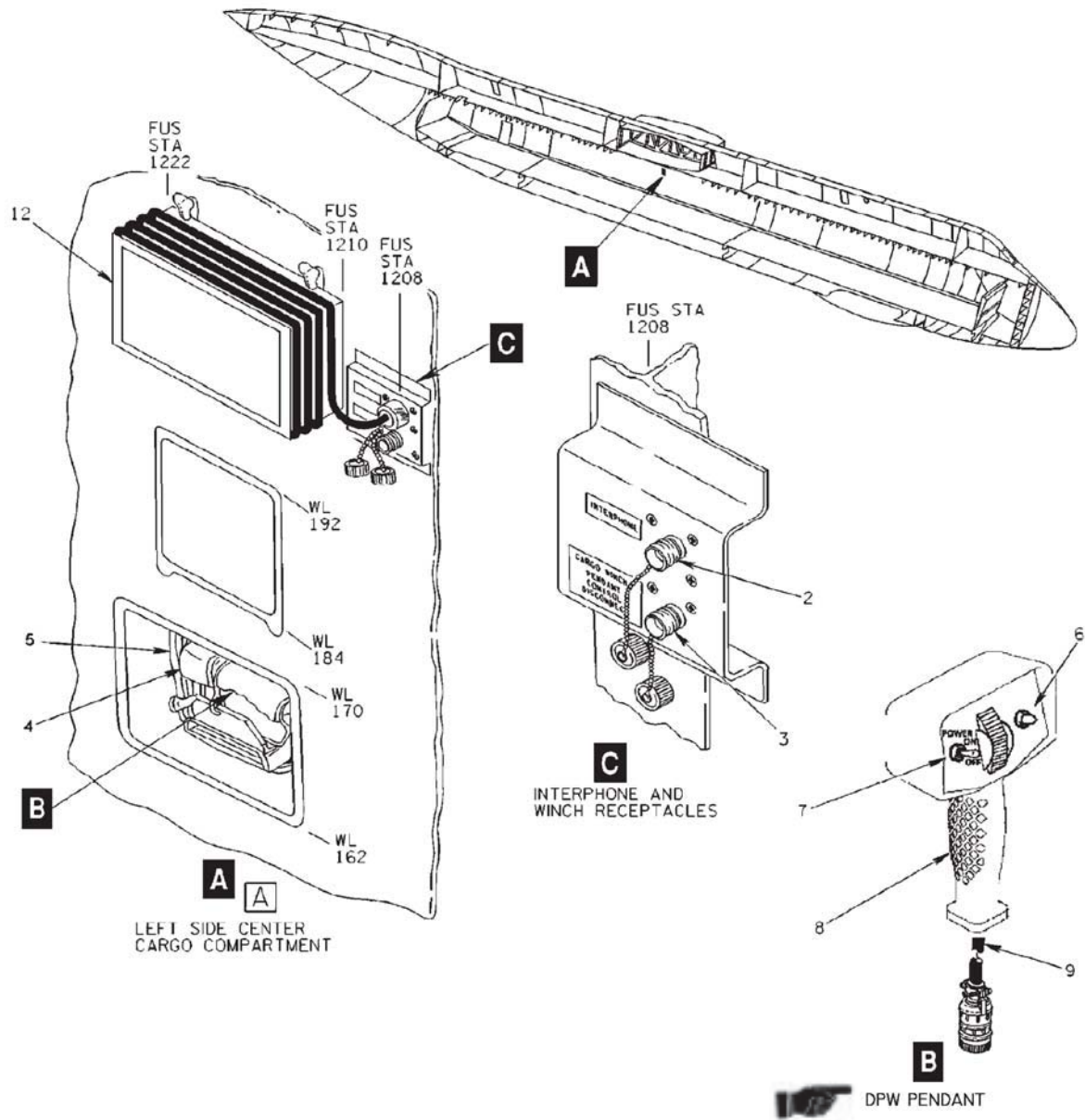


Figure 2-36. **B** Cargo Winch Controls (Sheet 3)

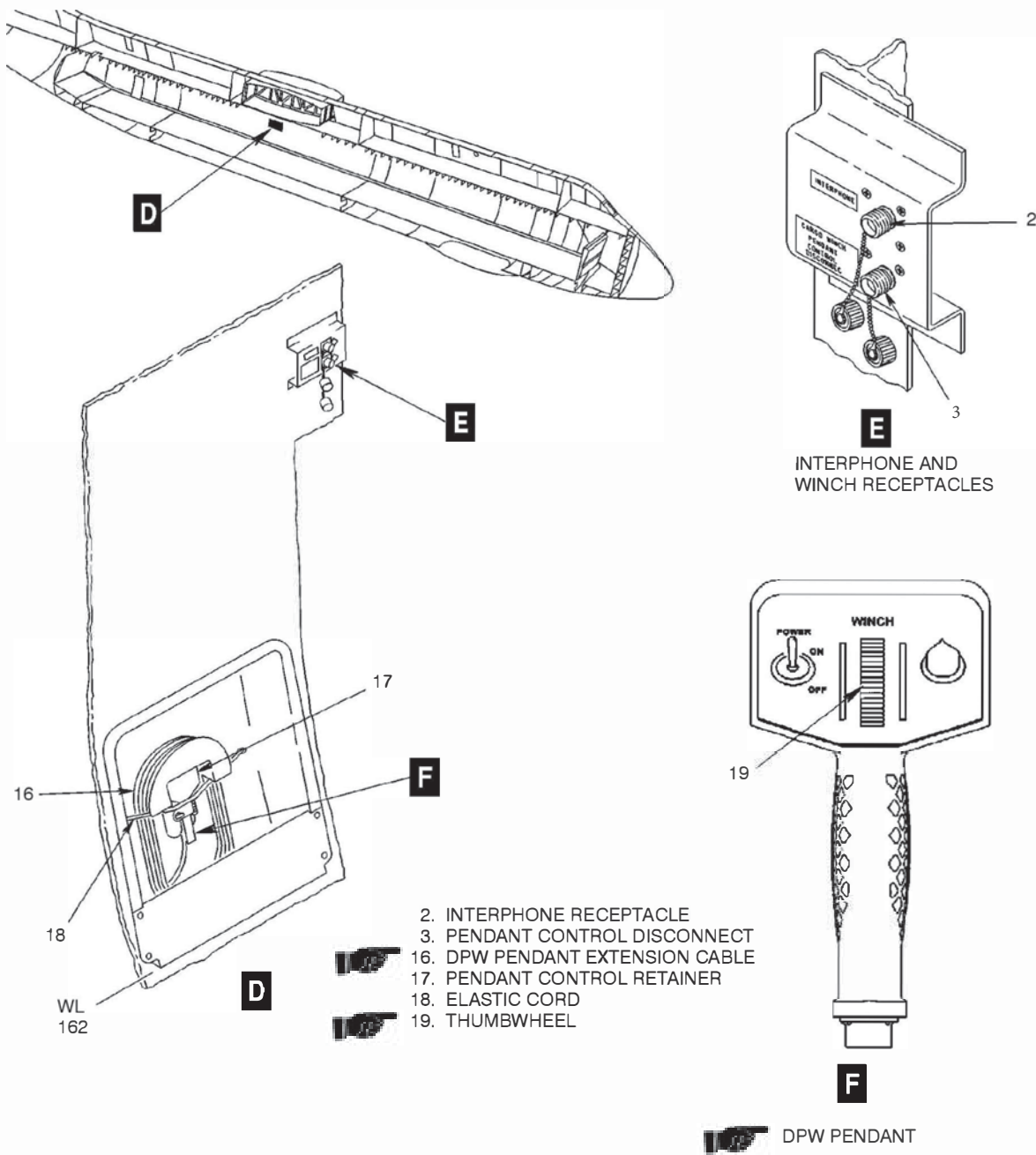
L1115277



- 2. INTERPHONE RECEPTACLE
- 3. CARGO WINCH PENDANT CONTROL DISCONNECT
- 4. DPW PENDANT
- 5. DPW PENDANT CABLE
- 6. THUMBWHEEL
- 7. POWER SWITCH
- 8. PENDANT GRIP
- 9. DPW PENDANT CABLE CONNECTOR
- 12. INTERPHONE CABLE STORAGE BOX

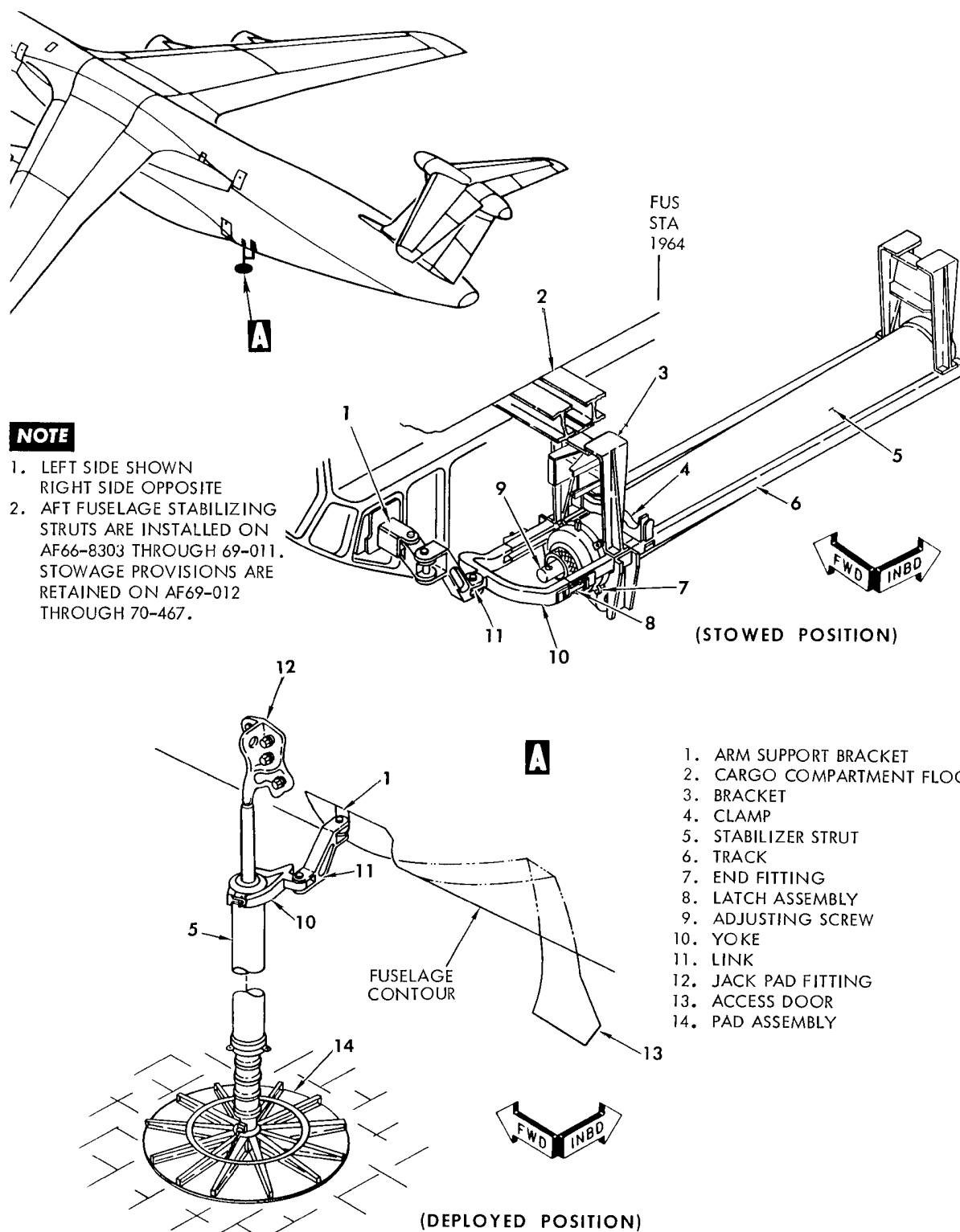
L1702094

Figure 2-36.1. Dual Powered Cargo Winch Controls (Sheet 1 of 2)



L1702095

Figure 2-36.1. Dual Powered Cargo Winch Controls (Sheet 2)



L1115278

Figure 2-37. [A] Stabilizing Struts – Aft Fuselage

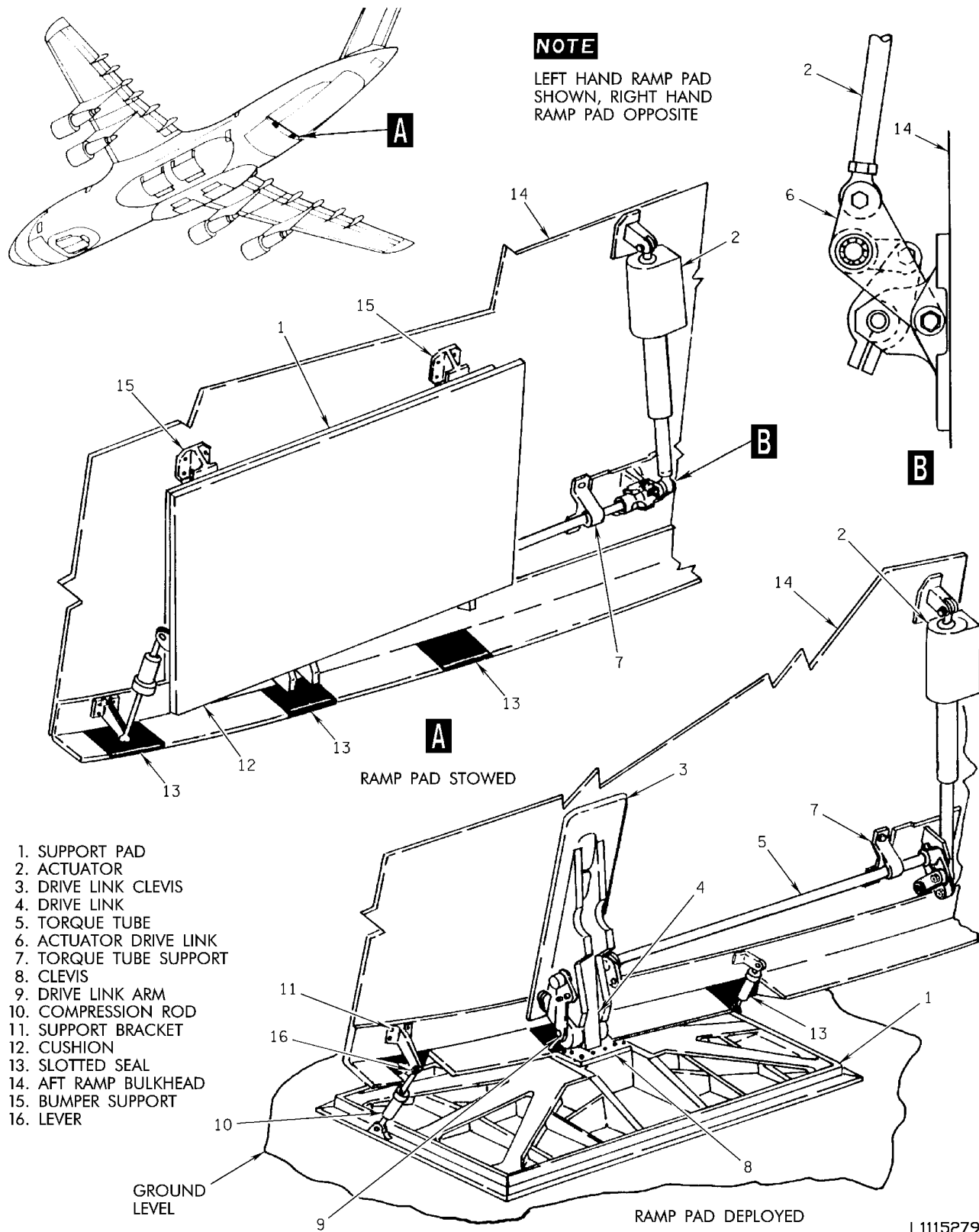
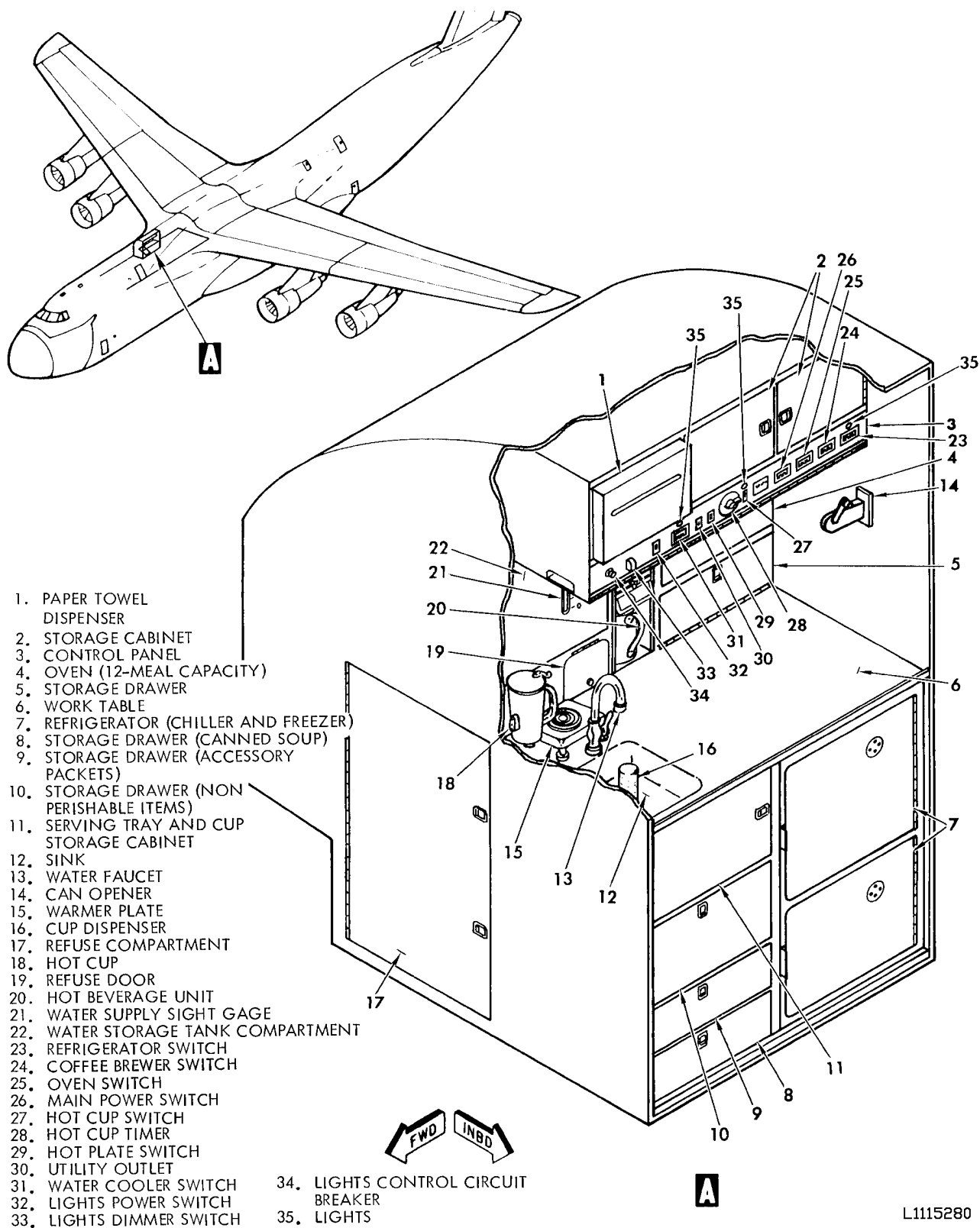
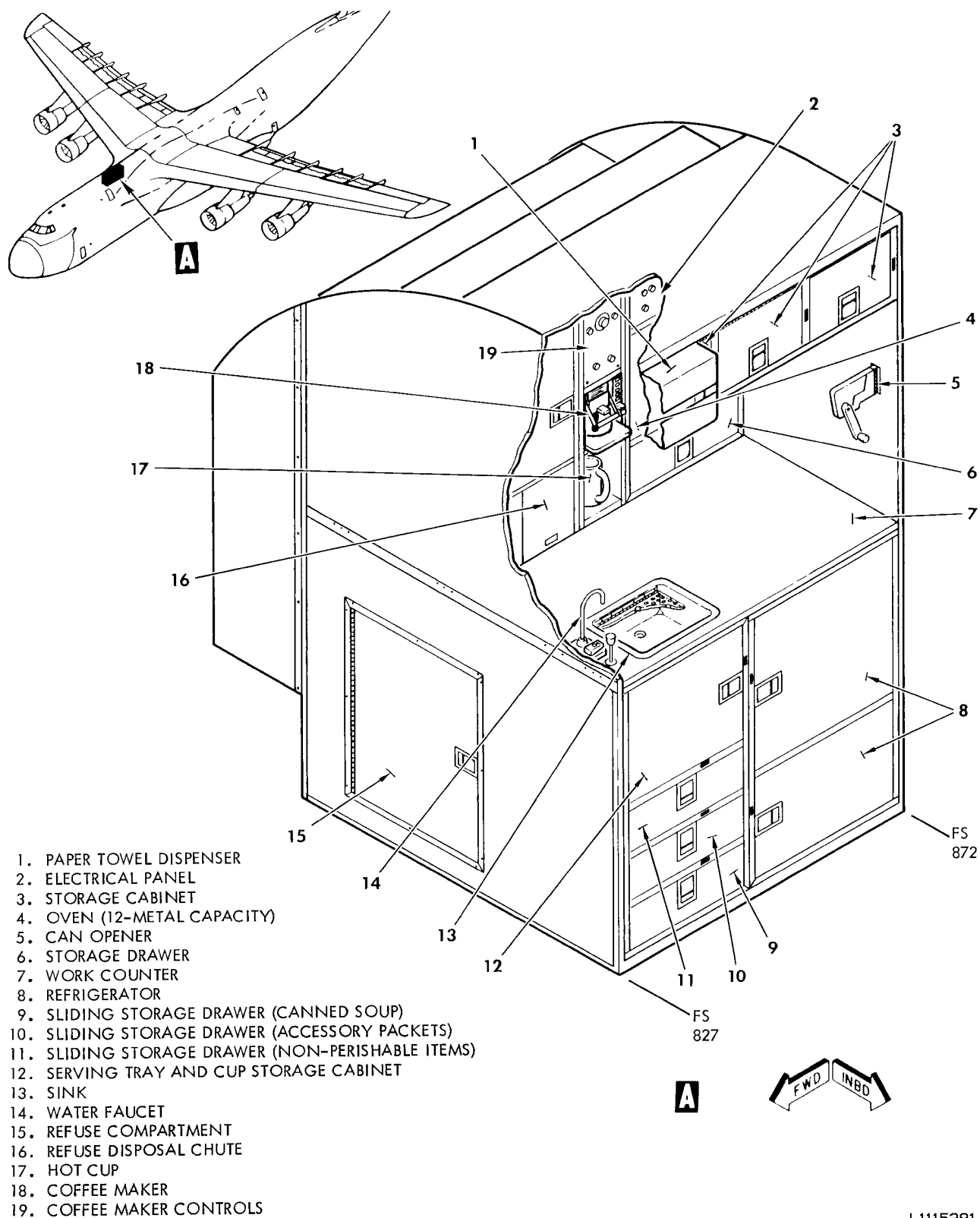


Figure 2-38. Aft Cargo Ramp – Ground Support Pads



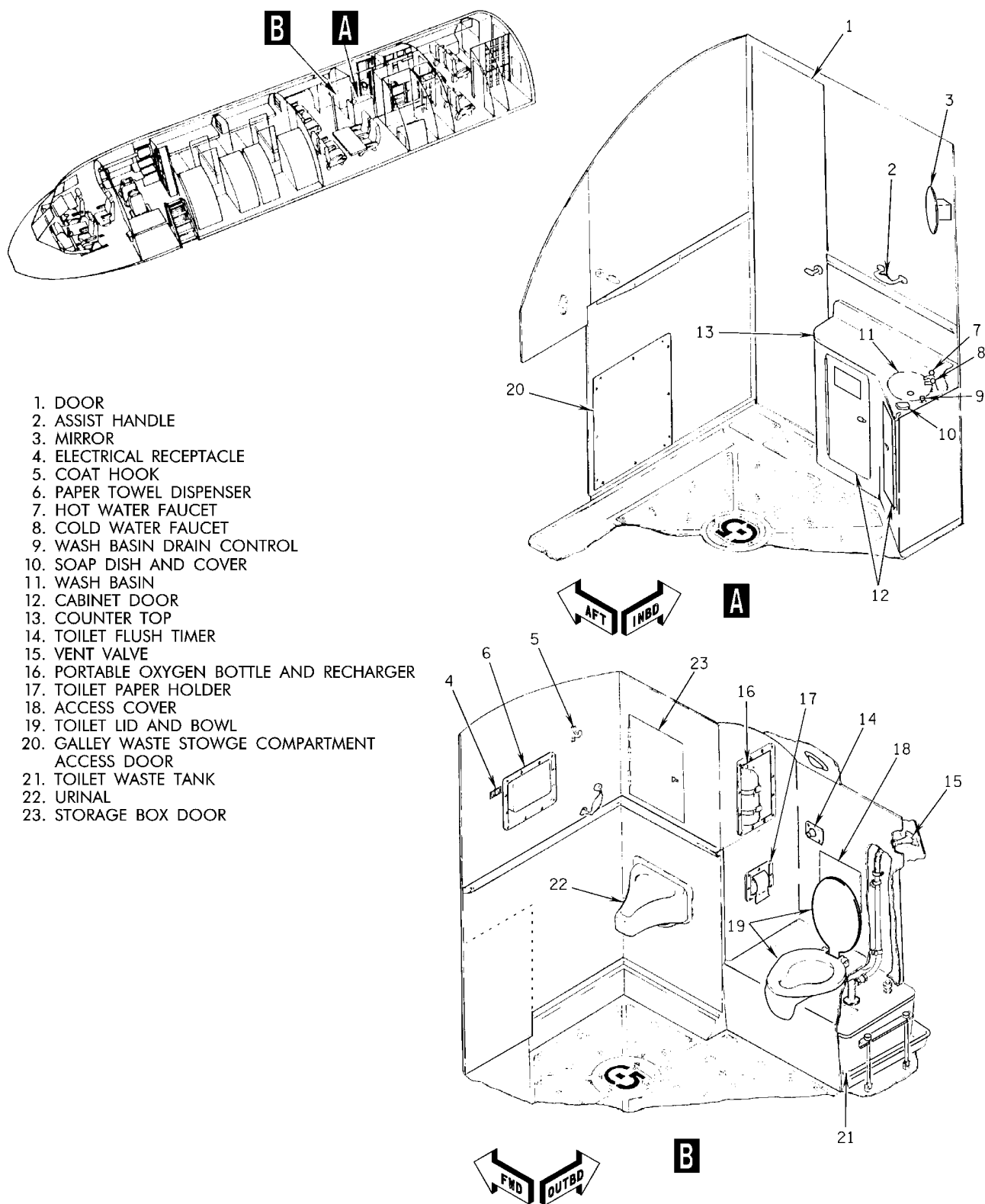
L1115280

Figure 2-39. **A** Crew, Relief Crew, or Courier Compartment Galley



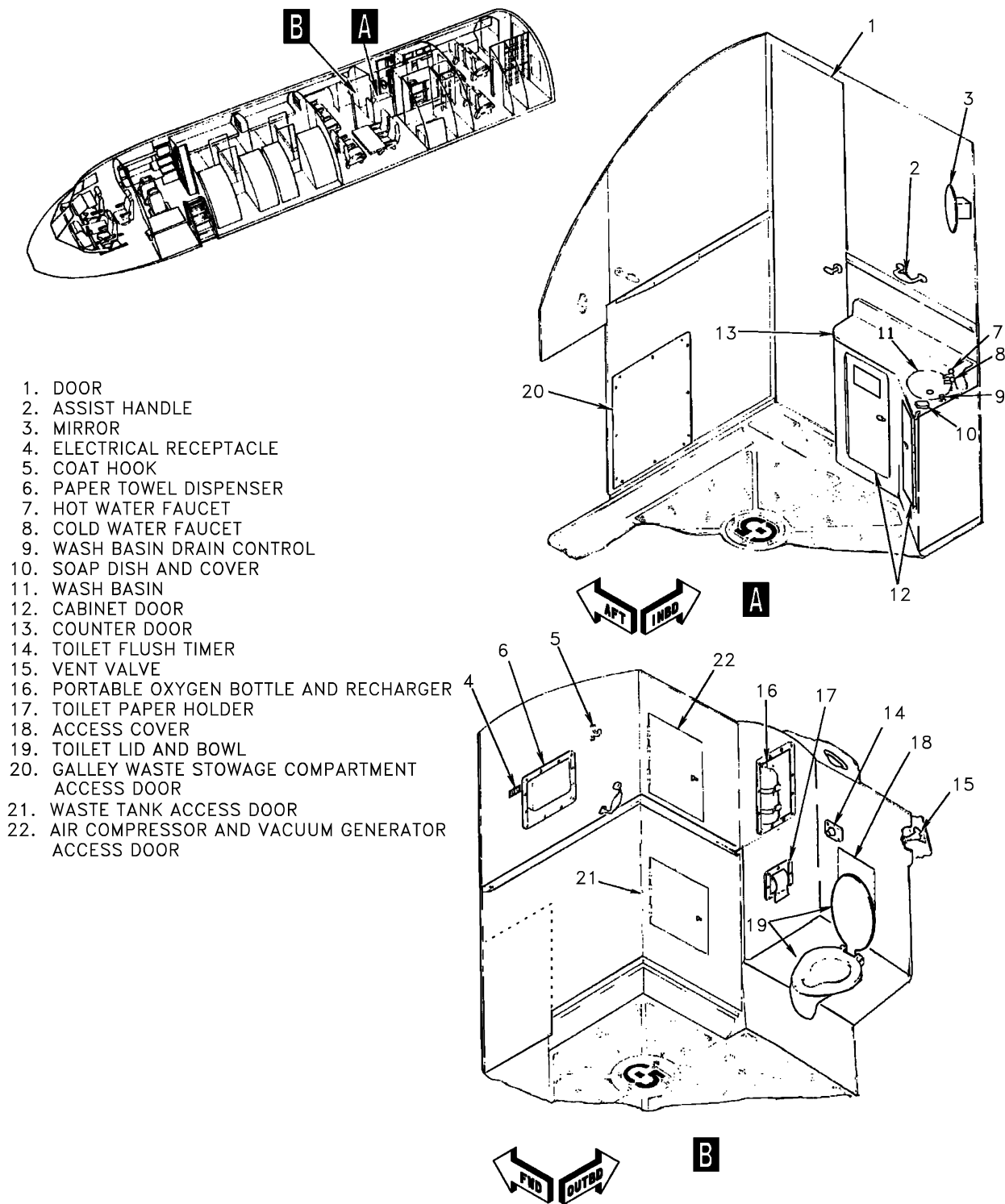
L1115281

Figure 2-40. **B** Crew, Relief Crew, or Courier Compartment Galley



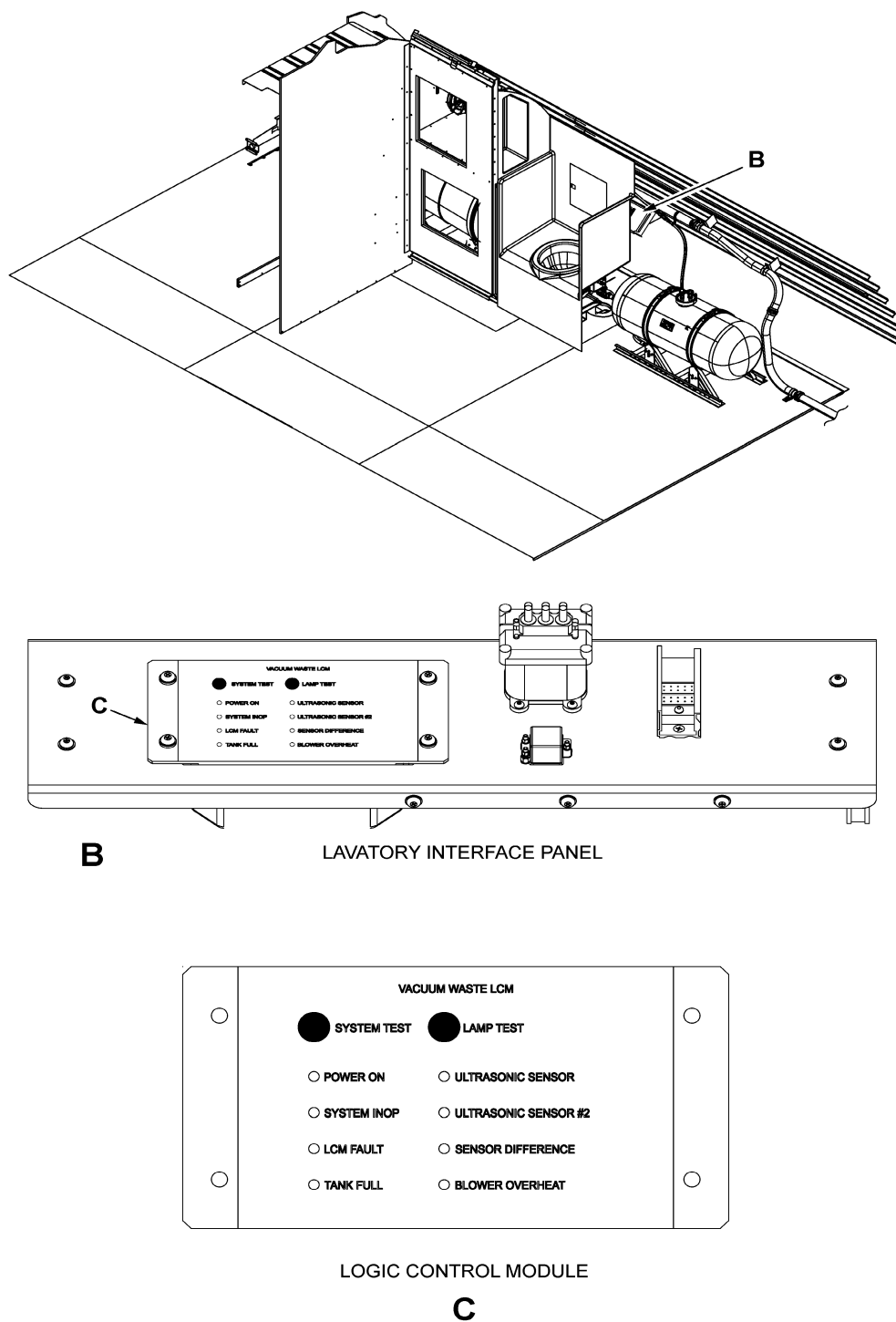
L1115282

Figure 2-41. Crew, Relief Crew, or Courier Compartment Toilet (Airplanes Not Modified By TO 1C-5M-544)



L1600101

Figure 2-42. Crew, Relief Crew, or Courier Compartment Toilet (Airplanes Modified By TO 1C-5M-544)



L1600104

Figure 2-43. Vacuum Lavatory System (Airplanes Modified By TO 1C-5M-544)

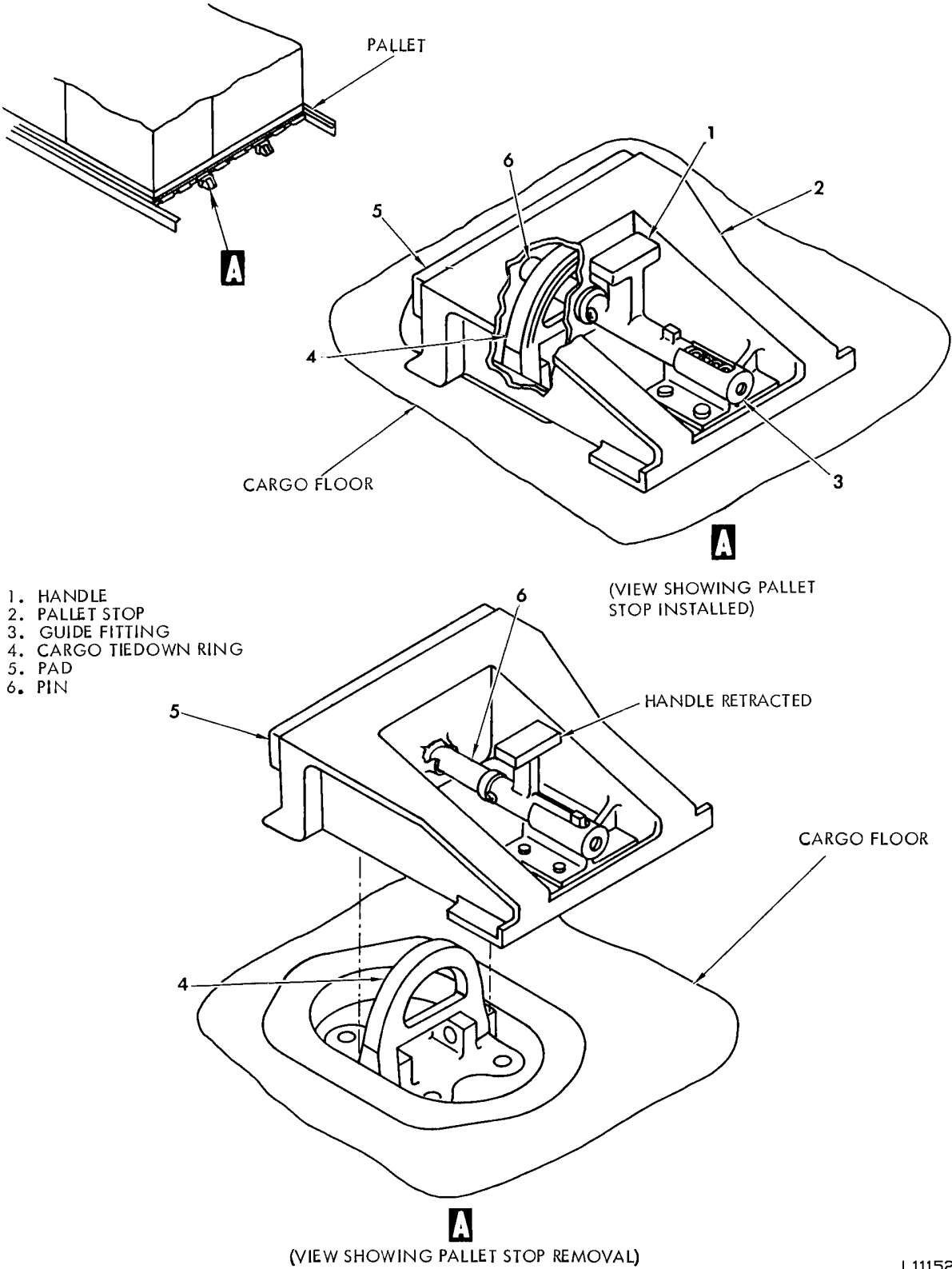


Figure 2-44. Pallet Stops

L1115283

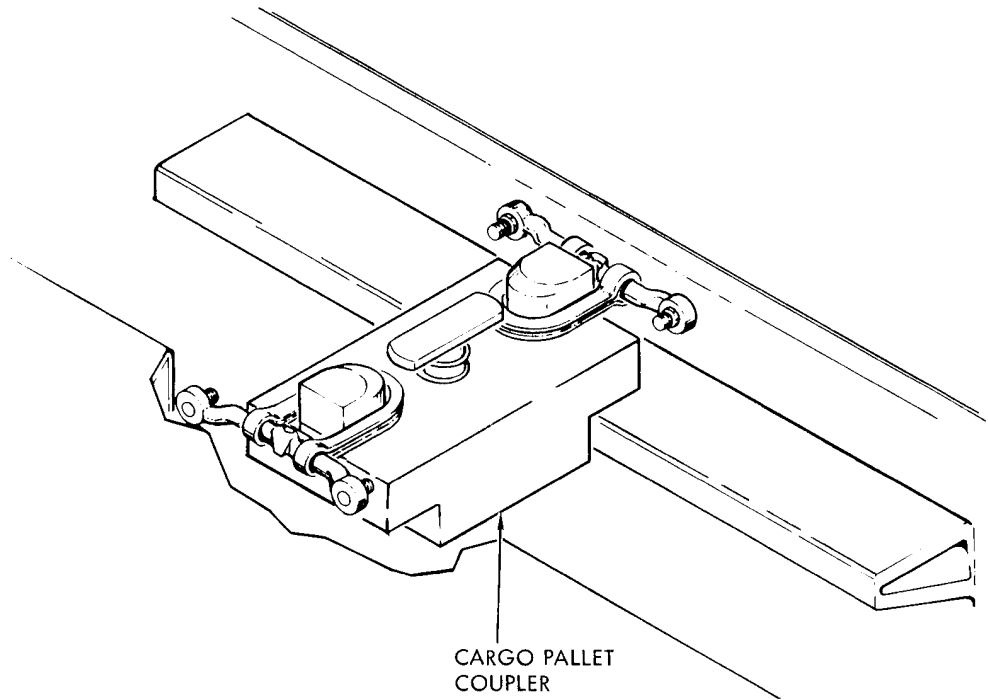


Figure 2-45. Cargo Pallet Coupler

L1115284

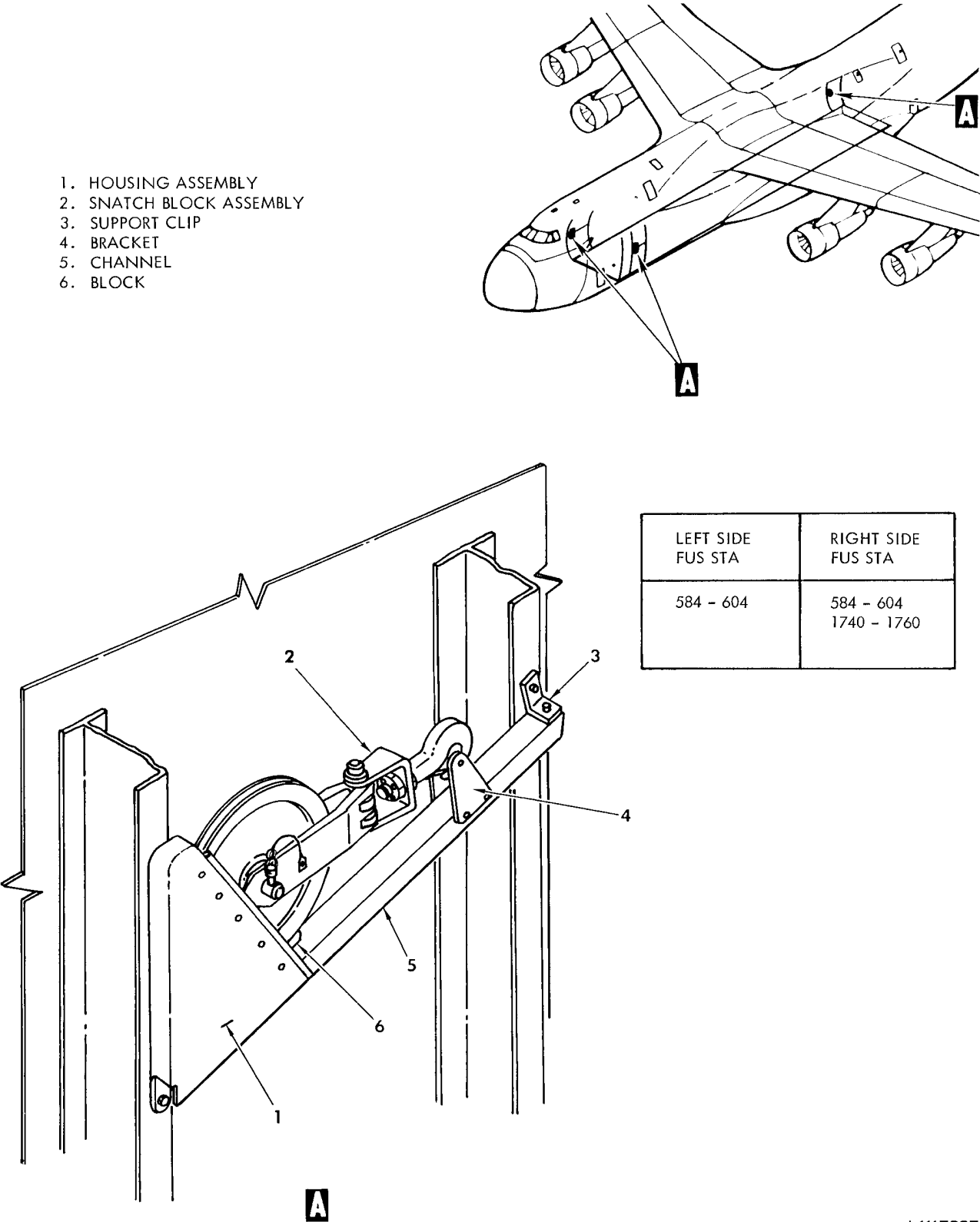


Figure 2-46. Snatch Block Stowage

L1115285

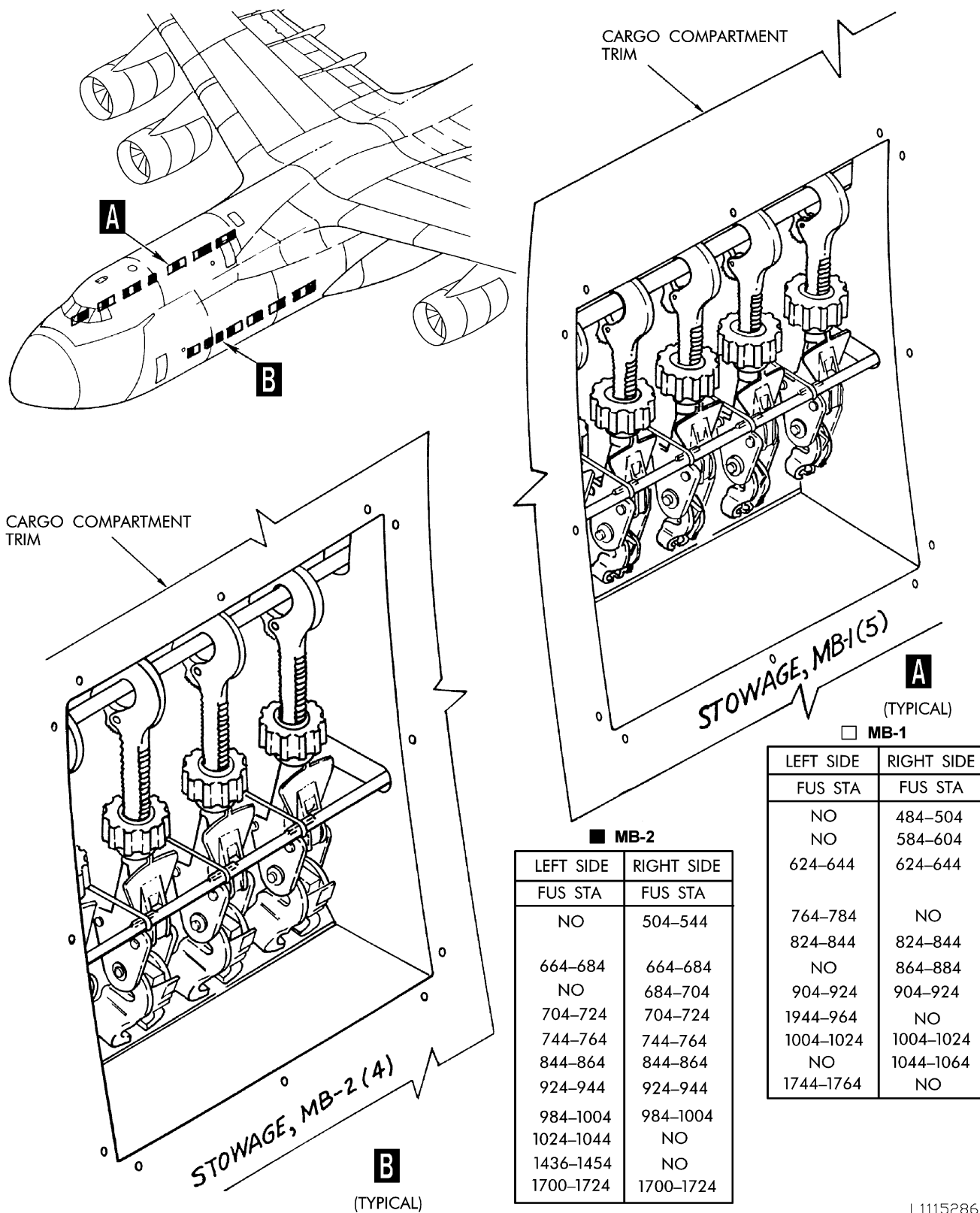
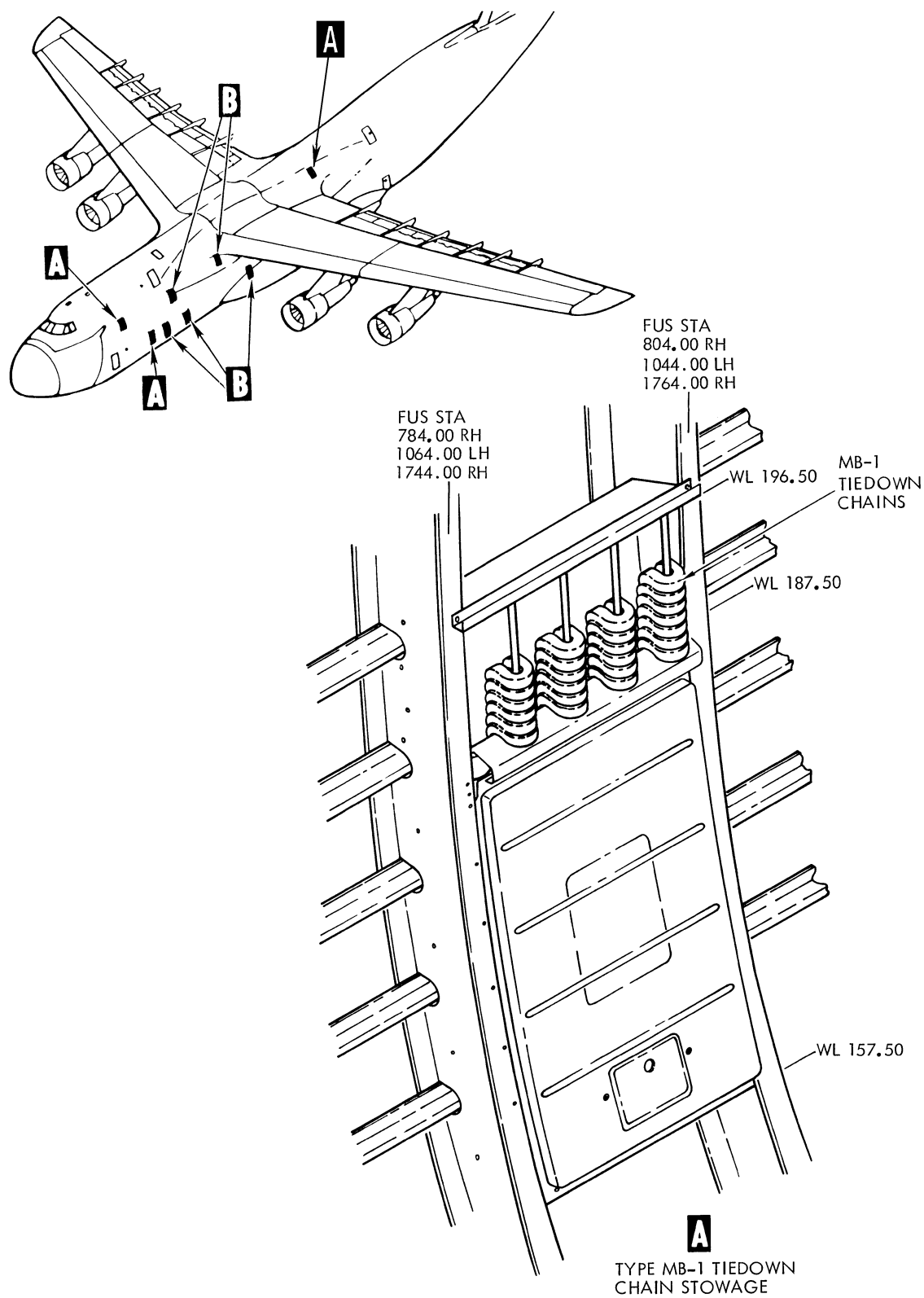


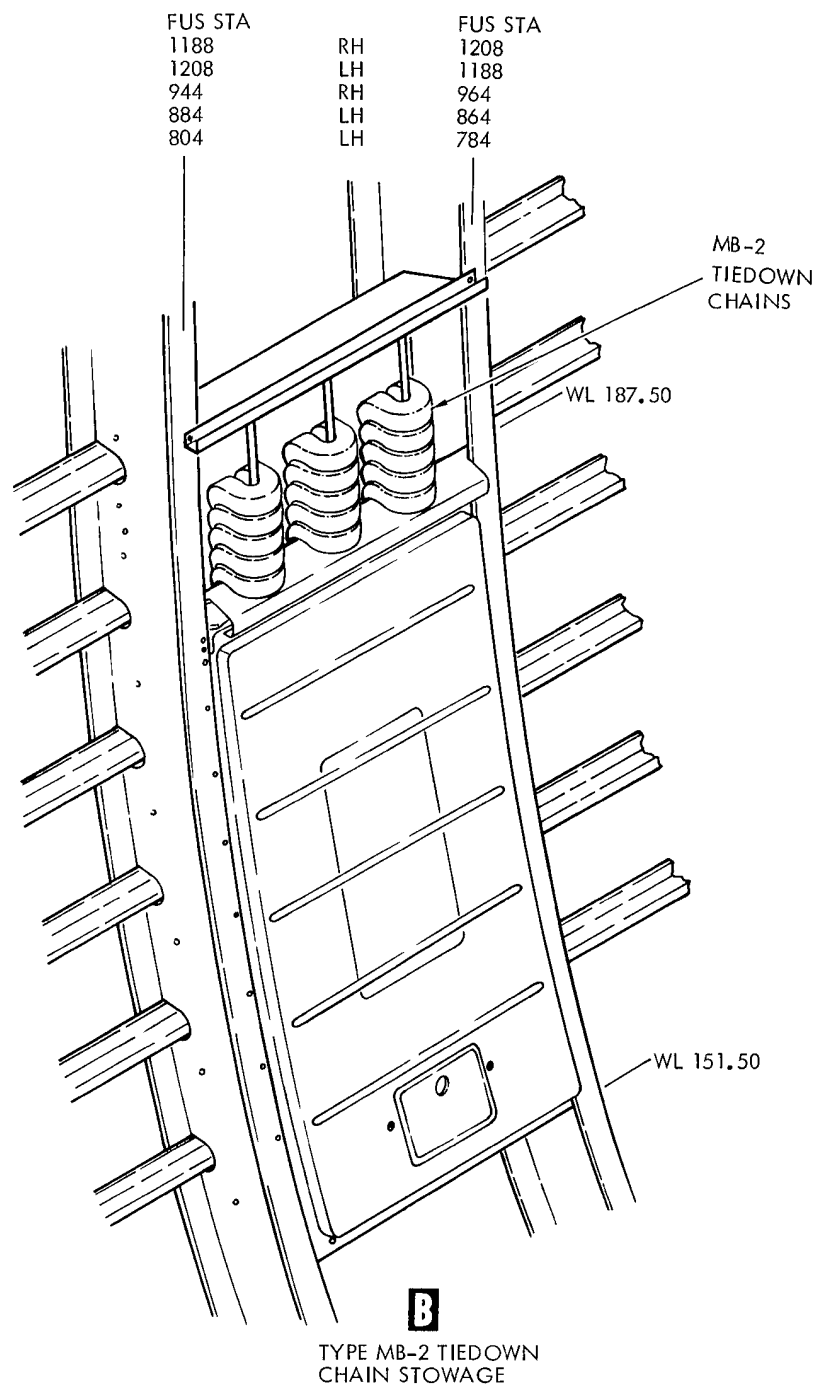
Figure 2-47. MB-1 and MB-2 Tiedown Device Stowage

L1115286



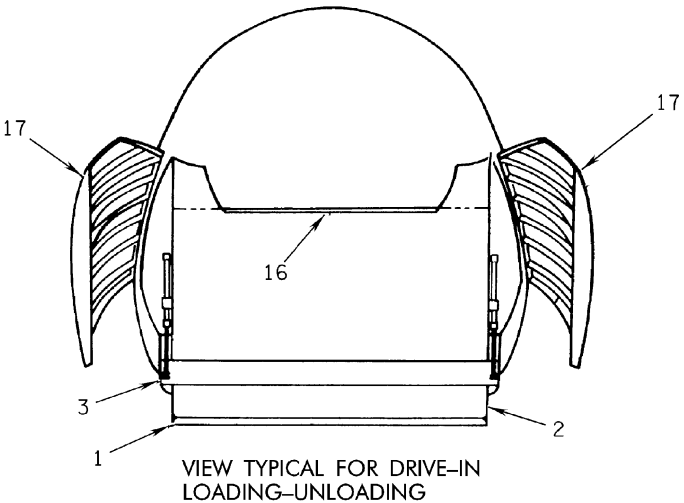
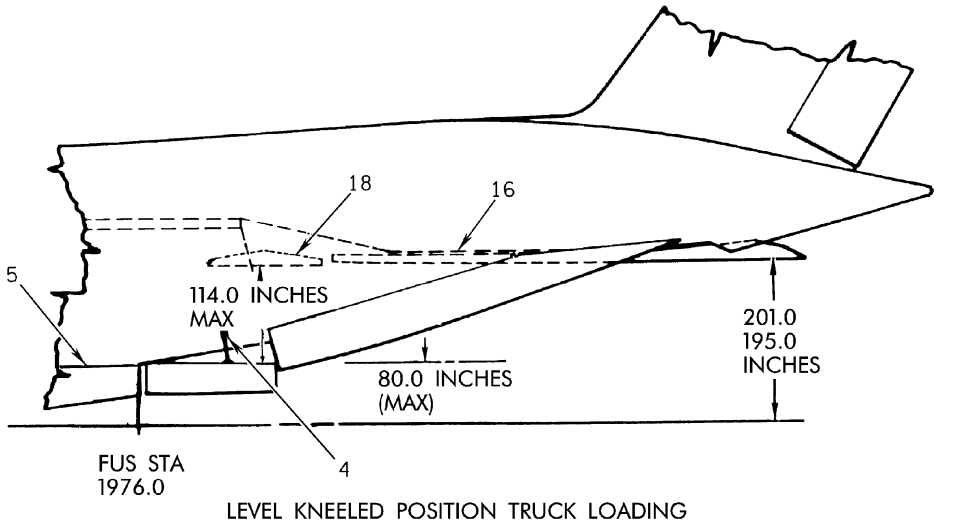
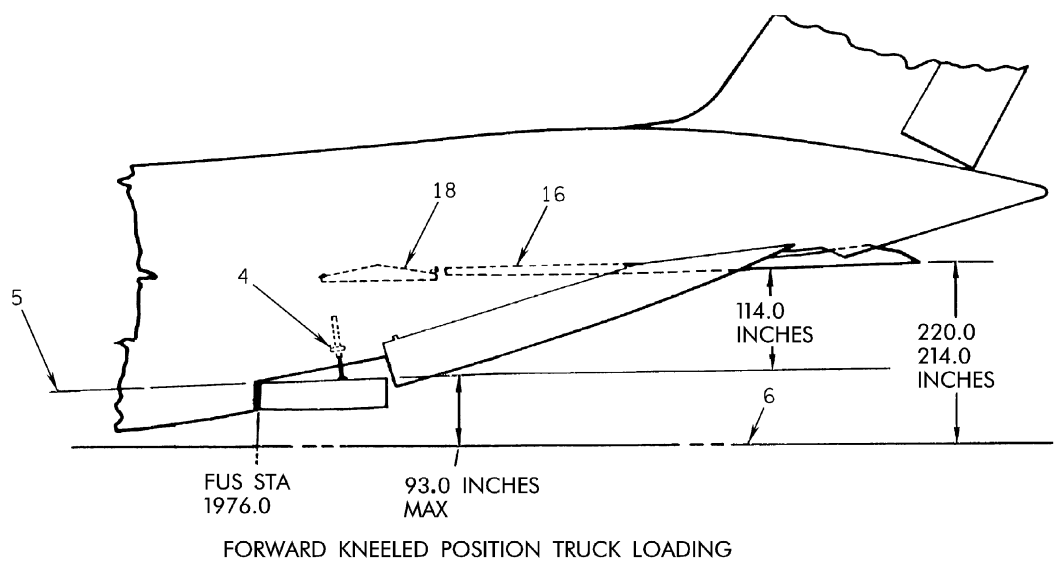
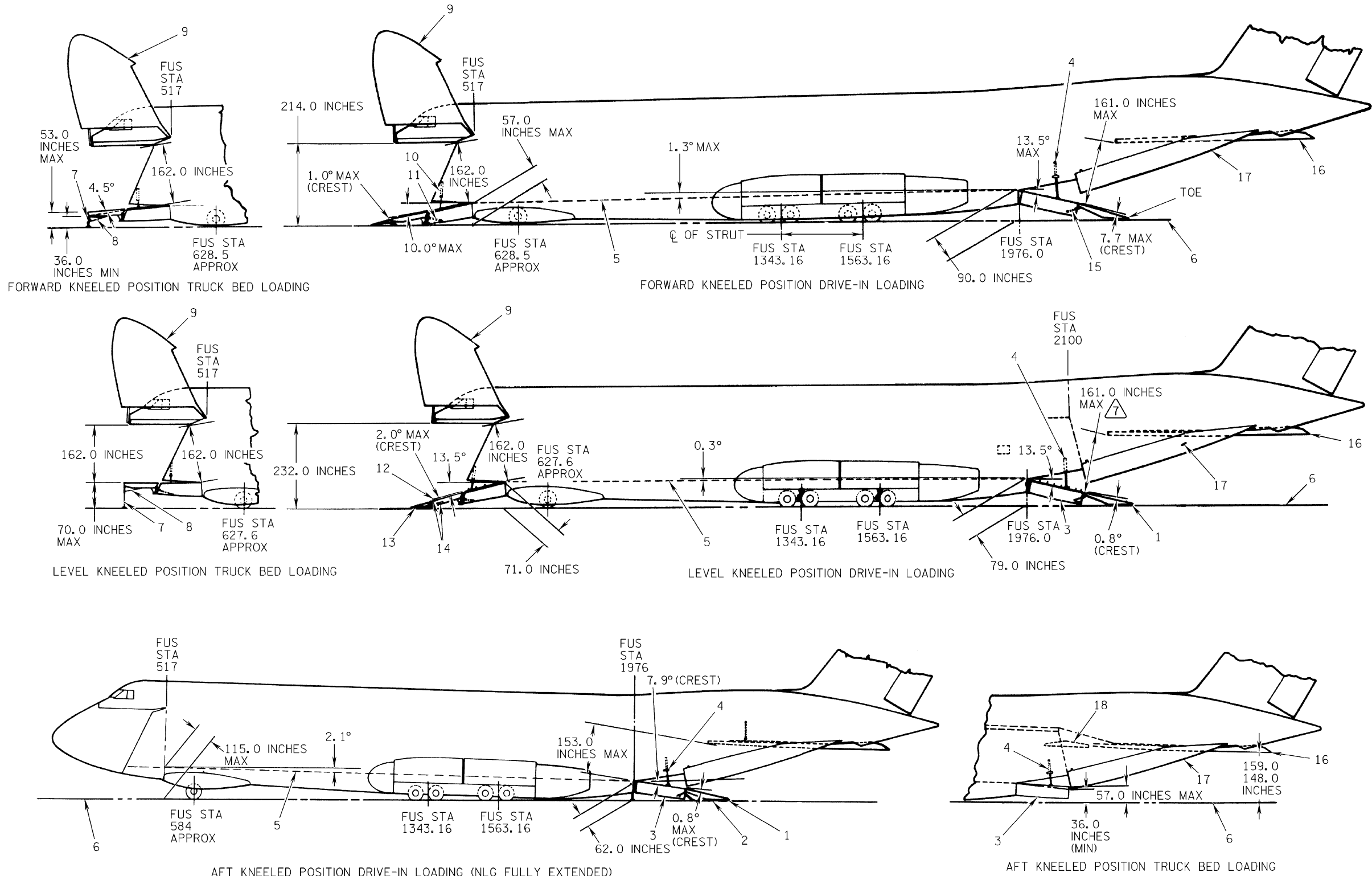
L1115287

Figure 2-48. MB-1 and MB-2 Tiedown Device Chain Stowage (Sheet 1 of 2)



L1115288

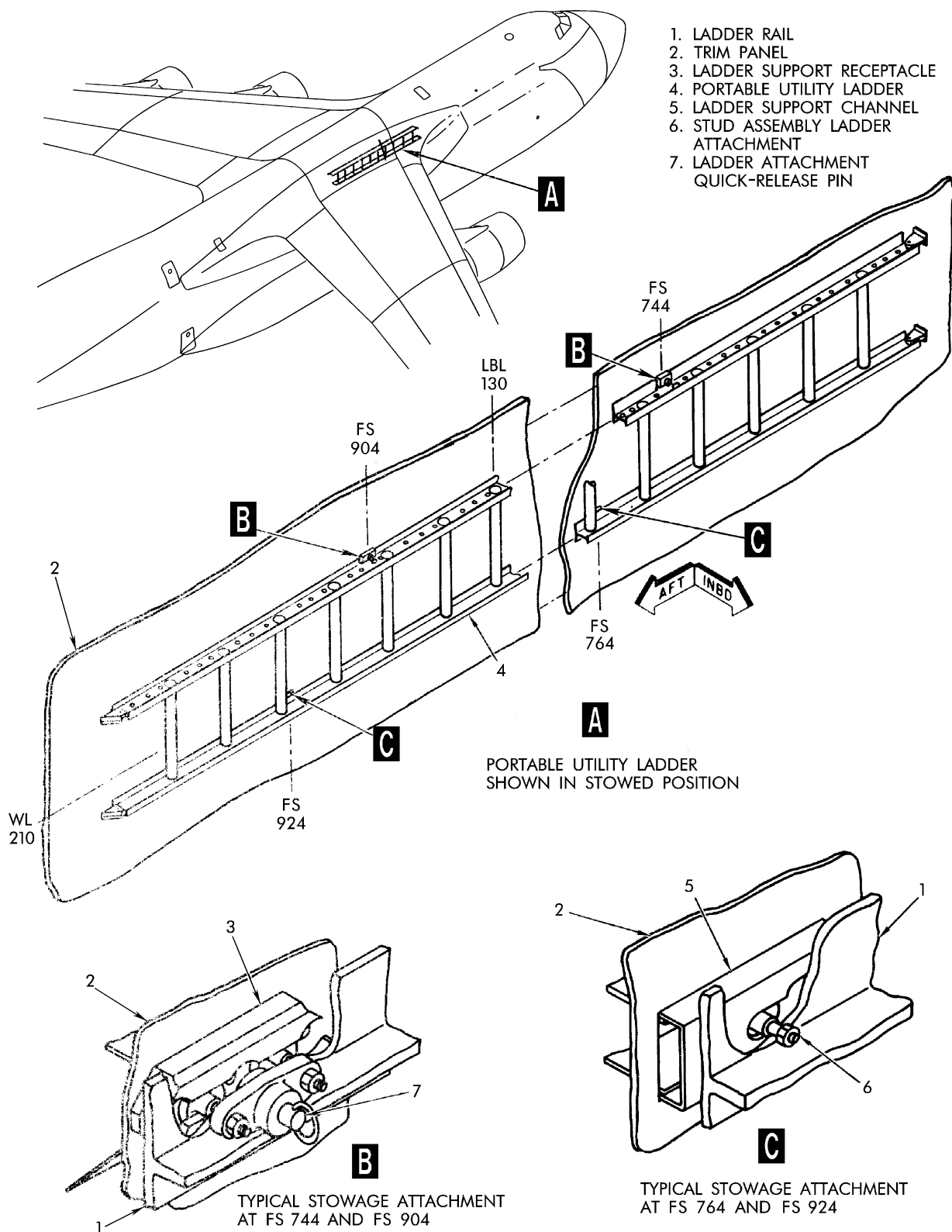
Figure 2-48. MB-1 and MB-2 Tiedown Device Chain Stowage (Sheet 2)



- 1. PRESSURE DOOR TOES
- 2. PRESSURE DOOR (DRIVE-IN LOADING POSITION)
- 3. AFT RAMP
- 4. AFT RAMP ACTUATOR
- 5. CARGO FLOOR
- 6. GROUND LINE
- 7. FORWARD RAMP EXTENSION JACK (DEPLOYED)
- 8. FORWARD RAMP EXTENSION TOES (STOWED)
- 9. VISOR
- 10. FORWARD RAMP ACTUATOR
- 11. FORWARD RAMP EXTENSION ACTUATOR
- 12. FORWARD RAMP EXTENSION
- 13. FORWARD RAMP EXTENSION TOES (DEPLOYED)
- 14. FORWARD RAMP EXTENSION JACKS (STOWED)
- 15. PRESSURE DOOR ACTUATOR
- 16. CENTER CARGO DOOR (LOADING POSITION)
- 17. SIDE CARGO DOORS (LOADING POSITION)
- 18. PRESSURE DOOR (OVERHEAD LOADING POSITION)

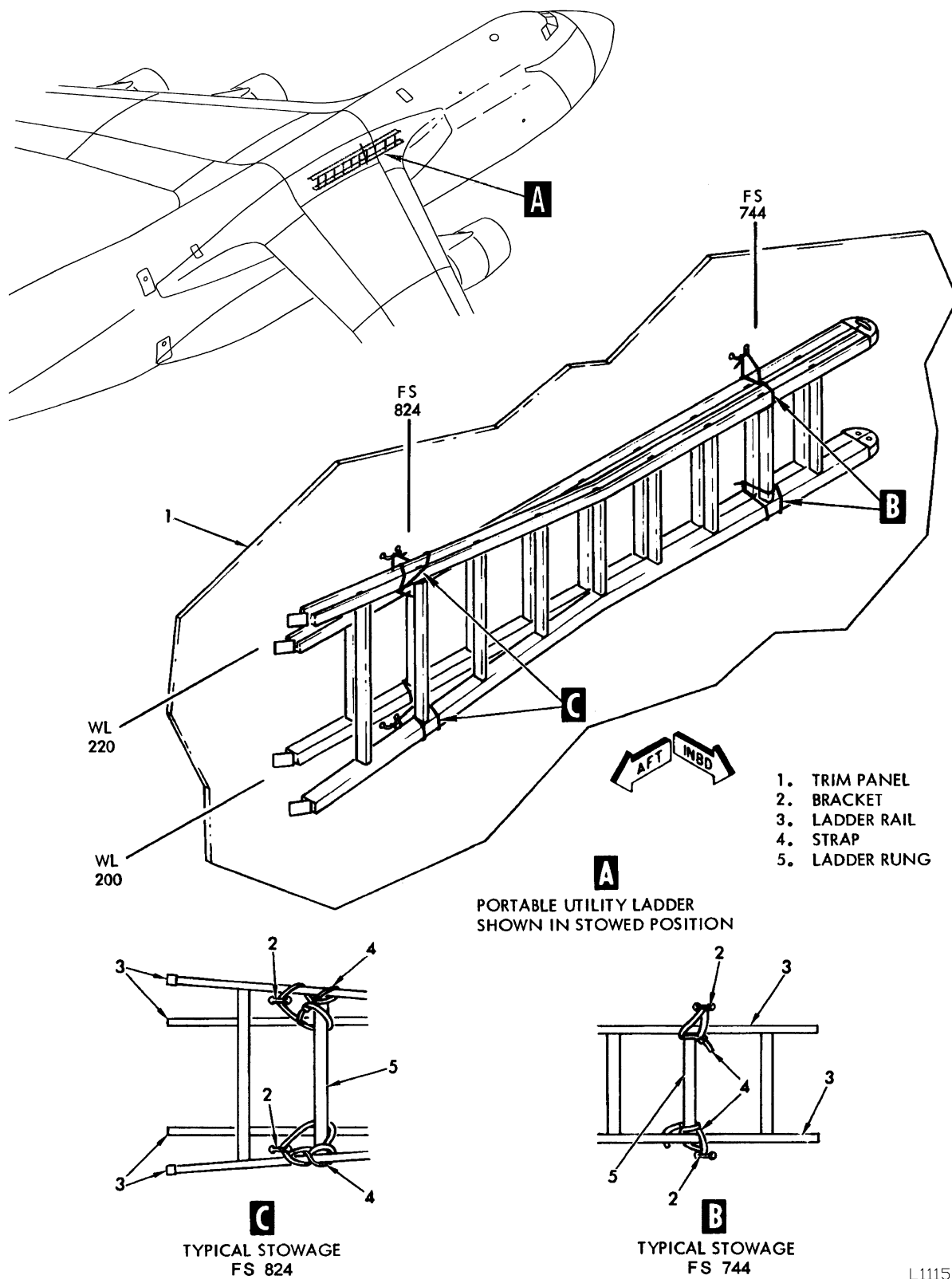
- NOTE**
- 1. COMBINED LENGTH OF FORWARD RAMP AND EXTENSION IN DRIVE-IN POSITION IS 273.0 INCHES.
 - 2. COMBINED LENGTH OF FORWARD RAMP AND EXTENSION IN TRUCK BED POSITION IS 228.0 INCHES.
 - 3. COMBINED LENGTH OF AFT RAMP AND PRESSURE DOOR DRIVE-IN POSITION IS 311.5 INCHES.
 - 4. ANGLE OF AFT RAMP TOES IS 24° MAX. ANGLE OF FORWARD RAMP TOES IS 17° MAX.
 - 5. CLOSED ANGLE OF AFT RAMP IS 10° MAX. CLOSED ANGLE OF FORWARD RAMP IS 3° MAX.
 - 6. THIS FIGURE REPRESENTS A 350,000 POUND AIRPLANE WITH A C.G. AT 39 PERCENT M.A.C.
 - 7. REPRESENTS VERTICAL CLEARANCE INSIDE CARGO COMPARTMENT.

Figure 2-49. Airplane Kneeling and Loading Positions – On/Off Loading



L1115290

Figure 2-50. **A** Portable Utility Ladder



L1115291

Figure 2-51. **B** Portable Utility Ladder

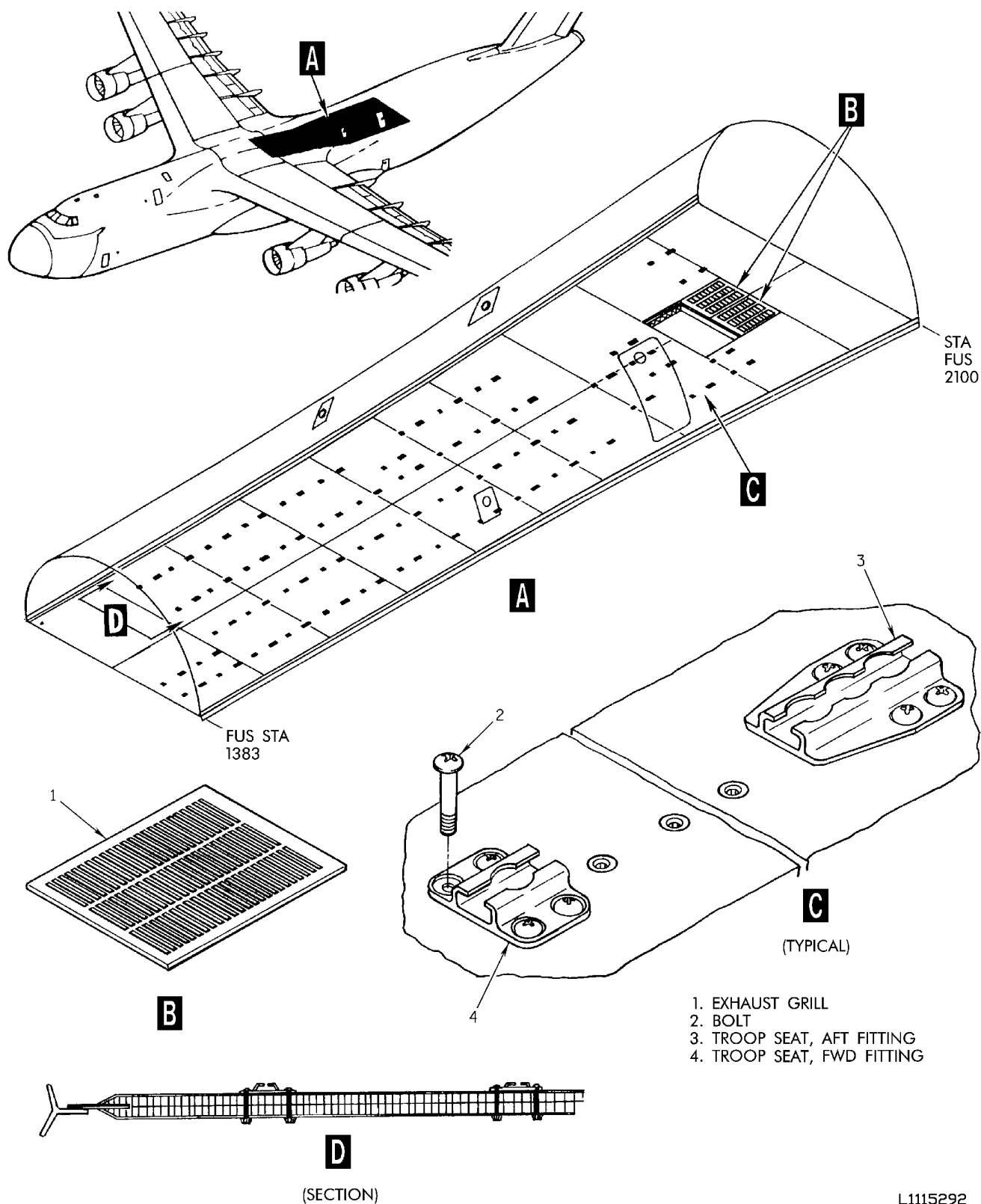
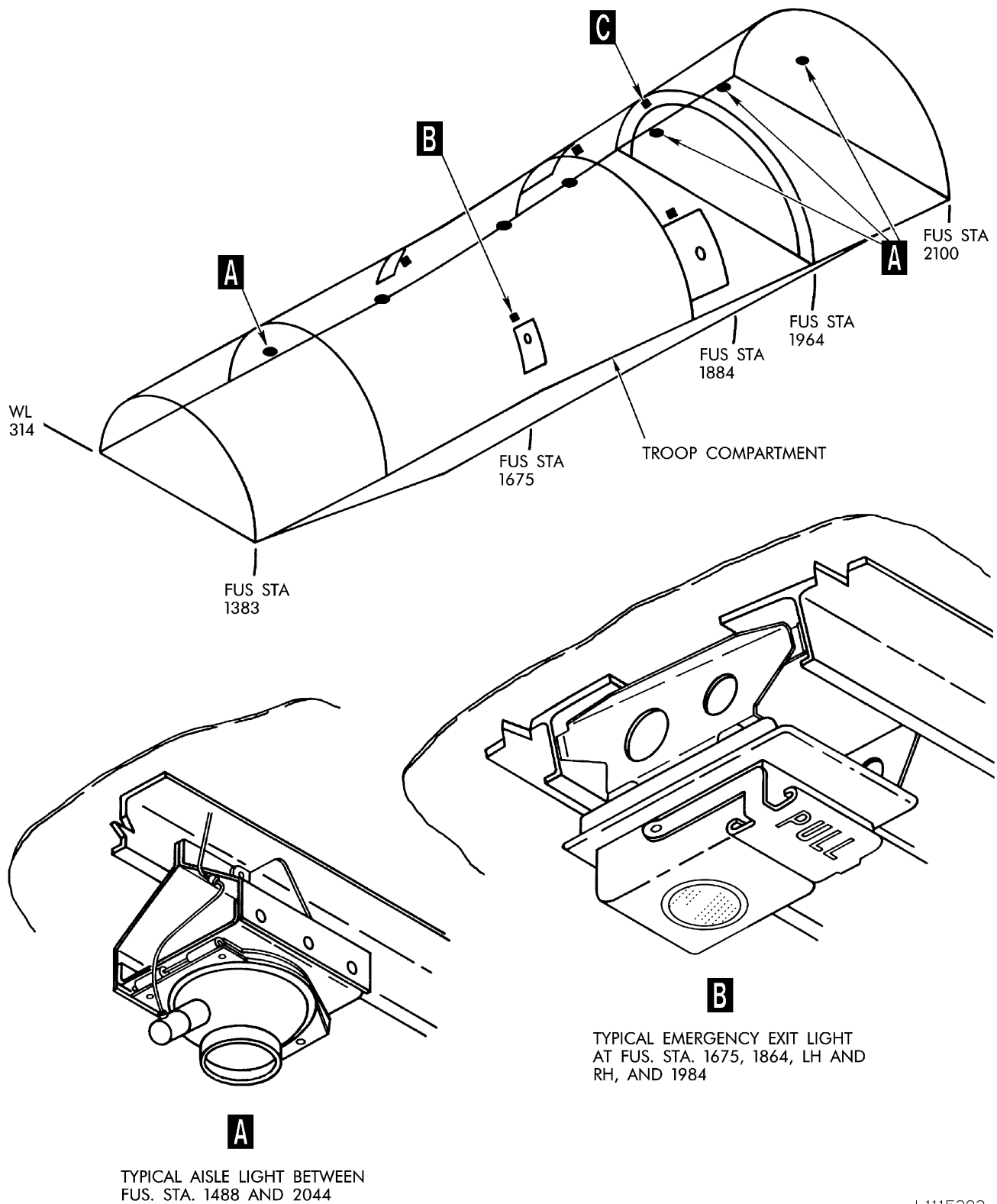


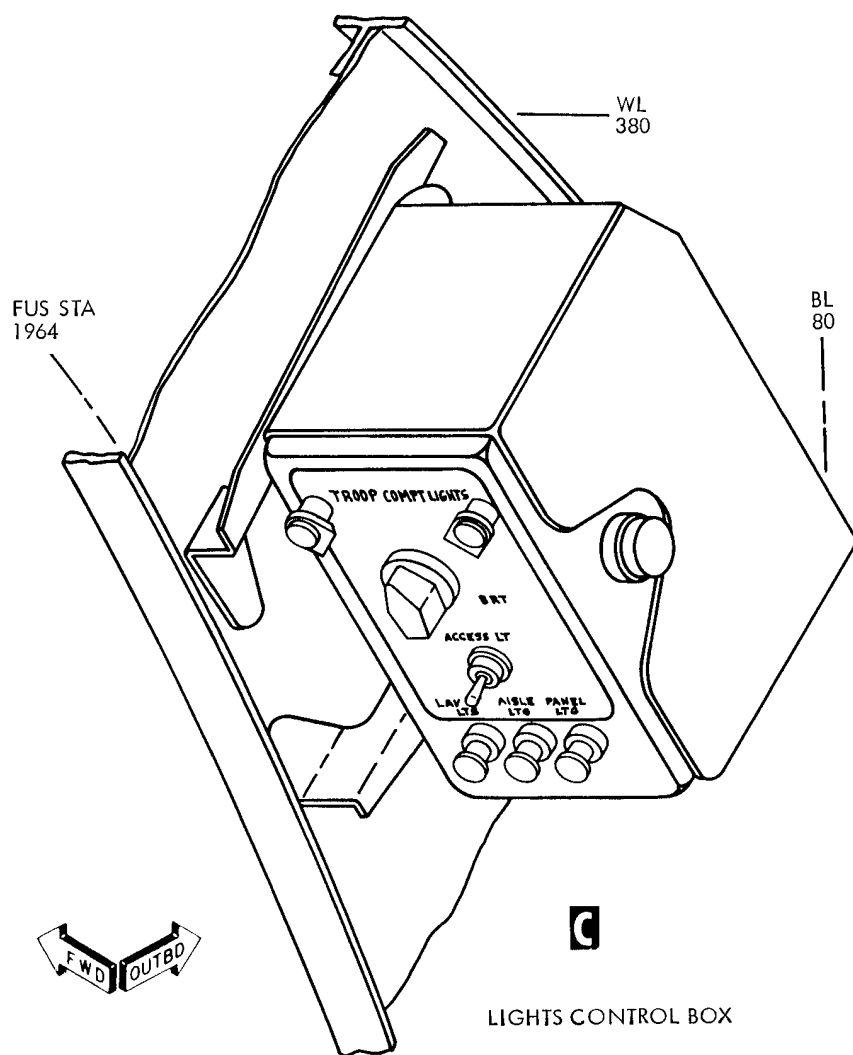
Figure 2-52. Troop Compartment Floor and Seat Tiedown

L1115292



L1115293

Figure 2-53. Troop Compartment Permanently Installed Lighting (Sheet 1 of 2)



LIGHTS CONTROL BOX

L1115294

Figure 2-53. Troop Compartment Permanently Installed Lighting (Sheet 2)

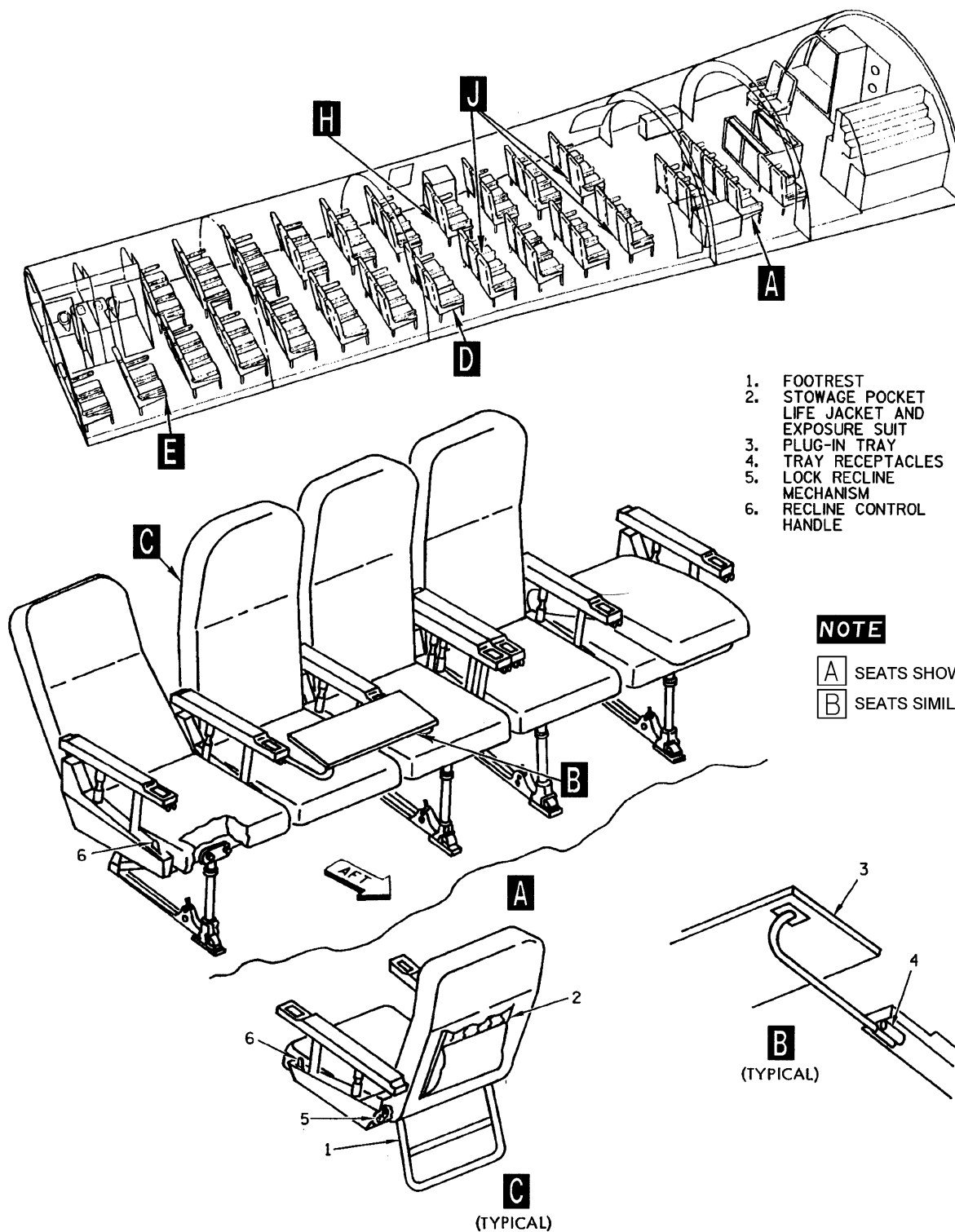
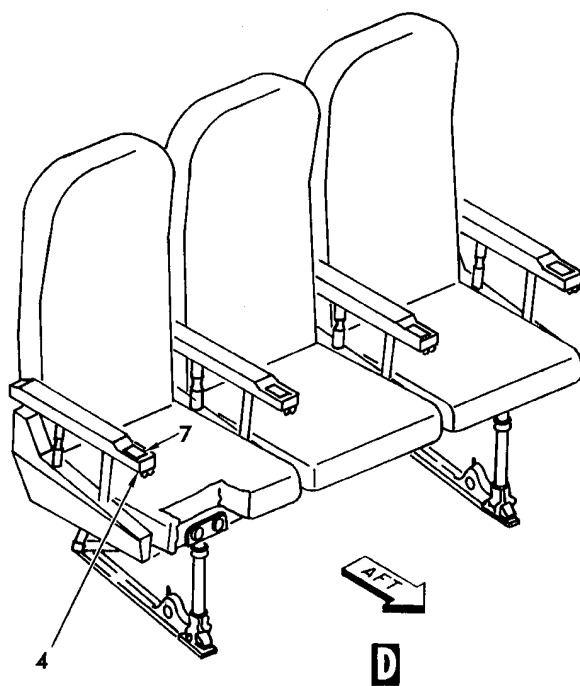
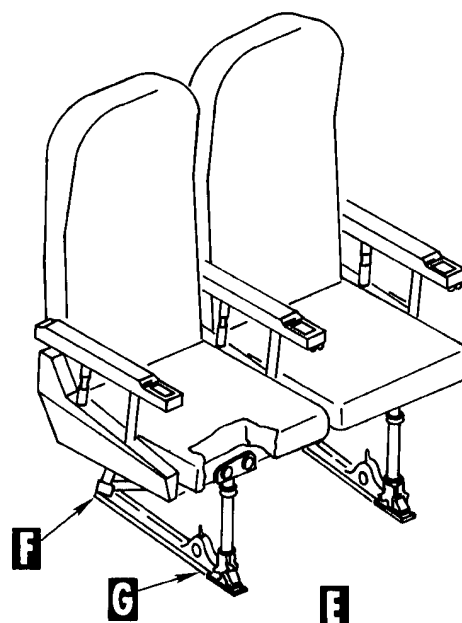


Figure 2-54. Troop Compartment Seats (Sheet 1 of 2)

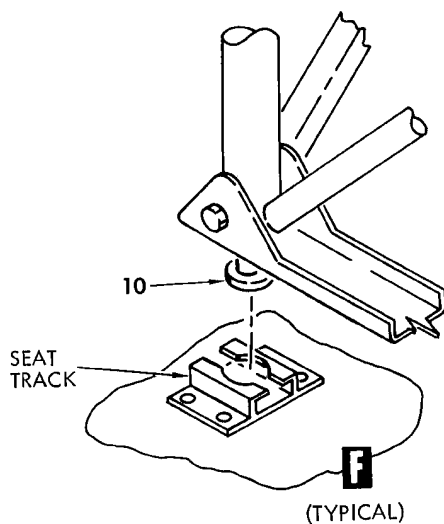


(TYPICAL 20 PLACES)

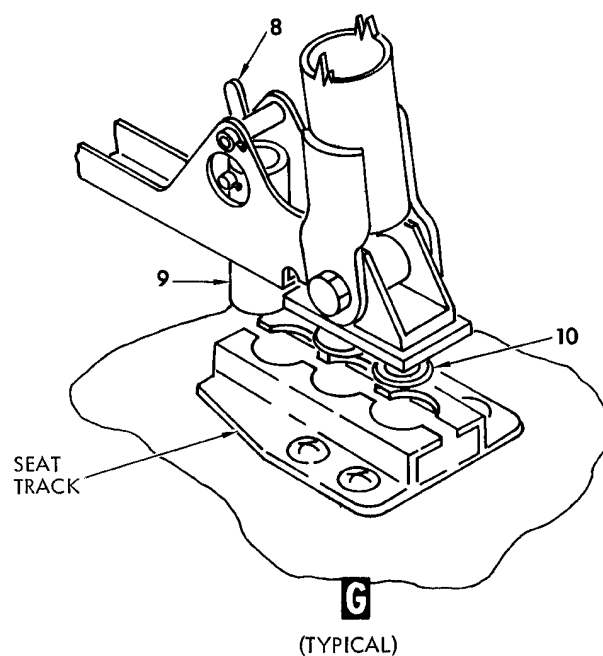


(TYPICAL 5 PLACES)

- 4. TRAY RECEPTACLES
- 7. ASHTRAY
- 8. SHEAR PIN LEVER
- 9. SHEAR PIN
- 10. SEAT TRACK STUDS



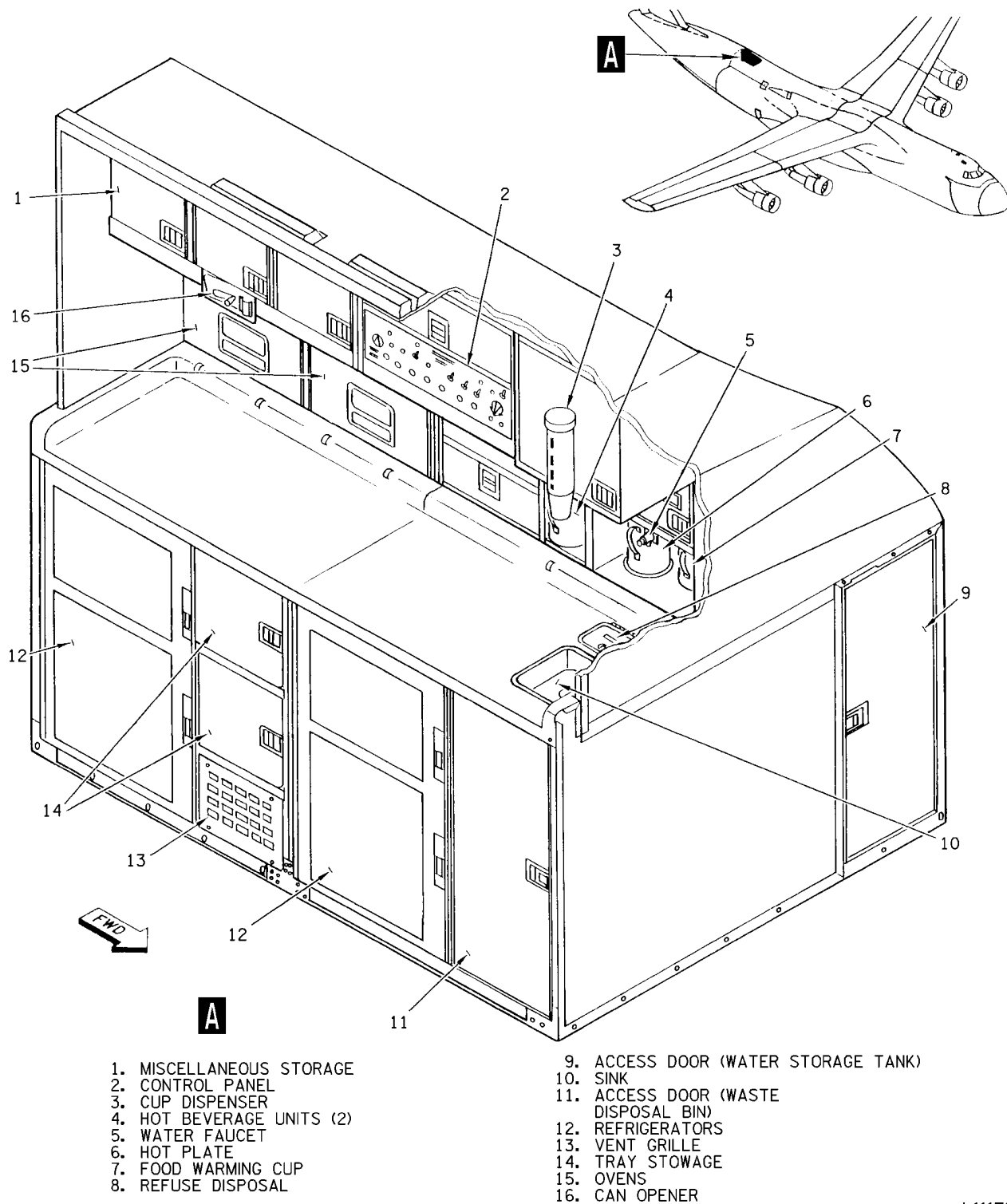
(TYPICAL)



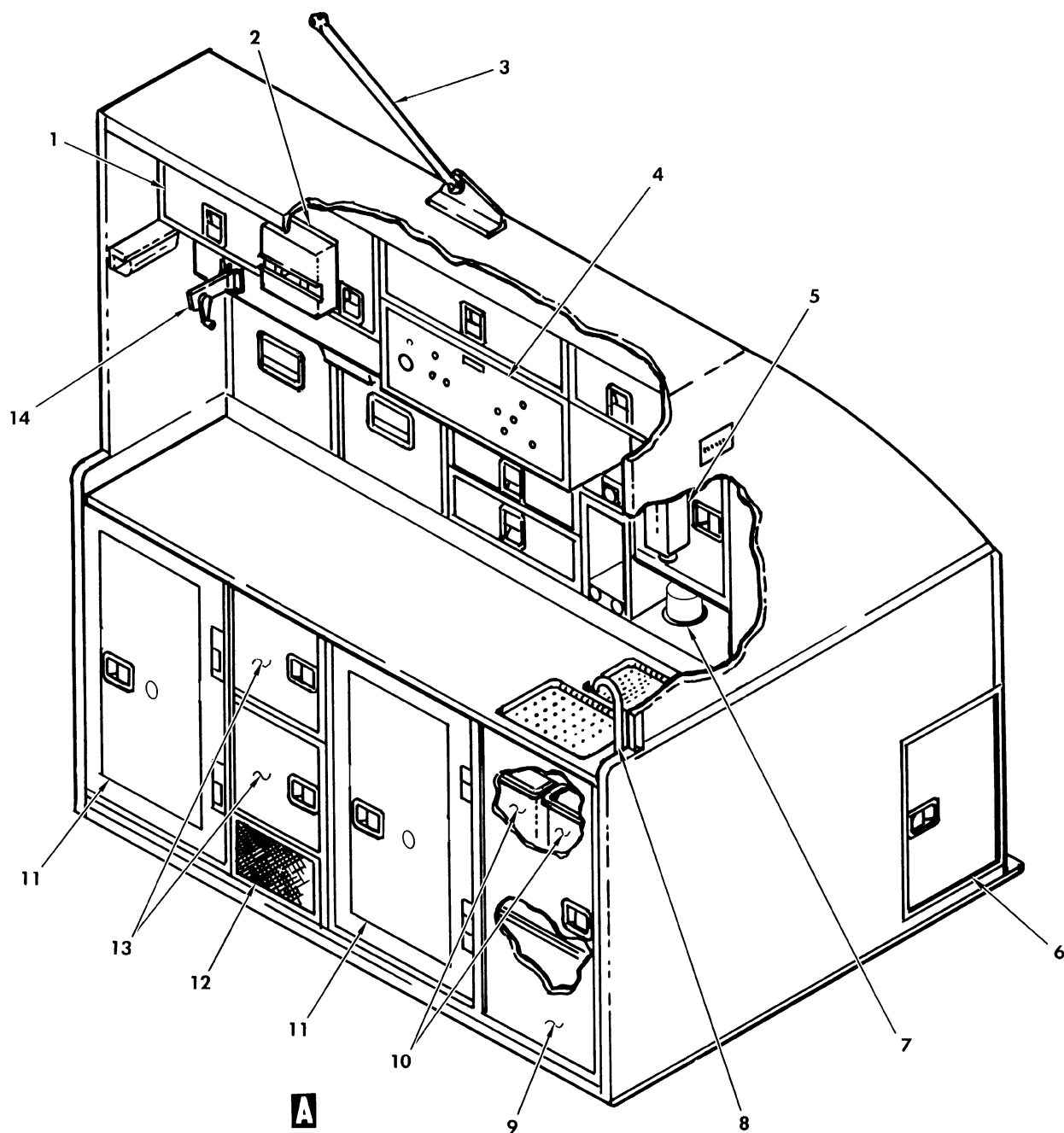
(TYPICAL)

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Figure 2-54. Troop Compartment Seats (Sheet 2)

Figure 2-55. **A** Troop Compartment Kit Galley

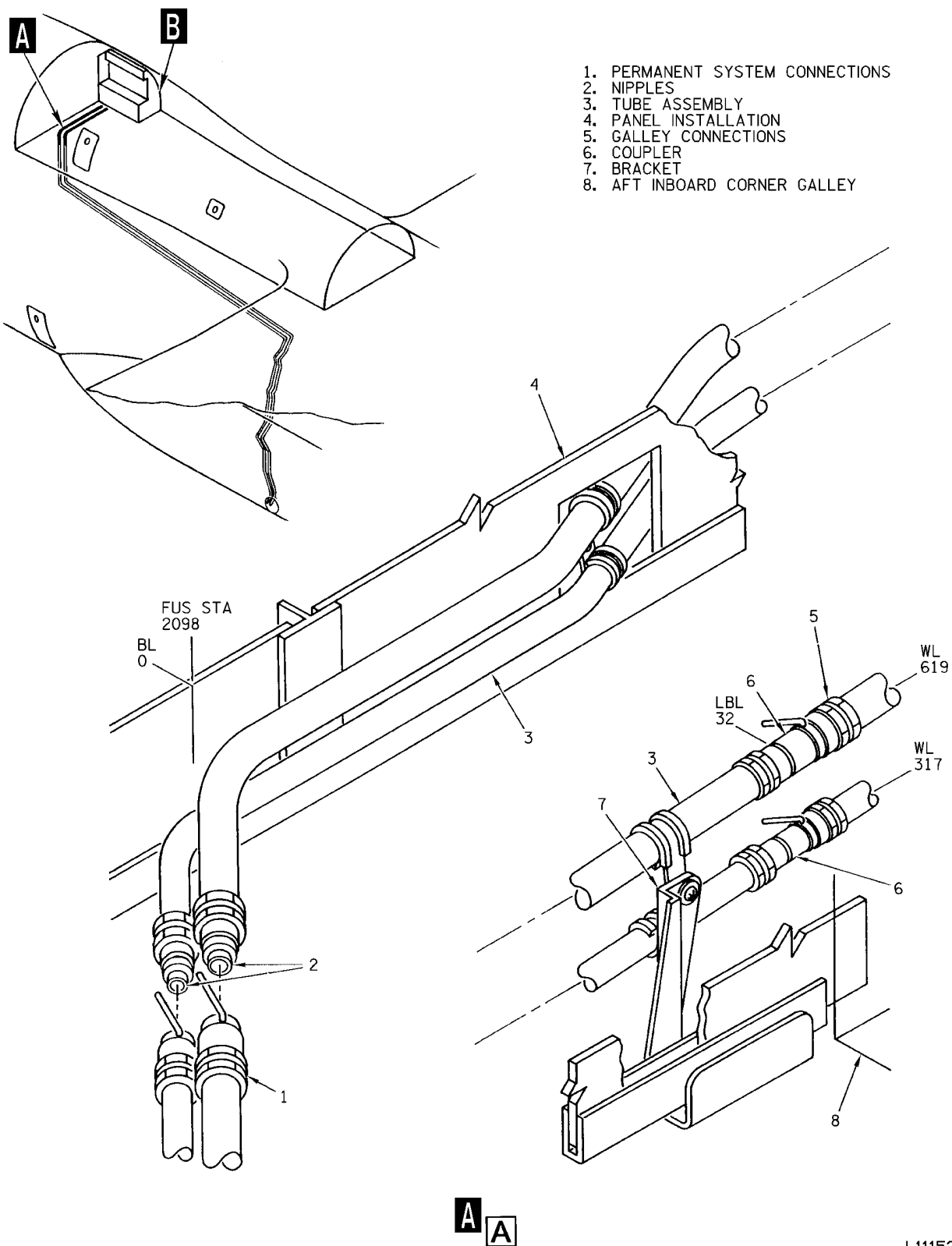
L1115297



1. MISCELLANEOUS STOWAGE	8. FAUCET
2. TOWEL HOLDER	9. ACCESS DOOR (WASTE CONTAINER)
3. TIE ROD ASSEMBLY	10. LIQUID CONTAINERS
4. CONTROL PANEL	11. REFRIGERATOR
5. CUP DISPENSER	12. VENT GRILLE
6. ICE CHEST IGLOO PROVISIONS	13. TRAY STOWAGE
7. FOOD WARMING CUP	14. CAN OPENER

