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INCH-POUND
MIL-STD-1320D
08 April 2014
SUPERSEDING
(See 6.3)

DEPARTMENT OF DEFENSE
STANDARD PRACTICE

FOR DESIGNING UNIT LOADS, TRUCKLOADS, RAILCAR LOADS, AND INTERMODAL LOADS FOR AMMUNITION AND EXPLOSIVES

AMSC N/A FSC 8140

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FOREWORD

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

2. This standard establishes the general design principles for loads used to move ammunition and explosives. It also provides guidance for interpretation of existing ammunition and explosive loads where MIL-STD-1322, MIL-STD-1323, MIL-STD-1325, and MIL-STD-1386 had been referenced in the plans. These plans, usually in the form of a dash sheet to the main specification, remain valid until cancelled or replaced by drawings.

3. Loads used to move ammunition and explosives need to be designed to provide a safe, efficient, and documented method to accommodate the different modes of the logistic cycle. The basis for most loads starts with a unit load. A load that fixes two or more items together to make a single handling unit. Movement from one facility to another is accomplished by a truckload, railcar load, or intermodal load. Documents, such as drawings (or equivalent), are used to define the procedures and methods for constructing these loads.

4. Military ammunition and explosives must be handled and shipped in a manner that will afford optimum protection against accidental ignition and detonation. Established and approved procedures need to be utilized to ensure that the loads of ammunition and explosives are designed, documented, assembled, and transported in a safe manner. This standard establishes these guidelines.

5. Comments, suggestions, or questions on this document should be addressed to Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy mil, with the subject line “Document Comment”. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

CAUTION: Following this standard alone does not constitute an authorized ammunition or explosive load. The Naval Packaging, Handling, Storage, and Transportation (PHST) Center, the U.S. Army Defense Ammunition Center (DAC), the U.S. Air Force Armament Directorate, and the U.S. Marine Corp Program Manager for Ammunitions are designated as the approving authorities for loads consisting of ammunition and explosive items. To request a load procedure, please contact your branch of service’s approving authority (see 4.2 and 4.7). All developed loads consisting of ammunition and explosive items must be reviewed and approved by the appropriate approval authority.

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1. SCOPE

1.1 Scope. This standard establishes general guidelines for the preparation of loads used to move ammunition and explosives (A&E). Definitive requirements for specific loads will depend on the type of load. The load types covered in this standard are unit loads, truckloads, railcar loads, and intermodal loads. This standard will be used by all personnel engaged in the transportation of A&E for the Department of Defense (DoD) as the basic reference document for the design of these specific loads.

1.2 Background. The DoD requires that established and approved procedures be used when transporting A&E. This standard details how these procedures are developed and the activities responsible for approving these procedures. The Department of Transportation (DOT) 49 CFR 173.60 (14) authorizes the shipment of DoD large and robust explosives articles provided that they are shipped using established and approved DoD procedures. Only loads reviewed and approved by the proper approval authority listed in 4.2 and 4.7 constitute an authorized ammunition or explosive load.

1.3 Application. This standard should be used by all personnel engaged in unitizing and transporting ammunition, explosives, and associated items for the DoD.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ARMY DEFENSE AMMUNITION CENTER DRAWINGS

AMC 19-48-75	-	Index of U.S. Army Unitization, Storage, and Out Loadings Drawings for Ammunition and Components

(Copies of this document are available online at https://www3.dac.army mil/DET/dapam/toc.html.)

CODE OF FEDERAL REGULATIONS (CFR)

49 CFR 100-399	-	Other Regulations Relating to Transportation
49 CFR 174.101-112	-	Carriage by Rail
49 CFR 174.115	-	Carriage by Rail, Loading Division 1.4 (Explosive) Materials

(Copies of these documents are available online at http://www.ecfr.gov.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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3. DEFINITIONS

3.1 Aft. At, near, or toward the rear of a conveyance.

3.2 Ammunition. Components, and explosives in any case or contrivance prepared to form a charge, complete round, or cartridge for cannon, howitzer, mortar, or small arms; or for any other weapon, torpedo, mine, bomb, depth charge, demolition charge, fuze, detonator, projectile, grenade, guided missile, rocket, and the like; signaling and illuminating pyrotechnic materials; explosive-loaded impulse devices such as bolts, squibs, and catapult charges; and all chemical warfare materials.