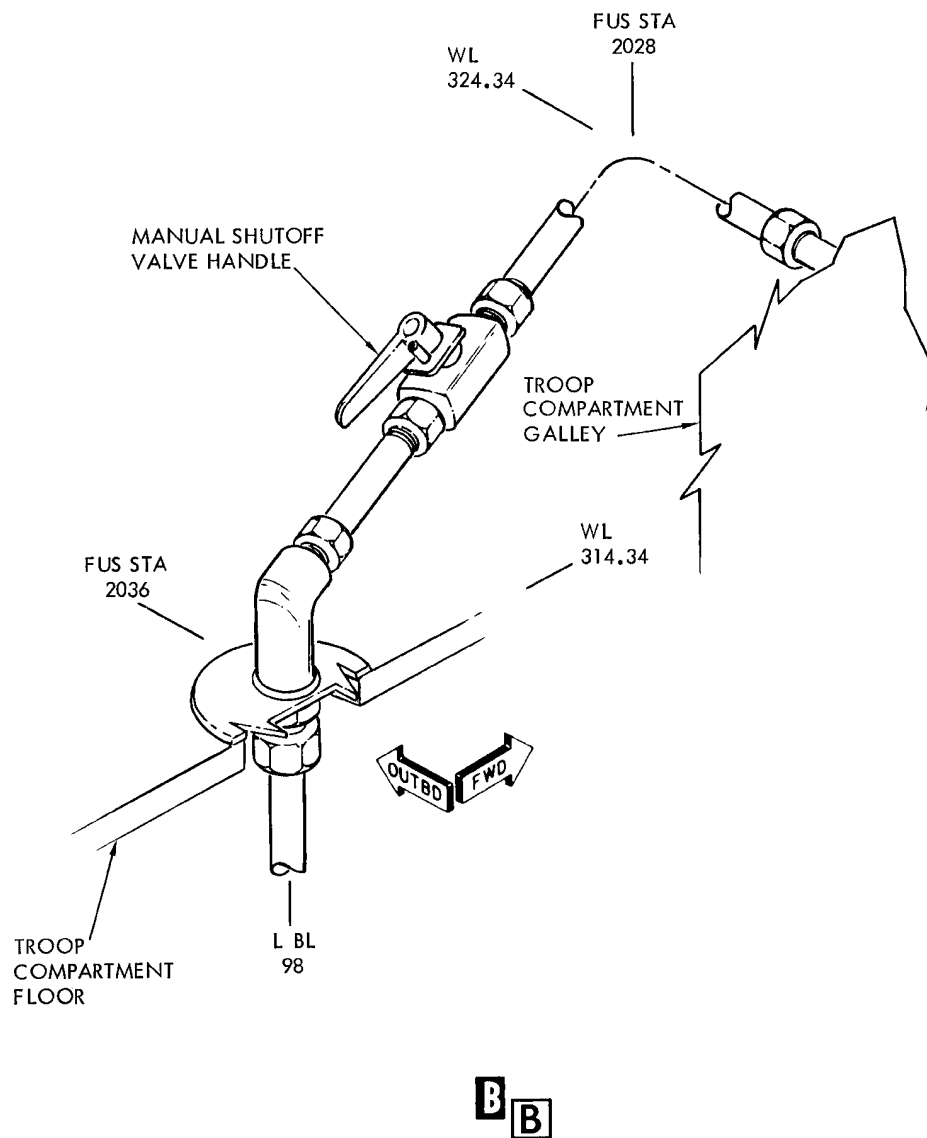
L1115298

Figure 2-56. **B** Troop Compartment Kit Galley



L1115299

Figure 2-57. Troop Compartment Seat Kit Galley Potable Water Supply Lines (Sheet 1 of 2)



L1115300

Figure 2-57. Troop Compartment Seat Kit Galley Potable Water Supply Lines (Sheet 2)

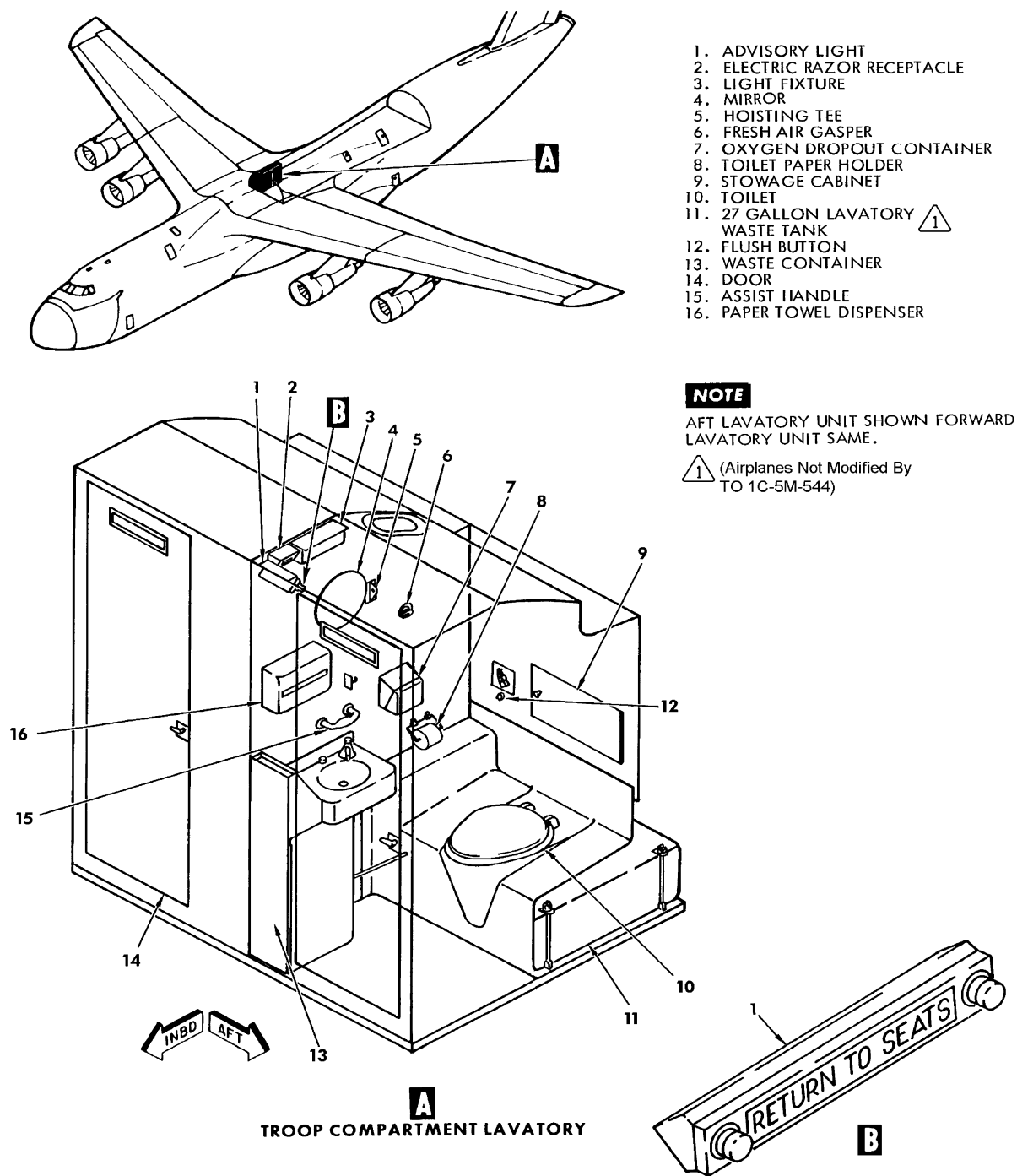
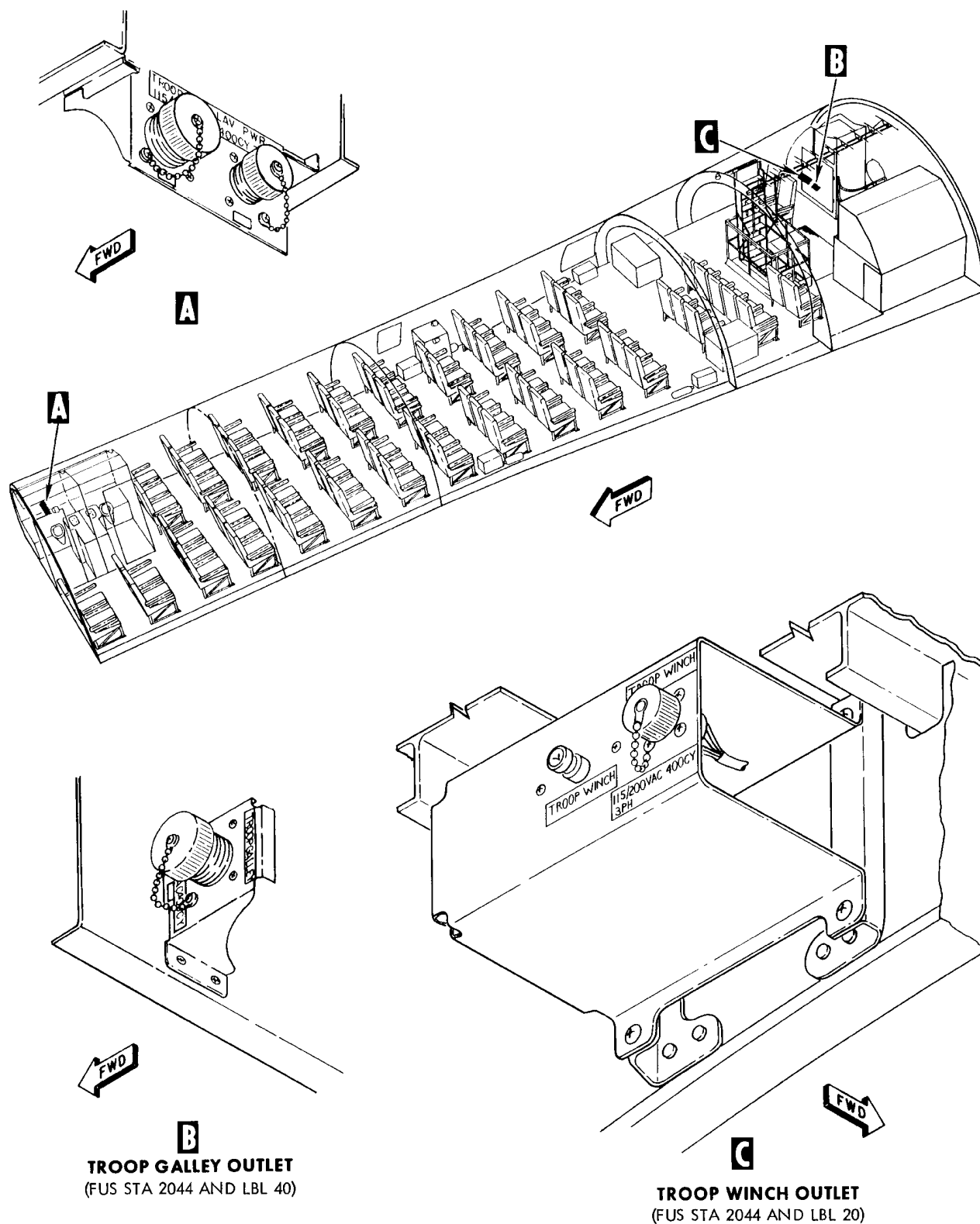


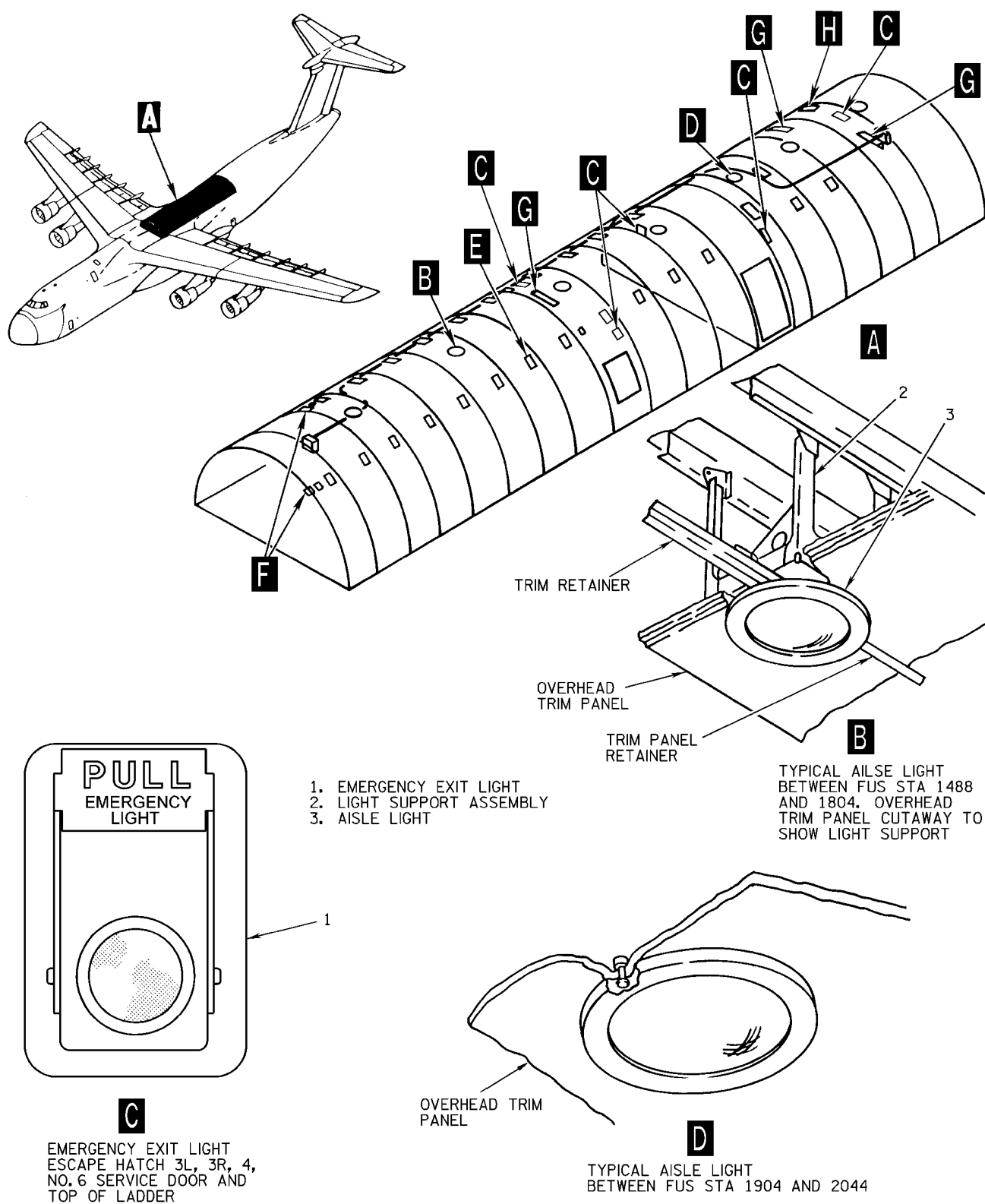
Figure 2-58. Troop Compartment Lavatory Units

L1600118



L1115302

Figure 2-59. Troop Compartment Electrical Outlets



L1115303

Figure 2-60. Troop Compartment Kit Lighting (Sheet 1 of 2)

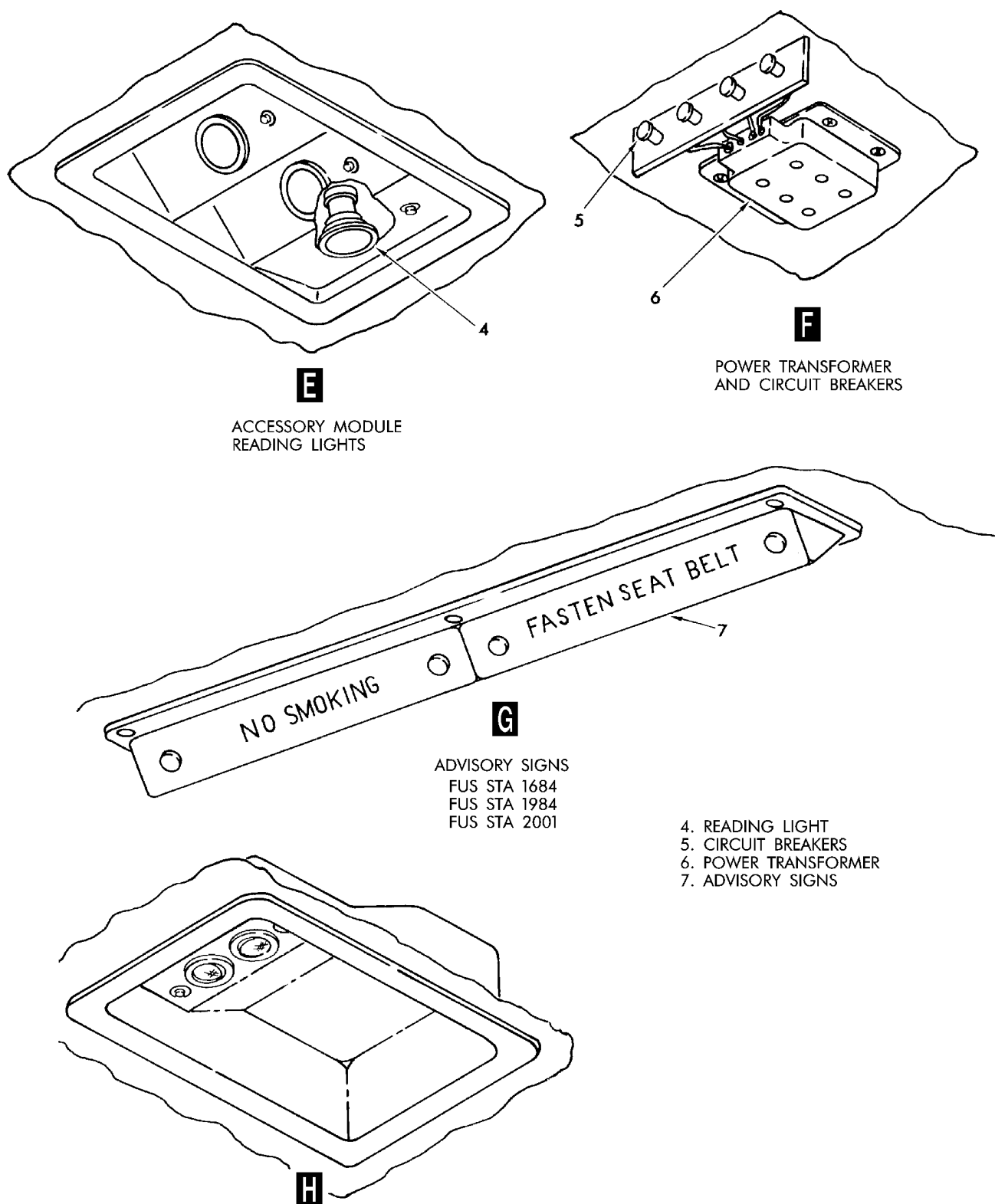


Figure 2-60. Troop Compartment Kit Lighting (Sheet 2)

L1115304

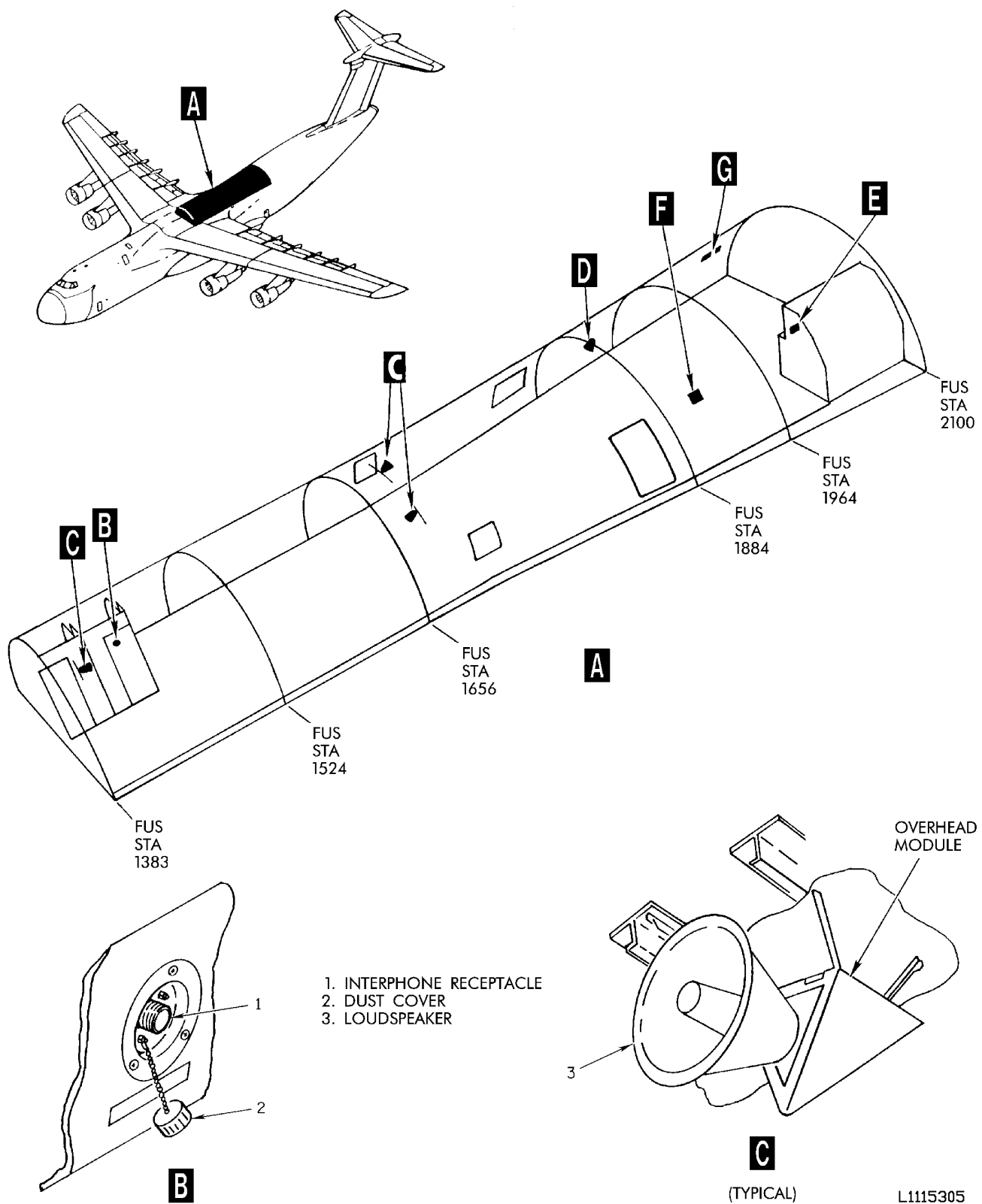
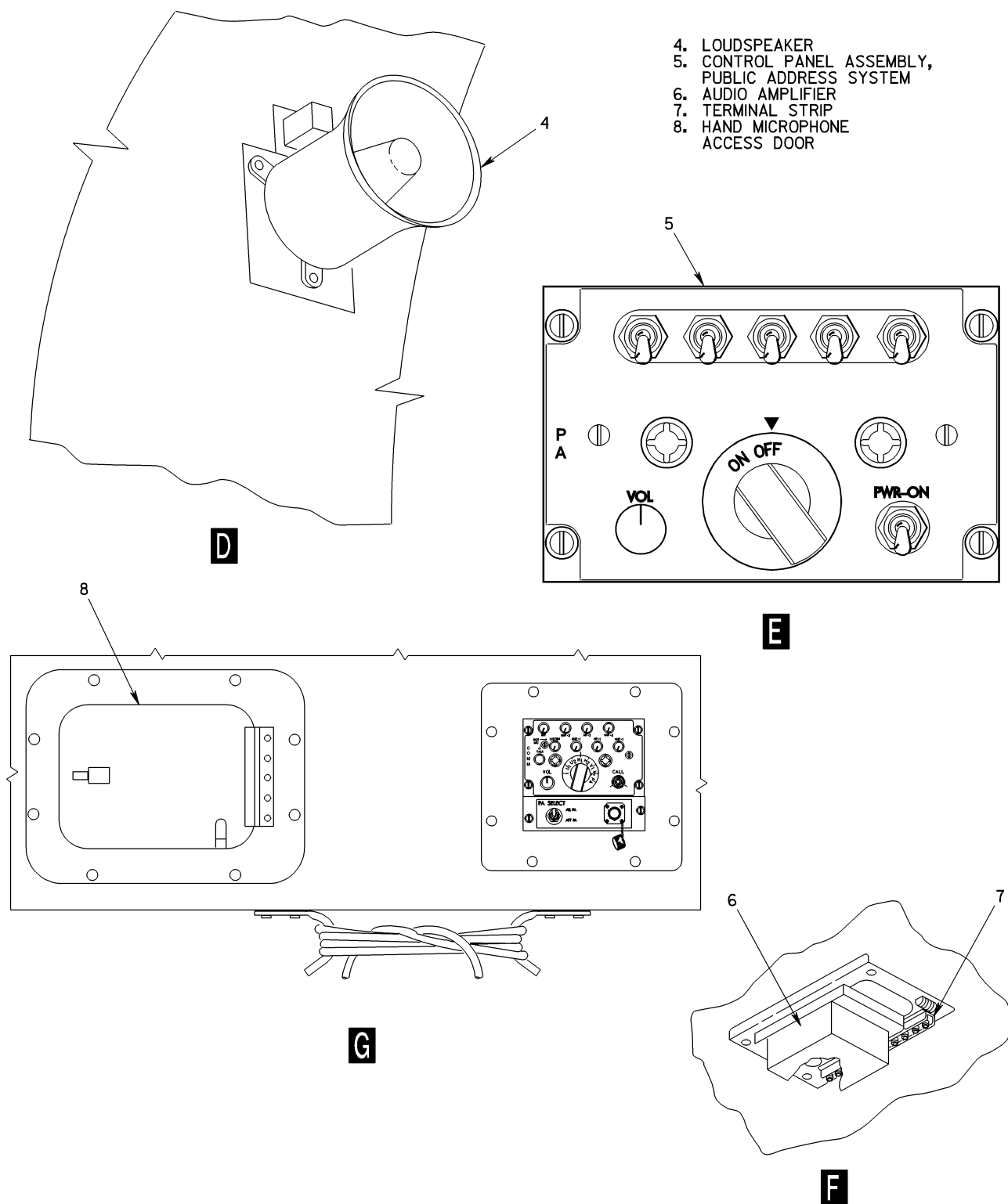


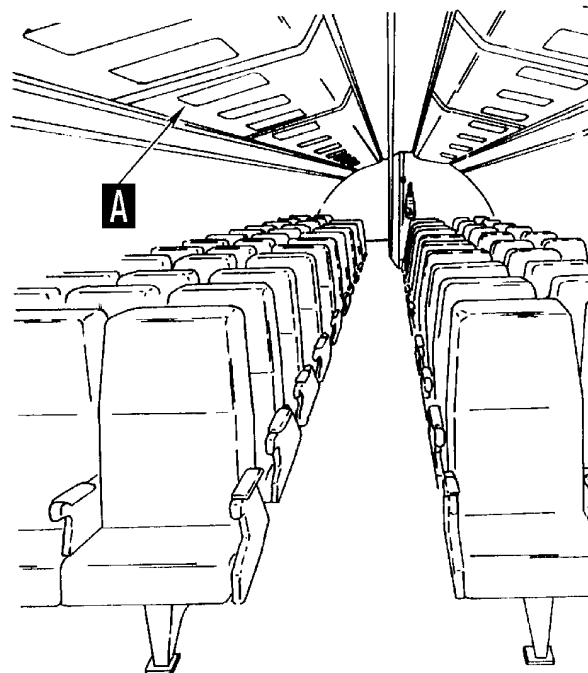
Figure 2-61. Troop Compartment Kit Interphone and Public Address System (Sheet 1 of 2)



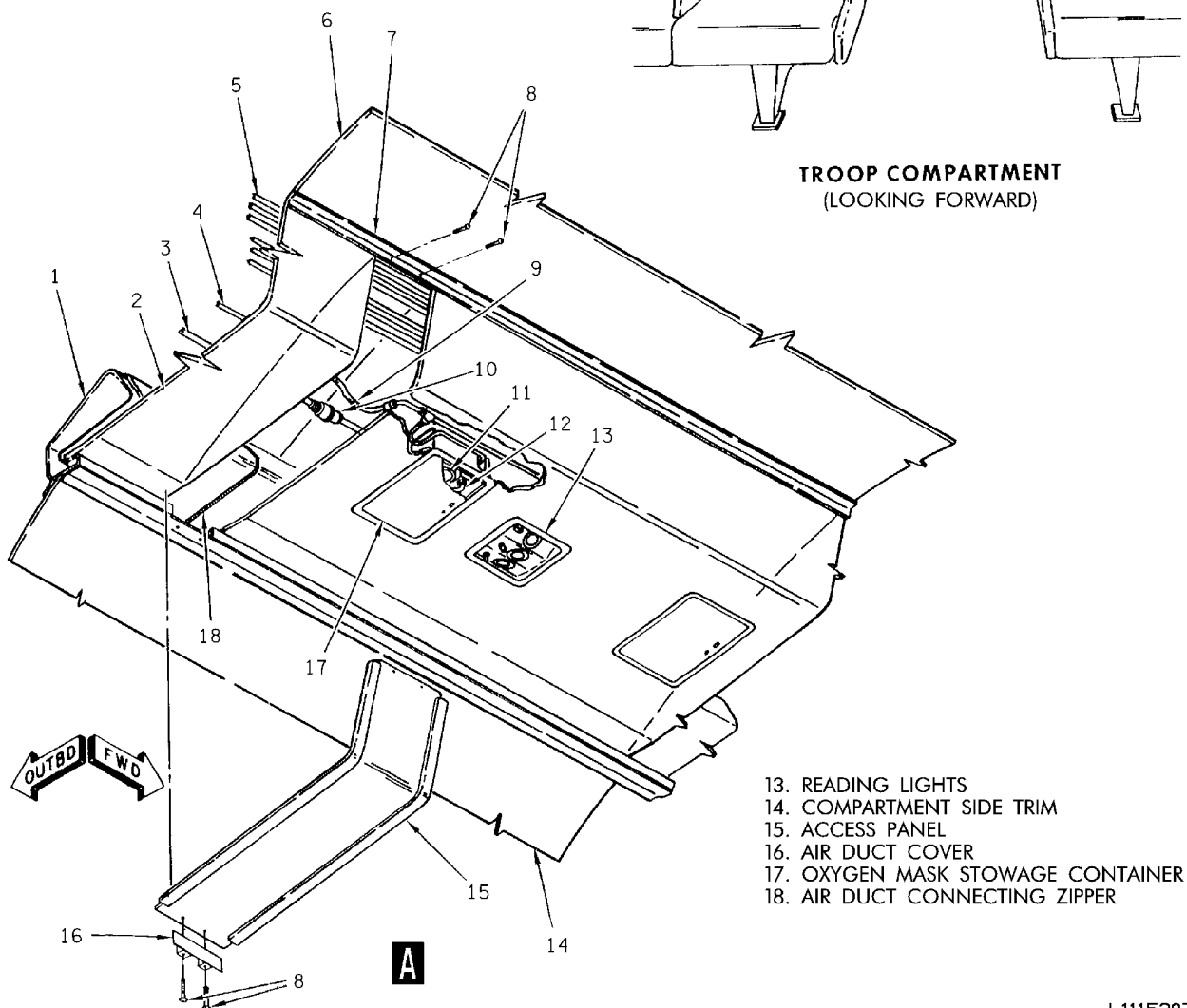
L1115306

Figure 2-61. Troop Compartment Kit Interphone and Public Address System (Sheet 2)

1. AIR DUCT
2. ACCESSORY MODULE
3. ELECTRICAL POWER CABLE
4. RIGID OXYGEN LINE
5. PERMANENTLY INSTALLED OXYGEN SYSTEM
6. COMPARTMENT OVERHEAD TRIM
7. TRIM SUPPORT
8. ACCESS PANEL ATTACHING SCREWS
9. FLEXIBLE OXYGEN HOSE
10. ELECTRICAL CABLE RECEPTACLE AND PLUG
11. OXYGEN MASK (AUTOMATICALLY PRESENTED)
12. FLEXIBLE OXYGEN LINE (TO MASK)



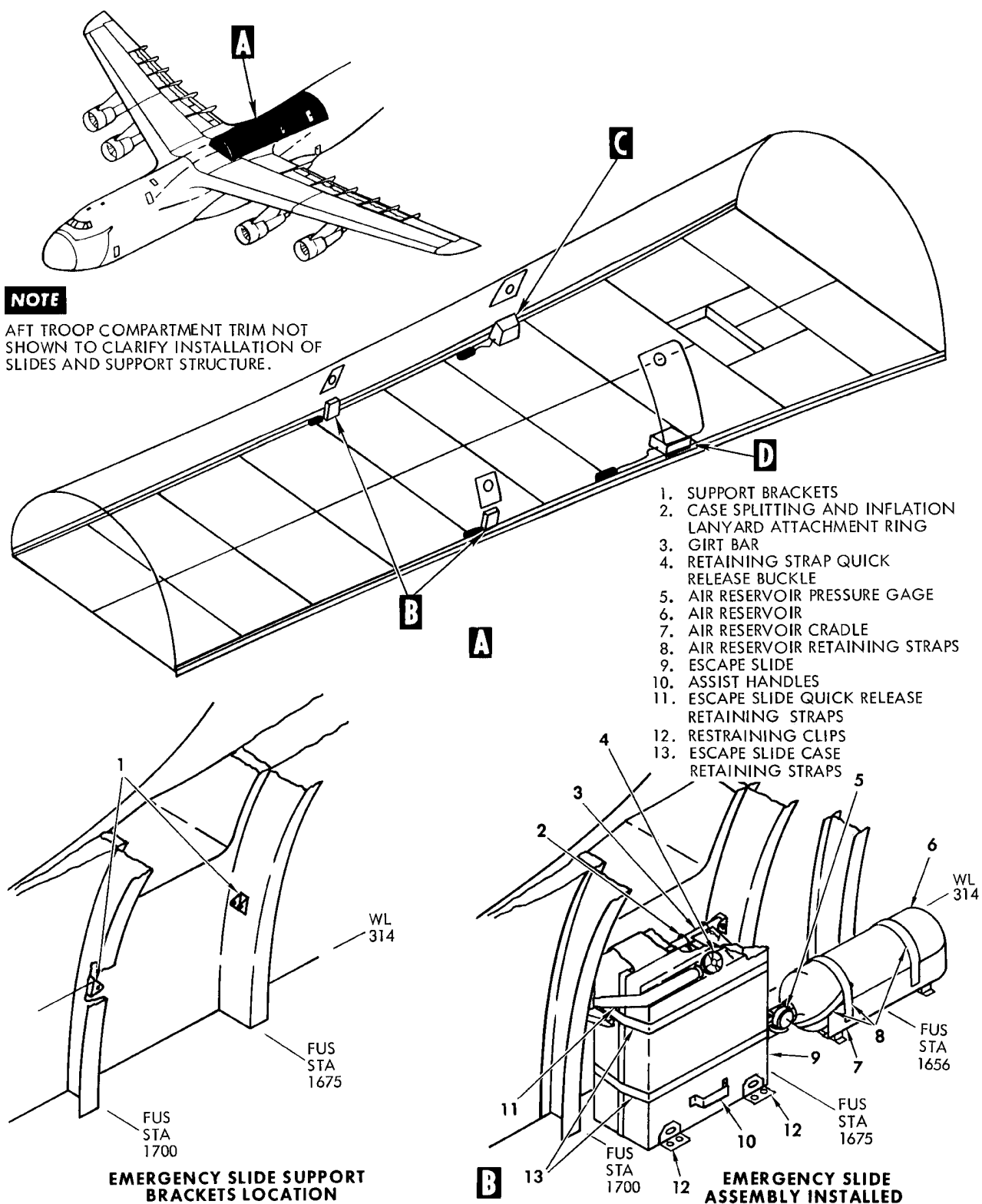
TROOP COMPARTMENT
(LOOKING FORWARD)



13. READING LIGHTS
14. COMPARTMENT SIDE TRIM
15. ACCESS PANEL
16. AIR DUCT COVER
17. OXYGEN MASK STOWAGE CONTAINER
18. AIR DUCT CONNECTING ZIPPER

L1115307

Figure 2-62. Troop Compartment Kit Accessory Module

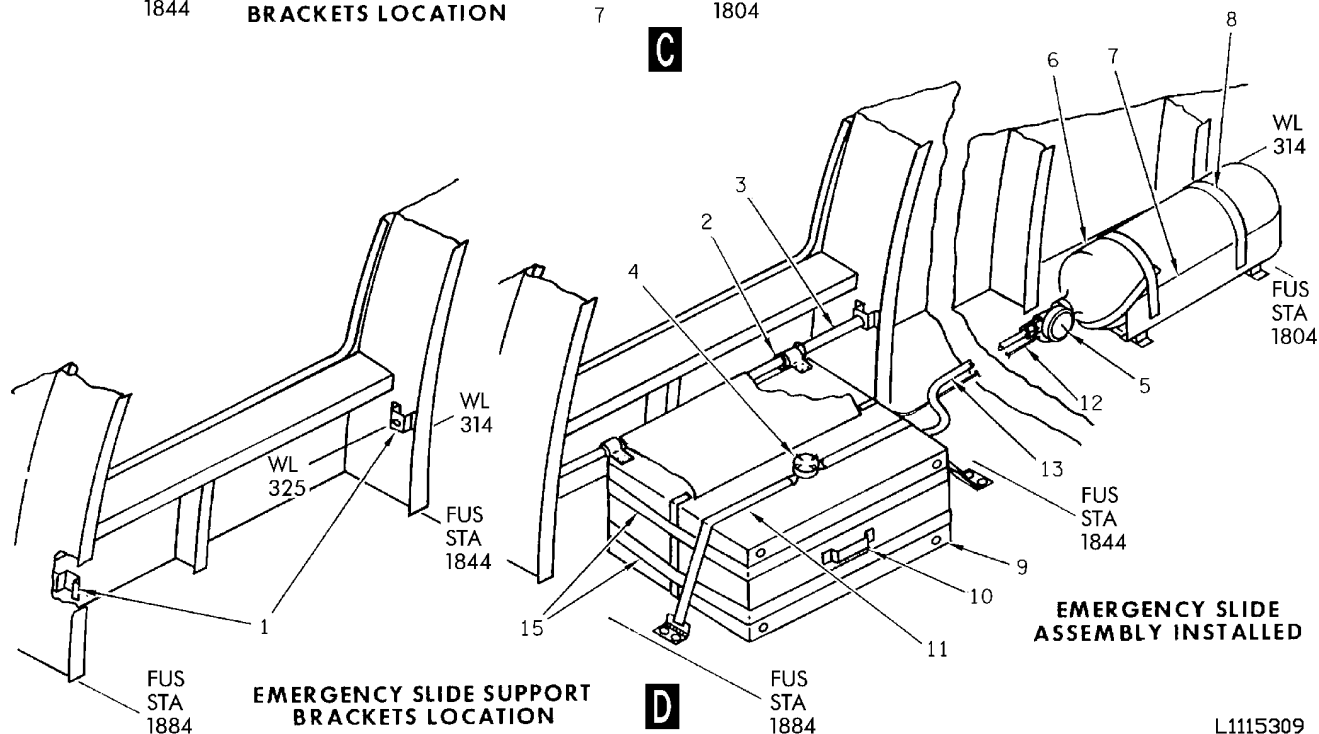
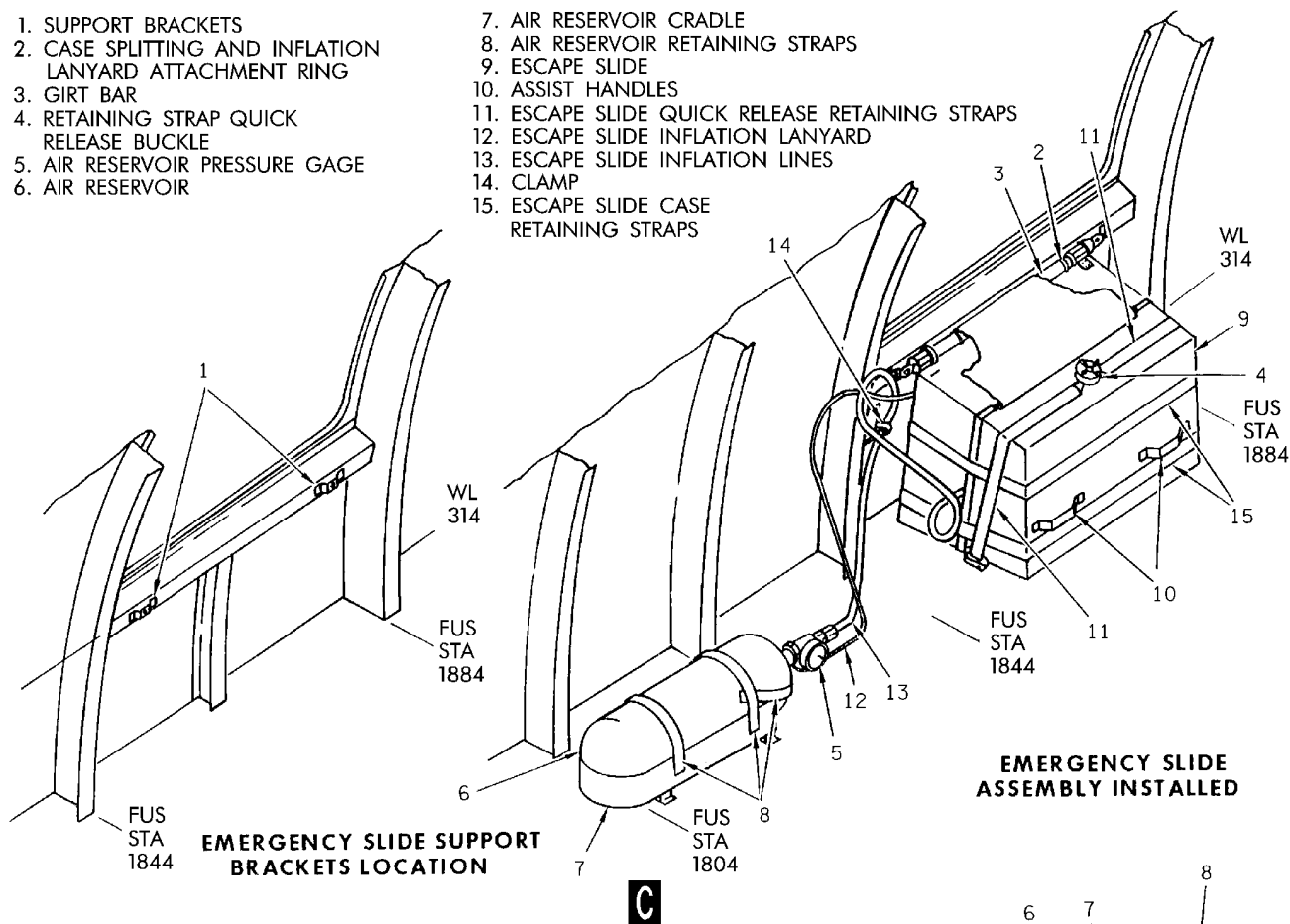


L1115308

Figure 2-63. Troop Compartment Kit Emergency Escape Slides (Sheet 1 of 2)

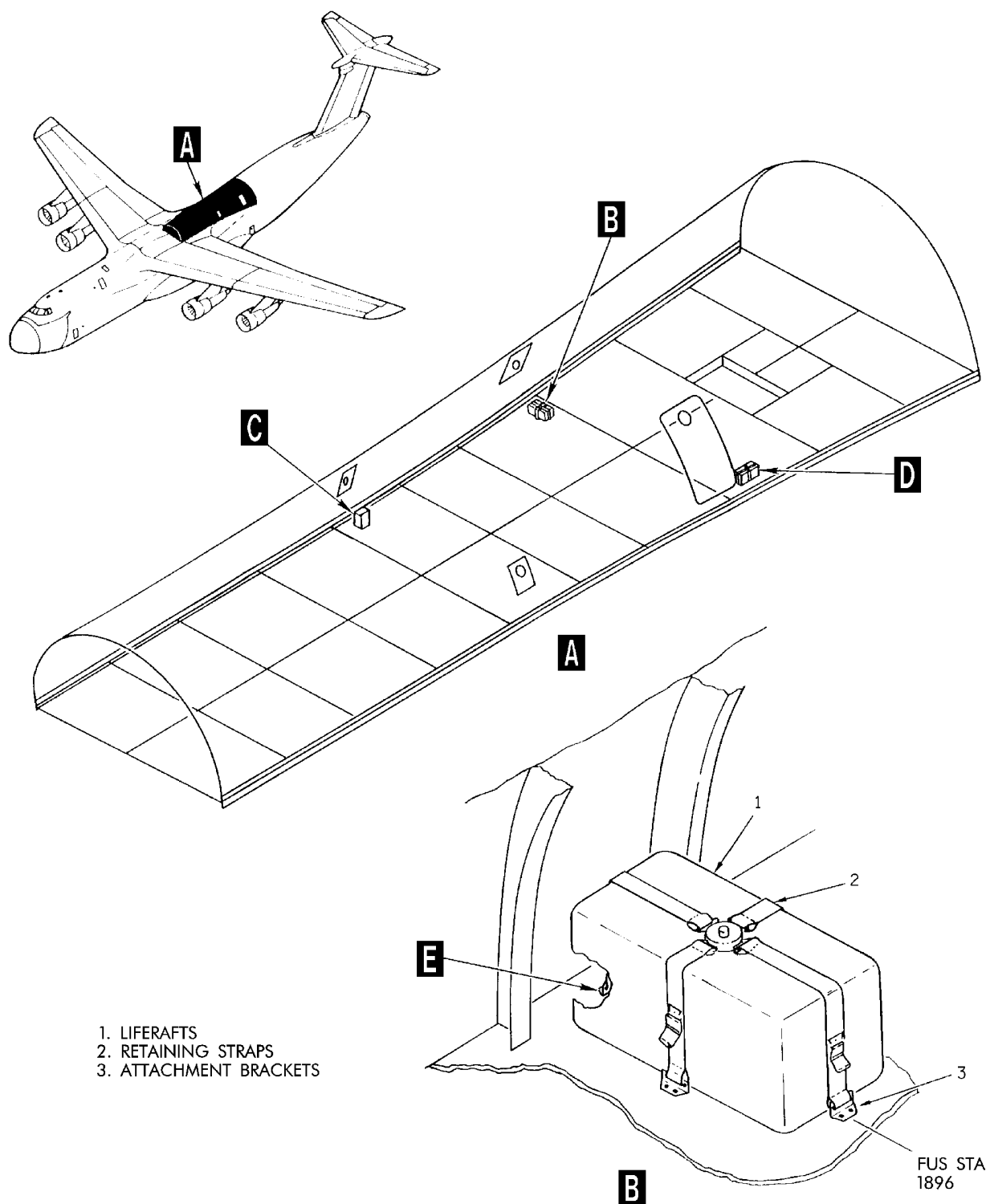
1. SUPPORT BRACKETS
2. CASE SPLITTING AND INFLATION LANYARD ATTACHMENT RING
3. GIRT BAR
4. RETAINING STRAP QUICK RELEASE BUCKLE
5. AIR RESERVOIR PRESSURE GAGE
6. AIR RESERVOIR

7. AIR RESERVOIR CRADLE
8. AIR RESERVOIR RETAINING STRAPS
9. ESCAPE SLIDE
10. ASSIST HANDLES
11. ESCAPE SLIDE QUICK RELEASE RETAINING STRAPS
12. ESCAPE SLIDE INFLATION LANYARD
13. ESCAPE SLIDE INFLATION LINES
14. CLAMP
15. ESCAPE SLIDE CASE RETAINING STRAPS



L1115309

Figure 2-63. Troop Compartment Kit Emergency Escape Slides (Sheet 2)



LIFERAFT INSTALLATION AT FUSELAGE STATION 1896

L1115310

Figure 2-64. Troop Compartment Kit Liferafts (Sheet 1 of 2)

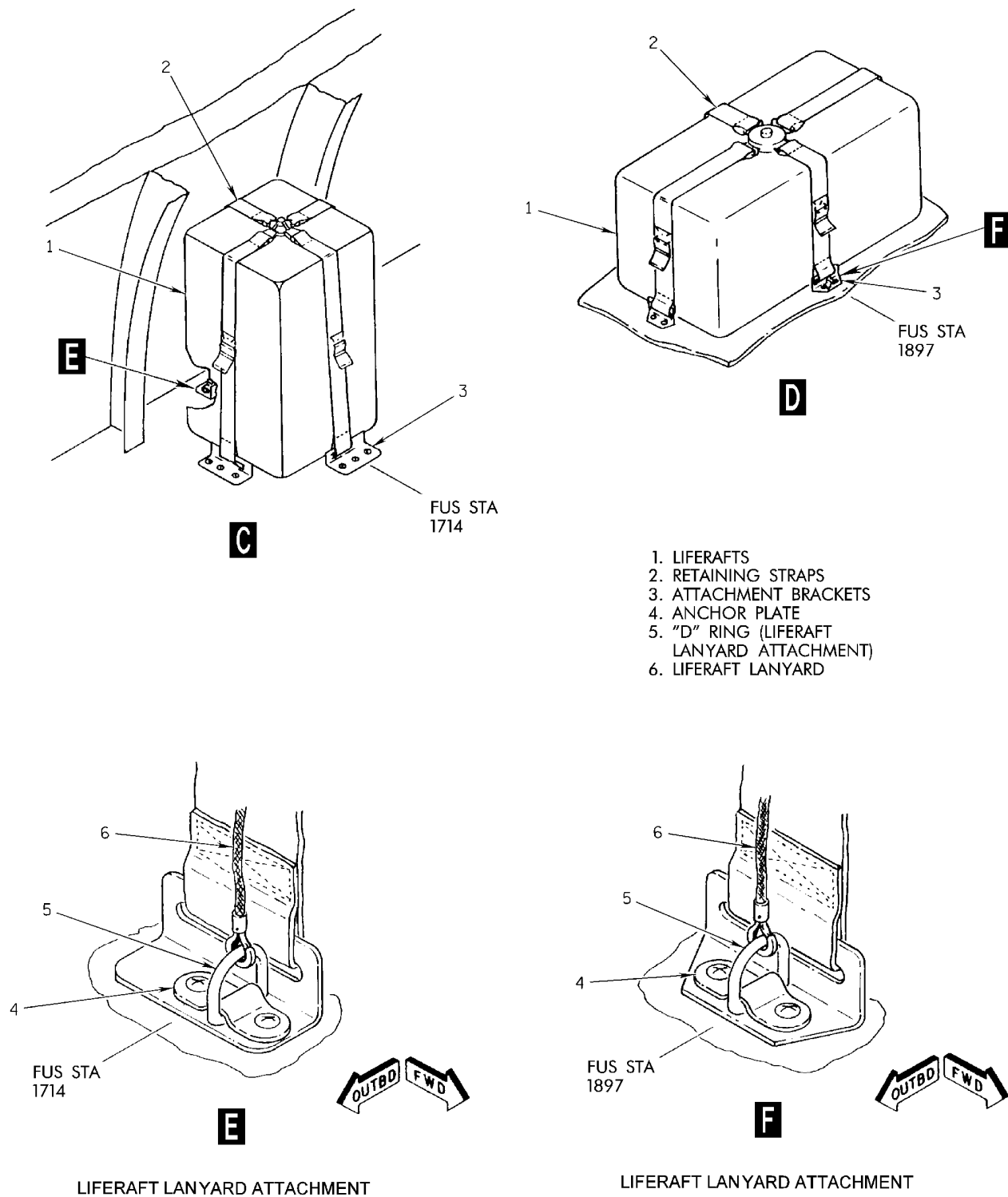


Figure 2-64. Troop Compartment Kit Liferafts (Sheet 2)

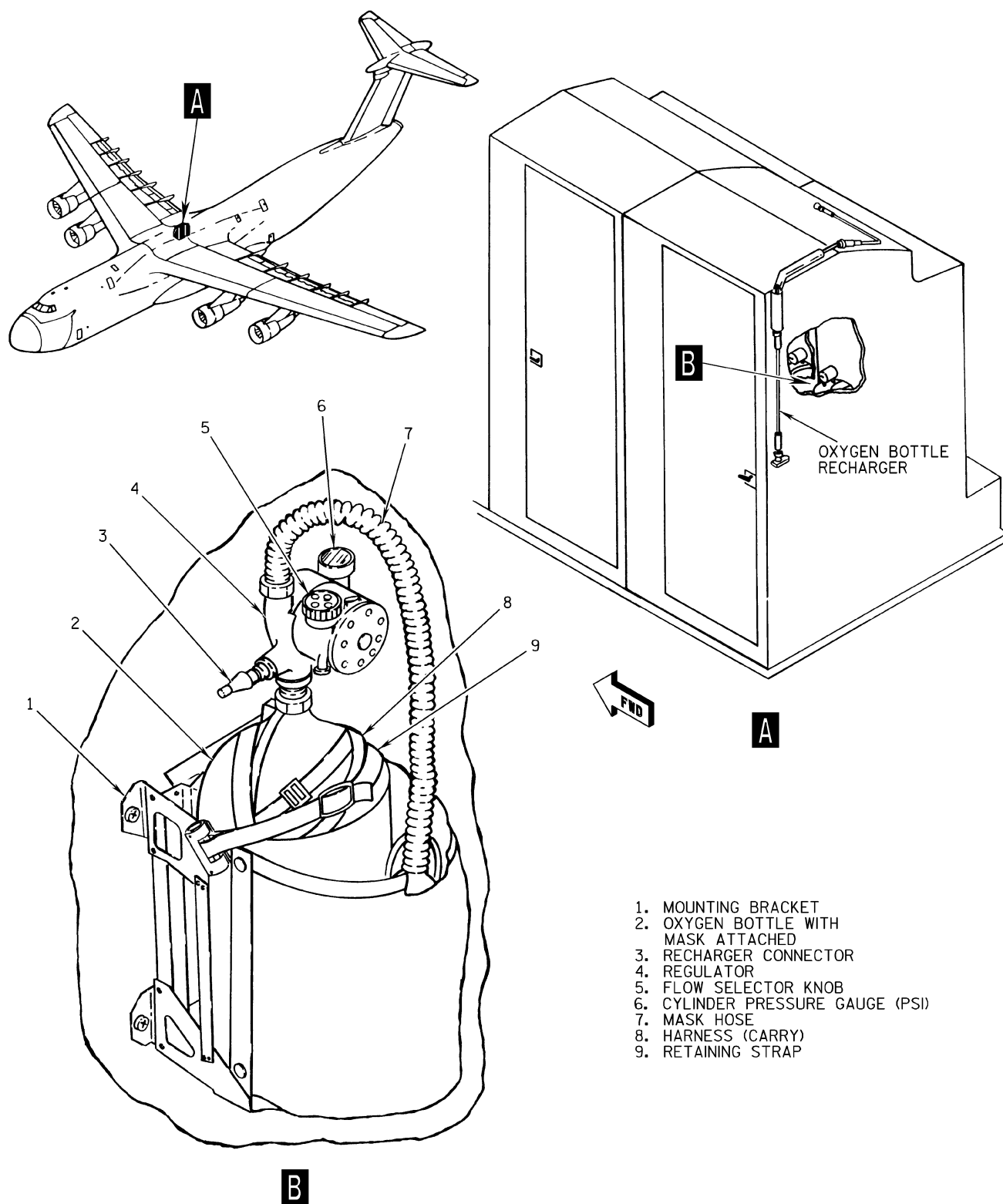
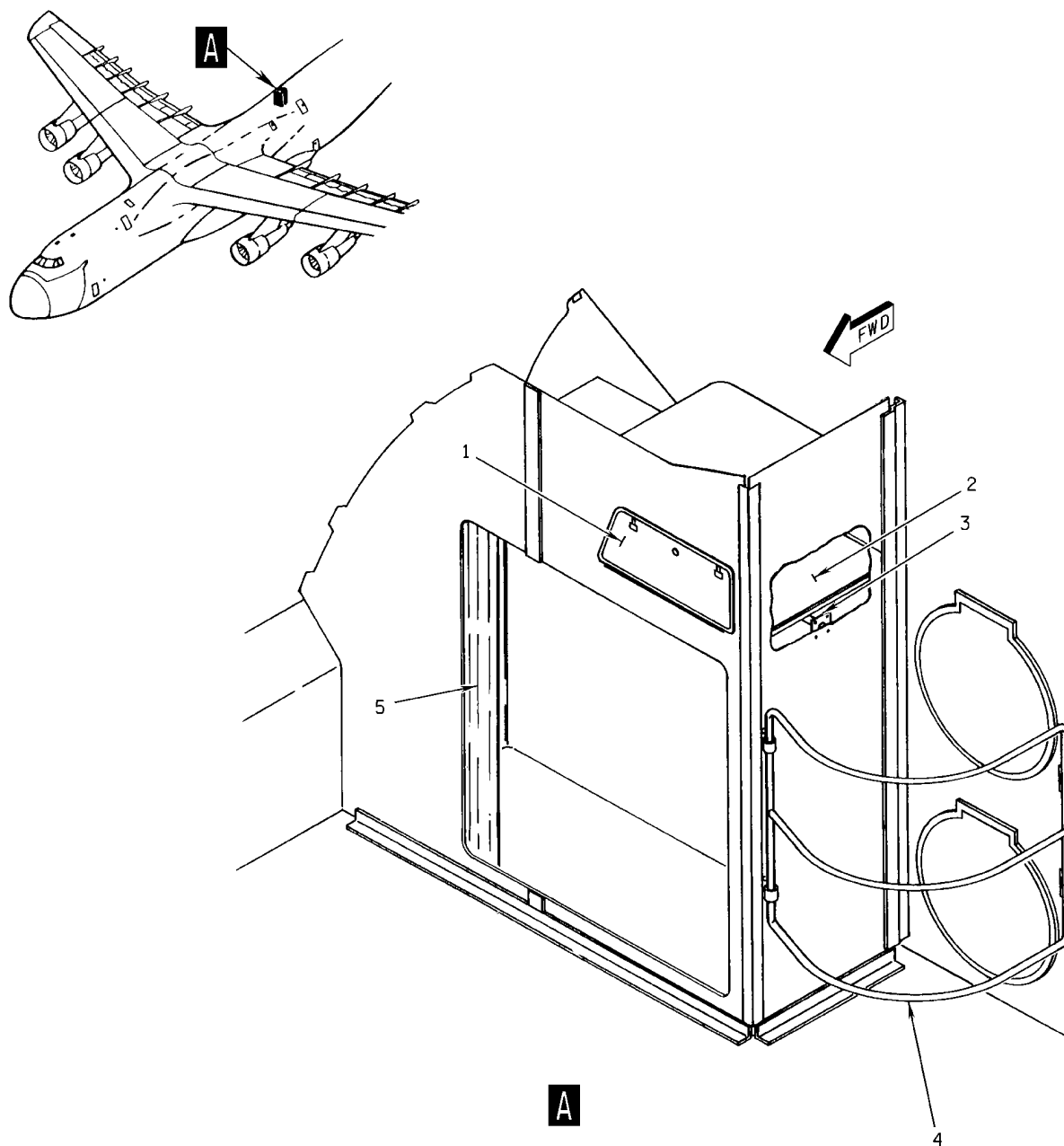


Figure 2-65. Troop Compartment Kit Portable Oxygen Bottle

L1115312



1. DOOR, STOWAGE
2. SHELF, STOWAGE
3. COAT RAIL
4. GUARD RAIL, VALVE DOORS
5. CURTAIN

L1115313

Figure 2-66. Troop Compartment Kit Closet

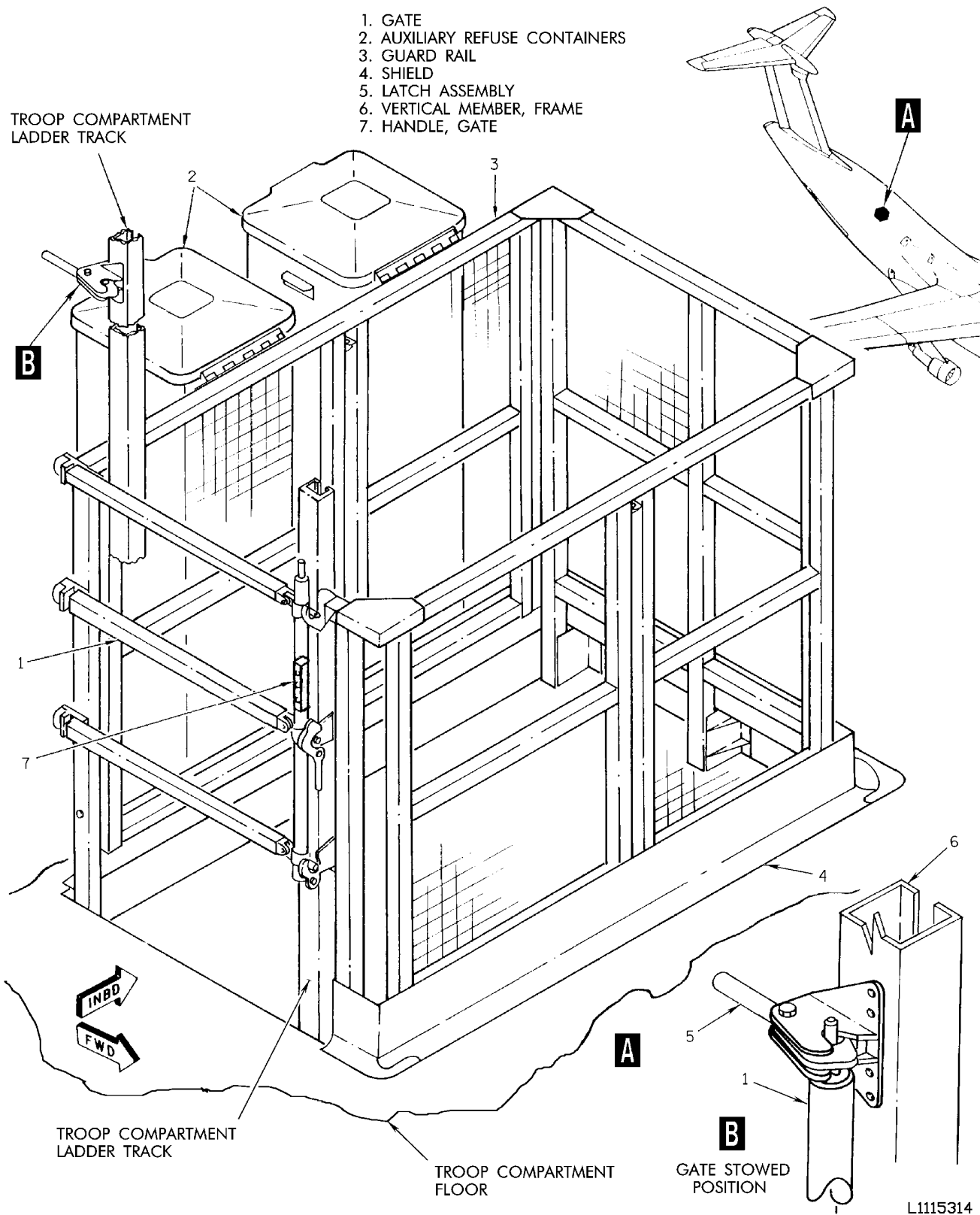
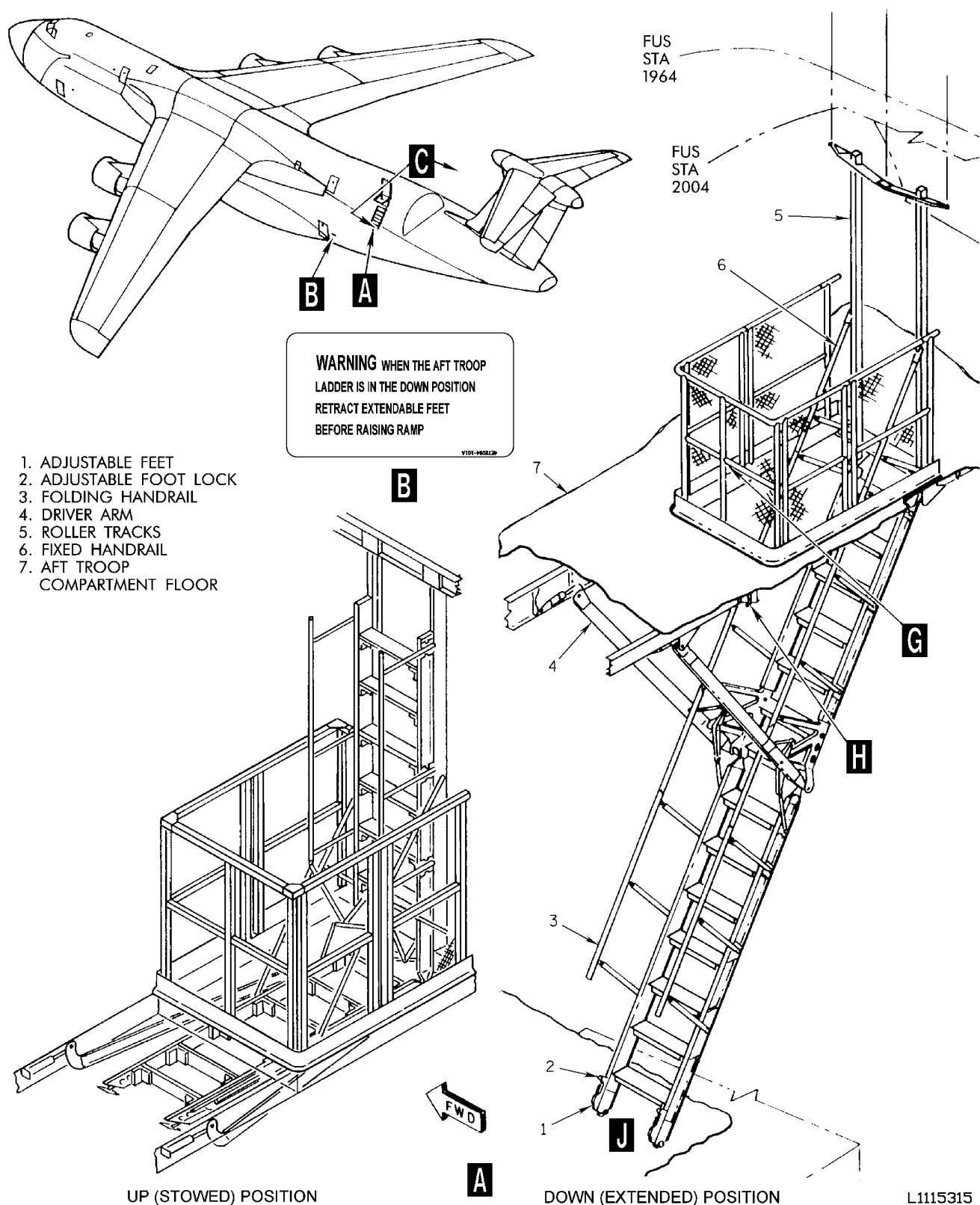


Figure 2-67. Troop Compartment Kit Ladder Guard Rail and Auxiliary Refuse Containers



L1115315

Figure 2-68. Troop Compartment Kit Ladder and Controls (Sheet 1 of 3)

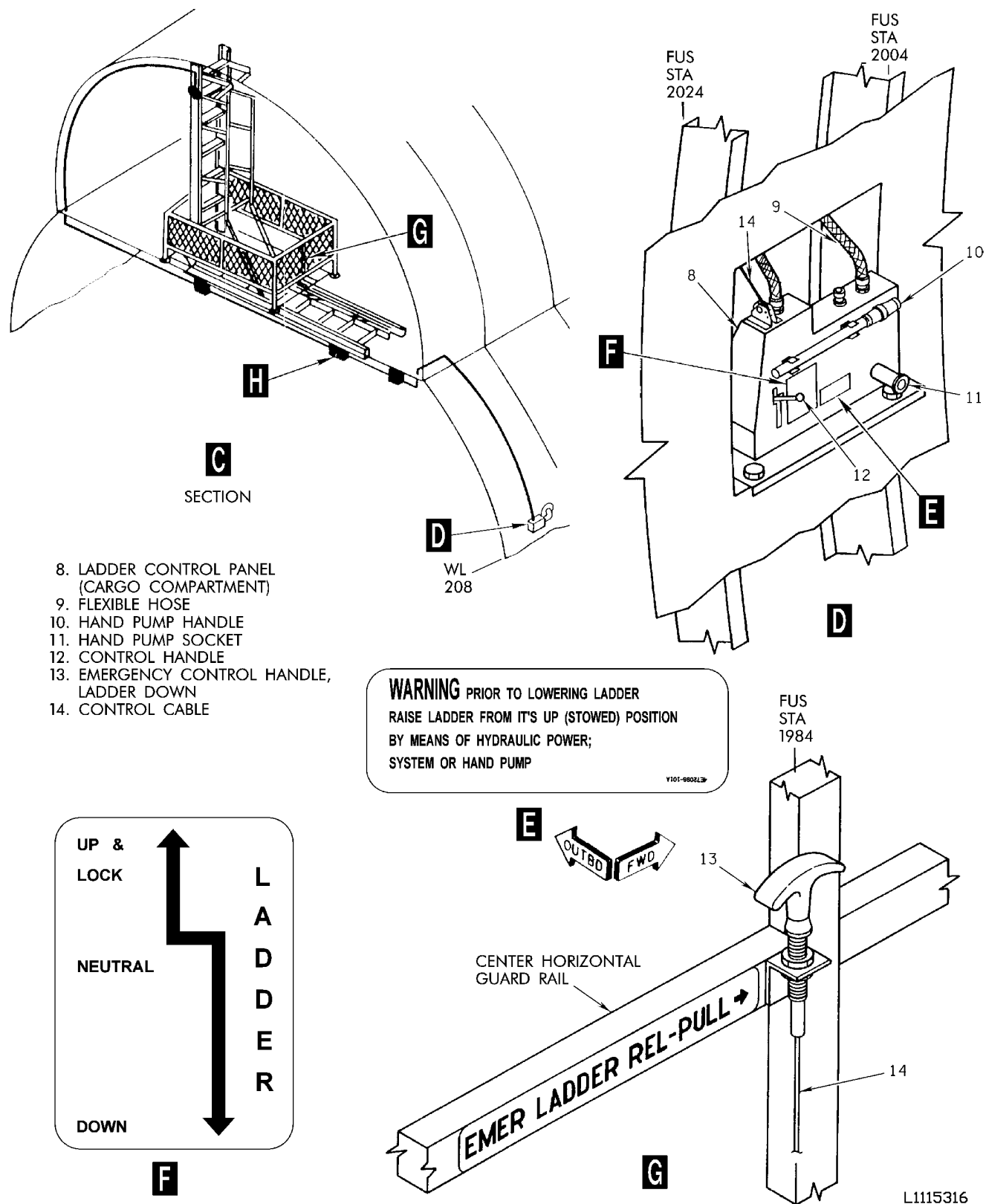
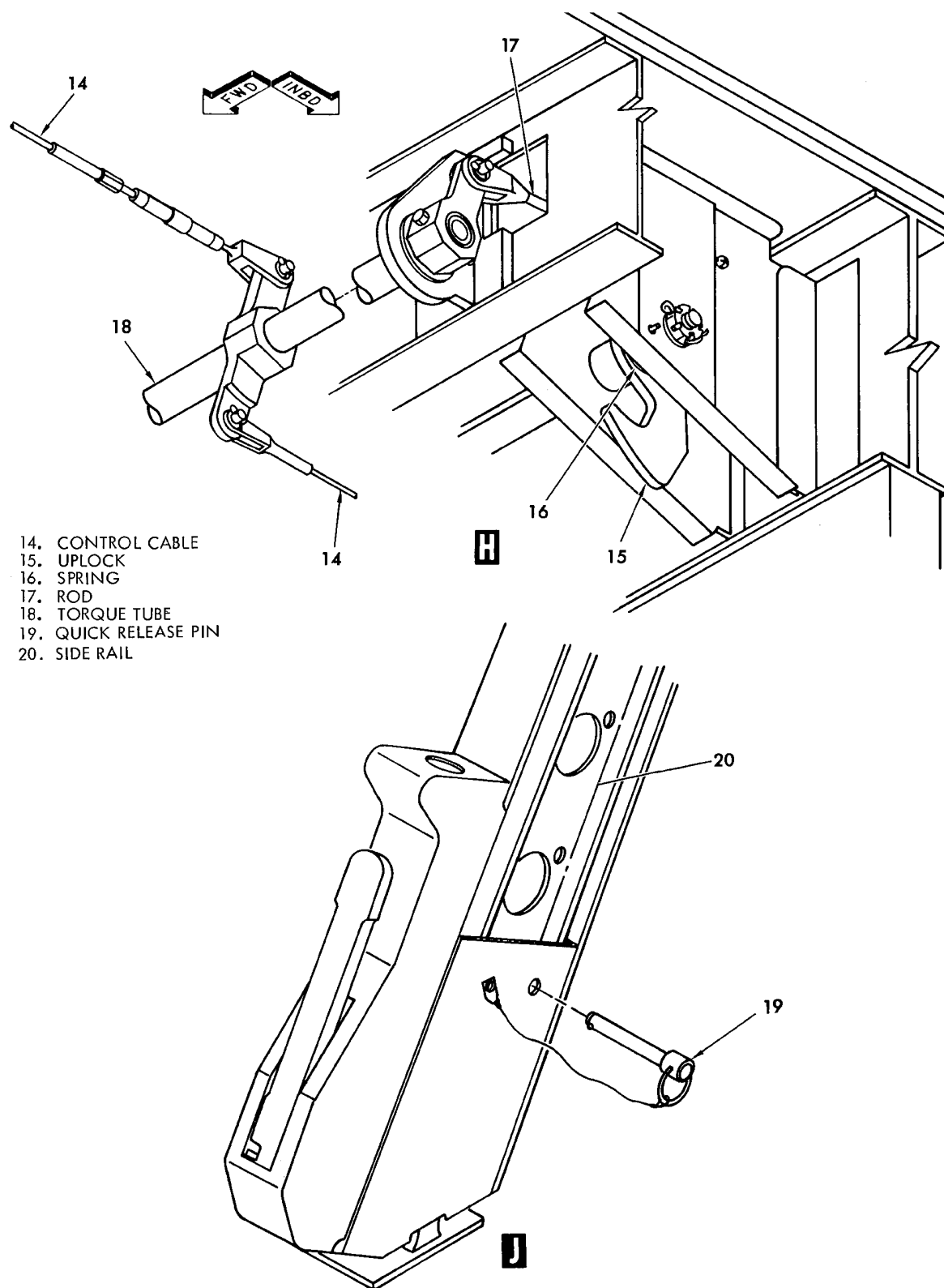


Figure 2-68. Troop Compartment Kit Ladder and Controls (Sheet 2)



L1115317

Figure 2-68. Troop Compartment Kit Ladder and Controls (Sheet 3)

CHAPTER 3

AIRPLANE CONFIGURATION

3.1 AIRPLANE FEATURES.

This chapter covers the operation of the logistics rails and roller conveyor systems, and cargo tiedown devices and the connection of the cargo compartment vents.

3.1.1 [A] Deploying, Extending, and Stowing Aft Fuselage Stabilizer Struts. (See Figure 3-1.)

3.1.2 Outboard Logistics Restraint Rails Mechanism Operation. Operate the outboard logistics rails as follows:

3.1.2.1 Engaging and Locking Detents.

NOTE

Outboard logistics rails with broken or missing cables may be used to restrain pallets, provided the detents are locked in the overcenter (locked) position with locking tees locally manufactured in accordance with Figure 3-4, and installed as shown in Figure 3-5.

- a. Check for satisfactory operation of all detents. If binding or difficulty is encountered during operation of the rail detents, proceed to Step b. If operation is satisfactory, proceed to Step c.
- b. If detent operation is not satisfactory, the cable should be disconnected from the detent. Use the detent locking tees as shown in Figure 3-5. Enter the discrepancy in the airplane Form 781.
- c. Check that all detents in the outboard restraint rails are in the unlocked, retracted position, and that the detents are retracted clear of the inboard side of the rails.
- d. Load the cargo pallets.

CAUTION

- Do not use the toggle action of the detents to align loaded pallets or damage to the detents will occur.
 - Do not use inoperative (unlocked) detents to secure cargo pallets.
- e. Check that the indents in the sides of the cargo pallets are aligned with the detents in the outboard restraint rails.
 - f. Progressively move each of the outboard rail control handles down to spread and lock the detents into the indents in the cargo pallets.
 - g. Check that all detents are locked correctly in pallet indents and that each control handle is in the down position.

3.1.2.2 Disengaging and Unlocking Detents. Disengage and unlock the detents from the cargo pallet indents by reversing the procedures in Engaging and Locking Detents (Paragraph 3.1.2.1) above.

3.1.3 Outboard Logistics Restraint Rail Retractable Lip Operation. (See Figure 2-16, Figure 2-20, and Figure 2-22.) Operation of the outboard logistics restraint rail retractable lips at the forward and aft end of the cargo compartment and the retractable lips in the forward and aft cargo ramp rails to the loading position is accomplished as follows:

NOTE

The retractable lips in the rail system will not close with the ADS platform in place in the rails because of the overhang of the platform lip.

- a. Place the retractable lips in the using position when ADS platforms are to be loaded into the logistics restraint rail system.
- b. Hold tab on the lip firmly and slide lip against compression spring.
- c. Still holding lip, rotate the lip outboard and release, allowing the lip to move to the loading position.
- d. Reverse Step b and Step c to lock the lip for pallet restraint.

3.1.4 Inboard Logistics Restraint Rail Operation. Operation of the inboard logistics restraint rails is accomplished as follows:

CAUTION

During on/off loading of cargo using the logistics rail system, do not step on the inboard rail linkage which is exposed when the rails are in their using position. Failure to observe this caution may result in damage to the linkage.

- a. Engaging and locking detents.
 - (1) Deploy the restraint rails to open (unlocked) position.

CAUTION

Detents shall be manually rotated to the full open (unlocked) position prior to on/off loading. Failure to comply could result in damage to the detents and rails if pallet is pushed against partially closed detents.

- (2) Place the detents in their full open (unlocked) position by releasing the spring-loaded lock at each of the detents, and manually rotating the detents fully inboard.

CAUTION

Ensure that the inboard detents are unlocked and that the detents are not inadvertently locked during on/off loading. Failure to comply could result in damage to the restraint rails.

- (3) Check that all inboard detents are in the unlocked position and remain unlocked during on/off loading operations.
- (4) Load the pallets, lock outboard rail detents.

CAUTION

- Restraint locks shall not be used unless a minimum of one lateral pair is operative (one inboard and one outboard).
 - Inoperative locking detents shall not be used for securing cargo pallets.
- (5) Rotate the detent inboard to lock into indents on cargo pallets.
 - (6) Check that all detents are locked correctly in pallet indents.

- b. Disengaging and unlocking detents.

(1) Disengage and unlock the detents in accordance with Step a (2).

(2) Offload pallets.

3.1.5 Inboard Logistics Restraint Rail Retractable Lip Operation. (See Figure 2-16, Figure 2-20, and Figure 2-22.) Operation of the inboard logistics restraint rail retractable lips at the forward and aft end of the cargo compartment and the retractable lips on the forward and aft ramps to the loading position is accomplished as follows:

NOTE

The retractable lips in the rail system will not close with the ADS platform in place in the rails because of the overhang of the platform lip.

- a. Place the retractable lips in the using position when ADS platforms are to be loaded into the logistics restraint rail system.
- b. Push or pull handle, as applicable, to unlock the lips and rotate open.
- c. Rotate the lips outboard to lock.

3.2 INSTALLATION OF CARGO TIEDOWN DEVICES.

3.2.1 Installation of MB-1 and MB-2 Tiedown Devices. (See Figure 3-2.)

3.2.2 Installation of AF Type CGU-1/B Tiedown Devices. (See Figure 3-3.)

3.3 CONNECTION AND DISCONNECTION OF CARGO COMPARTMENT VENTS.

(See Figure 2-4.)

3.3.1 Connection of Cargo Compartment Vents.

WARNING

Do not connect exhausts from low temperature materials to the right side vents, or exhausts from operating engines to the left side vents. Connection of low temperature exhausts to a vent contaminated with oil or grease may cause an explosion.

- a. Remove the coupling from vent tube.
- b. Remove plug from vent tube and allow to hang from retaining chain.
- c. On the right side vents, if the vent is to be used to connect an exhaust pipe, slide the vent nozzle into vent tube until the nozzle flange is flush with vent tube flange.
- d. Connect the cargo or comfort pallet vent, as applicable, to the cargo compartment vent tube so that they abut against each other.
- e. Slide the coupling over the abutted ends of the connected vents and lock together by tightening the coupling.

3.3.2 Disconnection of Cargo Compartment Vents.

- a. Disconnect the vents by reversing the installation procedure.
- b. Install and lock the sealing plugs in the vent tubes.

3.4 ON/OFF LOADING PALLETIZED CARGO.

3.4.1 Preparation of Forward Ramp Extension Inboard Logistics Rails. (See Figure 2-15.) Prepare the forward ramp extension inboard logistics rails for palletized cargo as follows:

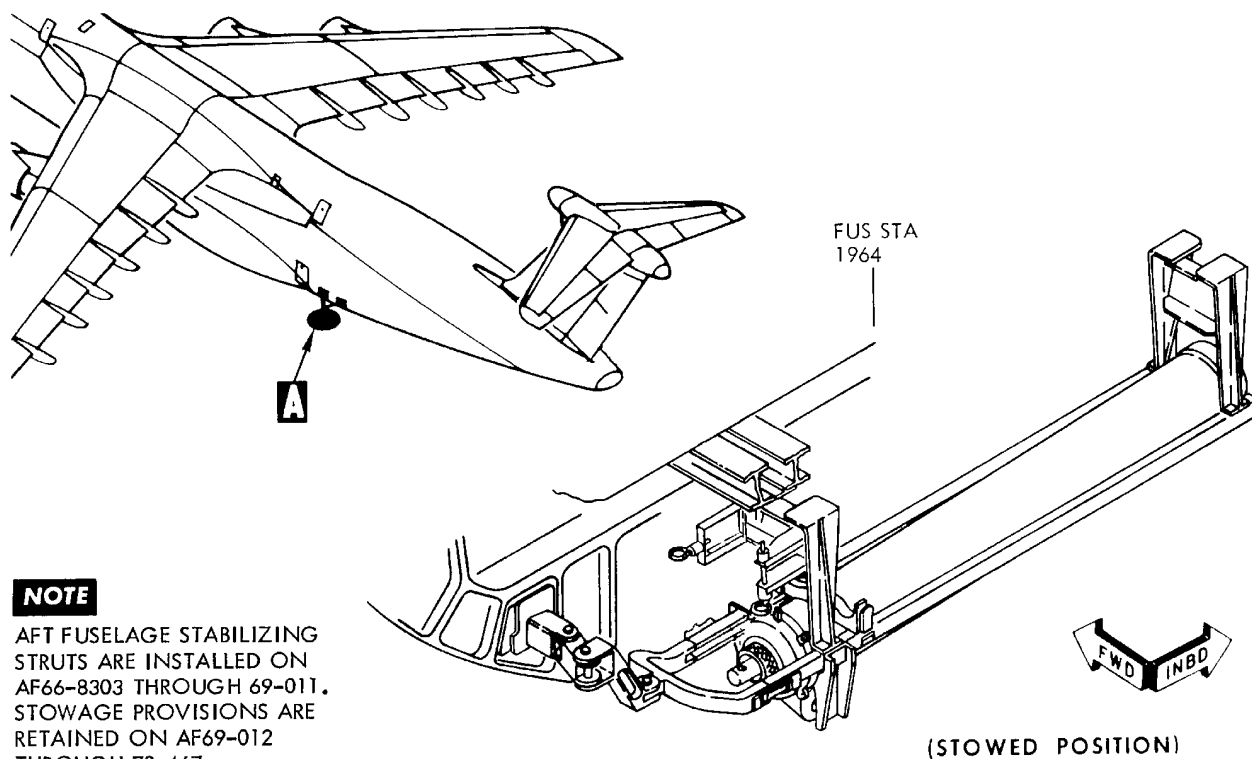
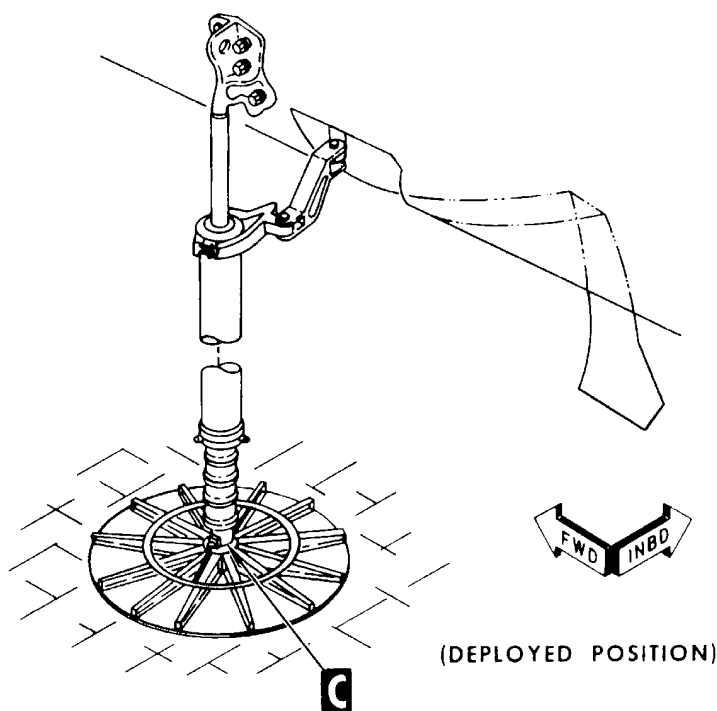
- a. Unlatch and remove the reversible access door.
- b. Reverse the door so that the integral rails face up, then reinstall the door and lock in place in the ramp extension floor.
- c. Unfasten the retaining strap holding the hinged section of rail.
- d. Rotate the forward section of the rail forward and lock to the extension floor by locking the lock-unlock device into the receptacle in the floor.
- e. Remove the rail aligner panel from its stowed position on the door by removing the quick-release pins.
- f. Install the aligner panel between the ramp extension fixed rails (part of the A-frame assembly) and the forward ramp inboard rails as follows:
 - (1) Lock the aft end of the rail aligner panel to the ramp rails by aligning bolts on the panel with slots in the ramp rails. Then slide the panel aft to lock the bolts in slots.
 - (2) Lock the forward end of the aligner panel to the fixed rails by installing the quick-release pins through the holes in the panel and access door brackets.
- g. Fasten retaining straps together to prevent damage and entanglement with cargo as it is on/off loaded.

3.4.2 Installation of Aft Ramp Inboard Aft Logistics A-Frame Rail Assembly. (See Figure 2-20.) Install the aft ramp inboard aft logistics A-frame rail assembly for palletized cargo as follows:

NOTE

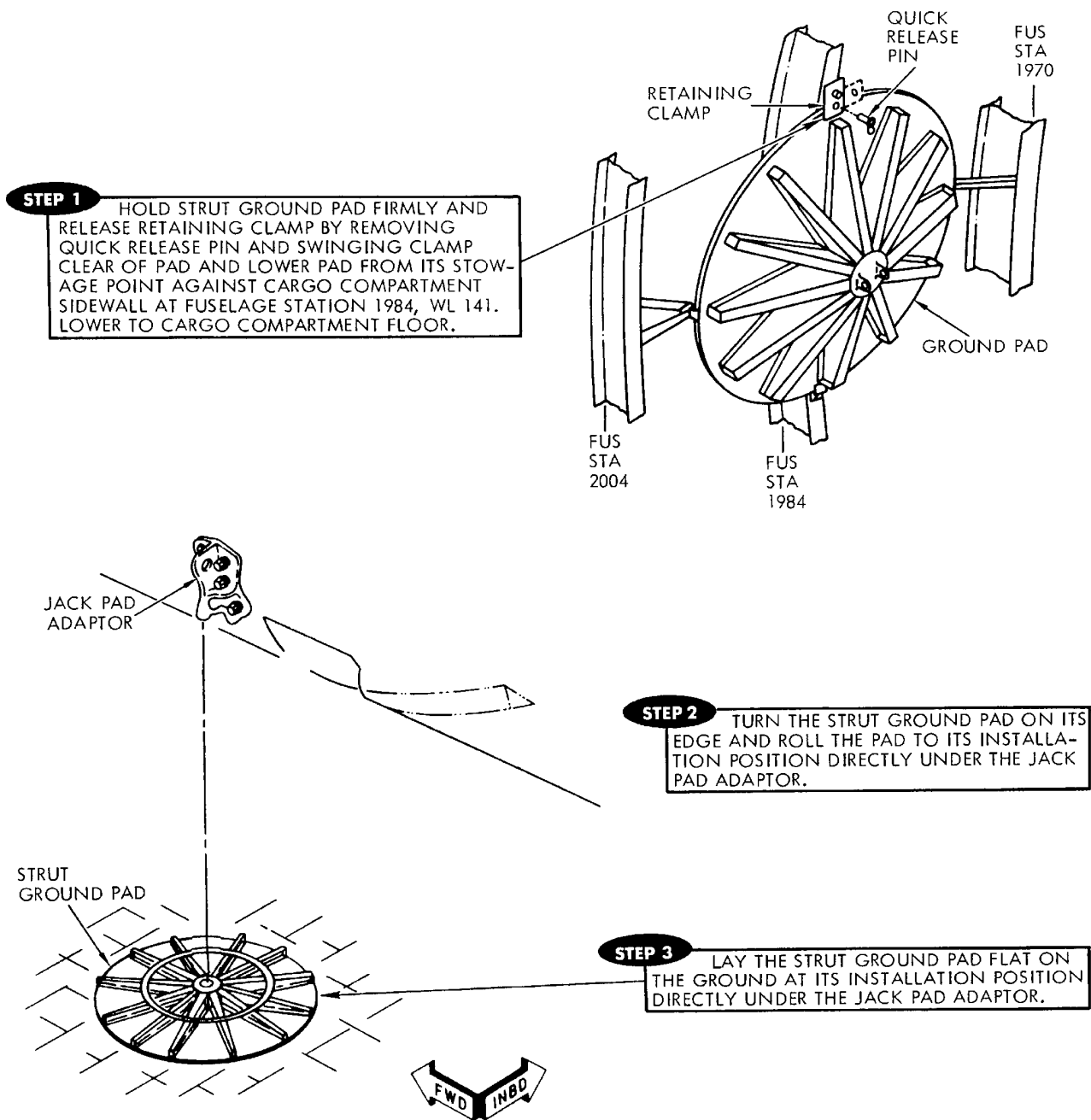
The aft inboard permanently installed logistics rails must be hinged down flush with the cargo ramp floor before the A-frame assembly can be installed.

- a. As applicable, hinge down the aft inboard set of logistics rails flush with the ramp floor.
- b. Remove the A-frame rail assembly from its stowed position against the fuselage left sidewall at FS 2024.
- c. Place the assembly in position on the ramp floor at RS 55.
- d. Unlatch and rotate the hinged A-section of the rail assembly aft.
- e. Align the two T-bolt locking devices on the assembly with the attachment receptacles in the ramp floor at RS 96 and 137.
- f. Align the spring-loaded device on the assembly with the cargo tiedown ring on the ramp floor at RS 54.
- g. Attach the assembly to the ramp floor by locking the T-bolt devices into the receptacles and locking the spring-loaded device through the cargo tiedown ring.

VIEW **A**

L1115318

Figure 3-1. **A** Deploying, Extending and Stowing Aft Fuselage Stabilizer Struts (Sheet 1 of 5)



L1115319

Figure 3-1. **A** Deploying, Extending and Stowing Aft Fuselage Stabilizer Struts (Sheet 2)

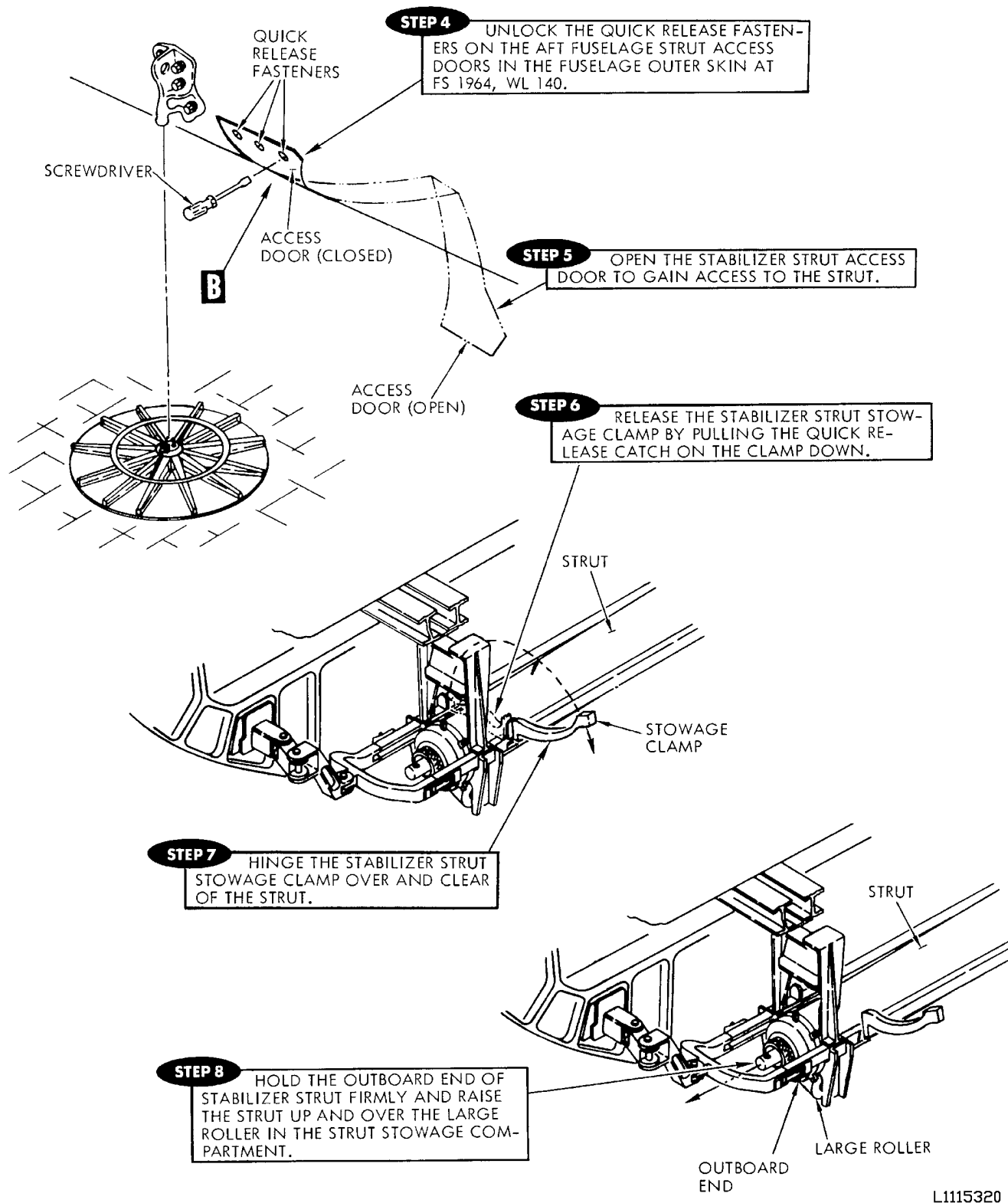


Figure 3-1. **A** Deploying, Extending and Stowing Aft Fuselage Stabilizer Struts (Sheet 3)

NOTE

WITH THE STRUT ROLLERS IN YOKE RECESS THE STRUT IS POSITIONED AND HELD IN THE YOKE ASSEMBLY READY FOR DEPLOYMENT.

STEP 9

STILL HOLDING THE STRUT FIRMLY, PULL THE STRUT OUTBOARD ON THE TRACKS UNTIL THE ROLLERS ON THE TOP END OF STRUT ENGAGE IN RECESS IN YOKE ASSEMBLY.

STEP 10

STILL HOLDING THE STRUT FIRMLY- SWING IT DOWN UNTIL IT HANGS DOWN IN ITS VERTICAL POSITION.

NOTE

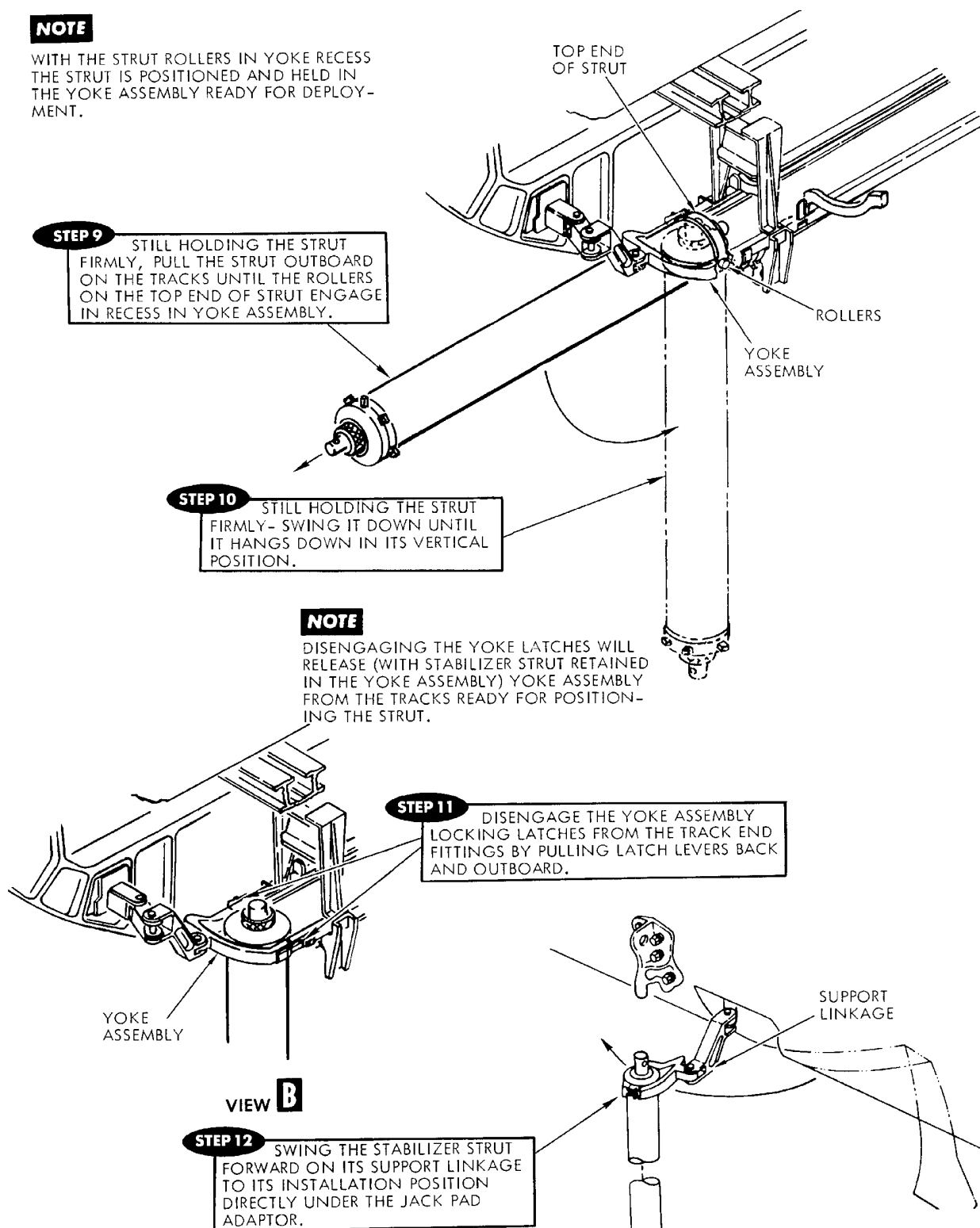
DISENGAGING THE YOKE LATCHES WILL RELEASE (WITH STABILIZER STRUT RETAINED IN THE YOKE ASSEMBLY) YOKE ASSEMBLY FROM THE TRACKS READY FOR POSITIONING THE STRUT.

STEP 11

DISENGAGE THE YOKE ASSEMBLY LOCKING LATCHES FROM THE TRACK END FITTINGS BY PULLING LATCH LEVERS BACK AND OUTBOARD.

VIEW **B****STEP 12**

SWING THE STABILIZER STRUT FORWARD ON ITS SUPPORT LINKAGE TO ITS INSTALLATION POSITION DIRECTLY UNDER THE JACK PAD ADAPTOR.

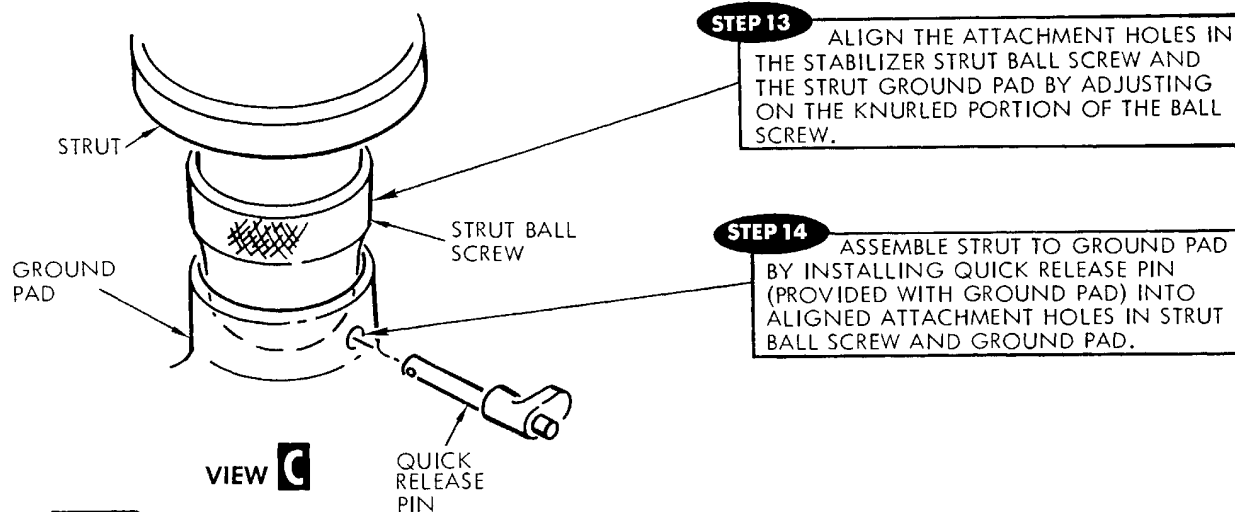


L1115321

Figure 3-1. **A** Deploying, Extending and Stowing Aft Fuselage Stabilizer Struts (Sheet 4)

NOTE

MAKE SURE THE STABILIZER STRUT GROUND PAD IS RESTING FIRMLY ON THE GROUND WHEN THE ATTACHMENT HOLES ARE ALIGNED.

**NOTE**

PROCEDURES FOR RETRACTING AND STOWING THE AFT FUSELAGE STABILIZER STRUTS ARE THE REVERSE OF DEPLOYMENT AND EXTENSION.

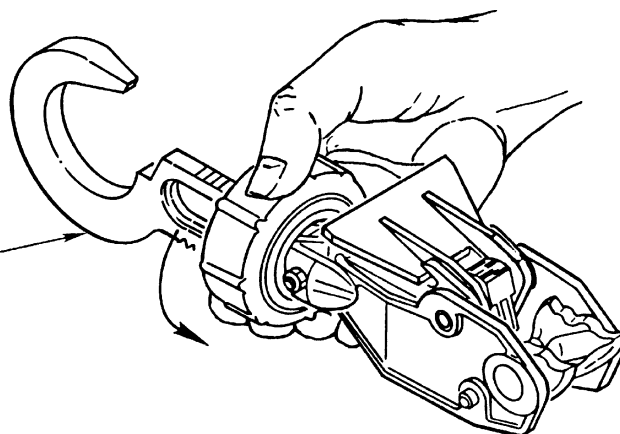
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Figure 3-1. **A** Deploying, Extending and Stowing Aft Fuselage Stabilizer Struts (Sheet 5)

INSTALLATION PROCEDURES

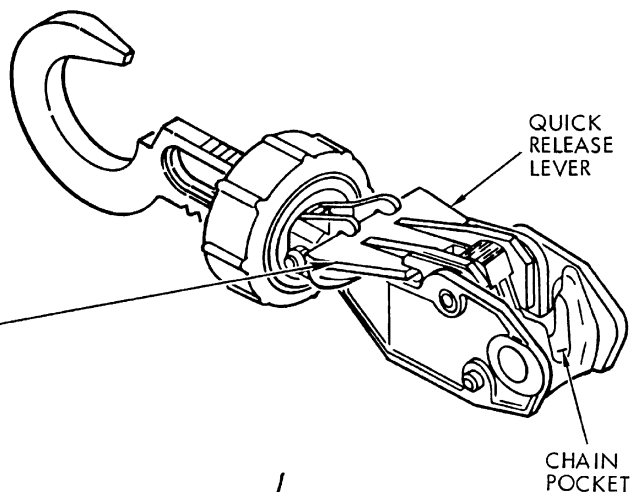
STEP 1

FULLY EXTEND ADJUSTABLE HOOK BY ROTATING TENSION GRIP.



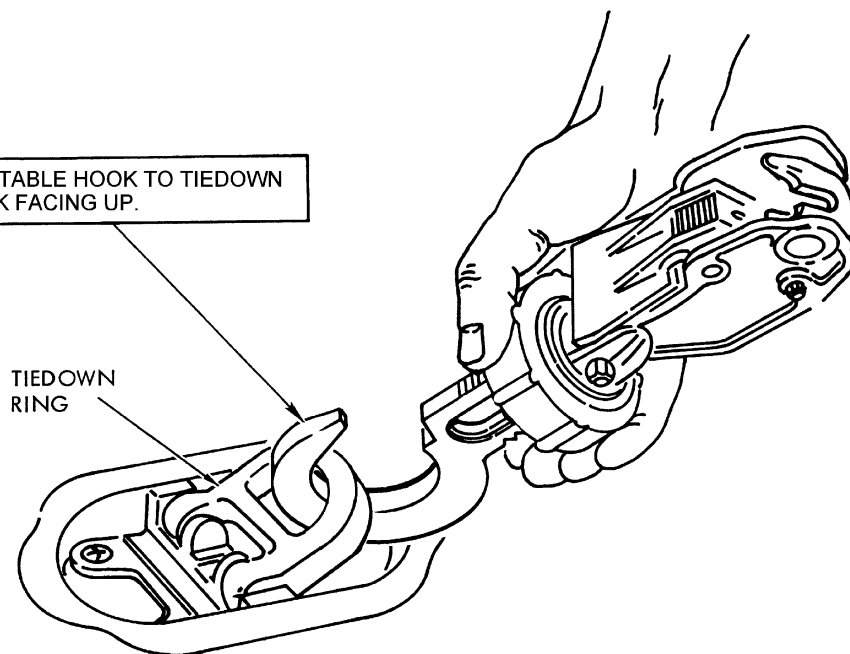
STEP 2

CLOSE CHAIN POCKET AND LOCK QUICK RELEASE LEVER BY PRESSING DOWN AND INTO LOCK LEVER.



STEP 3

ATTACH ADJUSTABLE HOOK TO TIEDOWN RING WITH THE HOOK FACING UP.

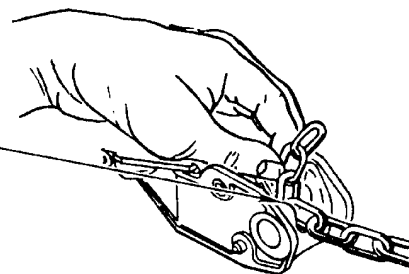


L1115323

Figure 3-2. Installation of MB-1 and MB-2 Tiedown Devices (Sheet 1 of 2)

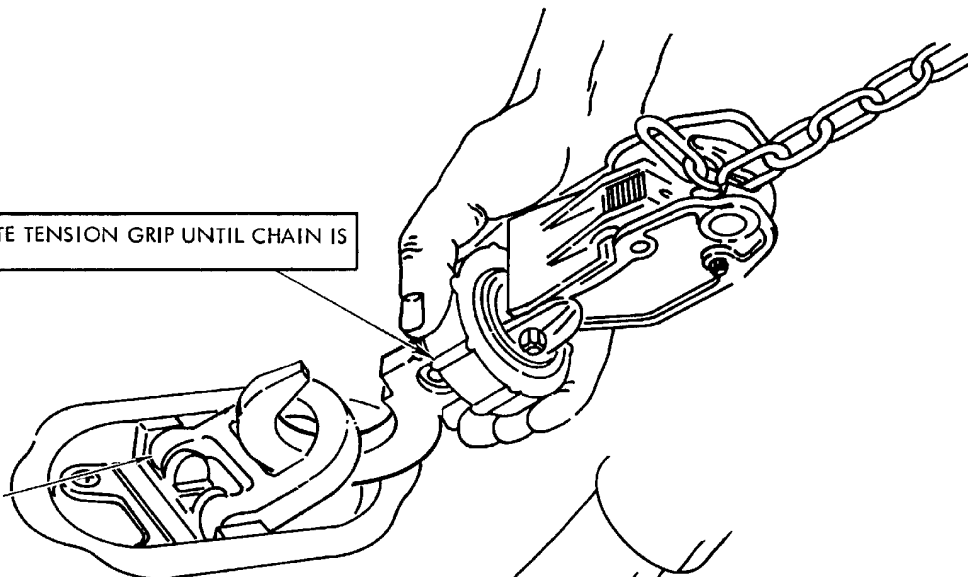
STEP 4

INSERT CHAIN IN CHAIN POCKET AND PUSH CHAIN DOWN UNTIL BOTTOM IS SECURED IN CHAIN LOCK.

**STEP 5**

ROTATE TENSION GRIP UNTIL CHAIN IS TIGHT.

TIEDOWN RING

**NOTE**

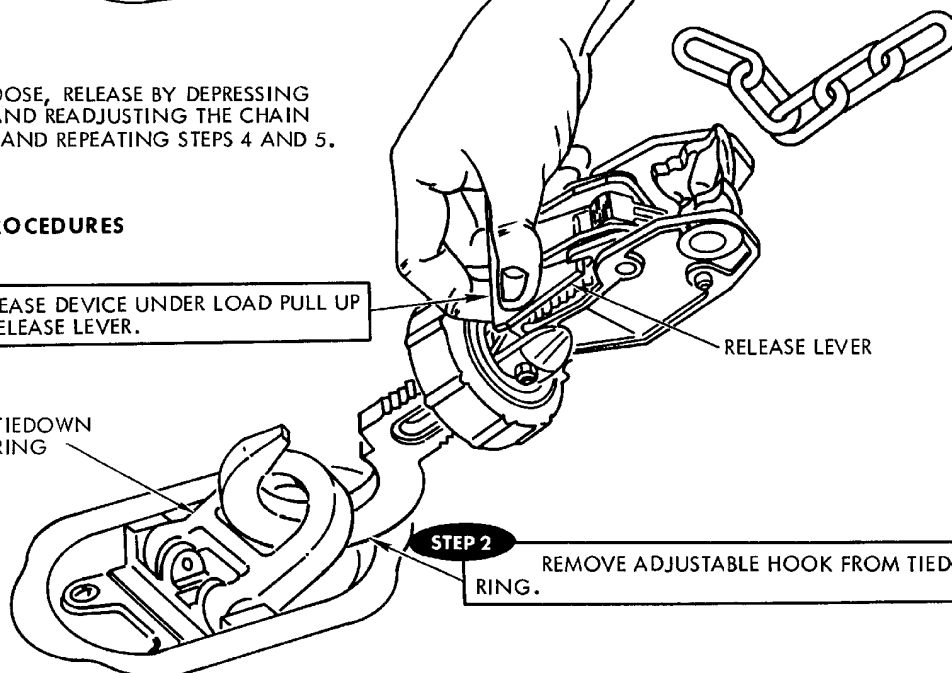
IF CHAIN IS TOO LOOSE, RELEASE BY DEPRESSING THE CHAIN LOCK, AND READJUSTING THE CHAIN TO PROPER LENGTH AND REPEATING STEPS 4 AND 5.

REMOVAL PROCEDURES**STEP 1**

TO RELEASE DEVICE UNDER LOAD PULL UP ON QUICK RELEASE LEVER.

RELEASE LEVER

TIEDOWN RING

**STEP 2**

REMOVE ADJUSTABLE HOOK FROM TIEDOWN RING.

L1115324

Figure 3-2. Installation of MB-1 and MB-2 Tiedown Devices (Sheet 2)

INSTALLATION OF TIEDOWN DEVICES

TOC

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CH 1

CH 2

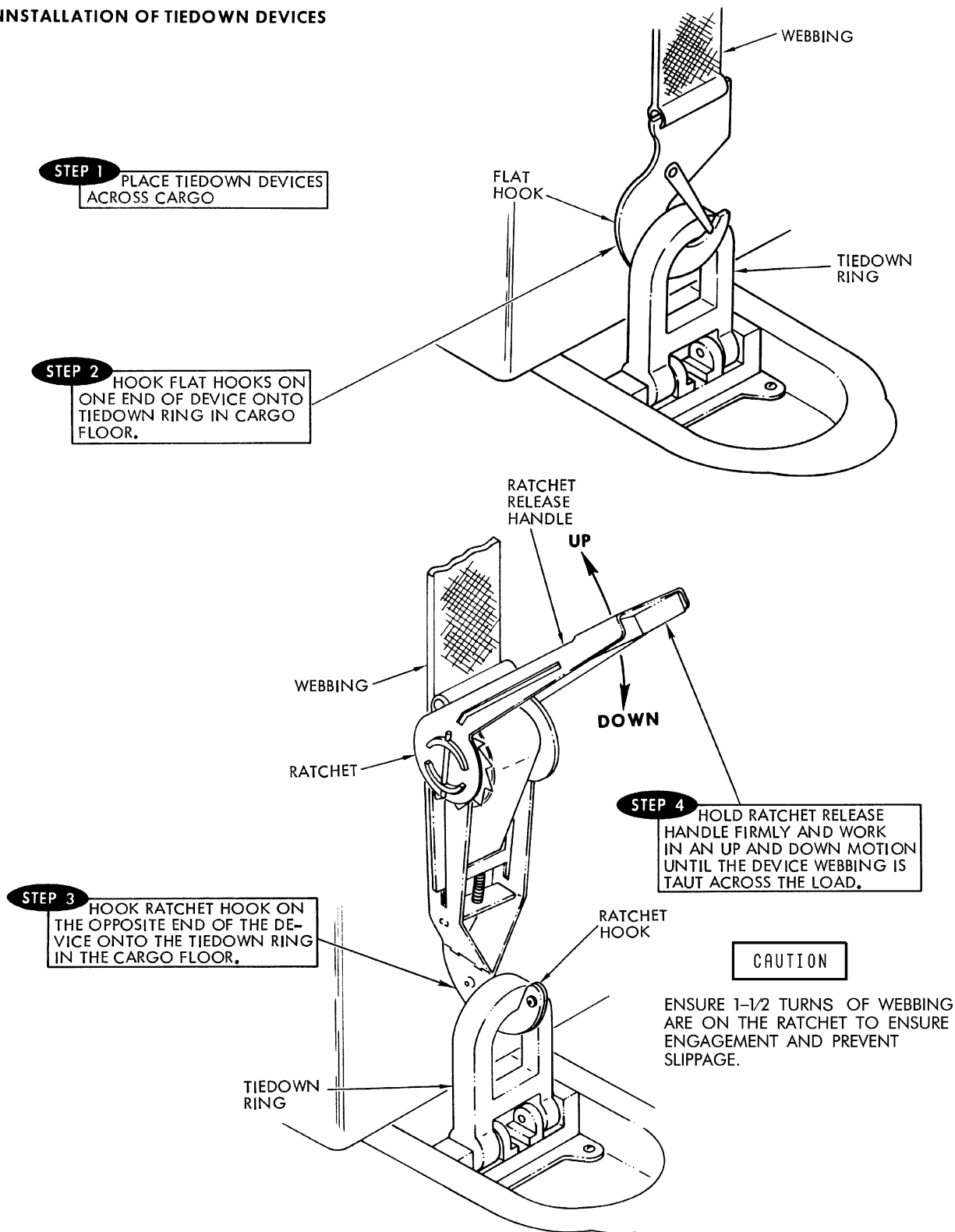
CH 3

CH 4

CH 5

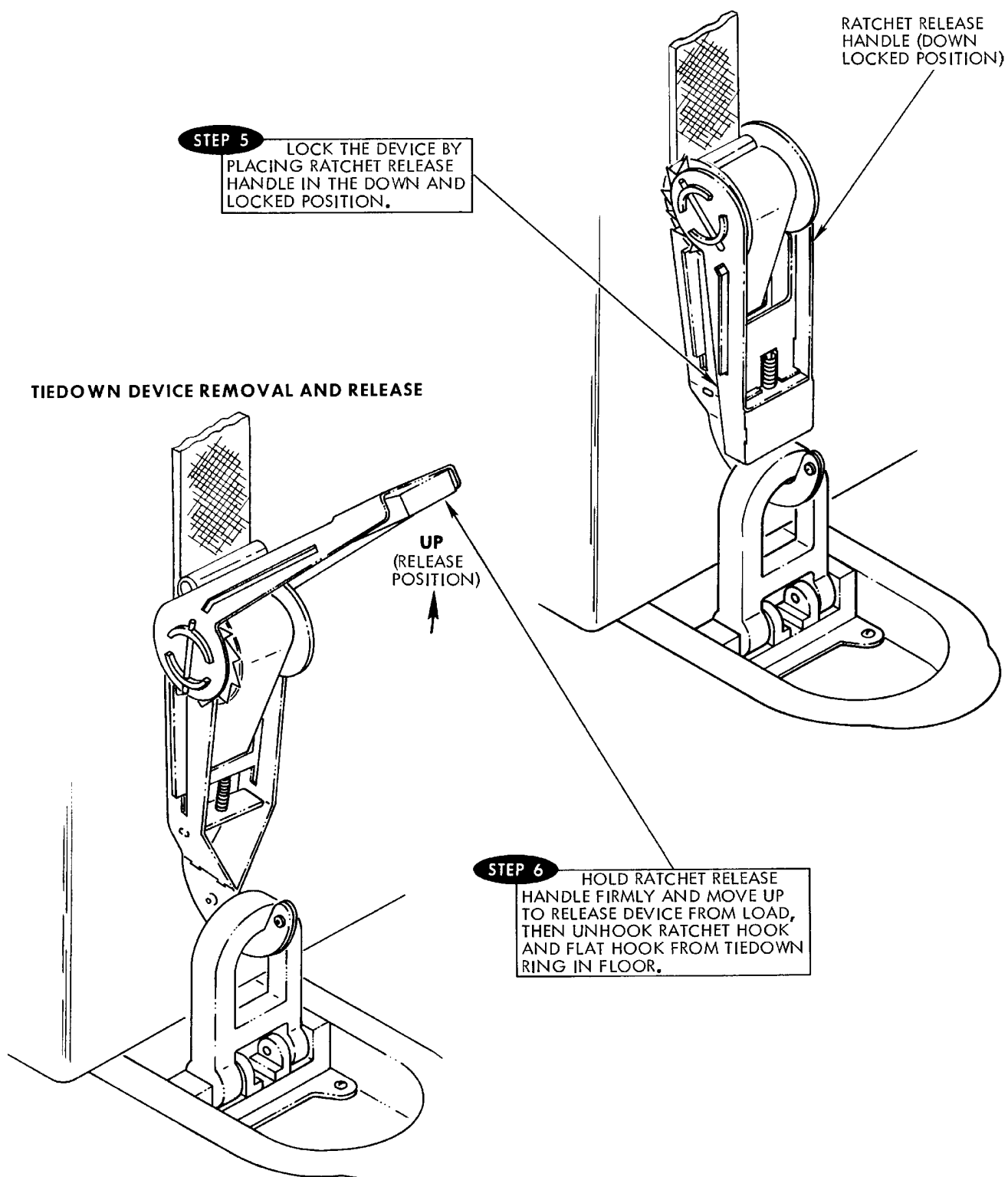
CH 6

PREV



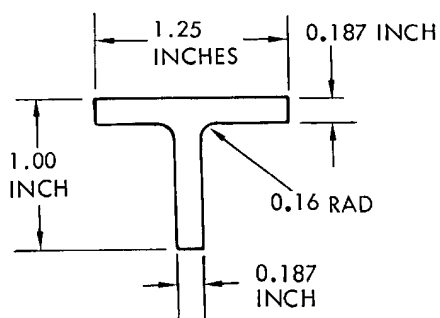
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Figure 3-3. Installation and Removal of AF Type CGU-1/B Tiedown Devices (Sheet 1 of 2)

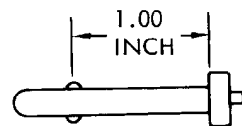
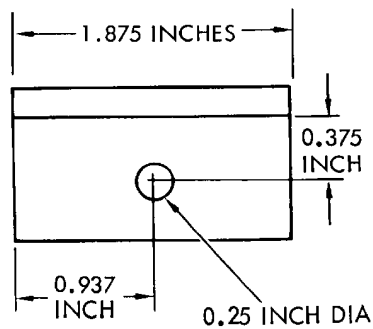


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Figure 3-3. Installation and Removal of AF Type CGU-1/B Tiedown Devices (Sheet 2)



DETENT LOCKING TEE

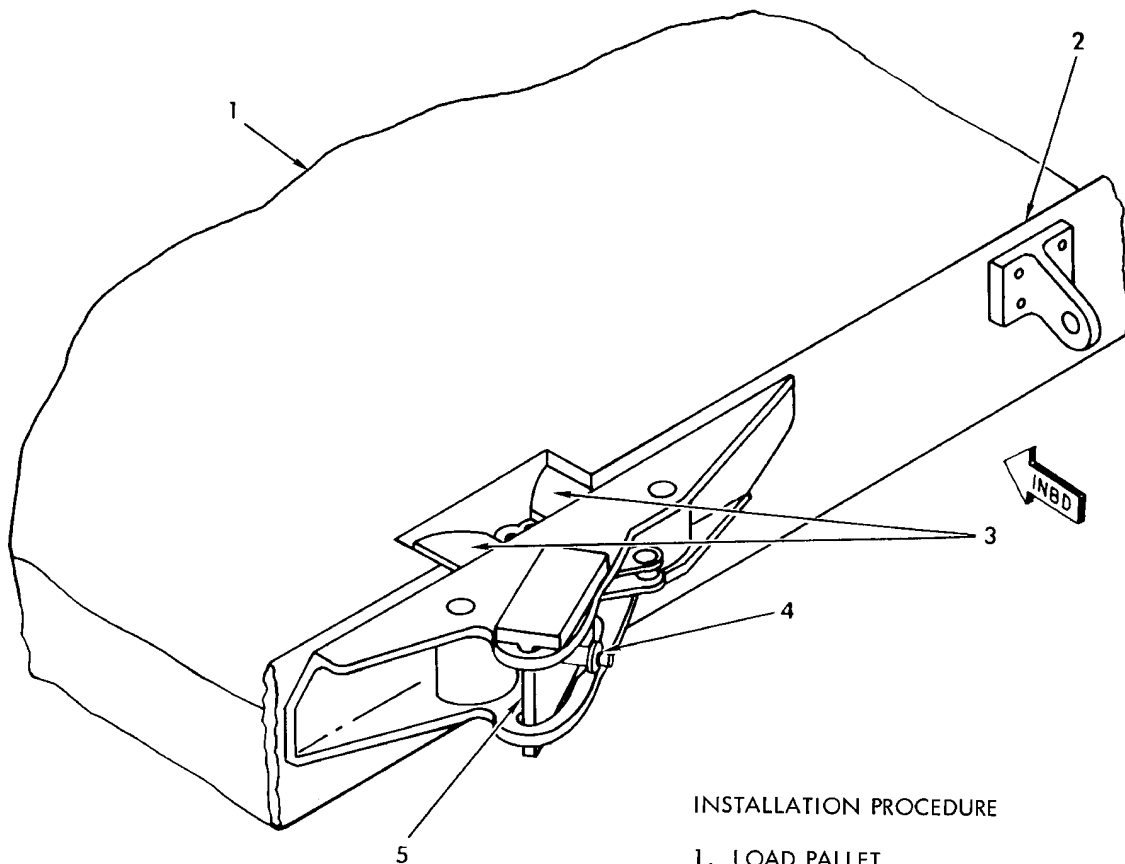


QUICK RELEASE PIN
NAS1334S3S09

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Figure 3-4. Detent Locking Tee and Quick Release Pin – Outboard Logistics Restraint Rails

- 1. PALLET
- 2. OUTBOARD LOGISTICS RESTRAINT RAIL
- 3. OUTBOARD LOGISTICS RESTRAINT RAIL DETENTS OVER CENTER
- 4. QUICK RELEASE PIN
- 5. DETENT LOCKING TEE



INSTALLATION PROCEDURE

1. LOAD PALLET
2. MANUALLY PUSH APPLICABLE DETENTS TO OVER CENTER (LOCKED) POSITION.
3. INSTALL DETENT LOCKING TEE AND LOCK IN PLACE WITH QUICK RELEASE PIN

L1115328

Figure 3-5. Detent Locking Tee Installation-Outboard Logistics Rail Detent Mechanisms (Mechanisms with Broken or Missing Cables)

CHAPTER 4

GENERAL PROCEDURES

This chapter is divided into five sections to provide specific instructions and procedures for load planning, charts and graphs, load methods and restraint, winching, and on/off loading. A brief description of the sections and contents follows:

Section I – LOAD PLANNING. This section contains information for load planning, prior to loading the airplane, and describes correct load placement in the airplane.

Section II – CHARTS AND GRAPHS. This section contains all charts and graphs used to determine cargo size and weight limitations, shoring requirements, and loading area clearance limits.

Section III – LOAD METHODS AND RESTRAINT. This section contains loading procedures and methods for restraining cargo on the cargo and ramp floors for air transport.

Section IV – WINCHING PROCEDURES. This section contains procedures for on/off loading cargo using the airplane winches or equipment with self-contained winches.

Section V – LOADMASTER ON/OFF LOADING PROCEDURES. This section contains a summary of information presented in other sections to be used for quick reference during on/off loading operations.

SECTION I LOAD PLANNING

4.1 LOAD PLANNING.

Load planning is a primary requirement for achieving efficient on/off loading operations, correct load placement in the airplane, correct tiedown of the cargo after loading to ensure maximum utilization of the available cargo space within the airplane, and for establishing a minimum turnaround time for the airplane at its destination.

4.1.1 Planning Factors. Load planning covers many factors that must be taken into consideration before any actual loading is accomplished. Load planning also makes it possible to know in advance whether a given load can be carried in the airplane while still maintaining the designed purpose of the particular mission. Load planning will also determine any additional loading aids that may be required for loading the cargo. The following are items that should be considered in load planning:

- a. Ensure that cargo is prepared for air shipment in accordance with appropriate directives.
- b. Inspect cargo for contaminated items, general condition, and hazardous material.
- c. Gather cargo to be transported.
- d. Select the desired cargo Center of Gravity (CG) location limits as described in applicable technical manual weight and balance data.
- e. For items having critical loading clearances, determine if the cargo item can be loaded.
- f. Ensure that positioned cargo units are within the limits of Cargo Floor Loading Limitations, Paragraph 4.4.2.
- g. Plan position of cargo so that jettisonable cargo can be readily jettisoned.
- h. Plan for ease of offloading at subsequent stops.
- i. Compute total cargo load center of gravity location. (See Figure 4-6.)
- j. Compare total cargo load CG with desired airplane CG (if CG differs appreciably, shift cargo to reduce differences).
- k. Compare contact-area pressures with contact-area pressure limitations.
- l. Compute compartment loads and check compartment load limitations.
- m. Determine shoring requirements, either rolling or parking.

4.1.2 Airplane Center of Gravity Planning. The cargo load must be planned so that the CG of the loaded airplane will be within the specified forward and aft limits for any given operating condition. A general rule for loading cargo into the airplane is to position the heavy units in the area of the optimum airplane CG, and lighter units forward and aft to balance the load. To avoid trial-and-error shifting of heavy and bulky cargo units, the loadmaster may first plan the cargo placement and tentative tiedown on paper.

WARNING

Failure to comply with the following procedures could result in the airplane center of gravity limits being exceeded and result in an unsafe flight condition.

4.1.2.1 The agency offering cargo for air shipment is responsible for marking each item of cargo and all vehicle type cargo with the correct gross weight and Center of Balance (CB) point as follows:

- a. Any item measuring 10 feet or longer.
- b. Any item having a balance point at other than its center.

- c. Vehicle type cargo having a load carrying capability shall be marked indicating an empty or loaded center of gravity, as appropriate.
- d. Wheeled items (vehicles, trailers, dollies, aerospace ground equipment, vans, etc.) weighing 2,000 pounds or more shall be marked with individual axle weights.
- e. The weight should be presented in terms of weight per pallet for cargo loads that span more than one pallet.
- f. If it is not possible to determine the weight per pallet for cargo loads that span more than one pallet, the combined weight shall be provided and the calculated CG shall be marked on the shipment.
- g. Items not marked as outlined above shall not be accepted for airlift.

4.1.3 Planning for the Loading and Placement of Hazardous Cargo. All classes of hazardous materials listed as acceptable for air transportation may be transported. Hazardous cargo that is considered jettisonable shall not be positioned forward of nonjettisonable cargo, e.g., vehicles, helicopters, pallet trains, etc., except when weight and location will permit jettisoning by hand.

4.2 GENERAL WEIGHT AND BALANCE REQUIREMENTS.

4.2.1 Maximum Weight Per Mission. The maximum weight that can be carried on any mission is limited by the maximum allowable gross weight and is dependent upon the airplane basic weight, number of crew members, and the amount of fuel and oil aboard the airplane. The center of gravity location is vitally important to airplane stability during flight. The airplane must be flown only when the center of gravity, as determined by TO 1-1B-50, is within the limits prescribed in TO 1C-5M-1.

4.2.2 Mathematical Formulas.

4.2.2.1 The following is a composite list of various formulas used in computing airplane weight and balance and load PSI calculations.

1. Weight and Balance Formulas:

- (a) $\text{arm} \times \text{weight} = \text{moment}$
- (b) $\text{moment} \div \text{arm} = \text{weight}$
- (c) $\text{moment} \div \text{weight} = \text{arm}$
- (d)

$$\frac{\text{length of Mean Aerodynamic Chord (MAC)} \times \text{desired \% MAC}}{100} + \text{distance to LEMAC} = \text{desired airplane CG station}$$

- (e) $\text{gross moment} \div \text{gross weight} = \text{airplane CG station}$

(f)

$$\frac{\text{airplane CG station} - \text{Leading Edge of MAC (LEMAC)}}{\text{length of MAC}} \times 100 = \% \text{ MAC}$$

2. Vehicle CG Formulas:

$$\frac{\text{distance from front axle to CG} \times \text{vehicle gross weight}}{\text{wheel base}} = \text{rear axle weight}$$

$$\frac{\text{rear axle weight} \times \text{wheel base}}{\text{vehicle gross weight}} = \text{distance from front axle to vehicle CG}$$

NOTE

For vehicles having more than two axles, multiply each axle weight by its distance from the front axle, and add them all together. Divide this sum by the sum of all the axle weights to get the distance from the front axle to the vehicle CG.

3. Wheel Load Formula:

$$\frac{\text{axle weight}}{\text{number of wheels}} = \text{wheel load (pounds)}$$

4. PSI and PSF Formulas:

- (a) Square or Rectangular Boxes:

$$\frac{\text{weight of box}}{\text{length} \times \text{width}} = \text{PSI or PSF}$$

- (b) Drums Without Rims:

$$\frac{\text{weight of drum}}{0.785 \times \text{diameter}^2} = \text{PSI or PSF}$$

- (c) Drums With Rims:

$$\frac{\text{weight of drum}}{(\text{outside diameter} + \text{inside diameter}) \times (\text{outside diameter} - \text{inside diameter}) \times 0.785} = \text{PSI or PSF}$$

- (d) Skidded Boxes:

$$\frac{\text{weight of box}}{\text{length of skid} \times \text{width of skid} \times \text{number of skids}} = \text{PSI or PSF}$$

- (e) Boxes with Triangular Shaped Bases:

$$\frac{\text{weight of box}}{1/2 \text{ height of triangle} \times \text{base of triangle}} = \text{PSI or PSF}$$

- (f) Pneumatic Tires:

$$\frac{\text{tire load}}{\text{length} \times \text{width} \times 0.785} = \text{PSI or PSF}$$

5. Cable Pull Formula:

$$(\cosine \text{ of ramp angle} \times \text{friction coefficient} + \sin \text{ of ramp angle} \times \text{weight}) = \text{cable pull (pounds)}$$

6. Load Shift Formula:

$$\text{Load Shift Arm (LSA)} \times \text{Load Shift Weight (LSW)} = \text{gross weight} \times \text{CG change in inches}$$

7. MAC = 370.52 LEMAC = 1,254.24

4.2.2.2 Use the standard rounding procedures in Table 4-1 when calculating airplane weight and balance and load PSI.

Table 4-1. Weight, Balance, and Loading Rounding Procedures

Computation	Rounding Rule	Example
Area	To the 10th, drop any remainder	0.4456984 = 0.4
PSI	To the 10th and increase with any remainder	0.4456984 = 0.5
CG arm	To the nearest 10th	0.4456984 = 0.4
Distance into MAC	To the nearest 10th	0.4456984 = 0.4
CG change in inches	To the nearest 10th	0.4456984 = 0.4
Tiedown computation	To the fourth digit, drop any remainder	0.4456984 = 0.4456
Weight, LSW, LSA, CG from Front Axle (CGFA), CG from Front End (CGFE) Moment	To the nearest whole number	0.4456984 = 0.0

4.2.2.3 Use the standard rounding procedures in Table 4-2 when calculating shoring requirements.

Table 4-2. Shoring Rounding Procedures

Allowable weight	To the whole pound	Never increase
Applied/actual weight	To the whole pound	Always increase
M factors	To the 100th	Never increase
Required length and width	To the 10,000th	Never increase
Effective length and width	To the 10,000th	Never increase
Shoring	To the 10th	Always increase
Roller load	To the 100th	Always increase

4.2.3 Center of Gravity of the Airplane. The center of gravity is the point around which the airplane will balance longitudinally. It is essential that the CG be located within the specified limits at all times. The flight performance of the airplane depends on the location of this point. As fuel, oil, cargo, and other weights are added, removed, or relocated within the airplane, the airplane CG changes. The airplane is designed to permit such CG changes, provided the center of gravity location remains within certain specified limits. Instructions for calculating the cargo CG are contained in this section of the manual. Refer to TO 1C-5M-5 series and TO 1-1B-50 for airplane CG calculation.

4.2.4 Determining Cargo Unit Weight and Center of Gravity Location. Methods of determining cargo unit weight and CG locations are shown in Figure 4-1. Cargo unit weight and center of gravity locations should be marked on each unit of cargo.

4.2.5 Vehicle Center of Gravity. An item of cargo, such as a vehicle, has a center of gravity; that is a point around which the vehicle will balance. See figures in this section of the manual for examples of calculating CG for different types of vehicles. (See Figure 4-2, Figure 4-3, Figure 4-4, Figure 4-5, and Figure 4-8.)

4.2.6 Total Cargo Load Center of Gravity. To determine the center of gravity of the total cargo load, use the following procedures and refer to the example cargo load shown in Figure 4-6.

- a. Multiply the weight of each unit of cargo by its fuselage station CG and divide the result by 100,000. The result is moment (inch-pounds/100,000).

$$\frac{\text{unit weight} \times \text{unit FS CG}}{100,000} = \text{moment}$$

- b. Total the results of Step a. The result is total cargo load moment (inch-pounds/100,000).

$$\text{Unit 1} + \text{Unit 2} + \text{Unit 3} + \text{Unit 4} = \text{Total cargo load moment}$$

- c. Total the weights of each unit of cargo. The result is the total cargo load weight in pounds.

$$\text{Unit 1} + \text{Unit 2} + \text{Unit 3} + \text{Unit 4} = \text{Total cargo load weight-pounds}$$

- d. Divide the result of Step b (total cargo load moment inch-pounds/100,000) by the result of Step c (total cargo load weight-pounds).

$$\frac{\text{Total cargo load moment (inch-pounds/100,000)}}{\text{Total cargo load weight (pounds)}} \times 100,000 = \text{Total cargo load CG}$$

- e. The result of Step d is the fuselage location of the CG for the total cargo load.

NOTE

These calculations include the weight of the cargo which may be carried in the vehicles.

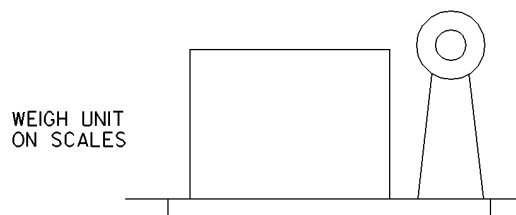
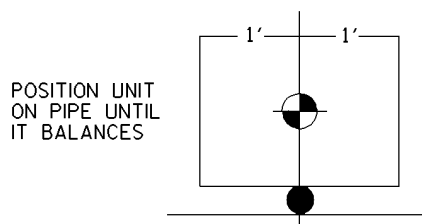
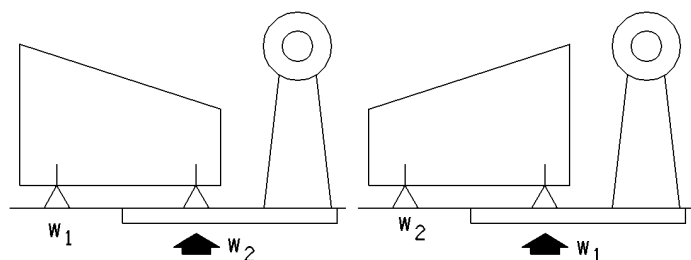
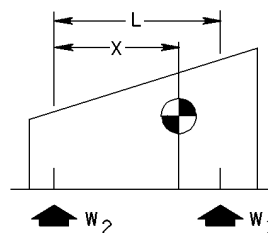
- f. Using the total cargo load CG (the result of Step d) and the airplane CG, convert to percent MAC by using TO 1C-5M-5-2 or math. If the percent MAC is within limits, it can be assumed that the planned load is acceptable, and will not cause the CG to fall outside limits when the Weight and Balance Clearance Form (Form F) is completed prior to flight. If the CG falls outside of limits, it will be necessary to relocate the vehicle, or another part of the cargo, to another position in the cargo compartment.

4.2.7 Calculation of Total Load CG-Spanning Load on Pallets. Equivalent CG of a pallet train can be computed following the instructions in Figure 4-7 for loads which span more than one pallet.

4.2.8 Calculation of Footprint Loads. (See Figure 4-9.)

4.2.9 Locating Vehicle Center of Gravity in Airplane. Use the following procedure to locate the fuselage station at which an individual vehicle may be placed in the cargo compartment.

- Position drawings of the vehicle on the cargo loading floor plan. (See Figure 4-10.) Place in position so that the floor loads shown in Cargo Floor Loading Limitations, Paragraph 4.4.2, are not exceeded. Consider the availability of tiedown rings at the selected position and their relationship to the tiedown points on the vehicle.
- Calculate the CG of the vehicle and mark this location on the drawing.
- Draw a line from the vehicle CG to the bottom of the cargo floor plan.
- Note the station line intersected by the vehicle CG line. For planning purposes, this is the station line over which the vehicle CG should be located when it is loaded in the cargo compartment.

I. GENERAL CARGO**A. TO DETERMINE WEIGHT****B. TO DETERMINE CENTER OF GRAVITY****II. LARGE OR SKID - MOUNTED CARGO****A. TO DETERMINE WEIGHT****B. TO DETERMINE CENTER OF GRAVITY**

$$X = \frac{LW_1}{W}$$

1. IF SCALES CANNOT ACCOMMODATE ENTIRE UNIT, DETERMINE WEIGHT OF EACH END, USING ANGLE IRONS AS FULCRUMS.

NOTE

MARK FULCRUM LOCATIONS ON BOTH SIDES OF UNIT WHEN WEIGHING ONE END. LINE UP FULCRUMS WITH MARKS WHEN WEIGHING OPPOSITE END.

2. DETERMINE UNIT WEIGHT BY ADDING END WEIGHTS.

WHERE

X = DISTANCE FROM FULCRUM POINT TO CENTER OF GRAVITY

L = DISTANCE BETWEEN FULCRUM POINTS

W₁ = WEIGHT OF ONE END OF UNIT

W₂ = WEIGHT OF OTHER END OF UNIT

W = TOTAL UNIT WEIGHT (W₁ + W₂)

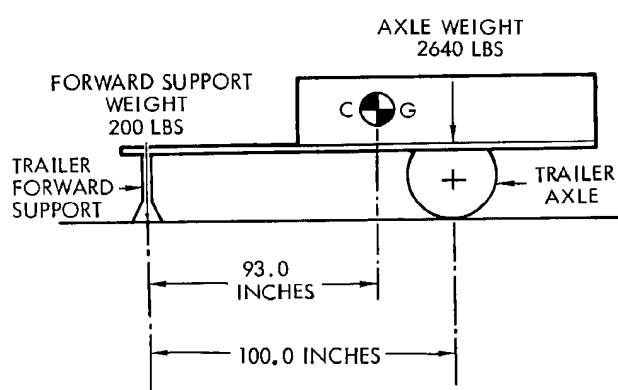
1. DETERMINE MOMENT AT FULCRUM POINT W₂ BY MULTIPLYING DISTANCE BETWEEN FULCRUM POINTS (L) BY UNIT WEIGHT AT FULCRUM POINT W₁.
2. DETERMINE X, THE CENTER OF GRAVITY DISTANCE FROM FULCRUM POINT W₂ BY DIVIDING MOMENT AT FULCRUM POINT W₂ (FROM STEP 1) BY TOTAL UNIT WEIGHT (W).

NOTE

THIS FIGURE ILLUSTRATES METHODS OF DETERMINING THE WEIGHT AND CENTER OF GRAVITY LOCATION OF TYPICAL CARGO UNITS. THESE CARGO UNITS INCLUDE GENERAL CARGO AND LARGE OR SKID-MOUNTED CARGO.

L1115329

Figure 4-1. Determining Cargo Unit Weight and Center of Gravity

**EXAMPLE PROBLEM:**

LOCATE CG OF A TRAILER.

TO LOCATE THE CG OF A TRAILER PROCEED AS FOLLOWS:

1. MULTIPLY THE AXLE WEIGHT BY ITS DISTANCE FROM THE FORWARD SUPPORT

$$2640 \times 100 = 264000$$

2. ADD THE WEIGHT OF THE FORWARD SUPPORT (200 LBS) AND THE WEIGHT OF THE AXLE (2640 LBS) TOGETHER

$$200 + 2640 = 2840 \text{ LBS}$$

3. DIVIDE THE RESULT OF STEP 2 (2840 LBS) INTO THE RESULT OF STEP 1 (264000)

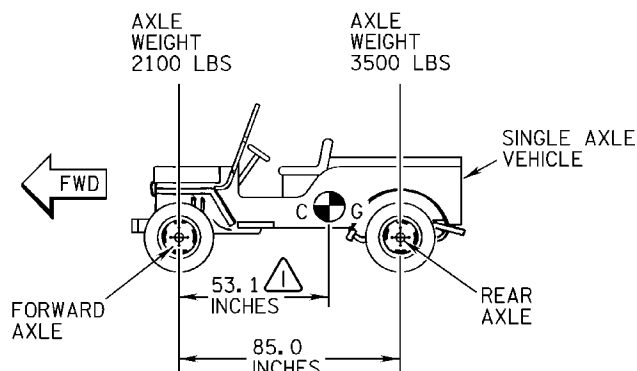
$$\frac{264000}{2840} = 93.0 \text{ INCHES}$$

ANSWER TO EXAMPLE PROBLEM = 93.0 INCHES

93.0 INCHES IS THE DISTANCE FROM THE FORWARD TRAILER SUPPORT TO THE TRAILER CG.

Figure 4-2. Calculation of CG – Trailer

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**NOTE**

△ 53.1 INCHES IS THE DISTANCE FROM THE VEHICLE FORWARD AXLE TO THE VEHICLE CG.

EXAMPLE PROBLEM:

LOCATE THE CG OF A SINGLE AXLE VEHICLE.

TO LOCATE THE CG OF A SINGLE AXLE VEHICLE PROCEED AS FOLLOWS:

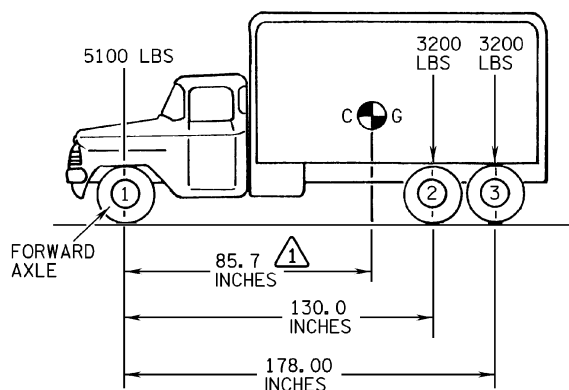
1. MULTIPLY THE REAR AXLE WEIGHT BY ITS DISTANCE FROM THE FORWARD AXLE.
 $3500 \times 85 = 297500$
2. ADD THE WEIGHT OF THE FORWARD AXLE AND THE WEIGHT OF THE REAR AXLE TOGETHER.
 $2100 + 3500 = 5600 \text{ LBS}$
3. DIVIDE THE RESULT OF STEP 2 (5600 LBS) INTO THE RESULT OF STEP 1 (297500).

ANSWER TO EXAMPLE PROBLEM:

$$\frac{297500}{5600} = 53.1 \text{ INCHES}$$

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Figure 4-3. Calculation of CG – Single Axle Vehicle

**NOTE**

FOR THE PURPOSE OF SIMPLIFYING THE PROCEDURES THE VEHICLE AXLES ARE NUMBERED 1 THROUGH 3 FROM FRONT TO REAR.

△ 85.7 INCHES IS THE DISTANCE FROM THE CENTER OF THE VEHICLE FORWARD AXLE TO THE VEHICLE CG.

EXAMPLE PROBLEM:

LOCATE THE CG OF A DUAL AXLE VEHICLE.

TO LOCATE THE CG OF A DUAL AXLE VEHICLE PROCEED AS FOLLOWS:

1. MULTIPLY EACH AXLE WEIGHT BY ITS DISTANCE FROM THE FORWARD AXLE. (AXLE 1).
AXLE 2 $3200 \times 130 = 416000$
AXLE 3 $3200 \times 178 = 569600$
2. ADD THE RESULTS OF STEP 1 TOGETHER.
 $416000 + 569600 = 985600$
3. ADD THE WEIGHT OF EACH AXLE (1 THROUGH 3) TOGETHER.
 $5100 + 3200 + 3200 = 11500 \text{ LBS}$
4. DIVIDE THE RESULT OF STEP 3 (11500 LBS) INTO THE RESULTS OF STEP 2 (985600).

$$\frac{985600}{11500} = 85.7 \text{ INCHES}$$

ANSWER TO EXAMPLE PROBLEM 85.7 INCHES

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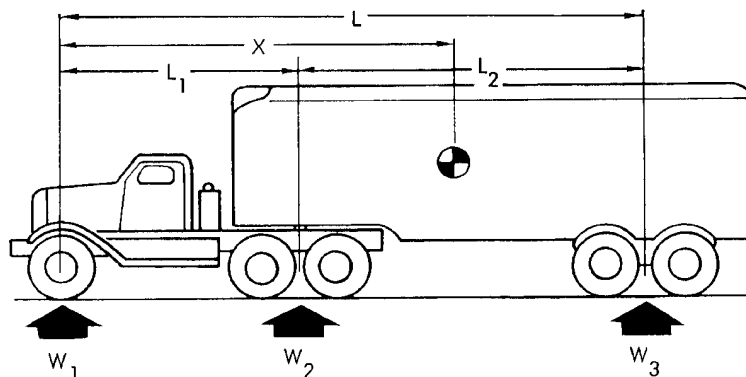
Figure 4-4. Calculation of CG – Dual Wheeled Vehicle

1. CENTER OF GRAVITY LOCATION

$$X = \frac{L_1 W_2 + L W_3}{W}$$

WHERE

- X = DISTANCE FROM FRONT AXLE TO UNIT
 CENTER-OF-GRAVITY LOCATION
 W₁ = FRONT AXLE LOAD
 L₁ = TRACTOR WHEELBASE
 W₂ = TRACTOR REAR AXLE LOAD
 L₂ = TRAILER WHEELBASE
 W₃ = TRAILER AXLE LOAD
 L = TOTAL WHEELBASE OF UNIT
 W = TOTAL WEIGHT OF UNIT



TO LOCATE CARGO UNIT CENTER OF GRAVITY, DETERMINE X

II. STEPS IN DETERMINING CENTER OF GRAVITY LOCATION (X).

1. DETERMINE AXLE LOADS BY WEIGHING ALL AXLES SEPARATELY (W₁, W₂, AND W₃).

NOTE

VEHICLE MUST BE LEVEL WHEN WEIGHING.

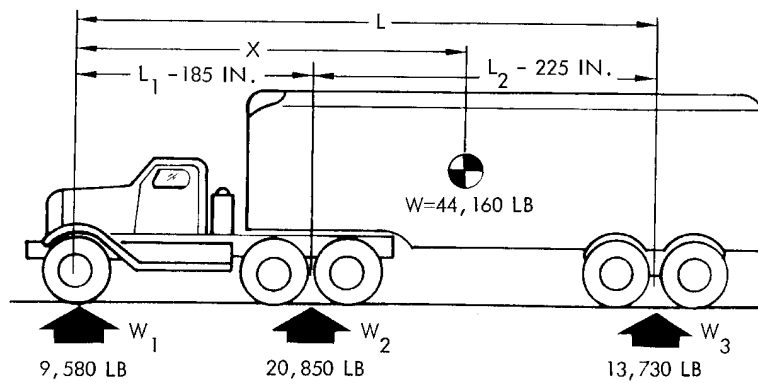
2. DETERMINE TOTAL WEIGHT OF UNIT (W) BY ADDING ALL AXLE LOADS.
3. DETERMINE TRACTOR WHEELBASE (L₁) AND TRAILER WHEELBASE (L₂).
4. DETERMINE TOTAL WHEELBASE OF UNIT (L).
5. DETERMINE TRACTOR REAR AXLE MOMENT ABOUT FRONT AXLE BY MULTIPLYING TRACTOR WHEELBASE (L₁) BY TRACTOR REAR AXLE LOAD (W₂).
6. DETERMINE TRAILER AXLE MOMENT BY MULTIPLYING TOTAL WHEELBASE (L) BY TRAILER AXLE LOAD (W₃).
7. DETERMINE TOTAL MOMENT ABOUT FRONT AXLE BY ADDING TRAILER AXLE MOMENT AND TRACTOR REAR AXLE MOMENT.
8. DETERMINE CENTER-OF-GRAVITY DISTANCE FROM FRONT AXLE (X) DIVIDING TOTAL MOMENT BY TOTAL WEIGHT (W).

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Figure 4-5. Center of Gravity Location – Multiple Unit Vehicle (Sheet 1 of 2)

III. SAMPLE PROBLEM:

DETERMINE THE LOCATION OF THE CENTER OF GRAVITY OF A VEHICLE WHOSE WEIGHT AND DIMENSIONS ARE AS SHOWN BELOW.

**SOLUTION:**

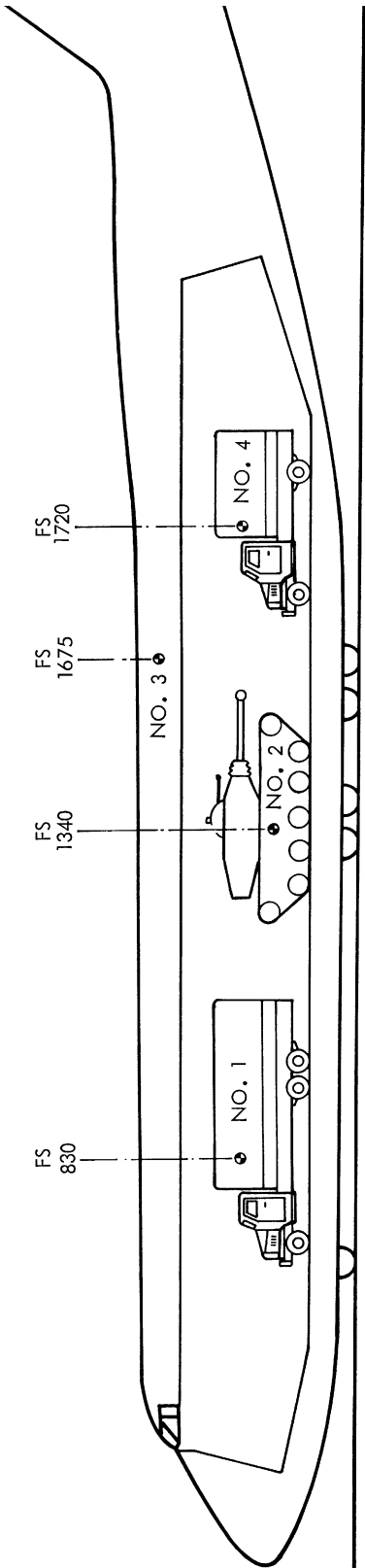
USING THE FORMULA $X = \frac{L_1 W_2 + L W_3}{W}$

$$X = \frac{(185 \text{ IN.} \times 20,850 \text{ LB}) + (410 \text{ IN.} \times 13,730 \text{ LB})}{44,160 \text{ LB}}$$

$$X = 214.8 \text{ IN.}$$

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Figure 4-5. Center of Gravity Location – Multiple Unit Vehicle (Sheet 2)



	COLUMN 1	COLUMN 2	COLUMN 3 = (COLUMN 1 X COLUMN 2) 100,000
VEHICLE	FS OF ITEM CG	VEHICLE WEIGHT (POUNDS)	MOMENT (INCH-POUNDS X 100,000)
NO. 1 TRUCK	830	19,180	159
NO. 2 TWO M-41 TANKS SIDE BY SIDE	1340	2 X 51,800 = 103,600	1,388
NO. 3 50 TROOPS AT 250 POUNDS EACH	1675	12,500	209
NO. 4 TRUCK	1720	7,450	128
TOTAL		142,730	1,884
NOTE FS 1320.0 REPRESENTS CG FOR TOTAL CARGO LOAD CG OF TOTAL LOAD = $\frac{188,494,900}{142,730} = \text{FS } 1320.0$			

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Figure 4-6. Calculation of CG – Total Cargo Load

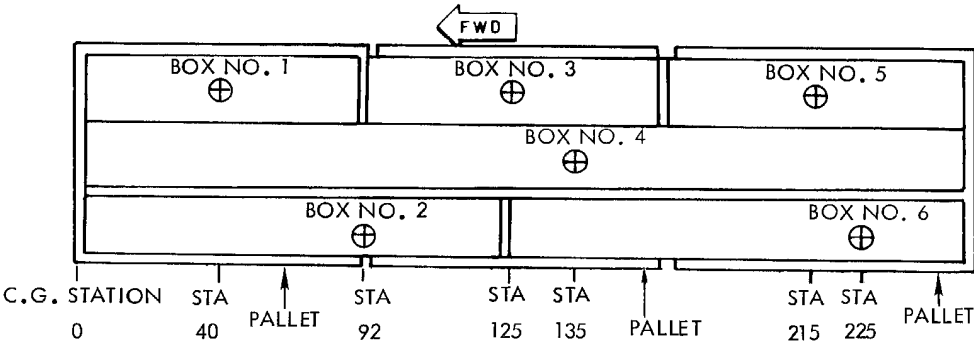
SAMPLE PROBLEM:

DETERMINE THE TOTAL LOAD CENTER-OF-GRAVITY OF A SPANNING LOAD ON THREE IN-TRAIN PALLETS.

NOTE

FOR PURPOSES OF THIS EXAMPLE ALL C.G. STATIONS ARE INDICATED IN INCHES AFT OF THE LEADING EDGE OF THE FORWARD PALLET.

BOX NO. 1	STATION 40	GROSS WEIGHT 1,000 POUNDS
BOX NO. 2	STATION 92	GROSS WEIGHT 2,000 POUNDS
BOX NO. 3	STATION 125	GROSS WEIGHT 1,000 POUNDS
BOX NO. 4	STATION 135	GROSS WEIGHT 1,500 POUNDS
BOX NO. 5	STATION 215	GROSS WEIGHT 1,000 POUNDS
BOX NO. 6	STATION 225	GROSS WEIGHT 2,000 POUNDS



SOLUTION:

1. THE CENTER OF GRAVITY LOCATION OF THE TOTAL LOAD IS EQUAL TO THE TOTAL INCH POUNDS OF THE LOAD DIVIDED BY THE TOTAL WEIGHT OF THE LOAD. $CG \text{ OF TOTAL LOAD} = \frac{\text{TOTAL INCH POUNDS}}{\text{TOTAL WEIGHT}}$
2. CALCULATE THE TOTAL INCH POUNDS OF THE LOAD BY MULTIPLYING THE PALLET STATION WHERE THE CENTER OF GRAVITY OF EACH PIECE OF CARGO IS POSITIONED BY THE WEIGHT OF THE CARGO. ADD THESE FIGURES TO OBTAIN THE TOTAL LOAD INCH-POUNDS.

BOX NO. 1	40 X 1000 =	40,000
BOX NO. 2	92 X 2000 =	184,000
BOX NO. 3	125 X 1000 =	125,000
BOX NO. 4	135 X 1500 =	202,500
BOX NO. 5	215 X 1000 =	215,000
BOX NO. 6	225 X 2000 =	450,000
TOTAL INCH POUNDS		1,216,500

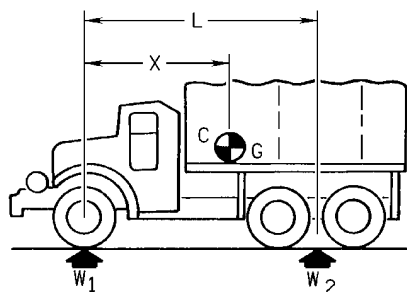
3. DIVIDE THE TOTAL LOAD INCH-POUNDS BY THE TOTAL LOAD WEIGHT TO OBTAIN THE CENTER OF GRAVITY LOCATION IN INCHES FROM THE LEADING EDGE OF THE FORWARD PALLET.

$$C.G. \text{ (TOTAL LOAD)} = \frac{1,216,500}{8,500}$$

$$C.G. \text{ (TOTAL LOAD)} = 143.1 \text{ INCHES FROM LEADING EDGE OF LOAD}$$

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Figure 4-7. Calculation of Total Load CG – Spanning Load of Pallets



X = DISTANCE FROM FORWARD AXLE TO VEHICLE CENTER OF GRAVITY

L = WHEELBASE

W_1 = FORWARD AXLE WEIGHT

W_2 = REAR AXLE WEIGHT

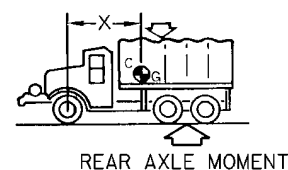
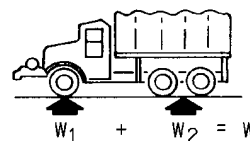
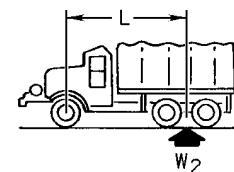
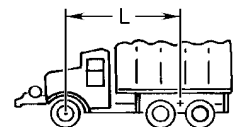
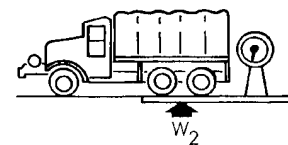
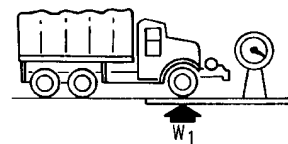
W = TOTAL WEIGHT OF VEHICLE ($W_1 + W_2$) WITH CARGO

EXAMPLE PROBLEM:

LOCATE THE CENTER OF GRAVITY OF A VEHICLE LOADED WITH CARGO WITH THE VEHICLE AXLE WEIGHTS AND WHEELBASE NOT KNOWN.

TO LOCATE THE CENTER OF GRAVITY OF A VEHICLE LOADED WITH CARGO WITH THE AXLE WEIGHTS NOT KNOWN, PROCEED AS FOLLOWS:

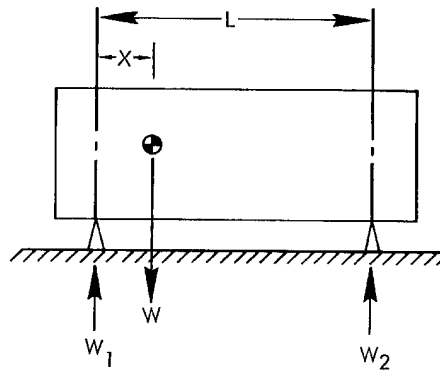
1. DETERMINE THE WEIGHT OF THE FORWARD AXLE (W_1) BY DRIVING THE VEHICLE ONTO THE SCALES SO THAT THE FORWARD AXLE WHEELS ARE RESTING ON THE SCALES.
2. READ AND RECORD THE FORWARD AXLE WEIGHT (W_1) INDICATED ON THE SCALES.
3. DRIVE THE VEHICLE OFF THE SCALES.
4. DETERMINE THE WEIGHT OF THE AFT AXLE (W_2) BY BACKING THE VEHICLE ONTO THE SCALES SO THAT THE REAR AXLE WHEELS ARE RESTING ON THE SCALES.
5. READ AND RECORD THE REAR AXLE WEIGHT (W_2) INDICATED ON THE SCALES.
6. DRIVE THE VEHICLE OFF THE SCALES.
7. DETERMINE THE VEHICLE WHEELBASE (L) BY MEASURING THE DISTANCE BETWEEN THE FORWARD AXLE AND THE REAR AXLE. RECORD THIS MEASUREMENT.
8. DETERMINE THE REAR AXLE MOMENT AROUND THE FORWARD AXLE BY MULTIPLYING THE AFT AXLE WEIGHT (W_2) BY THE VEHICLE WHEELBASE (L). RECORD THE RESULT.
9. DETERMINE THE TOTAL WEIGHT (W) OF THE VEHICLE LOADED WITH CARGO BY ADDING THE WEIGHT OF THE FORWARD AXLE (W_1) AND REAR AXLE (W_2) TOGETHER. RECORD THE RESULT.
10. DETERMINE THE CENTER OF GRAVITY DISTANCE (X) FROM THE FORWARD AXLE BY DIVIDING THE REAR AXLE MOMENT BY THE TOTAL WEIGHT OF THE VEHICLE (W).



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Figure 4-8. Calculation of CG – Vehicle Loaded with Cargo

EXAMPLE:
IF W , X , AND L ARE
KNOWN
FIND W_1 AND W_2



SOLUTION

$$W_1 = \frac{L - X}{L} \times W$$

(CONTACT POINT

$$W_2 = \frac{X}{L} \times W$$

WHERE

X = DISTANCE FROM FOOT PRINT (CONTACT POINT) TO CENTER OF GRAVITY.

L = DISTANCE BETWEEN FOOTPRINTS (CONTACT POINTS)

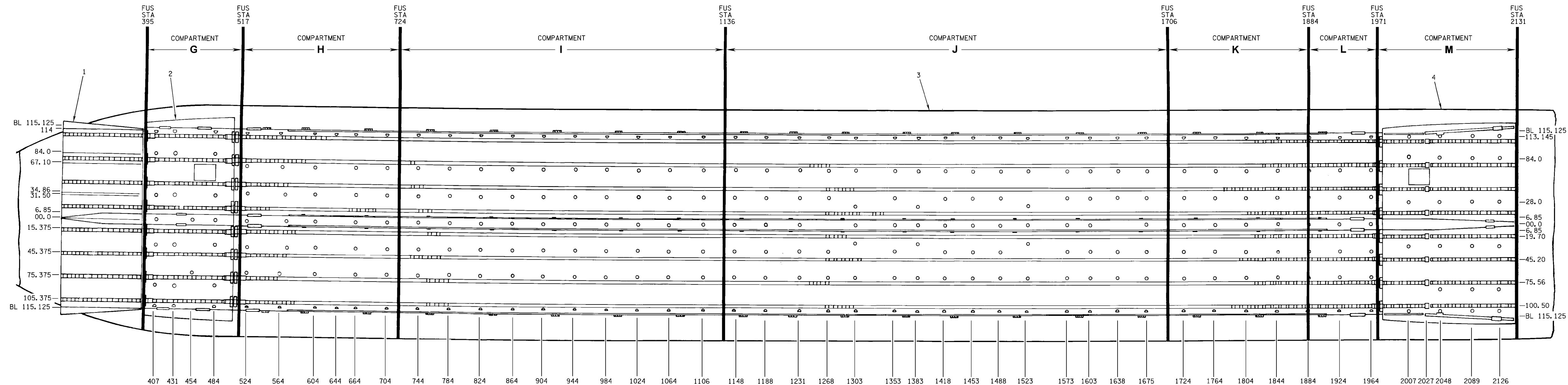
W_1 = WEIGHT AT ONE FOOTPRINT (CONTACT POINT).

W_2 = WEIGHT AT OTHER FOOTPRINT (CONTACT POINT).

W = TOTAL WEIGHT ($W_1 + W_2$)

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Figure 4-9. Calculation of Footprint Loads



CARGO LOADING PLAN VIEW LOGISTICS PALLETIZED CARGO
(INBOARD RESTRAINT RAILS AND GUIDE RAILS
DEPLOYED AND ROLLER CONVEYORS INSTALLED)

BUTTOCK LINE LOCATION				
	CARGO FLOOR	AFT RAMP	FWD RAMP	FWD RAMP EXTEN.
CENTERLINE OF ROLLER CONVEYORS				
INBOARD MOST	18.74	19.70	18.74	15.375
SECOND FROM BL 0	46.50	45.20	46.50	45.375
THIRD FROM BL 0	74.26	75.56	74.26	75.375
OUTBOARD MOST	102.02	100.50	102.02	105.375
INBOARD FACE OF OUTBOARD RAIL	115.125	115.125	115.125	115.125
OUTBOARD FACE OF INBOARD RAIL	6.85	6.85	6.85	6.85
TIEDOWN ATTACHMENT FITTINGS				
CENTERLINE OF 1st ROW FROM BL 0	34.86	28.0	31.50	
2nd ROW FROM BL 0	67.10	84.0	84.0	
OUTBOARD ROW	113.145	113.145	113.145	

- CARGO TIEDOWN RINGS
- RESTRAINT MECHANISM
- RETRACTABLE LIP
- ROLLER CONVEYORS

- FORWARD RAMP EXTENSION
- FORWARD RAMP
- CARGO COMPARTMENT FLOOR
- AFT CARGO RAMP

NOTE

- COMPARTMENT BOUNDARIES ARE MARKED ON THE SIDEWALLS OF THE CARGO COMPARTMENT WITH BLACK VERTICAL STRIPES.

Figure 4-10. Cargo Loading Plan View (Sheet 1 of 2)

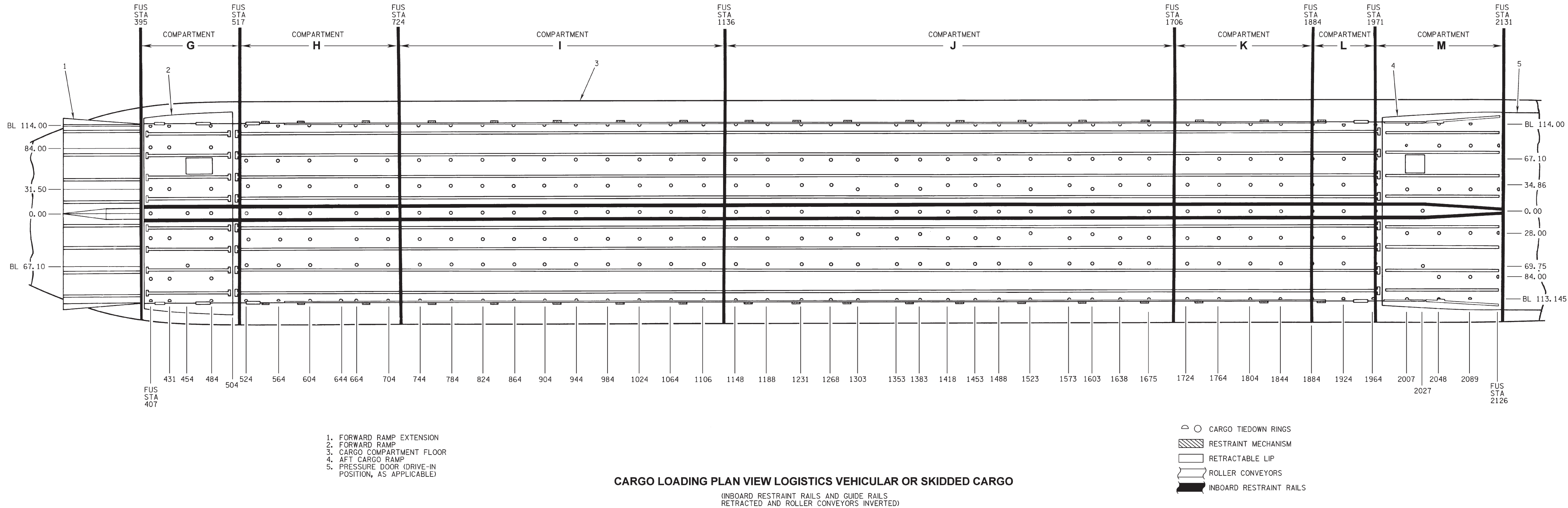


Figure 4-10. Cargo Loading Plan View (Sheet 2)

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SECTION II CHARTS AND GRAPHS

4.3 GEOMETRIC CONSIDERATIONS.

4.3.1 Cargo Size Limitations. (See Figure 2-1, Figure 2-9, Figure 2-10, Figure 2-49, Figure 4-10, and Figure 4-19 .) The cargo size is limited only by the internal dimensions of the cargo compartment and the clearance at its forward and aft openings as shown in Figure 2-49. Cargo size and shape shall be within the shape and dimensions in Figure 2-9, Figure 2-10, and Figure 2-49. These dimensions must be considered when loading long items of cargo such as missiles, trucks, and trailers from the ground with the airplane in the drive-in loading position. Due to the ramp and the ramp extension angles, the overall unit length and the unit height are factors that must be observed carefully during on/off loading operations. If the forward or the aft overhang is great, care must be taken to prevent contact with the ground or the compartment overhead structure. Ground clearance beneath the vehicle is an additional problem because, if the wheelbase is such that the middle of the load might contact the ramp crest, either the forward or the aft end of the load must be raised as it is loaded on the airplane.

4.3.2 Cargo Weight Loading Envelope. Observing the limits of the cargo weight loading envelope will ensure that the airplane center-of-gravity limits are safe, provided the standard fuel procedures are followed.

4.3.3 Forward Loading Area Clearance Limits. (See Figure 2-1 and Figure 2-49.) With the airplane in the level or forward kneeled position, the visor door open, and the forward cargo ramp, the forward ramp extension, and toes deployed to the truck loading or drive-in loading position, a clear opening of 162 inches high and 228 inches wide tapering at a height of 114 inches to 156 inches wide (78 inches either side of the airplane centerline), is provided for on/off loading of cargo. With the ramp and extension deployed for drive-in loading, the loading clearance will be the same with some restrictions imposed by the crest between the ramp and the cargo compartment floor. These restrictions occur primarily on very large items of cargo.

4.3.4 Aft Loading Area Clearance Limits. (See Figure 2-1 and Figure 2-49.) The aft loading clearance limits are governed by the restrictions imposed by the position of the pressure door, the aft center cargo door, and the loading position of the aft cargo ramp, and the kneeled position of the airplane.

4.3.4.1 With the airplane in the forward kneel, level kneel, or the aft kneel position, and the pressure door, the aft center cargo door, and the aft cargo ramp deployed to the truck loading position, a clear opening of 114 inches high and 228 inches wide is provided for on/off loading of cargo.

4.3.4.2 In the level kneel or forward kneel position with the aft center cargo door, the aft cargo ramp, and the pressure door and toes deployed for drive-in loading, a clear opening 161 inches high and 228 inches wide and tapering in at a height of 114 inches to 156 inches wide (78 inches either side of the airplane centerline), is provided for on/off loading of cargo.

4.3.4.3 With the airplane in the aft kneel position, and the center cargo door, the aft cargo ramp, and the pressure door deployed for drive-in loading, a clear opening of 153 inches high and 228 inches wide, tapering in at a height of 114 inches to 156 inches wide (78 inches either side of the airplane centerline), is provided for on/off loading of cargo. When possible, load large items of cargo straight into the cargo compartment with the cargo ramp in the truck loading position.

4.3.4.4 Refer to Figure 4-19 for allowable cargo height within the cargo compartment envelope.

4.3.5 Forward and Aft End Loading Vehicle Projection Limits. (See Figure 4-17.) Projection difficulties can be expected during on/off loading of vehicles with the forward or aft end of the airplane configured for drive-in loading. This could be a greater problem when the critical dimension on the vehicle is greater than the, as applicable, combined length of the forward ramp and extension or, the aft ramp and pressure door (when it is used as the ramp extension). This could result in one set of wheels (of the critical dimension) reaching the cresting point between the ramp and the cargo floor before the other set of wheels (of the critical dimension) starts to move up, as applicable, the ramp extension, or the pressure door. Whether the vehicle can be safely on/off loaded is determined by the known height of the vehicle, the vehicle critical dimension, the known vehicle projection, the ramp angle, and the height of the ramp crest. In addition, vehicle overhang and ground clearance are other factors that affect vehicle on/off loading.

4.3.5.1 Figure 4-17 includes example problems showing how to determine if a vehicle can be on/off loaded with the airplane configured for drive-in loading. These same procedures can be used to determine the loadability of any other vehicle.

4.3.6 Vehicle Critical Dimensions. (See Figure 4-15.) The referenced figure shows the dimensions on vehicles that are critical during on/off loading. Each of these dimensions will have some effect either during the actual loading or unloading

operations or, when positioning the vehicle in the airplane near the forward or aft ramp areas. The ground clearance, vehicle height, and the vehicle critical dimension will be the dimension that will affect on/off loading. The front and rear overhang on the vehicle will be the dimensions that will affect load overhang when positioning the vehicle at the forward or aft ramp areas.

4.3.7 Ramp Crest Heights. (See Figure 4-18.) The referenced figure shows the forward and aft ramp crest height for each of the kneeled positions with the airplane configured for drive-in loading. These dimensions are critical during on/offloading of vehicles.

4.3.8 Ramp Crest Limits. (See Figure 4-18.) Vehicles with a long wheelbase and low ground clearance may drag across the ramp crest when loading from the drive-in loading position with the airplane in the forward kneeled or level kneeled positions for the forward loading area, or the forward kneeled, level kneeled, and aft kneeled positions for the aft loading area. The clearance available will depend on three factors: vehicle wheelbase, vehicle ground clearance, and cargo compartment floor height at the ramp crest.

4.3.8.1 An example ramp crest problem and procedure for using the graph is included in the referenced figure to enable the loadmaster in determining if a vehicle can be on/off loaded into and from the airplane with the forward ramp and ramp extension in the drive-in loading position, and the airplane forward or level kneeled.

4.3.9 Parking Overhang Clearance Limits. (See Figure 4-13.) To make maximum use of the available space in the cargo compartment, it is sometimes necessary to park a vehicle with its wheels at the forward or the aft edge of the cargo compartment floor. This will result in a portion of the vehicle projecting into the area of the ramp.

4.3.9.1 This projection is permissible if the overhang does not extend so far forward or aft that it will contact the ramp when the ramp is closed. The referenced figures show the maximum overhang that will clear the ramps when the forward or the aft wheel of the vehicle is placed at the ramp hinge center, which is at FS 511 for the forward ramp and at FS 1976 for the aft ramp.

4.3.9.2 An example parking overhang problem and the procedures for using the graph are included in the referenced figure to enable the loadmaster in determining the permissible parking overhang for a particular vehicle at the forward and aft ramp areas.

4.3.10 Loading Overhang Limits. (See Figure 4-16.) Vehicles which have structures extending long distances past the front or rear axles may have difficulty in on/off loading up or down the ramp with the forward ramp in the drive-in loading position and the airplane forward, or level kneeled. The same difficulty will be encountered with the aft ramp and pressure door in the drive-in position and the airplane forward, level, or aft kneeled. This is especially critical on vehicles with a low ground clearance.

NOTE

Since vehicles may be backed into the cargo compartment to facilitate offloading, the location of the overhang in determining clearance limits is referred to as being on the forward or the aft end of the vehicle.

4.3.10.1 When the vehicle is driven in, long overhang on the forward end of the vehicle causes the vehicle to run into the ramp before the wheels lift it up. Long overhang on the aft end of the vehicle causes the vehicle to drag on the ground when the forward end rises as it goes up the ramp.

4.3.10.2 An example loading overhang problem and the procedures for using the graph are included in the referenced figure to enable the loadmaster to determine the permissible overhang limit without angle adjustment.

4.3.11 Cargo Compartment Plan View. (See Figure 4-10.) The scale drawing on the plan view shows the tiedown rings available for the tiedown devices after the cargo unit is loaded into position on the cargo floor.

4.4 STRUCTURAL CONSIDERATIONS.

WARNING

Never exceed the limits of this section.

4.4.1 Cargo Weight Limitations. The weight of the cargo that can be carried in the airplane is limited to the cargo floor limits and permissible compartment loads that are covered in Paragraph 4.4.2. Table 4-3 and Figure 4-12, show the maximum weight which can be loaded and carried forward or aft of a given fuselage station in any 40-inch length of the cargo compartment floor. Information supplied in Paragraph 4.4.2 including Table 4-3 and Figure 4-12 shall be used for proper load distribution.

- 4.4.2 Cargo Floor Loading Limitations. Comply with the following as applicable, before attempting any loading:
- a. Ensure the center of gravity limits of the airplane are not exceeded.
 - b. Load may be made up of a single axle, two or more axles, a combination of axles and cargo, or all cargo.
 - c. The floor contact loading must meet the requirements of Figure 4-11; Figure 4-21 through Figure 4-26; and TO 1C-5M-5-2, Figure 2-10 and Figure 2-11.
 - d. The lateral location of the load shall meet the requirements of Figure 4-14.
 - e. Table 4-3 and Figure 4-12 show the maximum cargo weight which can be loaded at certain fuselage stations.

Table 4-3. Cargo Floor Loading Limitations

Fuselage Stations	Floor Limit
395 to 517 Compartment G	Maximum allowable load 3,600 pounds in any 20-inch length of ramp.
	Maximum single pallet weight on ramp is 7,500 pounds in the logistics rail system.
	Maximum allowable load 15,000 pounds total weight.
517 to 724 Compartment H	Maximum allowable load 20,000 pounds in any 40-inch length of cargo floor.
724 to 1884 Compartments I, J, & K	Maximum allowable load 36,000 pounds in any 40-inch length of cargo floor.
1458 to 1518 Compartment J	CAUTION Side-by-side, multiple wheeled vehicle axles and concentrated cargo loaded between FS 1458 and FS 1518 are limited to a combined maximum weight of 25,000 pounds. Tracked vehicles are excluded from this restriction.
1884 to 1971 Compartment L	Maximum allowable load 20,000 pounds in any 40-inch length of cargo floor.
1971 to 2131 Compartment M	Maximum allowable load 3,600 pounds in any 20-inch length of ramp.
	Maximum single pallet weight on ramp is 7,500 pounds in the logistics rail system.
	Maximum allowable load 15,000 pounds total weight.

4.4.2.1 Forward and Aft Cargo Ramp On/Off Loading Limitations. (See Table 4-3, Figure 4-12, and Figure 4-11.) The referenced table and figures show the maximum cargo weight which can be loaded and carried in any 20-inch length of the forward and aft ramp floor. Figure 4-11 shows the on/off loading limitations across the forward and aft cargo ramps.

4.4.3 Cargo Maximum Allowable Lateral CG Location. (See Figure 4-14.) The referenced figure provides a means of determining the proper lateral positioning of cargo within the lateral loading limits of the airplane. The figure should be used as a load planning method by the loadmaster to determine the lateral placement of cargo on the cargo compartment floor and the forward and aft ramp floors. An example problem is included in this figure.

4.4.4 Concentrated Floor Loads. The allowable concentrated floor loads are dependent on the size, shape, and type of material which make up the floor contact area. These limitations are in addition to the overall limitations in Paragraph 4.4.2, Table 4-3, and Figure 4-12. Floor contact materials fall into two general categories, rubber and non-rubber.

4.4.4.1 Concentrated Floor Loads – Rubber Contact Area. (See Figure 4-22 and Figure 4-24 through Figure 4-26.) The referenced figure gives the allowable loads for rubber contact surfaces. This category of cargo includes rubber tires, rubber treads on tracked vehicles, and any other cargo which makes contact with the cargo floor through rubber pads.

4.4.4.2 Concentrated Floor Loads – Non-Rubber Contact Area. (See Figure 4-21.) The referenced figure gives the allowable loads for non-rubber contact surfaces. This category of cargo includes boxes, crates, skidded loads, and any other cargo which makes contact with the cargo floor through non-rubber pads.

4.4.5 Hard Rubber or Steel Wheel Maximum Allowable Floor Loads. (See Figure 4-22.) The referenced figure gives the allowable cargo floor load limits for various widths of steel wheels and hard rubber tires. It also shows an example problem and plot-out instructions for using the graph.

4.4.6 Maximum Allowable Floor Loads for Vehicles with Tracked Pads. (See Figure 4-26.) The referenced figure gives the description and the allowable load for several known track pads. In addition, the referenced figure also gives an example problem for calculating the effects of a concentrated load such as a track pad on the cargo floor to determine if it is safe to load the vehicle.

4.4.7 Maximum Allowable Floor Loads for Concentrated Cargo Located Over Restricted Areas.



Side-by-side, multiple wheeled vehicle axles and concentrated cargo loaded between FS 1458 and FS 1518 are limited to a combined maximum weight of 25,000 pounds. Tracked vehicles are excluded from this restriction.

Figure 4-23 shows the areas of the cargo floor that must be considered before loading highly concentrated cargo loads. Heavy loads with a small contact area should not be placed directly on these areas without the use of shoring to spread the load over a larger area. Structural failure could occur if these instructions are not followed.

4.4.8 On/Off Loading Maximum Allowable Loads. (See Figure 4-25.)

4.5 SHORING REQUIREMENTS.

All dimensions for required shoring listed throughout this manual are actual size, and are represented as L × W × Ht or T, unless otherwise stated. Commercial size lumber may not satisfy this requirement (e.g., a commercial 2×4 only measures 1-5/8×3-5/8-inches). A 3/4-inch thick plywood panel weighs approximately 2 pounds per square foot of area. The approximate weight, in Pounds per Linear Foot (PLF), of plank shoring may be computed using the following formula:

$$\frac{\text{thickness} \times \text{width}}{4} = \text{PLF}$$

4.5.1 Types of Shoring. There are different shoring requirements that may be needed for loading and carrying concentrated cargo loads. These are parking shoring and rolling shoring. Each has its own specific function: parking shoring for spreading load concentration over a larger area of the floor, rolling shoring for protecting the ramp and cargo floor during loading of vehicles and skidded cargo. Wood planking, plywood, and metal honeycomb materials are used for shoring. The

overall size and thickness of the shoring will depend on its function and the direct contact area of the cargo with the cargo floor.

NOTE

The minimum thickness of shoring shall be 1/2-inch for all applications.

4.5.2 Shoring for Weight Distribution. Shoring is primarily used between the contact area of a highly concentrated cargo load and the cargo floor to spread the load concentration over a larger area of the cargo floor or pallet. Using shoring permits carrying a load with a higher concentration than would normally be allowed. Use of shoring can make the difference between carrying a given cargo load and not carrying this load. The effectiveness of shoring, however, should not be exaggerated.

4.5.2.1 The weight of the load is not spread evenly over the entire area of contact between the shoring and the surface on which the shoring is resting. The area of weight spread will be a great deal less than the area of shoring the surface contact. In general, shoring will only increase the area over which a load is distributed to whatever area is encompassed by extending a plane drawn downward and outward from the peripheral line of contact of the load, at an angle of 45 degrees, until it intersects the surface on which the shoring rests.

4.5.2.2 The effect of this geometric estimation is illustrated in Figure 4-27. Assume that the plank is 2 inches thick and the box is 12 inches long $\times$ 6 inches wide. The area of the contact between the box and the plank will be 6×12 inches, or 72 square inches. Now, extend imaginary lines downward and outward from the edges of the bottom of the box at angles of 45 degrees. Where these imaginary lines intersect the cargo floor, the area of contact will be 10×16 inches, or 160 square inches. In this particular case, the area of contact has been more than doubled, but the increase will not always be so proportionately increased. What has happened in this instance is that the area over which the load was distributed has been enlarged by the addition of a border 2 inches wide all around the contact area between the box and the shoring.

4.5.2.3 The direct proportion between the width of the border and the thickness of the shoring is generally applicable to all shoring. Since the addition of the area occurs only around the edge of the area of contact, the larger the object shored, the smaller the proportion of contact area. Shoring 2 inches thick under a box 12 inches square will increase the contact area 77 percent by adding 112 square inches of contact to the original 144 square inches of contact.

4.5.2.4 The spreading effect of simple shoring is the same regardless of the shape of the contact area. Figure 4-27 also shows the footprint of a wheel with a pneumatic tire resting on the plank. The plank shoring enlarges the weight distribution of the footprint by the same directly proportionate shoring-thickness to area-increase rule, there by adding a 2-inch border. Assuming the original footprint to be 25 square inches, a 2-inch border would spread the load over an area of 75 square inches.

4.5.2.5 Figure 4-24 illustrates how to determine the floor load that a vehicle equipped with pneumatic tires will exert on the cargo floor.

4.5.3 Rolling Shoring.

NOTE

If parking shoring is required, then rolling shoring may or may not be required for on/off loading (see Figure 4-25).

Rolling shoring is primarily used to protect the ramp and ramp extension and the cargo compartment floors from damage when vehicles with wheels or tracks are on/off loaded. It shall also be used for the same protection when on/off loading skidded cargo.

4.5.3.1 Vehicles with cleats, studs, or other gripping devices with which metallic wheels or tracks may be equipped, require rolling shoring. Cleated or lugged wheels will damage the supporting structure because the weight of the vehicle is carried on the cleats and lugs and therefore concentrated on a very small surface of the floor. Vehicles with cleats or lugs shall have shoring thick enough for the cleats or lugs to sink into without contacting the cargo floor.

4.5.3.2 Steel wheels provide only a small supporting area. Slight flexibility of both the floor and the wheel makes the contact a ribbon rather than a line, but the weight on a steel wheel is still concentrated. Solid rubber tires also often concentrate the load over a very small area. Ensure the allowable floor load limitations in Figure 4-22 are not exceeded.

4.5.4 Pedestal Shoring. Pedestal shoring may be used under the forward loading complex during on/off loading. Shoring shall be placed under all ramp support pads, ramp extension support jacks and ramp toes. Shoring placed under the ramp toes shall support the entire width of the supported toe or toes and must extend at least 11 inches back from the leading edge of the toe.

NOTE

Operations with 3 adjacent ramp extension jacks and/or support pads is approved (see Figure 4-11).

4.5.5 Parking Shoring. Parking shoring is that required under vehicles aboard the airplane during flight. A vehicle that requires rolling shoring also requires parking shoring. Rolling shoring requirements related to lugged, cleated, steel, and hard rubber wheeled vehicles also apply to parking shoring. When rolling shoring is used, it can be used as part of the parking shoring under the vehicle.

4.5.6 Sleeper Shoring. Sleeper shoring is used to prevent movement of a vehicle due to gust load conditions, where the tires or suspension system cannot withstand g-loads without failure to depression producing slack in tiedown devices. This can cause a whipping action on the tiedown device with potential failure. A tire failure could result in the wheel rim contacting the airplane floor and causing damage to the airplane. This type of shoring is placed between the airplane floor and a structural part of the vehicle such as the frame or axles. It can also be used between various parts of equipment that are spring-mounted to prevent their movement during flight.

NOTE

When sleeper shoring is required under a vehicle and the shoring is built up so that shoring is snug against the underside of the vehicle, parking shoring under the wheels of the vehicle is not required. Rolling shoring requirements must be calculated.

4.5.7 Calculation of Required Shoring for Concentrated Cargo Loads. (See Figure 4-21.) To calculate the shoring required for concentrated cargo loads, follow the procedures in the referenced figure. This figure includes an example problem for a concentrated load.

4.5.7.1 Airdrop platforms are limited by their length as the allowable load they can carry. Table 4-4 lists the airdrop platform allowable uniform load limits.

Table 4-4. Airdrop Platform Allowable Limits in Logistic Rails

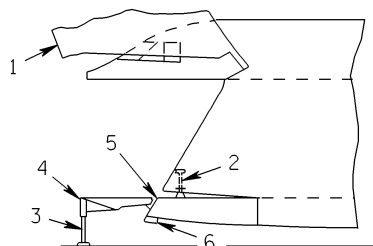
Platform Length	Gross Weight	Minimum No.
8 ft	10,000 lb	1
12 ft	16,250 lb	2
16 ft	22,500 lb	3
20 ft	28,750 lb	3
24 ft	35,000 lb	4
28 ft	41,250 lb	4

4.6 ROLLER CONVEYOR LIMITS.

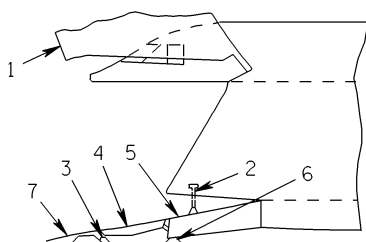
(See Figure 4-20.)

CAUTION

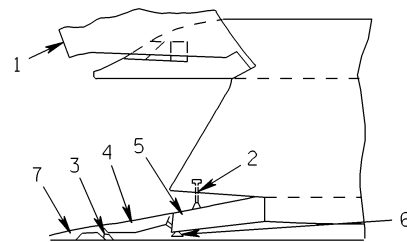
SHORING SHALL BE USED UNDER ALL THE RAMP EXTENSION SUPPORT JACKS AND RAMP SUPPORT PADS WHEN NECESSARY TO ENSURE PROPER CONTACT WITH THE GROUND DURING ON/OFF LOADING OPERATIONS. FAILURE TO COMPLY COULD RESULT IN DAMAGE TO THE RAMP EXTENSION ACTUATORS AND RAMP EXTENSION AND/OR RAMP STRUCTURE.



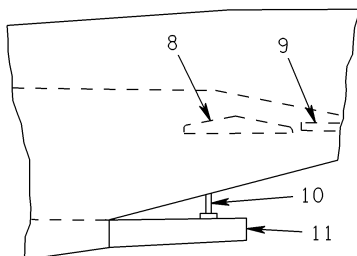
**TRUCK LOADING POSITION
RAMP ACTUATOR SUPPORTED** ①



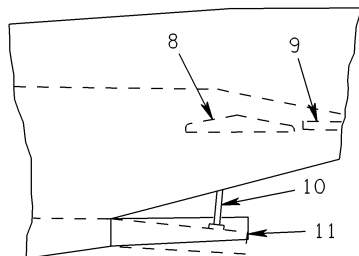
**DRIVE-IN LOADING POSITION
RAMP GROUND SUPPORTED** ②



**DRIVE-IN LOADING POSITION
RAMP ACTUATOR SUPPORTED** ②

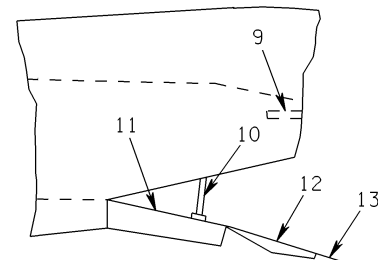


**TRUCK LOADING POSITION
RAMP ACTUATOR SUPPORTED** ③

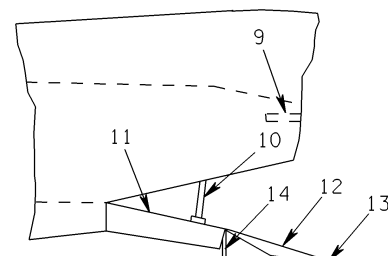


**TRUCK LOADING POSITION
RAMP ACTUATOR SUPPORTED** ④

1. VISOR
2. RAMP ACTUATOR
3. FORWARD RAMP EXTENSION JACKS
4. FORWARD RAMP EXTENSION
5. FORWARD RAMP
6. FORWARD RAMP GROUND SUPPORT PADS
7. FORWARD RAMP EXTENSION TOES
8. PRESSURE DOOR (OVERHEAD POSITION)
9. CENTER CARGO DOOR (OVERHEAD POSITION)
10. RAMP ACTUATOR
11. AFT RAMP
12. PRESSURE DOOR (RAMP EXTENSION POSITION)
13. PRESSURE DOOR TOES
14. AFT RAMP SUPPORT PADS



**DRIVE-IN LOADING POSITION
RAMP ACTUATOR SUPPORTED** ④



**DRIVE-IN LOADING POSITION
RAMP GROUND SUPPORTED** ⑤ ⑥

NOTE

- ① THE LIMITS IN THIS FIGURE ARE BASED ON LOADS MOVING ACROSS THE RAMP AND RAMP EXTENSION DURING ON/OFF LOADING OPERATIONS IN TRUCK LOADING POSITION.
- ② THE LIMITS IN THIS FIGURE ARE BASED ON LOADS MOVING ACROSS THE RAMP AND RAMP EXTENSION DURING ON/OFF LOADING OPERATIONS IN DRIVE-IN LOADING POSITION.
- ③ THE LIMITS IN THIS FIGURE ARE BASED ON LOADS MOVING ACROSS THE RAMP DURING ON/OFF LOADING OPERATIONS IN THE TRUCK LOADING POSITION WITH THE RAMP LEVEL WITH CARGO COMPARTMENT FLOOR.
- ④ THE LIMITS IN THIS FIGURE ARE BASED ON LOADS MOVING ACROSS THE RAMP DURING ON/OFF LOADING OPERATIONS IN THE TRUCK (WITH RAMP ADJUSTED BELOW LEVEL OF CARGO FLOOR) AND DRIVE-IN LOADING POSITIONS.
- ⑤ AFT RAMP SUPPORT PADS MUST BE DEPLOYED CONTACTING GROUND AND SUPPORTING RAMP. SHORING MAY BE USED UNDER PADS TO ACHIEVE THIS REQUIREMENT.
- ⑥ THE LIMITS IN THIS FIGURE ARE BASED ON LOADS MOVING ACROSS THE RAMP DURING ON/OFF LOADING OPERATIONS IN THE DRIVE-IN LOADING POSITION.

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Figure 4-11. Forward and Aft Cargo Ramp On/Off Loading Limitations (Sheet 1 of 2)

CAUTION

NO LOADING PERMITTED ACROSS THE FORWARD RAMP AND OR RAMP EXTENSION IN AFT KNEEL. FAILURE TO COMPLY COULD RESULT IN DAMAGE TO THE AIRPLANE.

RAMP	CONFIGURATION		RAMP GROUND SUPPORTED	RAMP ACTUATOR SUPPORTED
F O R W A R D	TRUCK BED	ALL RAMP EXTENSION JACKS	1 A E	
		2 OUTBOARD AND 1 INBOARD CAUTION	2 3	
		3 ADJ RAMP EXT JACKS	2 4 5 D	
	DRIVE-IN	ALL RAMP EXTENSION JACKS	6 E	A E
		2 OUTBOARD AND 1 INBOARD	PROHIBITED	
		3 ADJ RAMP EXT JACKS CAUTION	4 D	
		3 ADJACENT SUPPORT PADS	4 B F	A E
A F T	TRUCK BED		1 A E	
	DRIVE-IN	NORMAL	C E	A E

NOTE

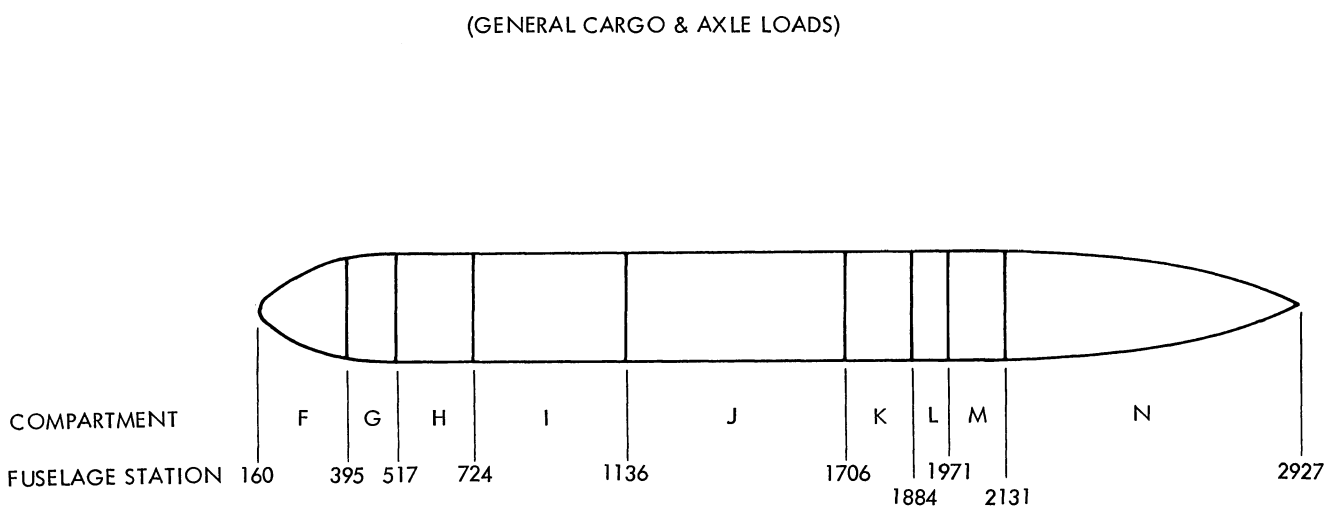
ALL LIMITS BASED ON LOADS MOVING ACROSS THE RAMP DURING ON/OFF LOADING OPERATIONS.

LIMITATIONS:

- ONE 50,000-POUND PLATFORM. TWO 40,000-POUND PLATFORMS SIDE-BY-SIDE.
 - 10,000-POUND PALLETS IN THE LOGISTICS RAIL SYSTEM.
 - 10,000-POUND PLATFORMS IN THE ADS RAIL SYSTEM.
 - ON/OFF LOAD ON SUPPORTED SIDE ONLY.
 - ADS LOADING PROHIBITED.
 - MAXIMUM TRACKED VEHICLE WEIGHT IS 129,000 POUNDS. TRACKED VEHICLES OVER 112,000 POUNDS SHALL BE LOADED WITH CG AT BL 0 (± 7 INCHES).
-
- MAXIMUM TRACKED VEHICLE WEIGHT IS 85,000 POUNDS. TRACKED VEHICLES OVER 62,000 POUNDS SHALL BE LOADED WITH CG AT BL 0 (± 7 INCHES).
 - CENTERLINE ON/OFF LOADING PROHIBITED.
 - MAXIMUM TRACKED VEHICLE WEIGHT IS 112,000 POUNDS.
 - VEHICLE AXLES OVER 25,000 POUNDS ARE PROHIBITED. 25,000-POUND AXLE VEHICLES AND TRACKED VEHICLES UP TO 62,000 POUNDS SHALL BE ON/OFF LOADED BETWEEN BL 30 ON THE SIDE WITH ONE SUPPORT JACK TO BL 114 ON THE SIDE WITH TWO SUPPORT JACKS.
 - VEHICLE AXLES OVER 25,000 POUNDS SHALL BE LOADED WITH CG AT BL 0 (± 7 INCHES). TWO 25,000-POUND AXLES IN TANDEM. ONE 36,000-POUND AXLE.
 - 25,000-POUND AXLE VEHICLES AND TRACK VEHICLES UP TO 112,000 POUNDS SHALL BE ON/OFF LOADED BETWEEN BL 30 ON THE SIDE WITH ONE SUPPORT JACK TO BL 114 ON THE SIDE WITH TWO SUPPORT JACKS.

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Figure 4-11. Forward and Aft Cargo Ramp On/Off Loading Limitations (Sheet 2)



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Figure 4-12. Cargo Floor Loading Diagram

PROCEDURES FOR CALCULATING PERMISSIBLE PARKING OVERHANG

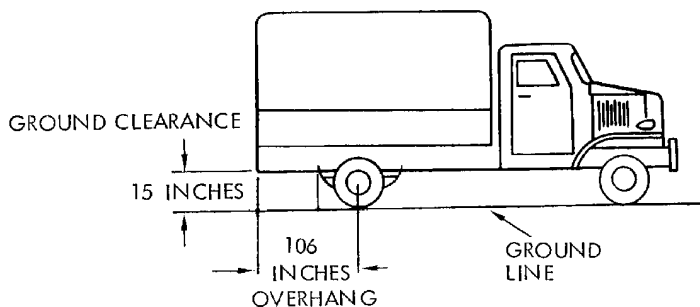
THE GRAPH IN THIS FIGURE PROVIDES A QUICK MEANS OF DETERMINING THE MAXIMUM PERMISSIBLE OVERHANG AT THE FORWARD AND AFT RAMP WITH THE RAMP'S CLOSED.

TO USE THE GRAPH TO DETERMINE THE PERMISSIBLE PARKING OVERHANG FORWARD OF THE FORWARD RAMP HINGE CENTERLINE OR, THE PERMISSIBLE OVERHANG AFT OF THE AFT RAMP HINGE CENTERLINE, PROCEED AS FOLLOWS:

1. LOCATE THE VEHICLE KNOWN GROUND CLEARANCE ON LEFT SCALE (VEHICLE GROUND CLEARANCE-INCHES) OF GRAPH.
2. MOVE RIGHT ACROSS THE GRAPH FROM LEFT SCALE (VEHICLE GROUND CLEARANCE-INCHES) TO THE INTERSECTION POINT WITH CURVE.
3. MOVE DOWN FROM INTERSECTION POINT WITH CURVE TO BOTTOM SCALE (PERMISSIBLE OVERHANG FORWARD OF FUS STA 517-FORWARD RAMP-INCHES/PERMISSIBLE OVERHANG AFT OF FUS STA 1971-AFT RAMP-INCHES AND TAKE A READING AT THIS POINT (AS APPLICABLE FOR THE FORWARD RAMP OR THE AFT RAMP).
4. THE READING OBTAINED IN STEP 3, IS THE MAXIMUM PERMISSIBLE OVERHANG POSSIBLE WITH THE VEHICLE WHEELS POSITIONED AT FUSELAGE STATION 517 (FOR FORWARD RAMP) OR, WITH THE VEHICLE WHEELS POSITIONED AT FUSELAGE STATION 1971 (FOR AFT RAMP).
5. IF THE KNOWN VEHICLE OVERHANG IS GREATER THAN THE PERMISSIBLE OVERHANG READING OBTAINED IN STEP 3, STEP 6 MUST BE COMPLETED TO CALCULATE THE DISTANCE IN INCHES THAT THE VEHICLE MUST BE POSITIONED WITH ITS WHEELS, AS APPLICABLE, AFT OF FUSELAGE STATION 517 OR FORWARD OF FUSELAGE STATION 1971.
6. SUBTRACT THE PERMISSIBLE OVERHANG READING (OBTAINED IN STEP 3) FROM THE VEHICLE KNOWN OVERHANG. THE RESULT IS THE DISTANCE IN INCHES THE VEHICLE MUST BE POSITIONED WITH ITS WHEELS AFT OF FUSELAGE STATION 517 (FOR FORWARD RAMP) OR, FORWARD OF FUSELAGE STATION 1971 (FOR AFT RAMP).

EXAMPLE PROBLEM:

DETERMINE THE MAXIMUM PERMISSIBLE VEHICLE OVERHANG AT THE AFT RAMP FOR A VEHICLE WITH A KNOWN OVERHANG OF 106 INCHES AND A KNOWN GROUND CLEARANCE OF 15 INCHES AT THE OVERHANG.



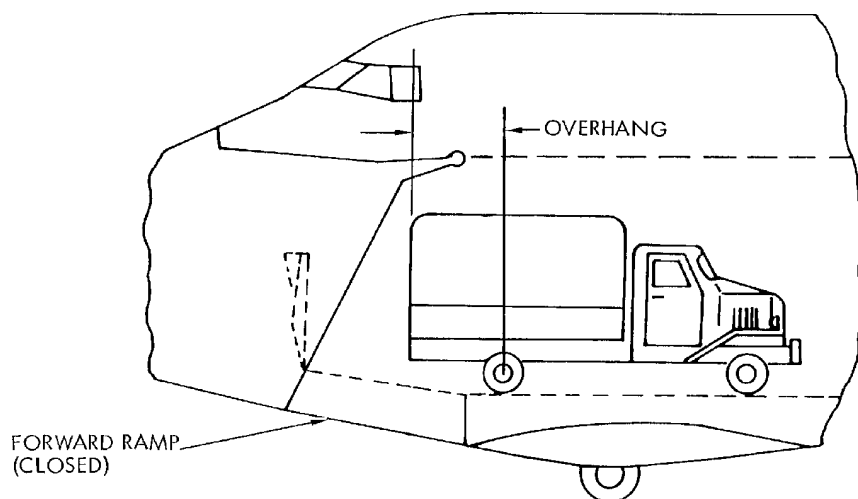
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Figure 4-13. Parking Overhang Clearance Limits (Sheet 1 of 3)

TO DETERMINE THE MAXIMUM PERMISSIBLE OVERHANG FOR THE EXAMPLE VEHICLE, PROCEED AS FOLLOWS:

1. LOCATE THE VEHICLE KNOWN GROUND CLEARANCE OF 15 INCHES ON LEFT SCALE (VEHICLE GROUND CLEARANCE-INCHES) OF GRAPH.
2. MOVE RIGHT ACROSS THE GRAPH FROM LEFT SCALE (VEHICLE GROUND CLEARANCE-INCHES) TO THE INTERSECTION POINT WITH CURVE.
3. MOVE DOWN ON GRAPH FROM INTERSECTION POINT WITH CURVE TO BOTTOM SCALE (PERMISSIBLE OVERHANG FORWARD OF FUS STA 517-FORWARD RAMP-INCHES/PERMISSIBLE OVERHANG AFT OF FUS STA 1971-AFT RAMP-INCHES) AND NOTE THE READING AT THIS POINT. THE READING FOR THE EXAMPLE VEHICLE IS 85 INCHES.
4. THE READING OF 85 INCHES (OBTAINED IN STEP 3) IS THE MAXIMUM PERMISSIBLE OVERHANG THAT IS POSSIBLE WITH THE EXAMPLE VEHICLE POSITIONED AT FUSELAGE STATION 1971.
5. THE EXAMPLE VEHICLE KNOWN OVERHANG OF 106 INCHES IS GREATER THAN THE MAXIMUM PERMISSIBLE OVERHANG OF 85 INCHES (OBTAINED IN STEP 3) FOR THE EXAMPLE VEHICLE, THEREFORE, STEP 6 MUST BE COMPLETED TO CALCULATE THE DISTANCE IN INCHES THAT THE VEHICLE MUST BE POSITIONED WITH ITS WHEELS FORWARD OF FUSELAGE STATION 1971.
6. SUBTRACT THE MAXIMUM PERMISSIBLE OVERHANG OF 85 INCHES (OBTAINED IN STEP 3) FROM EXAMPLE VEHICLE KNOWN OVERHANG OF 106 INCHES.

$$106 - 85 \text{ INCHES} = 21 \text{ INCHES} = \text{DISTANCE EXAMPLE VEHICLE MUST BE POSITIONED WITH ITS WHEELS FORWARD OF FUSELAGE STATION 1971, SO THAT VEHICLE WILL CLEAR AFT RAMP WITH RAMP CLOSED.}$$
7. POSITION EXAMPLE VEHICLE 21 INCHES FORWARD OF FUSELAGE STATION 1971 (AT FUSELAGE STATION 1950).

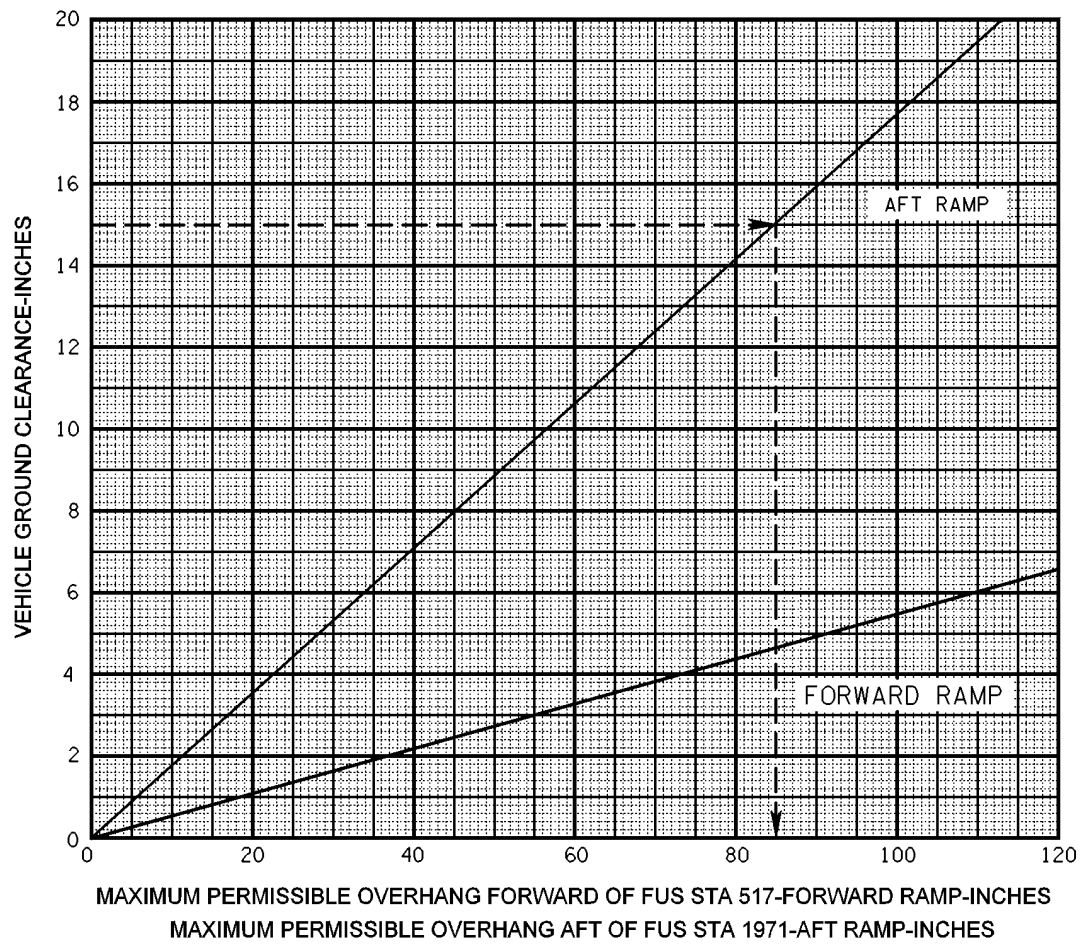
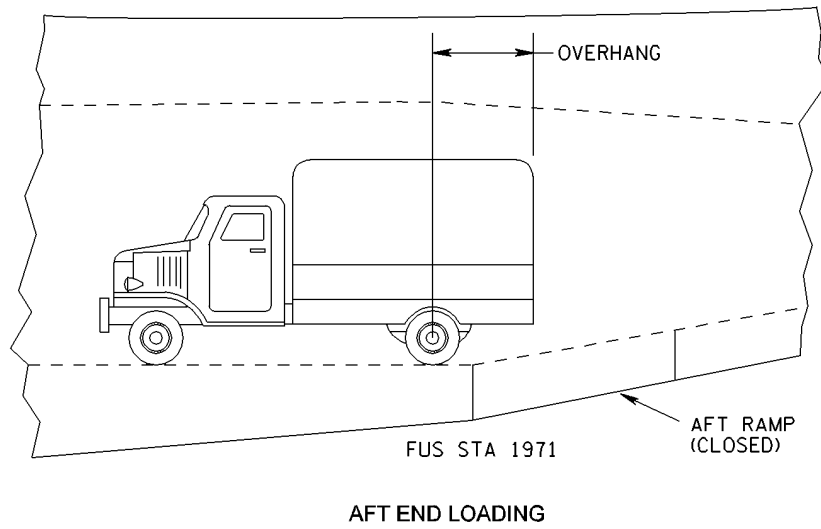


FUS STA 517

FORWARD END LOADING

L1115345

Figure 4-13. Parking Overhang Clearance Limits (Sheet 2)



L1115346

Figure 4-13. Parking Overhang Clearance Limits (Sheet 3)

PROCEDURE FOR DETERMINING CARGO MAXIMUM ALLOWABLE LATERAL CG LOCATION

NOTE

1. THE LOAD SHOWN IN THIS FIGURE IS THE TOTAL CARGO WEIGHT LOCATED IN ANY 40-INCH LENGTH OF CARGO FLOOR OR THE TOTAL CARGO WEIGHT LOCATED IN ANY 20-INCH LENGTH OF FORWARD OR AFT RAMPS.
2. THE CG LOCATION OF THE TOTAL LOAD MUST BE LOCATED Laterally WITHIN THE BUTT LINE LOCATIONS OF THE LATERAL LOADING LIMITS GRAPH.
3. ENSURE THE LOAD DOES NOT EXCEED THE CARGO FLOOR LIMITATIONS OF TABLE 4-3.
4. THE LATERAL LOADING LIMITS GRAPH SHALL BE USED TO DETERMINE THAT THE TOTAL CARGO/AXLE WEIGHT IS WITHIN THE MAXIMUM ALLOWABLE LATERAL CG LOCATION (BUTT LINE).