3.3 Anchor plate. A steel plate used to anchor steel strapping to a railcar. It is slotted to receive the strapping and drilled to permit nailing to railcar walls or floor.

3.4 Approved palletizing and unitizing plan. A palletizing or unitizing plan developed in the absence of drawings and approved for use by the activities listed in 4.2.

3.5 Batten. A wooden member used to fill space, protect against damage, or to provide additional surfaces for strapping or bearing.

3.6 Bay. A portion of a load in/on a conveyance consisting of laterally adjacent lading that may be separated from another bay by a common interface (e.g., center gate).

3.7 Belt rail. Steel rails that are welded to both side walls of the MIL-SPEC VAN (MILVAN) container, parallel to the floor, and at specified heights from the floor. The belt rails form the part of the mechanical bracing system into which the crossmembers are fastened.

3.8 Block. A bulky, usually solid piece of wood with one or more flat faces, usually used for securing vehicles.

3.9 Block, chock. A concave or beveled block of wood used to secure lading in position, usually used for securing vehicles.

3.10 Brace. A structural member used to transmit, divert, or resist forces acting on the lading during transportation. “Brace” is usually modified by a functional description such as “longitudinal” or “lateral.”

3.11 Brace, cross. A single member, wood or wood and metal combined, placed crosswise in a conveyance against the lading to secure the lading in position.

3.12 Brace, sway. A piece or assembly used to prevent sideways motion of the lading resulting from lateral sway of the conveyance.

3.13 Bracing. Assemblies or dunnage used to retain lading.

3.14 Bridge plate. A bridge laid between a railcar and a loading dock or between cars to facilitate access to the car for loading or unloading the lading.

3.15 Buffer piece. Dunnage member which serves as a bearing surface between lading or other dunnage pieces.

3.16 Buffer strip or board. A piece of lumber placed against a wall or piece of lading to provide a wide bearing surface to protect a sharp-edged or thin-walled item during transit.

3.17 Bulkhead, front. A dunnage assembly designed to square the front wall of a van to eliminate rounded corners, distribute the forward forces in the load over the frontal area of the van, and provide physical protection to the van’s front wall and lading.

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3.18 Bureau of explosives. The regulatory body of the Association of American Railroads responsible for the issuance and approval of appropriate rules for safety in the rail shipment of explosives and hazardous materials by the railroad.

3.19 Cap. A cover with sides extending perpendicularly from its perimeter used as a protection of lading against damage, or to help create a stable load. It may be used over the load, inverted under a load, or used under and over intermediate courses.

3.20 Capacity. The allowable weight of the lading in a conveyance, expressed in round numbers; for example, 100,000 pounds (not to be confused with load limit).

3.21 Car. A vehicle suitable for the carriage of freight by railroad. Cars used for carriage of hazardous materials by rail may be of several types.

3.21.1 Boxcar. A fully enclosed railroad car having a door or doors on both sides and, sometimes, on one or both ends. Used for general freight service.

3.21.2 Class 1.1 and 1.2 car. A car which has been inspected and certified for carrying of Class 1.1 and 1.2 explosives in accordance with 49 CFR 174.101.

3.21.3 Class 1.3 car. A car suitable for the carriage of Class 1.3 explosives in accordance with 49 CFR 174.112.

3.21.4 Class 1.4 car. A conventional boxcar suitable for the carriage of Class 1.4 explosives in accordance with 49 CFR 174.115.

3.21.5 DF-type car. A specially equipped boxcar known as dunnage free, having crossmembers as permanent load-securing devices which are attached to steel rails attached to the side walls of the car. Some DF-type cars have special cushioned draft gear to reduce shocks transmitted to the load.

3.21.6 Double-door car. A car with a pair of doors on each side.

3.21.7 Double-walled car. A boxcar with both sheathing and lining.

3.21.8 Dunnage. Wood packaging material used to secure or support a commodity, but which does not remain associated with the commodity.

3.21.9 End-door car. A boxcar with doors in each end. Not to be used for ammunition or explosives.

3.21.10 Flatcar. An open car without roof, side, or end walls.

3.21.11 Gondola car. An open car without roof, with low side and end walls.

3.21.12 Open car. A car without a roof.

3.21.13 Plug-door car. A car equipped with doors that close flush with the inside walls of the car. Each side of a plug-door boxcar may be equipped with a single plug door, double plug doors, or one plug door and one conventional door.

3.22 Car lining. A surface, usually wood, fastened to the inside of the car structure.

3.23 Car sheathing. May be the same as car lining or, in the case of a double-sheathed car, the boxcar will have an inside car lining and an outside sheathing which may be either wood or steel.

3.24 Carload plan. A specific design of the physical arrangement of lading and dunnage to protect particular items of lading from the hazards of rail transport.

3.25 Cleat. A member used to reinforce another member or to hold it in its position.

3.26 Cleat, backup. A reinforcing dunnage member nailed to the conveyance floor or wall to secure dunnage or dunnage assemblies.

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3.27 Cleat, hold-down. A dunnage member nailed to conveyance walls or other dunnage assemblies to minimize movement of the dunnage.

3.28 Cleat, pocket. One of a group of three or more cleats arranged to form a pocket to receive and restrain a cross brace of a hold-down member.

3.29 Cleat, strut. A horizontal member oriented crosswise to a conveyance and fastened to vertical dunnage members to serve as support for longitudinal struts. Also known as a strut ledger.

3.30 Clinching. To secure a nail or bolt that is driven through an item by bending over the protruding end.

3.31 Commercial boxcar. A boxcar owned by one of the nation's railroads.

3.32 Conveyance. A carrying device (e.g., trailer, railcar, intermodal container, etc.) used to transport items.

3.33 Crossmember. A wood dunnage member or part of a dunnage assembly that is oriented across the width of a conveyance. Also a metal dunnage member which fastens to steel rails that are permanently attached to the side walls of a conveyance.

3.34 Crossmember (load-bracing beam assembly). Metal-bracing dunnage member that installs across the width of a MILVAN between belt rails and locks into place. Normally, 25 crossmembers are provided with the MILVAN container.

3.35 Crosspiece. A horizontal piece of wood in a center gate, end gate, or other dunnage assembly, extending across the width of the conveyance. It may be placed directly against the lading or may hold or be held in position by the vertical dunnage members that are against the lading. Also called a horizontal gate member.

3.36 Deunitize. To disassemble a unit load.

3.37 Diagonal. Wood bracing placed at an angle.

3.38 DODIC or NALC. A four-digit alpha/numeric code which will be either a Department of Defense Identification Code (DODIC) assigned by the Defense Logistics Services Center (DLSC) or a Navy Ammunition Logistic Code (NALC) assigned by the Navy Ships Parts Control Center, Mechanicsburg, Pennsylvania.

3.39 Doorway member. A steel and wooden member installed across the doorway of a Department of Defense railroad (DODX) car, Series 2900, to permit installation of crossmembers across the car in the doorway area.

3.40 Doorway protection. Dunnage material in or spanning the doorway of a railcar to prevent the lading from falling or rolling out at the doorway or coming in contact with side doors.

3.41 DTR. Defense Transportation Regulation.

3.42 Dunnage. Any material (such as lumber, straps, or metal braces) used in transportation to support and secure the lading to protect it from damage or for convenience in handling.