DETERMINE THE ACTUAL LATERAL CG LOCATION AS FOLLOWS:

USE THE FOLLOWING FORMULA TO DETERMINE THE ACTUAL LATERAL CG LOCATION (BUTT LINE).

$$\text{LATERAL CG} = \frac{(L_1 + L_2) W_2}{W_1 + W_2} - L_1$$

WHERE: L_1 = DISTANCE OF W_1 FROM BL 0

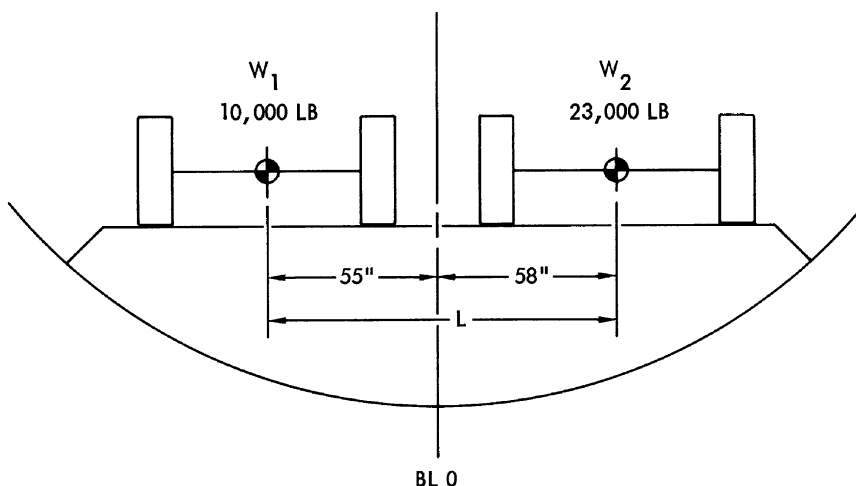
L_2 = DISTANCE OF W_2 FROM BL 0

W_1 = CARGO UNIT - LIGHTEST WEIGHT

W_2 = CARGO UNIT - HEAVIEST WEIGHT

EXAMPLE 1

DETERMINE ACTUAL LATERAL CG LOCATION (BUTT LINE) OF AXLES IN EXAMPLE 1 LOCATED IN A 40-INCH LENGTH OF CARGO FLOOR BETWEEN FS 724 AND FS 1884, AND IF THE LOAD IS ACCEPTABLE.



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Figure 4-14. Cargo Maximum Allowable Lateral CG Location (Sheet 1 of 3)

1. USE THE LATERAL CG FORMULA TO DETERMINE THE ACTUAL LATERAL CG LOCATION.

$$L_1 + L_2 = 55 + 58 = 113 \text{ INCHES}$$

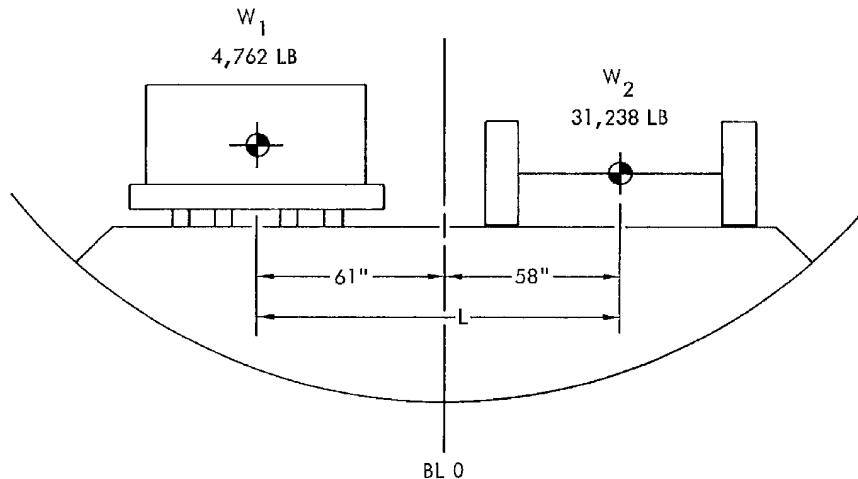
$$W_1 + W_2 = 10,000 + 23,000 = 33,000 \text{ POUNDS}$$

$$\begin{aligned} \text{LATERAL CG} &= \frac{(L_1 + L_2) W_2}{W_1 + W_2} - L_1 = \frac{(113) 23,000}{33,000} - 55 \\ &= \frac{2,599,000}{33,000} - 55 = 78.8 - 55.0 \\ &= 23.8 \text{ INCHES RIGHT OF BL 0} \end{aligned}$$

2. THE ALLOWABLE LATERAL CG LOCATION FROM THE LATERAL LOADING LIMITS GRAPH IS BL-58 LEFT OR RIGHT.
3. THE ACTUAL IS LESS THAN THE ALLOWABLE LATERAL CG THEREFORE, THE LOAD IS ACCEPTABLE.

EXAMPLE 2

DETERMINE ACTUAL LATERAL CG LOCATION (BUTT LINE) OF LOAD IN EXAMPLE 2 LOCATED IN A 40-INCH LENGTH OF CARGO FLOOR BETWEEN FUS. STA 724 AND FUS. STA. 1884 AND IS THE LOAD ACCEPTABLE.



NOTE

THE 463L PALLET LOAD SHOWN IS FOR A 40-INCH LENGTH OF A PALLET LOADED TO 10,000 LB. W_1 IS DETERMINED BY DIVIDING THE 40-INCH LENGTH INTO THE 84-INCH USEABLE PALLET LENGTH WHICH GIVES 2.1. 10,000 POUNDS IS DIVIDED BY 2.1 TO OBTAIN 4,762 POUNDS.

1. USE THE LATERAL CG FORMULA TO DETERMINE THE ACTUAL LATERAL CG LOCATION.

LATERAL CG LOCATION.

$$L_1 + L_2 = 61 + 58 = 119 \text{ INCHES}$$

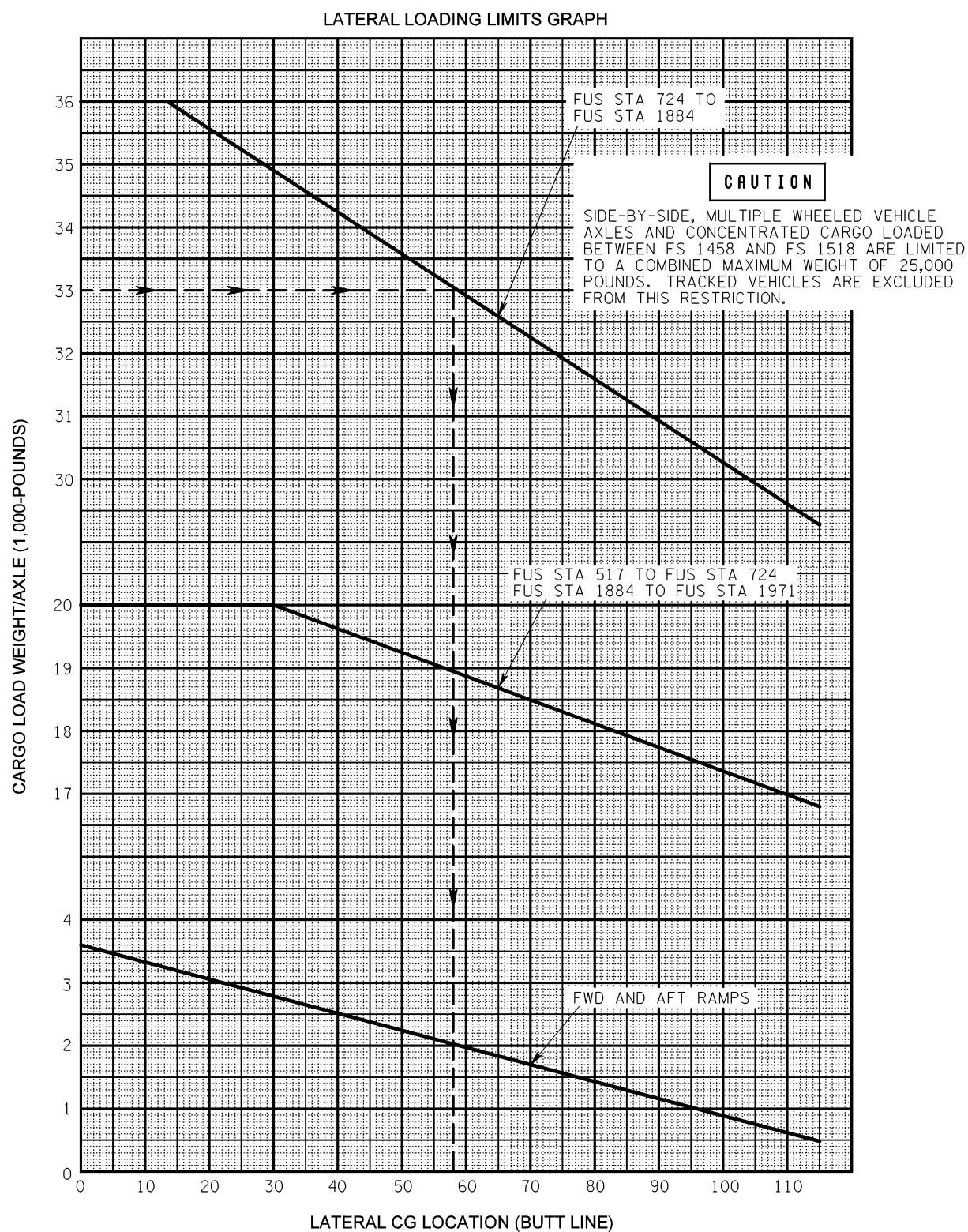
$$W_1 + W_2 = 4,762 + 31,238 = 36,000 \text{ POUNDS}$$

$$\begin{aligned} \text{LATERAL CG} &= \frac{(L_1 + L_2) W_2}{W_1 + W_2} - L_1 = \frac{(119) 31,238}{36,000} - 61 \\ &= \frac{3,717,322}{36,000} - 61 = 103.3 - 61.0 \\ &= 42.3 \text{ INCHES RIGHT OF BL 0.} \end{aligned}$$

2. THE ALLOWABLE LATERAL CG LOCATION FROM THE LATERAL LOADING LIMITS GRAPH IS BL 14 LEFT OR RIGHT.
3. THE ACTUAL IS GREATER THAN THE ALLOWABLE LATERAL CG THEREFORE, THE LOAD IS NOT ACCEPTABLE.

L1115348

Figure 4-14. Cargo Maximum Allowable Lateral CG Location (Sheet 2)

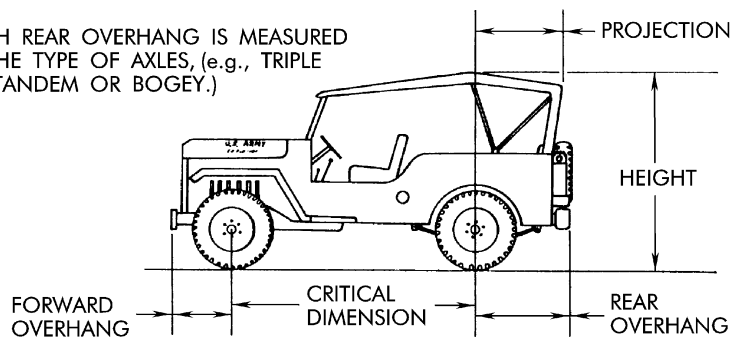
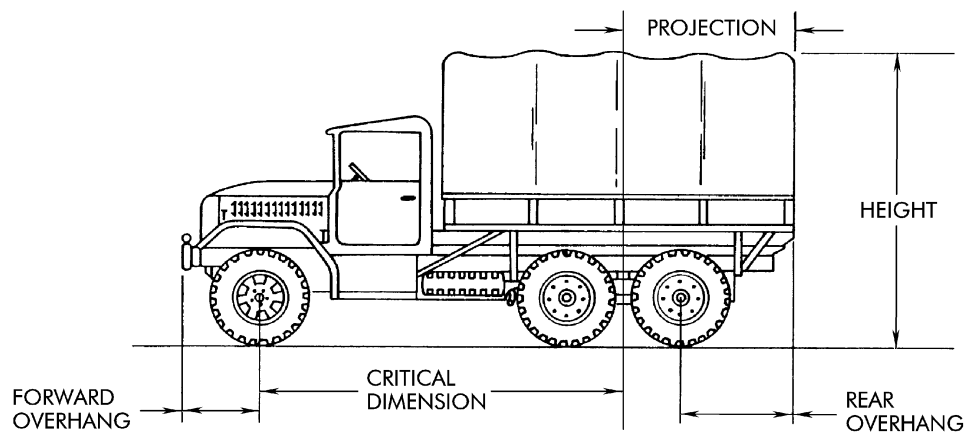
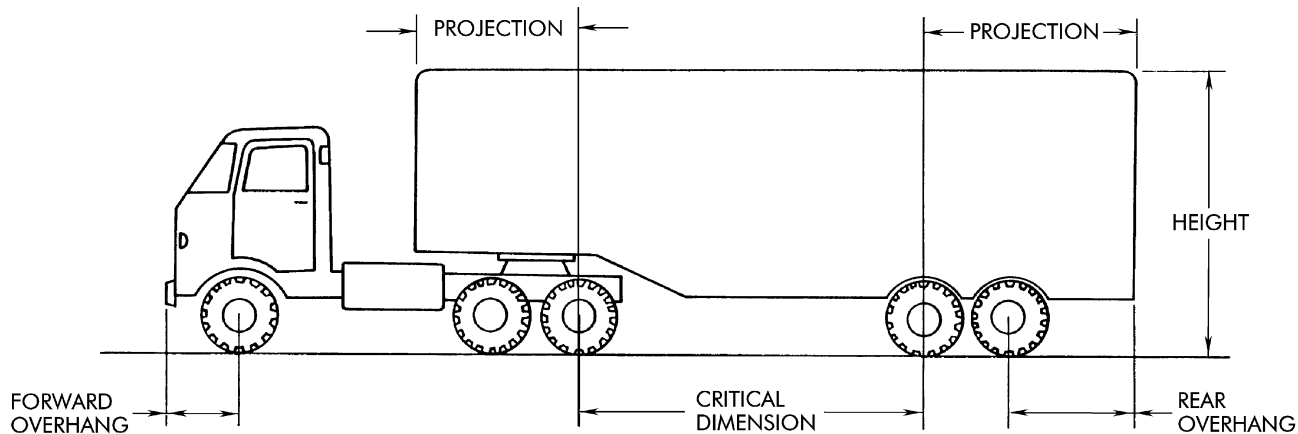


L1115349

Figure 4-14. Cargo Maximum Allowable Lateral CG Location (Sheet 3)

NOTE

THE AXLE FROM WHICH REAR OVERHANG IS MEASURED WILL DEPEND UPON THE TYPE OF AXLES, (e.g., TRIPLE ARTICULATING, DUAL TANDEM OR BOGEY.)

**SINGLE AXLE VEHICLE****BOGEY AXLE VEHICLE****TRACTOR-TRAILER
DUAL TANDEM**

L1115350

Figure 4-15. Vehicle Critical Dimensions

VEHICLE OVERHANG LIMITS - CALCULATION PROCEDURE FOR VEHICLE LOADING

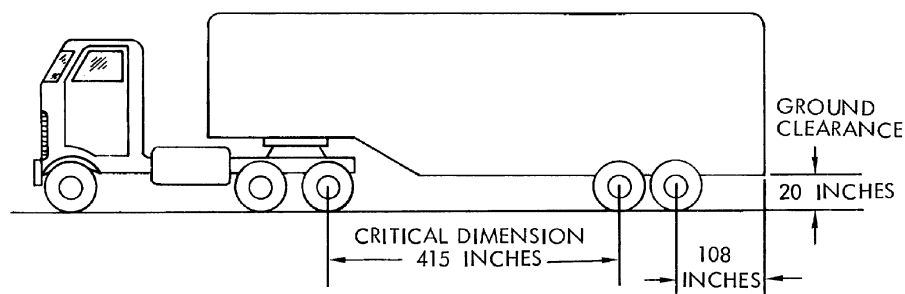
THE GRAPH IN THIS FIGURE PROVIDES A QUICK MEANS OF DETERMINING THE PERMISSIBLE OVERHANG OF VEHICLES (GROUND CONTACT LIMITATION) TO DETERMINE IF THE VEHICLES CAN BE SAFELY ON/OFF LOADED WITH THE AIRPLANE CONFIGURED FOR DRIVE-IN LOADING (WITHOUT THE VEHICLES DRAGGING ON THE GROUND OR THE RAMP) AND THE AIRPLANE FORWARD, LEVEL, OR AFT KNEELED.

TO USE THE GRAPH TO DETERMINE IF A VEHICLE CAN BE SAFELY ON/OFF LOADED, PROCEED AS FOLLOWS:

1. DETERMINE THE VEHICLE OVERHANG RATIO BY DIVIDING THE VEHICLE KNOWN GROUND CLEARANCE INTO THE VEHICLE KNOWN OVERHANG. THE RESULT IS THE VEHICLE OVERHANG RATIO.
2. LOCATE THE VEHICLE OVERHANG RATIO (OBTAINED IN STEP 1) ON THE LEFT SCALE (MAXIMUM OVERHANG RATIO) OF GRAPH.
3. LOCATE THE VEHICLE KNOWN CRITICAL DIMENSION ON BOTTOM SCALE (VEHICLE CRITICAL DIMENSION-INCHES) OF GRAPH.
4. SIMULTANEOUSLY MOVE RIGHT ACROSS THE GRAPH FROM LEFT SCALE (MAXIMUM OVERHANG RATIO) AND UP ON GRAPH FROM BOTTOM SCALE (VEHICLE CRITICAL DIMENSION-INCHES) TO THE INTERSECTION POINT FOR BOTH THESE VALUES.
5. LOAD THE VEHICLE AS INDICATED BY THE POSITION OF THE INTERSECTION POINT ON THE GRAPH AND THE RELATED LOADING INSTRUCTION NOTES ON THE GRAPH.

EXAMPLE PROBLEM:

DETERMINE IF A VEHICLE WITH A CRITICAL DIMENSION OF 415 INCHES, A GROUND CLEARANCE OF 20 INCHES AND AN OVERHANG OF 108 INCHES CAN BE SAFELY ON/OFF LOADED WITH THE AIRPLANE CONFIGURED FOR DRIVE-IN LOADING AND THE AIRPLANE IN THE FORWARD, LEVEL, OR AFT KNEELED POSITION.



L1115351

Figure 4-16. Forward and Aft Cargo Ramp Vehicle Overhang Limits (Sheet 1 of 4)

TO DETERMINE IF THE EXAMPLE VEHICLE CAN BE SAFELY ON/OFF LOADED PROCEED AS FOLLOWS:

1. DETERMINE THE VEHICLE MAXIMUM OVERHANG RATIO BY DIVIDING THE VEHICLE KNOWN GROUND CLEARANCE OF 20 INCHES INTO THE VEHICLE KNOWN OVERHANG OF 108 INCHES. THE RESULT IS THE VEHICLE MAXIMUM OVERHANG RATIO.

$$\frac{108 \text{ INCHES}}{20 \text{ INCHES}} = 5.4 = \text{VEHICLE MAXIMUM OVERHANG RATIO}$$

2. LOCATE THE VEHICLE MAXIMUM OVERHANG RATIO OF 5.4 ON LEFT SCALE (VEHICLE MAXIMUM OVERHANG RATIO) OF GRAPH.
3. LOCATE THE VEHICLE KNOWN CRITICAL DIMENSION OF 415 INCHES ON BOTTOM SCALE (VEHICLE CRITICAL DIMENSION-INCHES) OF GRAPH.
4. SIMULTANEOUSLY MOVE RIGHT ACROSS THE GRAPH FROM LEFT SCALE (MAXIMUM OVERHANG RATIO) AND UP ON GRAPH FROM BOTTOM SCALE (VEHICLE CRITICAL DIMENSION-INCHES) TO THE INTERSECTION POINT FOR BOTH THESE VALUES.
5. THE INTERSECTION POINT FOR EXAMPLE VEHICLE FALLS IN THE FOLLOWING POSITIONS ON GRAPHS:

ON FORWARD RAMP GRAPH - WITHIN LEVEL KNEELED ZONE

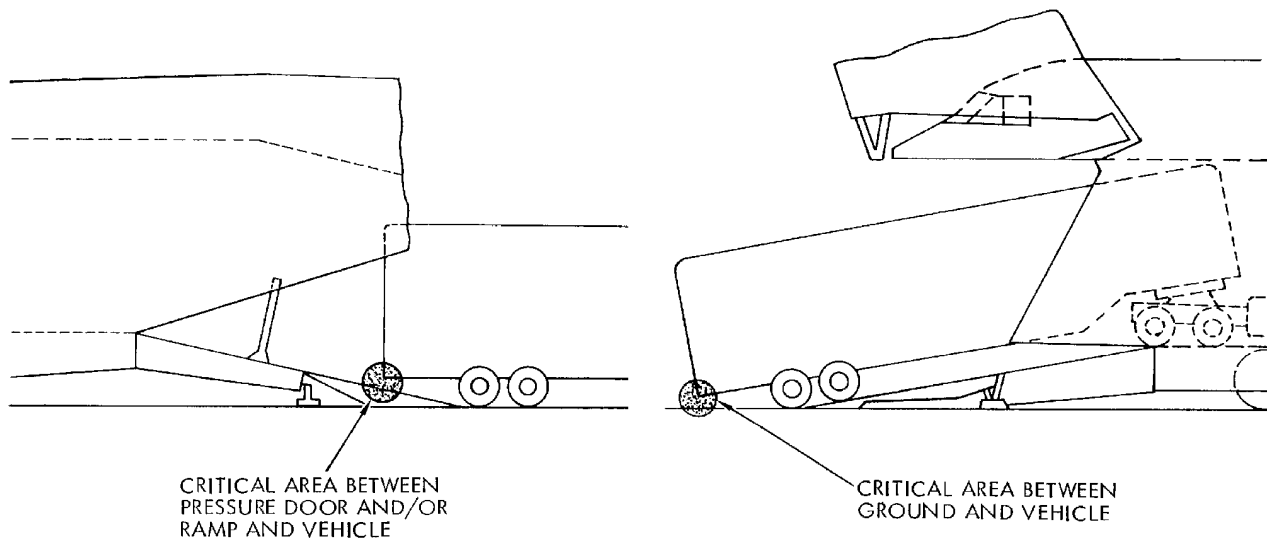
ON AFT RAMP GRAPH - WITHIN LEVEL KNEELED ZONE

6. ON OR OFF LOAD THE EXAMPLE VEHICLE AS FOLLOWS:

FORWARD END OF AIRPLANE - WITH AIRPLANE IN THE FORWARD OR LEVEL KNEELED POSITION

AFT END OF AIRPLANE - WITH AIRPLANE IN THE AFT OR LEVEL KNEELED POSITION

FORWARD AND AFT END LOADING

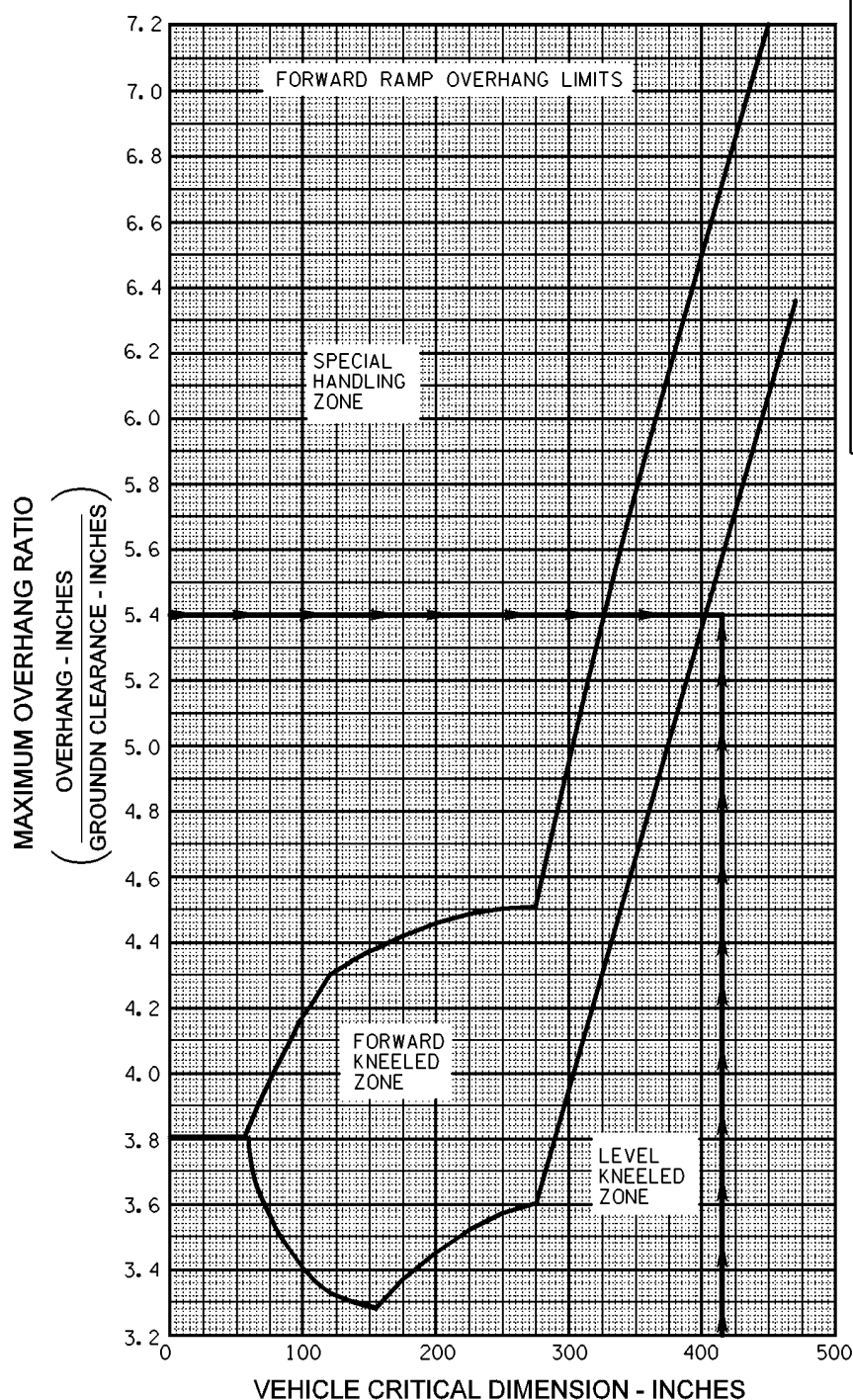


CAUTION

THE GROUND CLEARANCE OF SINGLE AXLE TRAILERS WILL CHANGE WHEN TOWED DURING LOADING/OFF LOADING. CONTACT COULD OCCUR IN THE AREA OF THE RAMP HINGE/TOES RESULTING IN DAMAGE TO THE AIRPLANE/TRAILER.

L1115352

Figure 4-16. Forward and Aft Cargo Ramp Vehicle Overhang Limits (Sheet 2)



FORWARD RAMP CONTACT LIMITS

CONFIGURATION	MAXIMUM OVERHANG RATIO
FWD KNEELED	4.59
FWD KNEELED (K-LOADER KIT)	6.00
LVL KNEELED	3.54

CAUTION

IF MAXIMUM OVERHANG RATIO IS EXCEEDED WHEN EITHER BACKING OR DRIVING A VEHICLE IN, IT MUST BE ON/OFF LOADED USING SPECIAL HANDLING PROCEDURES. THIS ONLY APPLIES TO RAMP CONTACT, NOT GROUND CONTACT.

NOTE

1. THE VEHICLE CAN BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY ANY ZONE, IF THE INTERSECTION POINT FALLS WITHIN THAT ZONE OR BELOW.
2. IF THE INTERSECTION POINT FALLS ABOVE THE FORWARD KNEELED ZONE, THE VEHICLE MUST BE ON/OFF LOADED WITH THE RAMP AND EXTENSION IN THE TRUCK LOADING POSITION, OR USING SPECIAL HANDLING PROCEDURES.
3. TO DETERMINE THE REQUIRED THICKNESS OF APPROACH SHORING FOR SPECIAL HANDLING, PROCEED AS FOLLOWS:

$$\frac{\text{REQUIRED GROUND CLEARANCE}}{\text{OVERHANG MAXIMUM OVERHANG RATIO}} =$$

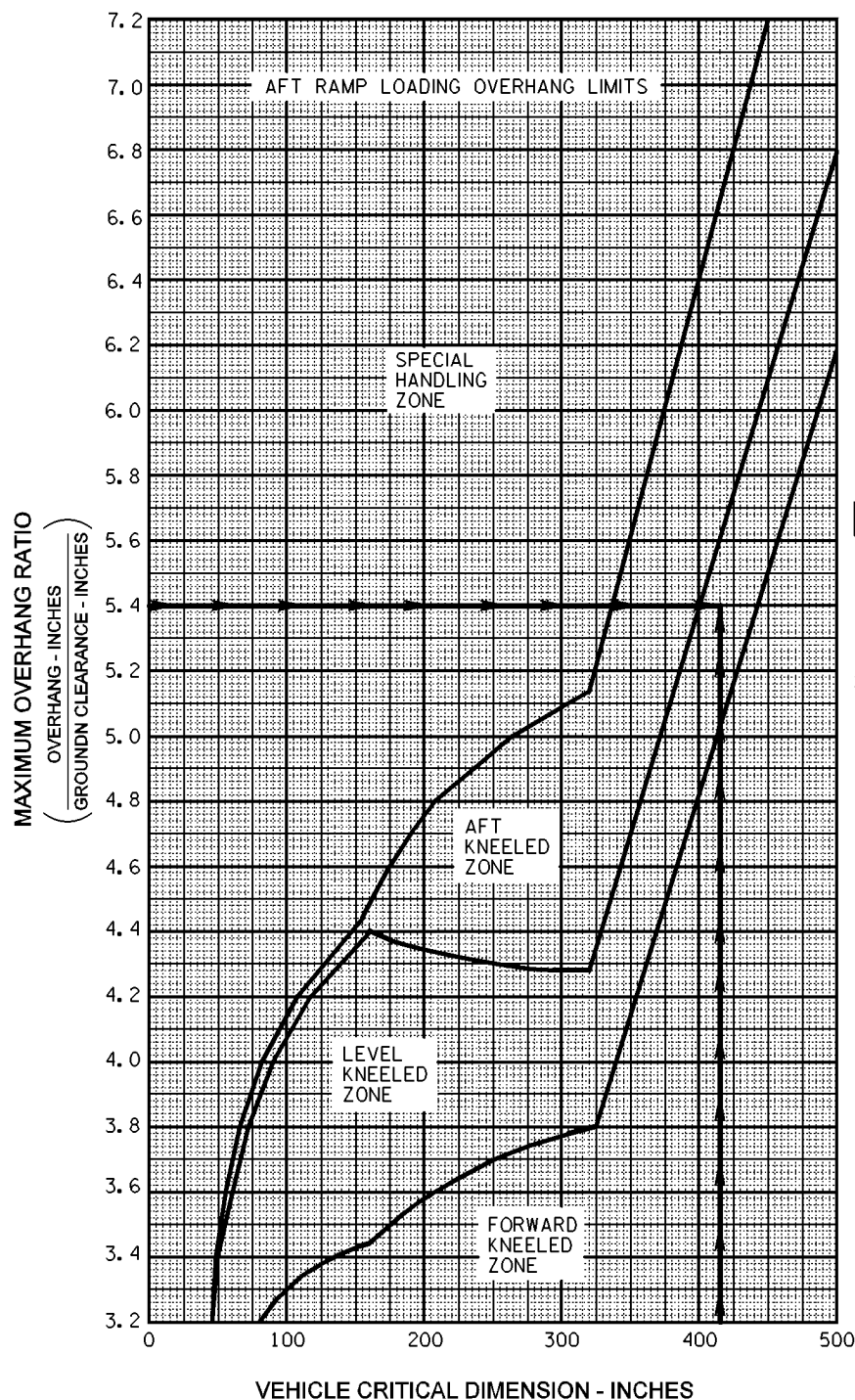
$$\text{APPROACH SHORING THICKNESS} = \frac{\text{REQUIRED GROUND CLEARANCE} - \text{ACTUAL GROUND CLEARANCE}}{\text{OVERHANG MAXIMUM OVERHANG RATIO}}$$

4. TO DETERMINE THE REQUIRED LENGTH OF APPROACH SHORING, PROCEED AS FOLLOWS:

$$\text{APPROACH SHORING LENGTH} = \frac{1}{2} \times \text{CRITICAL DIMENSION OR OVERHANG} + \text{SHORING THICKNESS (WHICHEVER IS GREATER)}$$

L1115353

Figure 4-16. Forward and Aft Cargo Ramp Vehicle Overhang Limits (Sheet 3)



AFT RAMP CONTACT LIMITS

CONFIGURATION	MAXIMUM OVERHANG RATIO
AFT KNEELED	5.26
FWD KNEELED	2.76
LVL KNEELED	4.00

CAUTION

IF MAXIMUM OVERHANG RATIO IS EXCEEDED WHEN EITHER BACKING OR DRIVING A VEHICLE IN, IT MUST BE ON/OFF LOADED USING SPECIAL HANDLING PROCEDURES. THIS ONLY APPLIES TO RAMP CONTACT, NOT GROUND CONTACT.

NOTE

1. THE VEHICLE CAN BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY ANY ZONE, IF THE INTERSECTION POINT FALLS WITHIN THAT ZONE OR BELOW.
2. IF THE INTERSECTION POINT FALLS ABOVE THE FORWARD KNEELED ZONE, THE VEHICLE MUST BE ON/OFF LOADED WITH THE RAMP AND EXTENSION IN THE TRUCK LOADING POSITION, OR USING SPECIAL HANDLING PROCEDURES.
3. TO DETERMINE THE REQUIRED THICKNESS OF APPROACH SHORING FOR SPECIAL HANDLING, PROCEED AS FOLLOWS:

$$\frac{\text{REQUIRED GROUND CLEARANCE}}{\text{OVERHANG}} = \frac{\text{OVERHANG}}{\text{MAXIMUM OVERHANG RATIO}}$$

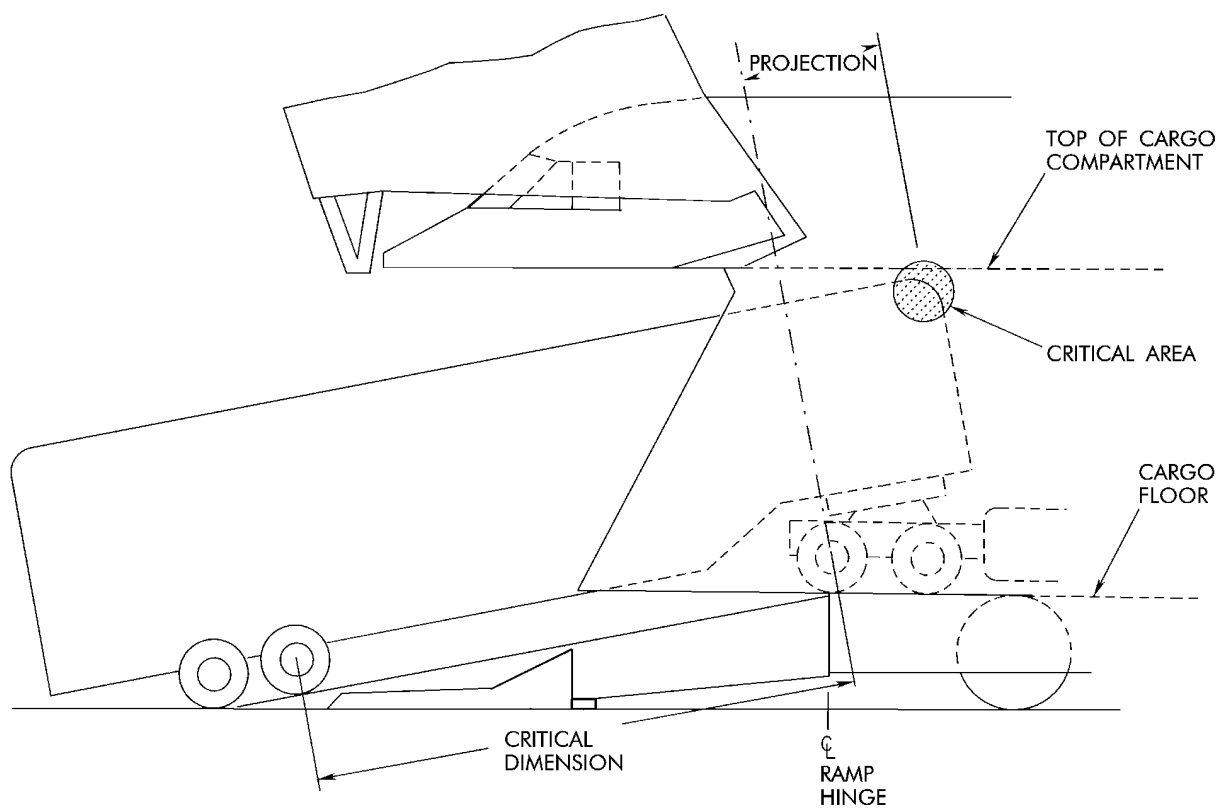
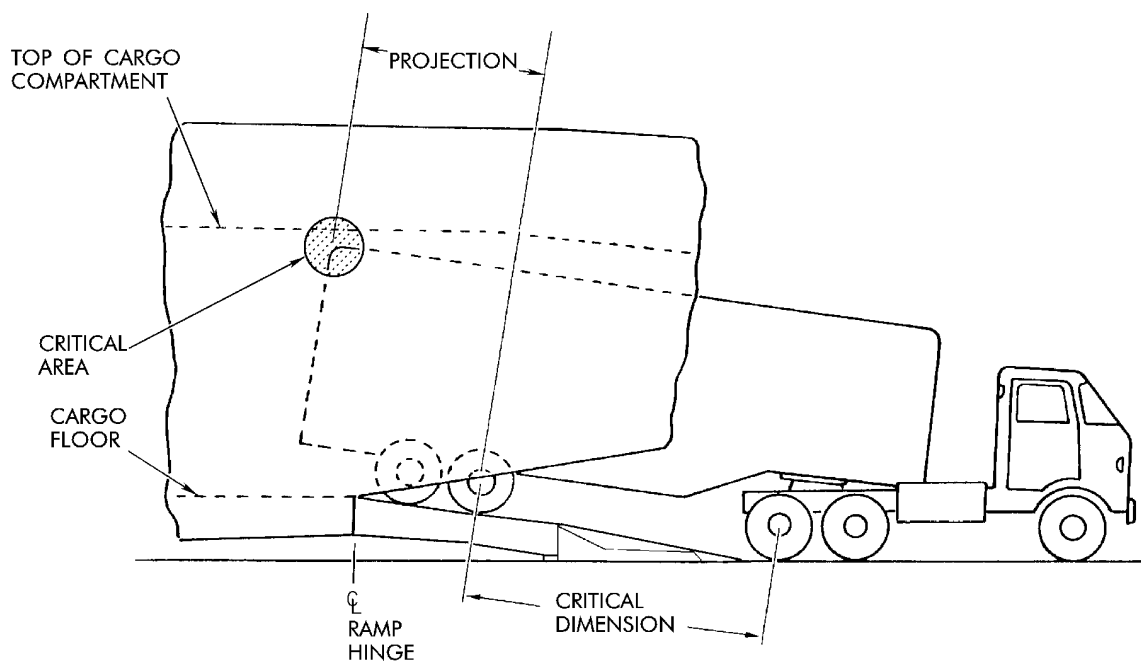
$$\text{APPROACH SHORING THICKNESS} = \frac{\text{REQUIRED GROUND CLEARANCE} - \text{ACTUAL GROUND CLEARANCE}}{\text{GROUND CLEARANCE}}$$

4. TO DETERMINE THE REQUIRED LENGTH OF APPROACH SHORING, PROCEED AS FOLLOWS:

$$\text{APPROACH SHORING LENGTH} = \frac{1}{2} \times \text{CRITICAL DIMENSION OR OVERHANG} + \text{SHORING THICKNESS (WHICHEVER IS GREATER)}$$

L1115354

Figure 4-16. Forward and Aft Cargo Ramp Vehicle Overhang Limits (Sheet 4)

**FORWARD LOADING****AFT LOADING**

L1115355

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 1 of 25)

VEHICLE PROJECTION LIMITS – CALCULATION PROCEDURES FOR VEHICLE LOADING

NOTE

- 1. SEE FIGURE 4-15 FOR VEHICLE DIMENSIONS AND CARGO FLOOR LOADING HEIGHTS THAT CAN AFFECT VEHICLE LOADING.
- 2. THE CALCULATION PROCEDURES ARE THE SAME REGARDLESS OF THE TYPE OF VEHICLE (SINGLE AXLE, BOGIE AXLE, OR TRACTOR TRAILER) THAT IS TO BE LOADED.
- 3. USE GRAPHS NO. 1 THROUGH NO. 4 AND NO. 11 FOR FORWARD END LOADING CALCULATIONS.
- 4. USE GRAPHS NO. 5 THROUGH NO. 10 AND NO. 12 FOR AFT END LOADING CALCULATIONS.

TO DETERMINE IF A VEHICLE CAN BE SAFELY ON/OFF LOADED, PROCEED AS FOLLOWS:

- 1. LOCATE VEHICLE KNOWN PROJECTION (P) ON LEFT SCALE OF GRAPH.
- 2. LOCATE VEHICLE KNOWN CRITICAL DIMENSION (C) ON BOTTOM SCALE OF GRAPH.
- 3. SIMULTANEOUSLY MOVE RIGHT ACROSS GRAPH FROM LEFT SCALE AND UP VERTICALLY ON GRAPH FROM BOTTOM SCALE TO THE INTERSECTION POINT FOR BOTH THESE KNOWN VALUES.
- 4. IF THE VEHICLE KNOWN HEIGHT (H) IS THE SAME AS OR LESS THAN THE CURVE (VEHICLE HEIGHT - INCHES) ON OR ABOVE THE INTERSECTION POINT (OBTAINED IN STEP 3), THE VEHICLE CAN BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY THE GRAPH.
- 5. IF THE VEHICLE KNOWN HEIGHT (H) IS GREATER THAN THE CURVE (VEHICLE HEIGHT - INCHES) ON OR ABOVE THE INTERSECTION POINT (OBTAINED IN STEP 3), THE VEHICLE CANNOT BE SAFELY LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED IN THE GRAPH AND MUST BE ON/OFF LOADED WITH THE VEHICLE IN THE TRUCK BED LOADING POSITION, IF POSSIBLE, OR USING SPECIAL ON/OFF LOADING PROCEDURES.

EXAMPLE PROBLEM NO. 1

DETERMINE IF A VEHICLE WITH A KNOWN PROJECTION OF 115 INCHES, A KNOWN CRITICAL DIMENSION OF 370 INCHES, AND A KNOWN HEIGHT OF 136 INCHES CAN BE SAFELY ON/OFF LOADED.

- 1. LOCATE THE VEHICLE KNOWN PROJECTION OF 115 INCHES ON THE LEFT SCALE OF GRAPH.
- 2. LOCATE THE VEHICLE KNOWN CRITICAL DIMENSION OF 370 INCHES ON THE BOTTOM SCALE OF GRAPH.
- 3. SIMULTANEOUSLY MOVE RIGHT ACROSS GRAPH FROM LEFT SCALE AND UPWARD ON GRAPH FROM BOTTOM SCALE TO THE INTERSECTION POINT FOR BOTH THESE VALUES.
- 4. THE INTERSECTION POINT (OBTAINED IN STEP3) INDICATES THAT THE EXAMPLE VEHICLE CAN BE SAFELY ON/OFF LOADED AS FOLLOWS:

- GRAPH NO. 1 THE KNOWN VEHICLE HEIGHT OF 136 INCHES IS LESS THAN THE MAXIMUM ALLOWABLE VEHICLE HEIGHT OF 146 INCHES AS INDICATED BY THE 146-INCH CURVE LOCATED ABOVE THE INTERSECTION POINT (OBTAINED IN STEP 3). THE VEHICLE CAN BE SAFELY ON/OFF LOADED IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 1.
- GRAPH NO. 2 THE KNOWN VEHICLE HEIGHT OF 136 INCHES IS LESS THAN THE MAXIMUM ALLOWABLE VEHICLE HEIGHT OF 142 INCHES AS INDICATED BY THE 142-INCH CURVE LOCATED ABOVE THE INTERSECTION POINT (OBTAINED IN STEP 3). THE VEHICLE CAN BE SAFELY ON/OFF LOADED IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 2.
- GRAPH NO. 3 THE KNOWN VEHICLE HEIGHT OF 136 INCHES IS GREATER THAN THE MAXIMUM ALLOWABLE VEHICLE HEIGHT OF 98 INCHES AS INDICATED BY THE 98-INCH CURVE LOCATED ABOVE THE INTERSECTION POINT (OBTAINED IN STEP 3). THE VEHICLE CANNOT BE SAFELY ON/OFF LOADED IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 3.

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Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 2)

- GRAPH NO. 4 THE KNOWN VEHICLE HEIGHT OF 136 INCHES IS GREATER THAN THE MAXIMUM ALLOWABLE VEHICLE HEIGHT OF 94 INCHES AS INDICATED BY THE 94-INCH CURVE LOCATED ON THE INTERSECTION POINT (OBTAINED IN STEP 3). THE VEHICLE CANNOT BE SAFELY ON/OFF LOADED IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 4.
- GRAPH NO. 5 THE KNOWN VEHICLE HEIGHT OF 136 INCHES IS EQUAL TO THE MAXIMUM ALLOWABLE VEHICLE HEIGHT OF 136 INCHES AS INDICATED BY THE 136-INCH CURVE LOCATED ON THE INTERSECTION POINT (OBTAINED IN STEP 3). THE VEHICLE CAN BE SAFELY ON/OFF LOADED IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 5.
- GRAPH NO. 6 THE KNOWN VEHICLE HEIGHT OF 136 INCHES IS LESS THAN THE MAXIMUM ALLOWABLE VEHICLE HEIGHT OF 140 INCHES AS INDICATED BY THE 140-INCH CURVE LOCATED ABOVE THE INTERSECTION POINT (OBTAINED IN STEP 3). THE VEHICLE CAN BE SAFELY ON/OFF LOADED IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 6.
- GRAPH NO. 7 THE KNOWN VEHICLE HEIGHT OF 136 INCHES IS LESS THAN THE MAXIMUM ALLOWABLE VEHICLE HEIGHT OF 140 INCHES AS INDICATED BY THE 140-INCH CURVE LOCATED ABOVE THE INTERSECTION POINT (OBTAINED IN STEP 3). THE VEHICLE CAN BE SAFELY ON/OFF LOADED IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 7.
- GRAPH NO. 8 THE KNOWN VEHICLE HEIGHT OF 136 INCHES IS GREATER THAN THE MAXIMUM ALLOWABLE VEHICLE HEIGHT OF 86 INCHES AS INDICATED BY THE 86-INCH CURVE LOCATED ON THE INTERSECTION POINT (OBTAINED IN STEP 3). THE VEHICLE CANNOT BE SAFELY ON/OFF LOADED IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 8.
- GRAPH NO. 9 THE KNOWN VEHICLE HEIGHT OF 136 INCHES IS GREATER THAN THE MAXIMUM ALLOWABLE VEHICLE HEIGHT OF 90 INCHES AS INDICATED BY THE 90-INCH CURVE LOCATED ABOVE THE INTERSECTION POINT (OBTAINED IN STEP 3). THE VEHICLE CANNOT BE SAFELY ON/OFF LOADED IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 9.
- GRAPH NO. 10 THE KNOWN VEHICLE HEIGHT OF 136 INCHES IS GREATER THAN THE MAXIMUM ALLOWABLE VEHICLE HEIGHT OF 98 INCHES AS INDICATED BY THE 98-INCH CURVE LOCATED ABOVE THE INTERSECTION POINT (OBTAINED IN STEP 3). THE VEHICLE CANNOT BE SAFELY ON/OFF LOADED IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 10.

EXAMPLE PROBLEM NO. 2

DETERMINE IF A VEHICLE WITH A KNOWN PROJECTION OF 152 INCHES, A KNOWN CRITICAL DIMENSION OF 490 INCHES, AND A KNOWN HEIGHT OF 132 INCHES CAN BE SAFELY ON/OFF LOADED.

1. LOCATE VEHICLE KNOWN PROJECTION OF 152 INCHES ON THE LEFT SCALE OF GRAPH.
2. LOCATE THE VEHICLE KNOWN CRITICAL DIMENSION OF 490 INCHES ON BOTTOM SCALE OF GRAPH.
3. SIMULTANEOUSLY MOVE RIGHT ACROSS GRAPH FROM LEFT SCALE AND UPWARD ON GRAPH FROM BOTTOM SCALE TO THE INTERSECTION POINT FOR BOTH THESE KNOWN VALUES.
4. THE INTERSECTION POINT (OBTAINED IN STEP 3) INDICATES THAT THE EXAMPLE VEHICLE CAN BE SAFELY ON/OFF LOADED IN THE CONFIGURATIONS REPRESENTED BY THE FOLLOWING GRAPHS:
GRAPH NO. 1, GRAPH NO. 2, GRAPH NO. 5, GRAPH NO. 6, AND GRAPH NO. 7.
5. THE INTERSECTION POINT (OBTAINED IN STEP 3) INDICATES THAT THE EXAMPLE VEHICLE CANNOT BE SAFELY ON/OFF LOADED IN THE CONFIGURATIONS REPRESENTED BY THE FOLLOWING GRAPHS:
GRAPH NO. 3, GRAPH NO. 4, GRAPH NO. 8, GRAPH NO. 9, AND GRAPH NO. 10.

L1115357

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 3)

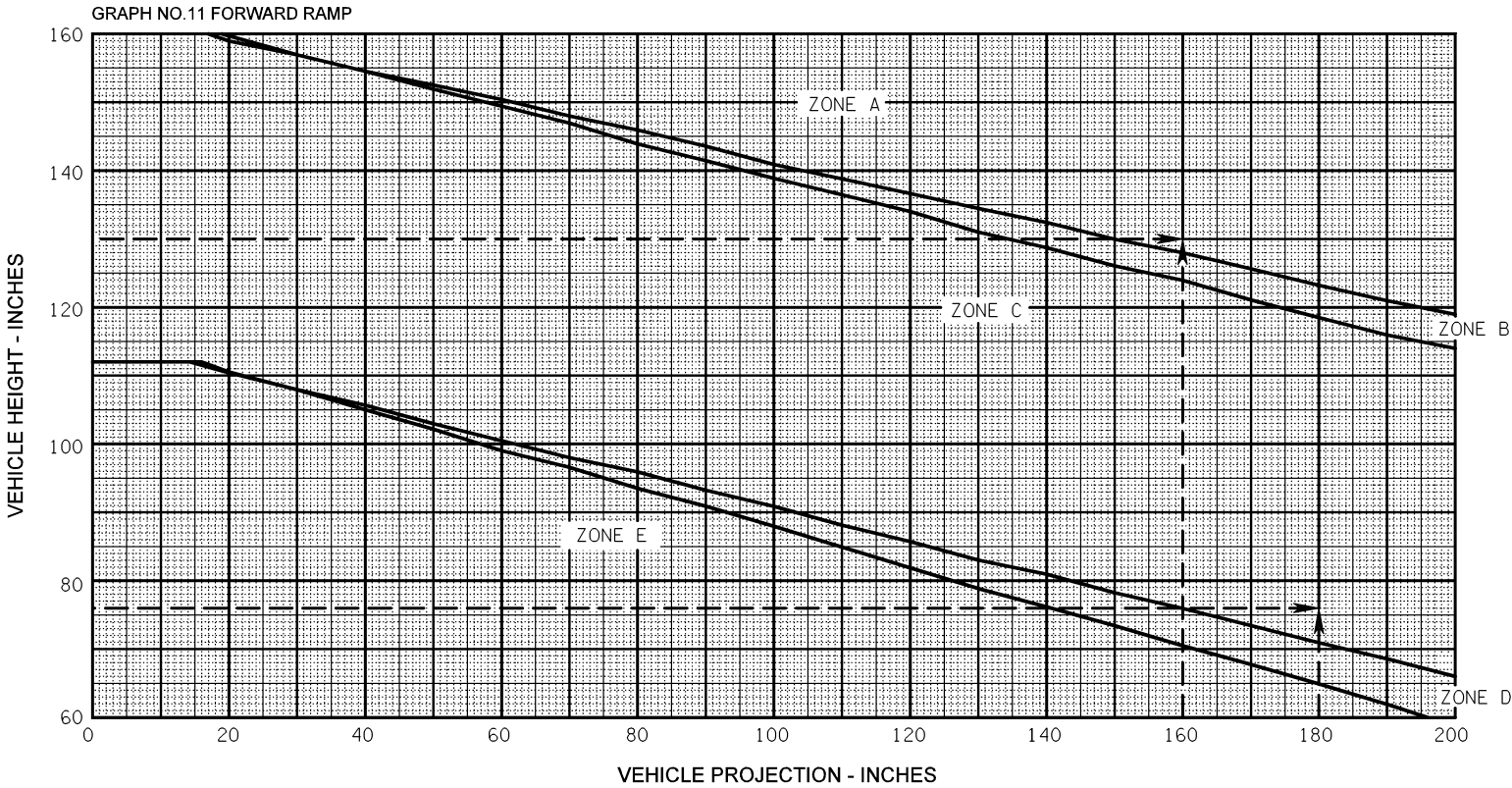
VEHICLE PROJECTION LIMITS - CRITICAL DIMENSION LESS THAN 275 INCHES

GRAPH ZONE

- A LOAD WITH RAMP AND EXTENSION IN TRUCK LOADING POSITION OR, USE SPECIAL HANDLING PROCEDURES.
- B LOAD BETWEEN BL 78 LEFT AND BL 78 RIGHT WITH AIRPLANE FORWARD KNEELED.
- C LOAD BETWEEN BL 78 LEFT AND BL 78 RIGHT WITH AIRPLANE FORWARD OR LEVEL KNEELED.
- D LOAD AT ANY POINT ACROSS CARGO FLOOR BETWEEN BL 114 LEFT AND BL 114 RIGHT WITH AIRPLANE FORWARD KNEELED, OR BETWEEN BL 78 LEFT AND BL 78 RIGHT WITH AIRPLANE IN ANY KNEELED POSITION.
- E LOAD AT ANY POINT ACROSS CARGO FLOOR BETWEEN BL 114 LEFT AND BL 114 RIGHT WITH AIRPLANE FORWARD OR LEVEL KNEELED.

NOTE

IF THE VEHICLE KNOWN HEIGHT IS GREATER THAN 112 INCHES AND THE CRITICAL DIMENSION IS GREATER THAN 275 INCHES, SEE GRAPHS 1 AND 2. IF THE VEHICLE KNOWN HEIGHT IS EQUAL TO OR LESS THAN 112 INCHES AND THE CRITICAL DIMENSION IS GREATER THAN 275 INCHES, SEE GRAPHS 3 AND 4.



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Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 4)

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 5)

L1115359

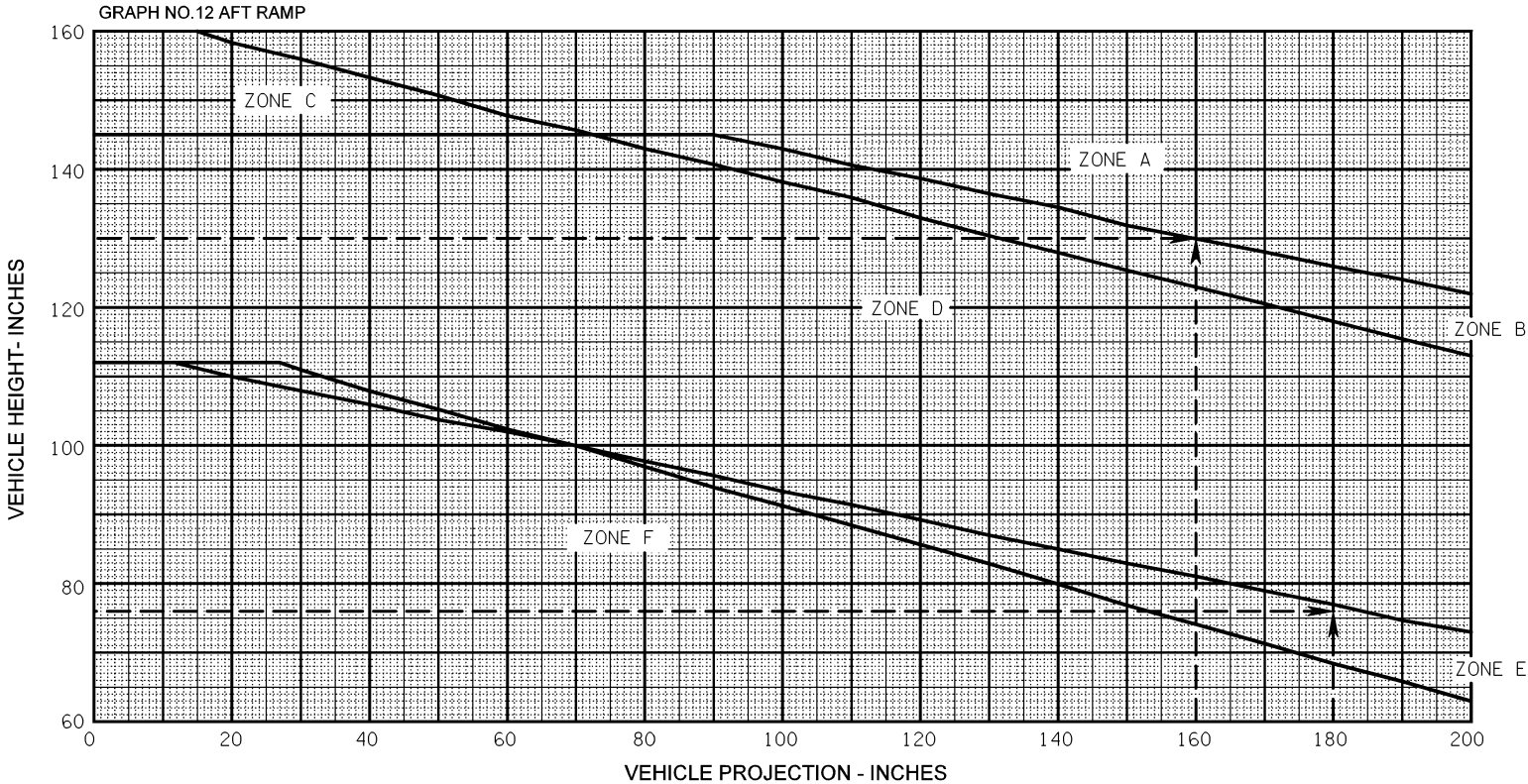
NOTE

IF THE VEHICLE KNOWN HEIGHT IS GREATER THAN 112 INCHES AND THE CRITICAL DIMENSION IS GREATER THAN 320 INCHES, SEE GRAPHS 5 THROUGH 7. IF THE VEHICLE KNOWN HEIGHT IS EQUAL TO OR LESS THAN 112 INCHES AND THE CRITICAL DIMENSION IS GREATER THAN 320 INCHES, SEE GRAPHS 8 THROUGH 10.

VEHICLE PROJECTION LIMITS - CRITICAL DIMENSION LESS THAN 320 INCHES

GRAPH ZONE

- A LOAD USING SPECIAL HANDLING PROCEDURES.
- B LOAD BETWEEN BL 78 LEFT AND BL 78 RIGHT WITH AIRPLANE AFT KNEELED.
- C LOAD BETWEEN BL 78 LEFT AND BL 78 RIGHT WITH AIRPLANE FORWARD OR LEVEL KNEELED.
- D LOAD BETWEEN BL 78 LEFT AND BL 78 RIGHT WITH AIRPLANE IN ANY KNEELED POSITION.
- E LOAD AT ANY POINT ACROSS CARGO FLOOR BETWEEN BL 114 LEFT AND BL 114 RIGHT WITH AIRPLANE AFT KNEELED, OR BETWEEN BL 78 LEFT AND BL 78 RIGHT WITH AIRPLANE IN ANY KNEELED POSITION.
- F LOAD ANY POINT ACROSS CARGO FLOOR BETWEEN BL 114 LEFT AND BL 114 RIGHT WITH AIRPLANE IN ANY KNEELED POSITION.



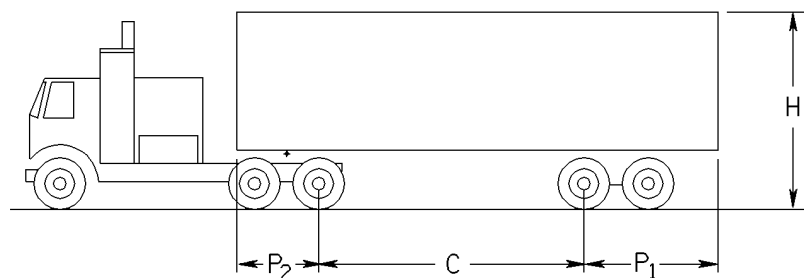
FORWARD END LOADING FORWARD KNEEL BL 78 LEFT TO BL 78 RIGHT

CAUTION

DO NOT LOAD THE VEHICLE THROUGH THE AIRPLANE FORWARD END WITH THE AIRPLANE FORWARD KNEELED IF THE LIMITS IN GRAPH NO. 1 ARE EXCEEDED.

NOTE

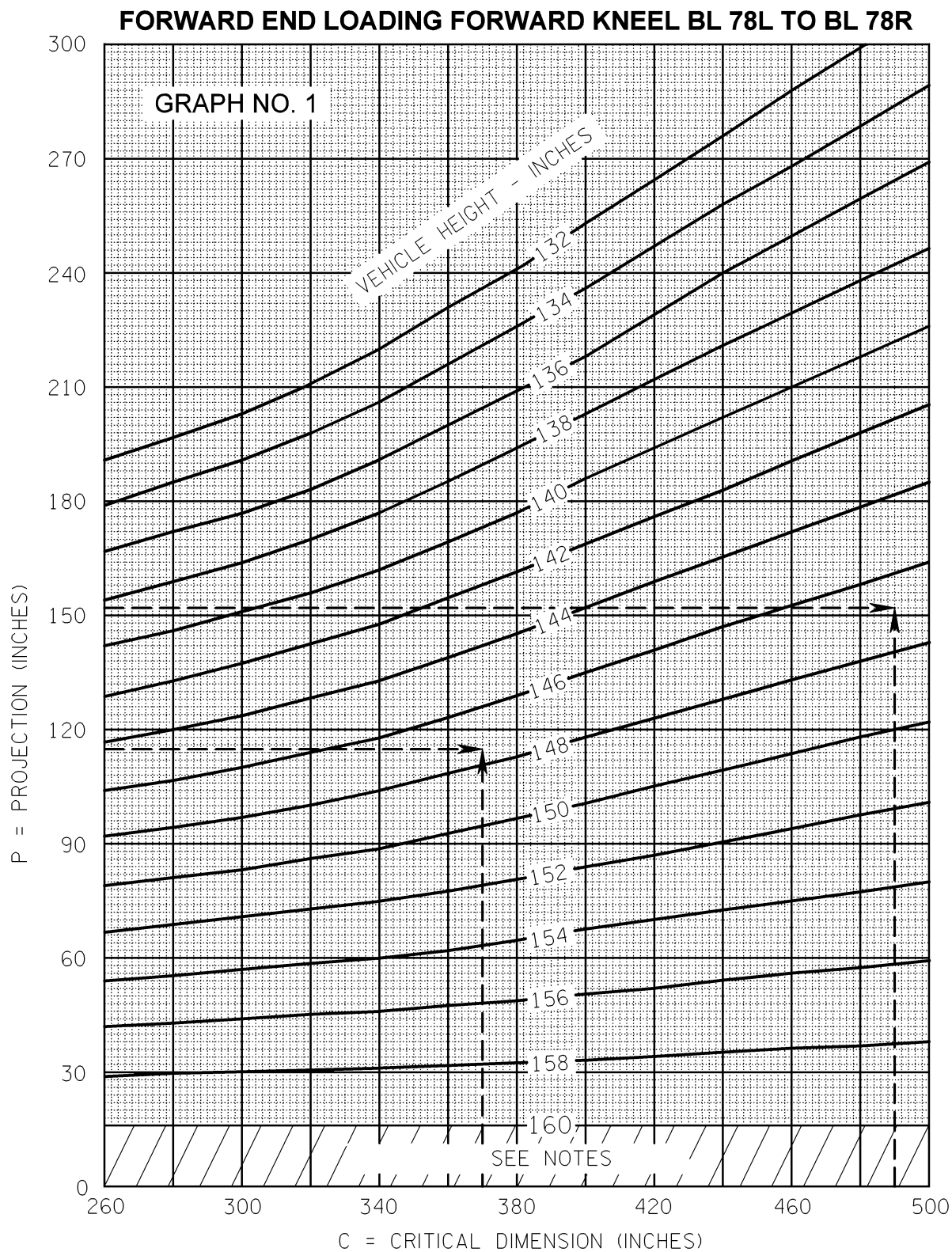
1. IF THE VEHICLE KNOWN HEIGHT IS GREATER THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE VEHICLE CANNOT BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 1.
2. IF THE VEHICLE KNOWN HEIGHT IS THE SAME OR LESS THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE VEHICLE CAN BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 1.
3. SEE THE CALCULATION PROCEDURES AND EXAMPLE PROBLEMS IN THIS FIGURE FOR EXPLANATION ON THE USE OF GRAPH NO. 1.



C = CRITICAL DIMENSION
H = HEIGHT
P = PROJECTION

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Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 6)



L1115361

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 7)

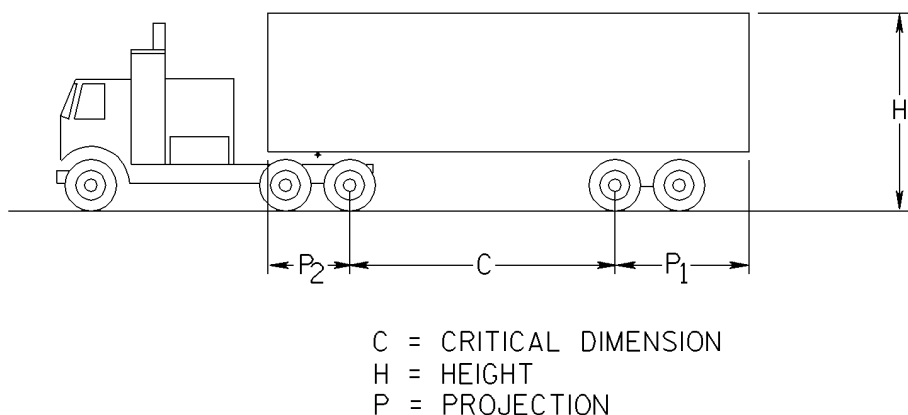
**FORWARD END LOADING
LEVEL KNEEL
BL 78 LEFT TO BL 78 RIGHT**

CAUTION

**DO NOT LOAD THE VEHICLE THROUGH THE
AIRPLANE FORWARD END WITH THE AIRPLANE
LEVEL KNEELED IF THE LIMITS IN GRAPH NO. 2
ARE EXCEEDED.**

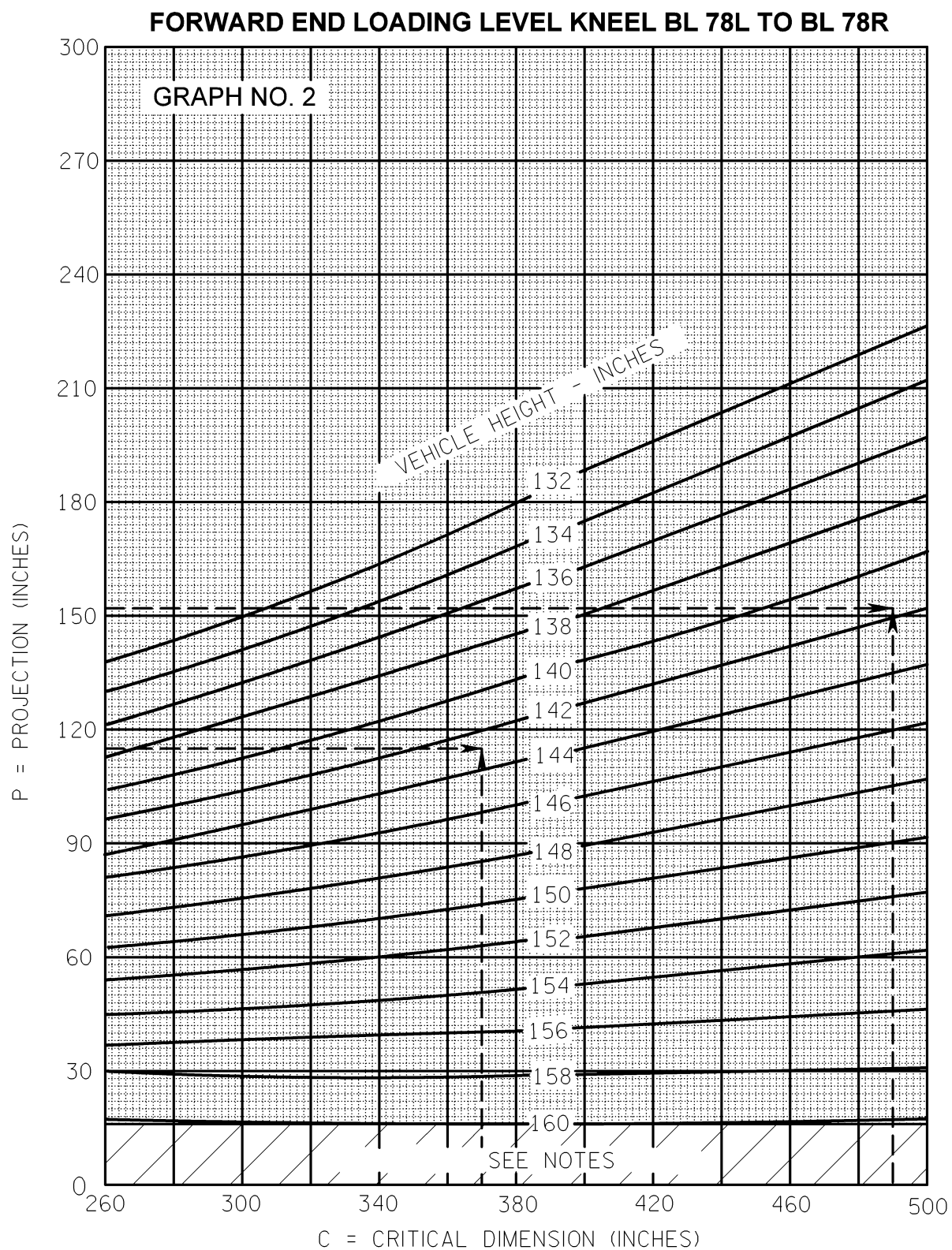
NOTE

1. IF THE VEHICLE KNOWN HEIGHT IS GREATER THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE VEHICLE CANNOT BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 2.
2. IF THE VEHICLE KNOWN HEIGHT IS THE SAME OR LESS THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE VEHICLE CAN BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 2.
3. SEE THE CALCULATION PROCEDURES AND EXAMPLE PROBLEMS IN THIS FIGURE FOR EXPLANATION ON THE USE OF GRAPH NO. 2.



L1115362

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 8)



L1115363

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 9)

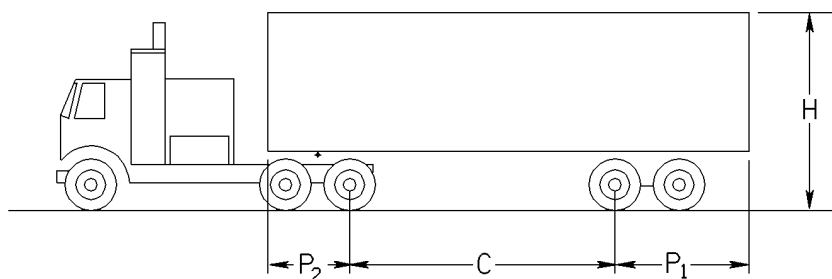
**FORWARD END LOADING
FORWARD KNEEL
BL 114 LEFT TO BL 114 RIGHT**

CAUTION

**DO NOT LOAD THE VEHICLE THROUGH THE
AIRPLANE FORWARD END WITH THE AIRPLANE
FORWARD KNEELED IF THE LIMITS IN GRAPH NO. 3
ARE EXCEEDED.**

NOTE

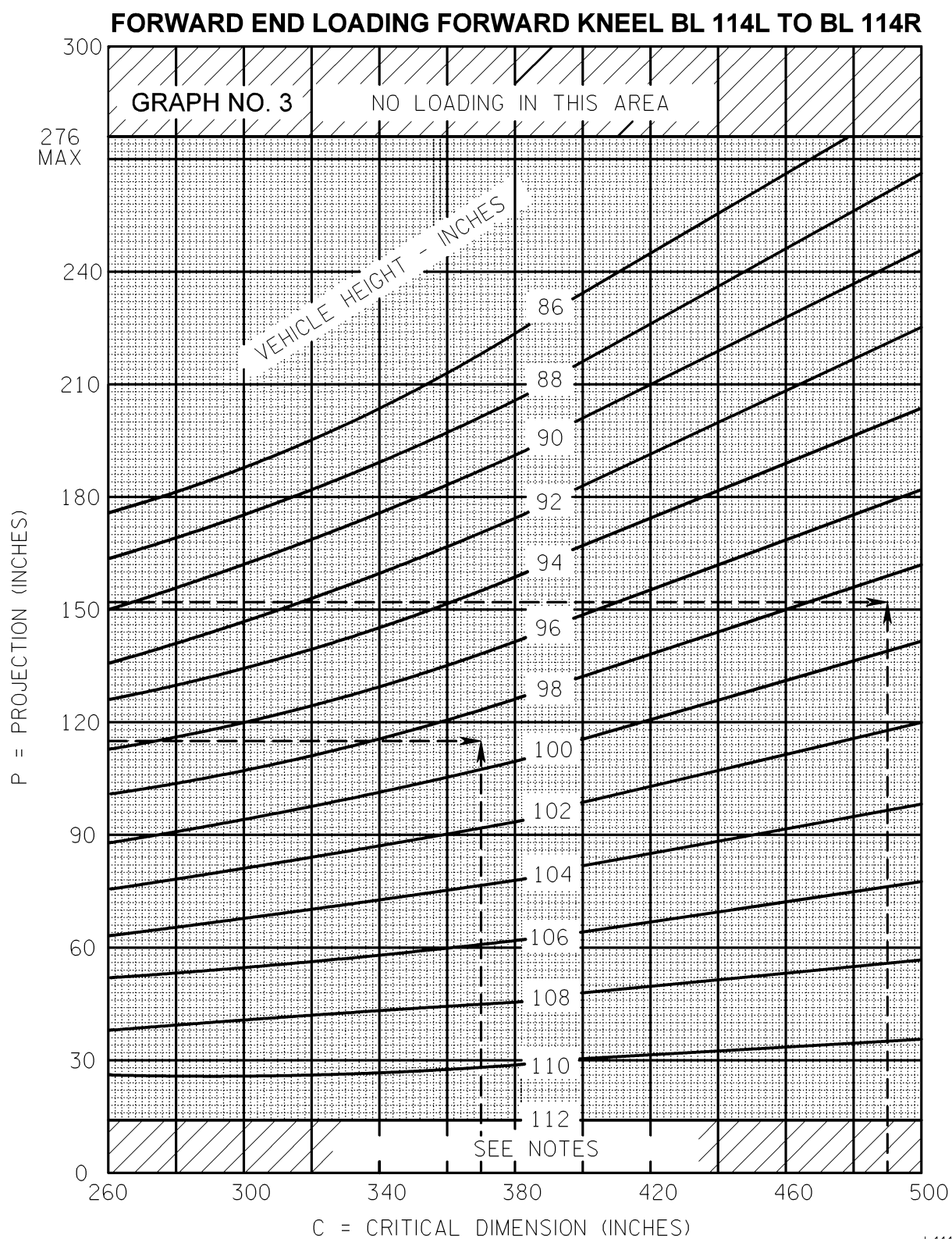
1. IF THE VEHICLE KNOWN HEIGHT IS GREATER THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE VEHICLE CANNOT BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 3.
2. IF THE VEHICLE KNOWN HEIGHT IS THE SAME OR LESS THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE VEHICLE CAN BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 3.
3. SEE THE CALCULATION PROCEDURES AND EXAMPLE PROBLEMS IN THIS FIGURE FOR EXPLANATION ON THE USE OF GRAPH NO. 3.



C = CRITICAL DIMENSION
H = HEIGHT
P = PROJECTION

L1115364

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 10)



L1115365

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 11)

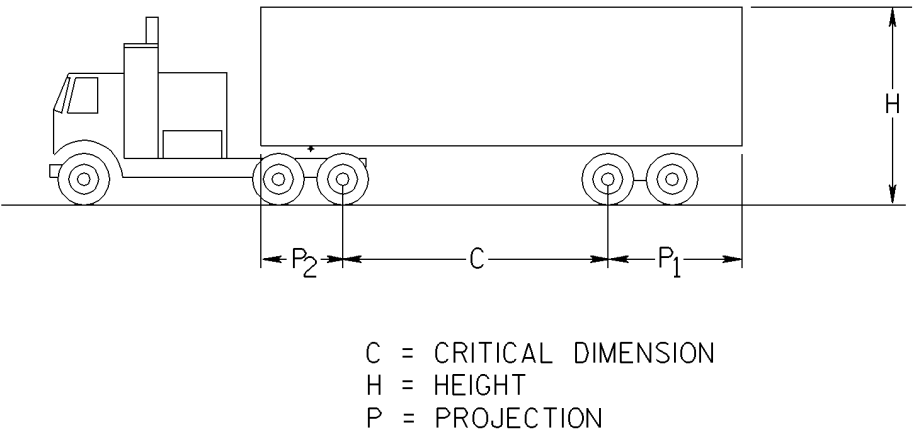
**FORWARD END LOADING
LEVEL KNEEL
BL 114 LEFT TO BL 114 RIGHT**

CAUTION

**DO NOT LOAD THE VEHICLE THROUGH THE
AIRPLANE FORWARD END WITH THE AIRPLANE
LEVEL KNEELED IF THE LIMITS IN GRAPH NO. 4
ARE EXCEEDED.**

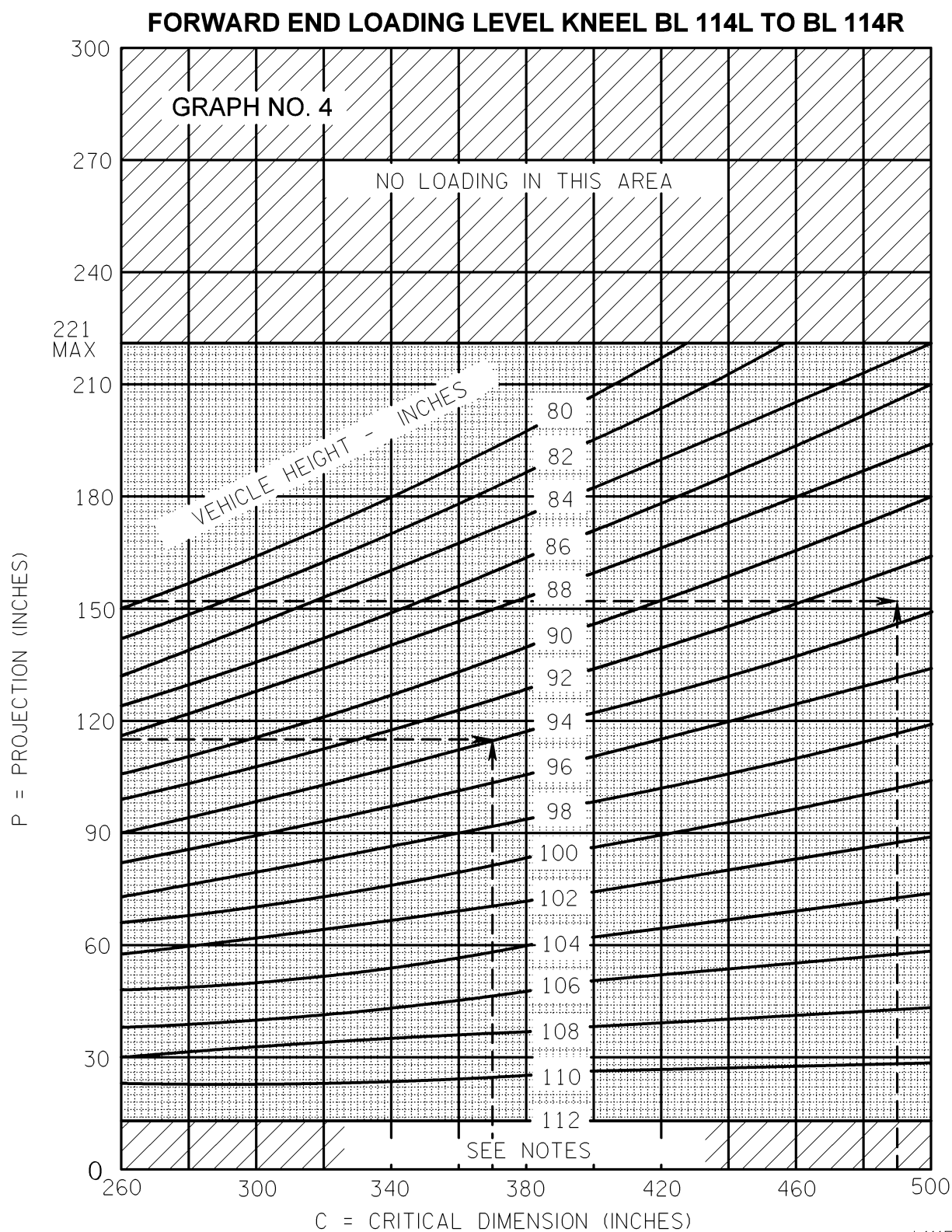
NOTE

- 1. IF THE VEHICLE KNOWN HEIGHT IS GREATER THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE VEHICLE CANNOT BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 4.
- 2. IF THE VEHICLE KNOWN HEIGHT IS THE SAME OR LESS THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE VEHICLE CAN BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 4.
- 3. SEE THE CALCULATION PROCEDURES AND EXAMPLE PROBLEMS IN THIS FIGURE FOR EXPLANATION ON THE USE OF GRAPH NO. 4.



L1115366

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 12)



L1115367

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 13)

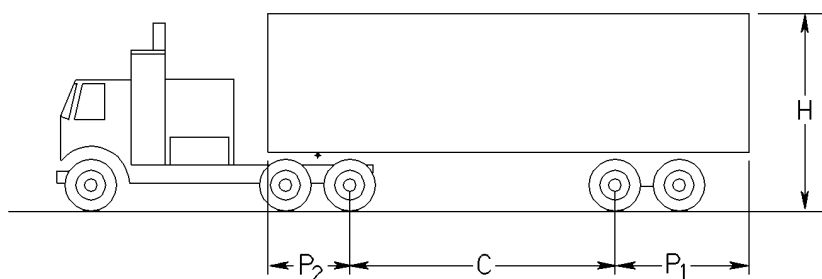
**AFT END LOADING
FORWARD KNEEL
BL 78 LEFT TO BL 78 RIGHT**

CAUTION

**DO NOT LOAD THE VEHICLE THROUGH THE
AIRPLANE AFT END WITH THE AIRPLANE
FORWARD KNEELED IF THE LIMITS IN GRAPH
NO. 5 ARE EXCEEDED.**

NOTE

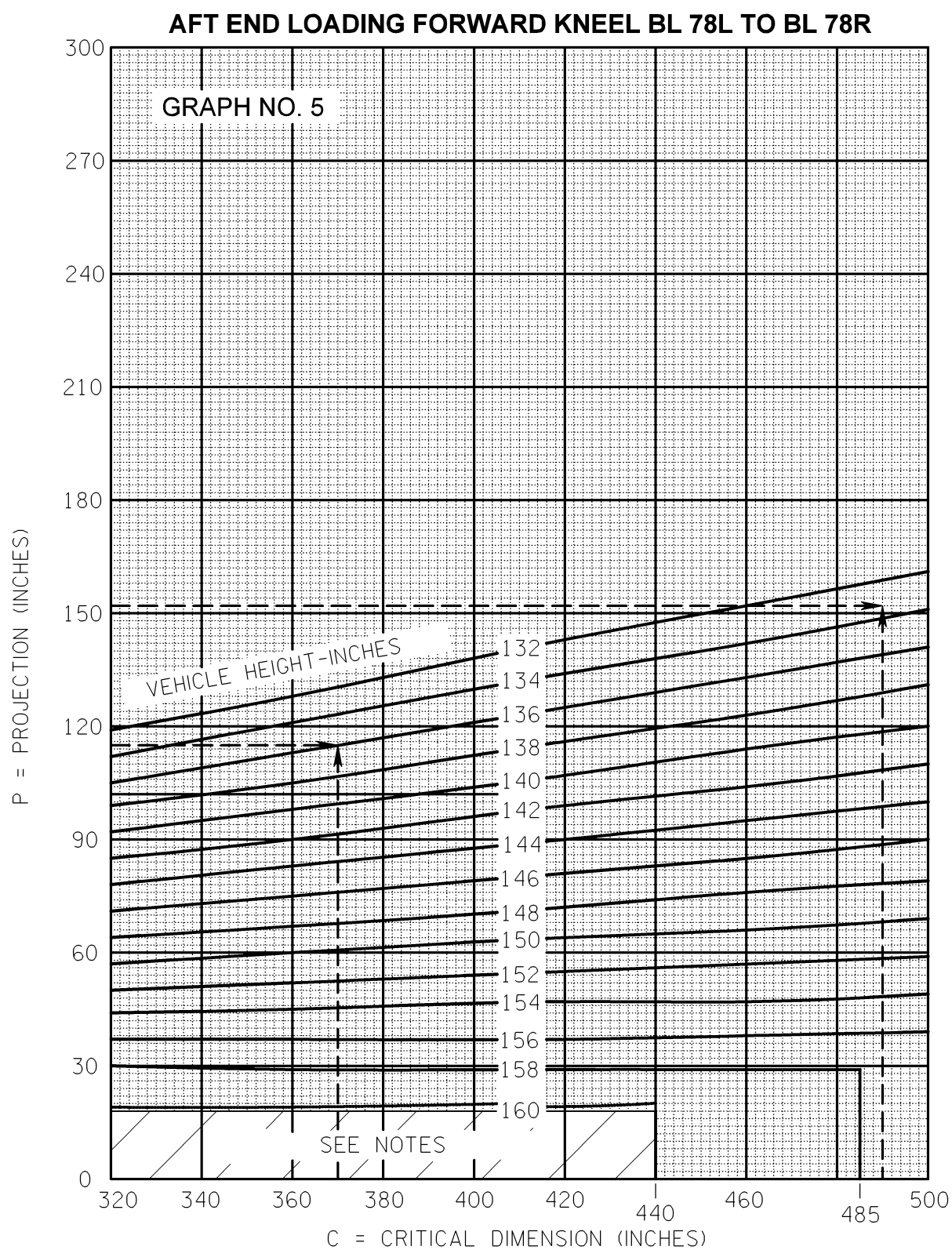
1. IF THE VEHICLE KNOWN HEIGHT IS GREATER THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE VEHICLE CANNOT BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 5.
2. IF THE VEHICLE KNOWN HEIGHT IS THE SAME OR LESS THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE VEHICLE CAN BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 5.
3. SEE THE CALCULATION PROCEDURES AND EXAMPLE PROBLEMS IN THIS FIGURE FOR EXPLANATION ON THE USE OF GRAPH NO. 5.



C = CRITICAL DIMENSION
H = HEIGHT
P = PROJECTION

L1115368

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 14)



L1115369

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 15)

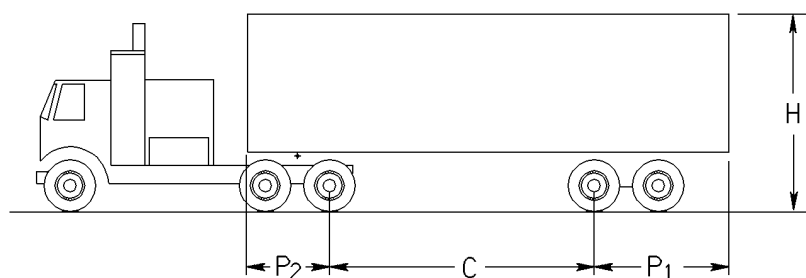
**AFT END LOADING
LEVEL KNEEL
BL 78 LEFT TO BL 78 RIGHT**

CAUTION

**DO NOT LOAD THE VEHICLE THROUGH THE
AIRPLANE AFT END WITH THE AIRPLANE LEVEL
KNEELED IF THE LIMITS IN GRAPH NO. 6
ARE EXCEEDED.**

NOTE

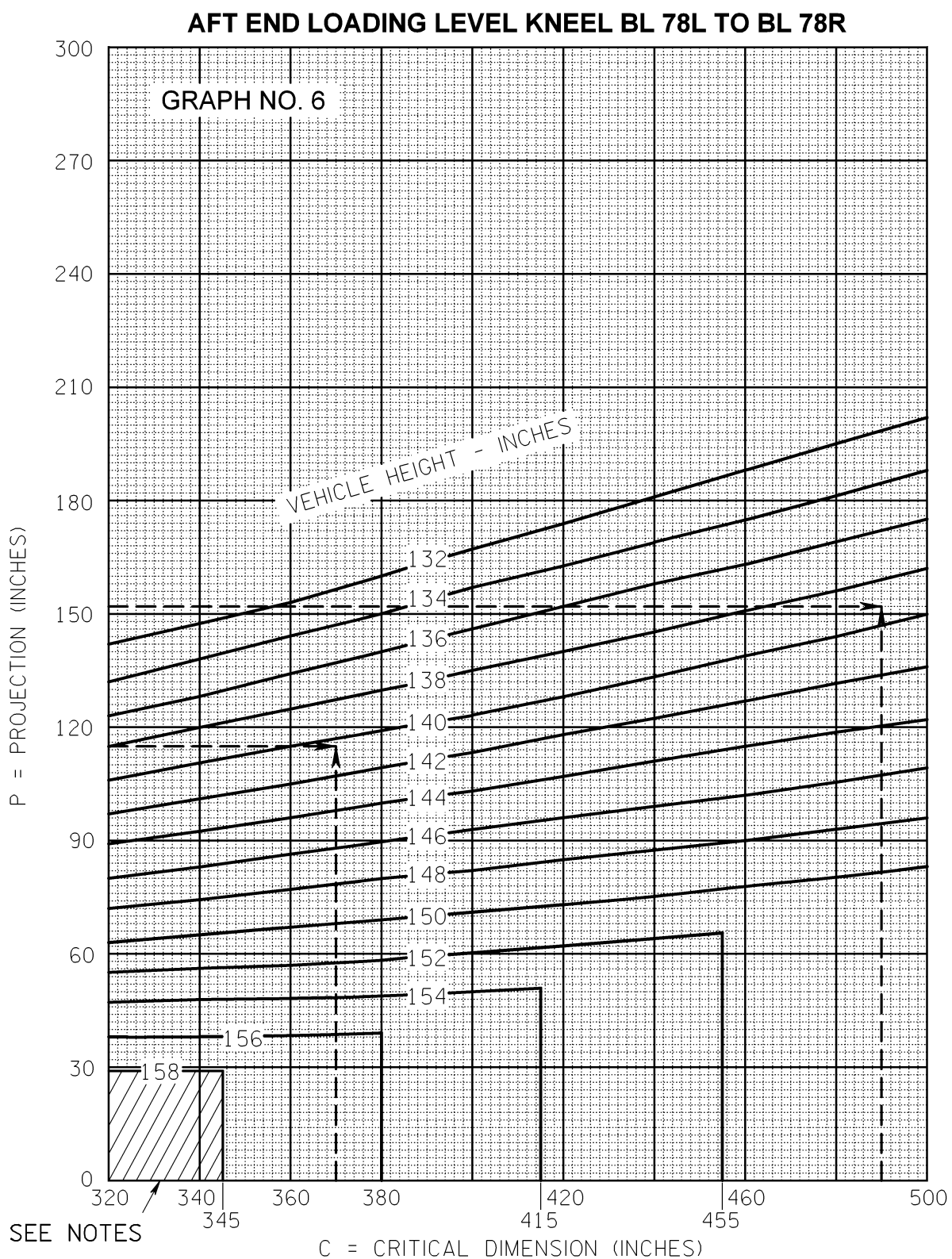
1. IF VEHICLE KNOWN HEIGHT IS GREATER THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE VEHICLE CANNOT BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 6.
2. IF THE VEHICLE KNOWN HEIGHT IS THE SAME OR LESS THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE VEHICLE CAN BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 6.
3. SEE THE CALCULATION PROCEDURES AND EXAMPLE PROBLEMS IN THIS FIGURE FOR EXPLANATION ON THE USE OF GRAPH NO. 6.



C = CRITICAL DIMENSION
H = HEIGHT
P = PROJECTION

L1115370

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 16)



L1115371

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 17)

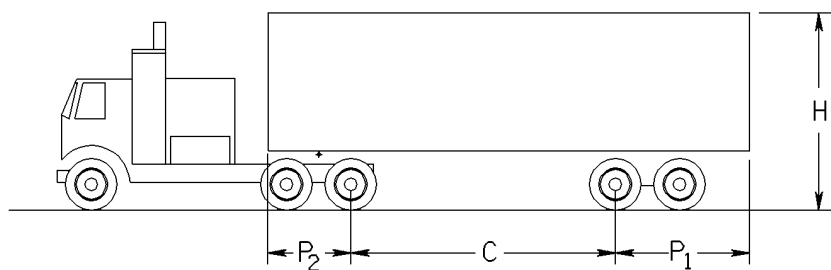
**AFT END LOADING
AFT KNEEL
BL 78 LEFT TO BL 78 RIGHT**

CAUTION

**DO NOT LOAD THE VEHICLE THROUGH THE
AIRPLANE AFT END WITH THE AIRPLANE AFT
KNEELED IF THE LIMITS IN GRAPH NO. 7
ARE EXCEEDED.**

NOTE

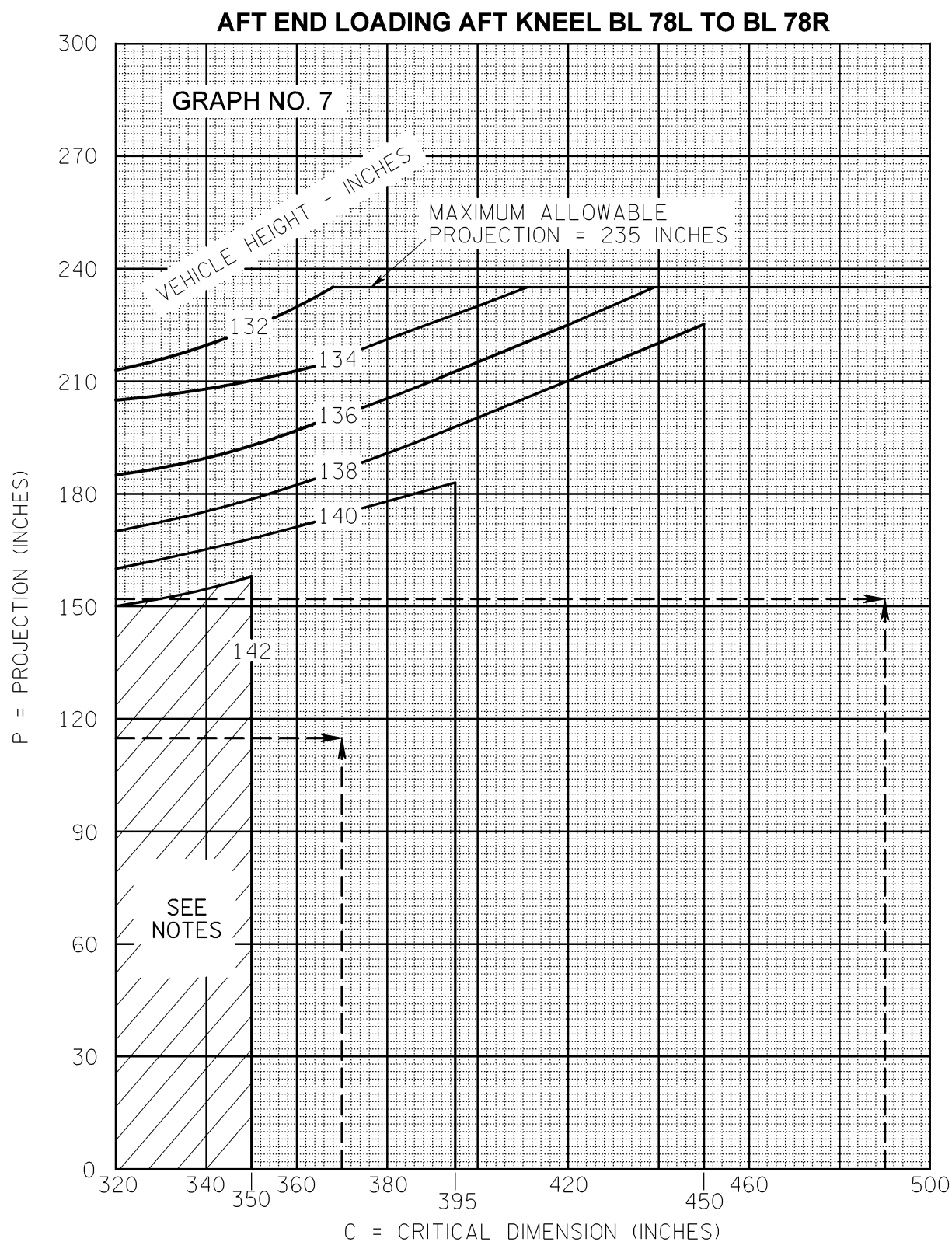
1. IF VEHICLE KNOWN HEIGHT IS GREATER THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE VEHICLE CANNOT BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 7.
2. IF THE VEHICLE KNOWN HEIGHT IS THE SAME OR LESS THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE THE VEHICLE CAN BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 7.
3. SEE THE CALCULATION PROCEDURES AND EXAMPLE PROBLEMS IN THIS FIGURE FOR EXPLANATION ON THE USE OF GRAPH NO. 7.



C = CRITICAL DIMENSION
H = HEIGHT
P = PROJECTION

L1115372

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 18)



L1115373

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 19)

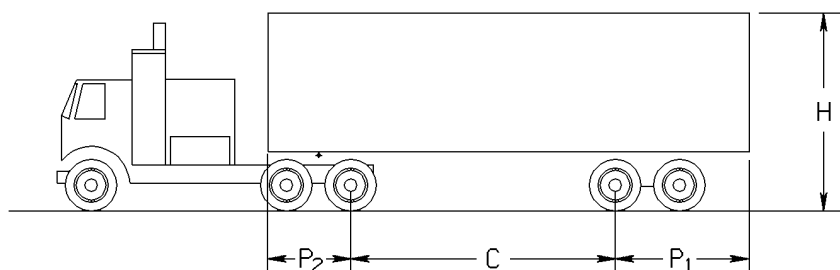
**AFT END LOADING
FORWARD KNEEL
BL 114 LEFT TO BL 114 RIGHT**

CAUTION

**DO NOT LOAD THE VEHICLE THROUGH THE
AIRPLANE AFT END WITH THE AIRPLANE
FORWARD KNEELED IF THE LIMITS IN GRAPH
NO. 8 ARE EXCEEDED.**

NOTE

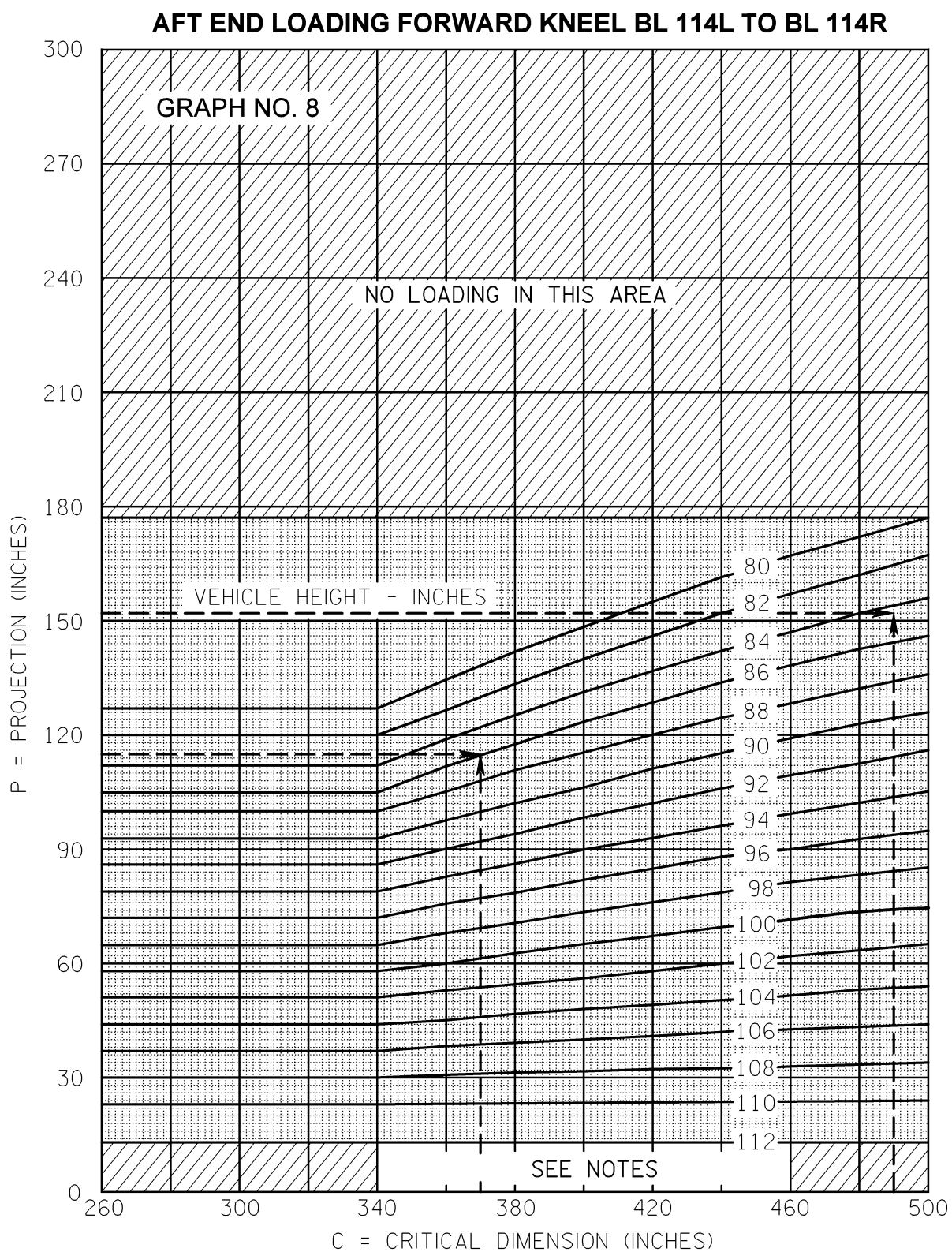
1. IF VEHICLE KNOWN HEIGHT IS GREATER THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE VEHICLE CANNOT BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 8.
2. IF THE VEHICLE KNOWN HEIGHT IS THE SAME OR LESS THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE VEHICLE CAN BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 8.
3. SEE THE CALCULATION PROCEDURES AND EXAMPLE PROBLEMS IN THIS FIGURE FOR EXPLANATION ON THE USE OF GRAPH NO. 8.



C = CRITICAL DIMENSION
H = HEIGHT
P = PROJECTION

L1115374

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 20)



L1115375

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 21)

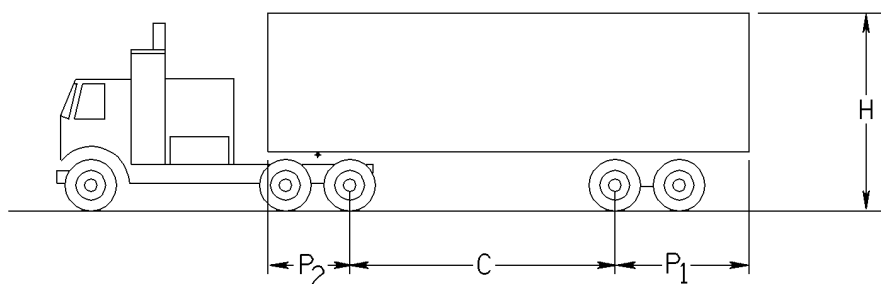
**AFT END LOADING
LEVEL KNEEL
BL 114 LEFT TO BL 114 RIGHT**

CAUTION

**DO NOT LOAD THE VEHICLE THROUGH THE
AIRPLANE AFT END WITH THE AIRPLANE
LEVEL KNEELED IF THE LIMITS IN GRAPH NO. 9
ARE EXCEEDED.**

NOTE

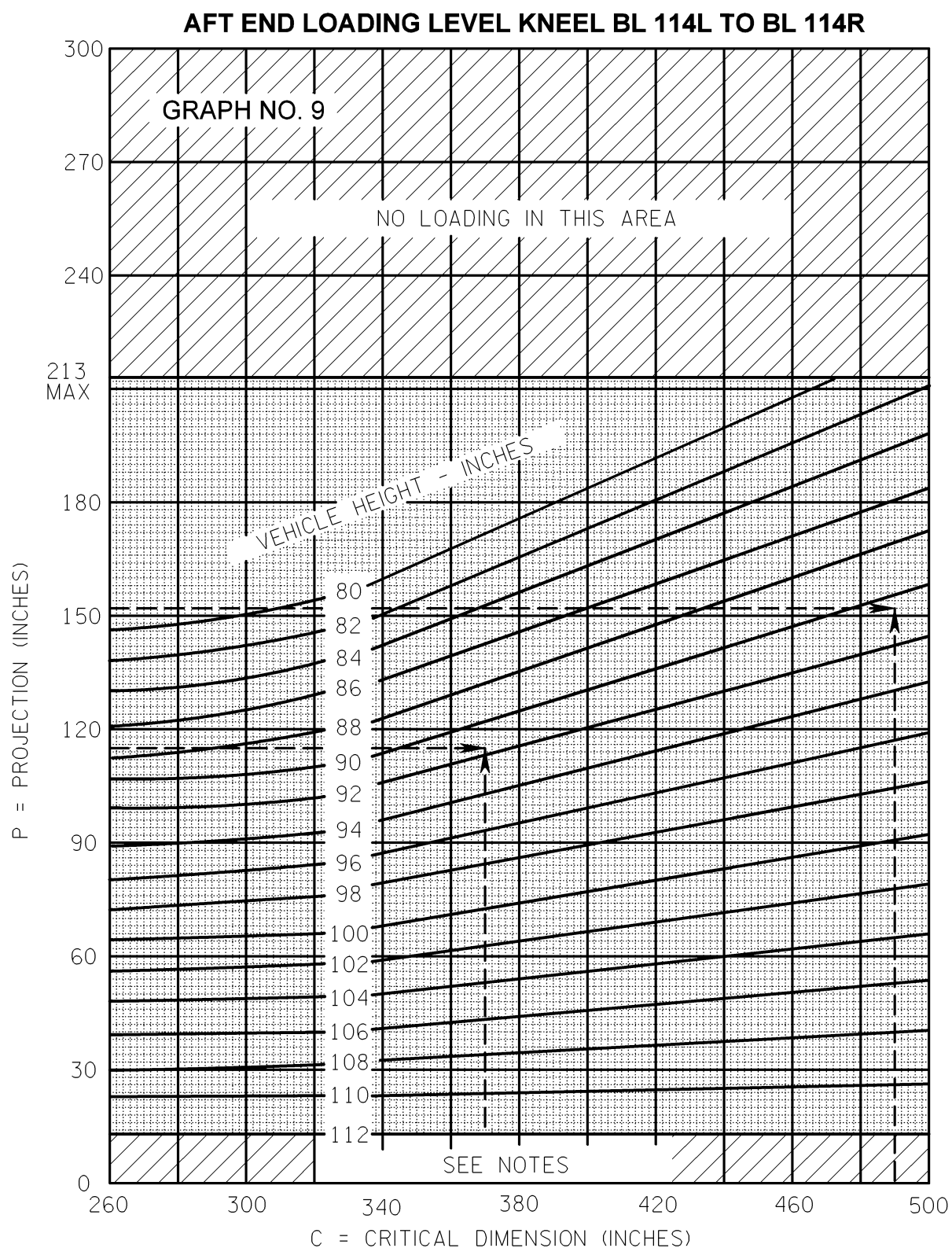
1. IF THE VEHICLE KNOWN HEIGHT IS GREATER THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE VEHICLE CANNOT BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 9.
2. IF THE VEHICLE KNOWN HEIGHT IS THE SAME OR LESS THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE VEHICLE CAN BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 9.
3. SEE THE CALCULATION PROCEDURES AND EXAMPLE PROBLEMS IN THIS FIGURE FOR EXPLANATION ON THE USE OF GRAPH NO. 9.



C = CRITICAL DIMENSION
H = HEIGHT
P = PROJECTION

L1115376

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 22)



L1115377

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 23)

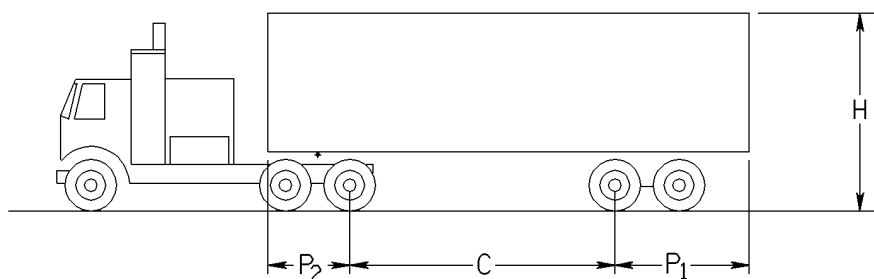
**AFT END LOADING
AFT KNEEL
BL 114 LEFT TO BL 114 RIGHT**

CAUTION

**DO NOT LOAD THE VEHICLE THROUGH THE
AIRPLANE AFT END WITH THE AIRPLANE
AFT KNEELED IF THE LIMITS IN GRAPH NO. 10
ARE EXCEEDED.**

NOTE

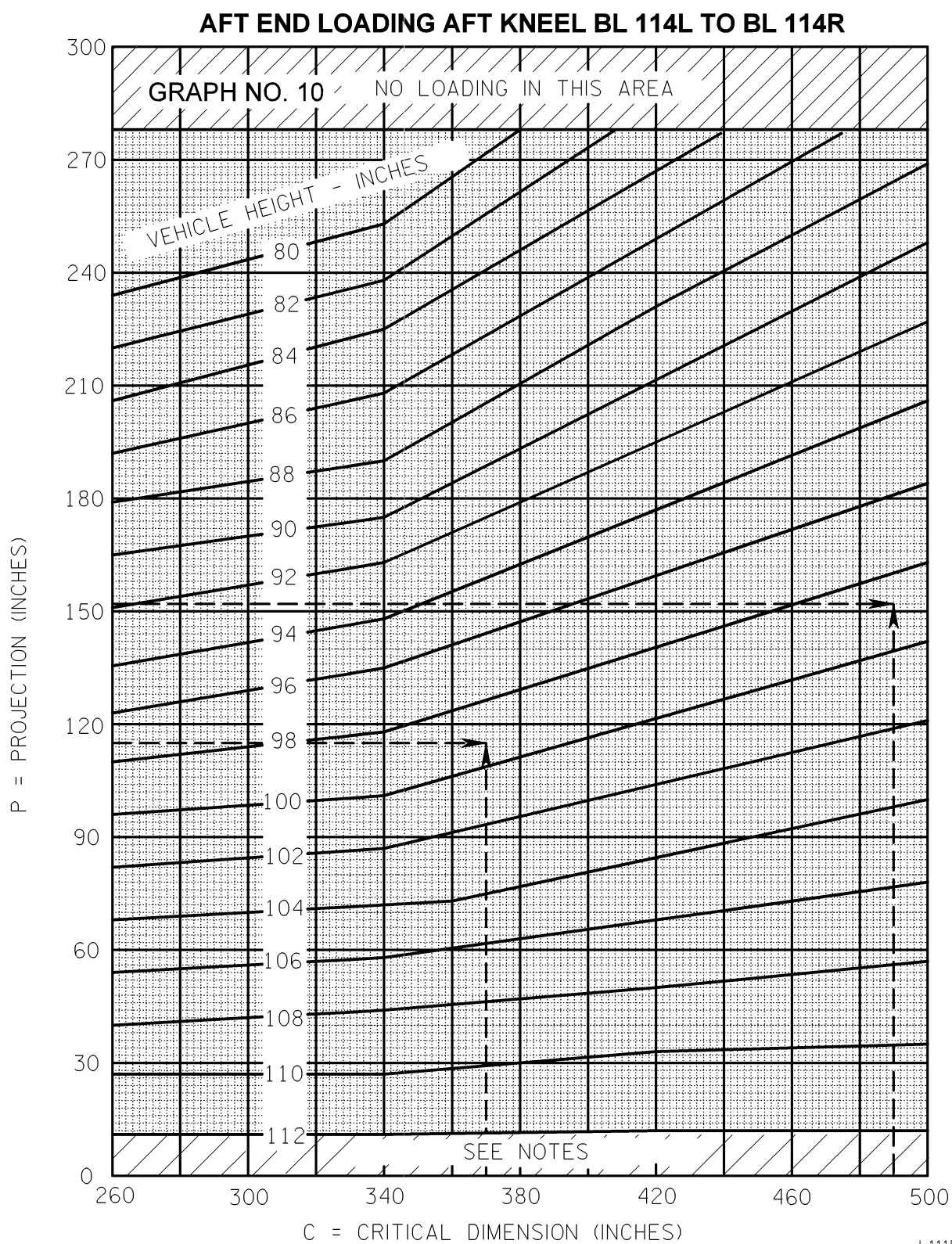
1. IF THE VEHICLE KNOWN HEIGHT IS GREATER THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE VEHICLE CANNOT BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 10.
2. IF THE VEHICLE KNOWN HEIGHT IS THE SAME OR LESS THAN THE HEIGHT REPRESENTED BY THE CURVE (VEHICLE HEIGHT-INCHES) ON OR ABOVE THE INTERSECTION POINT (OF VEHICLE PROJECTION AND CRITICAL DIMENSION), THE VEHICLE CAN BE SAFELY ON/OFF LOADED WITH THE AIRPLANE IN THE CONFIGURATION REPRESENTED BY GRAPH NO. 10.
3. SEE THE CALCULATION PROCEDURES AND EXAMPLE PROBLEMS IN THIS FIGURE FOR EXPLANATION ON THE USE OF GRAPH NO. 10.



C = CRITICAL DIMENSION
H = HEIGHT
P = PROJECTION

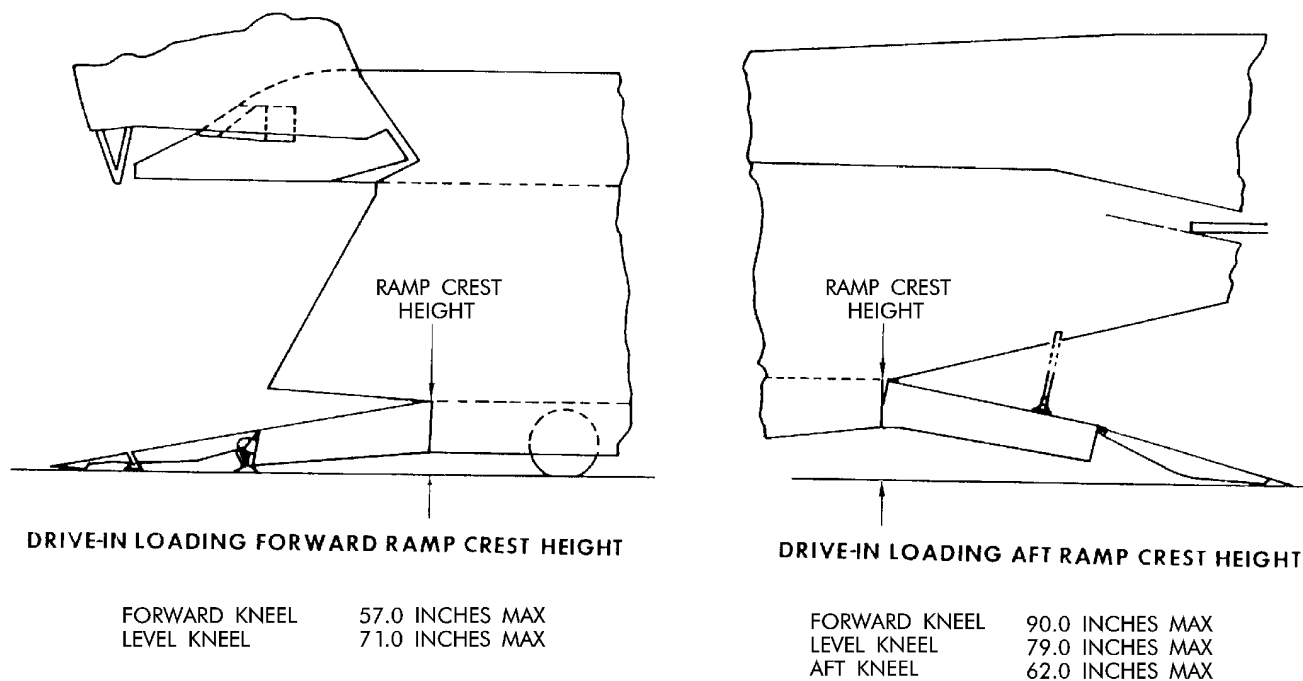
L1115378

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 24)



L1115379

Figure 4-17. Forward and Aft End Loading – Vehicle Projection Limits (Sheet 25)



CAUTION

THE GROUND CLEARANCE OF SINGLE AXLE TRAILERS WILL CHANGE WHEN TOWED DURING LOADING/OFF LOADING. CONTACT COULD OCCUR IN THE AREA OF THE RAMP HINGE/TOES RESULTING IN DAMAGE TO THE AIRPLANE/TRAILER.

RAMP CREST LIMITS - CALCULATION PROCEDURES FOR VEHICLE LOADING

THE GRAPH IN THIS FIGURE PROVIDES A QUICK MEANS OF DETERMINING IF A VEHICLE CAN BE SAFELY ON/OFF LOADED WITH THE FORWARD RAMP AND EXTENSION IN THE DRIVE-IN LOADING POSITION AND THE AIRPLANE IN THE FORWARD OR LEVEL KNEELED POSITION, OR WITH THE AFT RAMP AND PRESSURE DOOR IN THE DRIVE-IN LOADING POSITION AND THE AIRPLANE FORWARD, LEVEL OR AFT KNEELED.

TO USE THE GRAPH TO DETERMINE IF THE VEHICLE CAN BE ON/OFF LOADED PROCEED AS FOLLOWS:

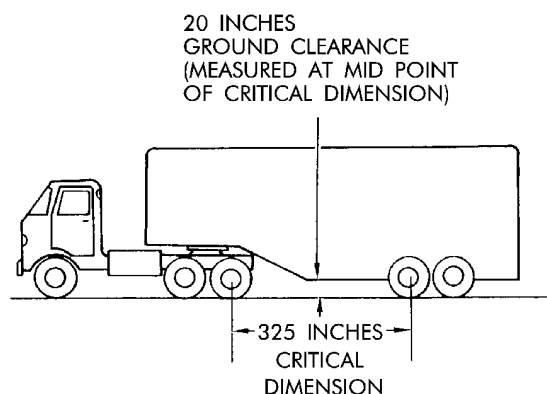
1. LOCATE THE VEHICLE MINIMUM GROUND CLEARANCE ON LEFT SCALE (MINIMUM GROUND CLEARANCE AT VEHICLE MID-CRITICAL DIMENSION-INCHES) OF GRAPH.
2. LOCATE THE VEHICLE KNOWN CRITICAL DIMENSION ON BOTTOM SCALE (VEHICLE CRITICAL DIMENSION-INCHES) OF GRAPH.
3. SIMULTANEOUSLY MOVE RIGHT ACROSS GRAPH FROM LEFT SCALE (MINIMUM GROUND CLEARANCE AT VEHICLE MID-CRITICAL DIMENSION-INCHES) AND UP ON GRAPH FROM BOTTOM SCALE (VEHICLE CRITICAL DIMENSION-INCHES), TO THE INTERSECTION POINT FOR BOTH THESE VALUES.
4. LOAD VEHICLE AS INDICATED BY THE POSITION OF THE INTERSECTION POINT ON GRAPH AND THE RELATED LOADING INSTRUCTION NOTES ON GRAPH.

L1115380

Figure 4-18. Forward and Aft Ramp Crest Limits (Sheet 1 of 7)

EXAMPLE PROBLEM NO. 1

DETERMINE IF A VEHICLE WITH A KNOWN CRITICAL DIMENSION OF 325 INCHES AND A GROUND CLEARANCE OF 20 INCHES CAN BE SAFELY ON/OFF LOADED WITH THE FORWARD AND AFT END OF THE AIRPLANE CONFIGURED FOR DRIVE-IN LOADING AND THE AIRPLANE, AS APPLICABLE, IN THE FORWARD, LEVEL OR AFT KNEELED POSITION.



TO DETERMINE IF THE EXAMPLE VEHICLE CAN BE SAFELY ON/OFF LOADED PROCEED AS FOLLOWS:

1. LOCATE THE VEHICLE KNOWN GROUND CLEARANCE OF 20 INCHES ON THE LEFT SCALE (MINIMUM GROUND CLEARANCE AT VEHICLE MID-CRITICAL DIMENSION-INCHES) OF GRAPH.
2. LOCATE THE VEHICLE KNOWN CRITICAL DIMENSION OF 325 INCHES ON BOTTOM SCALE (VEHICLE CRITICAL DIMENSION-INCHES) OF GRAPH.
3. SIMULTANEOUSLY MOVE RIGHT ACROSS GRAPH FROM LEFT SCALE (MINIMUM GROUND CLEARANCE AT VEHICLE MID-CRITICAL DIMENSION-INCHES) AND UP ON GRAPH FROM BOTTOM SCALE (VEHICLE CRITICAL DIMENSION-INCHES) TO THE INTERSECTION POINT FOR BOTH THESE VALUES.

L1115381

Figure 4-18. Forward and Aft Ramp Crest Limits (Sheet 2)

4. THE INTERSECTION POINTS FOR EXAMPLE VEHICLE (OBTAINED IN STEP 3) FALL IN THE FOLLOWING POSITIONS:

FORWARD RAMP GRAPH – FORWARD KNEELED ZONE

AFT RAMP GRAPH – AFT KNEELED ZONE

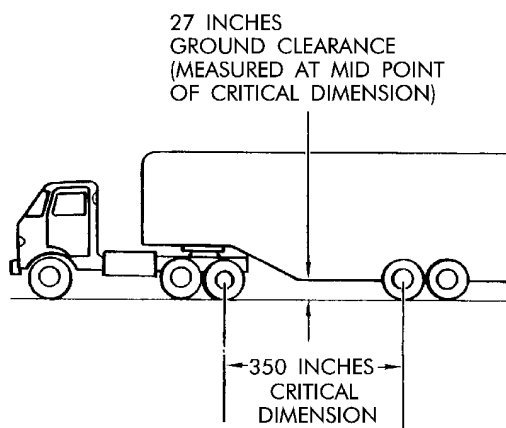
5. ON OR OFF LOAD EXAMPLE VEHICLE AS FOLLOWS:

FORWARD END OF AIRPLANE – WITH AIRPLANE IN FORWARD KNEELED POSITION.

AFT END OF AIRPLANE – WITH AIRPLANE IN AFT KNEELED POSITION.

EXAMPLE PROBLEM NO. 2

DETERMINE IF A VEHICLE WITH A KNOWN CRITICAL DIMENSION OF 350 INCHES AND A KNOWN GROUND CLEARANCE OF 27 INCHES CAN BE SAFELY ON/OFF LOADED WITH THE FORWARD AND AFT END OF THE AIRPLANE CONFIGURED FOR DRIVE ON LOADING AND THE AIRPLANE, AS APPLICABLE, IN THE FORWARD LEVEL OR AFT KNEELED POSITION.



TO DETERMINE IF THE EXAMPLE VEHICLE CAN BE SAFELY ON/OFF LOADED PROCEED AS FOLLOWS:

1. LOCATE THE VEHICLE KNOWN GROUND CLEARANCE OF 27 INCHES ON LEFT SCALE (MINIMUM GROUND CLEARANCE AT VEHICLE MID-CRITICAL DIMENSION-INCHES) OF GRAPH.
2. LOCATE THE VEHICLE KNOWN CRITICAL DIMENSION OF 350 INCHES ON BOTTOM SCALE (VEHICLE CRITICAL DIMENSION-INCHES) OF GRAPH.
3. SIMULTANEOUSLY MOVE RIGHT ACROSS THE GRAPH FROM LEFT SCALE (MINIMUM GROUND CLEARANCE AT VEHICLE MID-CRITICAL DIMENSION-INCHES) AND UP ON GRAPH FROM BOTTOM SCALE (VEHICLE CRITICAL DIMENSION-INCHES) TO THE INTERSECTION POINT FOR BOTH THESE VALUES.

L1115382

Figure 4-18. Forward and Aft Ramp Crest Limits (Sheet 3)

4. THE INTERSECTION POINTS FOR EXAMPLE VEHICLE (OBTAINED IN STEP 3) FALL IN THE FOLLOWING POSITION:

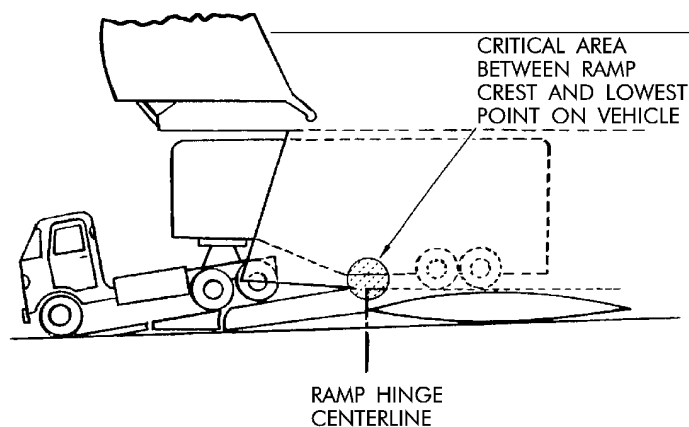
FORWARD RAMP GRAPH – WITHIN LEVEL KNEELED ZONE.

AFT RAMP GRAPH – WITHIN FORWARD KNEELED ZONE.

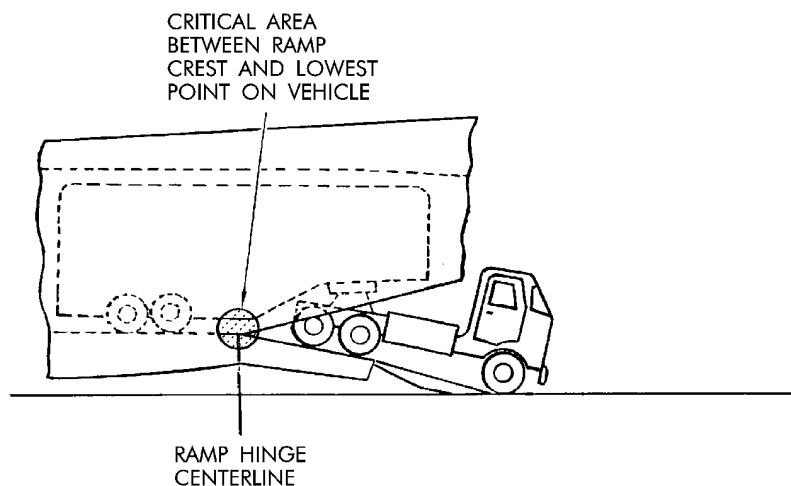
5. ON OR OFF LOAD EXAMPLE VEHICLE AS FOLLOWS:

FORWARD END OF AIRPLANE – WITH AIRPLANE IN LEVEL OR FORWARD KNEELED POSITION.

AFT END OF AIRPLANE – WITH AIRPLANE IN ANY KNEELED POSITION.



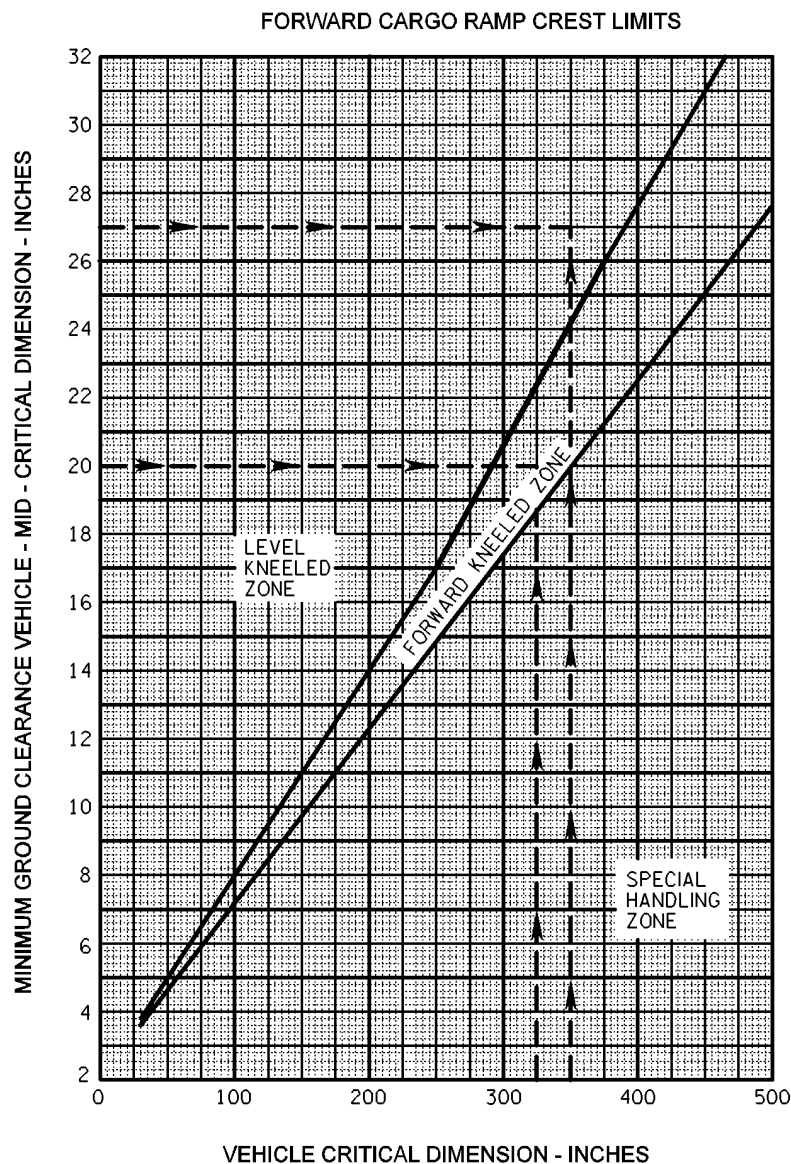
FORWARD END ON/OFF LOADING



AFT END LOADING

L1115383

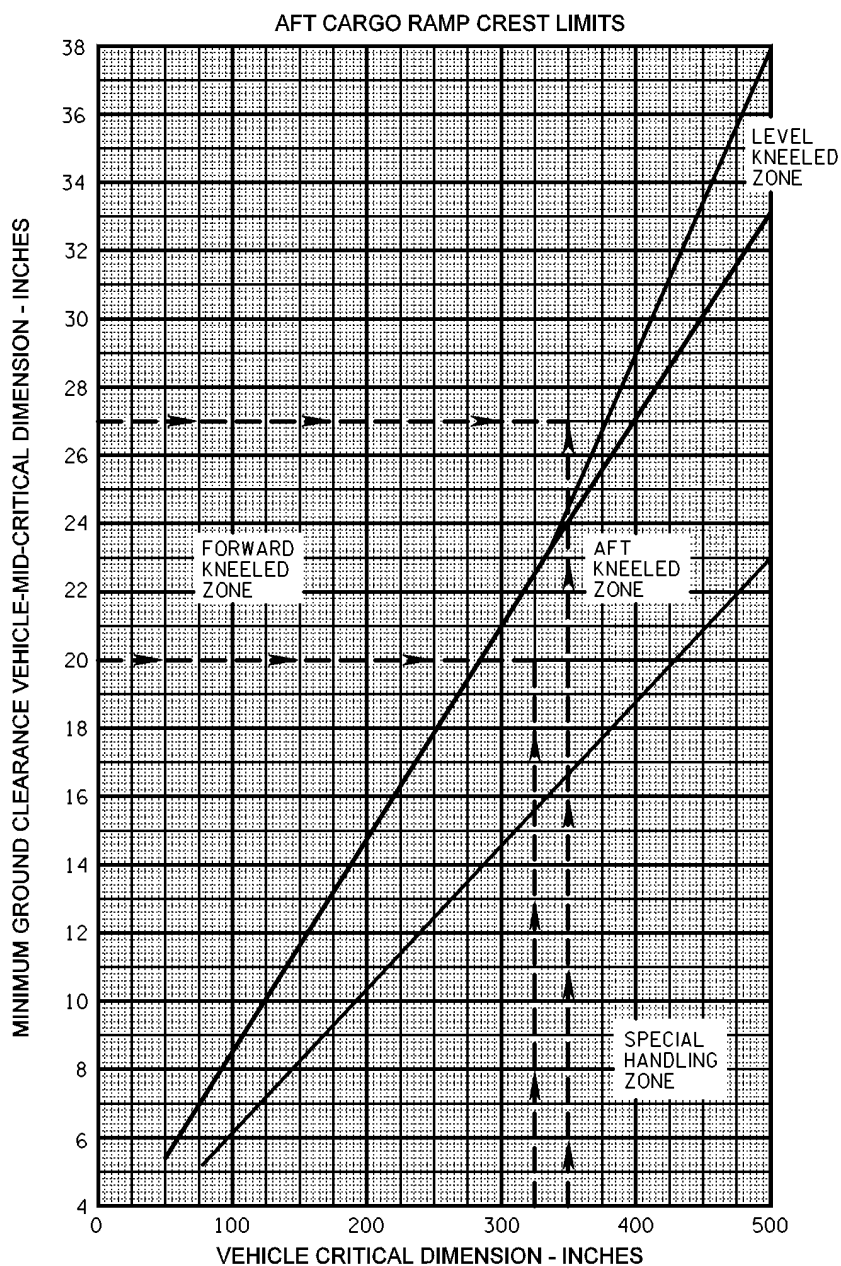
Figure 4-18. Forward and Aft Ramp Crest Limits (Sheet 4)

**NOTE**

1. THE VEHICLE CAN BE SAFELY ON/OFF LOADED, IF THE INTERSECTION POINT FALLS WITHIN OR ABOVE THE AIRPLANE CONFIGURATION ZONE.
2. IF THE INTERSECTION POINT FALLS BELOW THE FORWARD KNEELED ZONE, THE VEHICLE MUST BE ON/OFF LOADED WITH THE RAMP AND EXTENSION IN THE TRUCK LOADING POSITION OR, USING SPECIAL HANDLING PROCEDURES.
3. TO DETERMINE THE REQUIRED THICKNESS OF STEP-UP SHORING FOR SPECIAL HANDLING, PROCEED AS FOLLOWS:
 - a. USING THE VEHICLE CRITICAL DIMENSION MOVE UP TO THE APPROPRIATE KNEELED ZONE.
 - b. MOVE HORIZONTALLY TO READ THE REQUIRED GROUND CLEARANCE.
 - c. SUBTRACT THE ACTUAL GROUND CLEARANCE FROM THE REQUIRED GROUND CLEARANCE TO OBTAIN SHORING THICKNESS. SHORING MAY BE PLACED A DISTANCE EQUAL TO 1/2 VEHICLE CRITICAL DIMENSION ON EACH SIDE OF THE RAMP CREST.

L1115384

Figure 4-18. Forward and Aft Ramp Crest Limits (Sheet 5)

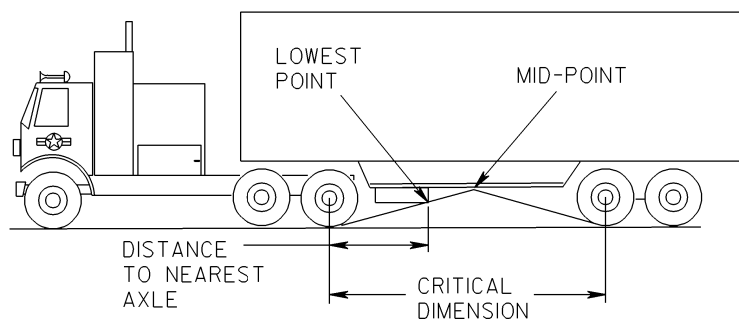
**NOTE**

1. THE VEHICLE CAN BE SAFELY ON/OFF LOADED, IF THE INTERSECTION POINT FALLS IN OR ABOVE THE AIRPLANE CONFIGURATION ZONE.
2. IF THE INTERSECTION POINT FALLS BELOW THE AFT KNEELED ZONE, THE VEHICLE MUST BE ON/OFF LOADED WITH THE RAMP AND PRESSURE DOOR IN THE TRUCK LOADING POSITION OR, USING SPECIAL HANDLING PROCEDURES.
3. TO DETERMINE THE REQUIRED THICKNESS OF STEP-UP SHORING FOR SPECIAL HANDLING, PROCEED AS FOLLOWS:
 - a. USING THE VEHICLE CRITICAL DIMENSION MOVE UP TO THE APPROPRIATE KNEELED ZONE.
 - b. MOVE HORIZONTALLY TO READ THE REQUIRED GROUND CLEARANCE.
 - c. SUBTRACT THE ACTUAL GROUND CLEARANCE FROM THE REQUIRED GROUND CLEARANCE TO OBTAIN SHORING THICKNESS. SHORING MAY BE PLACED A DISTANCE EQUAL TO 1/2 VEHICLE CRITICAL DIMENSION ON EACH SIDE OF THE RAMP CREST.

L1115385

Figure 4-18. Forward and Aft Ramp Crest Limits (Sheet 6)

RAMP CREST LIMITS - PROCEDURE FOR DETERMINING GROUND CLEARANCE FOR POINTS OTHER THAN MID-POINT.



TO DETERMINE IF AN EFFECTIVE MID-POINT GROUND CLEARANCE MUST BE CALCULATED, PROCEED AS FOLLOWS:

1. LOCATE THE MID-POINT OF THE VEHICLE CRITICAL DIMENSION.
2. EXTEND A TAPE MEASURE FROM THE LOWEST POINT OF THE VEHICLE AT MID-POINT DIAGONALLY TO THE GROUND, DIRECTLY BELOW THE CENTER OF THE AXLE. DO THIS FOR EACH AXLE.
3. IF THERE ARE ANY POINTS BELOW THIS LINE, AN EFFECTIVE MID-POINT GROUND CLEARANCE MUST BE CALCULATED.

TO CALCULATE EFFECTIVE MID-POINT GROUND CLEARANCE, PROCEED AS FOLLOWS:

EFFECTIVE MID-POINT GROUND CLEARANCE = (MID-POINT DISTANCE X LOWEST POINT GROUND CLEARANCE) HORIZONTAL DISTANCE TO NEAREST AXLE.

1. MEASURE THE GROUND CLEARANCE AT THE LOWEST POINT CLOSEST TO MID-POINT.
2. MEASURE THE HORIZONTAL DISTANCE TO THE NEAREST AXLE.
3. MULTIPLY THE ACTUAL MID-POINT DISTANCE BY THE LOWEST POINT GROUND CLEARANCE.
4. DIVIDE THIS SUM BY THE HORIZONTAL DISTANCE FROM THE LOWEST POINT TO THE NEAREST AXLE.
5. THE RESULTING NUMBER IS THE EFFECTIVE MID-POINT GROUND CLEARANCE. USE THIS NUMBER IN PLACE OF THE ACTUAL MID-POINT GROUND CLEARANCE IN THE RAMP CREST LIMITS CHARTS.

L1115386

Figure 4-18. Forward and Aft Ramp Crest Limits (Sheet 7)

THIS FIGURE PROVIDES A MEANS OF DETERMINING THE MAXIMUM ALLOWABLE HEIGHT OF CARGO OVER 114 INCHES HIGH FOR ANY GIVEN WIDTH. WIDTHS AND HEIGHTS ARE APPLICABLE TO BOTH THE FORWARD DOOR OPENING WITH RAMP AND RAMP EXTENSION IN THE TRUCK LOADING POSITION AND TO THE CARGO COMPARTMENT.

PROCEDURE:

1. ENTER GRAPH AT THE ACTUAL WIDTH OF CARGO AND MOVE UP VERTICALLY TO THE CLEARANCE CURVE.
2. MOVE HORIZONTALLY ACROSS AND READ MAXIMUM ALLOWABLE CARGO HEIGHT.

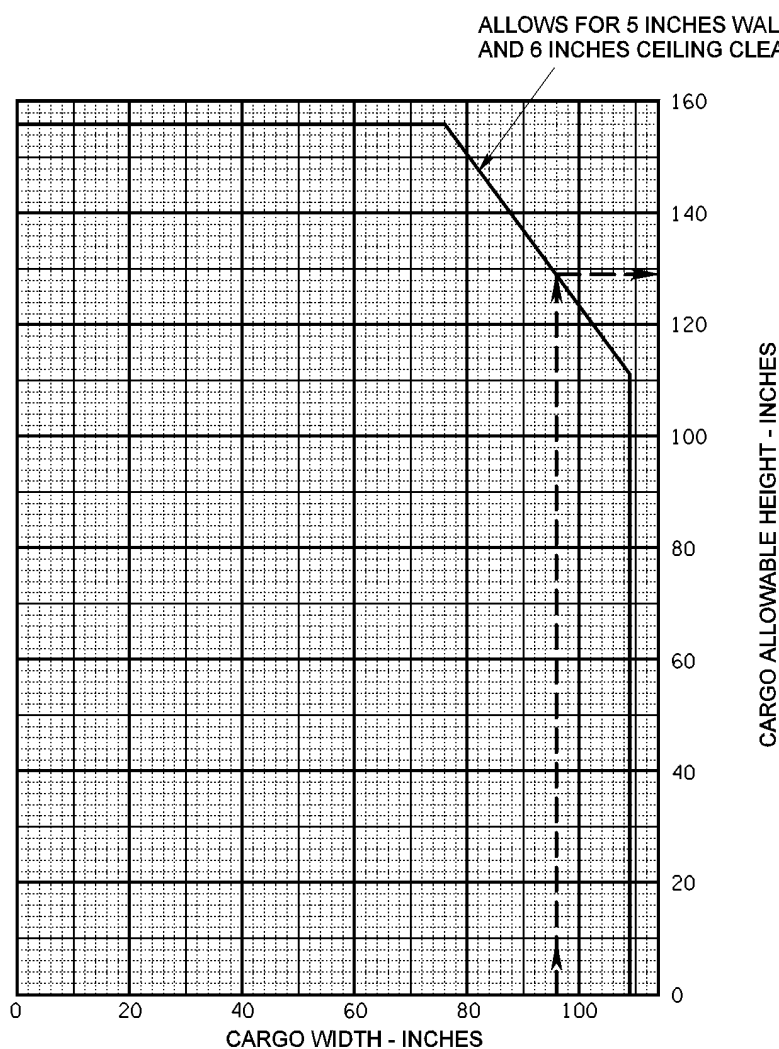
EXAMPLE PROBLEM:

DETERMINE IF A VEHICLE 96 INCHES WIDE AND 120 INCHES HIGH CAN BE LOADED ON THE RIGHT SIDE OF THE AIRPLANE.

1. ENTER GRAPH AT ACTUAL WIDTH OF 96 INCHES AND MOVE UP VERTICALLY TO THE INTERSECTION POINT ON THE CURVE.
2. MOVE HORIZONTALLY ACROSS AND READ CARGO ALLOWABLE HEIGHT OF 129 INCHES. THE ALLOWABLE HEIGHT OF 129 INCHES IS GREATER THAN ACTUAL HEIGHT OF 120 INCHES, THEREFORE THE VEHICLE CAN BE LOADED ON THE RIGHT SIDE OF THE CARGO COMPARTMENT.

NOTE

THE GRAPH AND PROCEDURE IS TO BE USED FOR EITHER SIDE OF AIRPLANE.



L1115387

Figure 4-19. Allowable Cargo Height

PROCEDURE FOR DETERMINING MAXIMUM ALLOWABLE ROLLER CONVEYOR SYSTEM FLIGHT LOADS AND CALCULATION OF SHORING WHEN REQUIRED

	MAXIMUM ALLOWABLE ROLLER CONVEYOR FLIGHT LOADS				
COLUMN	1		2	3	4
	EACH CONTACT POINT SUPPORTED BY ONE LONGITUDINAL ROLLER AND USES ONLY ONE ROLLER CONVEYOR FOR SUPPORT.		EACH CONTACT POINT SUPPORTED BY ONE LONGITUDINAL ROLLER AND USES 2 TO 4 ROLLER CONVEYORS FOR SUPPORT.	EACH CONTACT POINT SUPPORTED BY MORE THAN ONE LONGITUDINAL ROLLER AND USES 1 OR 2 ROLLER CONVEYORS FOR SUPPORT.	EACH CONTACT POINT SUPPORTED BY MORE THAN ONE LONGITUDINAL ROLLER AND USES 3 OR 4 ROLLER CONVEYORS FOR SUPPORT.
UNITS	POUNDS/ROLLER		POUNDS/LATERAL ROW	POUNDS/LINEAR INCH (PLI)	POUNDS/LINEAR INCH (PLI)
LOGISTIC SYSTEM	L ₁ ≤ 11.0 INCHES		L ₁ ≤ 11.0 INCHES	L ₁ > 11.0 INCHES	L ₁ > 11.0 INCHES
	FS 395-1971	1,100	  2,200	 100	 200
	FS 1971-2131	1,070	  2,140		
ADS	L ₁ ≤ 20.0 INCHES 3,205		L ₁ ≤ 20.0 INCHES   6,410	L ₁ > 20.0 INCHES  160	L ₁ > 20.0 INCHES  320

NOTE

-  IF EACH CONTACT POINT IS SUPPORTED BY ONE LONGITUDINAL ROLLER AND USES 5 ROLLER CONVEYORS FOR SUPPORT, ADD THE ALLOWABLE LOAD IN COLUMN 1 AND COLUMN 2.
-  IF EACH CONTACT POINT IS SUPPORTED BY ONE LONGITUDINAL ROLLER AND USES 6 OR MORE ROLLER CONVEYORS FOR SUPPORT, USE TWICE THE ALLOWABLE LOAD IN COLUMN 2.
-  IF EACH CONTACT POINT IS SUPPORTED BY MORE THAN ONE LONGITUDINAL ROLLER AND UTILIZES 5 OR 6 ROLLER CONVEYORS FOR SUPPORT, ADD THE ALLOWABLE LOAD IN COLUMN 3 AND COLUMN 4.
-  IF EACH CONTACT POINT IS SUPPORTED BY MORE THAN ONE LONGITUDINAL ROLLER AND UTILIZES 7 OR 8 ROLLER CONVEYORS FOR SUPPORT, USE TWICE THE ALLOWABLE LOAD IN COLUMN 4.

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Figure 4-20. Logistics and ADS Roller Conveyors – Maximum Allowable Flight Loads (Sheet 1 of 18)

DEFINITIONS

1. CONTACT POINT IS THE FOOTPRINT AREA THAT IS CREATED BY ANY PIECE OF CARGO PLACED UPON A PALLET/PLATFORM. AN EXAMPLE IS A SKID FOOTPRINT.
2. L_1 IS THE LONGITUDINAL LENGTH OF A CONTACT OR SOLID ITEM OF CARGO.
3. L_2 IS THE LATERAL DISTANCE BETWEEN THE CENTERS OF SEPARATE LONGITUDINAL CONTACT POINTS. (COLUMN 3 AND COLUMN 4 CONTACTS ONLY.)
4. COLUMN ALLOWABLE LOAD IS THE ALLOWABLE LOAD FOUND UNDER THE COLUMN NUMBER (IN SHEET 1) FOR A PARTICULAR CONTACT POINT.
5. CONTACT POINTS SUPPORTED BY ROLLER CONVEYORS OR BETWEEN ROLLER CONVEYORS ARE IN ZONE B.
6. CONTACT POINTS WITH CENTER OUTBOARD OF THE OUTBOARD ROLLER CONVEYORS ARE IN ZONE A.
7. ROLLER LOAD FACTOR (RLF) IS A NUMBER USED TO DECREASE THE COLUMN ALLOWABLE LOAD FOR TWO OR MORE CONTACT POINTS POSITIONED LONGITUDINALLY SIDE BY SIDE WITH AN L_1 GREATER THAN 11.0 INCHES (LOGISTIC SYSTEM) OR GREATER THAN 20.0 INCHES (ADS).
8. LATERAL CONTACT POINTS (FOOTPRINTS) ARE CREATED BY CONTACTS WITH AN $L_1 \leq 11.0$ INCHES (LOGISTIC SYSTEM) OR $L_1 \leq 20.0$ INCHES (ADS).

ADDITIONAL INFORMATION

1. THE LOGISTICS ROLLERS ARE SPACED APPROXIMATELY AT 5.3-INCH INTERVALS. THE ADS ROLLERS ARE SPACED AT APPROXIMATELY 10.0-INCH INTERVALS.
2. IF A LOAD IS TO BE POSITIONED Laterally ACROSS THE PALLET/PLATFORM WITH ONE CONTACT POINT IN ZONE A AND ONE CONTACT POINT IN ZONE B, USE THE MOST CRITICAL FACTOR FOR COMPUTATION.
3. A CONTACT THAT IS NOT DIRECTLY OVER ANY ROLLER/CONVEYOR IS CONSIDERED TO BE SUPPORTED BY ONE ROLLER/CONVEYOR. MINIMUM CONTACT SUPPORT IS ALWAYS CONSIDERED TO BE ONE, NEVER ZERO.
4. A CONTACT SUPPORTED BY TWO OR MORE ROLLER CONVEYORS MUST BE DIRECTLY OVER EACH ROLLER CONVEYOR.
5. THE MAXIMUM ALLOWABLE WEIGHT FOR TWO OR MORE LATERAL CONTACTS $L_1 \leq 11.0$ INCHES IS 2,200 POUNDS (LOGISTIC SYSTEM). $L_1 \leq 20.0$ INCHES (ADS) PER LATERAL ROW IS THE SAME AS THAT LISTED IN COLUMN 2 OF SHEET 1. (SEE DELTA NOTES ON SHEET 1 WHEN LOAD SPANS MORE THAN 4 ROLLER CONVEYORS.)
6. IF THE COMBINED L_1 OF TWO OR MORE LONGITUDINALLY ADJACENT CONTACTS PLUS THE SPACING BETWEEN THEM IS ≤ 11.0 INCHES, THEY SHALL BE CONSIDERED AS ONE LATERAL ROW.

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Figure 4-20. Logistics and ADS Roller Conveyors – Maximum Allowable Flight Loads (Sheet 2)

GENERAL PROCEDURES

- 1. DIVIDE CARGO WEIGHT BY NUMBER OF CONTACTS TO DETERMINE APPLIED LOAD.
- 2. DETERMINE LENGTH 1 (L₁) AND LENGTH 2 (L₂) IF APPLICABLE.
- 3. DETERMINE PALLET/PLATFORM ZONE IN WHICH CONTACT POINTS ARE LOCATED.
- 4. USE L₂ TO DETERMINE ROLLER LOAD FACTOR (RLF) FROM THE ROLLER LOAD FACTOR CHART.
- 5. COMPARE THE APPLIED LOAD PER CONTACT POINT OR POUNDS/LATERAL ROW WITH THE MAXIMUM ALLOWABLE LOAD IN COLUMN 1, 2, 3, OR 4 ON SHEET 1, AS APPLICABLE. IF THE ALLOWABLE LOAD IS EQUAL TO OR GREATER THAN THE APPLIED LOAD, NO SHORING IS REQUIRED. IF THE ALLOWABLE LOAD IS LESS THAN THE APPLIED LOAD, SHORING IS REQUIRED AND MUST BE DETERMINED FOR EACH CARGO UNIT THAT IS LOADED

NOTE

SHORING IS DETERMINED BY THE MOST CRITICAL CONTACT POINT AND MUST BE APPLIED EQUALLY AT ALL CONTACT POINTS.

NOTE

IF THE CONTACT POINT OVERHANGS THE SURFACE OF THE PALLET, DO NOT DIVIDE THE ADDITIONAL LENGTH BY TWO. THE ADDITIONAL LENGTH IS THE THICKNESS REQUIRED.

NOTE

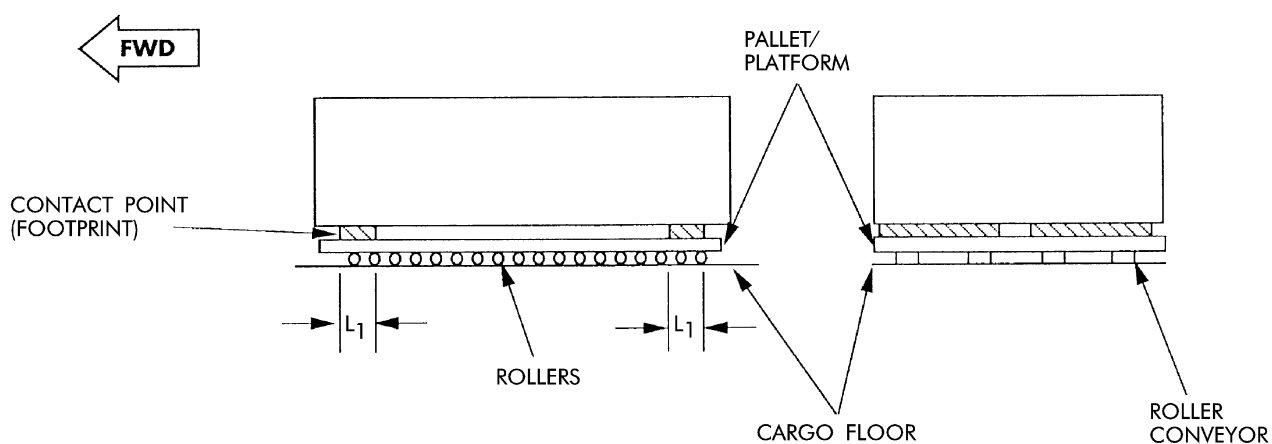
AN ALTERNATE METHOD IS TO INCREASE THE NUMBER OF CONTACTS.

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Figure 4-20. Logistics and ADS Roller Conveyors – Maximum Allowable Flight Loads (Sheet 3)

6. COMPARE THE UNIT (AS LOADED) TO THE MAXIMUM ALLOWABLE LOADS IN THIS FIGURE.

a. LOADS ON A PALLET/PLATFORM WITH CONTACT POINTS POSITIONED Laterally ON THE ROLLER CONVEYORS.



NOTE

THE PROCEDURES IN THE FOLLOWING EXAMPLES APPLY TO THE LOGISTICS SYSTEM FWD OF FS 1971. THE SAME PROCEDURES ARE USED FOR THE LOGISTICS SYSTEM AFT OF FS 1971 AND THE ADS SYSTEM EXCEPT THE APPLICABLE MAXIMUM ALLOWABLE ADS LOADS IN COLUMN 1, 2, 3 OR 4 ON SHEET 1.

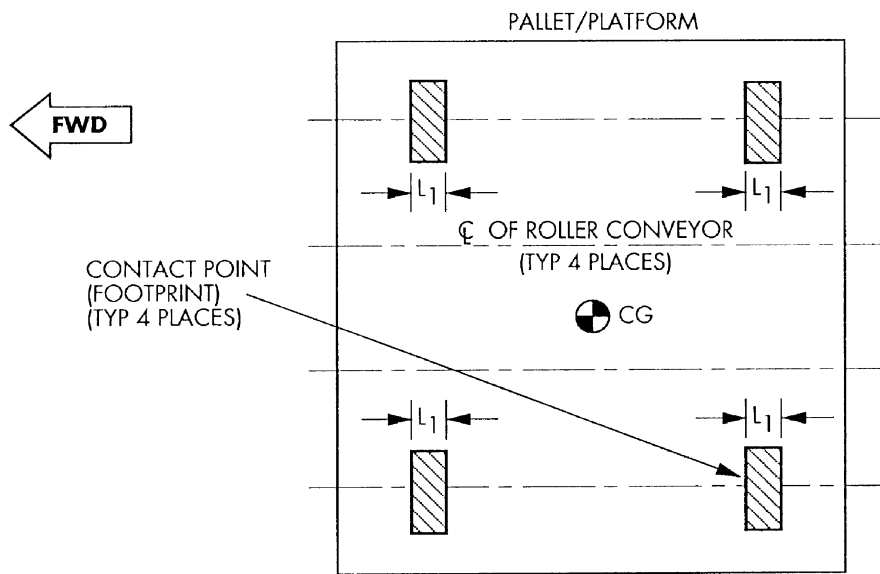
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Figure 4-20. Logistics and ADS Roller Conveyors – Maximum Allowable Flight Loads (Sheet 4)

(1) **EXAMPLE 1**

A CARGO UNIT IS LOADED ON A PALLET/PLATFORM LOCATED FWD OF FS 1971 AND THE WEIGHT IS SUPPORTED BY THE FOUR CONTACT POINTS AS SHOWN. THE FOLLOWING DATA IS GIVEN.

- UNIT WEIGHT = 4,080 LBS
- $L_1 = 10$ INCHES



DETERMINE IF THE CARGO UNIT CAN BE LOADED ON THE LOGISTICS SYSTEM WITHOUT USING SHORING.

- (a) DETERMINE APPLIED LOAD AT EACH CONTACT POINT.

$$\text{APPLIED LOAD PER CONTACT POINT} = \frac{4,080}{4} = 1,020 \text{ POUNDS}$$

- (b) DETERMINE MAXIMUM ALLOWABLE LOAD PER CONTACT POINT. USE COLUMN 1 ON SHEET 1 TO DETERMINE MAXIMUM ALLOWABLE LOAD PER CONTACT POINT FOR THIS EXAMPLE.

$$\text{LOGISTIC SYSTEM} = 1,100 \text{ LBS/ROLLER}$$

- (c) COMPARE THE MAXIMUM ALLOWABLE LOAD TO THE APPLIED LOAD AT EACH CONTACT POINT. THE APPLIED LOAD IS LESS THAN THE MAXIMUM ALLOWABLE LOAD PER CONTACT POINT, THEREFORE, NO SHORING IS REQUIRED.
- (d) COMPARE THE TOTAL CARGO UNIT WEIGHT TO THE MAXIMUM ALLOWABLE LOADS IN THIS FIGURE. THE CARGO UNIT IN EXAMPLE 1 CAN BE SAFELY LOADED ON THE LOGISTICS SYSTEM.

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Figure 4-20. Logistics and ADS Roller Conveyors – Maximum Allowable Flight Loads (Sheet 5)

(2) **EXAMPLE 2**

A CARGO UNIT IS LOADED ON A PALLET/PLATFORM THE SAME AS IN EXAMPLE 1 EXCEPT THE UNIT WEIGHT = 4,680 POUNDS. DETERMINE IF THE CARGO UNIT CAN BE LOADED ON THE LOGISTICS SYSTEM WITHOUT USING SHORING.

- (a) DETERMINE APPLIED LOAD AT EACH CONTACT POINT.

$$\text{APPLIED LOAD PER CONTACT POINT} = \frac{4,680}{4} = 1,170 \text{ POUNDS}$$

- (b) DETERMINE MAXIMUM ALLOWABLE LOAD PER CONTACT POINT. USE COLUMN 1 ON SHEET 1 TO DETERMINE MAXIMUM ALLOWABLE LOAD PER CONTACT POINT FOR THIS EXAMPLE.

$$\text{LOGISTIC SYSTEM} = 1,100 \text{ LBS/ROLLER}$$

- (c) COMPARE MAXIMUM ALLOWABLE LOAD PER CONTACT POINT TO THE APPLIED LOAD AT EACH CONTACT POINT. THE APPLIED LOAD IS GREATER THAN THE MAXIMUM ALLOWABLE LOAD, THEREFORE SHORING IS REQUIRED.

- (d) DETERMINE SHORING REQUIRED AS FOLLOWS:

NOTE

IN DETERMINING REQUIRED LENGTH (L_R), THE MAXIMUM ALLOWABLE LOAD IN COLUMN 3 ON SHEET 1 MUST BE USED SINCE EACH CONTACT POINT WILL BE SUPPORTED BY MORE THAN ONE LONGITUDINAL ROLLER AND USES 1 OR 2 ROLLER CONVEYORS.

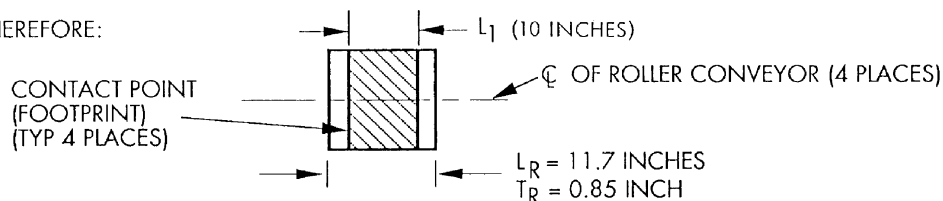
- REQUIRED LENGTH (L_R)

$$L_R = \frac{\text{APPLIED LOAD}}{\text{ALLOWABLE LOAD PER INCH}} = \frac{1,170}{100} = 11.7 \text{ INCHES}$$

- REQUIRED THICKNESS (T_R)

$$T_R = \frac{L_R - L_1}{2} = \frac{11.7 - 10}{2} = 0.85 \text{ INCH}$$

- THEREFORE:



- THE WIDTH OF SHORING MUST BE AT LEAST AS WIDE AS THE CONTACT POINT.

- (e) COMPARE THE TOTAL CARGO UNIT WEIGHT TO THE MAXIMUM ALLOWABLE LOADS IN THIS FIGURE. THE CARGO UNIT IN EXAMPLE 2 CAN BE SAFELY LOADED ON THE LOGISTIC SYSTEM.

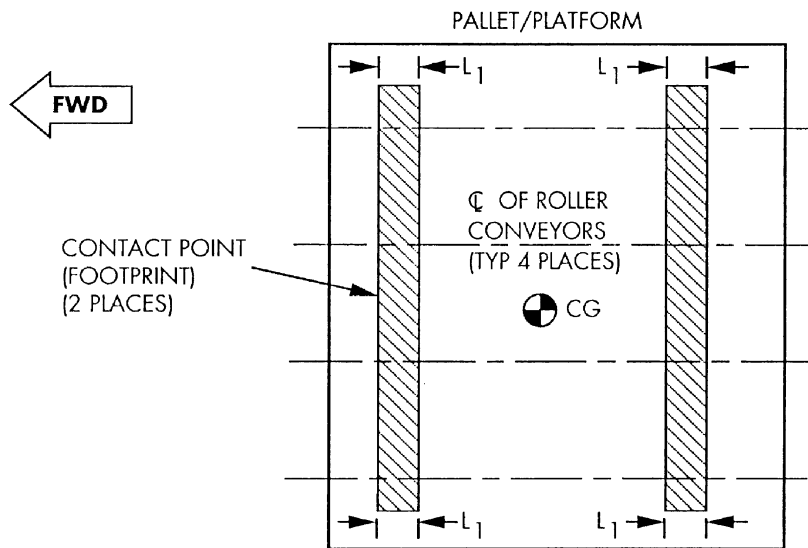
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Figure 4-20. Logistics and ADS Roller Conveyors – Maximum Allowable Flight Loads (Sheet 6)

(3) **EXAMPLE 3**

A CARGO UNIT IS LOADED ON A PALLET/PLATFORM LOCATED FWD OF FS 1971 AND THE WEIGHT IS SUPPORTED BY THE TWO CONTACT POINTS AS SHOWN. THE FOLLOWING DATA IS GIVEN.

- UNIT WEIGHT = 4,080 LBS
- $L_1 = 10$ INCHES



DETERMINE IF THE CARGO UNIT CAN BE LOADED ON THE LOGISTICS SYSTEM WITHOUT USING SHORING.

- (a) DETERMINE APPLIED LOAD PER LATERAL ROW OF ROLLER CONVEYORS.

$$\text{APPLIED LOAD PER LATERAL ROW} = \frac{4,080}{2} = 2,040 \text{ POUNDS}$$

- (b) DETERMINE MAXIMUM ALLOWABLE LOAD PER LATERAL ROW. USE COLUMN 2 ON SHEET 1 TO DETERMINE MAXIMUM ALLOWABLE LOAD PER LATERAL ROW FOR THIS EXAMPLE.

$$\text{LOGISTIC SYSTEM} = 2,200 \text{ LBS/LATERAL ROW}$$

- (c) COMPARE MAXIMUM ALLOWABLE LOAD TO APPLIED LOAD PER PAIR OF LATERAL ROWS OF ROLLER CONVEYORS. THE APPLIED LOAD IS LESS THAN THE MAXIMUM ALLOWABLE LOAD, THEREFORE, NO SHORING IS REQUIRED.
- (d) COMPARE THE TOTAL CARGO UNIT WEIGHT TO THE MAXIMUM ALLOWABLE LOADS IN THIS FIGURE. THE CARGO UNIT IN EXAMPLE 3 CAN BE SAFELY LOADED ON THE LOGISTICS SYSTEM.

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Figure 4-20. Logistics and ADS Roller Conveyors – Maximum Allowable Flight Loads (Sheet 7)

(4) **EXAMPLE 4**

A CARGO UNIT IS LOADED ON A PALLET/PLATFORM THE SAME AS IN EXAMPLE 3 EXCEPT THE UNIT WEIGHT = 4,680 POUNDS. DETERMINE IF THE CARGO UNIT CAN BE LOADED ON THE LOGISTICS SYSTEM WITHOUT USING SHORING.

- (a) DETERMINE APPLIED LOAD PER LATERAL ROW OF ROLLER CONVEYORS.

$$\text{APPLIED LOAD PER LATERAL ROW} = \frac{4,680}{2} = 2,340 \text{ POUNDS}$$

- (b) DETERMINE MAXIMUM ALLOWABLE LOAD PER LATERAL ROW. USE COLUMN 2 ON SHEET 1 TO DETERMINE MAXIMUM ALLOWABLE LOAD PER LATERAL ROW FOR THIS EXAMPLE.

$$\text{LOGISTIC SYSTEM} = 2,200 \text{ POUNDS/LATERAL ROW}$$

- (c) COMPARE MAXIMUM ALLOWABLE LOAD TO THE APPLIED LOAD PER LATERAL ROW OF ROLLERS CONVEYORS. THE APPLIED LOAD IS GREATER THAN THE MAXIMUM ALLOWABLE LOAD, THEREFORE, SHORING IS REQUIRED.

- (d) DETERMINE SHORING REQUIRED AS FOLLOWS:

NOTE

IN DETERMINING REQUIRED LENGTH (L_R), THE MAXIMUM ALLOWABLE LOAD IN COLUMN 4 ON SHEET 1 MUST BE USED SINCE EACH CONTACT POINT WILL BE SUPPORTED BY MORE THAN ONE LONGITUDINAL ROLLER AND WILL USE 3 OR 4 ROLLER CONVEYORS.

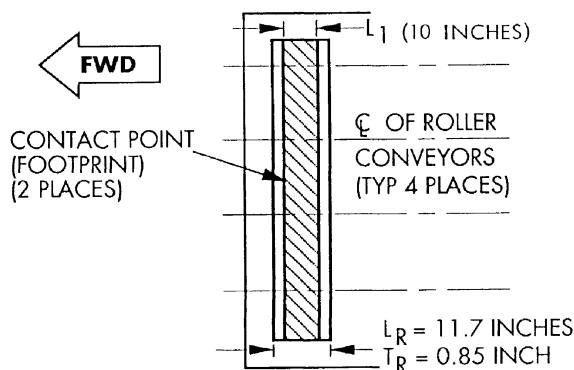
- REQUIRED LENGTH (L_R)

$$\bullet L_R = \frac{\text{APPLIED LOAD}}{\text{ALLOWABLE LOAD PER INCH}} = \frac{2,340}{200} = 11.7 \text{ INCHES}$$

- REQUIRED THICKNESS (T_R)

$$T_R = \frac{L_R - L_1}{2} = \frac{11.7 - 10}{2} = 0.85 \text{ INCH}$$

- THEREFORE:



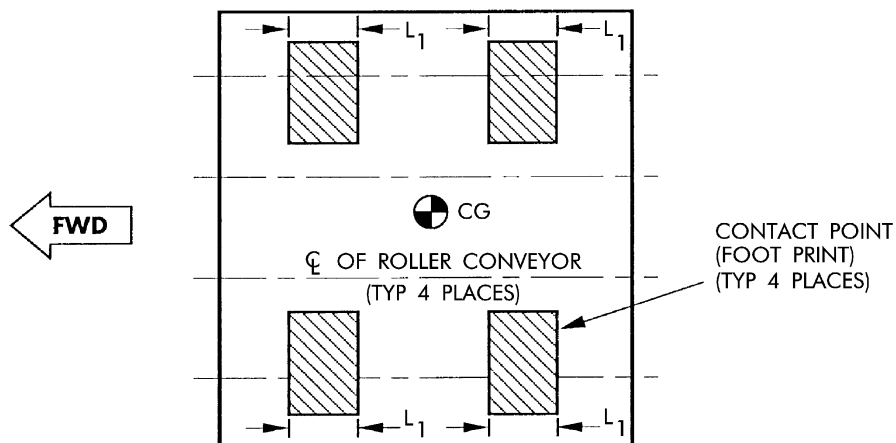
- THE WIDTH OF SHORING MUST BE AT LEAST AS WIDE AS THE CONTACT POINT.

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Figure 4-20. Logistics and ADS Roller Conveyors – Maximum Allowable Flight Loads (Sheet 8)

- (e) COMPARE THE TOTAL CARGO UNIT WEIGHT TO THE MAXIMUM ALLOWABLE LOADS IN THIS FIGURE. THE CARGO UNIT IN EXAMPLE 4 CAN BE SAFELY LOADED ON THE LOGISTICS SYSTEM.

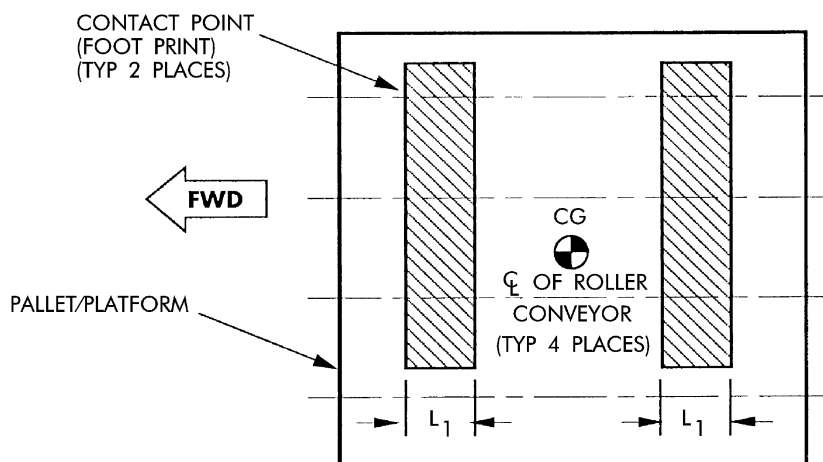
(5) **EXAMPLE 5**



NOTE

WHEN A CARGO UNIT WEIGHT IS SUPPORTED BY CONTACT POINTS AS SHOWN IN THIS EXAMPLE AND LENGTH (L_1) IS > 11.0 INCHES, USE THE SAME PROCEDURES AS SHOWN IN EXAMPLE 1 AND 2, EXCEPT USE THE MAXIMUM ALLOWABLE LOAD IN COLUMN 3 ON SHEET 1 AND MULTIPLY LOAD IN COLUMN 3 TIMES LENGTH (L_1) TO DETERMINE MAXIMUM ALLOWABLE LOAD PER CONTACT POINT.

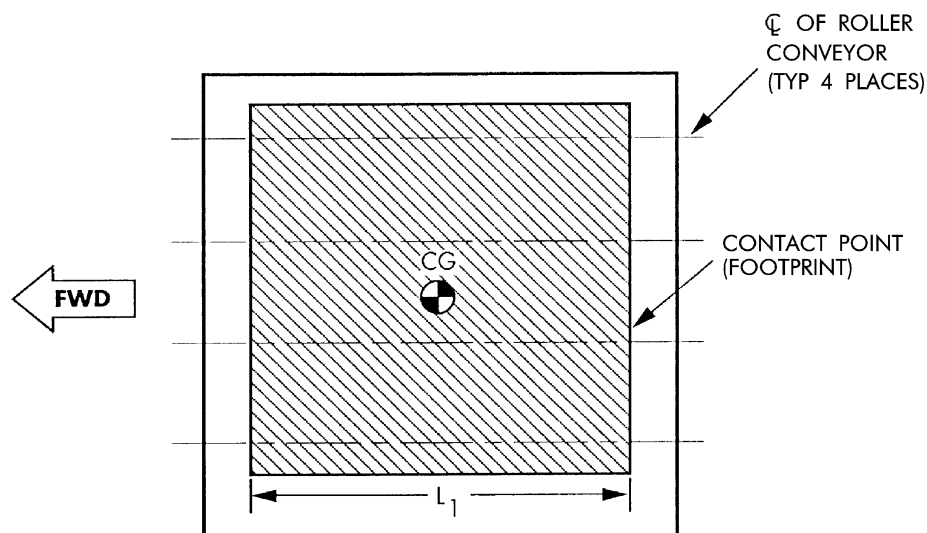
(6) **EXAMPLE 6**



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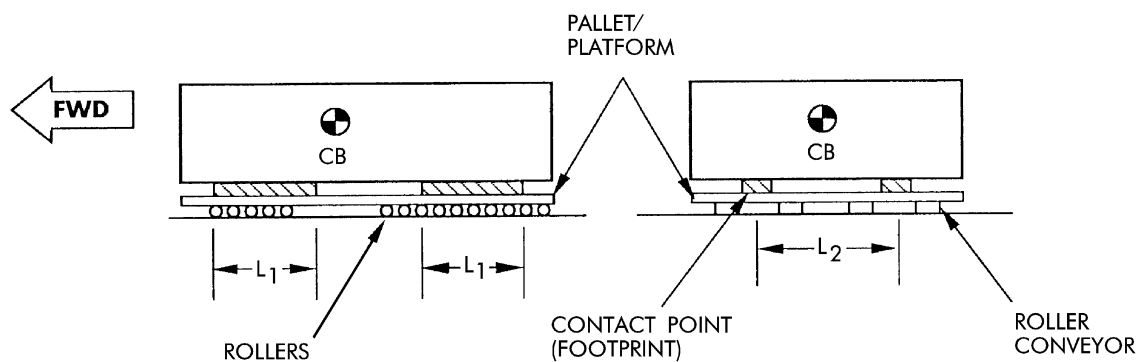
Figure 4-20. Logistics and ADS Roller Conveyors – Maximum Allowable Flight Loads (Sheet 9)

(7) EXAMPLE 7

**NOTE**

WHEN A CARGO UNIT WEIGHT IS SUPPORTED BY CONTACT POINTS AS SHOWN IN EXAMPLE 6 OR 7 AND LENGTH (L_1) IS EQUAL TO OR GREATER THAN 11.0 INCHES, USE THE SAME PROCEDURES AS SHOWN IN EXAMPLES 1 AND 2, EXCEPT USE THE MAXIMUM ALLOWABLE LOAD IN COLUMN 4 ON SHEET 1 AND MULTIPLY LOAD IN COLUMN 4 TIMES LENGTH (L_1) TO DETERMINE MAXIMUM ALLOWABLE LOAD PER CONTACT POINT.

B. LOADS ON A PALLET/PLATFORM WITH CONTACT POINTS POSITIONED LONGITUDINALLY ON THE ROLLER CONVEYORS.

**NOTE**

THE PROCEDURES IN THE FOLLOWING EXAMPLES APPLY TO THE LOGISTICS SYSTEM FWD OF FS1971. THE SAME PROCEDURES ARE USED FOR THE LOGISTICS SYSTEM AFT OF FS 1971 AND THE ADS SYSTEM EXCEPT THE APPLICABLE MAXIMUM ALLOWABLE ADS LOADS IN COLUMN 3 ON SHEET 1.

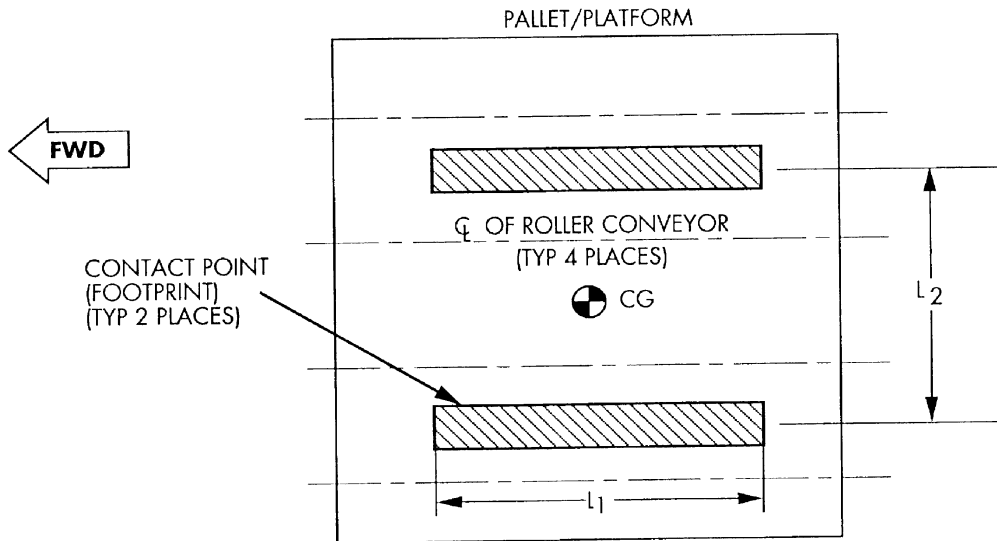
L1115397

Figure 4-20. Logistics and ADS Roller Conveyors – Maximum Allowable Flight Loads (Sheet 10)

(1) **EXAMPLE 1**

A CARGO UNIT IS LOADED ON A PALLET/PLATFORM AND THE WEIGHT IS SUPPORTED BY THE TWO CONTACT POINTS AS SHOWN. THE FOLLOWING DATA IS GIVEN.

- UNIT WEIGHT = 9,400 POUNDS
- $L_1 = 48$ INCHES, $L_2 = 56$ INCHES



DETERMINE IF THE CARGO UNIT CAN BE LOADED ON THE LOGISTICS SYSTEM WITHOUT USING SHORING.

(a) DETERMINE APPLIED LOAD AT EACH CONTACT POINT.

$$\text{APPLIED LOAD PER CONTACT POINT} = \frac{9,400}{2} = 4,700 \text{ POUNDS}$$

(b) DETERMINE MAXIMUM ALLOWABLE LOAD PER CONTACT POINT.

- THE ALLOWABLE LOAD PER CONTACT POINT IS CALCULATED BY DIVIDING THE APPROPRIATE LOAD FROM COLUMN 3 ON SHEET 1 BY THE ROLLER LOAD FACTOR, THEN MULTIPLYING THE RESULTS BY THE LONGITUDINAL LENGTH (L_1).

$$\text{ALLOWABLE LOAD} = \frac{\text{COLUMN 3 ALLOWABLE}}{R_{LF}} \times L_1$$

- THE R_{LF} FOR THIS EXAMPLE = 1.0 SINCE L_2 IS GREATER THAN 27 INCHES AND THE CONTACT POINTS ARE LOCATED IN ZONE B.

$$\text{ALLOWABLE LOAD} = \frac{100}{1.0} \times 48 = 4,800 \text{ POUNDS}$$

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Figure 4-20. Logistics and ADS Roller Conveyors – Maximum Allowable Flight Loads (Sheet 11)

- (c) COMPARE THE MAXIMUM ALLOWABLE LOAD TO THE APPLIED LOAD AT EACH CONTACT POINT. THE APPLIED LOAD IS LESS THAN THE MAXIMUM ALLOWABLE LOAD PER CONTACT POINT, THEREFORE, NO SHORING IS REQUIRED.
- (d) COMPARE THE TOTAL CARGO UNIT WEIGHT TO THE MAXIMUM ALLOWABLE LOADS IN THIS FIGURE. THE CARGO UNIT IN EXAMPLE 1 CAN BE SAFELY LOADED ON THE LOGISTICS SYSTEM.

(2) **EXAMPLE 2**

A CARGO UNIT IS LOADED ON A PALLET/PLATFORM THE SAME AS IN EXAMPLE 1 EXCEPT THE UNIT WEIGHT = 9,800 POUNDS. DETERMINE IF THE CARGO UNIT CAN BE LOADED ON THE LOGISTICS SYSTEM WITHOUT USING SHORING.

- (a) DETERMINE APPLIED LOAD AT EACH CONTACT POINT

$$\text{APPLIED LOAD PER CONTACT POINT} = \frac{9,800}{2} = 4,900 \text{ POUNDS}$$

- (b) DETERMINE MAXIMUM ALLOWABLE LOAD PER CONTACT POINT.

- THE ALLOWABLE LOAD PER CONTACT POINT IS CALCULATED BY DIVIDING THE APPROPRIATE LOAD FROM COLUMN 3 ON SHEET 1 BY THE R_{LF}, THEN MULTIPLYING THE RESULTS BY THE LONGITUDINAL LENGTH (L₁).
- ALLOWABLE LOAD = $\frac{\text{COLUMN 3 ALLOWABLE}}{R_{LF}} \times L_1$
- THE R_{LF} FOR THIS EXAMPLE = 1.0 SINCE L₂ IS GREATER THAN 27 INCHES AND THE CONTACT POINTS ARE LOCATED IN ZONE B.
- ALLOWABLE LOAD = $\frac{100}{1.0} \times 48 = 4,800 \text{ POUNDS}$

- (c) COMPARE MAXIMUM ALLOWABLE LOAD PER CONTACT POINT TO THE APPLIED LOAD AT EACH CONTACT POINT. THE APPLIED LOAD IS GREATER THAN THE MAXIMUM ALLOWABLE LOAD, THEREFORE, SHORING IS REQUIRED.

- (d) DETERMINE SHORING REQUIRED AS FOLLOWS:

- REQUIRED LENGTH (L_R)

$$L_R = \frac{\text{APPLIED LOAD} \times R_{LF}}{\text{ALLOWABLE LOAD PER INCH}} = \frac{4,900 \times 1.0}{100} = 49.0 \text{ INCHES}$$

NOTE

IF THE CONTACT POINT OVERHANGS THE SURFACE OF THE PALLET, DO NOT DIVIDE THE ADDITIONAL LENGTH BY TWO. THE ADDITIONAL LENGTH IS THE THICKNESS REQUIRED.

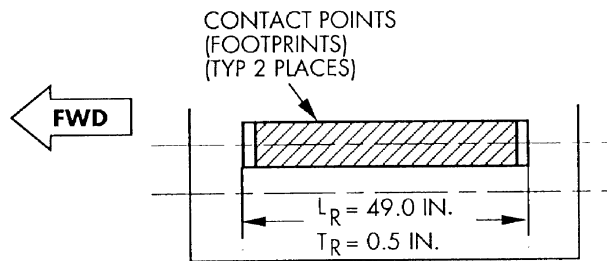
- REQUIRED THICKNESS (T_R)

$$T_R = \frac{L_R - L_1}{2} = \frac{49.0 - 48.0}{2} = 0.5 \text{ INCH}$$

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Figure 4-20. Logistics and ADS Roller Conveyors – Maximum Allowable Flight Loads (Sheet 12)

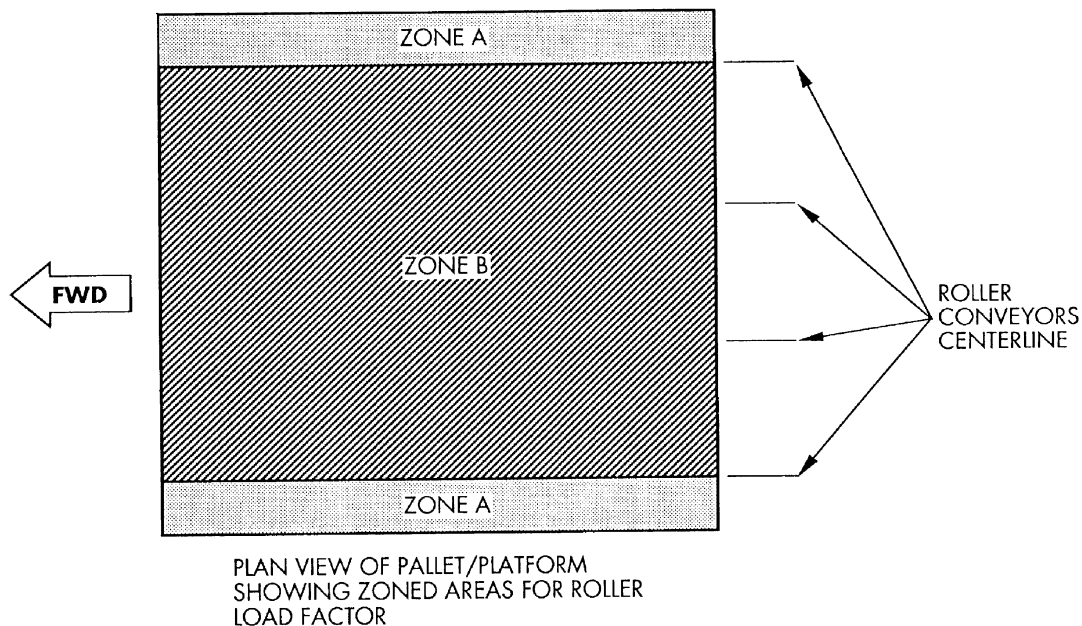
- THEREFORE:



- THE WIDTH OF SHORING MUST BE AT LEAST AS WIDE AS THE CONTACT POINT.
- (e) COMPARE THE TOTAL CARGO UNIT WEIGHT TO THE MAXIMUM ALLOWABLE LOADS IN THIS FIGURE. THE CARGO UNIT IN EXAMPLE 2 CAN BE SAFELY LOADED ON THE LOGISTICS SYSTEM.

NOTE

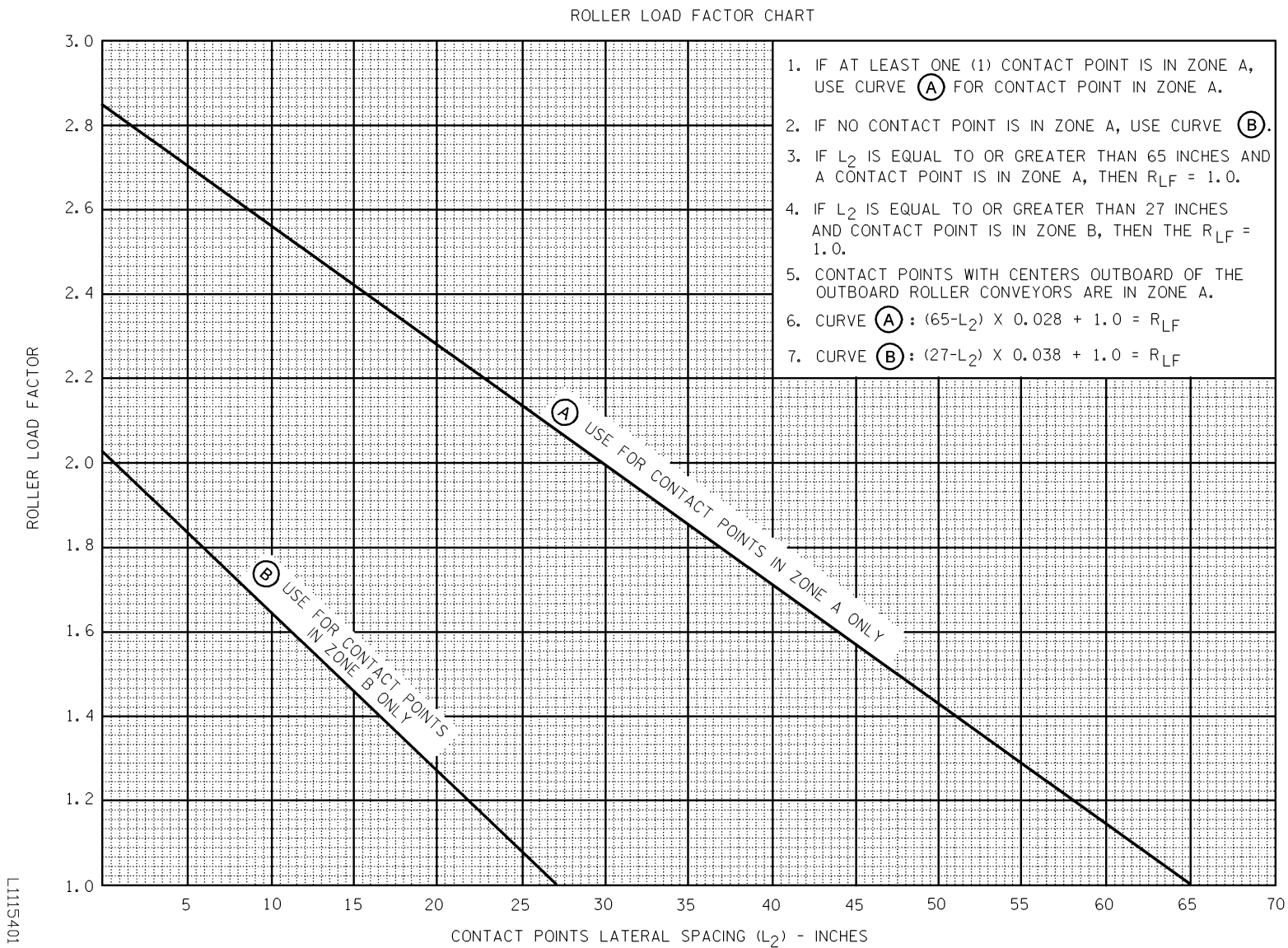
CONTACT POINTS SUPPORTED BY ROLLER CONVEYORS OR BETWEEN ROLLER CONVEYORS ARE IN ZONE B. CONTACT POINTS WITH CENTER OUTBOARD OF THE OUTBOARD ROLLER CONVEYORS ARE IN ZONE A.



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Figure 4-20. Logistics and ADS Roller Conveyors – Maximum Allowable Flight Loads (Sheet 13)

Figure 4-20. Logistics and ADS Roller Conveyors – Maximum Allowable Flight Loads (Sheet 14)

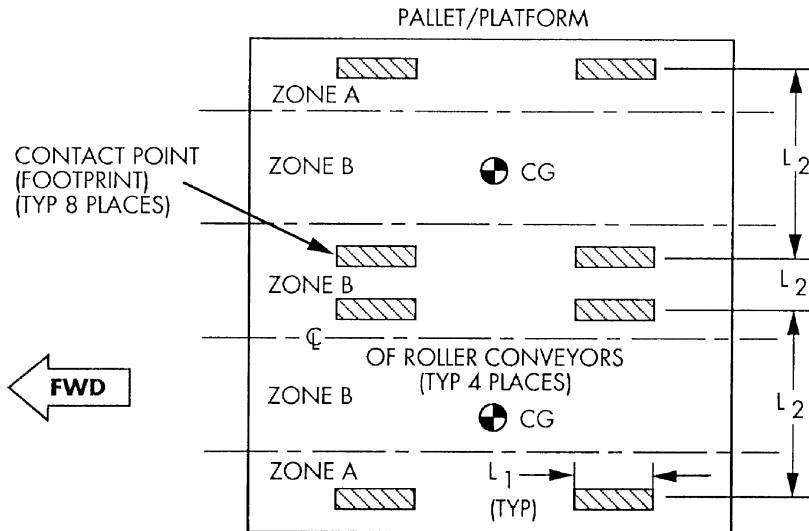


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(3) **EXAMPLE 3**

TWO DOLLIES ARE LOADED SIDE BY SIDE ON A PALLET/PLATFORM AND THE WEIGHT IS SUPPORTED BY THE CONTACT POINTS AS SHOWN. THE FOLLOWING DATA IS GIVEN.

- UNIT WEIGHT = 2,000 POUNDS EACH DOLLY
- $L_1 = 12$ INCHES, $L_2 = 40$ INCHES, $L_2' = 20$ INCHES



DETERMINE IF THE CARGO UNIT CAN BE LOADED ON THE LOGISTICS SYSTEM WITHOUT USING SHORING.

- (a) DETERMINE APPLIED LOAD AT EACH CONTACT POINT.

$$\text{APPLIED LOAD PER CONTACT POINT} = \frac{4,000}{8} = 500 \text{ POUNDS}$$

- (b) DETERMINE ZONE.

OUTBOARD CONTACT POINTS ARE IN ZONE A (ASSOCIATED WITH L_2)
 INBOARD CONTACT POINTS ARE IN ZONE B (ASSOCIATED WITH L_2')

- (c) DETERMINE ROLLER LOAD FACTOR (R_{LF})

- THERE ARE TWO LATERAL LENGTHS (L_2); THEREFORE, THERE ARE TWO ROLLER LOAD FACTORS. ONE IS FOR L_2 WHICH HAS CONTACT POINTS IN ZONE A.

$$R_{LF} = 1.72 \text{ (FROM CHART)}$$

- THE OTHER IS FOR L_2' WHICH HAS CONTACT POINTS IN ZONE B.

$$R_{LF} = 1.26 \text{ (FROM CHART)}$$

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Figure 4-20. Logistics and ADS Roller Conveyors – Maximum Allowable Flight Loads (Sheet 15)

(d) DETERMINE MAXIMUM ALLOWABLE LOAD PER CONTACT POINT.

- THE ALLOWABLE LOAD PER CONTACT POINT IS CALCULATED BY DIVIDING THE APPROPRIATE LOAD FROM COLUMN 3 ON SHEET 1 BY THE ROLLER LOAD FACTOR, THEN MULTIPLYING THE RESULTS BY THE LONGITUDINAL LENGTH (L_1).

$$\text{ALLOWABLE LOAD} = \frac{\text{COLUMN 3 ALLOWABLE}}{R_{LF}} \times L_1$$

- ALLOWABLE LOAD FOR CONTACT POINTS IN ZONE A

$$\frac{100}{1.72} \times 12 = 698 \text{ LB}$$

- ALLOWABLE LOAD FOR CONTACT POINTS IN ZONE B

$$\frac{100}{1.26} \times 12 = 952 \text{ LB}$$

(e) COMPARE THE MAXIMUM ALLOWABLE LOAD TO THE APPLIED LOAD AT EACH CONTACT POINT. THE APPLIED LOAD IS LESS THAN THE MAXIMUM ALLOWABLE LOAD PER CONTACT POINT, THEREFORE, NO SHORING IS REQUIRED.

(f) COMPARE THE TOTAL CARGO UNIT WEIGHT TO THE MAXIMUM ALLOWABLE LOADS IN THIS FIGURE. THE CARGO UNIT IN EXAMPLE 3 CAN BE SAFELY LOADED ON THE LOGISTICS SYSTEM.

L1115403

Figure 4-20. Logistics and ADS Roller Conveyors – Maximum Allowable Flight Loads (Sheet 16)

(4) EXAMPLE 4

A CARGO UNIT IS LOADED ON A PALLET/PLATFORM THE SAME AS IN EXAMPLE 3 EXCEPT THE UNIT WEIGHT = 4,000 POUNDS EACH DOLLY. DETERMINE IF THE CARGO UNIT CAN BE LOADED ON THE LOGISTICS SYSTEM WITHOUT USING SHORING.

- (a) DETERMINE APPLIED LOAD AT EACH CONTACT POINT.

$$\text{APPLIED LOAD PER CONTACT POINT} = \frac{8,000}{8} = 1,000 \text{ POUNDS}$$

- (b) DETERMINE ZONE.

OUTBOARD CONTACT POINTS ARE IN ZONE A (ASSOCIATED WITH L_2)
INBOARD CONTACT POINTS ARE IN ZONE B (ASSOCIATED WITH L_2')

- (c) DETERMINE ROLLER LOAD FACTOR (R_{LF})

- THERE ARE TWO LATERAL LENGTHS (L_2); THEREFORE, THERE ARE TWO ROLLER LOAD FACTORS. ONE IS FOR L_2 WHICH HAS CONTACT POINTS IN ZONE A.

$$R_{LF} = 1.72 \text{ (FROM CHART)}$$

- THE OTHER IS FOR L_2' WHICH HAS CONTACT POINTS IN ZONE B.

$$R_{LF} = 1.26 \text{ (FROM CHART)}$$

- (d) DETERMINE MAXIMUM ALLOWABLE LOAD PER CONTACT POINT.

- THE ALLOWABLE LOAD PER CONTACT POINT IS CALCULATED BY DIVIDING THE APPROPRIATE LOAD FROM COLUMN 3 ON SHEET 1 BY THE ROLLER LOAD FACTOR, THEN MULTIPLYING THE RESULTS BY THE LONGITUDINAL LENGTH (L_1).

$$\text{ALLOWABLE LOAD} = \frac{\text{COLUMN 3 ALLOWABLE}}{R_{LF}} \times L_1$$

- ALLOWABLE LOAD FOR CONTACT POINTS IN ZONE A

$$\frac{100}{1.72} \times 12 = 698 \text{ POUNDS}$$

- ALLOWABLE LOAD FOR CONTACT POINTS IN ZONE B

$$\frac{100}{1.26} \times 12 = 952 \text{ POUNDS}$$

- (e) COMPARE MAXIMUM ALLOWABLE LOAD PER CONTACT POINT TO THE APPLIED LOAD AT EACH CONTACT POINT. THE APPLIED LOAD IS GREATER THAN THE MAXIMUM ALLOWABLE LOAD, THEREFORE, SHORING IS REQUIRED.

L1115404

Figure 4-20. Logistics and ADS Roller Conveyors – Maximum Allowable Flight Loads (Sheet 17)

(f) DETERMINE SHORING REQUIRED AS FOLLOWS:

NOTE

SINCE SHORING IS DETERMINED BY THE MOST CRITICAL LOCATION AND THE SHORING MUST BE APPLIED EQUALLY AT ALL CONTACT POINTS, CALCULATIONS SHOULD BE SIMPLIFIED TO CONSIDER ONLY THE ZONE A CONTACT POINTS.

- REQUIRED LENGTH (L_R)

$$L_R \text{ (ZONE A)} = \frac{\text{APPLIED LOAD} \times R_{LF}}{\text{ALLOWABLE LOAD PER INCH}} = \frac{1,000 \times 1.72}{100} = 17.2 \text{ INCHES}$$

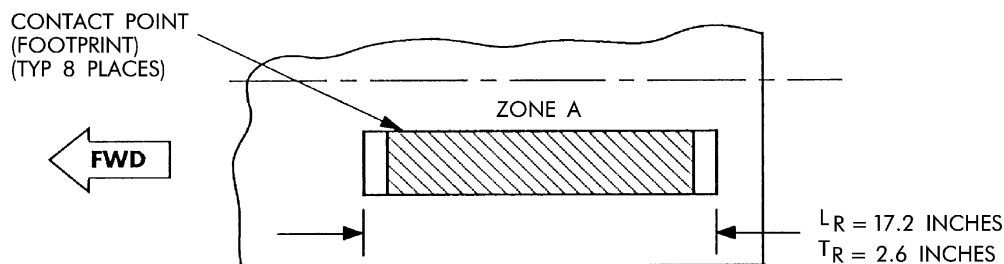
- REQUIRED THICKNESS (T_R)

$$T_R \text{ (ZONE A)} = \frac{L_R - L_1}{2} = \frac{17.2 - 12.0}{2} = 2.6 \text{ INCHES}$$

- THEREFORE:

NOTE

SINCE THE CONTACT POINTS IN ZONE A ARE THE MOST CRITICAL, L_R AND T_R FOR ZONE A MUST BE APPLIED EQUALLY TO ALL CONTACT POINTS.



- THE WIDTH OF SHORING MUST BE AT LEAST AS WIDE AS THE CONTACT POINT.

(g) COMPARE THE TOTAL CARGO UNIT WEIGHT TO THE MAXIMUM ALLOWABLE LOADS IN THIS FIGURE. THE CARGO UNIT IN EXAMPLE 4 CAN BE SAFELY LOADED ON THE LOGISTICS SYSTEM.

L1115405

Figure 4-20. Logistics and ADS Roller Conveyors – Maximum Allowable Flight Loads (Sheet 18)

PROCEDURES FOR DETERMINING CONCENTRATED CARGO MAXIMUM ALLOWABLE FLOOR LOADS AND CALCULATION OF SHORING WHEN REQUIRED.

CAUTION

IF A CONCENTRATED CARGO LOAD IS TO BE PARTIALLY SUPPORTED BY FLOOR DISCONTINUITIES SUCH AS STOWED INBOARD LOGISTICS RAILS, ROLLER CONVEYORS, AND TIEDOWN RING PANS, USE THE PROCEDURES IN FIGURE 4-23 TO DETERMINE IF SHORING IS REQUIRED.

NOTE

FOR LOADS LESS THAN 2 INCHES IN LENGTH PLUS WIDTH, USE 1-INCH THICK PLYWOOD UNDER THE LOAD AND ASSUME A 2-INCH LENGTH PLUS WIDTH TO DETERMINE THE REQUIRED SHORING.

USE OF FORMULAS:

- 1. IF ALLOWABLE LOAD IS EQUAL TO OR GREATER THAN CARGO LOAD, NO SHORING IS REQUIRED.
- 2. IF ALLOWABLE LOAD IS LESS THAN CARGO LOAD, SHORING IS REQUIRED.
- 3. IF THE CARGO LENGTH PLUS WIDTH IS EQUAL TO OR GREATER THAN THE REQUIRED LENGTH PLUS WIDTH, NO SHORING IS REQUIRED.
- 4. IF THE CARGO LENGTH PLUS WIDTH IS LESS THAN THE REQUIRED LENGTH PLUS WIDTH, SHORING MUST BE CALCULATED.

NOTE

THE SHORING SHALL PROJECT BEYOND THE CARGO FOOTPRINT ON ALL SIDES A MINIMUM DISTANCE EQUAL TO THE SHORING THICKNESS.

SHORING:

- SHORING THICKNESS ≥ MINIMUM SHORING THICKNESS
- SHORING WIDTH ≥ CARGO WIDTH + (2 × THICKNESS)
- SHORING LENGTH ≥ CARGO LENGTH + (2 × THICKNESS)

CALCULATION FORMULAS

NON-RUBBER CONTACT SURFACE (CARGO FLOOR)

- 1. ALLOWABLE LOAD = 404.7 (LENGTH + WIDTH)
- 2. REQUIRED LENGTH + WIDTH = CARGO LOAD ÷ 404.7
- 3. SHORING THICKNESS = $\frac{\text{REQUIRED (LENGTH + WIDTH)} - \text{ACTUAL (LENGTH + WIDTH)}}{4}$
- 4. MINIMUM SHORING THICKNESS = 1/2 INCH

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Figure 4-21. Concentrated Cargo Maximum Allowable Floor Loads (Sheet 1 of 3)

NON-RUBBER CONTACT SURFACE (RAMP FLOOR)

1. ALLOWABLE LOAD = 231.8 (LENGTH + WIDTH)
2. REQUIRED LENGTH + WIDTH = CARGO LOAD $\div$ 231.8
3. SHORING THICKNESS = $\frac{\text{REQUIRED (LENGTH + WIDTH)} - \text{ACTUAL (LENGTH + WIDTH)}}{4}$
4. MINIMUM SHORING THICKNESS = 1/2 INCH

EXAMPLE: DETERMINE IF SHORING IS REQUIRED AND, IF REQUIRED, DETERMINE THE SHORING REQUIREMENTS FOR A CONCENTRATED CARGO LOAD (WITH A NON-RUBBER CONTACT SURFACE), TO BE LOADED ON THE CARGO COMPARTMENT FLOOR. THE CARGO LOAD HAS CONTACT LENGTH OF 10 INCHES AND A CONTACT WIDTH OF 15 INCHES (10 $\times$ 15 INCHES) AND WEIGHS 11,900 POUNDS.

1. DETERMINE ALLOWABLE LOAD USING APPROPRIATE ALLOWABLE LOAD FORMULA.
 $404.7 (10 + 15) = 10117.50$
2. DETERMINE REQUIRED LENGTH + WIDTH.
 $11900 \div 404.7 = 29.4044$
3. THE ACTUAL LENGTH PLUS WIDTH IS LESS THAN THE REQUIRED LENGTH PLUS WIDTH; THEREFORE, SHORING IS REQUIRED AND IS CALCULATED AS FOLLOWS:
 - A. DETERMINE THE SHORING THICKNESS BY FIRST SUBTRACTING THE ACTUAL LENGTH PLUS WIDTH FROM THE REQUIRED LENGTH PLUS WIDTH.

REQUIRED LENGTH + WIDTH	29.4044 INCHES
ACTUAL LENGTH + WIDTH	25.0 INCHES
	<u>4.4044 INCHES</u>

MINIMUM ADDITIONAL LENGTH PLUS WIDTH
 - B. THE MINIMUM SHORING THICKNESS IS DETERMINED BY DIVIDING THE ADDITIONAL LENGTH PLUS WIDTH BY 4.
 $\text{THICKNESS} = 4.4 \div 4 = 1.125 \text{ INCHES}$
 - C. THE SHORING SHALL PROJECT BEYOND THE FOOTPRINT ON ALL SIDES BY A MINIMUM AMOUNT EQUAL TO THE SHORING THICKNESS.
 $\text{MINIMUM SHORING WIDTH} = 15.0 + 1.125 + 1.125 = 17.250 \text{ INCHES}$
 $\text{MINIMUM SHORING LENGTH} = 10.0 + 1.125 + 1.125 = 12.250 \text{ INCHES}$

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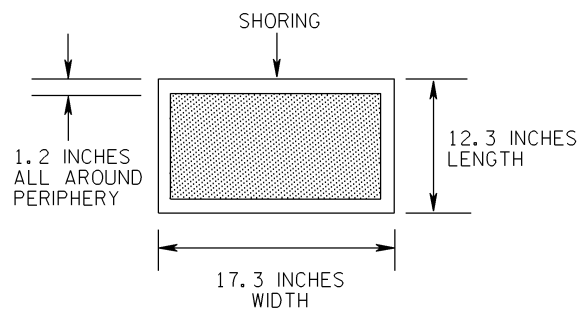
Figure 4-21. Concentrated Cargo Maximum Allowable Floor Loads (Sheet 2)

D. THE SHORING REQUIRED IS AS FOLLOWS:

THICKNESS $\geq$ 1.2 INCHES
WIDTH $\geq$ 17.3 INCHES
LENGTH $\geq$ 12.3 INCHES

NOTE

THE CARGO SHALL BE CENTERED ON THE SHORING SUCH THAT THE SHORING EXTENDS BEYOND THE CARGO ON ALL SIDES BY AN AMOUNT GREATER THAN OR EQUAL TO THE SHORING THICKNESS.



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Figure 4-21. Concentrated Cargo Maximum Allowable Floor Loads (Sheet 3)

PROCEDURE FOR DETERMINING HARD RUBBER OR STEEL WHEEL (NO MEASURABLE LENGTH) MAXIMUM ALLOWABLE FLOOR LOADS AND CALCULATION OF SHORING WHEN REQUIRED.

NOTE

USE THE PROCEDURES IN FIGURE 4-23 FOR WHEELS WITH A MEASURABLE LENGTH THAT WILL BE PARKED OVER DISCONTINUITIES.

WHEEL MUST BE PLACED IN CENTER OF SHORING.

1. ANY HARD RUBBER WHEEL OR STEEL WHEEL THAT CAN BE TRANSPORTED ON THE CARGO FLOOR WITHOUT SHORING, CAN BE ON/OFF LOADED WITHOUT SHORING ACROSS ALL THE CARGO FLOOR.
2. HARD RUBBER WHEELS ARE DEFINED AS SOLID RUBBER TIRES AND RUBBER WHEELS.

FORMULA STEPS

1. CALCULATE EFFECTIVE WIDTH (PARKED OVER DISCONTINUITY)

EFFECTIVE WIDTH = ACTUAL WIDTH - DISCONTINUITY WIDTH

2. CALCULATE ALLOWABLE LOAD

CARGO FLOOR (HARD RUBBER OR STEEL WHEEL)

ALLOWABLE LOAD = (ACTUAL OR EFFECTIVE WIDTH) X 468.5

RAMP FLOOR (HARD RUBBER WHEELS)

ALLOWABLE LOAD = (ACTUAL OR EFFECTIVE WIDTH) X 408

RAMP FLOOR (STEEL WHEELS)

ALLOWABLE LOAD = (ACTUAL OR EFFECTIVE WIDTH) X 342

3. CALCULATE SHORING (HARD RUBBER OR STEEL WHEEL - RAMP OR CARGO FLOOR)

A. REQUIRED (L+W)

CARGO FLOOR (HARD RUBBER OR STEEL WHEEL)

REQUIRED WIDTH = $\frac{\text{WHEEL LOAD}}{468.5}$

RAMP FLOOR (HARD RUBBER WHEELS)

REQUIRED WIDTH = $\frac{\text{WHEEL LOAD}}{408}$

RAMP FLOOR (STEEL WHEELS)

REQUIRED WIDTH = $\frac{\text{WHEEL LOAD}}{342}$

B. THICKNESS, LENGTH, AND WIDTH

THICKNESS = $\frac{\text{REQUIRED WIDTH} - (\text{ACTUAL OR EFFECTIVE WIDTH})}{2}$

LENGTH = 2 X THICKNESS

WIDTH = 2 X THICKNESS + ACTUAL WIDTH

MINIMUM LENGTH OF SHORING IS 1 INCH.