3.43 Edge protector. A light piece of wood, metal, fiberboard, or other material used at the edge of a load to prevent damage by strapping or to help make a stable load by containing and compacting the units.

3.44 Eggcrating. A method of dunnaging so that each unit of lading is confined in its own cell.

3.45 Explosive. A chemical compound or mixture of substances which, when subjected to suitable initiating impulses or agents such as flame, spark, heat, impact, or friction (whether applied mechanically or electrically), will undergo chemical and physical transformation at speeds varying from extremely rapid to virtually instantaneous, resulting in sudden and rapid development of very high pressure in the surroundings. Examples: black powder, smokeless powder, tetryl, Trinitrotoluene (TNT), and HBX.

3.46 Fill material. Dunnage lumber suitable for shimming between other dunnage components, conveyance walls, crossmembers, and the lading.

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3.47 Filler. Material, usually boards or frames, used to fill space throughout the load in order to provide a smooth bearing surface or to compensate for irregularities in the lading or conveyance.

3.48 Fillers or spacer frames. Structures, frames, or strips used to fill void spaces throughout the load to obtain a tight load.

3.49 Frame. A wooden structure consisting of sheathing nailed to stringers used to protect the load or to help make a stable load by containing, compacting, compressing, or supporting the units in the load.

3.50 Gate. A structure placed crosswise in the conveyance and used to distribute the load or to fill space not occupied by lading. Gates may be of the various types:

3.51.1 Gate, center. A structure, usually located between load bays that separates the lading.

3.51.2 Gate, end. A structure placed against the end wall of a conveyance for the purpose of filling the space in a load, to distribute the load more evenly over end wall, or to protect the lading.

3.51.3 Gate, separator (intermediate or divisional). A structure used to facilitate transmittal of longitudinal forces from one stack to another or to separate the stacks of lading into sections throughout the conveyance.

3.52 Handling equipment. Any equipment or special handling device used for moving packages, packs, unit loads, package containers, items, or components.

3.53 Hazardous materials. A substance or material which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce and which has been so designated in 49 CFR 100-399.

3.54 Header. A wood dunnage member or assembly that is oriented across the width of a conveyance.

3.55 Hold-down. Dunnage component placed across the top of lading to prevent upward movement.

3.56 Hold-down member. A member secured by cleats used to prevent upward movement of the lading, gate, or bracing structure.

3.57 Horizontal. Dunnage member serving as a horizontal component of a dunnage structure.

3.58 Humping. A railroad operation used to connect railcars with one car moving and the other is motionless; usually performed in a railroad switching yard.

3.59 Intermodal. Specially designed to facilitate the carriage of goods by one or more modes of transport without requiring reloading and so equipped with International Organization for Standardization (ISO) standard corners fittings to permit ready handling from one mode to the other.

3.60 Kicker. A strip of wood nailed to the floor to restrain other dunnage bracing.

3.61 Lading. The load or cargo being shipped.

3.62 Laminate. To make by putting together in layers.

3.63 Layer. A course or stratum of the lading parallel to the floor of the conveyance and one package container or unit load high.

3.64 Load, divided. A load separated into two or more bays by a center gate assembly, separator gates, nailed blocking, etc.

3.65 Load limit. The greatest allowable weight which may be loaded into a conveyance.

3.66 Load, palletized unit. Several (usually similar) items secured to a pallet to facilitate handling, shipment, and storage.

3.67 Load pattern. The arrangement of lading units in a conveyance.

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3.68 Load, through. A load which extends through the doorway area of a railcar and is not separated by center gates or divisional gates, for the full length, or almost the full length of the car.

3.69 Nail finder. A light rake or board having a metal edge used to drag over the conveyance lining in order to find protruding nails and staples that might damage lading.

3.70 Nominal dimension. A dimension used for purpose of general identification. Actual size will approximately be this size, but with some small variation.