L1115409

Figure 4-22. Hard Rubber or Steel Wheel Maximum Allowable Floor Loads

PROCEDURES FOR DETERMINING MAXIMUM ALLOWABLE FLOOR LOADS FOR CONCENTRATED CARGO LOCATED OVER RESTRICTED AREAS AND CALCULATION OF SHORING WHEN REQUIRED.

LEGEND

W - WIDTH OF CARGO CONTACT

L - LENGTH OF CARGO CONTACT

OA - AREA OF CARGO CONTACT IN SQUARE INCHES

LD - LENGTH OF DISCONTINUITY

WD - WIDTH OF DISCONTINUITY

AD - AREA OF DISCONTINUITY IN SQUARE INCHES

EA - EFFECTIVE AREA OF CARGO CONTACT

CALCULATION FORMULAS

1. ALLOWABLE LOAD FORMULAS:

$$\text{ALLOWABLE LOAD} = 404.7 (L + W) \sqrt{M}$$

$$\text{CONCENTRATED CARGO (ON RAMP)} = 231.8 (L + W) \sqrt{M}$$

$$\text{HARD RUBBER OR STEEL WHEELS} = 234.3 (L + W) \sqrt{M}$$

2. SHORING CALCULATION FORMULAS:

$$\text{REQUIRED } (L + W) = \frac{\text{CARGO LOAD}}{404.7}$$

$$\text{REQUIRED } (L + W) \text{ (CARGO ON RAMP)} = \frac{\text{CARGO LOAD}}{231.8}$$

3. EFFECTIVE (L + W) FORMULA:

$$\text{EFFECTIVE } (L + W) = (L + W) \sqrt{M}$$

4. THICKNESS FORMULA:

$$\frac{\text{REQUIRED } (L + W) - \text{EFFECTIVE } (L + W)}{4} = \text{THICKNESS}$$

NOTE

THE FOLLOWING PROCEDURE IS USED TO CALCULATE IF SHORING IS REQUIRED WHEN A CONCENTRATED CARGO LOAD IS TO BE PARTIALLY SUPPORTED BY FLOOR DISCONTINUITIES SUCH AS STOWED INBOARD LOGISTIC RAILS, ROLLER CONVEYORS, TIEDOWN RECEPTACLES, AND ADS RAIL STUD CUTOUTS.

1. DETERMINE THE AREA IN SQUARE INCHES OF CARGO CONTACT (OA) WITH THE CARGO FLOOR BY MULTIPLYING LENGTH BY WIDTH AS APPLICABLE, OF THE TIRE, WHEEL, OR PAD IMPRINT.

$$L \times W = (\text{OA}) \text{ AREA OF CARGO CONTACT IN SQUARE INCHES.}$$

2. DETERMINE THE AREA IN SQUARE INCHES OF THE DISCONTINUITY (AD) UNDER THE AREA OF CARGO CONTACT (OA) BY MULTIPLYING LENGTH BY WIDTH OF THE DISCONTINUITY.

$$LD \times WD = (\text{AD}) \text{ AREA OF DISCONTINUITY IN SQUARE INCHES.}$$

L1115410

Figure 4-23. Maximum Allowable Floor Loads for Concentrated Cargo Located Over Restricted Areas (Sheet 1 of 4)

3. DETERMINE THE EFFECTIVE AREA OF CARGO CONTACT (EA) BY SUBTRACTING THE AREA OF DISCONTINUITY (AD) FROM THE AREA OF CARGO CONTACT (OA).

OA - AD = (EA) EFFECTIVE AREA OF CARGO CONTACT IN SQUARE INCHES.

4. DETERMINE THE M FACTOR BY DIVIDING EFFECTIVE AREA OF CARGO CONTACT (EA) BY THE AREA OF CARGO CONTACT (OA). $EA \div OA = M$ FACTOR.
5. DETERMINE ALLOWABLE LOAD USING THE APPROPRIATE ALLOWABLE LOAD FORMULA (USE M FACTOR FROM STEP 4).

6. COMPARE ACTUAL CARGO LOAD TO ALLOWABLE CARGO LOAD.

- a. IF THE ACTUAL CARGO LOAD IS EQUAL TO OR LESS THAN THE ALLOWABLE CARGO LOAD DETERMINED IN STEP 6, NO SHORING IS REQUIRED.
- b. IF THE ACTUAL CARGO LOAD IS GREATER THAN THE ALLOWABLE CARGO LOAD DETERMINED IN STEP 6, SHORING IS REQUIRED AND IS CALCULATED USING THE SHORING CALCULATION FORMULAS.

7. DETERMINE THE REQUIRED L + W AND THE EFFECTIVE LENGTH PLUS WIDTH UTILIZING EFFECTIVE L + W FORMULA (THIS NUMBER IS USED TO CALCULATE THE REQUIRED THICKNESS IF REQUIRED). EFFECTIVE $[(L + W) \sqrt{M}]$ FACTOR]

8. DETERMINE SHORING THICKNESS UTILIZING THICKNESS FORMULA:

$$\frac{\text{REQUIRED } L + W - \text{EFFECTIVE } L + W}{4} = \text{SHORING THICKNESS}$$

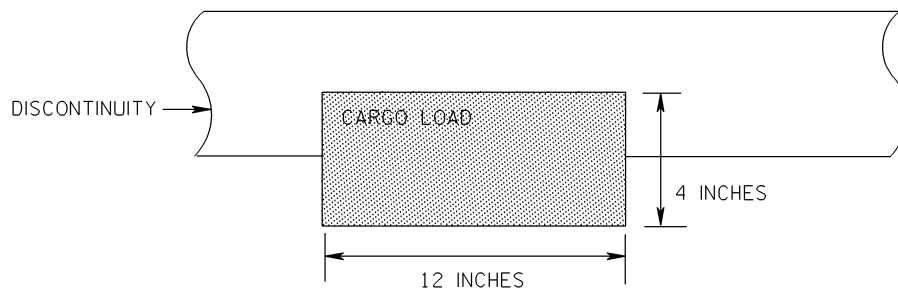
- a. IF THE REQUIRED L + W IS LESS THAN OR EQUAL TO THE EFFECTIVE L + W, USE THE MINIMUM SHORING THICKNESS OF 1/2 INCH.
- b. IF THE THICKNESS IS LESS THEN 1/2 INCH, USE THE MINIMUM SHORING THICKNESS OF 1/2 INCH.
- c. THE SHORING MUST BE CENTERED UNDER THE CARGO FOOTPRINT AND EXTEND TO AN AMOUNT EQUAL TO THE SHORING THICKNESS ON ALL SIDES.

EXAMPLE:

DETERMINE IF PARKING SHORING IS REQUIRED FOR A PIECE OF CONCENTRATED CARGO WITH AN IMPRINT OF 12"L X 4"W AND A WEIGHT OF 6,100 POUNDS THAT WILL BE PLACED PARTIALLY ON A STOWED INBOARD LOGISTIC RAIL IN THE CARGO COMPARTMENT.

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Figure 4-23. Maximum Allowable Floor Loads for Concentrated Cargo Located Over Restricted Areas (Sheet 2)



THE AREAS (AD) OF THE FLOOR DISCONTINUITIES ARE AS FOLLOWS:

TIEDOWN RING PAN (AD) = 18 SQUARE INCHES

ROLLER CONVEYOR (AD) = $2.5 \times \text{FOOTPRINT LENGTH}$

INBOARD LOGISTICS RAIL (AD) = $4.3 \times \text{FOOTPRINT LENGTH}$

ADS RECEPTACLE (AD) = 2.4 SQUARE INCHES

1. DETERMINE THE AREA IN SQUARE INCHES OF ACTUAL CARGO CONTACT (OA) WITH THE CARGO FLOOR BY MULTIPLYING WIDTH BY LENGTH OF CONCENTRATED CARGO IMPRINT.

$$4 \times 12 \text{ INCHES} = 48.0 \text{ SQUARE INCHES (OA) ACTUAL CARGO CONTACT}$$

2. DETERMINE THE AREA IN SQUARE INCHES OF THE FLOOR DISCONTINUITY (AD) UNDER THE AREA OF ACTUAL CARGO CONTACT (OA) BY MULTIPLYING WIDTH BY LENGTH OF THE CONTACT AREA.

$$12 \times 2 = 24.0 \text{ SQUARE INCHES (AD) AREA OF DISCONTINUITY}$$

3. DETERMINE THE ACTUAL EFFECTIVE CARGO CONTACT AREA (EA) BY SUBTRACTING THE AREA OF THE DISCONTINUITY (AD) FROM THE ACTUAL CARGO CONTACT (OA).

4. DETERMINE THE $\underline{M}$ FACTOR BY DIVIDING THE ACTUAL EFFECTIVE CARGO CONTACT (EA) BY THE ACTUAL CARGO CONTACT AREA (OA).

$$\frac{\text{EA } 24.0 \text{ SQUARE INCHES}}{\text{OA } 48.0 \text{ SQUARE INCHES}} = 0.50 = \underline{M} \text{ FACTOR}$$

5. DETERMINE EFFECTIVE $L + W$ UTILIZING EFFECTIVE $L + W$ FORMULA. (THIS NUMBER IS NEEDED IF SHORING THICKNESS IS REQUIRED).

$$(16) \sqrt{0.5} = 11.3137$$

6. DETERMINE ALLOWABLE LOAD USING THE APPROPRIATE ALLOWABLE LOAD FORMULA

$$(\text{USE } \underline{M} \text{ FACTOR FROM STEP 4}) 234.3 (16) \sqrt{0.5} = 2650.8015 \text{ POUNDS}$$

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Figure 4-23. Maximum Allowable Floor Loads for Concentrated Cargo Located Over Restricted Areas (Sheet 3)

7. COMPARE ACTUAL CARGO LOAD TO ALLOWABLE LOAD

- A. IF THE ACTUAL CARGO LOAD IS EQUAL OR LESS THAN THE ALLOWABLE CARGO LOAD DETERMINED IN STEP 6, NO SHORING IS REQUIRED.
- B. IF THE ACTUAL CARGO LOAD IS GREATER THAN THE ALLOWABLE CARGO LOAD DETERMINED IN STEP 6, SHORING IS REQUIRED AND IS CALCULATED USING THE SHORING CALCULATION FORMULAS. DETERMINE REQUIRED L + W.

$$6100 \div 404.7 = 15.07$$

- C. DETERMINE SHORING THICKNESS UTILIZING THICKNESS FORMULA.

$$\frac{\text{REQUIRED L+W } 15.07 - \text{EFFECTIVE L+W } 11.3137}{4} = 0.9391 \text{ INCHES} = 1.0$$

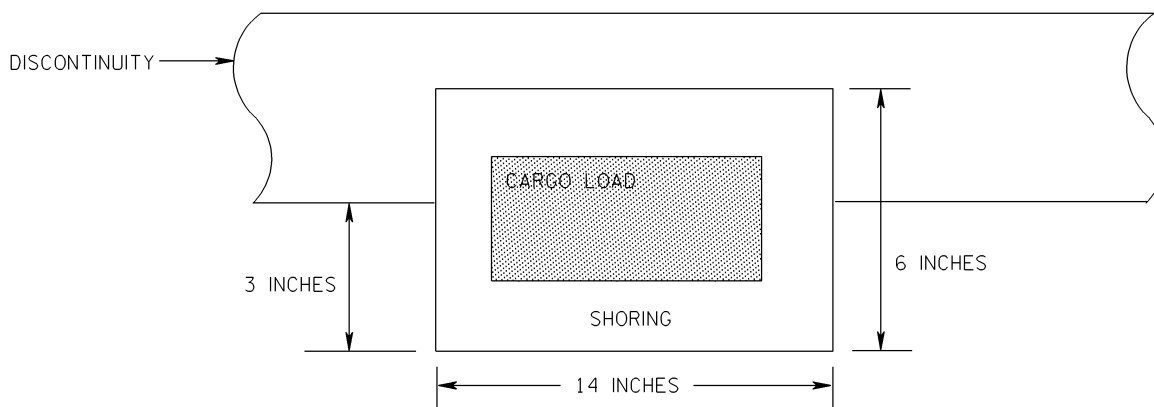
8. THE SHORING MUST BE CENTERED UNDER THE CARGO FOOTPRINT AND EXTEND TO AN AMOUNT EQUAL TO THE SHORING THICKNESS ON ALL SIDES.

ANSWER

THICKNESS (≥) 1.00 INCHES

WIDTH (≥) 4.0 + 1.0 + 1.0 = 6.0 INCHES

LENGTH (≥) 12.0 + 1.0 + 1.0 + 14.0 INCHES



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Figure 4-23. Maximum Allowable Floor Loads for Concentrated Cargo Located Over Restricted Areas (Sheet 4)

PROCEDURES FOR DETERMINING PNEUMATIC TIRE MAXIMUM ALLOWABLE FLOOR LOADS AND CALCULATION OF SHORING WHEN REQUIRED.

1. THE FOLLOWING DEFINITIONS APPLY FOR TIRE TYPES USED IN THIS FIGURE.

TIRE TYPE	DEFINITIONS
OVER-THE-ROAD	THIS TIRE IS FOR USE ON PAVED ROADS AND HAS A LARGE AMOUNT OF TREAD CONTACT IN THE FOOTPRINT. TREAD PATTERNS ARE OFTEN COMPLEX. USE $M = 0.78$.
OFF-ROAD	THIS TIRE IS FOR USE ON PAVED OR DIRT ROADS AND CAN BE USED FOR LIMITED CROSS-COUNTRY TRAVEL. THE TIRE FOOTPRINT IS HALF TREAD AND HALF SPACE. USE $M = 0.50$.
CROSS-COUNTRY	THIS TIRE IS USED MAINLY IN AREAS WITHOUT ROADS. IT IS ALSO DRIVEN ON DIRT ROADS, BUT SELDOM USED ON PAVED ROADS. THE SPACES IN THE TIRE FOOTPRINT ARE LARGER THAN THE TREAD AREAS. USE $M = 0.30$.

2. USE THE VALUE OF M APPROPRIATE TO THE TIRE OBSERVED. WHEN IN DOUBT USE THE NEXT LOWER VALUE OR CALCULATE M BY USING PROCEDURES FOR IRREGULARLY SHAPED RUBBER PADS IN ACCORDANCE WITH FIGURE 4-26.
3. DO NOT EXCEED THE MANUFACTURERS' RATED TIRE LOAD. ALL TIRES SHALL BE INFLATED TO NORMAL RATED PRESSURE.

CAUTION

WHEN PNEUMATIC TIRE AIR PRESSURE EXCEEDS 100 PSI AND THE TIRE IS PARKED ON THE INBOARD LOGISTICS RAILS, SHORING SHALL BE USED THAT IS A MINIMUM OF 1/2 INCH THICK AND 6 INCHES WIDE OR THE WIDTH OF THE TIRE, WHICHEVER IS GREATER.

4. PNEUMATIC TIRE AIR PRESSURE IS LIMITED TO 100 PSI ON THE INBOARD LOGISTICS RAILS AND 300 PSI ELSEWHERE.
5. VEHICLES WITH TIRE FOOTPRINTS EQUAL TO OR GREATER THAN 17.6 INCHES (LENGTH PLUS WIDTH) HAVE THE FOLLOWING ALLOWABLE LOADS WITHOUT USING SHORING.

		ALLOWABLE LOAD CARGO FLOOR	
TIRE TYPE	M FACTOR	NOT LOCATED OVER TIEDOWN RING PAN	LOCATED OVER TIEDOWN RING PAN
OVER-THE-ROAD	0.78	6,900	6,000
OFF-ROAD	0.50	5,500	4,800
CROSS-COUNTRY	0.30	4,300	3,700

6. THE ALLOWABLE LOAD FOR VEHICLES WITH TIRE FOOTPRINTS LESS THAN 17.6 INCHES (LENGTH PLUS WIDTH) SHALL BE CALCULATED. THE ALLOWABLE LOAD FOR VEHICLES WITH TIRE FOOTPRINTS GREATER THAN 17.6 INCHES MAY BE DETERMINED BY CALCULATIONS IN LIEU OF USING THE ALLOWABLE LOADS CALLED OUT IN STEP 5.
7. THE ONLY FLOOR DISCONTINUITY APPLICABLE TO PNEUMATIC TIRES IS THE TIEDOWN RING PANS.

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Figure 4-24. Pneumatic Tire Allowable Loads (Sheet 1 of 6)

CALCULATION FORMULAS

1. ALLOWABLE LOAD FORMULA

$$A. \text{ ALLOWABLE LOAD ON RAMP} = 389.6 (L + W) \sqrt{M}$$

$$B. \text{ ALLOWABLE LOAD ON FLOOR} = 443.8 (L + W) \sqrt{M}$$

2. REQUIRED (LENGTH PLUS WIDTH) FORMULA

$$A. \text{ REQUIRED (L+W) SHORING ON FLOOR} = \text{TIRE LOAD} \div 404.7$$

$$B. \text{ REQUIRED (L+W) SHORING ON RAMP} = \text{TIRE LOAD} \div 231.8$$

3. EFFECTIVE (LENGTH PLUS WIDTH) FORMULA

$$A. \text{ EFFECTIVE (L+W)} = (L+W) \sqrt{M}$$

PROCEDURE AND EXAMPLE PROBLEM.

DETERMINE IF SHORING IS REQUIRED FOR A VEHICLE PARKED ON THE CARGO FLOOR WITH OVER-THE-ROAD TIRES AND WHEEL WEIGHTS GREATER THAN 6,900 POUNDS PER WHEEL.

1. IF VEHICLE WEIGHT IS NOT KNOWN, WEIGH VEHICLE TO DETERMINE AXLE WEIGHTS.

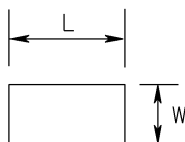
GIVEN: THE AXLE WEIGHT IS 28,000 POUND AND THE AXLE CONTAINS TWO WHEELS.

2. DETERMINE LOAD PER WHEEL AS FOLLOWS:

$$\frac{\text{AXLE WEIGHT}}{\text{NUMBER OF WHEELS}} = \text{LOAD PER WHEEL (POUNDS)}$$

$$\frac{28,000}{2} = 14,000 \text{ POUNDS PER WHEEL}$$

3. DETERMINE THE IMPRINT AS FOLLOWS:



L = TIRE IMPRINT LENGTH

W = TIRE IMPRINT WIDTH

NOTE

THIS PROCEDURE APPLIES TO OVER-THE-ROAD, OFF-ROAD AND CROSS-COUNTY TIRES.

- A. PARK THE VEHICLE ON FLAT GROUND.

- B. MARK OFF ACTUAL LENGTH (L) AND WIDTH (W) OF THE TIRE IMPRINT ON GROUND.

- C. MOVE VEHICLE AND MEASURE L + W.

4. IF L WAS DETERMINED TO BE 22 INCHES AND W 12 INCHES. THEN LENGTH PLUS WIDTH
= 22.0 + 12.0 = 34.0 INCHES, $\underline{M}$ FACTOR = 0.78

L1115415

Figure 4-24. Pneumatic Tire Allowable Loads (Sheet 2)

5. TO OBTAIN ALLOWABLE LOAD, USE THE PNEUMATIC TIRE ON FLOOR ALLOWABLE LOAD FORMULA.

$$443.8 (22 + 12) \times \sqrt{0.78} = 13326.4206$$

6. COMPARE THE ACTUAL TIRE LOAD TO THE ALLOWABLE TIRE LOAD.

- A. IF THE ACTUAL TIRE LOAD IS EQUAL TO OR LESS THAN THE ALLOWABLE TIRE LOAD DETERMINED IN STEP 5, NO SHORING IS REQUIRED.
- B. IF THE ACTUAL TIRE LOAD IS GREATER THAN THE ALLOWABLE TIRE LOAD DETERMINED IN STEP 5, SHORING IS REQUIRED AND IS CALCULATED AS FOLLOWS.

NOTE

WHEN SHORING IS PLACED UNDER A PNEUMATIC TIRE, THE EFFECT IS AN INCREASED M FACTOR AND INCREASED EFFECTIVE FOOTPRINT SIZE. IF THE SHORING THICKNESS IS AT LEAST HALF THE DISTANCE BETWEEN THE TREADS, THE M FACTOR IS EQUAL TO 1.0, AND THE TIRE IS CONSIDERED CONCENTRATED CARGO. THE MINIMUM SHORING THICKNESS IS 1/2 INCH.

NOTE

IF THE TIRE IS TO BE PARKED OVER A TIEDOWN RING PAN, PROCEED TO STEP 8. IF THE TIRE WILL NOT BE PARKED OVER A TIEDOWN RING PAN, CALCULATE THE REQUIRED SHORING AS FOLLOWS.

7. SHORING CALCULATION FOR TIRE NOT PARKED OVER A TIEDOWN RING PAN.

- A. USE THE PNEUMATIC TIRE ON FLOOR REQUIRED (L + W) FORMULA.

$$14,000 \div 404.7 = 34.5935 \text{ REQUIRED (L + W)}$$

- B. IF THE REQUIRED LENGTH PLUS WIDTH IS GREATER THAN THE ACTUAL LENGTH PLUS WIDTH, PROCEED AS FOLLOWS TO CALCULATE THE SHORING THICKNESS:

$$\text{THICKNESS} = \frac{\text{REQUIRED (L + W)} - \text{ACTUAL (L + W)}}{4}$$

OR

$$\text{THICKNESS} = 1/2 \text{ SPACING BETWEEN TIRE TREADS}$$

OR

$$1/2 \text{ INCH}$$

WHICHEVER IS LARGER

$$\text{THICKNESS} = \frac{34.5935 - 34.0}{4} = 0.1484 = 0.15 \text{ INCH}$$

THEREFORE, USE 1/2 INCH MINIMUM THICKNESS

- C. IF THE REQUIRED LENGTH PLUS WIDTH IS EQUAL TO OR LESS THAN THE ACTUAL LENGTH PLUS WIDTH, THE SHORING THICKNESS IS CALCULATED AS FOLLOWS:

$$\text{THICKNESS} = 1/2 \text{ SPACING BETWEEN TIRE TREADS}$$

OR

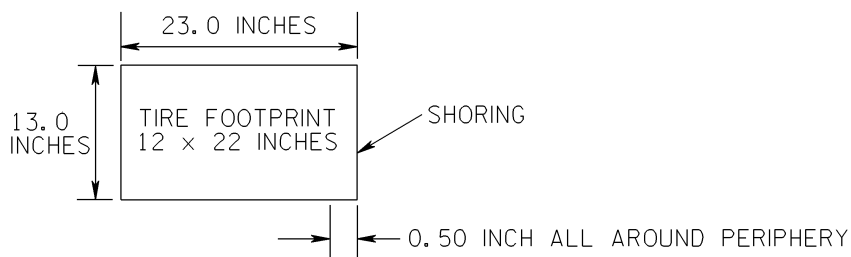
$$\text{THICKNESS} = 1/2 \text{ INCH}$$

WHICHEVER IS LARGER

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Figure 4-24. Pneumatic Tire Allowable Loads (Sheet 3)

- D. THE SHORING SHALL PROJECT ON ALL SIDES BY AN AMOUNT EQUAL TO THE THICKNESS DETERMINED IN STEP B OR C.



8. IF THE TIRE IS PARKED OVER A TIEDOWN RING PAN, CALCULATE THE REQUIRED SHORING AS FOLLOWS:
- USE 18 SQUARE INCHES FOR THE DISCONTINUITY AREA (AD) OF A TIEDOWN RING PAN.
 - THE EFFECT OF THE TIEDOWN RING PAN DISCONTINUITY IS TO REDUCE THE $\underline{M}$ FACTOR OF THE TIRE FOOTPRINT. THE FOLLOWING FORMULA IS USED TO CALCULATE THE TIRE $\underline{MD}$ FACTOR (INCLUDING THE DISCONTINUITY):

$$\underline{MD} = \frac{(OA - AD) \underline{M}}{OA}$$

- WHERE:
- W = WIDTH OF CARGO CONTACT
 - L = LENGTH OF CARGO CONTACT
 - AD = AREA OF DISCONTINUITY = 18 SQUARE INCHES
 - $\underline{M}$ = RATIO OF TREAD AREA TO FOOTPRINT AREA FOR THE TIRE
 - $\underline{MD}$ = $\underline{M}$ FACTOR THAT ACCOUNTS FOR BOTH THE TREAD AND DISCONTINUITY EFFECTS
 - OA = AREA OF CARGO CONTACT IN SQUARE INCHES

EXAMPLE PROBLEM: OA = 12 × 22 = 264 SQUARE INCHES

$$\underline{M} = 0.78$$

$$\begin{aligned} \underline{MD} &= \frac{(264-18) 0.78}{264} \\ &= \frac{(246) 0.78}{264} \\ &= 0.7268 \end{aligned}$$

- C. TO OBTAIN ALLOWABLE LOAD USE THE PNEUMATIC TIRE ON FLOOR ALLOWABLE LOAD FORMULA.

$$443.8 (L + W) \times \text{SQ. ROOT OF } \underline{M} \text{ FACTOR}$$

$$443.8 (34) \times \text{SQ. ROOT OF } 0.72 = 12803.186 = 12803$$

L1115417

Figure 4-24. Pneumatic Tire Allowable Loads (Sheet 4)

D. COMPARE THE ACTUAL TIRE LOAD TO THE ALLOWABLE TIRE LOAD.

- (1) IF THE ACTUAL TIRE LOAD IS EQUAL TO OR LESS THAN THE ALLOWABLE TIRE LOAD DETERMINED IN STEP C, NO SHORING IS REQUIRED.
- (2) IF THE ACTUAL TIRE LOAD IS GREATER THAN THE ALLOWABLE TIRE LOAD DETERMINED IN STEP C, SHORING IS REQUIRED AND IS CALCULATED AS FOLLOWS:

a. USE THE PNEUMATIC TIRE ON FLOOR REQUIRED LENGTH PLUS WIDTH FORMULA

$$14,000 \div 404.7 = 34.5935$$

b. CALCULATE THE EFFECTIVE LENGTH PLUS WIDTH OF THE TIRE FOOTPRINT OVER A TIEDOWN RING PAN WITH THE TIRE M FACTOR EQUAL TO 1. THIS IS TO ACCOUNT FOR THE EFFECT OF SHORING ON A PNEUMATIC TIRE (TIRE M FACTOR BECOMES 1.0) AND ALSO TO ACCOUNT FOR THE TIEDOWN RING PAN DISCONTINUITY. USE THE FORMULA IN STEP 8B AS FOLLOWS:

$$\begin{aligned} \underline{MD} &= \frac{(OA - AD) M}{OA} \\ &= \frac{(264 - 18) 1.0}{264} \\ &= 0.93181 = 0.93 \end{aligned}$$

$$\begin{aligned} \text{EFFECTIVE } (L + W) &= \sqrt{\underline{MD}} \times (L + W) \\ &= \sqrt{0.93} \times (22.0 + 12.0) \\ &= 32.7884 \text{ INCHES} \end{aligned}$$

c. IF THE REQUIRED LENGTH PLUS WIDTH IS GREATER THAN THE EFFECTIVE LENGTH PLUS WIDTH, PROCEED AS FOLLOWS TO CALCULATE THE SHORING THICKNESS:

$$\text{THICKNESS} = \frac{(\text{REQUIRED LENGTH PLUS WIDTH}) - (\text{EFFECTIVE LENGTH PLUS WIDTH})}{4}$$

OR

THICKNESS = 1/2 SPACING BETWEEN TIRE TREADS

OR

1/2 INCH MINIMUM

WHICHEVER IS LARGER

FOR THE EXAMPLE PROBLEM:

$$\begin{aligned} \text{THICKNESS} &= \frac{34.5935 - 32.7884}{4} \\ &= \frac{1.8051}{4} \\ &= 0.4513 \text{ INCH} = 0.45 \end{aligned}$$

USE 1/2 INCH MINIMUM THICKNESS

L1115418

Figure 4-24. Pneumatic Tire Allowable Loads (Sheet 5)

- d. IF THE REQUIRED LENGTH PLUS WIDTH IS EQUAL TO OR LESS THAN THE EFFECTIVE LENGTH PLUS WIDTH, THE SHORING THICKNESS IS CALCULATED AS FOLLOWS:

THICKNESS = $1/2$ (SPACING BETWEEN TIRE TREADS)

OR

THICKNESS = $1/2$ INCH

WHICHEVER IS LARGER.

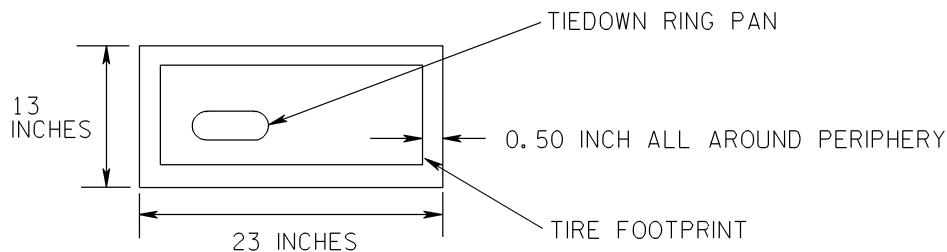
- e. THE SHORING CALCULATED IN STEP (C) OR (D) MUST BE LARGE ENOUGH TO PROJECT AN AMOUNT EQUAL TO THE SHORING THICKNESS ON ALL SIDES.

ANSWER TO EXAMPLE PROBLEM:

LENGTH $\geq 22 + 0.50 + 0.50 = 23$ INCHES

WIDTH $\geq 12 + 0.50 + 0.50 = 13$ INCHES

THICKNESS ≥ 0.50 INCHES



L1115419

Figure 4-24. Pneumatic Tire Allowable Loads (Sheet 6)

PROCEDURES FOR DETERMINING ON/OFF LOADING MAXIMUM ALLOWABLE LOADS AND CALCULATING ROLLING SHORING WHEN REQUIRED.

NOTE

- 1. VEHICLES WITH OVER-THE-ROAD PNEUMATIC TIRES MAY BE ON/OFF LOADED WITHOUT THE USE OF ROLLING SHORING.
- 2. ALL OTHER RATIOS OF FOOTPRINT AREA TO RECTANGULAR AREA MUST BE DETERMINED FROM FIGURE 4-24.
- 3. THESE PROCEDURES ALSO APPLY TO HARD RUBBER AND STEEL WHEELS. FOR THESE WHEELS $M = 1.0$ AND ACTUAL LENGTH (L) EQUALS ZERO (0).
- 4. IF PARKING SHORING IS REQUIRED FOR FLIGHT, ROLLING SHORING MAY OR MAY NOT BE REQUIRED FOR ON/OFF LOADING CARGO. ROLLING SHORING REQUIREMENTS MUST BE DETERMINED USING THE FOLLOWING PROCEDURES.

DETERMINE ON/OFF LOADING MAXIMUM ALLOWABLE ROLLING LOADS AS FOLLOWS:

CALCULATION FORMULAS

NOTE

A VEHICLE THAT REQUIRES ROLLING SHORING ALSO REQUIRES PARKING SHORING. SEE PARAGRAPH 4.5.4.

ALLOWABLE LOAD

HARD RUBBER TIRE ALLOWABLE LOAD = 1175 (W)

STEEL WHEEL ALLOWABLE LOAD = 985 (W)

PNEUMATIC TIRE ALLOWABLE LOAD = 699 (L + W) $\sqrt{M}$

SHORING:

PNEUMATIC TIRE ROLLING ON SHORING = REQUIRED (L + W) = $\frac{\text{WHEEL LOAD}}{668}$

HARD RUBBER AND STEEL WHEEL ON SHORING = REQUIRED SHORING WIDTH = $\frac{\text{WHEEL LOAD} - (L)}{668}$

- 1. DETERMINE THE M FACTOR USING THE PROCEDURES IN FIGURE 4-24.
- 2. DETERMINE ALLOWABLE LOAD UTILIZING THE APPROPRIATE FORMULA.
- 3. DETERMINE WHEEL LOAD BY DIVIDING AXLE WEIGHT BY THE NUMBER OF WHEELS.
- 4. IF THE ACTUAL WHEEL LOAD IS EQUAL TO OR LESS THAN THE ALLOWABLE WHEEL LOAD, THE CARGO MAY BE ON/OFF LOADED WITHOUT ROLLING SHORING.
- 5. IF THE WHEEL LOAD IS GREATER THAN THE ALLOWABLE WHEEL LOAD, THEN ROLLING SHORING IS REQUIRED.

CALCULATE ROLLING SHORING REQUIREMENTS AS FOLLOWS:

- 1. USE THE REQUIRED SHORING LENGTH PLUS WIDTH FORMULA TO COMPUTE THE REQUIRED LENGTH PLUS WIDTH. (PNEUMATIC TIRES)

L1115420

Figure 4-25. On/Off Loading Maximum Allowable Loads (Sheet 1 of 4)

2. USE THE REQUIRED SHORING WIDTH FORMULA TO COMPUTE THE REQUIRED WIDTH.
(HARD RUBBER TIRES AND STEEL WHEELS)
3. IF THE REQUIRED LENGTH PLUS WIDTH IS LESS THAN OR EQUAL TO THE ACTUAL LENGTH PLUS WIDTH, THEN THE MINIMUM THICKNESS OF ROLLING SHORING REQUIRED IS EQUAL TO:
 - A. HALF THE DISTANCE BETWEEN THE TIRE TREADS OR A MINIMUM OF 1/2 INCH FOR PNEUMATIC TIRES.
 - B. 1/2 INCH FOR HARD RUBBER TIRES OR STEEL WHEELS.
4. IF THE REQUIRED LENGTH PLUS WIDTH IS GREATER THAN THE ACTUAL LENGTH PLUS WIDTH, CALCULATE THE MINIMUM ROLLING SHORING THICKNESS AS FOLLOWS:
 - A. FOR PNEUMATIC TIRES:

$$\text{THICKNESS} = \frac{(\text{REQUIRED LENGTH PLUS WIDTH}) - (\text{ACTUAL LENGTH PLUS WIDTH})}{4}$$
 OR

$$\text{THICKNESS} = 1/2 \text{ (SPACING BETWEEN TIRE TREADS)}$$
 OR
 1/2 INCH
 WHICHEVER IS GREATER.
 - B. FOR HARD RUBBER TIRES AND STEEL WHEELS (LENGTH EQUALS ZERO):

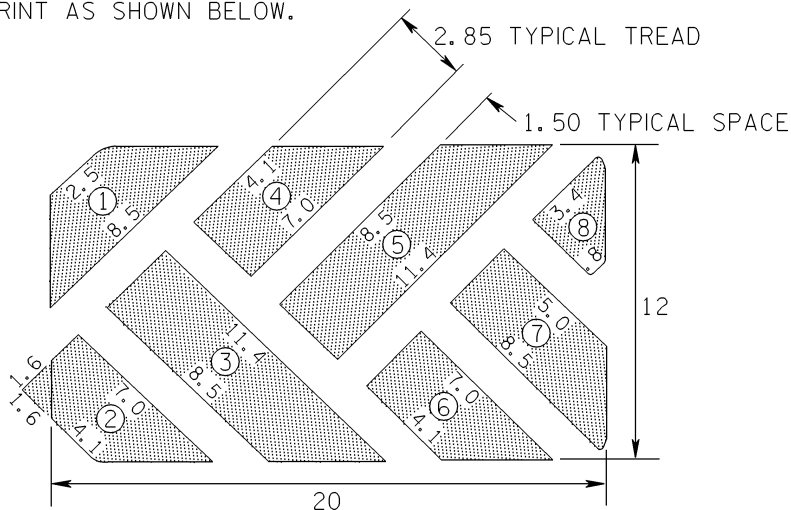
$$\text{THICKNESS} = \frac{(\text{REQUIRED WIDTH} - \text{ACTUAL WIDTH})}{4}$$
 OR
 1/2 INCH
 WHICHEVER IS GREATER
5. THE WIDTH OF ROLLING SHORING THAT PROJECTS BEYOND THE TIRE ON EACH SIDE MUST BE AT LEAST EQUAL TO THE ROLLING SHORING THICKNESS.

NOTE

PNEUMATIC TIRE LENGTH DEPENDS ON CARGO PLACEMENT IN THE AIRPLANE.

EXAMPLE 1

DETERMINE IF ROLLING SHORING IS REQUIRED, AND IF REQUIRED, DETERMINE THE SHORING REQUIREMENT FOR A VEHICLE TO BE ON/OFF LOADED WITH AN AXLE LOAD OF TWO PNEUMATIC TIRES AND A FOOTPRINT AS SHOWN BELOW.



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Figure 4-25. On/Off Loading Maximum Allowable Loads (Sheet 2)

1. DETERMINE
- A_{NET}
- (SHADED AREA) FOR THE TIRE FOOTPRINT.

$$\begin{array}{rcl}
 A_1 & = & 1/2 (8.5 + 2.5) \times 2.85 = 15.7 \\
 A_2 & = & 1/2 (4.1 + 7.0) \times 2.85 - 1/2 (1.6) (1.6) = 14.5 \\
 A_3 & = & 1/2 (8.5 + 11.4) \times 2.85 = 28.4 \\
 A_4 & = & 1/2 (4.1 + 7.0) \times 2.85 = 15.8 \\
 A_5 & = & 1/2 (8.5 + 11.4) \times 2.85 = 28.4 \\
 A_6 & = & 1/2 (4.1 + 7.0) \times 2.85 = 15.8 \\
 A_7 & = & 1/2 (5.0 + 8.5) \times 2.85 = 19.2 \\
 A_8 & = & 1/2 (3.4 + 0.8) \times 2.85 = 6.0 \\
 & & A_{NET} \quad 143.8
 \end{array}$$

2. DETERMINE
- A_{GROSS}
- FOR THE TIRE FOOTPRINT.

$$A_{GROSS} = 12 \times 20 = 240 \text{ SQUARE INCHES}$$

3. DETERMINE
- M
- FACTOR FOR THE TIRE.

$$M = \frac{A_{NET}}{A_{GROSS}} = \frac{143.0}{240.0} = 0.60$$

4. USE PNEUMATIC TIRE ALLOWABLE FORMULA TO DETERMINE ALLOWABLE LOAD.

$$699 (20 + 12) \sqrt{0.60} = 17326.1783 = 17326$$

5. DETERMINE ACTUAL LOAD PER WHEEL.

$$\frac{\text{AXLE WEIGHT}}{\text{NO. OF WHEELS}} = \frac{36,000}{2} = 18,000 \text{ POUNDS}$$

6. THE ACTUAL LOAD PER WHEEL IS GREATER THAN THE ALLOWABLE LOAD PER WHEEL; THEREFORE, ROLLING SHORING IS REQUIRED AND IS CALCULATED AS FOLLOWS:

- A. UTILIZING THE PNEUMATIC TIRE ROLLING SHORING FORMULA, COMPUTE THE REQUIRED
- $L + W$
- .

$$\frac{18,000}{668} = 26.9461 = 27$$

- B. THE REQUIRED LENGTH PLUS WIDTH IS LESS THAN THE ACTUAL LENGTH PLUS WIDTH; THEREFORE, THE MINIMUM ROLLING SHORING THICKNESS IS
- $1/2$
- THE DISTANCE BETWEEN THE TIRE THREADS.

$$\text{THICKNESS} = 1/2 (1.50) = 0.75 \text{ INCH} = 0.8$$

- C. THE WIDTH OF ROLLING SHORING PROJECTED BEYOND THE TIRE ON EACH SIDE MUST BE AT LEAST EQUAL TO THE ROLLING SHORING THICKNESS; THEREFORE:

$$\text{THICKNESS} = 0.8 \text{ INCH}$$

$$\text{WIDTH} = 12 + (2 \times 0.8) = 13.6 \text{ INCHES}$$

L1115422

Figure 4-25. On/Off Loading Maximum Allowable Loads (Sheet 3)

NOTE

THE ROLLING SHORING SHALL BE CENTERED UNDER EACH WHEEL DURING ON/OFF LOADING.

EXAMPLE 2

DETERMINE IF ROLLING SHORING IS REQUIRED AND, IF REQUIRED, DETERMINE THE SHORING REQUIREMENT FOR A FOUR-WHEELED DOLLY UNIFORMLY LOADED WITH 24,000 POUNDS OF CARGO. THE WHEELS ARE HARD RUBBER WITH A TREAD WIDTH OF 4.0 INCHES.

1. ACTUAL WHEEL WIDTH = 4.0 INCHES, ACTUAL WHEEL LENGTH = 0.0 INCHES.
2. USE THE HARD RUBBER TIRE ALLOWABLE FORMULA TO DETERMINE ALLOWABLE LOAD.

$$1175 (4) = 4,700 \text{ POUNDS}$$

3. DETERMINE ACTUAL LOAD PER WHEEL.

$$\frac{\text{TOTAL CARGO WEIGHT}}{\text{NO. OF WHEELS}} = \frac{24,000}{4} = 6,000 \text{ POUNDS}$$

4. THE ACTUAL LOAD PER WHEEL IS GREATER THAN THE ALLOWABLE LOAD PER WHEEL, THEREFORE, ROLLING SHORING IS REQUIRED AND IS CALCULATED AS FOLLOWS:

- A. UTILIZING THE HARD RUBBER AND STEEL WHEELS ROLLING ON SHORING FORMULA COMPUTE THE REQUIRED WIDTH.

$$\frac{6000}{668} = 8.9820 \text{ INCHES}$$

- B. THE REQUIRED LENGTH PLUS WIDTH IS GREATER THAN THE ACTUAL LENGTH PLUS WIDTH; THEREFORE, THE MINIMUM ROLLING SHORING THICKNESS IS:

$$\text{THICKNESS} = \frac{(\text{REQUIRED WIDTH} - \text{ACTUAL WIDTH})}{4}$$

OR 1/2 INCH

WHICHEVER IS GREATER

$$\text{THICKNESS} = \frac{(8.9820 - 4.0)}{4} = 1.2455 \text{ INCHES} = 1.3 \text{ INCHES}$$

- C. THE WIDTH OF ROLLING SHORING PROJECTING BEYOND THE TIRE ON EACH SIDE MUST BE AT LEAST EQUAL TO THE ROLLING SHORING THICKNESS, THEREFORE;

$$\text{THICKNESS} = 1.3 \text{ INCHES}$$

$$\text{WIDTH} = 4.0 + (2 \times 1.3) = 6.6 \text{ INCHES}$$

NOTE

THE ROLLING SHORING SHALL BE CENTERED UNDER EACH WHEEL DURING ON/OFF LOADING.

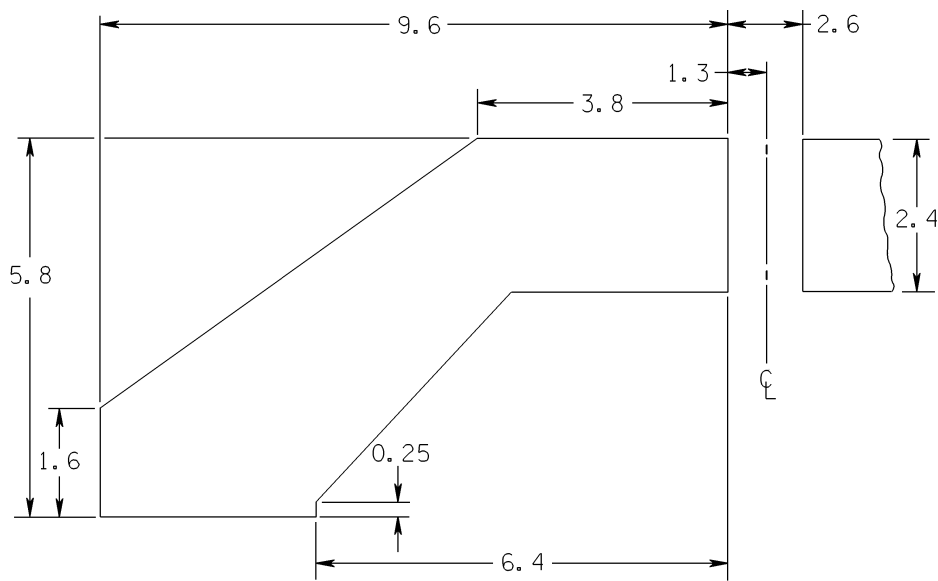
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Figure 4-25. On/Off Loading Maximum Allowable Loads (Sheet 4)

PROCEDURES FOR DETERMINING MAXIMUM ALLOWABLE FLOOR LOADS FOR VEHICLES WITH TRACKED PADS AND CALCULATION OF SHORING WHEN REQUIRED.

NOTE

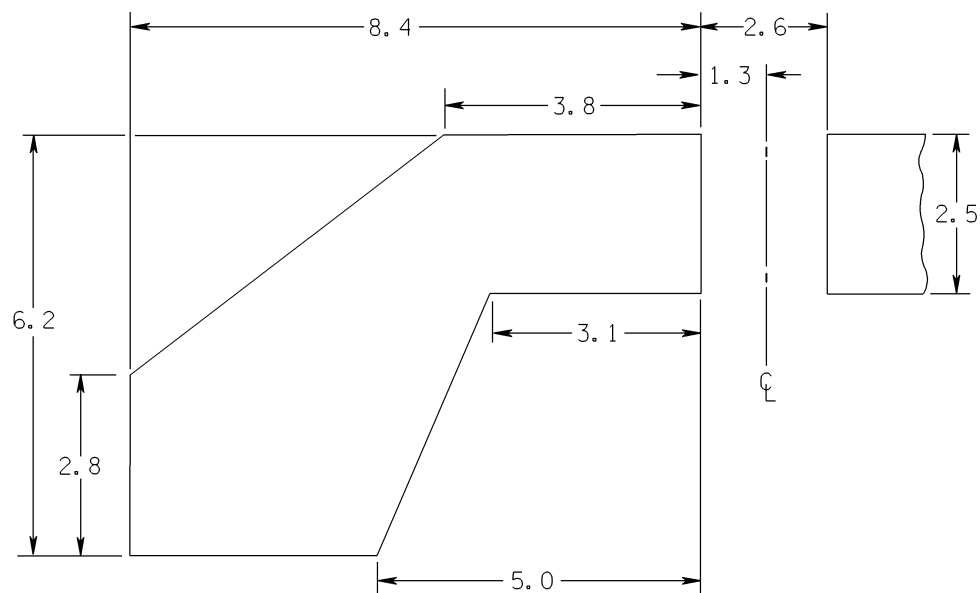
- 1. ALLOWABLE LOAD IS FOR ONE WHEEL OF THE TRACKED VEHICLE.
- 2. VEHICLES WITH TRACKED PADS NOT COVERED WITH RUBBER, OR EXCESSIVE WEAR TO THE RUBBER PADS WHICH COULD RESULT IN STEEL GROUSERS BOTTOMING OUT ON THE CARGO FLOOR DURING FLIGHT, SHALL USE SHORING UNDER THE VEHICLE TRACKS THICK ENOUGH FOR GROUSERS TO SINK INTO WITHOUT CONTACTING THE CARGO FLOOR.
- 3. THE FOLLOWING ILLUSTRATIONS SHOW THE DIMENSIONS, SHAPE, AND ALLOWABLE LOAD CAPABILITY OF KNOWN TRACKED PADS:



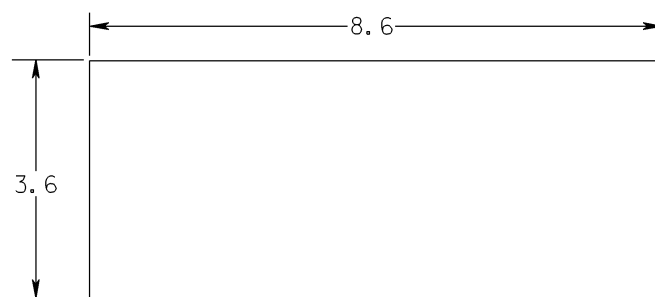
TYPE NO. T-97E2
(USED ON M-48, M-60, AND M-728 VEHICLES)
ALLOWABLE LOAD = 10,700 POUNDS

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Figure 4-26. Maximum Allowable Floor Loads for Vehicles with Tracked Pads (Sheet 1 of 8)



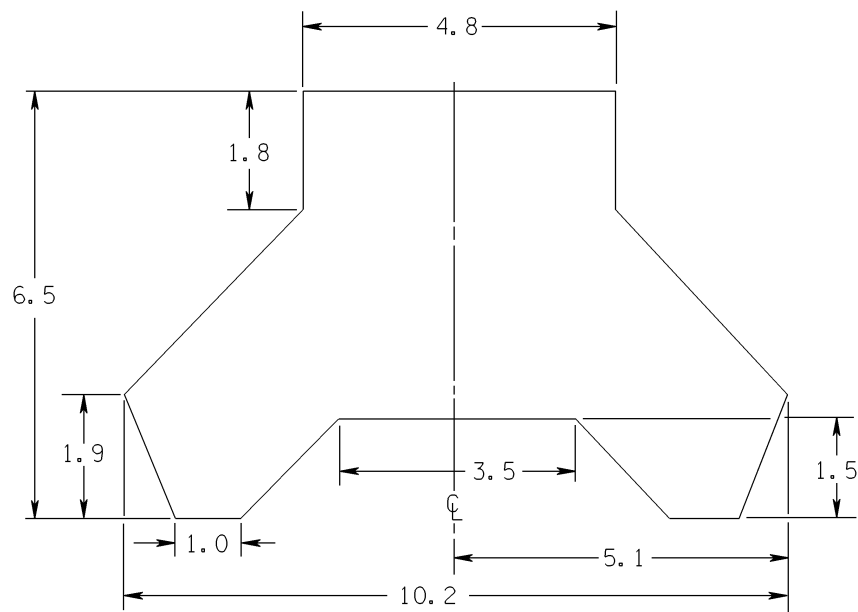
TYPE NO. T-107
(USED ON M-88 VEHICLES)
ALLOWABLE LOAD = 9,400 POUNDS



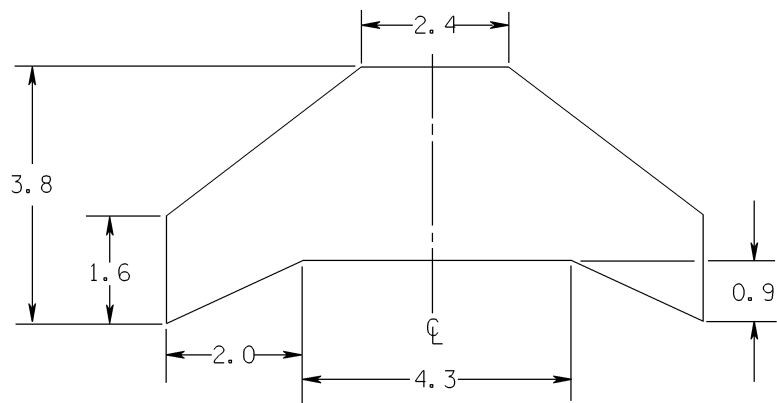
TYPE NO. T-132E1
(USED ON M-107, AND M-110 VEHICLES)
ALLOWABLE LOAD = 6,200 POUNDS

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Figure 4-26. Maximum Allowable Floor Loads for Vehicles with Tracked Pads (Sheet 2)



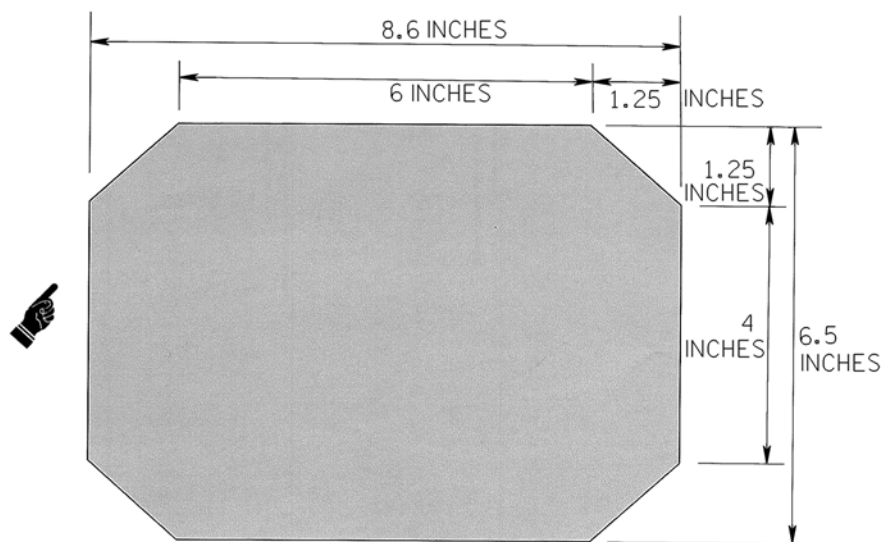
TYPE NO. T-91E3
(USED ON M-41 VEHICLE)
ALLOWABLE LOAD = 5,200 POUNDS



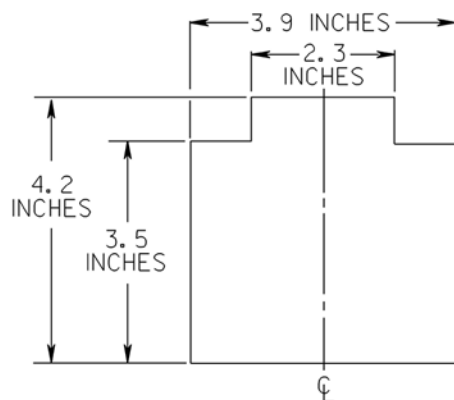
TYPE NO. T-136
(USED ON M-108, AND M-109 VEHICLES)
ALLOWABLE LOAD = 3,700 POUNDS

L1115426

Figure 4-26. Maximum Allowable Floor Loads for Vehicles with Tracked Pads (Sheet 3)




 TYPE NO. T-158
 (USED ON ALL M-1 TANK MODELS)
 ALLOWABLE LOAD = 6,919 POUNDS



TYPE NO. T-130
 (USED ON M-113 VEHICLE)
 ALLOWABLE LOAD = 4,058 POUNDS

DETERMINE THE MAXIMUM ALLOWABLE FLOOR LOADS FOR TRACKED PADS OTHER THAN THE ONES SHOWN AS FOLLOWS:

NOTE

FOR SQUARE OR RECTANGLE PADS, MEASURE THE PAD ACTUAL WIDTH AND LENGTH. USE THESE VALUES IN THE GRAPH TO DETERMINE THE ALLOWABLE LOAD FOR THE PAD.

NOTE

TO SIMPLIFY CALCULATION; THE PAD SHAPE SHOULD BE SQUARED OFF TO A RECTANGLE SHAPE.

L1115427

Figure 4-26. Maximum Allowable Floor Loads for Vehicles with Tracked Pads (Sheet 4)

1. TO DETERMINE THE ALLOWABLE LOAD FOR PADS OF ANY SHAPE, USE THE FOLLOWING METHOD AND THE EXAMPLE SHOWN:
2. SQUARE OFF COMPLETE PAD TO A RECTANGULAR SHAPE.
3. DETERMINE AREA OF COMPLETE PAD IN SQUARE INCHES BY MULTIPLYING LENGTH BY WIDTH.
 $L \times W = \text{OVERALL AREA OF COMPLETE PAD IN SQUARE INCHES} = OA$
4. DETERMINE ACTUAL CONTACT AREA OF COMPLETE PAD AS FOLLOWS:
 - A. SQUARE OFF HALF OF COMPLETE PAD TO A RECTANGULAR SHAPE (IF PAD IS SYMMETRICAL ABOUT CENTER LINE):
 - B. MULTIPLY WIDTH BY LENGTH OF ONE HALF PAD TO OBTAIN OVERALL AREA:
 $L \times W = \text{OVERALL AREA OF HALF PAD IN SQUARE INCHES} = A$
 - C. DETERMINE AREA OF CUTAWAYS IN PAD BY MULTIPLYING LENGTH BY WIDTH:
 $L \times W = \text{AREA OF CUTAWAYS IN SQUARE INCHES} = A$
 - D. DEDUCT CUTAWAY AREA FROM OVERALL AREA TO OBTAIN ACTUAL CONTACT AREA OF ONE HALF PAD:
 $A - A = \text{ACTUAL CONTACT AREA OF ONE HALF PAD IN SQUARE INCHES} = ACA$
 - F. MULTIPLY ACTUAL CONTACT AREA OF ONE HALF PAD BY 2 TO OBTAIN ACTUAL CONTACT AREA OF COMPLETE PAD:
 $ACA \times 2 = \text{ACTUAL CONTACT AREA OF COMPLETE PAD IN SQUARE INCHES} = CA$

NOTE

FOR PADS TO BE PARTIALLY SUPPORTED BY A CARGO FLOOR DISCONTINUITY, DETERMINE COMPLETE AREA OF DISCONTINUITY BY MULTIPLYING LENGTH BY WIDTH OF DISCONTINUITY UNDER PAD AND SUBTRACT FROM THE ACTUAL CONTACT AREA OF THE COMPLETE PAD.

5. DETERMINE M BY DIVIDING ACTUAL CONTACT AREA OF COMPLETE PAD BY THE OVERALL AREA OF THE COMPLETE PAD:

$$\frac{CA_{cp}}{OA_{cp}} = M \text{ FOR COMPLETE PAD}$$

CALCULATION FORMULAS**ALLOWABLE LOAD**

$$\text{ALLOWABLE LOAD ON RAMP} = 204.0 (L + W) \sqrt{M}$$

$$\text{ALLOWABLE LOAD ON CARGO FLOOR} = 236.1 (L + W) \sqrt{M}$$

EFFECTIVE (L + W)

$$\text{EFFECTIVE LENGTH AND WIDTH} = (L + W) \sqrt{M}$$

SHORING REQUIREMENTS

$$\text{SHORING ON RAMP REQUIRED } (L + W) = \frac{\text{PAD LOAD}}{231.8}$$

$$\text{SHORING ON CARGO FLOOR REQUIRED } (L + W) = \frac{\text{PAD LOAD}}{404.7}$$

6. DETERMINE ALLOWABLE LOAD USING THE APPROPRIATE ALLOWABLE LOAD FORMULA.

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Figure 4-26. Maximum Allowable Floor Loads for Vehicles with Tracked Pads (Sheet 5)

7. COMPARE THE ACTUAL TRACKED PAD LOAD TO THE ALLOWABLE TRACKED PAD LOAD.

A. IF THE ACTUAL TRACKED PAD LOAD IS EQUAL TO OR LESS THAN THE ALLOWABLE TRACKED PAD LOAD DETERMINED IN STEP 6, NO SHORING IS REQUIRED.

B. IF THE ACTUAL TRACKED PAD LOAD IS GREATER THAN THE ALLOWABLE TRACKED PAD LOAD DETERMINED IN STEP 6, SHORING IS REQUIRED AND IS CALCULATED AS FOLLOWS:

(1) DETERMINE REQUIRED LENGTH AND WIDTH UTILIZING THE APPROPRIATE FORMULA IN STEP 5

(2) DETERMINE EFFECTIVE LENGTH AND WIDTH UTILIZING THE APPROPRIATE FORMULA IN STEP 5

(3) IF THE REQUIRED LENGTH PLUS WIDTH IS LESS THAN OR EQUAL TO THE EFFECTIVE LENGTH PLUS WIDTH, USE THE MINIMUM SHORING THICKNESS OF 1/2 INCH.

(4) IF THE REQUIRED LENGTH PLUS WIDTH IS GREATER THAN THE EFFECTIVE LENGTH PLUS WIDTH, THE SHORING THICKNESS (T) WILL BE COMPUTED AS FOLLOWS:

$$\text{THICKNESS} = \frac{(\text{REQUIRED LENGTH PLUS WIDTH}) - (\text{EFFECTIVE LENGTH PLUS WIDTH})}{4}$$

OR

1/2 INCH MINIMUM,

WHICHEVER IS GREATER

(5) THE SHORING SIZE IS AS FOLLOWS:

WIDTH = PAD WIDTH + 2T

LENGTH = TOTAL LENGTH OF TRACK CONTACT + 2T

NOTE

THE SHORING SHALL PROJECT AN AMOUNT EQUAL TO THE SHORING THICKNESS ON ALL SIDES.

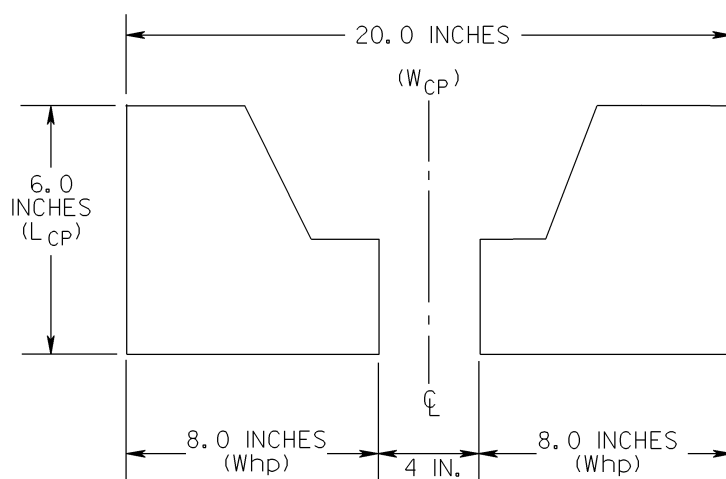
EXAMPLE PROBLEM

DETERMINE THE ALLOWABLE LOAD CAPABILITY OF THE FOLLOWING ILLUSTRATED RUBBER TRACKED PAD TO BE LOADED ON THE CARGO COMPARTMENT FLOOR.

PAD LOAD = 6,000 POUNDS

NOTE

TRACKED PADS COME IN VARIOUS CONFIGURATIONS. SOME ARE A COMPLETE RECTANGLE; SOME ARE SPLIT IN THE MIDDLE.



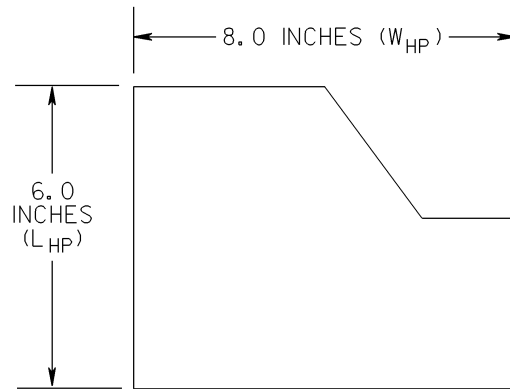
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Figure 4-26. Maximum Allowable Floor Loads for Vehicles with Tracked Pads (Sheet 6)

1. SQUARE OFF COMPLETE PAD TO A RECTANGULAR SHAPE.
2. DETERMINE AREA OF COMPLETE PAD IN SQUARE INCHES BY MULTIPLYING PAD WIDTH BY ITS LENGTH:

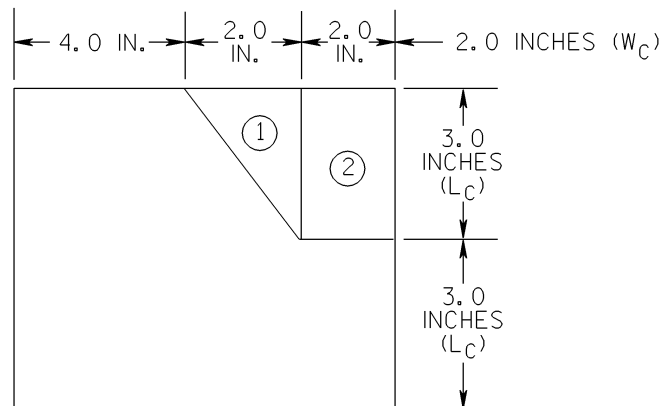
$$20.0 \times 6.0 \text{ INCHES} = 120.0 - \text{AREA OF COMPLETE PAD IN SQUARE INCHES} = OA_{cp}$$

3. DETERMINE ACTUAL CONTACT AREA OF COMPLETE PAD AS FOLLOWS:
- A. SQUARE OFF ONE HALF OF COMPLETE PAD TO A RECTANGULAR SHAPE:
(IF PAD IS SYMMETRICAL ABOUT CL).



- B. MEASURE OVERALL AREA OF ONE HALF PAD AND MULTIPLY WIDTH BY LENGTH TO OBTAIN OVERALL AREA IN SQUARE INCHES.

$$8.0 \times 6.0 \text{ INCHES} = 48.0 - \text{OVERALL AREA OF ONE HALF PAD IN SQUARE INCHES} = \text{AHP}$$



- C. DETERMINE AREA OF CUTAWAY, ZONES ① AND ② BY MULTIPLYING WIDTH BY LENGTH:

ZONE ① 1/2 2.0 x 3.0 INCHES = 3.0 SQUARE INCHES

ZONE (2) 2.0 x 3.0 INCHES = 6.0 SQUARE INCHES

TOTAL CUTAWAY AREA ZONE (1) AND (2) = 9.0 SQUARE INCHES

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Figure 4-26. Maximum Allowable Floor Loads for Vehicles with Tracked Pads (Sheet 7)

- D. DEDUCT CUTAWAY AREA FROM OVERALL AREA TO OBTAIN ACTUAL CONTACT AREA OF ONE HALF PAD:

$$\text{OVERALL AREA OF ONE HALF PAD} = 48.0 \text{ SQUARE INCHES} = A_{HP}$$

$$\text{TOTAL CUTAWAY OF ONE HALF PAD} = 9.0 \text{ SQUARE INCHES} = A_C$$

$$\text{CONTACT AREA OF ONE HALF PAD} = 39.0 \text{ SQUARE INCHES} = A_{CA_{HP}}$$

- E. MULTIPLY ACTUAL CONTACT AREA OF ONE HALF PAD BY 2 TO OBTAIN ACTUAL CONTACT AREA OF COMPLETE PAD:

$$39.0 \times 2 = 78.0 \text{ SQUARE INCHES} = \text{TOTAL CONTACT AREA OF COMPLETE PAD} = CA_{CP}$$

4. DETERMINE M BY DIVIDING ACTUAL CONTACT AREA OF COMPLETE PAD BY THE OVERALL AREA OF COMPLETE PAD:

$$\frac{\text{ACTUAL CONTACT AREA OF COMPLETE PAD } (CA_{CP})}{\text{OVERALL AREA OF COMPLETE PAD } (OA_{CP})} = \frac{78.0 \text{ INCHES}}{120.0 \text{ INCHES}} = 0.65$$

$$0.65 = M \text{ FOR COMPLETE PAD}$$

5. DETERMINE ALLOWABLE LOAD USING THE APPROPRIATE ALLOWABLE LOAD FORMULA.

$$236.1 (20 + 6) \sqrt{0.65} = 4949.0975 \text{ POUNDS} = 4949$$

6. COMPARE THE ACTUAL TRACKED PAD LOAD TO THE ALLOWABLE TRACK PAD LOAD.

- A. IF THE ACTUAL TRACKED PAD LOAD IS EQUAL TO OR LESS THAN THE ALLOWABLE TRACKED PAD LOAD DETERMINED IN STEP 5, NO SHORING IS REQUIRED.

- B. IF THE ACTUAL TRACKED PAD LOAD IS GREATER THAN THE ALLOWABLE TRACKED PAD LOAD DETERMINED IN STEP 5, SHORING IS REQUIRED AND IS CALCULATED AS FOLLOWS:

- (1) DETERMINE REQUIRED LENGTH AND WIDTH UTILIZING THE APPROPRIATE FORMULA

$$6000 \div 404.7 = 14.8258$$

- (2) DETERMINE EFFECTIVE LENGTH AND WIDTH UTILIZING THE APPROPRIATE FORMULA

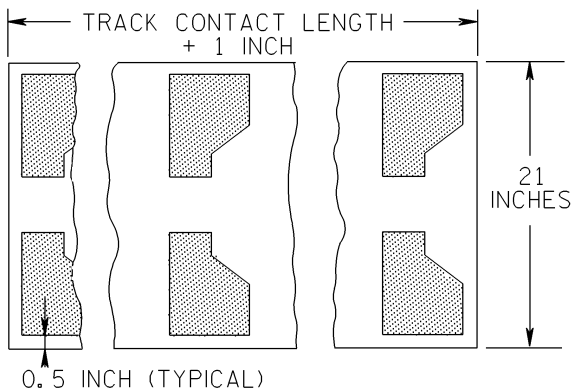
$$(20 + 6) \sqrt{0.65} = 20.9619$$

- (3) SINCE THE REQUIRED LENGTH PLUS WIDTH IS LESS THAN OR EQUAL TO THE EFFECTIVE LENGTH PLUS WIDTH, USE THE MINIMUM SHORING THICKNESS OF 1/2 INCH.

- (4) THE SHORING SIZE IS AS FOLLOWS:

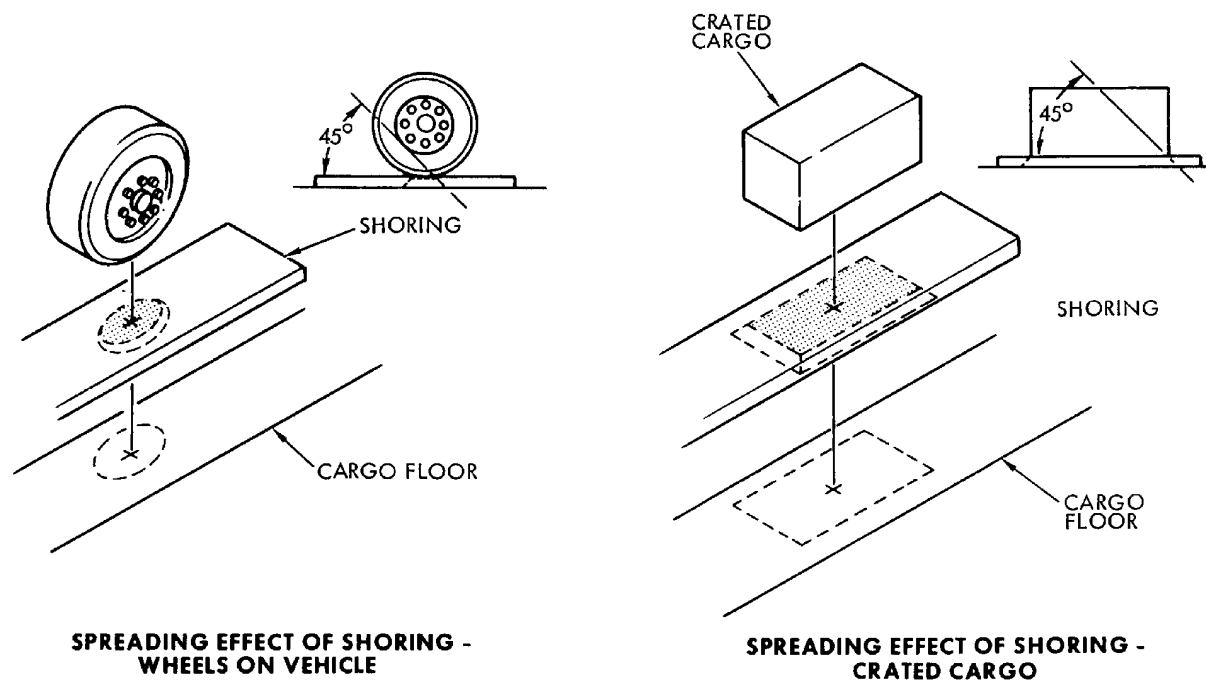
$$\text{WIDTH} = 20 + 2 (0.5) = 21 \text{ INCHES}$$

$$\text{LENGTH} = \text{TRACK CONTACT LENGTH} + 2 (0.5) = \text{TRACK CONTACT LENGTH} + 1 \text{ INCH}$$



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Figure 4-26. Maximum Allowable Floor Loads for Vehicles with Tracked Pads (Sheet 8)



L1115432

Figure 4-27. Load Shoring Effect

SECTION III LOAD METHODS AND RESTRAINT

4.7 CARGO LOADING, RESTRAINING, AND SECURING GENERAL INSTRUCTIONS.

This section contains general instructions for on/off loading cargo and restraining cargo.

4.8 LOADING METHODS.

WARNING

On/off loading cargo during fueling operations is permissible only under certain conditions. Refer to TO 00-25-172 for additional instructions.

The loading method used for a specific item of cargo will depend on its size, weight, and physical characteristics. The method selected from the following should, in addition to accommodating the geometry and floor structure of the cargo compartment, take into consideration availability of materials handling equipment and mission requirements:

- a. From the ground with forward ramp/ramp extension and/or the aft ramp and pressure door in the drive-in loading position.

WARNING

- The aft ramp is approximately 110 inches above the ground when the airplane is not in the kneeled position. Exercise caution when on/off loading cargo in the unkneeled position. Failure to comply could result in personnel injury.
 - Do not on/off load cargo through the forward door loading area with the airplane in the unkneeled position. Failure to comply could result in personnel injury.
- b. Truck loading over the forward ramp/ramp extension with the airplane in the forward or level kneeled positions.
 - c. Truck loading over the aft ramp with the airplane in the forward, level, or aft kneeled positions.
 - d. Truck loading over the aft ramp with the airplane in the unkneeled position. Cargo shall only be on/off loaded utilizing a 463L K loader when the airplane is in the unkneeled configuration.
 - e. Palletized/skidded cargo and vehicles can be winched into or out of the airplane through the forward or the aft cargo loading opening, using the airplane cargo winch or a portable cargo winch. Any portable cargo winch can be used provided it is compatible with the airplane electrical system or is connected directly with a suitable external power source. It must also be compatible with the airplane structural capability.

CAUTION

Do not use a prime mover to push any rolling stock with a vertically articulated tongue onto the airplane. Do not use a prime mover to pull this type of cargo off the airplane.

- f. The primary method for loading vehicular cargo is ground ramp loading with the airplane in one of its drive-in configurations. The secondary method is from a 463L K loader or flatbed with the airplane in the truck bed (straight-in) loading configuration. The bridge plates shown in the Figure 4-30 shall be used for all vehicular cargo loaded using the secondary method of loading.
- g. The normal method of loading skidded cargo is from 463L K loaders/flatbed/truck bed with the airplane in the truck bed (straight-in) loading configuration. The secondary method is ground ramp loading with the airplane in one of the drive-in loading configurations.

WARNING

On/off loading cargo with a forklift is prohibited with the airplane in the unkneeled position. Failure to comply could result in personnel injury.

- h. Forklift loading of bulk, skidded, or wheeled cargo on the airplane ramps may be accomplished. Cargo loaded in this manner can then be repositioned by winching, materials handling equipment, or manually.
- i. The normal method for loading palletized cargo is from 463L K loaders with the airplane in the truck bed loading configuration. An alternate method is from a rollerized flatbed with the airplane in the truck bed loading configuration.

CAUTION

Guides shall be positioned to monitor clearances during forklift operations in the door/ramp area. Failure to comply could result in damage to the airplane.

- j. An alternate method for loading 463L pallets may be accomplished by using 10K 463L forklifts equipped with rollerized tines or in conjunction with rollerized pallet trailers.

CAUTION

Exercise caution when on/off loading 463L pallets by bare tine forklift method. Do not place the forklift tines on the roller conveyors or the edge of the ramp. Avoid abrupt maneuvering of pallets onto the forklift tines. Failure to comply could result in damage to the airplane and cargo.

- k. Pallets may be on/off loaded using the bare tines of a forklift only when no other means are available. Restrain the pallet to forklift if tines are less than 72 inches.

4.8.1 Portable Loading Ramp Extension. (See Figure 4-28.) A portable loading ramp extension is provided to assist in the on/off loading of some vehicular loads. It is used as an extension of the forward ramp extension on the airplane. With the airplane in the forward kneeled position and the forward ramp and extension in the truck loading position (with the forward end of the ramp extension at a loading height of 50.5 (±0.5) inches), it provides a shallow on/off loading angle for the cargo as it is driven into or out of the airplane. The portable loading ramp extension can be disassembled for air transport as part of the cargo load.

4.8.1.1 Assembly Procedures – Portable Loading Ramp Extension. (See Figure 4-29.) To assemble the portable loading ramp extension, proceed as follows:

NOTE

Perform the following steps before assembling the portable loading ramp extension for on/off loading.

- a. Forward kneel the airplane.
- b. Place forward ramp and ramp extension in the truck loading position.
- c. Adjust forward end of ramp extension to a loading height of 50.5 (±0.5) inches.
- d. When required, adjust the height of the adjustable feet (identified as 1, 2, 3, and 4 components of 4S80057) until 1.5 inches of thread are exposed on the foot shaft.

NOTE

Each of the components of the portable loading ramp extension is identified with a sequence-of-assembly number and a location reference to its position to the airplane on assembly. The numbers and location reference are stencilled on the side of each component; for example, 1 of 13 COMPONENTS OF 4S80057 and OUTBOARD SIDE, LEFT SIDE OF SHIP. The odd numbered components are the left side components and the even numbered components the right side of components of the portable loading ramp extension. For ease of assembly, the left side of the ramp should be assembled first. The left and right sides are then locked together laterally to complete the assembly. For handling of the components during assembly/disassembly operation, utilize a suitable forklift whose tines will mate with the receptacles of the forklift adapter assembly. (See Figure 4-28.)

- e. Use the forklift truck to pick up the forklift adapter (component 13 of 13). Raise the forklift adapter to a convenient height for attachment of the adapter cables to the hoist point on the ramp extension components.

WARNING

Step f and Step g adjustments must be performed after lifting any component clear of the ground. Failure to comply could result in personnel injury.

- f. Adjust the forklift adapter pulley block so that it is positioned at the center of the adapter beam.
- g. Lock both ends of the pulley block chain around one of the hooks on the beam to prevent the pulley block from moving off center.

NOTE

Attach the forklift adapter cables to the components at the positions marked HOIST HERE and approach the components on the side marked OUTBOARD SIDE OF SHIP.

- h. Attach and lock forklift adapter cables to component 1.
- i. Lift and place component 1 in position with the rubber bumpers on its aft end 3 (± 1) inches from the forward edge of the forward ramp extension and the inboard edge at BL 10.
- j. Attach forklift adapter cables to component 3.
- k. Lift and place component 3 in position with its aft end against the forward end of component 1.
- l. Adjust the position of component 3 to align guide plates with slots in the forward end of component 1.
- m. Use the forklift adapter pulley block for lateral adjustment. Slide component 3 aft to engage guide plates with slots in 1. Align the holes in guide plates and module and install quick-release pins to lock components together longitudinally.
- n. Repeat Step h through Step m to position, align, and lock component 5 to component 3.
- o. Attach and lock forklift adapter cables to component 7.
- p. Lift and place component 7 in position with the beam on the aft end of the component positioned laterally between and resting on the pads provided on component 5 ground pads.
- q. Lower component 7 further until its forward end rests on the ground.
- r. Assemble component 9 as follows:
 - (1) Attach and lock forklift adapter cables to component.
 - (2) Lift and place component in position with its aft end against the forward end of the previously assembled component.

- (3) Adjust the position of component as necessary to align the attachment holes in the component with the attachment hole.
 - (4) Install quick-release pins in the aligned holes to lock the components together.
- s. Manually place component 11 in position with its aft end against the forward end of component 9.
 - t. Manually raise the forward end of component 9.
 - u. Manually slide component 11 under the forward end of component 9 so that its aft end is directly under the forward end of component 9.
 - v. Lower component 9 until its base plate rests on the base plate on the aft end of component 11.
 - w. Repeat Step h through Step v to assemble the right side of the portable loading ramp extension.
 - x. Ensure all adjustable feet are resting firmly on the ground. Adjust any feet as necessary to make firm contact with the ground.
 - y. Lock the left and right sides of the portable loading ramp extension together as follows:

NOTE

If the holes in the eye-end and clevis assemblies cannot be aligned by adjustment of component 2, loosen the four bolts securing eye-end to module, align holes, and then retighten bolts.

- (1) Adjust the position of component 2 as necessary to align module clevis assemblies with eye-end assemblies on component 1, and install quick-release pins to lock the components together laterally.
- (2) Unlock tie-bar on the forward inboard side of component 3 and connect the tie-bar to the attachment point on the forward inboard side of component 4. Adjust components as necessary to align the attachment holes and install quick-release pins to lock the components together laterally.
- (3) Repeat Step y (2) to lock components 5 and 6 together.

4.8.1.2 Disassembly Procedures – Portable Loading Ramp Extension. Disassembly of the portable loading ramp extension is the reverse of the assembly procedures.

4.8.2 Bridge Plates for Truck Bed, Flatbed, or Loading Dock On/Off Loading. Locally manufactured aluminum/steel bridge plates shall be used to bridge the gap between flatbeds/K loaders and the airplane forward ramp extension or the aft ramp during on/off loading of wheeled cargo. The bridge plates allow the cargo to make a smooth transition from the loading vehicle to the airplane and vice versa. Each plate is designed to support a maximum weight of 7,500 pounds. (See Figure 4-30.)

4.8.3 Type MA-1 Pry Bar (Johnson Bar). A wheeled pry bar (Johnson bar) Type MA-1 can be used to assist in positioning cargo on the cargo floor. The pry bar can be used anywhere on the cargo floor without shoring provided the weight on the pry bar does not exceed 1,000 pounds. If weights in excess of 1,000 pounds are to be lifted and moved, multiple pry bars must be used so that the weight on each pry bar does not exceed 1,000 pounds. (See Figure 4-32.)

4.9 GENERAL VEHICLE LOADING PROCEDURES.**CAUTION**

- Do not skid or spin vehicle wheels during on/off loading. Skidding and wheel spin produces heat which may result in disbonding or buckling of the cargo floor or ramp.
- Non-articulated tracked vehicles, those whose unpowered road wheels (bogies) have no suspension, shall only be loaded over the aircraft ramps while in the truck-bed configuration, regardless of kneel mode.

4.9.1 Safety Precautions. The following procedures must be complied with during on/off loading operations. Failure to comply could result in personnel injury or damage to the airplane and cargo.

WARNING

On/off loading cargo during fueling operations is permissible only under certain conditions. Refer to TO 00-25-172 for additional instructions.

- Refer to AFMAN 24-204(I) and Chapter 4, Section V of this manual for instructions on vehicle fuel limits.
- Ensure that fire extinguishers are available during all cargo on/off loading.
- Ensure that all on/off loading personnel are briefed, and understand instructions and hand signals.
- When vehicles are loaded, the operator shall remain at the controls until a minimum of one forward and one aft restraint has been applied. When offloading, the operator shall be in position before removing the final forward and aft restraints.
- Ensure non essential personnel are clear of the winching cable and equipment prior to starting winching operation.
- Ensure that the airplane is properly ventilated when on/off loading self-propelled vehicles.
- Do not deflate tires to reduce vehicle height.
- Vehicles/helicopters with a combination of small wheel size and high weight shall not be driven/winched over the stowed omnidirectional roller conveyors without using a minimum of 1/2-inch rolling shoring over the length of the roller conveyors.
- Vehicles that require reducing the angle of entry into the airplane to provide ground/overhead clearance shall be on/off loaded as follows:
 - The portable loading ramp, prefabricated auxiliary ramp extensions, or approach shoring shall be used to reduce the angle of entry into the airplane. To prevent damage to the aircraft, a minimum 1/2-inch of shoring shall be placed between all prefabricated metal loading ramps and the airplane ramp toes and/or ramp extension.
 - If approach shoring is used, the vehicle shall be winched on/off the airplane. Winching is not required when using small amounts of shoring to overcome the ramp toe angle.
 - For shoring that is used to support vehicle wheel loads, the height of the shoring must not exceed the length or width of the shoring, whichever is smaller.
 - For shoring used to support ground support pads or toe assemblies that will not contact vehicle wheels, the height of the shoring must not exceed 1.5 times the length or width of the shoring, whichever is smaller.

CAUTION

The use of aft ramp pedestal shoring is prohibited unless directed by TO 1C-5M-9-2. Approach shoring or step-up shoring used during on/off loading with the aft ramp shall be placed on top of the ramp structure.

- j. Check vehicle brakes for proper functioning prior to on/off loading.
- k. Do not connect the exhaust from low temperature materials to the right side vents.
- l. Do not connect the exhausts from operating engines to the left side vents.
- m. If the troop doors are opened for ventilation, exercise care not to damage the doors during vehicle on/off loading.

4.9.1.1 Ensure that the vehicle and all vehicle cargo and loose equipment (spare wheels, tool boxes, etc.) are properly restrained for air transport by the user.

4.9.1.2 Each component part of some vehicles must be restrained in addition to vehicle restraint. Some examples are:

- o Dump truck bodies
- o Crane/booms
- o Bulldozer blades
- o Truck mounted cranes

4.9.1.3 Drive vehicles on/off the airplane with the transmissions in the lowest gear and the transfer case or auxiliary transmissions in low range/all wheel drive.

4.9.1.4 Ensure that guides are stationed inside and outside the airplane to monitor clearances. Guidance to the vehicle crew will be given by prearranged signals. Guide commands to the vehicle driver shall be mandatory. Vehicle drivers shall not attempt to judge clearances for themselves.

NOTE

Personnel may occupy the troop compartment upon completion of multiple vehicle on/off loading with vehicle engines operating provided airflow has been furnished to the troop compartment during on/off loading operations.

4.9.1.5 Personnel should not remain on the flight deck or troop compartment during multiple vehicle on/off loading with vehicle engines operating unless an operational necessity exists. If personnel are required on the flight deck or troop compartment, comply with the following:

- a. Auxiliary ventilation system shall be operating.
- b. The flight station stair ladder door shall be closed.
- c. Open the troop doors, the No. 6 service door, and the opposite cargo loading doors if operationally feasible.

4.9.1.6 Attach exhaust hoses to the vehicle and cargo compartment exhaust vents when the vehicle engines or auxiliary power units are operated for extended periods.

4.9.1.7 Instruct the guides on sequencing of vehicles for loading and the location of each vehicle on the cargo floor. The location of the vehicle on the cargo floor is dependent upon gross weight, axle loads, and tire contact pressure. The vehicle must be positioned so that the allowable cargo floor limit is not exceeded and the optimum load CG is achieved.

4.9.1.8 After each vehicle has been positioned, ensure the following:

- a. Vehicles with automatic transmissions are in park. Diesel-powered vehicles with automatic transmissions without park, or standard transmissions, are in neutral. Gasoline-powered vehicles with standard transmissions are in lowest gear.
- b. The vehicle brakes are set.

- c. Vehicle ignition off.
- d. Driver remains in vehicle until the engine has stopped and a minimum of one chain and device for forward and aft restraint have been applied.

4.9.1.9 Stow the flight station and troop compartment ladders when vehicle dimensions require.

4.9.2 Dimensions and Gross Weight. Check dimensions of all vehicles to ensure that ground/overhead clearance is adequate to permit safe on/off loading. Vehicle dimensions may be changed as follows for on/off loading:

- a. Vehicle height may be reduced by removing auxiliary equipment that is not a permanent part of the structure (e.g., antennas, exhaust stacks, bows, etc.).
- b. Vehicle length may be reduced by removing bumpers and spare tires.

4.9.2.1 Determine vehicle gross weight by determining the weight on the axles and wheels. Wheel and axle weights must be within allowable limits for the position at which vehicle will be located on the cargo floor.

4.9.3 Security of Vehicles in Turbulence. When vehicles are airlifted through turbulence and any other violent movements, they are subject to extreme gravitational forces that may allow pneumatic tires to compress, thus slackening tension on tiedown chains. When this slack-chain condition exists, the release of tire compression occurring simultaneously with the pull of gravity in the same direction may result in the chain snapping taut and imposing abnormal loads on tiedown rings, devices, and cargo attachment points. This same reaction may be experienced with vehicle springs flexing under like conditions. Any special purpose vehicle (e.g., forklifts, scoop loaders, graders, etc.) equipped with tires that are not designed for highway travel and weighing over 20,000 pounds may impose these stress conditions on the airplane. These vehicles must be braced between the floor of the airplane and the vehicle axle or chassis by the use of sleeper shoring. Sleeper shoring shall be placed as flush as practical with axle or chassis and secured to maintain the preset condition throughout the flight. Sleeper shoring shall be placed under the chassis of spring mounted vehicles. Sleeper shoring floor contact area shall be sufficient to ensure airplane floor limitations are not exceeded if the entire weight rests on the sleeper shoring during turbulence or any violent movements.

4.9.4 Hand Signals.

CAUTION

Since the guide is facing the driver, the guide must exercise care not to become confused in rendering hand signals. Whether the vehicle is backing or moving forward, the driver must always turn his wheels in the direction of the guide's extended hand or light.

Guidance by hand or light signals, given by assistants positioned at vantage points, is a prime requirement when on/off loading self-propelled vehicles.

4.10 PALLETIZED CARGO ON/OFF LOADING PROCEDURES.

4.10.1 HCU 6/E Pallet Construction. The pallet is constructed of aluminum with a wood core. The pallet contains 22 tiedown rings around the perimeter for securing cargo nets. The tiedown rings have free movement of 240 degrees in the vertical plane. Tiedown ring capacity is 7,500 pounds. Pallet dimensions are 108 × 88 inches and it weighs 290 pounds.

4.10.2 HCU 6/E Pallet Load Limitations.**CAUTION**

The pallet shall never be used as shoring. The construction within the pallet does not permit load spread.

Maximum load distribution over the pallet surface is 250 PSI. Loads that exceed 250 PSI must be shored to reduce the PSI to the maximum allowable. The pallet load CG must fall within 14 inches of the lateral centerline and 12 inches of the longitudinal centerline of the pallet. If the load is concentrated on one side of the pallet, an equal weight must be placed on the opposite side to permit the common CG of both loads to fall within the 24× 28 inch rectangle in the pallet center. It is recommended that shoring be used for steel-wheeled vehicles due to the thin line contact made on the pallet surface. The airplane roller conveyor system is the limiting factor for the maximum total weight on the pallet.

4.10.2.1 For example, if a load with a footprint area 5 × 5 inches is resting on a pallet placed directly over a roller, the load limit would be 1,100 pounds if loaded forward of FS 1971 or 1070 pounds if loaded aft of FS 1971. (See Figure 4-20.) The other load limitations would also apply; i.e., the maximum total load on two or more lateral rollers, maximum roller conveyor loading, and total load with two or more rollers. The pallet may be used as a mobility platform, outside of the logistics rail system. In order to determine the cargo load which may be placed on the pallet, it is necessary to determine the footprint area, area of load, and location of the load with respect to roller location in both the longitudinal and lateral axes.

4.10.3 Pallet Preparation.**WARNING**

Pallets/nets with missing D-rings, exposed deteriorated wood core, extreme delamination, or with evidence of fungus stain/dampness shall not be used. A damaged pallet or net cannot maintain restraint requirements and would be a hazard to flight safety.

Before loading cargo on pallets, all pallets shall be thoroughly cleaned of all mud, dirt, oil, and stains. Pallets shall be inspected for missing D-rings, exposed deteriorated wood core, and/or extreme delamination or warp. Pallets with this damage shall not be used.

NOTE

It is not acceptable to take a pallet that has been rejected for airlift (missing rings, delaminated, etc.) and place it on top of another pallet to airlift it. If the pallet has been rejected for airlift, it shall not be used in any way to support cargo.

4.10.3.1 Dense cargo and crated/boxed cargo shall be loaded on the pallet first. Crushable cargo and light density cargo shall be stacked on top of the load. Small wheeled items or skidded cargo should be restrained separately to the pallet in addition to the use of the net. All cargo shall be stacked within the vertical stacking lines of the pallet boundaries. Any cargo stacked or positioned on the pallet shall be positioned so that it does not require restraint for stability in a static condition.

NOTE

All stacking heights and vertical dimensions are measured from the top surface of the pallets.

4.10.3.2 The normal stacking height of cargo for single pallets or double/triple pallet trains, when the cargo is netted with side and top nets, is 96 inches and may be increased to 100 inches. The following restrictions apply to palletized cargo.

- a. The maximum cargo weight on a single pallet secured with nets and stacked to 96 inches shall not exceed 10,000 pounds.
- b. The maximum cargo weight on a single pallet secured with nets and stacked above 96 inches (not to exceed 100 inches) shall not exceed 8,000 pounds.

- c. The maximum cargo weight on two or three pallet trains secured with nets and stacked to 96 inches shall not exceed 26,000 pounds.
- d. The maximum cargo weight on two or three pallet trains secured with nets and stacked above 96 inches (not to exceed 100 inches) shall not exceed 21,000 pounds.
- e. The maximum height of cargo for pallet positions 35 and 36 (aft ramp) shall not exceed 70 inches measured on the aft side of the pallet.
- f. 463L pallets loaded in pallet positions 1, 2, 35, and 36 (forward and aft ramps) shall have a 14-inch access which will extend from the outboard edge of the pallet to the vertical stacking line of the cargo.
- g. Maximum usable area (single netted pallet) of 84 × 104 inches of the pallet shall not be exceeded.
- h. Cargo placed on two- or three-pallet trains and secured with nets shall be positioned in such a manner as to allow the nets to provide all required restraint in all directions (vertical, lateral, forward, and aft). Ensure cargo is uniformly distributed and does not overhang the perimeters of the pallets.
- i. The weight and vertical CG of pallets loaded in positions 33 and 34 must conform to the following limitations, or full restraint must be provided by tiedown to the cargo floor fittings.

Pallet Weight	Vertical CG Above Upper Surface of Pallet
0 – 6,000 lb.	48 in.
6,001 – 7,500 lb.	37 in.
7,501 – 10,355 lb.	27 in.

- j. The height limitations for oversized single items of palletized cargo (e.g., airplane fuselage assemblies, containers, and special equipment, etc.) is 108 inches above the surface of the pallet for cargo to be loaded through the aft end of the airplane and 156 inches for cargo to be loaded through the forward end of the airplane. To ensure proper understanding, oversized cargo is that palletized cargo larger than the normal dimensions (84× 104 × 96 inches) of a single HCU-6/E pallet. Unitized cargo is multiple items secured together to form one unitized single piece of cargo with the same physical characteristics that are secured together with straps or chains to form a single unit (e.g., helicopter blades, fuel tip tank, etc.). The 108- and 156-inch height limitations will provide a minimum amount of clearance between the airplane structure and the cargo; therefore, extra care shall be taken during on/off loading to prevent any contact between the cargo and the airplane structure. Oversized cargo positioned on pallets shall have the support base for the cargo physically on the pallet, and structural limits of the airplane roller conveyors shall not be exceeded. All cargo stacked or positioned on the pallet shall be positioned so that it does not require restraint for stability in the static conditions.

4.10.3.3 When securing cargo to pallet(s), use the following net configuration.

- a. For a single pallet, use two HCU-7/E side nets and one HCU-15/C top net.
- b. For a two-pallet train, use three HCU-7/E side nets and two HCU-15/C top nets.
- c. For a three-pallet train, use four HCU-7/E side nets and three HCU-15/C top nets.
- d. One HCU-7/E side net weighs 22 pounds and one HCU-15/C top net weighs 21 pounds.

4.10.4 Palletized Cargo Restraint. Cargo restraint shall be provided as follows:**WARNING**

A minimum of one pair of logistics restraint lock mechanisms shall be operative and engaged for restraint of palletized cargo (one inboard, one outboard). (See Figure 4-31.) Chains or other devices shall not be substituted unless a symmetrical pattern can be obtained. Failure to comply can result in damage to airplane equipment and injury to personnel.

- a. The cargo compartment logistics restraint rails and detents provide all the restraint necessary for cargo loaded on standard HCU-6/E pallets provided the cargo weight does not exceed 10,000 pounds and it is attached to the pallet to meet the minimum restraint criteria established for the airplane.
- b. Procedures to be used in attaching 463L nets to 463L pallets are as follows:
 - (1) Begin at any corner and fasten HCU-7/E side net (Figure 4-33) attaching hooks to the pallet D-ring around the pallet periphery to the corner diagonally opposite from the beginning corner. Using another side net piece, continue fastening the net attaching hooks to the D-rings around the pallet(s) to the beginning corner. Fasten side pieces together using fastening devices at each end of net side pieces.

WARNING

Top net fastening devices (hooks) shall not be connected to the side net webbing, the pallet tiedown rings, or the bottom row of side net rings. Top net fastening devices shall not be routed under the side net webbing and then back up to a side net ring. Netted cargo shall not be loaded onto the airplane until the fastening devices are properly connected. Improperly rigged nets will not provide required restraint and are a matter of safety of flight.

- (2) For a single pallet, throw the HCU-15/C top net (Figure 4-33) over the cargo load and fasten to side net pieces using fastening devices provided on top and side nets.

WARNING

Tiedown straps shall not be used in lieu of top nets on two-and three-pallet trains.

- (3) For two- or three-pallet trains, attach the fastening devices of the top nets together on the long sides to form a continuous top net (two or three top nets). Throw the top net over the cargo and fasten to side net pieces using the fastening devices provided on top and side nets.
- (4) Lock all fastening devices (hooks) securely.

NOTE

When the cargo weight exceeds 2,500 pounds, or the height exceeds 45 inches, the top net shall only be used for vertical restraint. Supplemental straps or chains and devices shall be used to provide all restraint required for forward, aft, and lateral directions. Supplemental restraint must be totally attached to the pallet or to the cargo floor. Attaching restraint to a mix of pallet rings and cargo floor rings is not authorized.

- c. The top net will provide adequate restraint in all directions provided:
 - o The cargo weight does not exceed 2,500 pounds.
 - o The cargo height does not exceed 45 inches from the top of the pallet.
 - o The net is installed over the cargo and all hooks are serviceable and attached to pallet rings.
- d. The side nets may be used for restraints without the top net (single pallets only) provided that the side nets are pulled tight and secured by the use of tiedown straps. The straps will be connected to the highest level of side rings on or

near the top of the cargo. A minimum of seven straps, four longitudinal and three lateral, shall be used for this purpose.

- e. For pallet restraint, the 463L material handling system utilizes 108× 88-inch pallets in conjunction with side and top cargo nets normally interfaced into an airplane restraint rail system to achieve the required load restraint. Cargo which is oversized to single 463L pallet and must be loaded on two or more pallets shall be restrained with nets (provided the restrictions in Pallet Preparation (Paragraph 4.10.3) are not exceeded), chain gates/straps, or chains to the pallet to provide the necessary restraint, and then loaded into the airplane logistics rail system. Chains and straps shall not be combined to meet the restraint requirements for the same load direction. The maximum weight for all oversized pallet loads is 10,000 pounds per pallet utilizing the airplane logistics restraint rail system. Oversized single items of palletized cargo with an outboard height of 108 inches or greater or with cargo lateral overhang should be positioned laterally out of the airplane logistics restraint rail system to ensure vertical clearance when near the cargo compartment sidewall. Chain gates/straps and chains shall be used for restraint and secured to the airplane tiedown rings. Chain gate restraint shall be accomplished in accordance with Figure 4-35. When restraint is provided by using the airplane tiedown rings instead of the detents in the logistics rails system, the limiting factor becomes the airplane roller conveyor system and load per unit area on the pallet.

4.10.5 Airplane Pallet Positions and Loading Procedures. Up to 36 pallets can be accommodated in the airplane in the logistics restraint rail system. Normally, one pallet space on the forward ramp is utilized for loose equipment stowage. Thirty-two pallets, each capable of carrying 10,000 pounds of bulk cargo, can be positioned in the main cargo compartment in pallet positions 3 through 34. The other pallets will be positioned on the forward and aft ramps in positions 1 and 2 and 35 and 36. They are limited to a maximum weight of 7,500 pounds each, including the weight of the cargo, pallets, nets, and any other equipment in each respective ramp pallet position. The total maximum allowable forward or aft ramp load, including cargo, pallets, nets, and any other equipment on the ramps, shall be limited to a maximum of 15,000 pounds for each ramp.

WARNING

Any pallet(s), single or multiple, weighing 15,000 pounds or more shall be restrained when on/off loading by use of the airplane winch when the airplane is in either the forward or aft kneeled position. Pallets weighing less than 15,000 pounds may be restrained at the option of the loadmaster in consideration of the number of loading personnel available for manual restraint, nature of the cargo, adverse floor angle, etc.

CAUTION

All pallets shall be inspected prior to loading to ensure the maximum width of 104 inches of usable area of the pallet is not exceeded, and that there are no lateral projections or lateral overhangs that could damage the aircraft pressure door seals, side sloping longeron panels, forward ramp actuators, and the airplane logistics restraint rail system.

4.10.5.1 If a requirement exists to winch a pallet(s) into or out of the airplane, at least two attaching points shall be used for the chain bridle, preferably the tiedown rings on each corner of the pallet. (See Figure 4-44.) Failure to use this method could result in irreparable damage to the pallet. Under no conditions should a single point of pull be used.

4.10.5.2 Chain gate restraint of general cargo should be accomplished in accordance with Figure 4-35.

4.10.5.3 Use a restraint barrier (3/4-inch plywood) for loose items such as lumber, pipe, long metal/wood/cardboard boxes, etc. Additional layers may be needed to adequately restrain heavy items. When restraint barrier height exceeds 30 inches, install a minimum of two chain gates/bridles. Additional gates/bridles may be required to provide minimum restraint criteria.

4.11 RESTRAINT CRITERIA.**CAUTION**

Do not use commercial cargo straps. The only authorized cargo straps are the CGU/1B, 5K Air Cargo Strap, PN# 1670-00-725-1437; Strap, Webbing Universal Tiedown, PN# 5340-00-980-9277 (Army version of the AF CGU/1B, 5K strap); and the 10,000-pound Restraint Assembly Cargo, NSN 1670-00-406-2657.

All cargo in the airplane shall be restrained so it will not shift during any flight conditions normally experienced by the airplane. Forces caused by various flight conditions tend to move the cargo in a forward, aft, side, or vertical direction or in certain combinations of these directions. These forces are directly proportional to the cargo weight. The ratio between the cargo weight and the maximum force that will act in each direction is called the load factor.

4.11.1 Restraint Criteria Summary. Diversified cargo, including vehicles, shall be restrained for loads in all directions by the types of tiedown devices best adapted to the type of cargo to be restrained.

CAUTION

Tiedown devices connected to the cargo and routed from main cargo floor to the ramp or from the ramp to main cargo floor shall be removed prior to opening the ramp.

4.11.1.1 Tiedown devices shall be installed to provide adequate restraint without overstressing the tiedown fittings or damaging the cargo. Ensure that tiedown device hook point does not contact the tiedown pan.

NOTE

Cargo that is loaded and tied down to the ramps while the ramp is in any open position shall be rechecked for security and tautness of tiedowns.

4.11.1.2 Restraint criteria for airplane cargo are based upon the weight of each cargo unit and the dynamic forces imposed upon each unit due to a change in motion (changing direction, slowing down, or speeding up). The dynamic forces increase as the rate of change in motion increases. An object that is slowed down over a long distance has lower dynamic forces than the same object traveling at the same velocity when stopped in a short distance. These dynamic forces may be simulated by increasing the static loads (the unit weights multiplied by a constant) to equal the dynamic loads. The constant used in this case is the load factor (the ratio between the weight of an object and the force acting on the object in each direction).

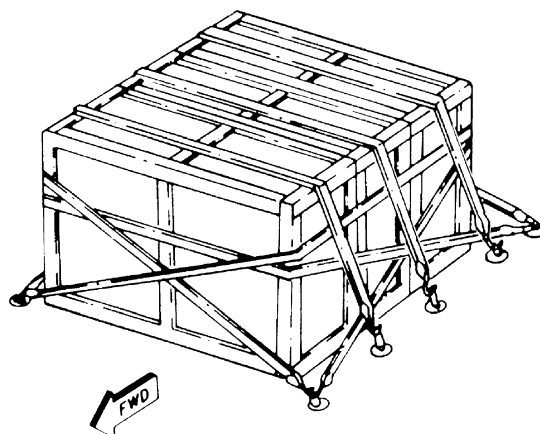
4.11.2 Cargo Restraint Load Factors. Cargo must be restrained so it will not shift because of loads resulting from dynamic forces encountered during flight and landing. The restraint must be adequate for the greatest load that may result. These loads are expressed in terms of cargo weight times the applicable load factor. If a cargo unit is subjected to a load equal to 1.5 times its weight, it must be restrained for a load factor of 1.5 to prevent it from shifting. Counter forces applied to the cargo to prevent movement are identified by the direction in which the cargo would move if it were unrestrained. Forward restraint keeps the cargo from moving forward, aft restraint prevents the cargo from moving rearward, lateral restraint prevents side-to-side movement, and vertical restraint prevents the cargo from rising off the cargo floor.

4.11.3 Minimum Restraint Forces. The minimum restraints used to prevent the cargo from moving in any direction are called restraint criteria. Expressed in units of the force of gravity, the minimum restraint criteria for logistics and ADS cargo are as follows:

- Forward – 3.0g
- Aft – 1.5g
- Lateral – 1.5g
- Vertical – 2.0g

4.11.4 Fundamental Principles of Cargo Restraint. Certain fundamental principles must be observed when tying down cargo. Although the details of tying down each unit of cargo vary with its bulk, weight, configuration, and position in the airplane, these fundamental principles of restraint are always applicable. If the fundamental principles are observed, satisfactory restraint of cargo movement can be achieved.

4.11.4.1 Ties made solely for one load direction cannot be expected to restrain cargo against a load applied simultaneously from another direction. This applies to tiedowns that are passed around or over the top of the cargo and not directly attached to it. Cargo properly restrained for all load directions is as shown.



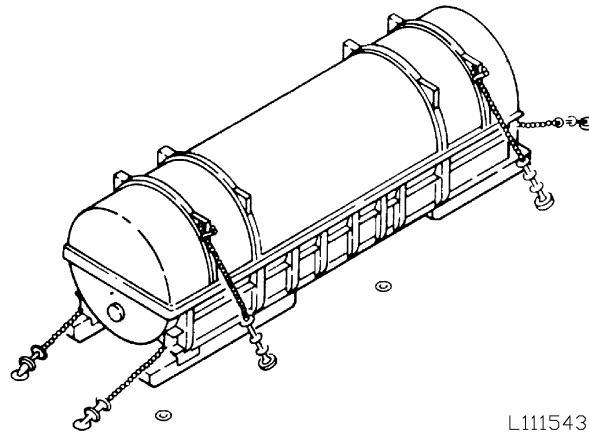
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4.11.4.2 When a tiedown strap or chain is placed around a cargo unit or attachment point, and the tiedown attachment points are two adjacent tiedown fittings, the value of the strap or chain is doubled provided the fittings are equal to or higher than the value of the strap or chain.

When a tiedown strap or chain is attached directly to or through a cargo unit attachment point, restraint may be applied for more than one load direction, depending on the strength of the device and the angle of pull-off from the tiedown fitting. By varying the angle of attachment, a tiedown device can be attached to the cargo so that restraint may be available simultaneously in three directions.

Restraint may be applied for two directions when a tiedown strap or chain is placed over and around or through a cargo unit.

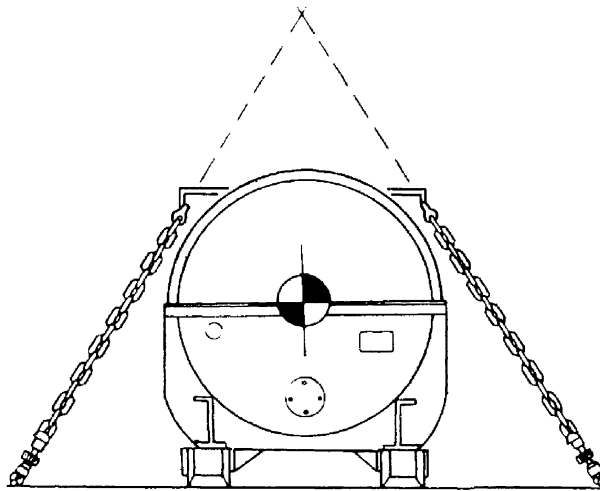
Restraint shall be calculated for all intended directions.



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4.11.4.3 The point of attachment of a tiedown device to a cargo unit must be substantial enough to withstand the loads for which the cargo unit is being restrained. A tiedown device must not be attached to any convenient protrusion on a cargo unit without due consideration of the protrusion's strength.

4.11.4.4 When tiedown devices are attached to cargo, the lines of action of the tiedown devices should, if possible, intersect above the cargo CG as shown. Such a tiedown reduces the tendency of cargo to overturn when subjected to combined upward and side loads.



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4.11.4.5 When boxes are stacked, the strongest should be at the bottom. Otherwise, they may crush weaker boxes beneath them, causing one or more of the boxes in the stack to shift, loosening the tiedowns and permitting the stack to collapse.

4.11.4.6 If cylindrical cargo units have protrusions, palletize or shore to distribute the load.

4.11.4.7 Unsymmetrical tiedowns permit load distribution which may ultimately result in tiedown device failure. This failure would result from the different load-deflection rates of dissimilar materials or of identical materials of different length. Any material subjected to a tension load will stretch a given percentage of its length. Therefore the greater the length, the

greater the potential amount of stretch. If, as a result, the shorter tie should be overstressed and fail, the longer tie would be subjected to the full load and it too would probably fail.

4.11.4.8 Although all materials stretch in direct proportion to the applied load, different materials have different rates of stretch. Nylon devices stretch more readily than steel and, under tension, almost immediately permit the steel device to assume the majority of the load. Therefore, when two or more tiedown devices are required to restrain a unit of cargo for a given load direction, the devices shall be of similar materials and the ties shall be of approximately the same length.

4.11.5 Determining Type and Quantity of Tiedown Devices Required. Determination of the types and quantities of tiedown devices to be used in restraining cargo should be based on the following considerations:

- Appropriate strength rating to afford adequate restraint with the minimum number of tiedown devices.
- Tiedown device strength rating shall be determined by strength rating of available tiedown fittings or points of attachment to the cargo if they are less than the tiedown device used.
- Straps and chains shall not be used together to restrain cargo in the same direction. Similar materials, e.g., an MB-1 and MB-2 device with the appropriate chains, may be used for a given direction of restraint.
- Units of general cargo may be grouped and effectively restrained by cargo nets. Concentrated cargo units within such groupings must rest on the cargo floor or pallets and be individually restrained by appropriate tiedown devices.
- Tiedowns should be attached in a symmetrical pattern by using corresponding fittings on each side of the cargo floor centerline.
- Tiedown devices should be securely attached to the cargo and all the slack removed so that any tendency toward motion is immediately restrained.
- A symmetrical tiedown arrangement should be used whenever possible.
- Use nylon tiedown devices on crates, boxes, and other large units that might crush easily.
- Do not use nylon tiedown devices over sharp edges.
- Use steel tiedown devices on heavy objects which have attachment lugs or a hard surface for the chains to go around.

4.11.6 Effect of Applying Restraint at Angles. Every tiedown device is rated to withstand a force exerted parallel to the tiedown device as shown in Figure 4-36, View 1. When one end of the device is secured to a tiedown ring on the cargo floor, the longitudinal force will not be exerted parallel to the length of the device unless the device is attached to the cargo as shown in View 2. If attached as shown in View 2, all the rated strength will be available to prevent the cargo from moving in the direction of the longitudinal arrow.

4.11.6.1 Because it is seldom practical to fasten a tiedown device as shown in View 1 and View 2, they are usually attached at some point above the cargo floor as shown in View 3. When attached in this manner, only part of the device will be available to prevent cargo longitudinal movement. Vertical restraint will be provided, but no lateral restraint will be provided. A compromise position as shown in View 4 generally provides restraint simultaneously in three directions: forward, vertical, and lateral. Aft restraint is obtained by attaching tiedown devices symmetrically in pairs to the front of the cargo.

4.11.7 General Rules for Applying Tiedowns. (See Figure 4-37 and Figure 4-38.) Tiedown devices attached to all types of cargo generally follow similar patterns because of the tiedown ring layout on the cargo floor, and the restraint requirements. The following are the rules to be complied with when attaching tiedown devices to the cargo and the tiedown rings on the compartment floor:

- Always compute the number of tiedown chains required. Apply aft restraint (tiedowns 1, 2, 5, and 6) in the opposite direction but at the same angle as the forward restraint (tiedowns 3, 4, 7, and 8). Use the same attachment point (points A, B, C, or D) on the cargo for attaching a forward and aft restraint chain if possible.
- Always attach an even number of tiedowns (4 chains, or 6 chains, etc.) in pairs (1 and 2, 3 and 4, 5 and 6, 7 and 8, etc.) for forward or for aft restraint. The tiedown chains should be attached in a symmetrical pattern by connecting to opposite fittings (A opposite B, C opposite D, E opposite F) across the cargo floor centerline.
- If the CG is remote from the geometric center of the load as in the referenced figure, add an additional tiedown (tiedowns 9 and 10) on each side of the load so that the CG will be between a pair of tiedowns.

CAUTION

Inspect the axles and structures for the presence of hydraulic lines or electrical cables before attaching tiedown chains around these hidden areas.

- Do not attach more than half the total number of tiedowns required in any given direction to the axles of spring-mounted vehicles. Figure 4-39 shows some of the vehicle attachment points and method of attaching tiedown chains.

4.11.8 Tiedown Angles. (See Figure 4-36.) Tiedown chains attached to a load at a point above the cargo floor form three angles that can be measured: a floor angle, a longitudinal plan angle, and a lateral plan angle. The floor angle (sometimes called the vertical angle) is the angle between the chain and the floor. The longitudinal plan angle is the angle between the chain and a line which runs fore and aft in the cargo compartment through the attachment point. The lateral plan angle is the angle between the chain and a line which runs across the cargo compartment through the attachment points.

4.11.8.1 Tiedown chains attached at floor and plan angles of 30 degrees provide the best compromise for adequate restraint of the cargo in all directions. Frequently it will not be possible to use the 30-degree angles, and other arrangements will be necessary. In these cases, try to place the tiedowns as close as possible to the 30-degree angle. Increasing the floor angle while keeping constant plan angles will provide a higher value of vertical restraint but will reduce the amount of longitudinal and lateral restraint. Keeping the same floor angle but increasing the plan angle in one direction will not affect the vertical restraint but will affect the longitudinal and lateral restraint. Using the optimum 30-degree angles, an MB-1 chain will provide 7,500 pounds of longitudinal restraint and an MB-2 chain will provide 18,750 pounds of longitudinal restraint.

4.11.9 Calculating Tiedown Devices Required. Method used for calculating required tiedown is the tiedown angle ratio method.

4.11.9.1 Tiedown Angle Ratio Method. Use Figure 4-40 to calculate tiedown angle ratios.

4.11.9.2 Vertical Restraint Limits – Tiedown Rings. All tiedown rings in the cargo compartment floor have an individual restraint capacity of 25,000 pounds. Multiple chains attached to tiedown rings at a given fuselage station will decrease vertical restraint capability. An unsymmetrical tiedown is any two given devices on the same fuselage station providing vertical restraint with different floor angles. Table 4-5 shows the vertical restraint that is available when more than one tiedown ring is loaded simultaneously at any one fuselage station in the cargo compartment.

Table 4-5. Vertical Restraint – Tiedown Rings

Tiedown Rings ¹	Installation Condition	Allowable Vertical Restraint Available per Fitting
1	Symmetrical or Unsymmetrical	25,000 lb
2	Symmetrical	25,000 lb
3	Symmetrical	20,000 lb
3	Unsymmetrical	18,000 lb
4	Symmetrical or Unsymmetrical	18,000 lb
5	Symmetrical	15,000 lb
5	Unsymmetrical	12,000 lb
6	Symmetrical or Unsymmetrical	12,000 lb
7	Symmetrical	12,000 lb
¹ Number of rings used per fuselage station (loaded simultaneously)		

4.11.9.3 Typical Tiedown of Dolly Mounted Engine. (See Figure 4-34.)

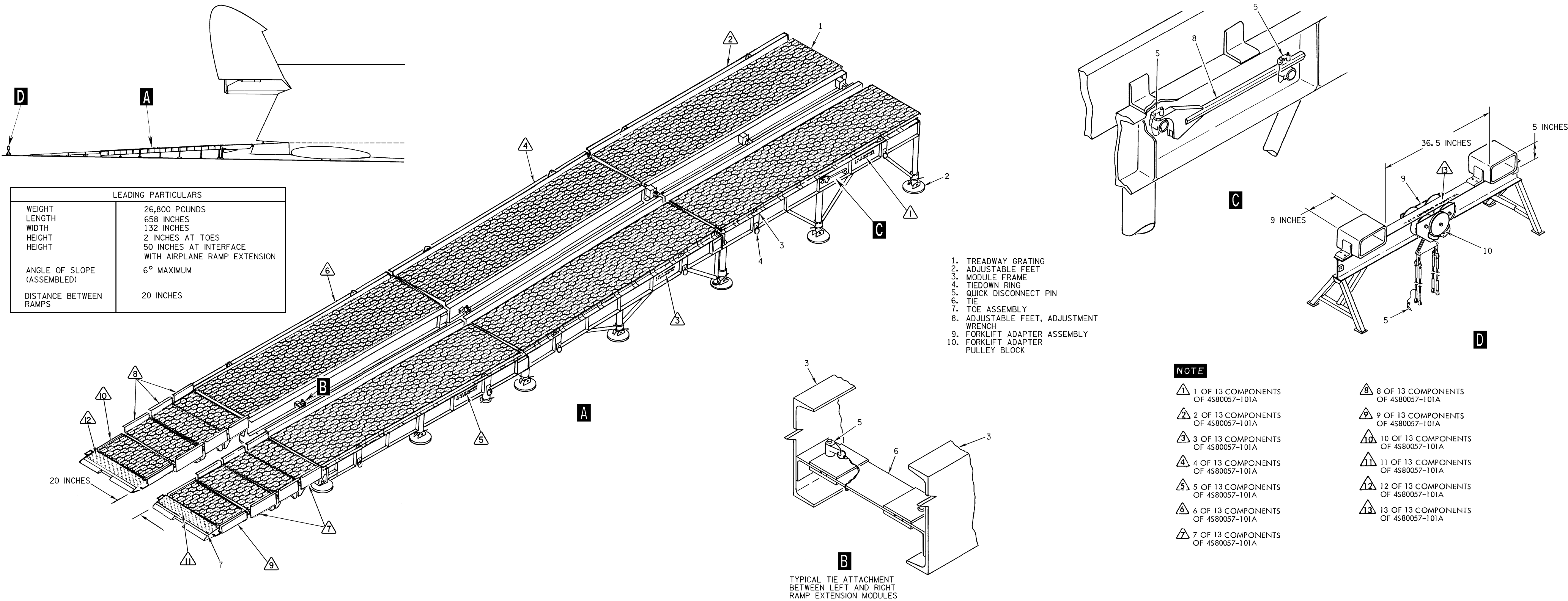
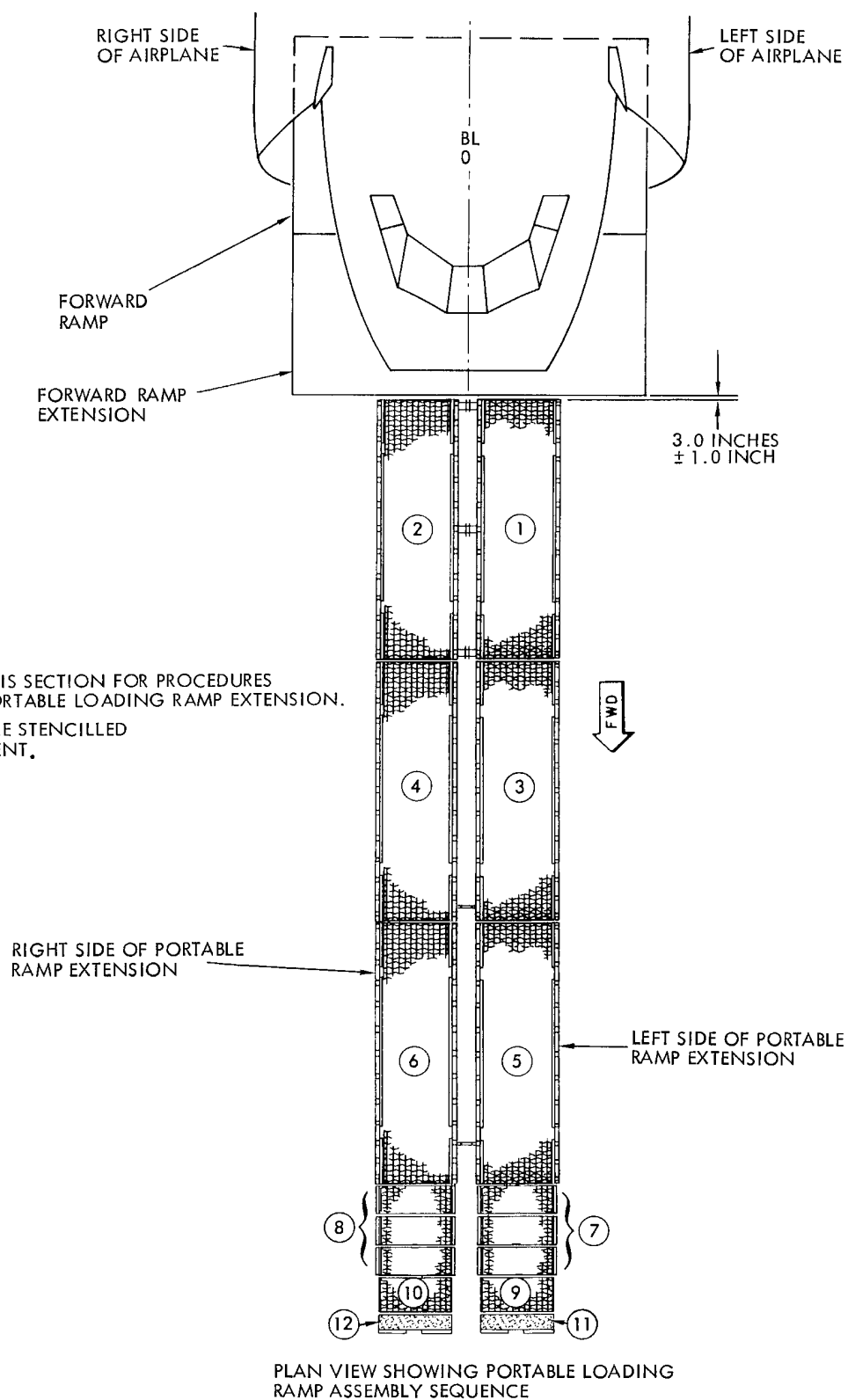


Figure 4-28. Portable Loading Ramp Extension

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NOTE

1. REFER TO TEXT IN THIS SECTION FOR PROCEDURES FOR ASSEMBLING PORTABLE LOADING RAMP EXTENSION.
2. NUMBERS SHOWN ARE STENCILLED ON EACH COMPONENT.

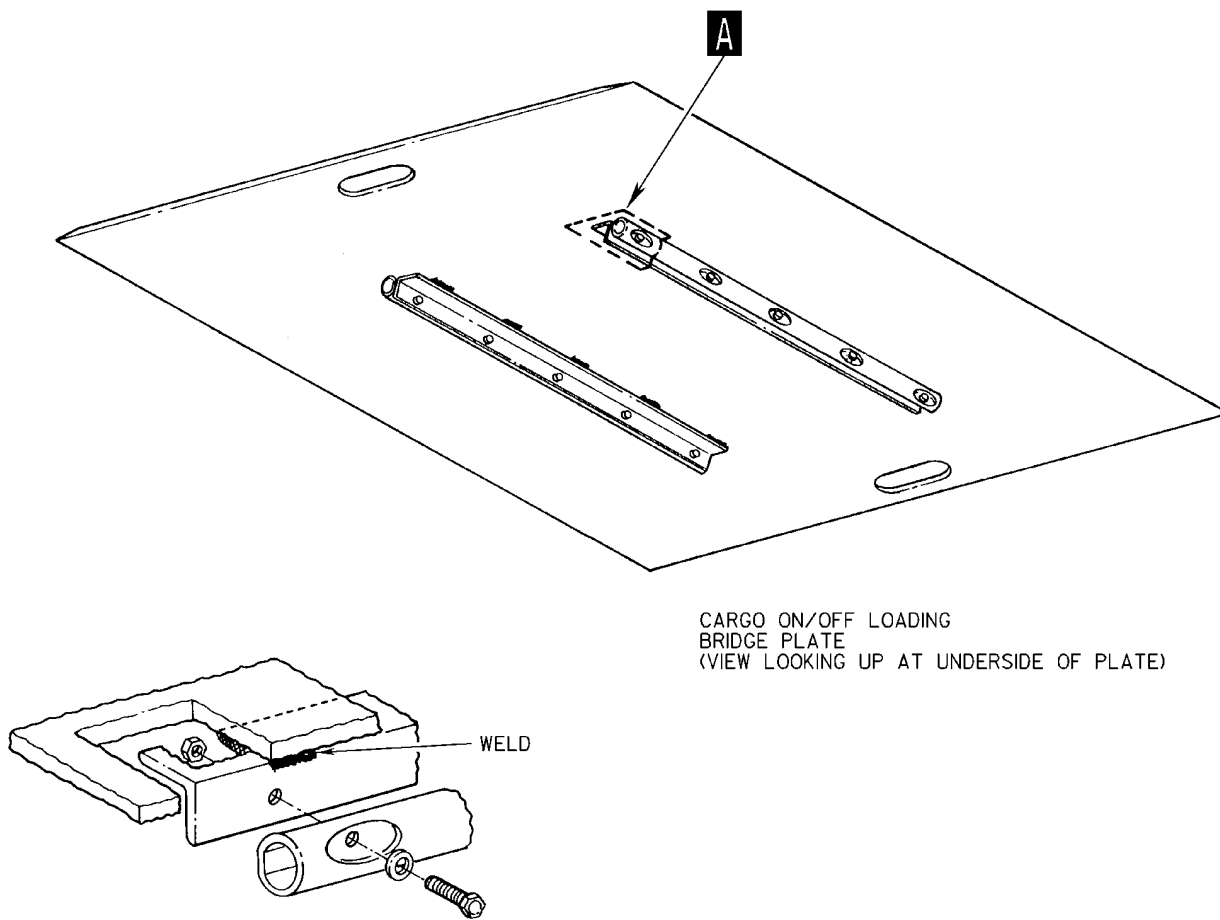


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Figure 4-29. Portable Loading Ramp Extension Assembly Sequence

CAUTION

PLATE(S) WILL NOT BE INSTALLED UNTIL
AFTER VEHICLE IS IN POSITION FOR
LOAD OR OFF LOAD



CARGO ON/OFF LOADING
BRIDGE PLATE
(VIEW LOOKING UP AT UNDERSIDE OF PLATE)

A

(TYP. 10 PLCS. EA. PLATE)

NOTE

1. MAXIMUM LOAD ALLOWED IS 7,500 POUNDS PER PLATE.
2. STEEL PLATES LOCALLY MANUFACTURED IN ACCORDANCE WITH AF DRAWING NO. 7329573, 8027770, 8027771, AND 8027772 (WR-ALC).
3. ALUMINUM PLATES LOCALLY MANUFACTURED IN ACCORDANCE WITH AF DRAWING NO. 8935894 (WR-ALC).

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Figure 4-30. Bridge Plates

TOC

LOI

CH 1

CH 2

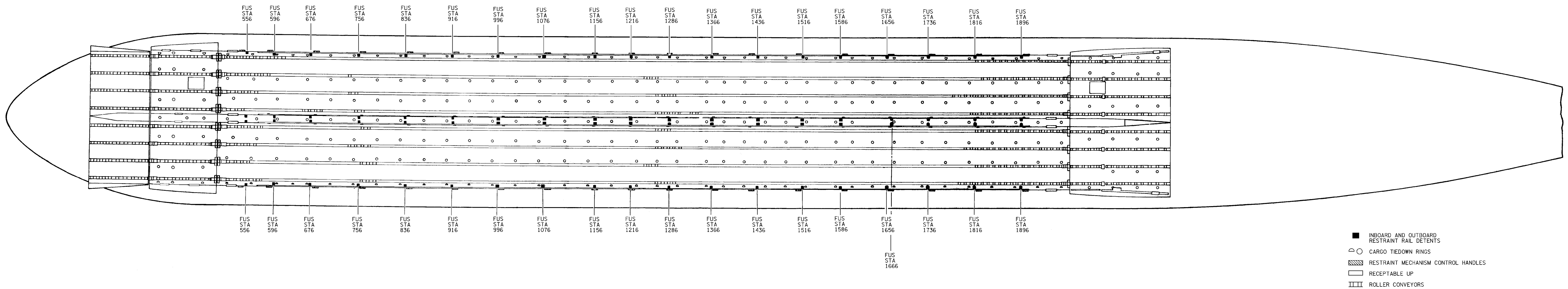
CH 3

CH 4

CH 5

CH 6

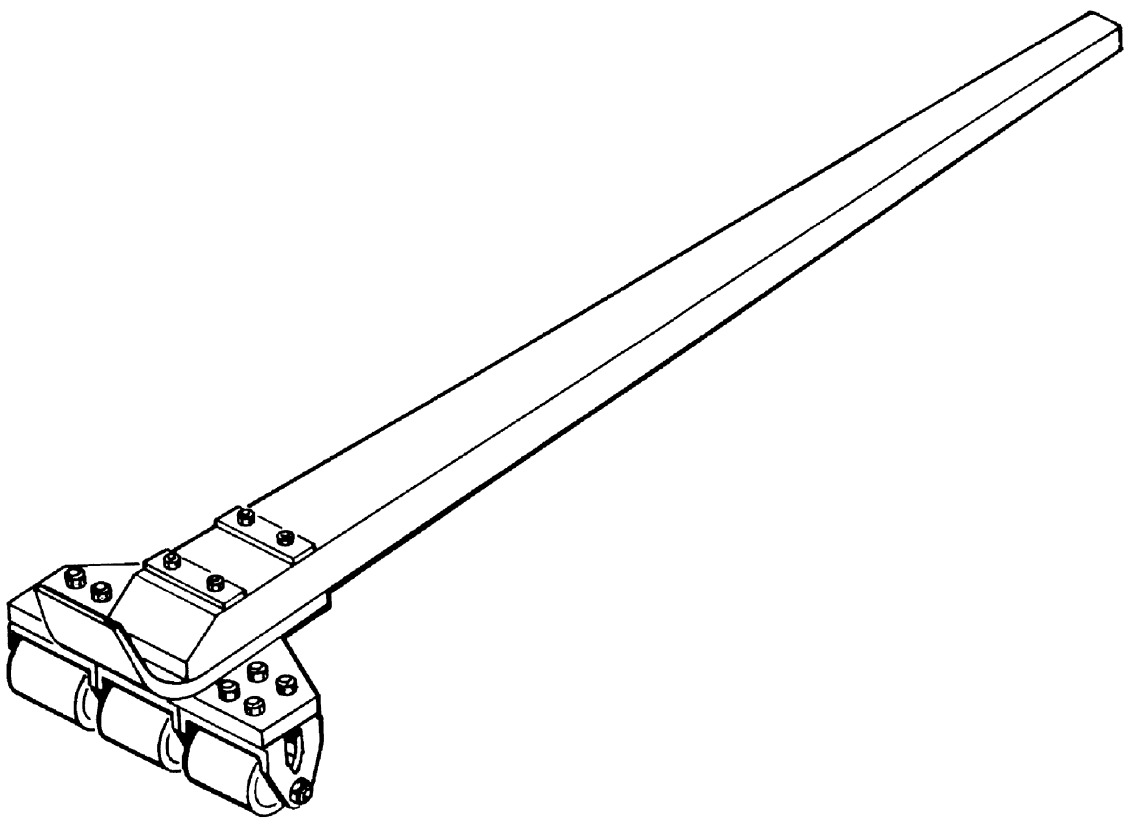
PREV



PLAN VIEW SHOWING INBOARD AND OUTBOARD
LOGISTICS RESTRAINT RAIL MECHANISM DETENT LOCATIONS

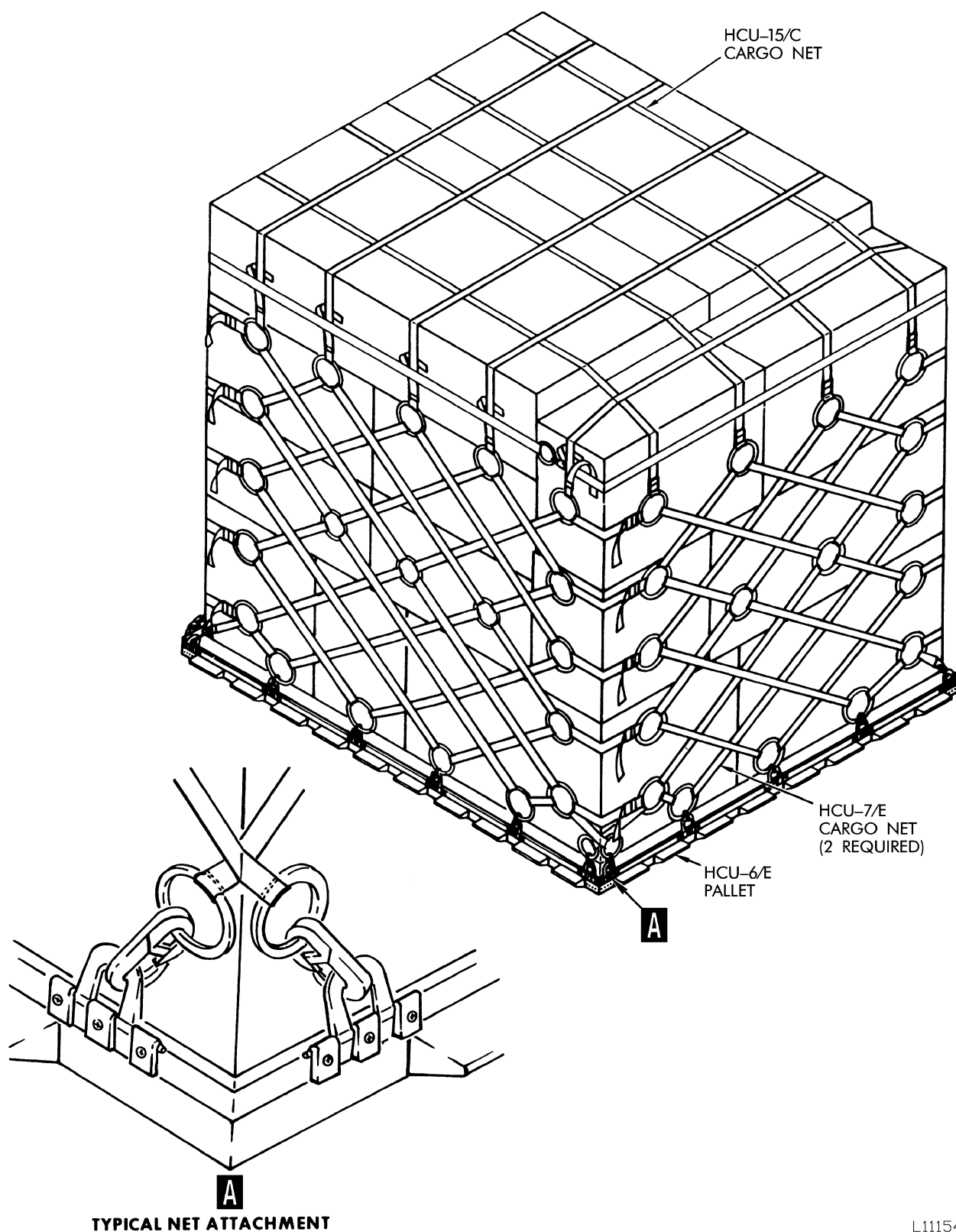
Figure 4-31. Inboard and Outboard Restraint Rail Mechanism Detent Locations

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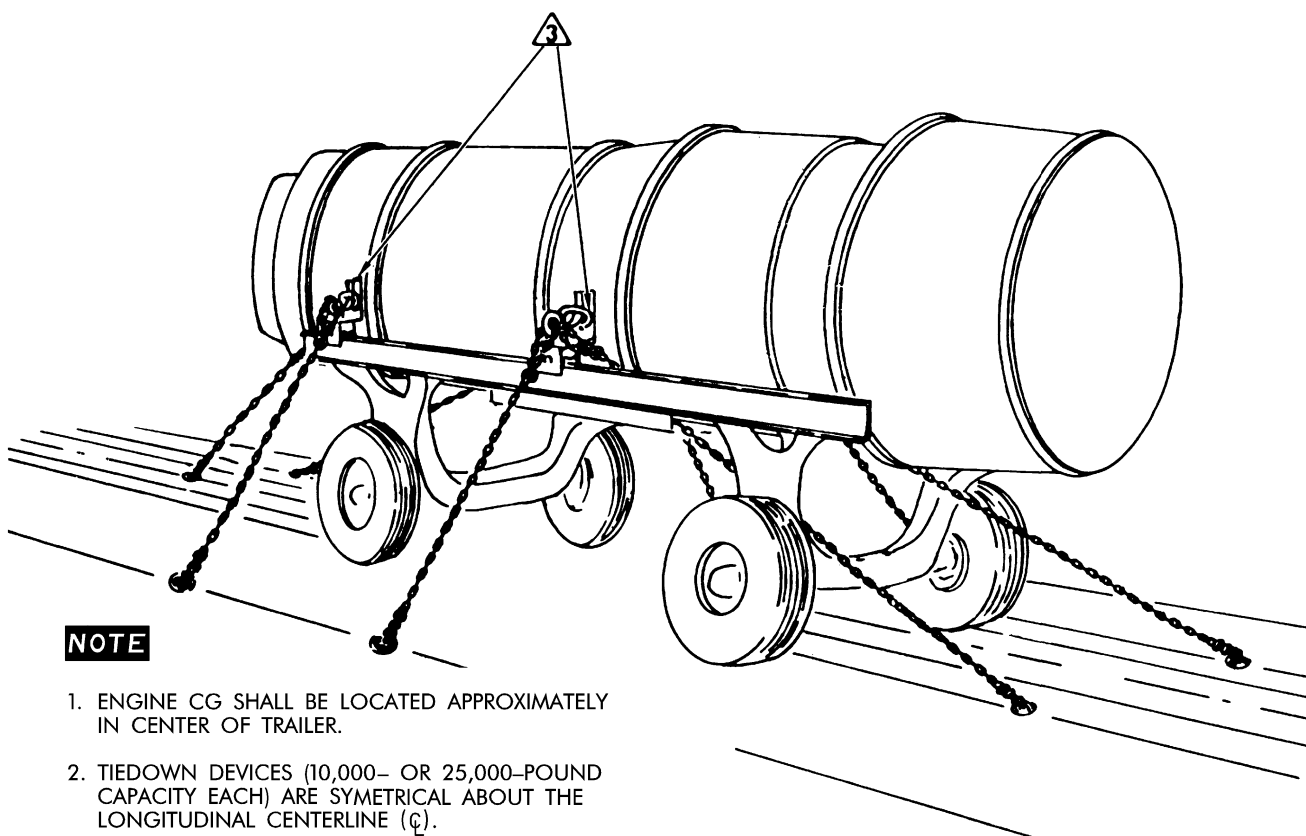
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Figure 4-32. MA-1 Pry Bar (Johnson Bar)



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Figure 4-33. Miscellaneous Cargo and Troop Baggage Tiedown Using Pallet and Cargo Net

**NOTE**

1. ENGINE CG SHALL BE LOCATED APPROXIMATELY IN CENTER OF TRAILER.
2. TIEDOWN DEVICES (10,000- OR 25,000-POUND CAPACITY EACH) ARE SYMETRICAL ABOUT THE LONGITUDINAL CENTERLINE (C).
3. TIEDOWN DEVICES SHALL BE ATTACHED THROUGH LIFTING/TIEDOWN EYES ON THE ENGINE ADAPTER ONLY.
4. IF THE ENGINE ADAPTER DOES NOT HAVE LIFTING/TIEDOWN EYES, RESTRAINT WILL BE APPLIED BY LOOPING CHAINS AROUND THE CRADLE ADAPTER BLOCKS ADJACENT TO THE TRAILER RAILS.

CAUTION

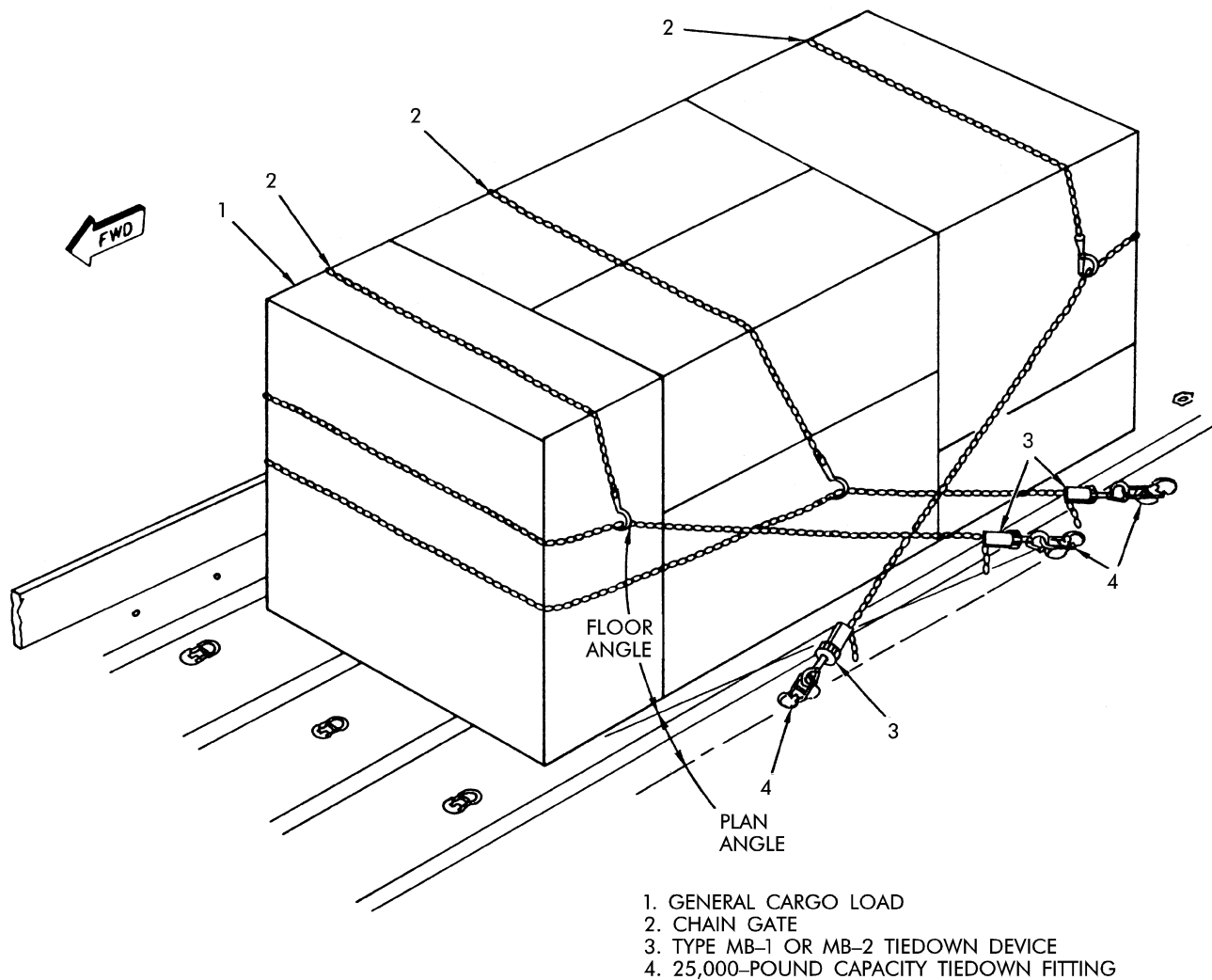
THE ENGINE, IF NOT SECURED TO THE ENGINE ADAPTER FOR FLIGHT, COULD SLIDE OFF THE TRAILER DURING LOADING/OFF LOADING.

CAUTION

TIEDOWN SHALL BE POSITIONED TO AVOID CONTACT WITH ANY PART OF THE ENGINE OR TRAILER TO PREVENT CHAFING. HOLE IN END OF RAILS SHALL NOT BE USED FOR ATTACHING TIEDOWN.

Figure 4-34. Typical Tiedown of Dolly Mounted Engine

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**CAUTION**

ENSURE CARGO STRUCTURE/CONTAINER IS CAPABLE OF WITHSTANDING CHAIN GATE RESTRAINT FORCES.

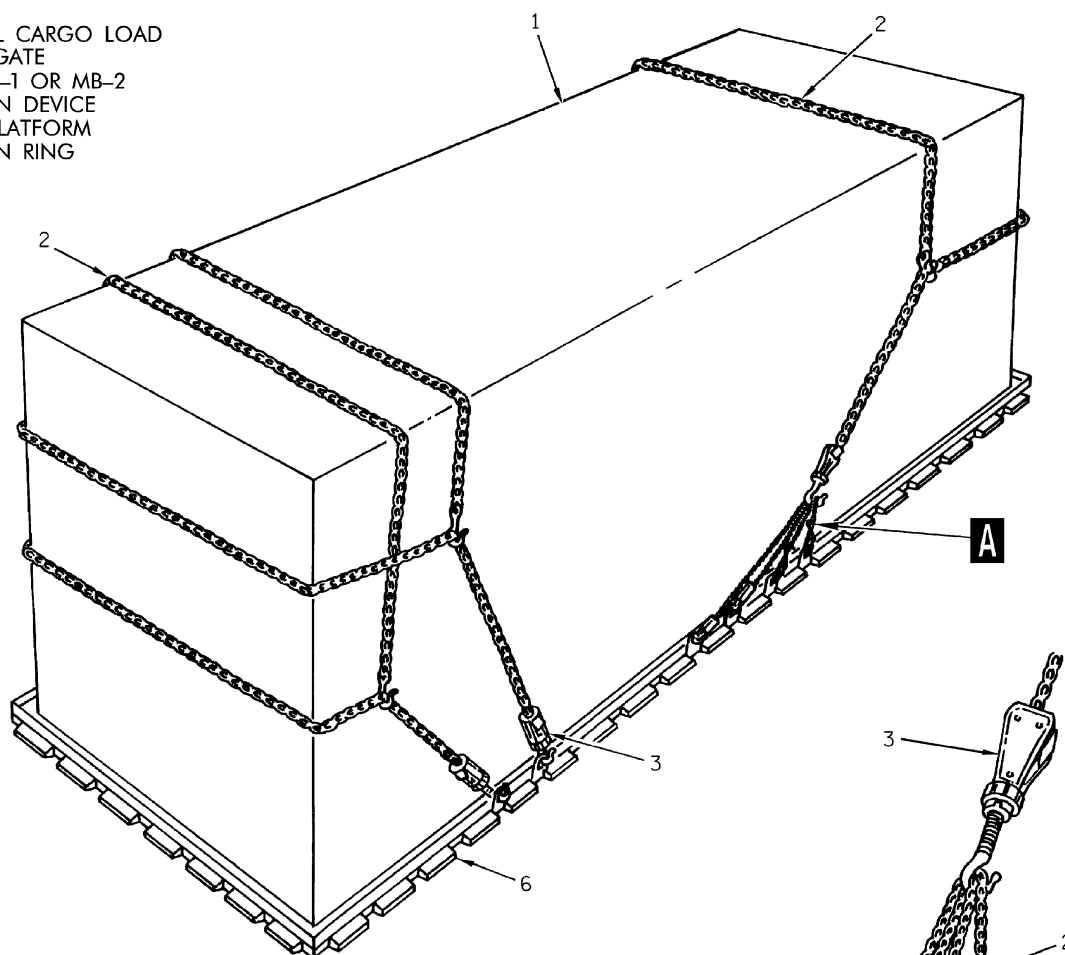
NOTE

1. THE CHAIN GATE SHALL BE MADE USING ONLY 10,000/25,000-POUND CAPACITY TIEDOWN CHAINS.
2. TYPE MB-1/MB-2 TIEDOWN DEVICES SHALL BE USED AT BOTH ENDS OF THE CHAIN GATE.
3. THE CHAIN GATE MAY BE USED IN CONJUNCTION WITH OTHER RESTRAINT FEATURES, SUCH AS TIEDOWN STRAPS AND NETS. HOWEVER, THESE FEATURES HAVE BEEN OMITTED FROM THIS ILLUSTRATION FOR CLARITY.

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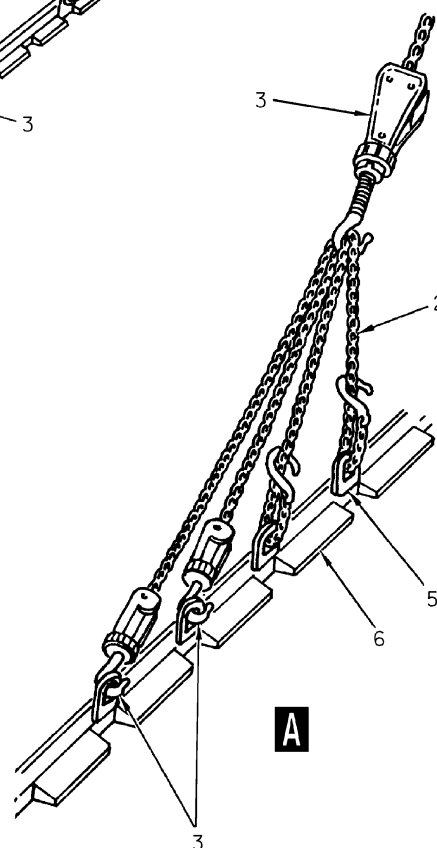
Figure 4-35. Chain Gate Restraint of Cargo (Sheet 1 of 2)

1. GENERAL CARGO LOAD
2. CHAIN GATE
3. TYPE MB-1 OR MB-2 TIEDOWN DEVICE
5. PALLET/PLATFORM TIEDOWN RING
6. PALLET



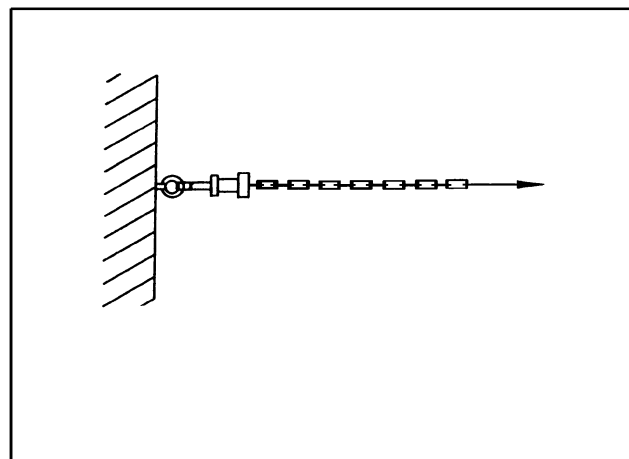
NOTE

4. THE CHAIN GATE MAY BE USED TO PROVIDE SUPPLEMENTAL RESTRAINT FOR OVERSIZE LOADS THAT ARE LOADED ON PALLETS, AIRDROP PLATFORMS, OR THE CARGO FLOOR. CARGO ON PALLETS PLACED IN THE LOGISTICS RAILS MUST BE SECURED TO THE PALLET/AIRDROP PLATFORM TIEDOWN RINGS.
5. USE OF TWO MB-1 CHAINS AND DEVICES AS SHOWN WILL ALLOW FULL STRENGTH OF THE MB-2 CHAINS WITHOUT EXCEEDING 7,500-POUND LIMIT OF THE PALLET TIEDOWN RINGS. THE LOOP FORMED BY THE MB-1 CHAINS SHALL BE AT LEAST SEVEN FEET MEASURED ALONG THE CHAIN FROM ONE PALLET RING TO THE OTHER AND SHOULD BE CONNECTED TO ALTERNATE RINGS.
6. PROPERLY INSTALLED CHAIN GATES ARE AN ACCEPTABLE METHOD OF OBTAINING LATERAL RESTRAINT AS LONG AS FORWARD AND AFT RESTRAINT CRITERIA ARE MET BY THE CHAIN GATES. (MEASUREMENTS FOR LATERAL RESTRAINT NOT REQUIRED). IT MAY BE NECESSARY TO INSTALL ADDITIONAL TIEDOWNS AT INTERVALS TO PROVIDE ADDITIONAL VERTICAL RESTRAINT IN THE CENTER OF THE PALLET TRAINS. RESTRAINT CALCULATION SHALL BE MADE FROM THE POINT WHERE THE CHAIN ANGLE CHANGES DIRECTION.

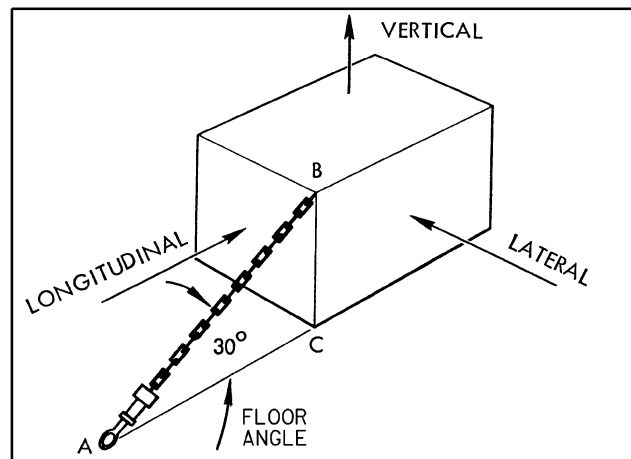


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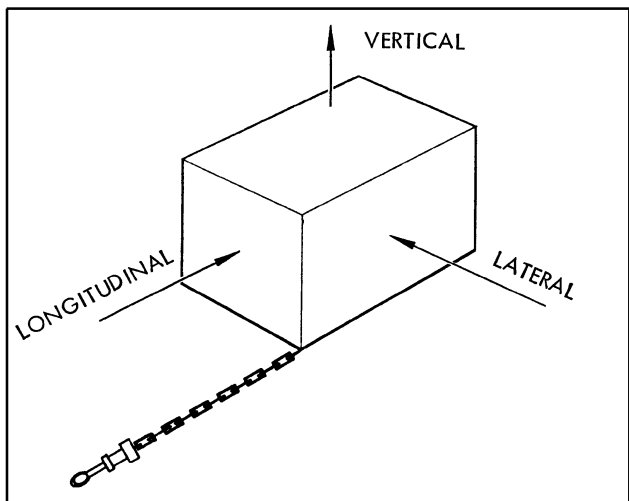
Figure 4-35. Chain Gate Restraint of Cargo (Sheet 2)



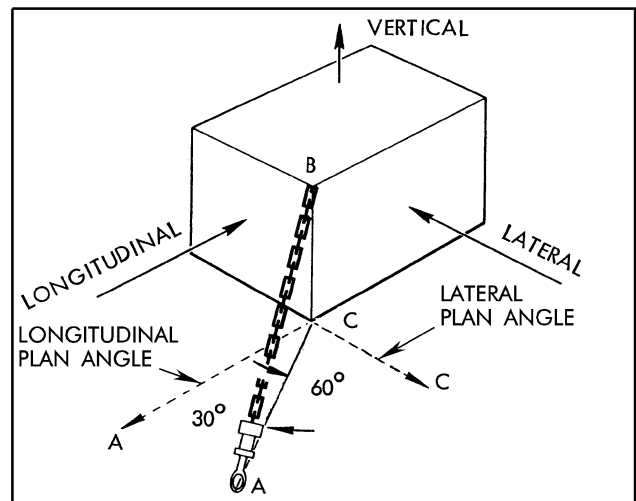
VIEW 1



VIEW 3



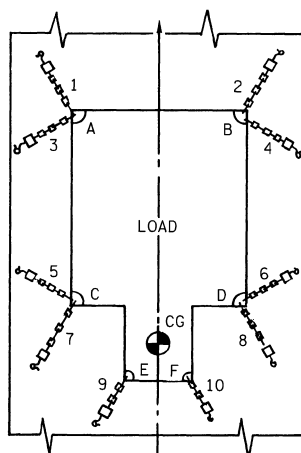
VIEW 2



VIEW 4

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Figure 4-36. Cargo Restraint

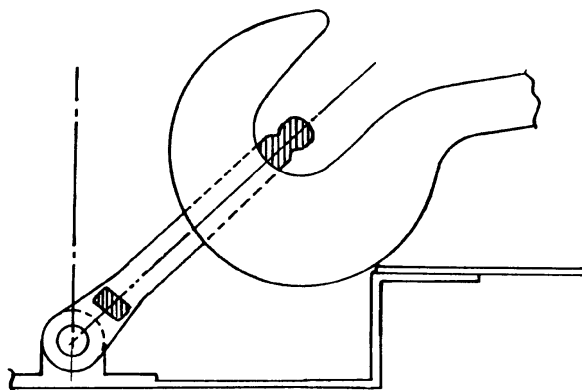


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Figure 4-37. General Rules for Applying Tiedowns

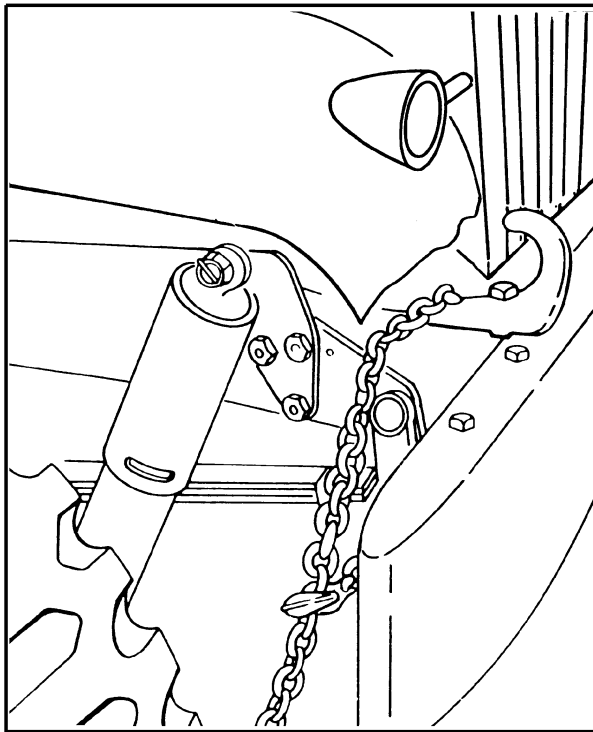
CAUTION

THE HOOK POINT MUST NOT CONTACT THE
TIE DOWN PAN OR STRUCTURAL DAMAGE
MIGHT OCCUR

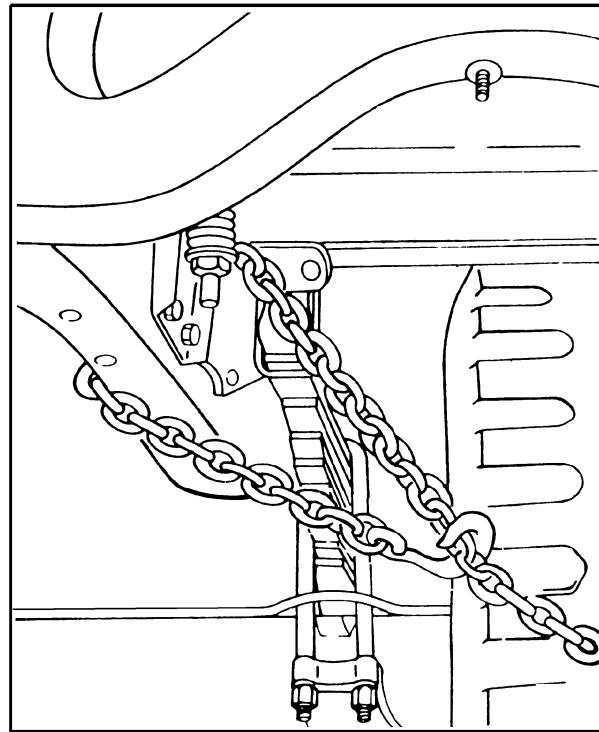


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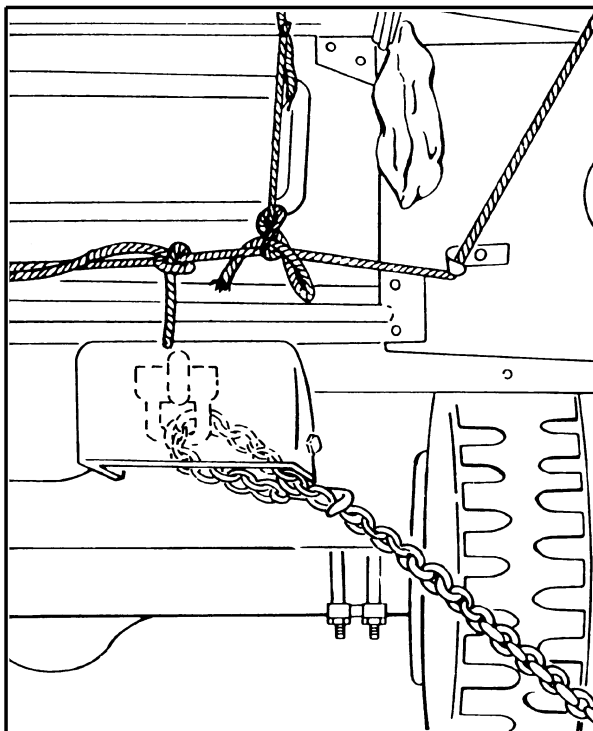
Figure 4-38. Tiedown Precautions



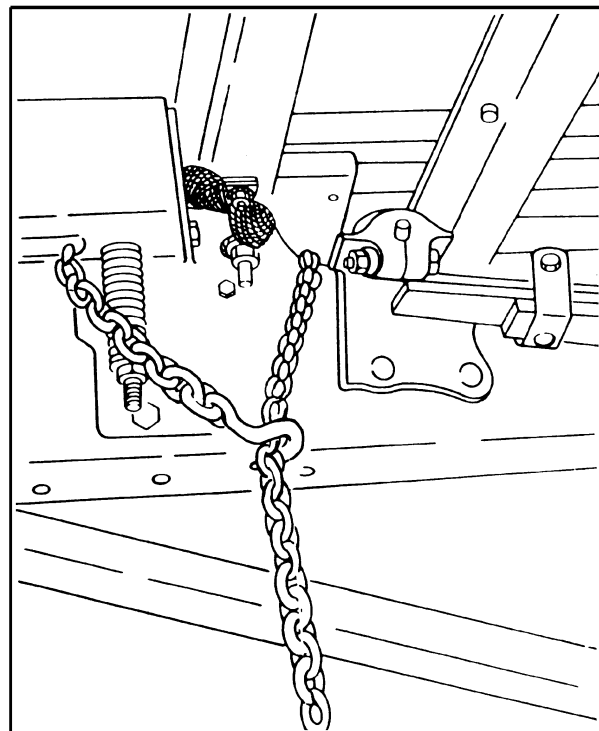
AROUND FRAME, AFT OF BUMPER



AROUND FRAME



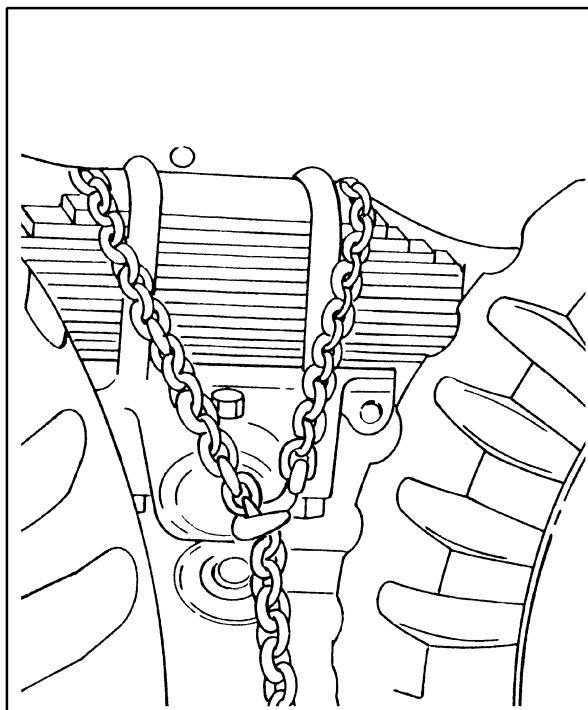
AROUND REAR LIFTING CLEVISES



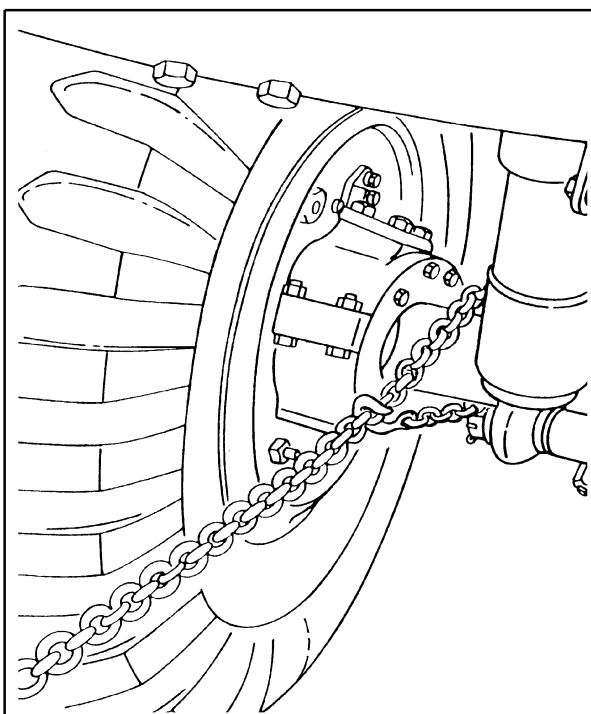
OVER FRAME AND UNDER CROSS MEMBER

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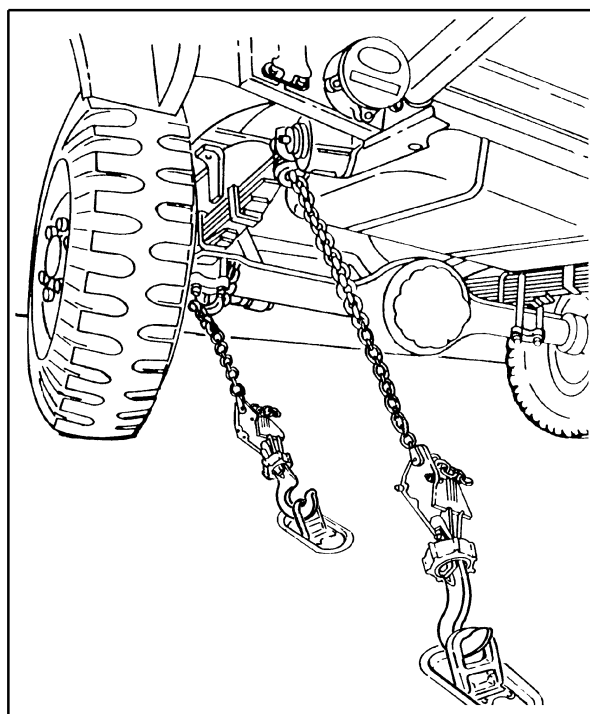
Figure 4-39. Typical Vehicle Tiedown Attaching Points (Sheet 1 of 2)



AROUND EQUALIZER TRUNNION BAR AND OVER SPRING



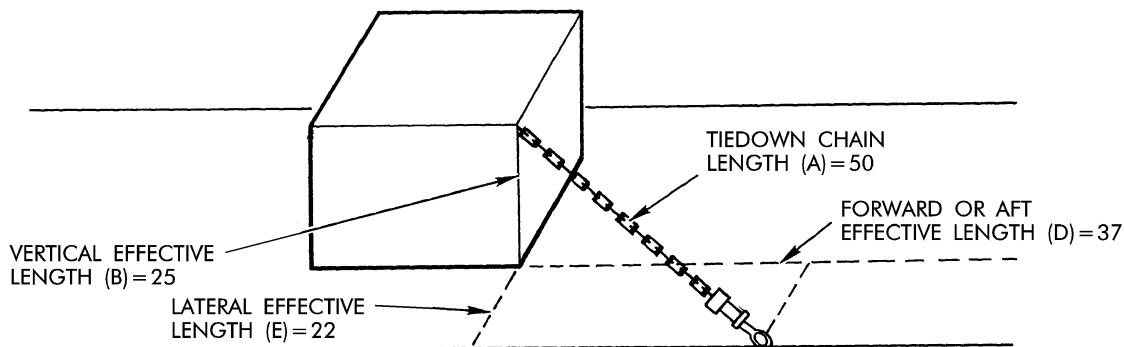
AROUND AXLE



MB-1 TIEDOWNS ATTACHED TO FLOOR FITTINGS

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Figure 4-39. Typical Vehicle Tiedown Attaching Points (Sheet 2)

**NOTE**

THIS FIGURE ILLUSTRATES A METHOD OF DETERMINING EFFECTIVE RESTRAINT FOR CARGO TIEDOWN. AS ILLUSTRATED, TIEDOWN RATIOS CAN BE DETERMINED BY DIVIDING TIEDOWN CHAIN LENGTH INTO EFFECTIVE LENGTH FOR DIRECTION IN WHICH RESTRAINT IS REQUIRED. THIS RATIO IS THEN MULTIPLIED BY THE STRENGTH OF THE TIEDOWN CHAIN, OR ATTACHMENT POINT, WHICHEVER IS LESS, TO FIND THE RESTRAINT RECEIVED FROM THE TIEDOWN PATTERN USED.

EXAMPLE:

- A. MEASURE LENGTH OF TIEDOWN CHAIN (A) FROM TIEDOWN FITTING TO ATTACHMENT POINT ON CARGO (50 INCHES).
- B. MEASURE EFFECTIVE VERTICAL LENGTH (B) FROM ATTACHMENT POINT ON CARGO TO A POINT DIRECTLY BENEATH IT ON THE CARGO FLOOR (25 INCHES).
- C. DIVIDE TIEDOWN CHAIN LENGTH (A) INTO VERTICAL EFFECTIVE LENGTH (B) TO DETERMINE RATIO.

$$\frac{25}{50} = 0.50 \text{ RATIO}$$

- D. MULTIPLY THIS RATIO BY RATED RESTRAINT (10,000 POUNDS) OF TIEDOWN CHAIN. 

10,000 X 0.50 = 5,000 POUNDS
EFFECTIVE VERTICAL RESTRAINT
RECEIVED FROM CHAIN.

- E. FOR DETERMINING EFFECTIVE FORWARD OR AFT RESTRAINT, OBTAIN A FORWARD OR AFT EFFECTIVE LENGTH (D) BY MEASURING FROM A POINT DIRECTLY BENEATH ATTACHMENT POINT ON THE CARGO ALONG A LONGITUDINAL AXIS TO A POINT LATERAL TO THE TIEDOWN FITTING BEING USED (37 INCHES)

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Figure 4-40. Tiedown Angle Ratio (Sheet 1 of 2)

- F. DIVIDE TIEDOWN CHAIN LENGTH (A) INTO FORWARD OR AFT EFFECTIVE LENGTH (D) TO DETERMINE RATIO.

$$\frac{37}{50} = 0.74 \text{ RATIO}$$

- G. MULTIPLY THIS RATIO BY RATED RESTRAINT (10,000 POUNDS) OF TIEDOWN CHAIN. 

10,000 X 0.74 = 7,400 POUNDS
EFFECTIVE FORWARD OR
AFT RESTRAINT RECEIVED
FROM CHAIN.

- H. FOR DETERMINING EFFECTIVE LATERAL RESTRAINT OBTAIN A LATERAL EFFECTIVE LENGTH (E) BY MEASURING FROM A POINT DIRECTLY BENEATH ATTACHMENT POINT ON THE CARGO TO THE ROW OF TIEDOWN FITTINGS BEING USED (22 INCHES).

- I. DIVIDE TIEDOWN CHAIN LENGTH (A) INTO LATERAL EFFECTIVE LENGTH (E) TO DETERMINE RATIO.

$$\frac{22}{50} = 0.44 \text{ RATIO}$$

- J. MULTIPLY THIS RATIO BY RATED RESTRAINT (10,000 POUNDS) OF TIEDOWN CHAIN. 

10,000 X 0.44 = 4,400 POUNDS
EFFECTIVE LATERAL RESTRAINT
RECEIVED FROM CHAIN.

NOTE

-  IF THE TIEDOWN CHAIN IS ATTACHED TO A PALLET RING, THE RATED RESTRAINT WOULD BE 7,500 POUNDS. THE RATIO WOULD BE MULTIPLIED BY 7,500 TO DETERMINE THE EFFECTIVE RESTRAINT RECEIVED.

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Figure 4-40. Tiedown Angle Ratio (Sheet 2)

SECTION IV WINCHING PROCEDURES

4.12 WINCH ON/OFF LOADING.

Winching should be used when on/off loading extremely heavy cargo such as large skidded loads, certain types of jet engines on shipping dollies and vehicles, when it is not practical to drive them on or off the airplane using their own power.

4.12.1 Winch Use. Winch on/off loading is accomplished through either the forward or the aft end of the airplane using the cargo winch that is provided with the airplane. The winch can be installed in either the forward or aft ramp winch compartment, however:

- Every effort should be made to use the winch in the aft winch compartment. Only use the winch in the four 90-degree positions.
- If utilizing the forward winch, route the cable 90 degrees inboard, then use a snatch block(s) to route the cable in the needed direction.
- When downloading cargo, avoid stopping on the ramp and avoid having slack in the winch cable when going over the ramp crest.

4.13 FRICTION EFFECTS ON WINCHING.

4.13.1 Friction. Friction is responsible for the additional load on the winching cable. In addition, when the load is being pulled up an inclined surface, gravitational force is also added to the load on the winch cable. Before starting winching operations, the additional load added to the winch cable by the cargo load friction and the gravitational force, added when the load is loaded up an inclined surface, must be calculated to make sure the particular load of cargo can be safely loaded within the limits of the winch cable.

4.13.1.1 The force of friction is proportional to the perpendicular pressure between the contacting surfaces. The ratio of this force to the perpendicular load is called the coefficient of friction.

4.13.1.2 When winching a unit of cargo along a level surface, the pull on the winch cable is equal to the weight of the unit of cargo times its coefficient of friction. Therefore, the coefficient of friction of a given unit of cargo can be calculated by dividing the weight of the unit into the amount of pull required to winch it along this level surface.

4.13.2 Coefficient of Friction. Each material or combination of materials has its average coefficient of friction. Average is used to define the coefficient of friction because of the many variables which tend to change the coefficient of friction.

4.13.3 Rolling Friction. More variables appear when determining coefficient of friction for a cargo mounted on wheels or rollers. Some of the variables encountered in determining the coefficient for wheeled vehicles are:

- Wheel width
- Wheel diameter
- Type of tread
- Tire pressure
- Bearing variables (at least seven)

4.13.4 Average Coefficient of Friction. To simplify the problem of variable effects of the coefficient of friction, an average value under normal conditions is used for each material, or combination thereof, and is called the average coefficient of friction. (See Table 4-6.)

NOTE

Although the average coefficient of friction is satisfactory in most cases, certain conditions such as wet wood can increase the coefficient.

4.13.5 Winching Up an Incline. When winching cargo up an incline, the load on the winching cable is resisted by two forces; the gravitational pull down the ramp and the force of friction. Both of these forces act parallel to the inclined plane of the ramp and in direct opposition of the force exerted by the winching cable. Both of these forces vary as the angle of the ramp varies. Refer to Table 4-6 for the ramp and toe loading angles.

4.13.5.1 Example (Incline Winching).

- a. Given: A 26,000-pound trailer with pneumatic tires is to be winched up the forward ramp in forward kneel configuration with a C-5B conversions hydraulic winch.
- b. Find: The load on the winch cable and the number of lines required.
- c. Solution:
 - (1) Obtain the constant (Table 4-6): Constant = 0.242
 - (2) Calculate the load on the winch cable:
 - (a) $\text{constant} \times \text{cargo weight} = \text{cable pull}$
 - (b) $0.242 \times 26,000 = 6,292 \text{ lb.}$
 - (3) Calculate winch factor:
 - (a) $\text{cable pull} \div \text{maximum winch pull} = \text{winch factor}$
 - (b) $6,292 \div 7,500 = 0.84$
 - (c) 0.84 is less than 1 so only a single line is required.

4.13.6 Winching Along Horizontal Cargo Floor. When winching cargo along the horizontal cargo floor, the load on the winch cable is equal to the weight of the cargo unit times its coefficient of friction on the cargo floor surface. Assuming a unit weight of 10,000 pounds and its coefficient of friction with dry wooden shoring on the cargo floor of 0.490, the load on the cable unit would be 10,000 pounds times 0.490 or 4,900 pounds ($10,000 \times 0.490 = 4,900$).

4.14 WINCHING PROCEDURES.**WARNING**

Only essential personnel are permitted in the cargo compartment during winching operation.

4.14.1 Preparation. Perform the following procedures prior to on/off loading cargo by winching.**WARNING**

- Maintain tension on the cable to prevent a slack cable condition during offloading. A slack cable condition can occur as the cargo goes over the ramp crest causing the cargo to lunge forward, jerking the cable, causing cable failure, injury to personnel, and damage to equipment.
- Do not use wheel chocks to prevent vehicles or other wheeled equipment from rolling down the forward ramp, ramp extension and toes or the aft ramp, pressure door and toes in the drive-in position. Failure to comply could result in injury to personnel as vehicle could jump the chocks.

CAUTION

- When cargo is to be winched into or out of the airplane, maintain a minimum of 12 inches of clearance between truck bed or flat bed and the end of the airplane ramp (aft loading) or ramp extension (forward loading). This clearance is to allow for possible movement of the vehicle or the airplane.
 - When snatch blocks are attached to the cargo floor, ensure shoring is placed between the snatch block hook and the tiedown ring pan receptacle. This will prevent damage to the tiedown ring pan receptacle during the winching operations.
- a. Ensure that the airplane is prepared for on/off loading.
 - b. Ensure that shoring is installed if required.
 - c. Ensure that winch cable loads and friction coefficients have been determined for the cargo to be loaded. (See Table 4-6.)
 - d. Ensure that all on/off loading personnel have been briefed on winching operations and prearranged hand signals.
 - e. Ensure that winching operations are performed by a minimum of a winch operator and two guides. The guides shall be responsible for the following:
 - (1) Monitor cargo clearances.
 - (2) Control the position of the cargo through the use of prearranged hand signals.
 - (3) Ensure that winch cable does not foul or snag.
 - f. Ensure that communications are maintained at all times between all on/off loading personnel.

4.14.2 Winch Cables.**WARNING**

- If the airplane snatch blocks are to be used, do not exceed their rated capacity of 15,000 pounds or 3/8-inch diameter cable size. Failure to comply could cause failure of the snatch block.
- Ensure that crew members and loading crew wear work gloves when handling the winch cable.
- Ensure that personnel do not step over a winch cable attached to cargo.

CAUTION

- When cargo is being on/off loaded and the winch cable does not rest on one of the cable wear strips, provide a temporary wear strip under the cable to protect the crest of the ramp. Failure to comply could result in damage to the ramp floor at the crest area.
- Synthetic cable: When cargo is being on/off loaded and the winch synthetic cable does not rest on one of the cable wear strips, use shoring to provide a temporary wear strip under the cable to protect the synthetic cable from damage. Failure to comply could result in damage to the synthetic cable.

Determine that the winch and cable are of sufficient strength to safely on/off load the cargo item prior to starting winching operations using Table 4-6.

NOTE

Attach cables as low as possible on the load to help reduce cable tension.

4.14.3 **A** Cargo Winch Operating Procedures Using Cargo Winch Control Panel. The winch control panel is located on the right side of the cargo compartment at FS 1904. The control panel controls operation of the cargo winch. The cargo winch is operated from the control panel as follows:

CAUTION

Do not operate the cargo winch if fluid accumulation (oil leakage or spillage) is found in the winch compartment. Failure to comply could result in damage to the airplane structure or the cargo winch.

NOTE

Winch may be operated with the forward or aft ramp in any position.

- Check the winch compartment for accumulation of fluid (oil leakage or spillage). Ensure the winch is properly installed and all four locking pins are in place. Check the oil level in oil port No. 2. Erect the folding output sheave.
- Ensure that the electrical power cables for power supply and control of the winch are properly connected to the power receptacles in the winch compartment.
- Check that the appropriate electrical power source is available and winch circuit breakers are closed before attempting to operate the winch.
- Ensure that direct communication is established between the loadmaster and the loading crew.

CAUTION

Maintain tension on winch cable, while reeling IN and OUT, to prevent cable entanglement and snagging.

- Advise the loading crew member to hold the winch cable taut while the cable is reeled out.

- f. Place the SELECT switch to, as applicable, FWD or AFT (corresponding to the installed position of the cargo winch).
- g. Place the MODE switch to the FAST position.
- h. Place and hold the OPERATE switch to UNWIND until the entire length of cable is reeled out, then release the switch.

WARNING

An unserviceable winch cable can be a hazard to the loading crew during winch on/off loading operations. It could break under load and whiplash, resulting in serious injury to personnel or causing severe damage to the airplane structure. Before any winching is accomplished, inspect the winch cable as described in Step i and Step j.

- i. Examine the winch cable to see that it is in a serviceable condition. Replace winch cables if four or more broken wires per strand inch or seven or more broken wires per cable inch are found. Any cable that has three broken wires or less per strand inch or six broken wires or less per cable inch shall be considered serviceable. The maximum number of broken wires shall not occur in any 2 consecutive inches of cable (i.e., if six wires are broken in 1 inch of cable, no additional broken wires shall be allowed in the next inch of cable). Any cable not within the above specified limits shall be replaced. A kink is a short tight bend or twist in the cable which can result in internal cable damage and may require replacement. Examine the cable strands at the kink. If an individual strand shows a sharp bend or deformation, the cable should be replaced. The loadmaster shall determine the degree of kink requiring cable change.
- j. Examine the hook and cable assembly for security. Ensure that the thrust bearing is installed and serviceable. There are two types of lockwashers currently in use. The first is tabbed and must be secured with at least one tab bent down into the cable assembly notches and one tab bent up into the hook assembly notches (total of two). The second is a flat washer that must be indented twice in the cable assembly notches and twice in the hook assembly notches (total of four indentations). Check the spring and clip, and that the hook rotates freely.
- k. When applicable, install the winch snatch blocks at their predetermined loading positions on the cargo floor by hooking to the appropriate tiedown rings, then assemble the winch cable around the snatch block pulleys.
- l. Attach the winch cable.
- m. Carefully take up the slack in the winch cable by placing the MODE switch to SLOW OR REMOTE and placing and holding the OPERATE switch to WIND. Release the OPERATE switch when slack is taken up.

CAUTION

Ensure output sheave on top of cargo winch is aligned with the direction of the cable pull. Failure to comply could cause a side load condition, resulting in damage to the cargo winch.

- n. Check all the attachment points for security, and the cable routing through the snatch blocks for proper cable run.

NOTE

Fast speed loading can only be accomplished where pull will not exceed 2,000 pounds. Should the pull exceed 2,000 pounds, the winch will automatically downshift to low speed.

- o. As applicable, leave the MODE switch at SLOW OR REMOTE or place to FAST.

WARNING

If the winch cycles rapidly on and off causing a jerking of the cable, discontinue reeling in and reduce cable load before proceeding with winch operation. Failure to comply could result in injury to personnel and damage to the winch.

- o. Place and hold OPERATE switch to WIND until the cargo unit is in the desired position, then release the switch.
- p. Restrain cargo in accordance with procedures in Chapter 4, Section III.
- q. Advise the loading crew to unhook the winch cable from bridle on cargo unit.
- r. Repeat Step k through Step q until all cargo is on/off loaded
- s. Advise the loading crew to remove the winch cable from around the snatch blocks.
- t. Advise the loading crew to detach snatch blocks from tiedown rings on the cargo floor and stow.

CAUTION

Maintain tension on winch cable, while reeling IN and OUT, to prevent cable entanglement and snagging.

- u. Place MODE switch to FAST and OPERATE switch to WIND until all the winch cable is reeled in. Release the OPERATE switch.
- v. Place the SELECT switch to OFF.
- w. Stow the output sheave on the cargo winch and install the winch compartment hatch.
- x. Check and make sure the AFT WINCH COMPT HATCH indicator light on the LH aft loadmaster control panel is off, indicating the hatch is correctly locked.

4.14.3A [A] Dual Powered Winch Operating Procedures Using Cargo Winch Control Panel.

NOTE

The dual powered winch cannot be operated using the controls on the cargo winch control panel located at FS 1904. Refer to paragraph 4.15.5A for operations using the winch pendant assembly.

4.14.4 [A] Cargo Winch Operating Procedures Using Winch Remote Control Grip Assembly. A winch remote control grip assembly is located on the left side of the cargo compartment at FS 1208, WL 170. The cargo winch is operated using the remote control grip assembly as follows:

NOTE

Winch may be operated with the forward or aft ramp in any position.

CAUTION

Do not operate the cargo winch if fluid accumulation (oil leakage or spillage) is found in the winch compartment. Failure to comply could result in damage to the airplane structure or the cargo winch.

- a. Check the winch compartment for accumulation of fluid (oil leakage or spillage). Ensure the winch is properly installed and all four locking pins are in place. Check the oil level in oil port No. 2. Erect the folding output sheave.
- b. Check that the appropriate electrical power source is available and winch circuit breakers are closed before attempting to operate the winch.
- c. Ensure that direct communication is established between the loadmaster and the loading crew.
- d. Connect the winch remote control grip assembly to the applicable CARGO WINCH PENDANT CONTROL DISCONNECT receptacle in the cargo compartment.

NOTE

Step f and Step g are accomplished at the cargo winch control panel on the right side of the cargo compartment at FS 1904. Step f permits electrical power to the winch. Step g provides electrical control power to the CARGO WINCH PENDANT CONTROL DISCONNECT receptacles for operation of the winch using the winch remote control grip assembly.

- e. Place the SELECT switch, as applicable, to FWD or AFT (corresponding to the installed position of the cargo winch).
- f. Place the MODE switch to SLOW or REMOTE.

CAUTION

Maintain tension on winch cable, while reeling IN and OUT, to prevent cable entanglement and snagging.

- g. Advise the loading crew member to hold the winch cable taut while the cable is reeled out.

NOTE

Step i through Step k are accomplished with the winch remote control grip assembly.

- h. Place the MODE switch to FAST.
- i. Place the SELECT switch to UNWIND.
- j. Squeeze and hold the trigger switch until the entire length of winch cable is reeled out, then release the switch.

WARNING

An unserviceable winch cable can be a hazard to the loading crew during winch on/off loading operations. It could break under load and whiplash resulting in serious injury to personnel and/or causing severe damage to the airplane structure. Before any winching is accomplished, inspect the cable as described in Step k and Step l.

- k. Examine the winch cable to see that it is in a serviceable condition. Replace winch cables if four or more broken wires per strand inch or seven or more broken wires per cable inch are found. Any cable that has three broken wires or less per strand inch or six broken wires or less per cable inch shall be considered serviceable. The maximum number of broken wires shall not occur in any 2 consecutive inches of cable; i.e., if six wires are broken in 1 inch of cable, no additional broken wires shall be allowed in the next consecutive inch of cable. Any cable not within the above specified limits shall be considered unserviceable and shall be replaced. A kink is a short tight bend or twist in the cable which can result in internal cable damage and may require replacement. Examine the cable strands at the kink. If an individual strand shows a sharp bend or deformation, the cable should be replaced. The loadmaster shall determine the degree of kink requiring a cable change.
- l. Examine the hook and cable assembly for security. Ensure that the thrust bearing is installed and serviceable. There are two types of lockwashers currently in use. The first is tabbed and must be secured with at least one tab bent down into the cable assembly notches and one tab bent up into the hook assembly notches (total of two). The second is a flat washer that must be indented twice in the cable assembly notches and twice in the hook assembly notches (total of four indentions). Check the spring and clip, and that the hook rotates freely.
- m. When applicable, install the winch snatch blocks at their predetermined loading positions on the cargo floor by hooking to the appropriate tiedown rings, then assemble the winch cable around the snatch block pulleys.
- n. Attach the winch cable.

NOTE

Step o through Step u and Step z through Step ac are accomplished with the winch remote control grip assembly.

- o. Place the MODE switch to SLOW.
- p. Place the SELECT switch to WIND.
- q. Carefully take up the slack in the winch cable by squeezing and holding the trigger switch and then releasing the switch.

CAUTION

Ensure output sheave on top of cargo winch is aligned with the direction of the cable pull. Failure to comply could cause a side load condition, resulting in damage to the cargo winch.

- r. Check all attachment points for security, and the cable routing through the snatch blocks for proper cable run.

NOTE

Fast speed loading can only be accomplished where pull will not exceed 2,000 pounds. Should the pull exceed 2,000 pounds, the winch will automatically downshift to low speed.

- s. As applicable, leave the MODE switch at SLOW or place to FAST.

WARNING

If the winch cycles rapidly on and off causing a jerking of the cable, discontinue reeling in and reduce cable load before proceeding with winch operation. Failure to comply could result in injury to personnel and damage to the winch.

- t. Squeeze and hold the trigger switch until the cargo unit is in the desired position, then release the switch.
- u. Restrain cargo in accordance with procedures in Chapter 4, Section III.
- v. Advise the loading crew to unhook the winch cable from bridle on the cargo unit.
- w. Repeat Step m through Step v until all the cargo is on/off loaded.
- x. Advise the loading crew to detach snatch blocks from tiedown rings on cargo floor and stow.

CAUTION

Maintain tension on winch cable, while reeling IN and OUT, to prevent cable entanglement and snagging.

- y. Place the MODE switch to FAST.
- z. Place the SELECT switch to WIND.
- aa. Squeeze and hold the trigger switch until all the winch cable is reeled in, then release the switch.
- ab. Place the SELECT switch to OFF.
- ac. Place the SELECT switch on the cargo winch control panel to OFF.
- ad. Disconnect the winch remote control grip assembly from its receptacle and stow.

- ae. Stow the output sheave on the cargo winch and install the winch compartment hatch.
- af. Check and make sure the AFT WINCH COMPT HATCH indicator light on the LH aft loadmaster control panel is off, indicating the hatch is correctly locked in place.

4.14.5 **B** Cargo Winch Operating Procedures.

NOTE

Winch operations may be accomplished with the forward or aft ramp in any position.

The cargo winch can be used from either the forward or aft compartments for on/off loading cargo. The cargo winch is operated as follows:

CAUTION

Do not operate the cargo winch if fluid accumulation (oil leakage or spillage) is found in the winch compartment. Failure to comply could result in damage to the airplane structure or cargo winch.

- a. Check the winch compartment for accumulation of fluid (oil leakage or spillage). Ensure the winch is properly installed and all four locking pins are in place. Erect the folding output sheave and secure with locking pins.

CAUTION

On airplanes that have cable assemblies installed for electric winch operation, ensure the shorting plug assembly at FS 1904 RH is disconnected from the WINCH PENDANT CONTROL DISC receptacle. (See Figure 2-36.) Failure to comply will result in damage to the cargo winch control panel.

NOTE

The winch hydraulic and electrical connectors will normally be connected unless the winch is moved from the stowed position.

- b. Use the winch remote control pendant at the aft cargo winch control panel or remove the pendant and extension cable from the retainer at FS 1208.
- c. Connect the pendant extension cable to the appropriate pendant control disconnect receptacle. (See Figure 2-36.)
- d. Use appropriate procedure at the following locations:
 - (1) When the control pendant is connected at FS 1231 right side cargo compartment:
 - (a) Place the pendant selector switch at FS 1231 to RH PENDANT.
 - (b) Place the left selector switch on the cargo winch remote control panel to FWD PENDANT. Place the right selector switch to FWD WINCH or AFT WINCH as appropriate.
 - (2) When the control pendant is connected at FS 1208 left side cargo compartment:
 - (a) Place the pendant selector switch at FS 1231 to LH PENDANT.
 - (b) Place the left selector switch on the cargo winch remote control panel to FWD PENDANT. Place the right selector switch to FWD WINCH or AFT WINCH as appropriate.
 - (3) When the control pendant is connected at FS 1904 cargo winch remote control panel, place the left selector switch on the cargo winch remote control panel to AFT PENDANT. Place the right selector switch to FWD WINCH or AFT WINCH as appropriate.

- e. Check the manual hydraulic selector valves on the cargo compartment right side at FS 604 and FS 1620 for proper positioning for the hydraulic system to be used and winch location.
- f. Pressurize No. 1 or No. 4 hydraulic system as appropriate.
- g. Establish direct communication between loadmaster and loading crew.

CAUTION

- Initial reel-out of the cable shall be accomplished by a sharp pull to prevent cable entanglement.
- Maintain tension on winch cable while reeling IN and OUT to prevent cable entanglement and snagging.
- h. Have a loading crew member hold the winch cable taut while the cable is reeled out.
- i. Place the pendant POWER switch to ON.
- j. Place the pendant SPEED switch to HI.
- k. Move the WINCH thumbwheel control towards the OUT direction. Hold the thumbwheel control towards the OUT direction until no further movement can be obtained.
- l. Allow cable to reel out until entire length of cable is obtained and release the thumbwheel control.

WARNING

An unserviceable winch cable could result in personnel injury. Inspect the winch cable in accordance with Step m and Step n prior to performing winching operations.

- m. Examine the winch cable to see that it is in a serviceable condition. Replace winch cables if four or more broken wires per strand inch or seven or more broken wires per cable inch are found. Any cable that has three broken wires or less per strand inch or six broken wires or less per cable inch shall be considered serviceable. The maximum number of broken wires shall not occur in any consecutive 2 inches of cable (e.g., if six wires are broken in 1 inch of cable, no additional broken wires shall be allowed in the next consecutive inch of cable). Any cable not within the above specified limits shall be replaced. A kink is a short, tight bend or twist in the cable which can result in internal cable damage and may require replacement. Examine the cable strands at the kink. If an individual strand shows a sharp bend or deformation, the cable should be replaced. The loadmaster shall determine the degree of kink requiring a cable change.
- n. Examine the hook and cable assembly for security. Ensure that the thrust bearing is installed and serviceable. There are two types of lockwashers currently in use. The first is tabbed and must be secured with at least one tab bent down into the cable assembly notches and one tab bent up into the hook assembly notches (total of two). The second is a flat washer that must be indented twice in the cable assembly notches and twice in the hook assembly notches (total of four indentations). Check the spring and clip, and that the hook rotates freely.
- o. When applicable, install the winch snatch blocks at their predetermined loading positions on the cargo floor by hooking to the appropriate tiedown rings, then assemble the winch cable around the snatch block pulleys.
- p. Attach the winch cable.
- q. Slowly move the WINCH thumbwheel control towards the IN direction to take up cable slack. Release the thumbwheel control.

CAUTION

Ensure output sheave on top of cargo winch is aligned with the direction of the cable pull. Failure to comply could cause a side load condition, resulting in damage to the cargo winch.

- r. Check all the attachment points for security, and the cable routing through the snatch blocks for proper cable run.

WARNING

- Closely observe load movement during winching operation. If at any time load movement stops, reverses, or cable jerking is experienced during winching, the control pendant thumbwheel shall be immediately released to the neutral position to ensure brake engagement.
- If the winch motor stalls or the cable jerks; discontinue winching operations. Reduce the cable load prior to continuing with winching operations.

NOTE

Fast speed loading can only be accomplished where pull will not exceed 2,000 pounds.

- s. Place the pendant SPEED switch to HI or LOW as appropriate.
- t. Move the WINCH thumbwheel control towards the IN direction. Continue to move thumbwheel control toward the IN direction until desired reel-in speed is obtained.
- u. When the cargo is in the desired position, release the thumbwheel control. Slowly move thumbwheel control towards the OUT direction to release cable tension and release thumbwheel control.
- v. Restrain the cargo.
- w. Unhook the winch cable.
- x. Repeat Step o through Step w until all cargo is loaded.
- y. Remove winch cable from snatch blocks.
- z. Stow snatch blocks.

CAUTION

Maintain tension on winch cable, while reeling IN and OUT, to prevent cable entanglement and snagging.

- aa. Have a loading crew member hold the winch cable taut while the cable is reeled in.
- ab. Place the pendant SPEED switch to HI.
- ac. Move the WINCH thumbwheel control towards the IN direction. Hold the thumbwheel control towards the IN direction until the winch cable is reeled in, then release the thumbwheel.
- ad. Place the pendant POWER switch to OFF.
- ae. Turn off hydraulic system as appropriate.
- af. If used, disconnect the pendant extension cable from the receptacle and stow the pendant and cable in the retainer at FS 1208.
- ag. Stow the output sheave on the cargo winch and install the winch compartment hatch.

- af. Check and make sure the AFT WINCH COMPT HATCH indicator light on the LH aft loadmaster control panel is off, indicating the hatch is correctly locked in place.

4.14.5 **A** Dual Powered Winch Operating Procedures Using Winch Pendant Assembly. The winch control panel is located on the right side of the cargo compartment at fuselage station 1208, WL170. The winch is operated as follows using the winch pendant.

CAUTION

- Do not operate the dual powered winch (DPW) if fluid accumulation (oil leakage or spillage) is found in the winch compartment. Failure to comply could result in damage to the airplane structure and/or cargo winch.
- Ensure folding output sheave lock is fully engaged and locking pin is flush with housing. Failure to comply could result in damage to DPW or equipment.

NOTE

Winch operation may be accomplished with the forward or aft ramp in any position.

- a. Check the winch compartment for accumulation of fluid (oil leakage or spillage). Make sure the winch is properly installed and all four locking pins are in place. Erect the folding output sheave.
- b. Check that the appropriate electrical power source is available and winch circuit breakers are closed before attempting to operate the DPW.
- c. Ensure that direct communication is established between the loadmaster and the loading crew.
- d. Connect the DPW pendant to the applicable CARGO WINCH PENDANT CONTROL DISCONNECT receptacle in the cargo compartment.

NOTE

- Step e and step f are accomplished at the cargo winch control panel on the right side of the cargo compartment at fuselage station 1904.
 - Step e permits electrical power to the winch.
 - Step f provides electrical control power to the CARGO WINCH PENDANT CONTROL DISCONNECT receptacles for operation of the DPW pendant.
- e. Place the SELECT switch to, as applicable, “FWD” or “AFT” (corresponding to the installed position of the cargo winch).
 - f. Place the MODE switch to “SLOW OR REMOTE.”

CAUTION

- Maintain tension on winch cable using body weight, while reeling “IN” or “OUT,” to prevent cable entanglement and snagging.
 - Do not step on the winch cable at any time. Doing so may cause damage to the cable core.
- g. Advise the loading crew member to hold the winch cable taut while the cable is reeled out.

NOTE

Step h, step i and step j are accomplished with the DPW pendant.

- h. Place Power Switch to “ON”.

NOTE

Allow 5 - 7 seconds for winch to 'boot up' after placing 'Power Switch' to 'On'.

- i. Using thumb, rotate thumbwheel in the "OUT" direction.

NOTE

Increasing the degree of rotation of the thumbwheel increases the cable speed in the direction selected.

- j. Hold the thumbwheel in the desired position until the required length of cable is reeled out, then release the thumbwheel.

WARNING

An unserviceable DPW synthetic cable can fail during winch on/off loading operations, releasing the load, potentially resulting in serious injury to personnel or damage to the airplane structure. Before any winching is accomplished, inspect the DPW synthetic cable as described in step k and step l.

NOTE

The cable speed will automatically slow when approximately 240 feet of cable has been removed from the DPW drum, and stop when 250 feet has been removed.

- k. Examine the synthetic cable for three conditions, to determine whether it is in serviceable condition. First, inspect the length of the synthetic cable for damage to the sheath (external cover). Any amount of wear on the sheath is acceptable as long as the cable core is not exposed. The cable core is colored bright orange. If the cable core is visible, the sheath has been breached and the synthetic cable is unserviceable. Second, inspect the length of the synthetic cable for any sharp reduction in diameter. If a sharp reduction in diameter is found, this indicates damage to one or more of the cable internal strands and the synthetic cable is unserviceable. Third, if any section of the cable bends into an abrupt corner, this indicates damage to one or more of the internal strands and the cable is unserviceable.
- l. Examine the hook and cable assembly for security. Ensure the pin attaching the loop to the hook is tightly in place. Check the spring and clip to ensure they are operating freely and that the clip snaps into place correctly. Inspect the outer sheathing to ensure the cable core is not exposed. There should be no abrupt changes in the cable diameter (not including the area where the inner core is spliced together). If any of these conditions exist the cable is unserviceable.
- m. When applicable, the loadmaster installs the winch snatch blocks at their predetermined loading positions on the cargo floor by hooking to the appropriate tiedown rings, then assembles the winch synthetic cable around the snatch block pulleys.
- n. Attach the winch synthetic cable to the bridle of the cargo unit to be on/off loaded.

NOTE

Step o, step p, step r and step s are accomplished with the DPW pendant.

- o. Ensure that the Power Switch is in the ON position.
- p. Carefully take up the slack in the winch synthetic cable by slightly rotating the thumbwheel the "IN" direction. Release the thumbwheel when the slack is removed from the synthetic cable.

CAUTION

Ensure output sheave on top of the DPW is aligned with the direction of the cable pull. Failure to comply could cause a side load condition, resulting in damage to the DPW.

- q. Check all the attachment points for security, and the cable routing through the snatch blocks for proper cable run.
- r. Adjust to desired speed by rotating the thumbwheel to the desired position.

WARNING

If the winch cycles rapidly on and off causing a jerking of the cable, discontinue reeling in and reduce cable load before proceeding with winch operation. Failure to comply could result in injury to personnel and damage to the winch.

- s. When cargo unit approaches desired position slowly reduce the degree of rotation on the thumbwheel to reduce cable speed. When the cargo unit is in the desired position, release the thumbwheel.

CAUTION

- Winching items at higher speeds may require addition stopping time. Slower speeds should be used when clearances are critical.
 - If winching direction needs to be changed and the winch fails to respond, release the switch and wait 3 seconds before attempting to reverse direction.
- t. Restrain cargo in accordance with procedures in Section III.
 - u. Advise the loading crew to unhook the winch cable from bridle on cargo unit.
 - v. Repeat step m through step u until all cargo is on/off loaded.
 - w. Advise the loading crew to remove the winch synthetic cable from around the snatch blocks
 - x. Advise the loading crew to detach the snatch blocks from tie down rings on the cargo floor and stow.

CAUTION

Maintain tension on winch cable using body weight, while reeling “IN” or “OUT,” to prevent cable entanglement and snagging.

NOTE

The winch will automatically slow with approximately 240 feet of cable in. Winch will automatically stop when all of the cable is reeled in except for the length necessary to stow the cable hook.

- y. Reel cable in at desired speed by rotating the thumbwheel toward the “IN” position until the winch cable automatically stops. Release the thumbwheel.
- z. Place the winch pendant Power Switch to “OFF”.
- aa. Disconnect the DPW pendant from its receptacle and stow.
- ab. Stow the output sheave on the cargo winch and install the winch compartment hatch.
- ac. Check and make sure the AFT WINCH COMPT HATCH indicator light on the LH aft loadmaster’s control panel is off, indicating the hatch is correctly locked.

4.14.6 **B** Electric Cargo Winch Operating Procedures Using the Remote Control Grip Assembly.**WARNING**

Ensure winch control pendant and electrical cable are routed free of the winch sheave and winch cable assembly to ensure entanglement will not occur.

CAUTION

Ensure shorting plug assembly is installed in the WINCH PENDANT CONTROL DISC receptacle on the aft CARGO WINCH CONTROL panel at FS 1904 RH. (See Figure 2-35.)

The electric cargo winch can be operated on airplanes using the remote control grip assembly when cable assemblies are installed. (See Figure 4-41.)

NOTE

Winch may be operated with the forward or aft ramp in any position.

- a. Open the following circuit breakers and attach warning tags.
 - (1) CARGO WINCH SELECTOR circuit breaker on flight engineer circuit breaker panel No. 5.
 - (2) FWD BUFFET/OUTLET circuit breaker located at FS 607.
 - (3) AFT BUFFET/OUTLET circuit breaker located at FS 761.
 - (4) SERVICE OUTLET RH circuit breakers (all three phase) located on the AC LOAD CENTER MONITOR AC BUS NO. 3.
- b. Uncoil and route the 115-volt AC cable assembly to the forward or aft winch compartment as appropriate.
- c. Connect the winch electrical connector to the 115-volt AC cable assembly. Connect one section of the 28-volt DC cable assembly to the winch wiring harness. Connect the other section of the 28-volt DC cable assembly to the existing 28-volt DC receptacle in the winch compartment. (See Figure 4-41.)

CAUTION

Do not operate the cargo winch if fluid accumulation (oil leakage or spillage) is found in the winch compartment. Failure to comply could result in damage to the airplane structure and/or cargo winch.

- d. Check the winch compartment for accumulation of fluid (oil leakage or spillage). Ensure the winch is properly installed and all four locking pins are in place. Check the oil level in oil port No. 2. Erect the folding output sheave.
- e. Connect the winch remote control grip cable to the 28-volt DC connector.
- f. Connect cable assemblies to service outlet at FS 624 for forward winch operation or FS 758 for aft winch operation.
- g. Check that appropriate electrical power source is available.
- h. Close the following circuit breakers and remove warning tags.
 - (1) CARGO WINCH SELECTOR circuit breaker on flight engineer circuit breaker panel No. 5.

- (2) FWD BUFFET/OUTLET circuit breaker located at FS 607.
- (3) AFT BUFFET/OUTLET circuit breaker located at FS 761.
- (4) SERVICE OUTLET RH circuit breakers (all three phase) on AC LOAD CENTER MONITOR AC BUS NO. 3.
- i. Establish direct communication between the loadmaster and the loading crew.

WARNING

Ensure winch control pendant and electrical cable are routed free of the winch sheave and winch cable assembly to ensure entanglement will not occur.

CAUTION

Maintain tension on winch cable while reeling in and out to prevent cable entanglement and snagging.

- j. Advise the loading crew member to hold the winch cable taut while the cable is reeled out.
- k. Place the MODE switch to FAST.
- l. Place the SELECT switch to UNWIND.
- m. Squeeze and hold the trigger switch until the entire length of winch cable is reeled out, then release the switch.

WARNING

An unserviceable winch cable can be a hazard to the loading crew during winch on/off loading operations. It could break under load and whiplash resulting in serious injury to personnel and/or causing severe damage to the airplane structure. Before any winching is accomplished, inspect the cable as described in Step n and Step o.

- n. Examine the winch cable to see that it is in a serviceable condition. Replace winch cables if four or more broken wires per strand-inch or seven or more broken wires per cable-inch are found. Any cable that has three broken wires or less per strand-inch or six broken wires or less per cable-inch shall be considered serviceable. The maximum number of broken wires shall not be allowed in any two consecutive inches of a serviceable cable. For example, if six wires are broken in 1 inch of cable, no additional broken wires shall be allowed in the next inch of cable. Any cable not within the above specified limits shall be considered unserviceable and shall be replaced. A kink is a short tight bend or twist in the cable which can result in internal cable damage and may require replacement. Examine the cable strands at the kink. If an individual strand shows a sharp bend or deformation, the cable should be replaced. The loadmaster shall determine the degree of kink requiring a cable change.
- o. Examine the hook and cable assembly for security. Ensure that the thrust bearing is installed and serviceable. There are two types of lockwashers currently in use. The first is tabbed and must be secured with at least one tab bent down into the cable assembly notches and one tab bent up into the hook assembly notches (total of two). The second is a flat washer that must be indented twice in the cable assembly notches and twice in the hook assembly notches (total of four indentations). Check the spring and clip, and that the hook rotates freely.
- p. When applicable, install the winch snatch blocks at their predetermined loading positions on the cargo floor by hooking to the appropriate tiedown rings, then assemble the winch cable around the snatch block pulleys.
- q. Attach the winch cable.
- r. Place the MODE switch to SLOW.
- s. Place the SELECT switch to WIND.
- t. Carefully take up the slack in the winch cable by squeezing and holding the trigger switch and then releasing the switch.

CAUTION

Ensure output sheave on top of cargo winch is aligned with the direction of the cable pull. Failure to comply could cause a side load condition, resulting in damage to the cargo winch.

- u. Check all attachment points for security, and the cable routing through the snatch blocks for proper cable run.

NOTE

Fast-speed loading can only be accomplished where pull will not exceed 2,000 pounds. Should the pull exceed 2,000 pounds, the winch will automatically downshift to low speed.

- v. As applicable, leave the MODE switch at SLOW or place to FAST.

WARNING

If the winch cycles rapidly on and off causing a jerking of the cable, discontinue reeling in and reduce cable load before proceeding with winch operation.

- w. Squeeze and hold the trigger switch until the cargo unit is in the desired position, then release the switch.
- x. Restrain the cargo.
- y. Advise the loading crew to unhook the winch cable.
- z. Repeat Step p through Step y until all cargo is loaded.
- aa. Stow snatch blocks.

CAUTION

Maintain tension on winch cable while reeling in and out to prevent cable entanglement and snagging.

- ab. Place the MODE switch to FAST.
- ac. Place the SELECT switch to WIND.
- ad. Squeeze and hold the trigger switch until all the winch cable is reeled in, then release the switch.
- ae. Place the SELECT switch to OFF.
- af. Open the following circuit breakers and at warning tags.
 - (1) CARGO WINCH SELECTOR circuit breaker on MAIN DC BUS NO. 2 on flight engineer circuit breaker panel No. 5.
 - (2) FWD BUFFET/OUTLET circuit breaker located at FS 607.
 - (3) AFT BUFFET/OUTLET circuit breaker located at FS 761.
 - (4) SERVICE OUTLET RH circuit breakers (all three phase) on AC LOAD CENTER MONITOR AC BUS NO. 3.
- ag. Disconnect cable assemblies.
- ah. Disconnect the winch remote control grip assembly.

CAUTION

Ensure that the winch AC and DC electrical cables are disconnected, coiled, and stowed before securing the winch compartment access hatch.

- ai. Disconnect the AC and DC cable assemblies in the winch compartment and coil and stow cables.
- aj. Close the following circuit breakers and remove warning tags.
 - (1) CARGO WINCH SELECTOR circuit breaker on MAIN DC BUS NO. 2 on flight engineer circuit breaker panel No. 5.
 - (2) FWD BUFFET/OUTLET circuit breaker located at FS 607.
 - (3) AFT BUFFET/OUTLET circuit breaker located at FS 761.
 - (4) SERVICE OUTLET RH circuit breakers (all three phase) on AC LOAD CENTER MONITOR AC BUS NO.3.
- ak. Stow the output sheave on the cargo winch and install the winch compartment hatch.
- al. Check and make sure the AFT WINCH COMPT HATCH indicator light on the LH aft loadmaster control panel is off.

4.14.6A **B** Dual Powered Winch Operating Procedures Using Winch Pendant Assembly, Hydraulic. The winch can be used from either the forward or aft compartments for on/off loading cargo. The winch is operated as follows:

CAUTION

Do not operate the dual powered winch (DPW) if fluid accumulation (oil leakage or spillage) is found in the winch compartment. Failure to comply could result in damage to the airplane structure and/or cargo winch.

NOTE

Winch operation may be accomplished with the forward or aft ramp in any position.

- a. Check the winch compartment for accumulation of fluid (oil leakage or spillage). Make sure the DPW is properly installed and all four locking pins are in place. Erect the folding output sheave.

CAUTION

On airplanes that have cable assemblies installed for electric winch operation, ensure the shorting plug assembly at fuselage station 1904 RH is disconnected from the WINCH PENDANT CONTROL DISC receptacle. (See figure 2-34). Failure to comply will result in damage to the cargo winch control panel.

NOTE

The winch hydraulic and electrical connectors will normally be connected unless the winch is moved from the stowed position.

- b. Connect the winch pendant cable to the appropriate pendant control disconnect receptacle (See Figure 2-34).
- c. Procedure to be used when the DPW pendant is connected at the following locations:
 - (1) Fuselage station 1231 right side cargo compartment.