3.71 Outloading. The operation of moving items from a facility to a required location.

3.72 Overhang. The portion of a component of a unit load that extends beyond the edges of the pallet.

3.73 Pack. An exterior container, including necessary internal bracings, cushioning, interior packages, and marking.

3.74 Package. An interior container together with contained wrappings, cushioning, and identification marking.

3.75 Pallet. A low, portable platform of wood, metal, or other suitable material to facilitate handling, stowage, and transportation of materials as a unit by mechanical equipment. It is used as the base of a unit load to support and combine groups of commodities (or to confine single items) for handling and shipping as a single entity.

3.76 Pallet adapter. A wood or metal framework designed to aid in securing irregularly shaped articles to a pallet.

3.77 Pallet, special purpose. A pallet which is specifically designed for use with a particular ammunition item or for use in a specific handling or transportation environment.

3.78 Palletized unit load. Two or more units' components arranged and secured to a pallet, intended to be handled mechanically as a single unit.

3.79 Partial unit loads. A partial unit load is a unit load which holds or contains a quantity of items which is less than the number of items in a unit load constructed in accordance with the drawing or approved palletizing/unitizing plan for the item.

3.80 Penny. A system of measurement for nails. The larger the number, the larger the size of the nail. The abbreviation for penny is "d."

3.81 Pitch. The movement of a ship in which the bow and stern alternately moves up and down.

3.82 Protector, stake pocket. Material used in a stake pocket of a flatbed trailer, rail, or flatcar to prevent tiedown strapping from wearing through.

3.83 Purchase board. A wood board added to a chain or strapping board. The purchase board is located above the inside lading to provide a downward force when chain/strapping tiedowns are used.

3.84 Riser. A unit, usually made of wood, used to step down a load; in some cases, units of lading may be utilized as a riser.

3.85 Riser pieces. Material used in a dunnage assembly for the purpose of raising the assembly a certain distance vertically.

3.86 Roll. Ship motion described as angular displacement about the longitudinal axis of the ship.

3.87 Row. A series of containers/unit loads extending lengthwise of the conveyance, parallel to the sides of the conveyance and one unit wide.

3.88 Seal. Metal device for fastening and securing metal straps.

3.89 Separator. Plywood sheet serving in the same capacity as a separator gate.

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3.90 Separator gate. Dunnage assembly placed between load bays.

3.91 Shim. Dunnage component of suitable thickness to fill voids between dunnage member or assemblies and lading or conveyance.

3.92 Side blocking assembly. Dunnage structure constructed so that it extends from a side of a conveyance to the lading. Restricts movement in the lateral direction.

3.93 Side blocking, nailed. Wood member nailed to the floor and butted against the lading to prevent lateral movement.

3.94 Sleeper. Wood member nailed to floor and butted against the lading to prevent lateral movement. Also known as "nailed side blocking."

3.95 Spacer. Small pieces of lumber used to adequately space other dunnage members.

3.96 Spacer, notched. A piece of heavy lumber cut out across one face, or opposing faces, at regular intervals, used underneath and between courses of units stacked horizontally as a protection against damage, or to make a stable load by supporting the units.

3.97 Stack. A series of containers or unit loads in a vertical alignment.

3.98 Stepdown load. Method of arranging the lading so that the bulk of the weight is on the axles and is stepped down to the center of the vehicle. Stepdown is usually accomplished by use of risers.

3.99 Stiffener. Wood member used to unitize stacked unit loads or to reinforce bracing.

3.100 Storage. Storing of weapons and components in a magazine, warehouse, or out-of-doors for reserve, accumulation, and issue.

3.101 Strap, bundling. A strap used to secure together smaller items into a bundle.

3.102 Strap, steel. A length of flat steel strapping placed around a load or unit load under tension to compact and secure the load.