- (a) Place the pendant selector switch at fuselage station 1231 to “RH PENDANT.”
- (b) Place the left selector switch on the cargo winch remote control panel to “FWD PENDANT.” Place the right selector switch to “FORWARD WINCH” or “AFT WINCH” as appropriate.
- (2) Fuselage station 1208 left side cargo compartment.
 - (a) Place the pendant selector switch at fuselage station 1231 to “LH PENDANT.”
 - (b) Place the left selector switch on the cargo winch remote control panel to “FWD PENDANT.” Place the right selector switch to “FORWARD WINCH” or “AFT WINCH” as appropriate.
- (3) Fuselage station 1904 left side cargo compartment.
 - (a) Place the left selector switch on the cargo winch remote control panel to “AFT PENDANT.”
 - (b) Place the right selector switch to “FORWARD WINCH” or “AFT WINCH” as appropriate.
- d. Check the manual hydraulic selector valves on the cargo compartment right side at fuselage stations 604 and 1620 for proper positioning for the hydraulic system to be used and winch location.
- e. Pressurize No. 1 or No. 4 hydraulic system as appropriate.
- f. Establish direct communication between the loadmaster and the loading crew.

CAUTION

- Maintain tension on winch cable using body weight, while reeling “IN” or “OUT,” to prevent cable entanglement and snagging.
- g. Have a loading crew member hold the winch cable taut while the cable is reeled out.
- h. Place the pendant POWER switch to “ON”.

NOTE

Allow 5 - 7 seconds for winch to ‘boot up’ after placing ‘Power Switch’ to ‘On’.

- i. Using thumb, rotate thumbwheel in the “OUT” direction.

NOTE

Increasing the degree of rotation of the thumbwheel increases the cable speed in the direction selected.

- j. Hold the thumbwheel in the desired position until the required length of cable is reeled out, then release the thumbwheel.

WARNING

An unserviceable DPW synthetic cable can fail during winch on/off loading operations, releasing the load, potentially resulting in serious injury to personnel or damage to the airplane structure. Before any winching is accomplished, inspect the DPW synthetic cable as described in step k and step l.

NOTE

The cable speed will automatically slow when approximately 240 feet of synthetic cable has been removed from the DPW drum, and stop when 250 feet has been removed.

- k. Examine the synthetic cable for three conditions to determine whether it is in serviceable condition. First, inspect the length of the synthetic cable for damage to the sheath (external cover). Any amount of wear on the sheath is acceptable as long as the cable core is not exposed. The cable core is colored bright orange. If the cable core is visible, the sheath has been breached and the synthetic cable is unserviceable. Second, inspect the length of the synthetic cable for any sharp reduction in diameter. If a sharp reduction in diameter is found, this indicates damage to one or more of the cable internal strands and the synthetic cable is unserviceable. Third, if any section of the cable bends into an abrupt corner, this indicates damage to one or more of the internal strands and the cable is unserviceable.
- l. Examine the hook and cable assembly for security. Ensure the pin attaching the loop to the hook is tightly in place. Check the spring and clip to ensure they are operating freely and that the clip snaps into place correctly. Inspect the outer sheathing to ensure the cable core is not exposed. There should be no abrupt changes in the cable diameter (not including the area where the inner core is spliced together). If any of these conditions exist the cable is unserviceable.
- m. When applicable, the loadmaster installs the winch snatch blocks at their predetermined loading positions on the cargo floor by hooking to appropriate tiedown rings, then assembles the winch synthetic cable around the snatch lock pulleys.
- n. Attach the winch synthetic cable to the bridle of the cargo unit to be on/off loaded.
- o. Carefully take up the slack in the winch synthetic cable by slightly rotating the thumbwheel in the "IN" direction. Release the thumbwheel when the slack is removed from the synthetic cable.

CAUTION

Ensure output sheave on top of the DPW is aligned with the direction of the cable pull. Failure to comply could cause a side load condition, resulting in damage to the DPW.

- p. Check all attachments points for security, and the cable routing through the snatch blocks for proper cable run.

WARNING

If the winch cycles rapidly on and off causing a jerking of the cable, discontinue reeling in and reduce cable load before proceeding with winch operation. Failure to comply could result in injury to personnel and damage to the winch.

- q. Adjust to desired speed by rotating the thumbwheel to the desired position.
- r. When cargo unit approaches desired position slowly reduce the degree of rotation on the thumbwheel to reduce cable speed. When the cargo unit is in the desired position, release the thumbwheel.

CAUTION

- Winching items at higher speeds may require additional stopping time. Slower speeds should be used when clearances are critical.

- If the winch fails to respond after rotating the thumbwheel in the desired direction, release the thumbwheel and wait 3 seconds before resuming winching operation.

- s. Restrain the cargo in accordance with procedures in Section III.
- t. Advise the loading crew to unhook the winch synthetic cable from the bridle on cargo unit.
- u. Repeat step m through step t until all cargo is on/off loaded.
- v. Advise the loading crew to remove winch synthetic cable from around snatch blocks.
- w. Advise the loading crew to detach snatch blocks from tiedown rings on cargo floor and stow.

CAUTION

Maintain tension on winch cable using body weight, while reeling “IN” or “OUT,” to prevent cable entanglement and snagging.

- x. Have a loading crew member hold winch cable taut while the cable is reeled in.

NOTE

The winch will automatically slow with approximately 240 feet of cable in. Winch will automatically stop when all of the cable is reeled in except for the length necessary to stow the cable hook.

- y. Reel cable in at desired speed by rotating the thumbwheel toward the “IN” position until the winch cable automatically stops. Release the thumbwheel.

- z. Place the winch pendant POWER switch to “OFF”.

- aa. Turn off hydraulic system as appropriate.

- ab. If used, disconnect the DPW pendant from its receptacle, stow the pendant and cable in the retainer at fuselage station 1208.

- ac. Stow the output sheave on the cargo winch and install the winch compartment hatch.

- ad. Check and make sure the AFT WINCH COMPT HATCH indicator light on the LH aft loadmaster’s control panel is off, indicating the hatch is correctly locked.

4.14.6B **B** Dual Powered Winch Operating Procedures Using Winch Pendant, Electric. The DPW can be operated on airplanes using the DPW winch pendant when pendant cables are installed. The winch can be used from either the forward or aft compartments for on/off loading cargo. The winch is operated as follows:

WARNING

Ensure DPW pendant and pendant cable are routed free of the winch sheave and winch cable to prevent entanglement.

CAUTION

- Ensure the shorting plug assembly is installed in the WINCH PENDANT CONTROL DISC receptacle on the aft CARGO WINCH CONTROL panel at fuselage station 1904 RH. (See Figure 2-34).
- Do not operate the cargo winch if fluid accumulation (oil leakage or spillage) is found in the winch compartment. Failure to comply could result in damage to the airplane structure and/or cargo winch.

NOTE

- Winch operation may be accomplished with the forward or aft ramp in any position.
 - There is approximately a five second delay when operating the winch.
- Open the following circuit breakers and attach danger tags.
 - CARGO WINCH SELECTOR circuit breaker on flight engineer circuit breaker panel No. 5.
 - BUFFET/LAV OUTLET circuit breakers (all three phases) on AC LOAD CENTER MONITOR AC BUS NO. 2.
 - SERVICE OUTLET RH circuit breakers (all three phases) on AC LOAD CENTER MONITOR AC BUS NO. 3.
 - Uncoil and route the 115-volt AC cable assembly to the forward or aft winch compartment as appropriate.
 - Connect the winch electrical connector to the 115-volt AC cable assembly. Connect one section of the 28-volt DC cable assembly to the winch wiring harness. Connect the other section of the 28-volt DC cable assembly to the existing 28-volt DC receptacle in the winch compartment. (See Figure 4-44).
 - Check the winch compartment for accumulation of fluid (oil leakage or spillage). Make sure the DPW is properly installed and all four locking pins are in place. Erect the folding output sheave.
 - Connect the DPW pendant cable to the 28-volt DC connector.
 - Connect cable assemblies to service outlet at FS 624 for forward winch operation or FS 758 for aft winch operation.
 - Check that appropriate electrical power source is available.
 - Close the following circuit breakers and remove danger tags.
 - CARGO WINCH SELECTOR circuit breaker on flight engineer circuit breaker panel No. 5.
 - BUFFET/LAV OUTLET circuit breakers (all three phases) on AC LOAD CENTER MONITOR AC BUS NO. 2.
 - SERVICE OUTLET RH circuit breakers (all three phases) on AC LOAD CENTER MONITOR AC BUS NO. 3.
 - Ensure that direct communication is established between the loadmaster and the loading crew.

WARNING

Ensure DPW pendant and pendant cable are routed free of the winch sheave and winch cable to prevent entanglement.

CAUTION

- Maintain tension on winch cable using body weight, while reeling “IN” or “OUT,” to prevent cable entanglement and snagging.
 - Do not step on the winch cable at any time. Doing so may cause damage to the cable core.
- j. Advise the loading crew member to hold the winch cable taut while the cable is reeled out.
- k. Place Power Switch to “ON”.

NOTE

Allow 5 - 7 seconds for winch to ‘boot up’ after placing ‘Power Switch’ to ‘On’.

- l. Using thumb, rotate thumbwheel in the “OUT” direction.

NOTE

Increasing the degree of rotation of the thumbwheel increases the cable speed in the direction selected.

- m. Allow synthetic cable to reel out until required length of cable is obtained and release the thumbwheel.

WARNING

An unserviceable DPW synthetic cable can fail during winch on/off loading operations, releasing the load, potentially resulting in serious injury to personnel or damage to the airplane structure. Before any winching is accomplished, inspect the DPW synthetic cable as described in step n and step o.

NOTE

The cable speed will automatically slow when approximately 240 feet of cable has been removed from the DPW drum, and stop when 250 feet has been removed.

- n. Examine the synthetic cable for three conditions to determine whether it is in serviceable condition. First, inspect the length of the synthetic cable for damage to the sheath (external cover). Any amount of wear on the sheath is acceptable as long as the cable core is not exposed. The cable core is colored bright orange. If the cable core is visible, the sheath has been breached and the synthetic cable is unserviceable. Second, inspect the length of the synthetic cable for any sharp reduction in diameter. If a sharp reduction in diameter is found, this indicates damage to one or more of the cable internal strands and the synthetic cable is unserviceable. Third, if any section of the cable bends into an abrupt corner, this indicates damage to one or more of the internal strands and the cable is unserviceable.
- o. Examine the hook and cable assembly for security. Ensure the pin attaching the loop to the hook is tightly in place. Check the spring and clip to ensure they are operating freely and that the clip snaps into place correctly. Inspect the outer sheathing to ensure the cable core is not exposed. There should be no abrupt changes in the cable diameter (not including the area where the inner core is spliced together). If any of these conditions exist the cable is unserviceable.

- p. When applicable, the loadmaster installs the winch snatch blocks at their predetermined loading positions on the cargo floor by hooking to the appropriate tiedown rings, then assembles the winch synthetic cable around the snatch block pulleys.
- q. Attach the winch synthetic cable to the bridle of the cargo unit to be on/off loaded.
- r. Carefully take up the slack in the winch synthetic cable by slightly rotating the thumbwheel in the “IN” direction. Release the thumbwheel when the slack is removed from the synthetic cable.

CAUTION

Ensure output sheave on top of the DPW is aligned with the direction of the cable pull. Failure to comply could cause a side load condition, resulting in damage to the DPW.

- s. Check all the attachment points for security, and the cable routing through the snatch blocks for proper cable run.

WARNING

If the winch cycles rapidly on and off causing a jerking of the cable, discontinue reeling in and reduce cable load before proceeding with winch operation. Failure to comply could result in injury to personnel and damage to the winch.

- t. Adjust to desired speed by rotating the thumbwheel toward the desired position.
- u. When cargo unit approaches desired position slowly reduce the degree of rotation on the thumbwheel to reduce cable speed. When the cargo unit is in the desired position, release the thumbwheel.

CAUTION

- Winching items at higher speeds may require addition stopping time. Slower speeds should be used when clearances are critical.
- If the winch fails to respond after rotating the thumbwheel in the desired direction, release the thumbwheel and wait 3 seconds before resuming winching operation.

- v. Restrain cargo in accordance with procedures in Section III.
- w. Advise the loading crew to unhook the winch synthetic cable from bridle on cargo unit.
- x. Repeat step p through step w until all cargo is on/off load.
- y. Advise the loading crew to remove the winch cable from around the snatch blocks.
- z. Advise the loading crew to detach the snatch blocks from tie down rings on the cargo floor and stow.

CAUTION

■ Maintain tension on winch cable using body weight, while reeling “IN” or “OUT,” to prevent cable entanglement and snagging.

NOTE

The winch will automatically slow with approximately 240 feet of cable in. Winch will automatically stop when all of the cable is reeled in except for the length necessary to stow the cable hook.

- aa. Reel cable in at desired speed by rotating the thumbwheel toward the “IN” position until the winch cable automatically stops. Release the thumbwheel.
- ab. Place the Power Switch to “OFF”.
- ac. Open the following circuit breakers and attach danger tags.
 - (1) CARGO WINCH SELECTOR circuit breaker on flight engineer circuit breaker panel No. 5.
 - (2) BUFFET/LAV OUTLET circuit breakers (all three phases) on AC LOAD CENTER MONITOR AC BUS NO. 2.
 - (3) SERVICE OUTLET RH circuit breakers (all three phases) on AC LOAD CENTER MONITOR AC BUS NO. 3.
- ad. Disconnect cable assemblies from service outlet at FS 624 or FS 758.
- ae. Disconnect the DPW pendant from its receptacle and stow.

CAUTION

Ensure that the winch AC and DC electrical cables are disconnected, coiled and stowed before securing the winch compartment access hatch.

- af. Disconnect the AC and DC cable assemblies in the winch compartment and coil and stow cables.
- ag. Close the following circuit breakers and remove danger tags.
 - (1) CARGO WINCH SELECTOR circuit breaker on flight engineer circuit breaker panel No. 5.
 - (2) BUFFET/LAV OUTLET circuit breakers (all three phases) on AC LOAD CENTER MONITOR AC BUS NO. 2.
 - (3) SERVICE OUTLET RH circuit breakers (all three phases) on AC LOAD CENTER MONITOR AC BUS NO. 3.
- ah. Stow the output sheave on the DPW and install the winch compartment hatch. Check and make sure the AFT WINCH COMPT HATCH indicator light on the LH aft loadmaster’s control panel is off, indicating the hatch is correctly locked.

4.14.7 Winch Loading Logistics Palletized Cargo. Figure 4-44 shows the recommended methods for winch loading logistics palletized cargo. Use the airplane cargo winch provided as part of the airplane equipment and the snatch block as required. The winch may be used for on/off loading cargo or as a restraint when load control is necessary.

NOTE

If utilizing the forward winch, route the cable 90 degrees inboard, then use a snatch block(s) to route the cable in the needed direction.

4.15 PORTABLE HEAVY CARGO WINCH.

4.15.1 Portable Heavy Cargo Winch Installation. Install the portable heavy cargo winch in the airplane in accordance with Figure 4-42. Attach the winch to the cargo floor tiedown rings. A 15-inch offset on the winch is recommended for a single line pull since it allows the cargo to be positioned closer to the winch without exceeding the 8-degree pull-off limitations. Diagonally attached tiedown chains and devices will prevent the winch from sliding laterally under load as the cable is reeled across the drums.

4.15.2 Winching Using Portable Heavy Cargo Winch. The portable heavy cargo winch may be used for on/off loading of cargo. A locally manufactured electrical power cable (see TO 1C-5M-2-2) shall be used between the winch and the airplane power receptacle to make the winch compatible with the airplane electrical power system.

WARNING

Do not use the emergency crank handle when electric power failure has occurred when the winch is under load. Winch must be under a no-load condition and cable slack before engaging the manual operation.

4.15.2.1 The portable heavy cargo winch can be operated (in event of a power failure) using an emergency crank handle provided with the winch for this purpose.

4.15.3 Pre-Operation Checkout – Portable Heavy Cargo Winch.

CAUTION

When cargo is being on/off loaded and the winch cable does not rest on one of the hinge wear strips, provide a temporary wear strip under the cable to protect the crest of the ramp.

Complete the following checks before operating the portable heavy cargo winch:

- a. Inspect the bolts on the top lifting and lower tiedown rings prior to use to ensure that no threads are showing.
- b. Ensure the winch is securely tied down to the cargo floor. (See Figure 4-42.)
- c. Ensure the oil level in the winch two-speed gearbox is between FULL and ADD. If it is below this level, service with Specification MIL-L-7870 oil.
- d. Ensure winch manual unreeling control knob and control lock are in the engaged (in) position.

4.15.4 Portable Heavy Cargo Winch Operation.

- a. Prior to connecting or disconnecting electrical power to the heavy duty winch, open the following circuit breakers and attach warning tags:
 - (1) For the left side power connection, SERVICE OUTLET LH circuit breakers (all three phases), located on the AC LOAD CENTER, MONITOR AC BUS NO. 2.
 - (2) FWD BUFFET/OUTLET circuit breaker located at FS 607.

- (3) AFT BUFFET/OUTLET circuit breaker located at FS 761.
- b. Ensure the winch is properly connected to the power source; close the circuit breakers and remove the warning tags.
- c. Energize applicable the electrical buses.
- d. Advise the crew members to hold the winch cable taut while the cable is reeled out.
- e. Place the speed selection control switch on the control pendant in the S or F position.

CAUTION

- The IN and OUT buttons on the control pendant are electrically interlocked and shall not be depressed simultaneously. Failure to comply could result in damage to the winch.
- f. Unwind the winch cable by depressing and holding OUT button and signal the crew members to pull on the cable until sufficient cable has been unwound.
 - g. Release OUT button to stop winch.

WARNING

An unserviceable winch cable can be a hazard to the loading crew during winch operation. It could break under load and whiplash resulting in injury to personnel and/or causing severe damage to the airplane structure.

- h. Examine the winch cable to see that it is in a serviceable condition. Replace winch cables if four or more broken wires per strand inch or seven or more broken wires per cable inch are found. Any cable that has three broken wires or less per strand inch or six broken wires or less per cable inch shall be considered serviceable. The maximum number of broken wires shall not occur in any two consecutive inches of cable (e.g., if six wires are broken in one inch of cable, no additional broken wires shall be allowed in the next consecutive inch of cable). Any cable not within the above specified limits shall be replaced. A kink is a short tight bend or twist in the cable which can result in internal cable damage and may require replacement. Examine the cable strands at the kink. If an individual strand shows a sharp bend or deformation, the cable should be replaced. The loadmaster shall determine the degree of kink requiring a cable change.

WARNING

The snatch blocks supplied as loose equipment with the airplane shall not be used due to incompatibility with the diameter of the winch cable on the portable heavy duty cargo winches. Do not exceed heavy duty snatch block rated capacity of 30,000 pounds or 9/16-inch diameter cable size.

- i. When applicable, route the cable through the snatch block and attach the cable hook to the cargo. Proceed to on/off load the cargo.
- j. Ensure that all personnel are clear of the cargo, then on/off load the cargo.
- k. Prior to disconnecting electrical power from the heavy duty winch, open the following circuit breakers and attach warning tags:
 - (1) For the left side power connection, SERVICE OUTLET LH circuit breakers (all three phases), located on the AC LOAD CENTER, MONITOR AC BUS NO. 2.
 - (2) FWD BUFFET/OUTLET circuit breaker located at FS 607.
 - (3) AFT BUFFET/OUTLET circuit breaker located at FS 761.
- l. Remove electrical power from the heavy duty winch, close the circuit breakers and remove the warning tags.

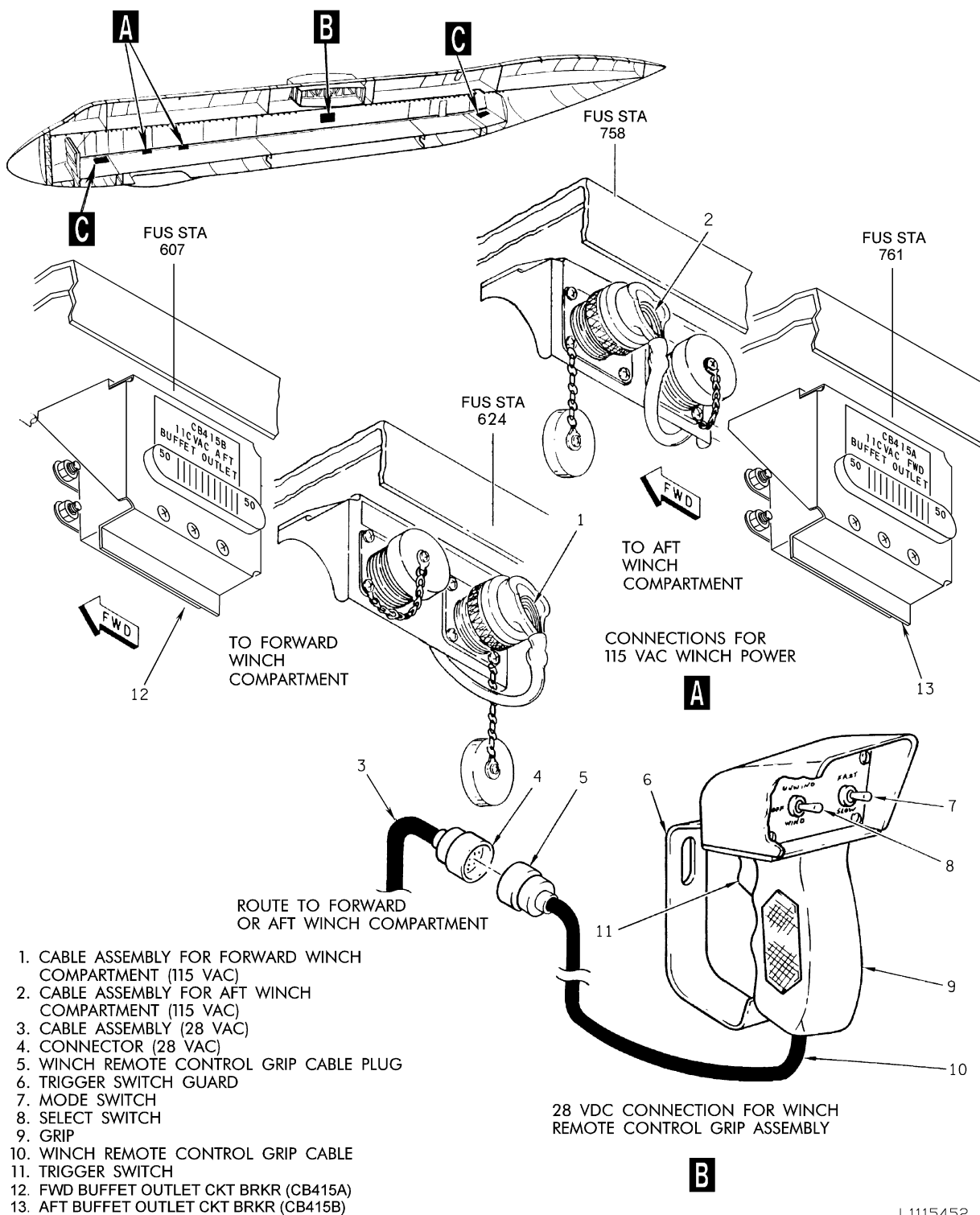
4.16 VEHICLE-MOUNTED WINCH.

4.16.1 External Winching Using a Vehicle-Mounted Winch. For loads that exceed internal winching capability or when adequate internal winching is not available, an external winch will be used to load various types of cargo. A winch mounted on a stationary vehicle must be used for external winching operations. Figure 4-43 shows a typical cable diagram in which the cable is run from the prime mover into the cargo compartment, through a snatch block, and back to the load.

4.16.2 Vehicle Self-Winching. Self winching is preferred to external winching. A vehicle equipped with a winch may be self-winched into the airplane by attaching its winch cable to tiedown chains forming a bridle as shown in Figure 4-45.

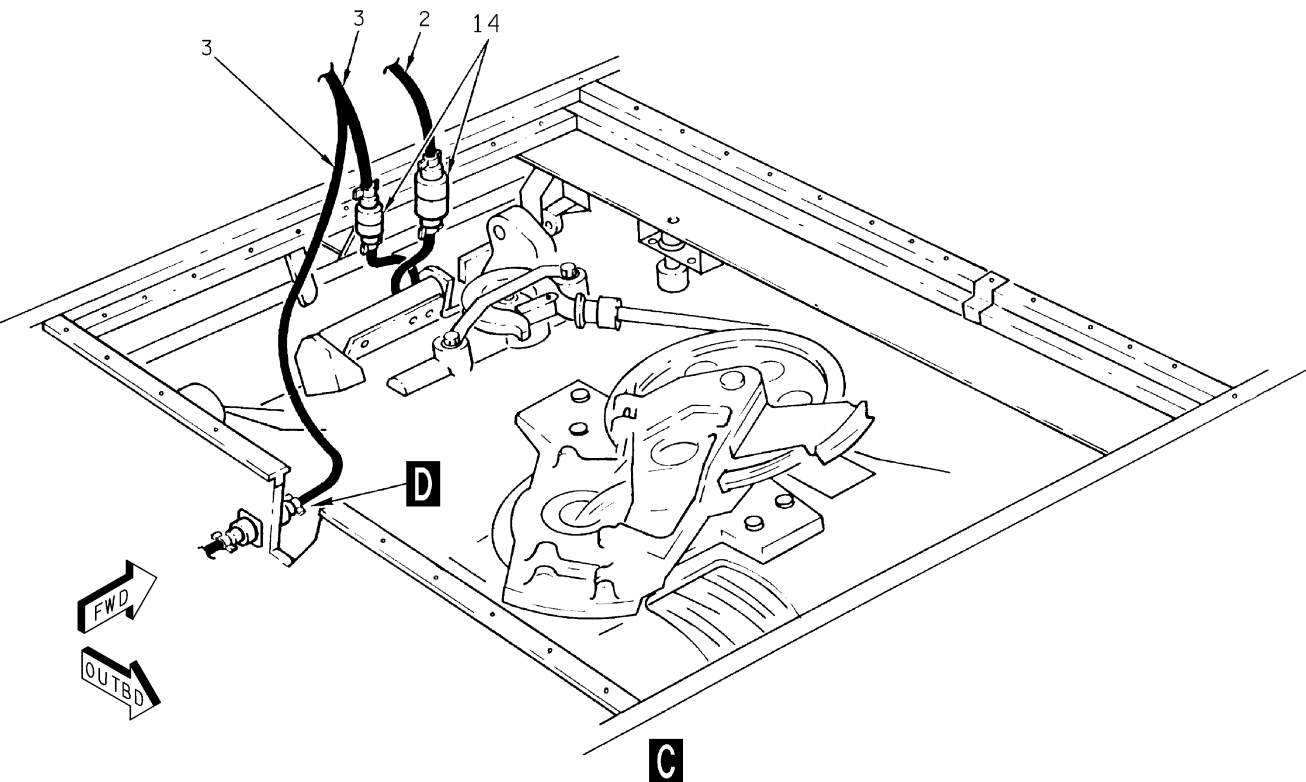
Table 4-6. Calculation of Maximum Cable Pull Versus Ramp Angle and Friction Coefficient

Type of Surface:		Rolling				Sliding				
		Rails (Steel Wheels)	Steel/ Hard Rub- ber Wheels	Con- veyors	Pneu- matic Tires	Tracks	Greased Shor- ing	Dry Shor- ing	Skids on Non- Skid Sur- face	Non- Skid Sur- face
Friction Coefficient:		0.005	0.018	0.020	0.030	0.080	0.260	0.490	0.815	1.000
Configuration	Sine/ Cosine	Constants								
Cargo Compt Floor Forward Kneel (1.3°)	0.0227/ 0.9997	0.028	0.041	0.043	0.053	0.103	0.283	0.513	0.837	1.022
Forward Ramp For- ward Kneel (12.3°)	0.2130/ 0.9770	0.218	0.231	0.233	0.242	0.291	0.467	0.692	1.009	1.190
Aft Ramp Forward Kneel (19.9°)	0.3404/ 0.9403	0.345	0.357	0.359	0.369	0.416	0.585	0.801	1.107	1.281
Forward Ramp Level Kneel (15.7°)	0.2706/ 0.9627	0.275	0.288	0.290	0.299	0.348	0.521	0.742	1.055	1.233
Aft Ramp Level Kneel (14.0°)	0.2419/ 0.9703	0.247	0.259	0.261	0.271	0.320	0.494	0.717	1.033	1.212
Cargo Compt Floor Aft Kneel (2.1°)	0.0366/ 0.9993	0.042	0.055	0.057	0.067	0.117	0.296	0.526	0.851	1.036
Aft Ramp Aft Kneel (10.7°)	0.1857/ 0.9826	0.191	0.203	0.205	0.215	0.264	0.441	0.667	0.986	1.168
Forward Ramp Exten- sion Toes (17.0°)	0.2924/ 0.9563	0.297	0.310	0.311	0.321	0.369	0.541	0.761	1.072	1.249
Aft Ramp Toes (24.0°)	0.4067/ 0.9135	0.411	0.423	0.425	0.434	0.480	0.644	0.854	1.151	1.320
NOTE - Angles are based on level parking ramp. - Constants are calculated as follows: constant = (friction coefficient × cosine of ramp angle) + sine of ramp angle. - Calculate cable pull as follows: cable pull = constant × cargo weight - Calculate winch configuration as follows: winch factor = cable pull ÷ maximum winch pull. - If winch factor is: >0 but ≤1 use a single line >1 but ≤2 use a double line >2 but ≤3 use a triple line										

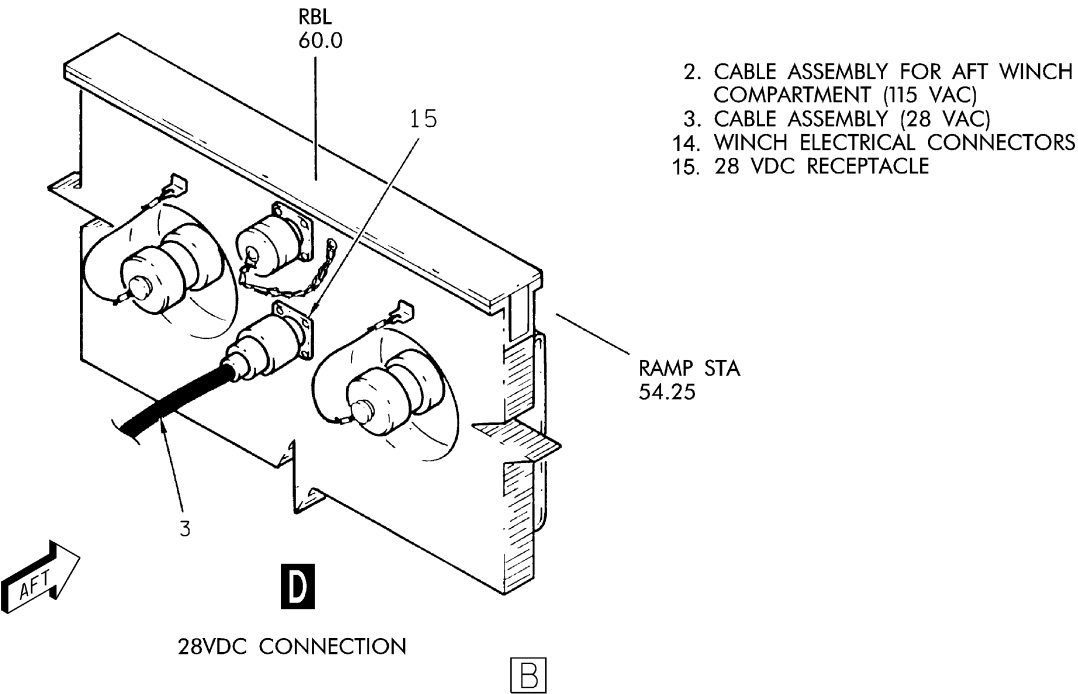


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Figure 4-41. Electric Cargo Winch Components Locations (Sheet 1 of 2)



AFT WINCH COMPARTMENT ELECTRICAL CONNECTIONS
SHOWN, FORWARD WINCH SIMILAR



- 2. CABLE ASSEMBLY FOR AFT WINCH
COMPARTMENT (115 VAC)
- 3. CABLE ASSEMBLY (28 VAC)
- 14. WINCH ELECTRICAL CONNECTORS
- 15. 28 VDC RECEPTACLE

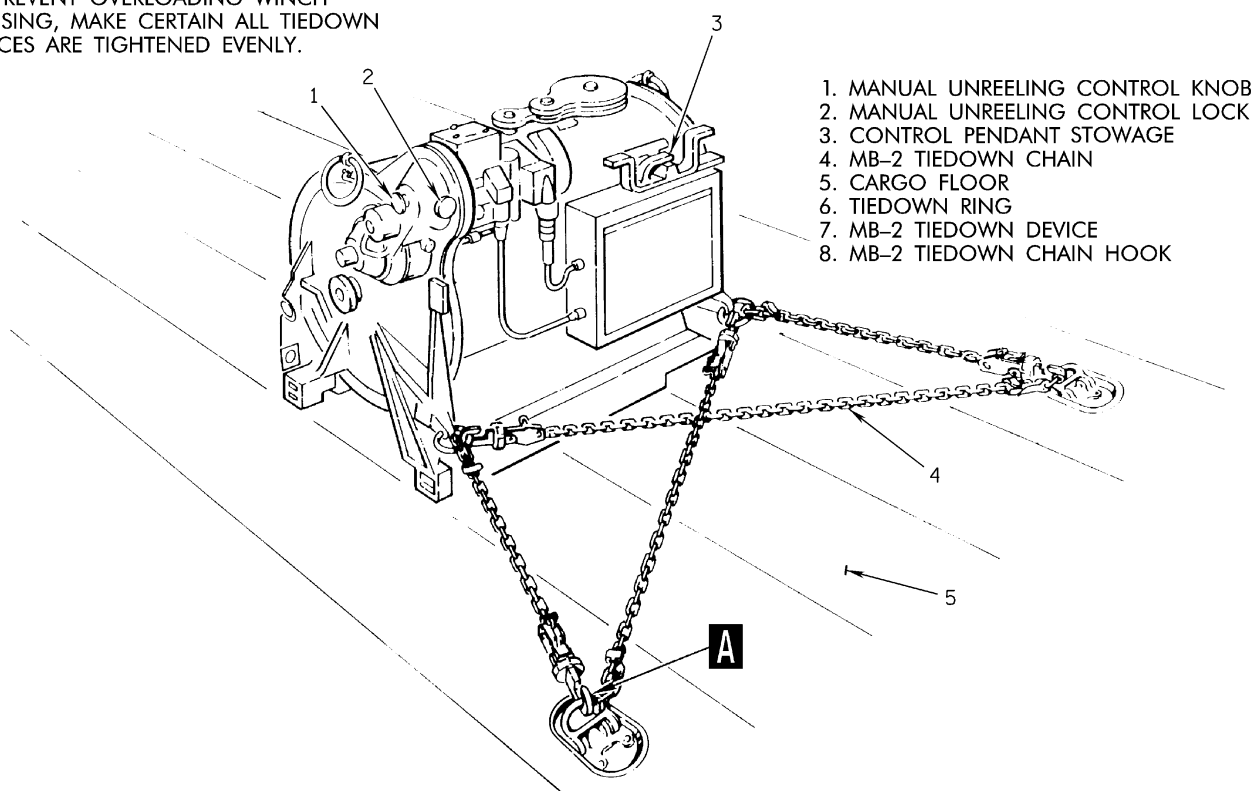
28VDC CONNECTION

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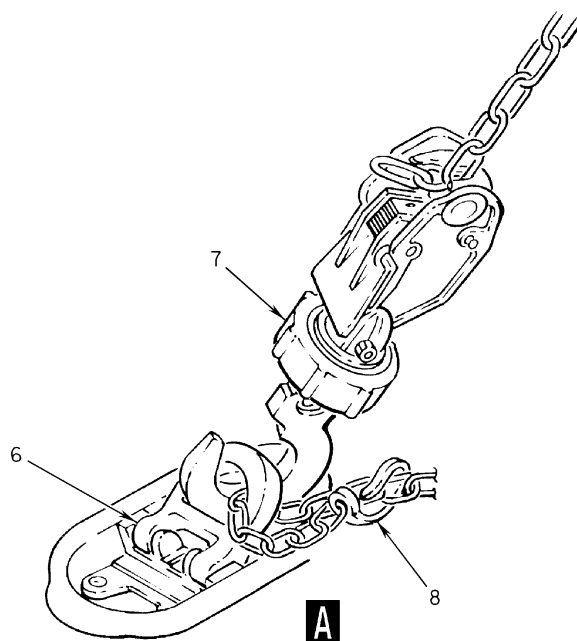
Figure 4-41. Electric Cargo Winch Components Locations (Sheet 2)

CAUTION

TO PREVENT OVERLOADING WINCH HOUSING, MAKE CERTAIN ALL TIEDOWN DEVICES ARE TIGHTENED EVENLY.



TYPICAL TIEDOWN DIAGRAM

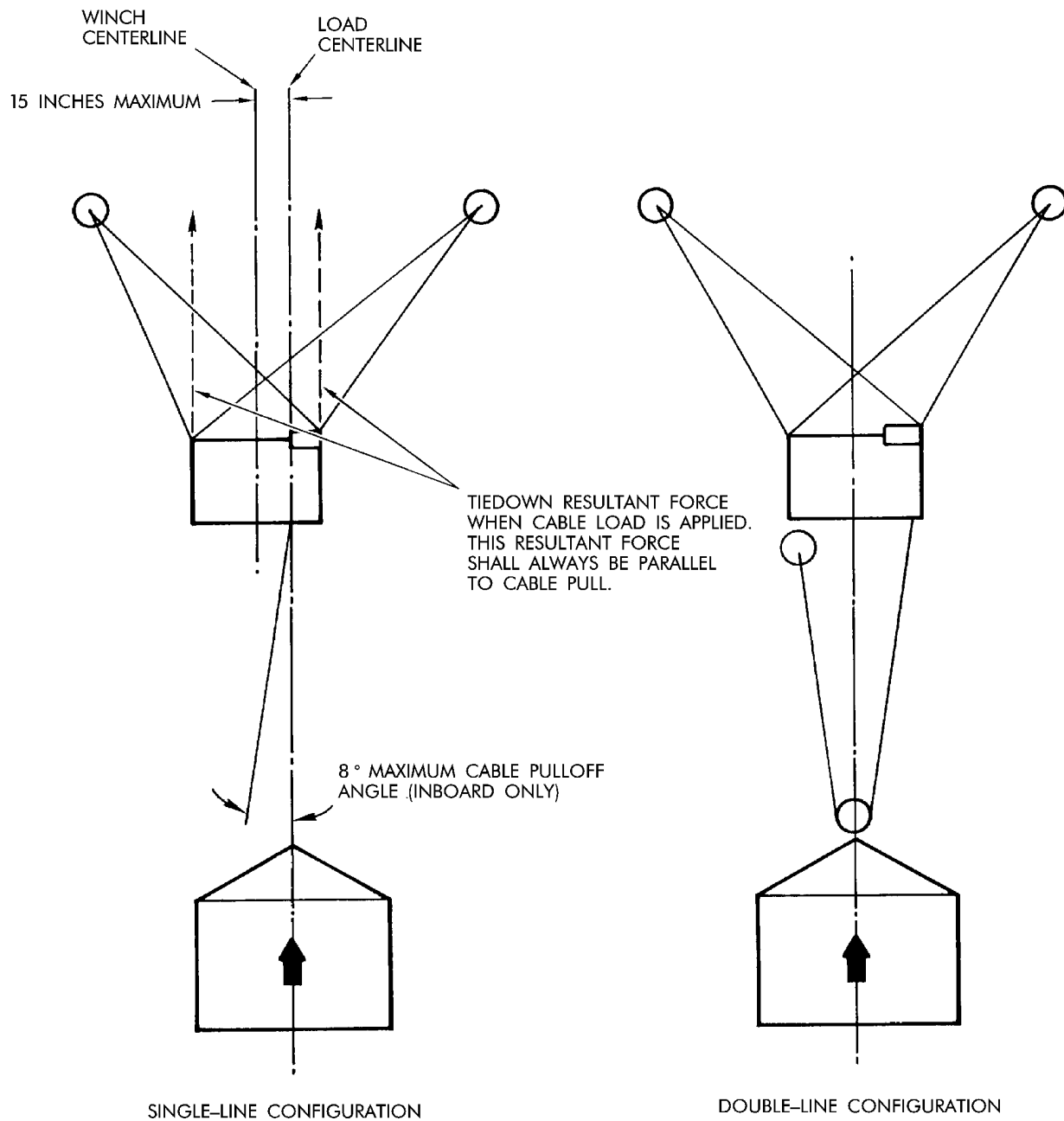


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Figure 4-42. Portable Heavy Cargo Winch Installation and Loading Configuration (Sheet 1 of 2)

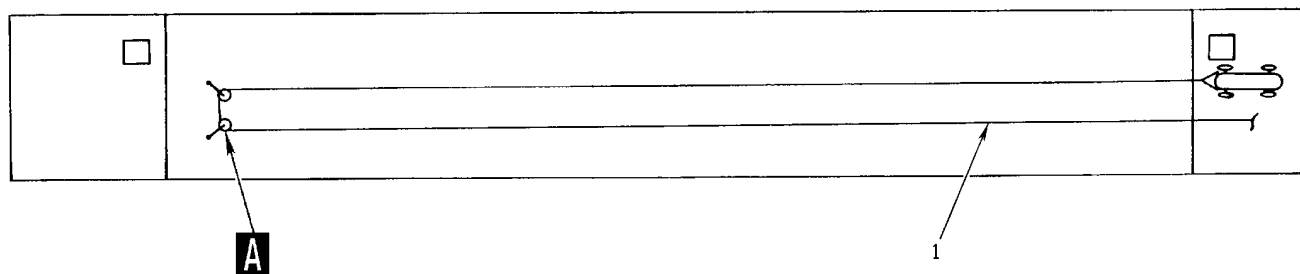
CAUTION

TO PREVENT STRUCTURAL DAMAGE TO WINCH, DO NOT EXCEED 8-DEGREE CABLE PULLOFF ANGLE (INBOARD ONLY).



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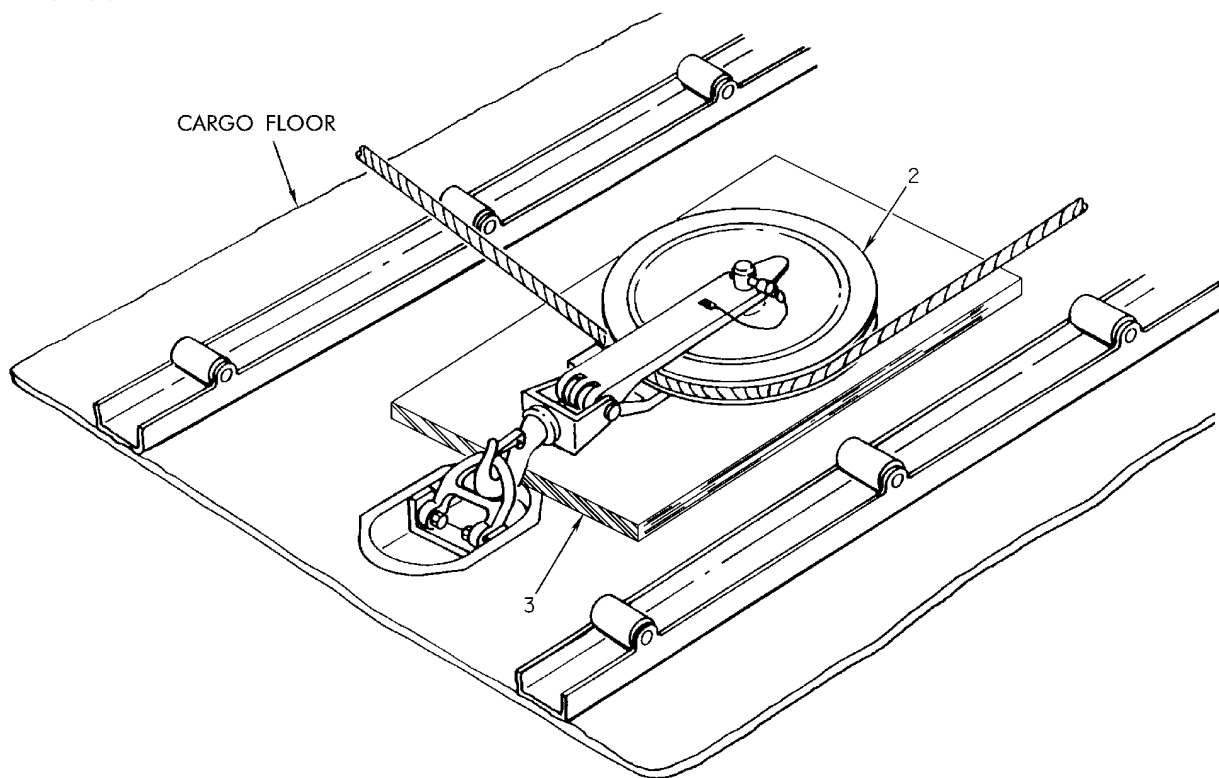
Figure 4-42. Portable Heavy Cargo Winch Installation and Loading Configuration (Sheet 2)



WARNING

IF THE AIRPLANE SNATCH BLOCKS ARE TO BE USED, DO NOT EXCEED THEIR RATED CAPACITY OF 15,000 POUNDS OR 3/8-INCH DIAMETER CABLE SIZE. FAILURE TO COMPLY COULD CAUSE FAILURE OF THE SNATCH BLOCK AND RESULT IN INJURY TO PERSONNEL.

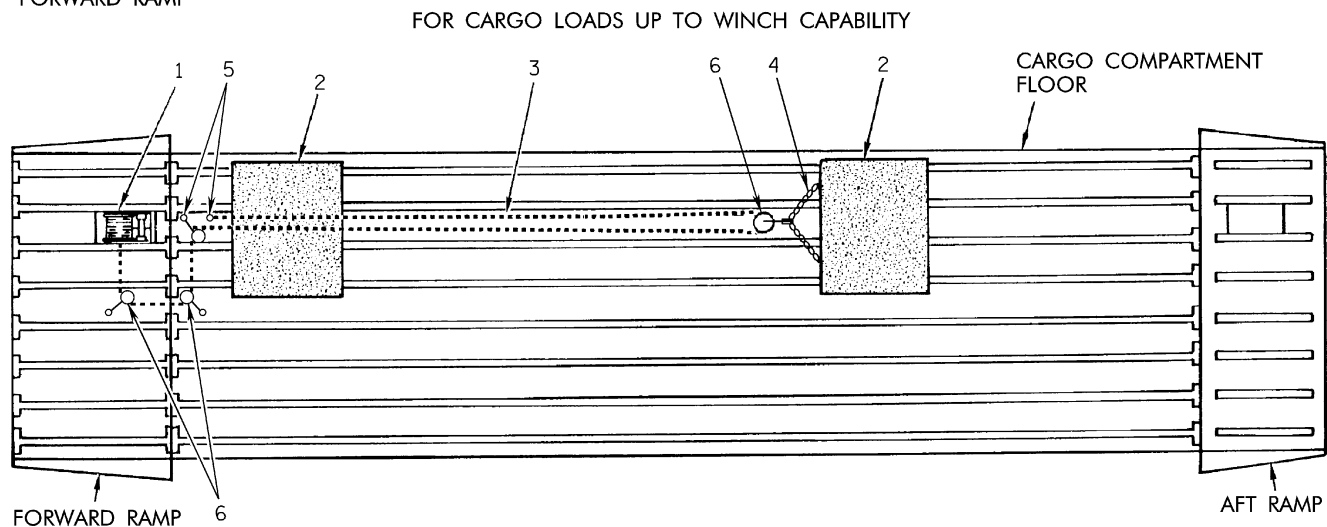
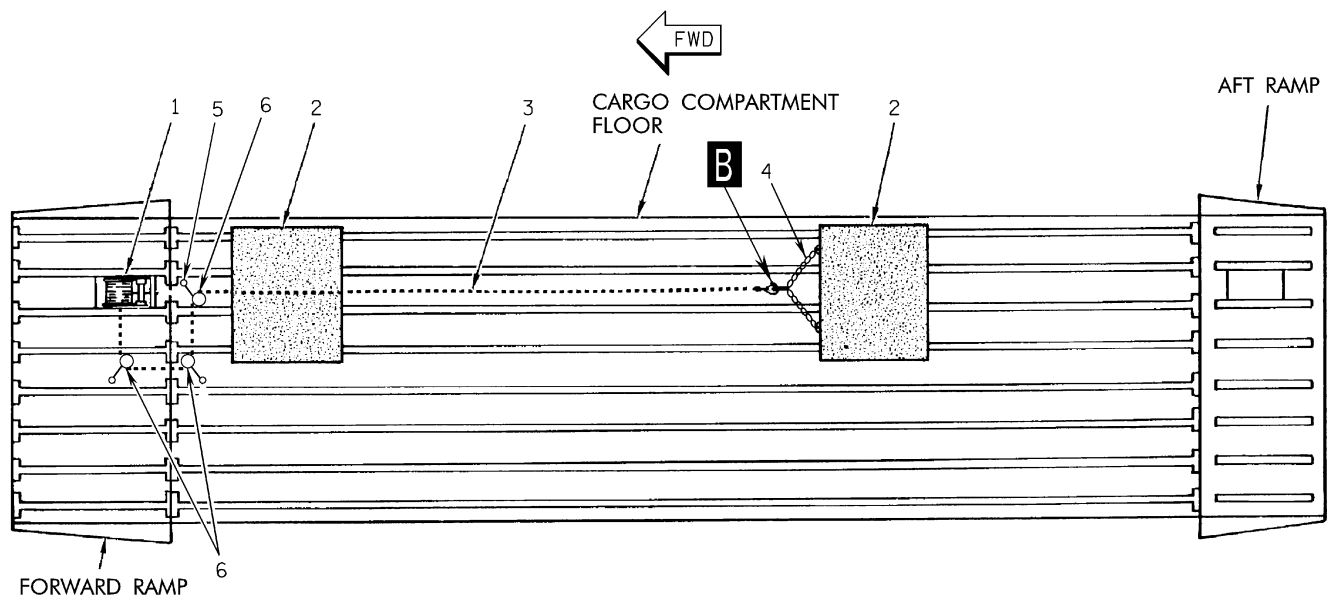
1. EXTERNAL WINCH CABLE
2. SNATCH BLOCK ASSEMBLY
3. SHORING



A
TYPICAL VIEW OF SNATCH
BLOCK ATTACHMENT TO
CARGO TIEDOWN RING

L1115456

Figure 4-43. External Winching Using Vehicle-Mounted Winch



**WINCH LOADING RH SIDE OF CARGO COMPARTMENT
THROUGH AFT CARGO OPENING (WINCH IN FORWARD RAMP)**

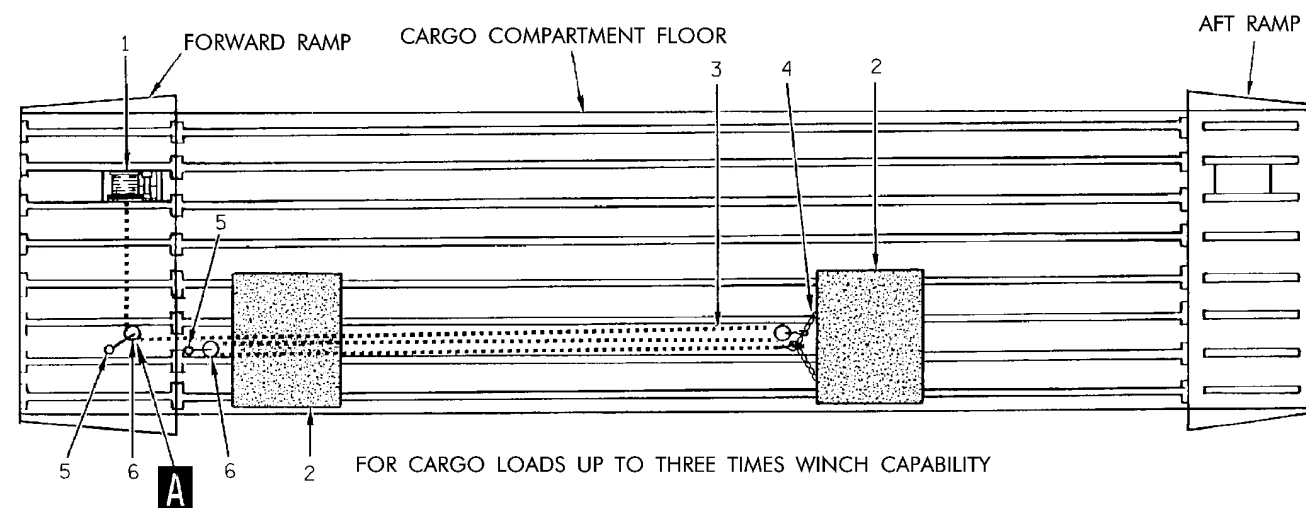
NOTE

IF UTILIZING THE FORWARD WINCH ROUTE THE CABLE 90 DEGREES INBOARD.
THEN USE A SNATCH BLOCK(S) TO ROUTE THE CABLE IN THE NEEDED DIRECTION.

1. CARGO WINCH
2. CARGO LOAD
3. WINCH CABLE
4. TIEDOWN CHAIN BRIDLE
5. CARGO TIEDOWN RING
6. SNATCH BLOCK

L1115457

Figure 4-44. Winch Loading Logistics Cargo (Sheet 1 of 5)

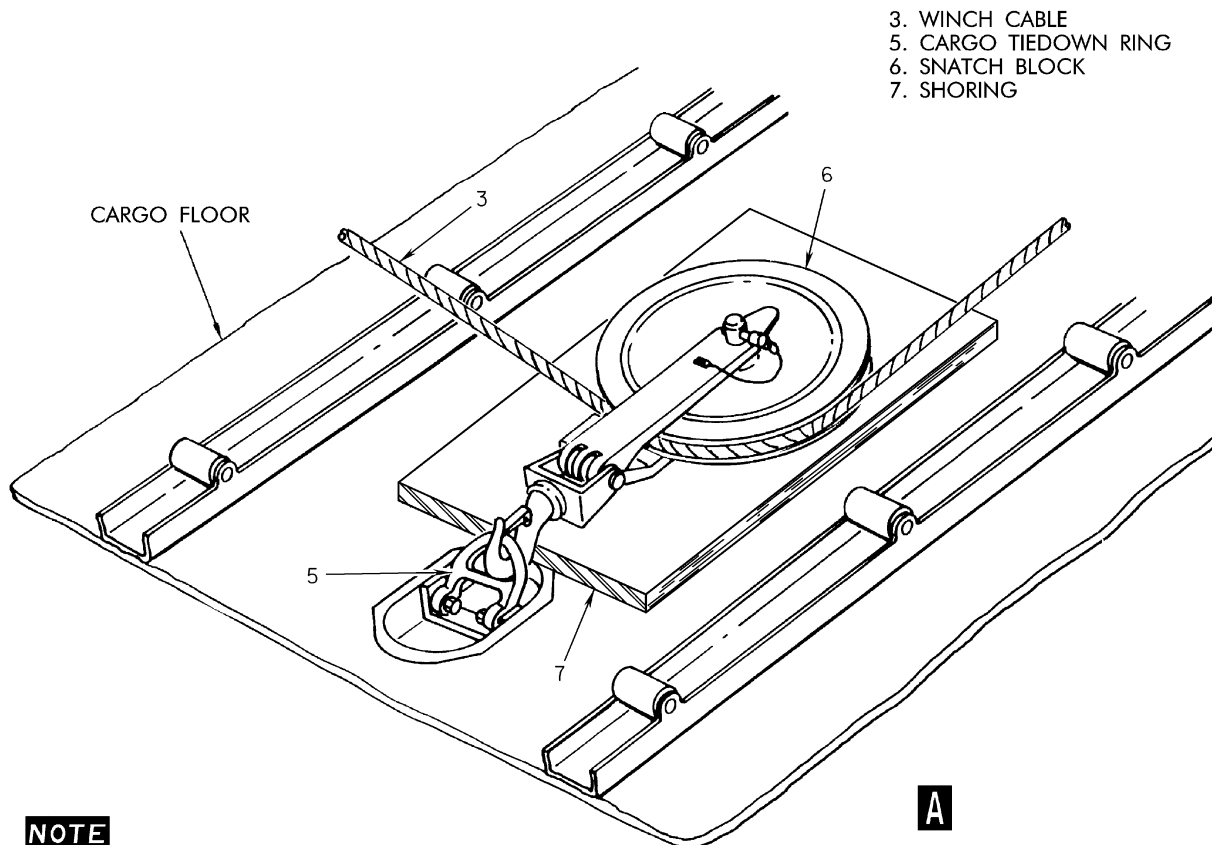


L1115458

Figure 4-44. Winch Loading Logistics Cargo (Sheet 2)

WARNING

IF THE AIRPLANE SNATCH BLOCKS ARE TO BE USED, DO NOT EXCEED THEIR RATED CAPACITY OF 15,000 POUNDS OR 3/8-INCH DIAMETER CABLE SIZE. FAILURE TO COMPLY COULD CAUSE FAILURE OF THE SNATCH BLOCK AND RESULT IN INJURY TO PERSONNEL.

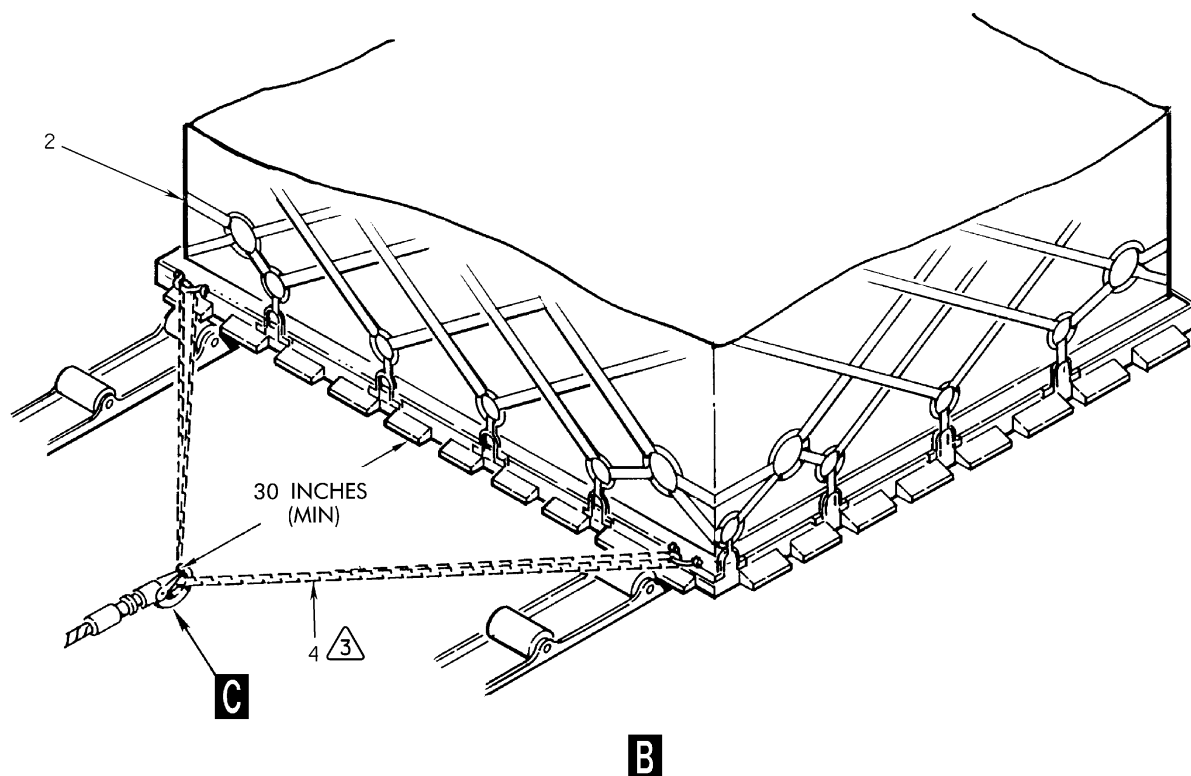
**NOTE**

1. A WINCH CAPABILITY IS 6,500 POUNDS PULL AT 30 FEET PER MINUTE.
- B WINCH CAPABILITY IS 7,500 POUNDS PULL AT 0-15 FEET PER MINUTE.
2. WINCH LOAD THROUGH FORWARD CARGO OPENING (WITH WINCH INSTALLED IN AFT RAMP) USING SIMILAR LOADING METHODS.

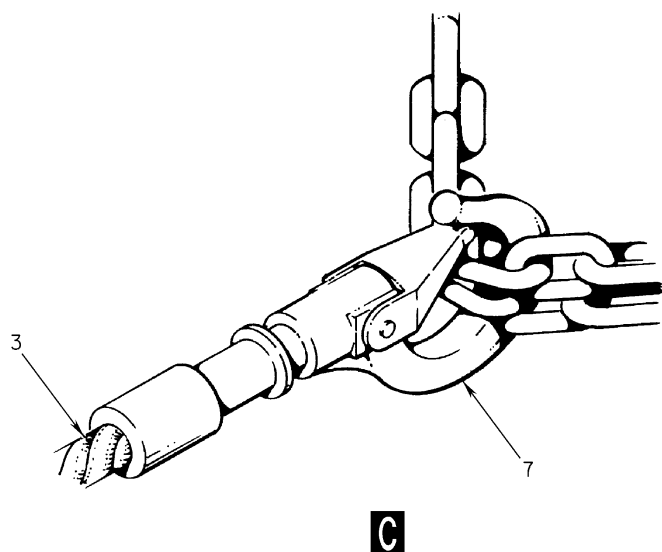
TYPICAL VIEW OF SNATCH BLOCK ATTACHMENT TO CARGO TIEDOWN RING

L1115459

Figure 4-44. Winch Loading Logistics Cargo (Sheet 3)



CARGO WINCH CABLE HOOK CONNECTED TO WINCHING BRIDLE (TWO INBOARD ROLLER CONVEYOR SECTIONS OMITTED FOR CLARITY)



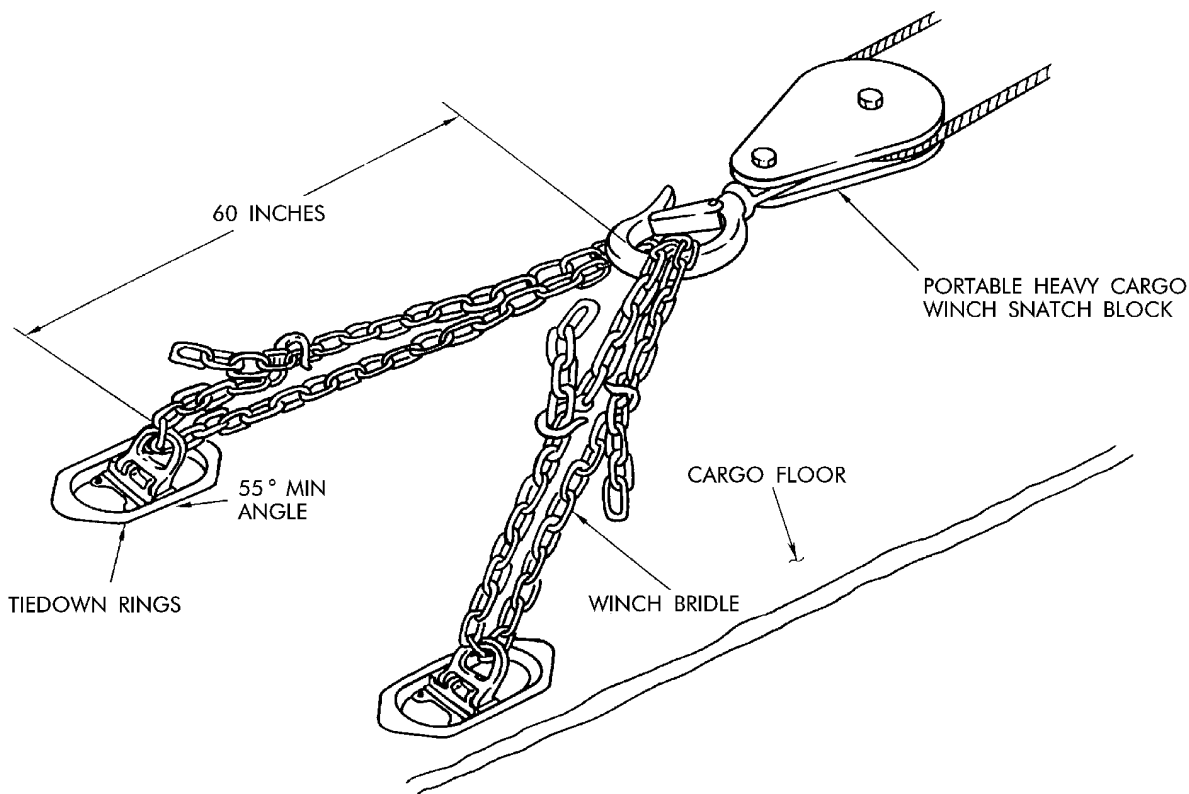
- 2. CARGO LOAD
- 3. WINCH CABLE
- 4. TIEDOWN CHAIN BRIDLE 
- 7. SWIVEL CABLE HOOK

NOTE

 MADE FROM AT LEAST THREE 10,000 POUND TIEDOWN CHAINS ASSEMBLED TOGETHER TO FORM ONE CONTINUOUS CHAIN.

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Figure 4-44. Winch Loading Logistics Cargo (Sheet 4)

**D**

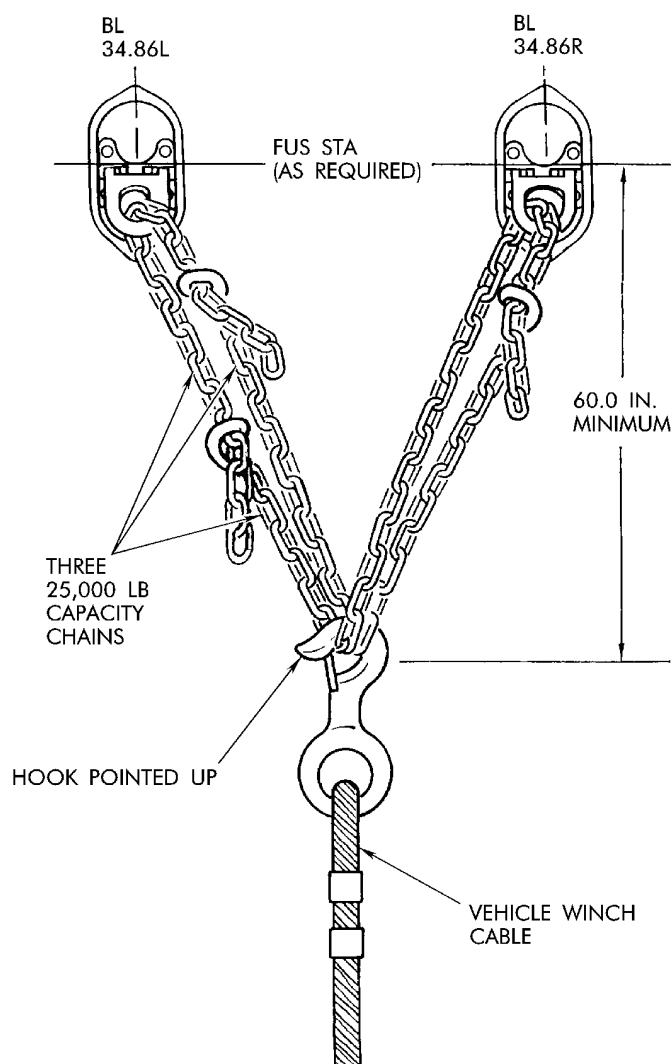
TYPICAL VIEW OF PORTABLE HEAVY CARGO WINCH SNATCH BLOCK ATTACHMENT TO CARGO TIEDOWN RINGS WHEN OPERATING PORTABLE HEAVY CARGO WINCH IN TRIPLE LINE CONFIGURATION, LOW SPEED, 6 FPM, 15,000 POUNDS MODE UNDER LOAD.

NOTE

4. MAKE UP WINCHING BRIDLE AS FOLLOWS:
 - A. ASSEMBLE AND LOCK TOGETHER THREE 25,000 POUND TIEDOWN CHAINS TO FORM ONE CONTINUOUS CHAIN.
 - B. THREAD TIEDOWN CHAIN THROUGH TIEDOWN RINGS ON CARGO FLOOR AND LOCK IN PLACE TO FORM A WINCHING BRIDLE.

L1115461

Figure 4-44. Winch Loading Logistics Cargo (Sheet 5)

**NOTE**

1. ASSEMBLE AND LOCK TOGETHER THREE 25, 000 POUND TIEDOWN CHAINS TO FORM ONE CONTINUOUS TIEDOWN CHAIN.
2. THREAD TIEDOWN CHAIN THROUGH TIEDOWN RINGS ON THE CARGO FLOOR AND LOCK IN PLACE TO FORM A WINCHING BRIDLE.
3. IF THE EXTERNAL WINCH DOES NOT EXCEED 15,000 POUND RATED CAPACITY CONNECT THE WINCH HOOK DIRECTLY TO ONE OF THE 25,000 POUND TIEDOWN RINGS ON THE CARGO FLOOR.
4. HOOK THE WINCH CABLE HOOK AROUND THE WINCHING BRIDLE.

L1115462

Figure 4-45. Bridle for Vehicle Self-Winching

SECTION V LOADMASTER ON/OFF LOADING PROCEDURES

4.17 LOADMASTER LOADING CHECKLISTS.

CAUTION

- Do not on/off load cargo with either of the aft MLG kneeled, unless maintenance stabilizer jacks are installed prior to kneeling the individual main landing gear.
- Any vehicle/item that exceeds the limitations/procedures of this manual shall have the specific approval of WR-ALC/LTET or a letter of air transportability certification from ASC/ENFC or it shall not be airlifted.
- Any time an item of cargo/equipment is temporarily positioned on the aircraft ramp, restraints shall be applied.
- Do not depress the N valve for side cargo door droop while MHE, vehicles and cargo is in the vicinity of the doors. Failure to comply could result in damage to the MHE, vehicles, cargo and aft cargo doors.

This section contains a summary of information presented in other sections to be used for quick reference during on/off loading operations. It is incomplete without the loadmaster checklist contained in TO 1C-5M-1.

4.18 INSPECTION OF CARGO.

See AFMAN 24-204(I), and DTR Part III for additional information.

- a. The aircrew must have visual and physical access to all hazardous materials to mitigate any hazard posed by an in-flight incident. If there is evidence of a leak, the crew-member can locate the hazard, determine the extent of the risk, and take appropriate action to get the leak under control or declare an in-flight emergency.
- b. Users will provide a key or combination for locked, unescorted containers to the aircraft commander or designated representative.
- c. All cargo is subject to inspection by the mobility force inspector and by the aircrew (see DTR Part III). If the cargo is determined by the deploying force to be "sight sensitive" and should be exempt from inspection, prior approval must be obtained from the Air Mobility Command (AMC), Director of Operations (AMC/A3), Director of Logistics (AMC/A4) or the Service/Major Command having operational control of the aircraft.
- d. Exceptions to the above guidelines can be found in AFMAN 24-204.
 - (1) Underwater Construction Team. Military aircraft may ship recompression vans and shelters. Hazardous items have been identified and approved for shipment by AFGLSC 401 SCMS/GUMA.
 - (2) Tactical Shelters. The following may be shipped inside: fire extinguishers in appropriate brackets/holders, support equipment or other mechanical apparatus, items shipped under the PSN "Life Saving Appliances", air conditioners, magnetic material, and thermometers.
- e. Deleted.

4.19 LOAD PLANNING CHECKLIST.

1. Load Plan — CHECKED
 - a. Allowable Cabin Load — DETERMINED
 - b. Zero Fuel CG — CHECKED

Ensure all weights, moments, and CG are accurate.
 - c. Load Sequence — CHECKED

- Load sequence will be based on airplane limitations and offload sequence.
- d. Hazardous Materials and Special Handling — CHECKED
Refer to AFMAN 24-204(I) and AFI 11-2C-5 Vol. 3 Addenda A for detailed hazardous cargo procedures.
 - (1) Size, Weight, Location — CHECKED
 - (2) Shipper’s Declaration for Dangerous Goods and Label(s) — CHECKED
Ensure the appropriate deviations are obtained for transporting passengers, if required.
 - (3) Compatibility and Separation Requirements — CHECKED
 - (4) Refrigerated Material — CHECKED
 - 2. Manifest — CHECKED
 - a. Destination — CHECKED
 - b. Gross Weight — CHECKED
 - c. Customs Requirements — CHECKED
 - d. Hazardous Materials — CHECKEDEnsure manifested hazardous materials agree with Shipper’s Declaration for Dangerous Goods.
 - 3. Cargo Size Limitations — CHECKED
 - 4. Cargo Floor Loading Limitations— CHECKED
 - 5. Lateral Loading Limitations— CHECKED
 - 6. Venting Requirements — CHECKED
 - o Overboard venting of cryogenic liquid storage and transfer tanks
 - o All cryogenic liquid storage and transport airplanes
 - o The shipper is responsible for providing specific venting instructions in the Shipper’s Declaration for Dangerous Goods and for providing the equipment needed to vent the container overboard. Preparation and hookup of the vent system will be accomplished by qualified shipper or aircraft maintenance personnel in accordance with the procedures outlined in TO 37C2-8-1-127. Air Terminal Operations Center (ATOC) prearranges for a qualified person to make the hookup at the desired time. Air terminal personnel and aircraft loadmasters are not qualified to make the hookups.

4.20 GENERAL WINCHING PREPARATION CHECKLIST.



- Only essential personnel are permitted in the cargo compartment during winching operations.
 - Winching is a potentially hazardous operation. Refer to all warnings and cautions in Section IV prior to winch operations.
 - On/off loading cargo during fueling operations is permissible only under certain conditions. Refer to TO 00-25-172 for additional instructions.
 - Use of the winch in the cargo compartment is prohibited during defueling operations.
- 1. Concurrent Operations — COORDINATED (AS REQUIRED)
Check with the Concurrent Service Supervisor prior to winching operations.
 - 2. Winch Preflight — COMPLETED
Refer to Section IV and TO 1C-5M-1 for [A] and [B] conversions and heavy duty portable winches. For other winches, check hook and cable condition and operation.
 - 3. Winch Cable Pull — DETERMINED
Compute cable pull and determine configuration to be used.
 - 4. Snatch Blocks — INSTALLED (AS REQUIRED)

When snatch blocks are attached to the cargo floor, ensure shoring is placed between the snatch block hook and tiedown ring pan receptacle.

5. Chain Bridle — INSTALLED (AS REQUIRED)

WARNING

- Ensure that personnel do not step over the winch cable attached to cargo.
- Crew members and loading crew shall wear work gloves when handling the winch cable.

6. Winch Cable — ATTACHED

When the hook is connected to a cargo floor tiedown ring, ensure that shoring is placed between the hook and the tiedown ring pan receptacle. Draw up the slack in the cable and check all attachment points and snatch blocks for security.

4.21 GENERAL WINCHING CHECKLIST.

1. General Winching Preparation Checklist — COMPLETED

2. Clearance Observers — ASSIGNED/BRIEFED

Assign observers to monitor critical clearances. Brief the observers on all signals to be used.

3. Interphone Communication— CHECKED (AS REQUIRED)

Observers will be on interphone if the configuration or size of the cargo being winched prevents a clear view of all observers by the winch operator, or if excessive noise prohibits verbal communication.

4. Vehicle Driver — BRIEFED (AS REQUIRED)

Brief the driver to follow all signals and not to apply brakes while item is being winched.

WARNING

Personnel shall not stand directly behind any item being winched into or out of the airplane.

5. Steering Yoke — ATTACHED (AS REQUIRED)

Attach a steering yoke by looping strap(s) through the eye of the towbar. The steering yoke should be long enough that personnel steering will not be directly behind or in front of the moving cargo. This method of steering is normally used for trailers or ground support equipment.

6. Cargo Compartment/Cargo — CLEAR

Ensure cargo floor is clear of obstructions and all personnel not involved in winching are well clear. The winch operator will coordinate with the observers, ensure the cargo to be winched is clear, and determine if it is safe to begin winching.

7. Cargo — POSITIONED

Winch cargo into position. If it is necessary to reconfigure the cable prior to reaching the final cargo position, attach safety chains, reconfigure the cable, and recheck all attachment points. Always maintain tension on the winch cable, while reeling IN or OUT, to prevent cable entanglement and snagging.

WARNING

Maintain tension on the cable to prevent a slack cable condition during offloading. A slack cable condition can occur as the cargo goes over the ramp crest, causing the cargo to lunge forward, jerking the cable, causing cable failure.

8. Offloading — ACCOMPLISHED

During offloading, before the load goes over the ramp crest, ensure that all cable slack is removed as follows:

- a. Rewind the cable until all slack is removed and tension is evident on the cable. Then maintain cable tension by gradually unwinding the cable as the cargo goes over the ramp crest.
- b. Offloading with the winch is essentially the reverse of loading.

4.22 PALLETIZED CARGO LOADING CHECKLIST.

WARNING

On/off loading cargo during fueling operations is permissible only under certain conditions. Refer to TO 00-25-172 for additional instructions.

1. Concurrent Operations — COORDINATED (AS REQUIRED)

Check with the Concurrent Service Supervisor prior to starting loading operations.

CAUTION

A close inspection shall be accomplished to ensure floor tiedown rings are stowed, roller conveyors are locked in position, and locking detents are retracted. Failure to comply could result in damage to the rails, locks, roller conveyors, and pallets.

2. Airplane Configuration — CHECKED

Ensure the rail system is prepared for pallet loading and the cargo floor is clear of obstructions.

WARNING

The on/off loading of cargo with a forklift is prohibited with the airplane in the unkneeled position.

3. Loading Vehicle — POSITIONED

- a. Chocks — POSITIONED

CAUTION

Ensure clearances are maintained when mating K-loaders head-on to the left side of the aft ramp when the loader cab is attached to the movable bed.

- b. Critical Clearances — MONITORED
- c. Brakes — SET

4. Netted Pallets — INSPECTED

- a. Pallet Identifier—CHECKED
Compare the load plan with the pallet identifier.

WARNING

Pallets and nets with missing tiedown rings, exposed deteriorated wood core, extreme delamination, nets with missing ring, hooks, or damaged/missing webbing shall not be loaded. A damaged pallet or net cannot maintain restraint requirements and is a flight safety hazard.

CAUTION

Ensure all pallets are free of excessive water, ice, and snow.

NOTE

It is not acceptable to take a pallet that has been rejected for airlift (missing rings, delaminated, etc.) and place it on top of another pallet to airlift it. If the pallet has been rejected for airlift, it shall not be used in any way to support cargo.

- b. Condition of Pallet and Nets— CHECKED
Ensure all pallets are free of excessive mud, dirt, and oil.

WARNING

Top net fastening devices (hooks) shall not be connected to the side net webbing, the pallet tiedown rings, or the bottom row of side net rings. Top net fastening devices shall not be routed under the side net webbing and then back up to a side net ring. Netted cargo shall not be loaded into the airplane until the fastening devices are properly connected. Improperly rigged nets will not provide required restraint and are a matter of flight safety.

- c. Security of Nets — CHECKED
Side nets shall be hooked to all pallet rings. Top nets and straps shall be hooked to rings on the highest possible level above the bottom row of rings on the side nets.

NOTE

When the cargo weight exceeds 2,500 pounds, or the height exceeds 45 inches, the top net shall only be used for vertical restraint. Supplemental straps or chains and devices shall be used to provide all restraint for forward, aft, and lateral directions. Supplemental restraint must be totally attached to the pallet or to the cargo floor. Attaching restraint to a mix of pallet rings and cargo floor rings is not authorized.

- d. Low Profile Cargo — RESTRAINED (AS REQUIRED)
 - (1) Cargo weight does not exceed 2,500 pounds.
 - (2) Cargo height does not exceed 45 inches from top of pallet.
 - (3) All hooks are serviceable and attached to pallet rings.

CAUTION

All pallets shall be inspected prior to loading to ensure the maximum width of 104 inches of usable area of the pallet is not exceeded, and that there are no lateral projections or lateral overhang that could damage the aircraft pressure door seals, side sloping longeron panels, forward ramp actuators, and the airplane logistics rail system.

- e. Dimensions — CHECKED
The height of cargo weighing 10,000 pounds on a single pallet secured with nets is limited to 96 inches and 100 inches for cargo weighing 8,000 pounds.
- f. Ramp Pallets — CHECKED

Pallets to be loaded in positions 1, 2, 35, and 36 shall have a 14-inch aisle on the outboard edge and not exceed 7,500 pounds gross weight each. Additionally, pallets loaded in positions 35 and 36 shall be limited to a maximum height of 70 inches at the aft edge of the pallet.

- g. Small Wheeled and Skidded Cargo— CHECKED

These items should be restrained separately to the pallet in addition to the use of the nets.

- h. Hazardous Cargo — CHECKED

Refer to AFMAN 24-204(I) and AFI 11-2C-5 Vol. 3 Addenda A for detailed hazardous cargo procedures.

- (1) Size, Weight, and Location Limitations — CHECKED
- (2) Shipper's Declaration for Dangerous Goods and Label(s) — CHECKED
- (3) Compatibility and Separation Requirements — CHECKED

- i. Roller Load Limitations — CHECKED

5. Pallet Train and Unnetted Pallets — INSPECTED

- a. Pallet Identifier — CHECKED

Compare load plan with pallet identifier.

- b. Center of Balance — CHECKED

If it is not possible to determine the weight per pallet for cargo loads that span more than one pallet, the combined weight shall be provided and the calculated CB will be marked on the shipment.

- c. Pallet Rings and Couplers— CHECKED

- d. Dimensions — CHECKED

To ensure vertical clearance when near the cargo compartment sidewall, position palletized cargo with an outboard height of 108 inches or greater or with lateral overhang, out of the logistics restraint rail system. Do not exceed 108 inches above the surface of the pallet when loaded through the aft doors or 156 inches when loaded through the forward doors.

- e. Roller Load Limitations — CHECKED

- f. Hazardous Cargo — CHECKED

Refer to AFMAN 24-204(I) and AFI 11-2C-5 Vol. 3 Addenda A for detailed information on hazardous cargo procedures.

- (1) Size, Weight, and Location Limitations — CHECKED
- (2) Shipper's Declaration for Dangerous Goods and Label(s) — CHECKED
- (3) Compatibility and Separation Requirements — CHECKED

CAUTION

Restraint locks shall not be used as pallet stops. Failure to comply could result in damage to the lock mechanisms.

6. Pallet Stops — AS REQUIRED

Pallet stops will be positioned as determined by the loadmaster.

WARNING

Any pallet(s), single or multiple, weighing 15,000 pounds or more shall be restrained when on/off loading by use of the airplane winch, when the airplane is in either the forward or aft kneeled position. Pallets weighing less may be restrained at the option of the loadmaster in consideration of the number of loading personnel available for manual restraint, nature of the cargo, adverse floor angle, etc.

CAUTION

If palletized cargo cannot be manually on loaded and the cargo winch is required for loading, the pallets shall be loaded out of the rail system, unless it can be positively determined that the weight of the pallet(s) is the only factor preventing its movement into the rail system.

7. Winch Pallets — AS REQUIRED

WARNING

When rolling pallets into the airplane, avoid excessive speed.

8. Pallets — POSITIONED

WARNING

A minimum of one pair of logistic restraint lock mechanisms shall be operative and engaged for restraint of palletized cargo (one inboard and one outboard). Chains or other devices shall not be substituted unless a symmetrical pattern can be obtained.

NOTE

Outboard logistic rail mechanisms with broken or missing cables may be used to restrain pallets provided the detents are locked in their overcenter (locked) positions, using locking tees locally manufactured and installed in accordance with Chapter 2.

9. Locks and Vertical Restraint Lips — ENGAGED

Ensure all detents are engaged, all required retractable lips are extended, and lip pins engaged. When pallet trains are loaded, ensure all lips and detents are engaged for the leading pallet. All of the remaining detents for the additional pallets will be engaged, if possible. When sufficient detents can not be engaged to provide the necessary restraint, tiedown chains and devices shall be used.

10. Cargo Restraint — COMPUTED/CHECKED

NOTE

When the loading operation is complete, accomplish the After Loading Checklist in TO 1C-5M-1CL-4.

4.23 VEHICLE INSPECTION CHECKLIST.

1. Vehicle — INSPECTED

- a. Soil Contamination and Pests— CHECKED
- b. Fluid Leaks — CHECKED
- c. Condition of Tires or Tracks— CHECKED

Check condition of tires and track pads and remove any foreign objects in tires or tracks. Shoring is required for track pads not covered with rubber or with excessive wear to the rubber pads which could result in the steel grousers bottoming out.

- d. Tanker Type/Fire Fighting Vehicles — CHECKED

Check for the presence of liquids. Tanker type vehicles (trailer or self-contained) are not normally certified as air transportable in a loaded configuration (liquid in tank). The structural integrity of most tanker type vehicles does not meet the design criteria to withstand the g forces encountered during flight. (Exceptions: The M-149A2 water trailer has been certified for airlift, provided the tank is no more than 3/4 full and the manhole cover is secured with tiedown straps. Fire fighting vehicles are certified for transport with up to 150 gallons of AFFF (foam agent) in the tank.)

- e. Shipper's Declaration for Dangerous Goods and Label(s) — CHECKED/ATTACHED (AS REQUIRED)
- f. Loose Equipment and Secondary Cargo — CHECKED/SECURE
Check that all loose equipment and secondary cargo is properly secured to the vehicle and shall meet the same restraint criteria required for the vehicle. Use a minimum of 1/2-inch diameter rope (not nylon) for cargo restraint. Consider all locally manufactured modifications as secondary cargo.
- g. Battery — CHECKED/SECURE
- h. Filler Caps — CHECKED
Ensure fuel, oil, and any other appropriate filler caps are tight and secure.
- i. Fuel Levels — CHECKED
Verify that fuel levels in vehicles/items are within AFMAN 24-204(I) limitations.
 - (1) Units that are susceptible to fuel spills or leakage shall be drained for movement.
 - (2) Vehicles/items loaded on the cargo ramp shall be positioned so the filler openings are on the high side of the ramp.
 - (3) LPG or compressed gas powered vehicles must have the gaseous fuel completely emptied from the pressurized vessel (fuel tank), lines and regulator for transportation by Channel, SAAM, or Tactical/Contingency Airlift. The tanks must be securely closed but purging is not required.
 - (4) Tactical and contingency airlift in accordance with AFMAN 24-204(I), Chapter 3.
 - (a) Vehicles and self-propelled units shall not exceed 3/4-tank capacity when placed on the airplane cargo floor, and 1/2-tank capacity when loaded on the cargo ramp.
 - (b) Wheeled engine-powered support equipment.
 - 1 Do not exceed one-half full tank.
 - 2 Palletized units shall be drained.
 - 3 Equipment mounted on a single axle disconnected from its prime mover and loaded with the tongue resting on the airplane floor must be drained (purging is not required).
 - (c) Non-wheeled engine-powered support equipment (palletized or unpalletized) must be drained (purging is not required).
 - (d) Vehicle-mounted bulk fuel tanks.
 - 1 Servicing trucks, trailers, and semitrailers containing bulk fuel (flash point of less than 38 °C) or bulk hazardous materials must be drained and purged.
 - 2 Servicing trucks, trailers, and semitrailers containing bulk fuel (flash point of 38 °C or greater) or bulk hazardous materials must be drained (purging is not required).
 - (e) Helicopter (and other aircraft) fuel tanks shall not exceed 150 gallons per tank, or 3/4-full per tank whichever is less, when units are loaded on the cargo floor. For units loaded on the cargo ramp, each fuel tank shall not be more than one-half full.
 - (5) Airlift in accordance with AFMAN 24-204(I), Attachment 13, for other than tactical and contingency operations.
 - (a) Vehicles and self-propelled units will not exceed 1/2-tank capacity. Tanks must be securely closed.
 - (b) Engine-powered support equipment (wheeled or non-wheeled):
 - 1 Must be drained.
 - 2 Up to 17 ounces (500 ml) of fuel may be left in engine components and fuel lines provided all lines and caps are securely closed to prevent leakage.
 - 3 Purging is not required unless directed by the applicable technical manual.
- j. Trailer Forward Support Leg(s)/Wheel(s) — SECURED
Ensure forward support legs or wheels are positioned and secured as required for upload.

- 2. Vehicle Weights — CHECKED
 - a. Gross Weight — CHECKED
 - b. Vehicle(s) CB (Loaded or Empty)— CHECKED
 - c. Axle Weights — CHECKED
 - d. Wheel Weights — COMPUTED
- 3. Geometric Considerations— CHECKED

NOTE

Consider the removal and stowage of equipment on vehicles (antennas, hooks, etc.) to eliminate or reduce the need for approach or step-up shoring.

- a. Vehicle Size Limitations— CHECKED
- b. Loading Overhang Limits — CHECKED
- c. Vehicle Projection Limits— CHECKED
- d. Ramp Crest Limits — CHECKED
- e. Parking Overhang Clearance Limits — CHECKED
- 4. Structural Considerations— CHECKED
 - a. Forward/Aft Ramp On/Off Loading Limitations — CHECKED
 - b. Rolling Shoring Requirements— COMPUTED (AS REQUIRED)
 - c. Cargo Floor Loading Limitations— CHECKED
 - d. Concentrated Floor Loads— CHECKED
 - e. Hard Rubber Tire and Steel Wheel Limitations — CHECKED
 - f. Lateral Loading Limitations— CHECKED
 - g. Parking Shoring Requirements— COMPUTED (AS REQUIRED)
 - h. Sleeper Shoring Requirements— COMPUTED (AS REQUIRED)

4.24 VEHICLE LOADING CHECKLIST.

WARNING

On/off loading cargo during fueling operations is permissible only under certain conditions. Refer to TO 00-25-172 for additional instructions.

- 1. Concurrent Operations — COORDINATED (AS REQUIRED)
Check with the Concurrent Service Supervisor prior to starting loading operations.
- 2. Airplane Configuration — CHECKED
 - a. Doors and Ramps — CONFIGURED (AS REQUIRED)
 - b. Cargo Floor — CONFIGURED/CLEAR (AS REQUIRED)
 - c. Loading Aids — POSITIONED (AS REQUIRED)

WARNING

Proper ventilation of the airplane shall be provided when on/off loading self-propelled vehicles. Personnel shall not be permitted to remain on the flight deck or in the troop compartment during multiple vehicle on/off loading unless the auxiliary ventilation system is operating. Exposure to carbon monoxide will produce adverse effects that may prove fatal to personnel.

- d. Ventilation — CHECKED

Open the troop doors, the No. 6 service door, and the opposite cargo loading doors if operationally feasible. If multiple vehicle on/off loading is to be accomplished and personnel are to remain in the upper deck area, ensure the auxiliary ventilation system is operating and the flight station ladder door is closed.

- 3. Vehicle Inspection Checklist— COMPLETED
- 4. Vehicle Driver(s) — BRIEFED
 - a. Hand Signals — BRIEFED
 - b. Transmission — LOW GEAR/LOWEST RANGE/ALL WHEEL DRIVE (AS APPLICABLE)
- 5. Engine and Brakes — CHECKED
Check vehicle engine and brakes for proper operation prior to loading.
- 6. Critical Clearance Observers— BRIEFED/POSITIONED
- 7. Shoring — POSITIONED (AS REQUIRED)



If slippery ramp conditions exist, the cargo winch shall be used.



- The ground clearance of single axle trailers will change when towed during loading. Contact could occur in the area of the ramp hinge/toes resulting in damage to the airplane/trailer.
 - Care must be taken to not turn a tracked vehicle while transiting the cargo ramps.
 - The use of aft ramp pedestal shoring is prohibited unless directed by TO 1C-5M-9-2. Approach shoring or step-up shoring used during on/off loading with the aft ramp shall be placed on top of the ramp structure.
- 8. Vehicle — LOADED
 - a. Load Plan — CHECKED
 - b. Brakes and Transmission — SET
Place vehicles with automatic transmissions in park. Diesel-powered vehicles with automatic transmissions without park, or standard transmissions, place in neutral. Place gasoline-powered vehicles with standard transmissions in lowest gear.
Place vehicles with automatic transmissions in park. Diesel-powered vehicles with automatic transmissions without park, or standard transmissions, place in neutral. Place gasoline-powered vehicles with standard transmissions in lowest gear.
 - c. Ignition — OFF
 - d. Safety Chains — INSTALLED
Install a minimum of one chain and device each for both forward and aft restraint.
 - e. Driver — RELEASED
 - 9. Restraint — COMPUTED/APPLIED
One person should be assigned to supervise the application of restraint.

NOTE

When the loading operation is complete, accomplish the After Loading Checklist in TO 1C-5M-1CL-4.

4.25 CARGO OFFLOADING CHECKLIST.

1. Airplane Configuration — CHECKED
Perform applicable portions of TO 1C-5M-1CL-4 checklist.
2. Offloading Equipment — POSITIONED
3. Ventilation — AS REQUIRED

WARNING

When offloading a vehicle, the operator shall be in position at the controls prior to removing final fore and aft restraint.

CAUTION

Do not remove all cargo tiedowns from pallet(s) prior to offloading.

4. Tiedowns/Forward Support Leg(s)/Wheel(s) — REMOVED/SECURED
Ensure the tiedowns are removed from vehicles before offloading from the airplane. Retain safety chains on vehicles which are not being immediately offloaded. Ensure forward support leg(s)/wheel(s) is up and secure.
5. Vehicle Driver(s) — BRIEFED
 - a. Hand Signals — BRIEFED
 - b. Transmission — LOW GEAR/LOWEST RANGE/ALL WHEEL DRIVE (AS APPLICABLE)
6. Engine and Brakes — CHECKED
Check vehicle engine and brakes for proper operation prior to offloading.
7. Winch — AS REQUIRED
Before a vehicle (other than self-propelled) is allowed to pass down the airplane ramps, a restraining cable must be attached to prevent these items from rolling/skidding uncontrolled out of the airplane.
8. Cargo — OFFLOADED

4.26 PERSONNEL LOADING CHECKLIST.**NOTE**

- When passenger stairs are available at a location, personnel shall not be loaded via the crew entrance door unless they are to be seated in the courier compartment. Extreme care must be exercised when passenger stairs are not available and the crew entry door is used. A clear aisle must be available from the crew entry door to the troop compartment ladder. Passengers shall not carry articles up the crew entry door ladder so both hands may be free to use the handrails. Alternate means of boarding personnel must be considered before utilizing the crew entry door.
- C-5 Galaxy Service Stairs may be used with the airplane in unkneeled, forward or level kneeled position. Wollard or Stiner stairs may only be used while the airplane is in the unkneeled position. There is a 25 knot wind limit for the use of the C-5 Galaxy Service Stairs and a 35 knot wind limit for use of the Wollard or Stiner stairs.

1. Airplane Configuration — CHECKED
2. Scanner — POSITIONED
3. APU/ATM — TURNED OFF
Turn off the APU/ATM on the side the passengers are loaded.
4. Brake Switch — EMER

- 5. Parking Brakes — SET
- 6. Personnel — LOADED/SEATED
- 7. Manifest — CHECKED
- 8. Personnel Briefing — COMPLETED
Brief personnel as required by current directives.
- 9. Baggage/Loose Equipment — SECURED
Ensure all hand held baggage is stowed under seats and loose equipment is secured.

4.27 PERSONNEL OFFLOADING CHECKLIST.

NOTE

- When passenger stairs are available at a location, personnel shall not be offloaded via the crew entrance door unless they were seated in the courier compartment. Extreme care must be exercised when passenger stairs are not available and the crew entry door is used. A clear aisle must be available from the crew entry door to the troop compartment ladder. Passengers shall not carry articles down the crew entry door ladder so both hands may be free to use the handrails. Alternate means of offloading personnel must be considered before utilizing the crew entry door.
 - C-5 Galaxy Service Stairs may be used with the airplane in unkneeled, forward or level kneeled position. Wollard or Stiner stairs may only be used while the airplane is in the unkneeled position. There is a 25 knot wind limit for the use of the C-5 Galaxy Service Stairs and a 35 knot wind limit for use of the Wollard or Stiner stairs.
- 1. Airplane Configuration — CHECKED

Position the airplane doors and ladders as required and ensure the cargo floor is clear of obstructions.
 - 2. Personnel — OFFLOADED

CHAPTER 5

EMERGENCY PROCEDURES

5.1 SCOPE.

This section covers the emergency procedures for cargo during ground operations. The section also covers the ground preparation for emergency in-flight jettison of logistics cargo loaded on pallets, or ADS cargo loaded on airdrop platforms and restrained by the logistics restraint rail system.

The in-flight emergency procedures and the procedures for emergency in-flight jettison of logistics cargo and ADS cargo are included in TO 1C-5M-1, as are the emergency procedures for the evacuation of personnel on the ground and the emergency evacuation of personnel after ditching.

5.2 EMERGENCY EXITS.

Refer to Chapter 2 of this manual for information on the emergency exits.

5.3 EMERGENCY PROCEDURES DURING ON/OFF LOADING OPERATIONS.

5.3.1 Fire During On/Off Loading Operations. Should fire occur in any item of cargo that is aboard the airplane during on/off loading operations, proceed as follows:

1. Personnel — EVACUATED

Warn the loading crew of the danger and direct the evacuation of the airplane. If in interphone contact with the loading crew, announce "EVACUATE AIRPLANE."

2. Fire Department — NOTIFIED

Notify the fire department by any available means.

3. Airplane Systems — OFF

Shut down all operating airplane systems.

WARNING

If flammable or explosive materials are on board, unload these items first. Failure to comply could result in spread of fire or explosions that could result in serious injury.

4. Immediately Remove Fire Source From Airplane — COMPLETED (IF EASILY ACCESSIBLE)

If the fire source is removable, and easily accessible, immediately remove from the airplane.

5. Extinguish Fire — COMPLETED (AS REQUIRED)

If possible, try to put out the fire with the aboard portable fire extinguishers or by the use of the Fire Suppression System.

6. Close Oxygen Manual Shutoff Valve (If Practical) And Evacuate — COMPLETED

If practical, close the oxygen manual shutoff valve prior to evacuating the airplane.

5.4 GROUND PREPARATION FOR IN-FLIGHT JETTISON OF LOGISTICS CARGO ON PALLETS AND ADS CARGO ON AIRDROP PLATFORMS.

Due to the aft cargo side doors not being designed to open in flight, and the resulting reduction of the aft opening on the airplane, it will be necessary to manhandle logistics cargo loaded on pallets, or ADS cargo loaded on airdrop platforms carried in the logistics rails system, out of the rails for jettison. After the cargo on the aft cargo ramp has been jettisoned, the cargo carried in the logistics rails system in the cargo compartment will have to be moved out onto the aft cargo ramp, and aligned with the center of the ramp so that it will slide out of the airplane without hitting either aft side cargo door.

NOTE

- Placement of the different items of cargo will be governed by the calculated CG of the total cargo load and the floor loading capacity of the cargo floor. It should also be planned to avoid any possibility of excessive out-of-CG conditions occurring as the cargo is jettisoned.
- When planning load placement in the airplane it is extremely important to consider the possibility of emergency in-flight jettison of all, or a part of the total cargo load.

5.4.1 Ground Preparation Loading Sequence. To make sure a minimum of time and effort is used during the emergency in-flight jettison of the cargo, and to make sure the most hazardous items of the cargo are jettisoned first, the following ground preparation loading sequence should be observed when planning the load placement and CG of the total cargo load.

NOTE

Planning should consider the possibility of closing the inboard logistics rails on the aft cargo ramp (after the cargo on the ramp has been jettisoned) so that the items of cargo in the cargo compartment can be more easily moved onto and aligned on the ramp for jettison.

5.4.2 Aft Cargo Ramp. Items of cargo that can be quickly broken down into smaller individual packages for sliding out over the aft cargo ramp, or in some instances out of the troop door openings.

5.4.3 Cargo Compartment.

- First Aftmost Load — Flammable and/or explosive materials for jettisoning through the troop door openings.
- Second Aftmost Load — Units of cargo on pallets or 8-foot platforms so that they can be pushed out of the compartment restraint rails onto the aft ramp and aligned for jettison.
- Remaining Units of Cargo — The remaining units of cargo should be positioned so that the heaviest unit of cargo in the total load is at the optimum airplane center of gravity.

CHAPTER 6
SPECIFIC PROCEDURES

6.1 SECTION CONTENTS.

This chapter has been replaced by supplemental manual TO 1C-5M-9-2.

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PREV

GLOSSARY

A

Acceleration	Rate of increase of speed.
Approach Shoring	Shoring used to reduce the ramp angle that a vehicle must travel during on/off loading.
Arm	The horizontal distance from a reference datum, or a fulcrum, to the CG of the item.
Axis	A central line around which parts of a body are symmetrically arranged.
Axle Load	The total load imposed by all wheels on one axle of a vehicle regardless of the number of wheels.

B

Bulkhead	A partition or wall separating one part of the fuselage from another.
Butt Line	An imaginary plane perpendicular to the lateral axis of the airplane. It is identified by its distance from the centerline of the airplane.

C

Center of Gravity	A point which an item will rotate when balanced. The term as used in this manual is synonymous with the center of balance.
Combination Load	A load made up for aerial delivery consisting of the following: paratroops, containers, troops, vehicles, and palletized cargo, and their airdrop equipment.
Component	An ingredient or item in a system or unit.
Concentrated Load	A load which is supported by a small area compared to the size and weight of the total package.
Configuration	A relative disposition, pattern, or arrangement of parts.
Coplanar	Without elevation or depressions; even; level; flat.
Criteria	Standards or established rules.

D

Deflector	A device designed to turn aside the rush of air from a straight or given course.
DD Form 1387	Military Shipping Label.
Discontinuities	The interrupted area of the cargo floor and ramp, consisting of the stowed inboard logistics rails, stowed logistics roller conveyors, and tiedown ring pans.

E

Ejection	Act of ejecting or throwing out.
Extraction	Act of extracting or pulling out.

F

Force	An influence which produces or tends to produce motion or change of motion.
Fulcrum	A point where an object turns or rotates.
Fuselage Station	An imaginary plane, perpendicular to the longitudinal axis of the airplane. It is identified by its distance from the reference datum.

G

General Cargo	Any nonvehicular load which rests directly on the cargo floor. Cargo on pallets or air drop platforms is not considered general cargo if the pallets or platforms are supported by the roller conveyors.

H

Horizontal	Parallel to the horizon. At right angles to the vertical.

I	
Integral	Formed as a unit with another part.
Intercommunication	Interphone communication within the airplane.
J	
Jettison	To throw or eject overboard; e.g., to lighten an airplane.
L	
Lanyard	A short rope or cord for securing or holding something.
Lateral	Pertaining to or extending along the axis perpendicular to the centerline of the airplane. Side-by-side.
Linear Foot	As applied to cargo floor; a measurement equal to the total width of the cargo floor by twelve inches in length (fore or aft).
Load Planning	The planning necessary for proper placement of cargo within the airplane floor load and airplane center of gravity limitations, prior to loading cargo.
Longitudinal	Pertaining to or extending along the fore-and-aft axis of the airplane.
Lunette	A towing ring in the trail plate of a towed vehicle.
M	
Moment	$\text{Weight} \times \text{Arm} = \text{Moment}$.
O	
Outsize Cargo	Cargo which exceeds the capability of the C-17 airplanes.
Oversize Cargo	Palletized cargo which due to its physical characteristics is larger than the normal logistics pallet cargo size 84 by 104 by 96 inches.
P	
Pallet Overhang	Cargo which due to its size overhangs the perimeter of the logistics pallet.
Palletized Cargo	Cargo loaded on pallets or air drop platforms.
Parallel	Extending in the same direction and at a constant distance apart, so as never to meet.
Pedestal Shoring	Shoring placed under the ramp structure to reduce the ramp angle a vehicle must travel during on/off loading.
Pounds per Linear Foot	The total load imposed on one lineal (longitudinal) foot across (lateral) the entire width of the cargo floor.
Pounds per Linear Inch	The total load imposed on one lineal (longitudinal) inch across (lateral) the entire floor width of the cargo floor.
Plug Type Door	A door which fits into; inserts.
Pressurized	The state of maintaining near normal atmospheric pressure (air) inside a sealed cabin.
Primary Loadmaster	The loadmaster who has overall responsibilities for loadmaster duties on board the airplane.
Projected Area for Bulk Cargo	The floor contact area, length times width, expressed as square feet. It is used to ensure lateral load distribution to prevent subfloor failure.
Projected Area for Cargo on Supports	The area encompassed by the outside length and width of the supports. This length times width expressed as square feet is used to ensure lateral load distribution to prevent subfloor failure.
PSF (Pounds per Square Foot)	The total load (uniformly distributed) imposed by one square foot of cargo load on one square foot of cargo floor.
PSI (Pounds per Square Inch)	The total load (uniformly distributed) imposed by one square inch of cargo load on one square inch of cargo floor.
R	
Radius	A straight line extending from the center of a circle to its circumference.
Ramp Station	An imaginary plane, perpendicular to the longitudinal axis of the airplane ramps.

Reference Datum	An imaginary vertical plane at or near the nose of the airplane, from which all horizontal distances along the longitudinal axis of the airplane are measured.
S	
Shoring	Boards or planking placed on the cargo floor to spread the load over a larger area or to prevent damage.
Specific Loads	Loads which, due to their physical characteristics, require special handling.
Standard Loads	All loads for which joint TM/TO have been established.
Step-Up Shoring	Shoring used to reduce the vehicle projection angle and/or increase the ground clearance.
Symmetrical	An item capable of division by a longitudinal plane into similar halves.
T	
Typical Loads	Loads which may be loaded and secured in a normal manner.
V	
Vehicle	Any unit of cargo which is supported on the cargo floor by wheels or tracks.
Vehicular	Of or pertaining to a vehicle or vehicles. A vehicular load is a load of vehicles.
Vertical	Being in a position or direction perpendicular to the plane of the horizon up and down.
W	
Water Line	An imaginary plane, parallel to both the longitudinal axis and the lateral axis of the airplane. Water line Zero (abbreviated as WL 0.0) is below the airplane. Other water lines are identified by distance from water line zero. The cargo floor is at water line 140.0.
Wheel Load	The total load imposed by one wheel on one axle of a vehicle regardless of the number of wheels.

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