3.103 Strap, unitizing. A strap placed around two or more items and tensioned to create a single handling unit.

3.104 Strap, web. A length of nylon webbing placed over a load and tensioned to secure the lading.

3.105 Strapped unit load. Packages secured to each other and to a pallet with straps to form a unit load.

3.106 Strapping. Web or metal (steel) banding used for securing lading or unitizing or bundling load units.

3.107 Strapping board. A wooden member between the lading and a steel strap. Used in most cases to provide protection to the lading and also provide stiffness.

3.108 Stringer. Members secured to the conveyance floor or placed under or between layers of lading, running lengthwise of the conveyance, and used to support or to provide a supporting surface for a load. Also, the longitudinal member of a sway-brace assembly.

3.109 Strut. Wooden member that spreads or separates the load bearing surfaces of a blocking assembly.

3.110 Sway brace. A dunnage component or assembly used to prevent lateral motion of the lading.

3.111 Technical directing activity (TDA). An activity designated by the cognizant systems command headquarters by contract, task assignment, or project order to assume responsibility for performing, directing, or monitoring the design and test of packaging, packing, shipping and handling, and transportation equipment for weapon system components.

3.112 Tie bars. Members used to brace strut with spans of 4 feet or more. Reduces the tendency for buckling failure of the strut.

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3.113 Tie piece. Dunnage component which connects two other dunnage members.

3.114 Tiedown, direct. A direct tiedown is when slings or chains are connected to the trailer and then directly attached to the lading.

3.115 Tiedown, indirect. An indirect tiedown is when a sling or chain is attached to one side of the conveyance, runs over or through the lading, and is attached to the other side of the conveyance.

3.116 Tier. Items extending from one side of the conveyance to the other, parallel to the ends, one item in length, and one item in height.

3.117 Tomming. The securing of lading so that it cannot move upwards.

3.118 Truckloading plan. A specific design concerning the physical arrangement of lading and dunnage materials to protect the lading from damage during transportation.

3.119 Truss. Wood members used to increase tension on horizontal portions of strapping. Also known as a purchase board.

3.120 Ultimate load limit. The average load or force at which the item fails or no longer supports the load.

3.121 Underhang. The portion of a pallet that extends beyond the edges of the components on the pallet.

3.122 Unit load. Composed of two or more items banded together to make a single unit, generally supported on a pallet or base to facilitate handling with mechanical handling equipment.

3.123 Unit load, palletized. A unit load that utilizes a pallet as its common base for shipping and handling.

3.124 Unit load, unpalletized. A unit load assembled without a pallet (e.g., two containers strapped or latched together to create one handling unit).

3.125 Unitize. Strapping together of two or more items or unit loads for restraint during shipment or sometimes storage.

3.126 Vehicle. A self-propelled wheeled machine that transports goods or people (e.g., car, truck, train). For a tractor-trailer and railroad operation, the tractor and the locomotive are the vehicle.

3.127 Vertical. Dunnage member serving as a vertical component of a dunnage structure.

3.128 Void. Space between package container or unit loads within a given load pattern or space between units of lading and the conveyance sides or crossmembers.

3.129 Wall member. A detachable member that fastens to the wall of a DODX car to locate and hold crossmembers.

3.130 Web-strap assembly. An assembly of nylon web strapping with a ratchet device on one end and a hook on the other end.

3.131 Wood packaging material (WPM). Wood packaging material is hardwood or softwood packaging material that is used in supporting, protecting, or carrying a commodity. Examples: pallets, wood boxes, and dunnage. As used here, WPM does not include processed and manufactured wood products like plywood or particleboard. WPM is subject to phytosanitary requirements for shipping outside of the continental United States (OCONUS).

3.132 Working load limit. The maximum load that an item is authorized to support in service.

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4. GENERAL REQUIREMENTS

4.1 Danger in shipment. Military A&E are produced for waging war and as such are manufactured primarily to kill and destroy. Such products have inherent hazards that affect all handling operations from time of manufacture until expended in service. With a knowledge of the hazards involved, the first and foremost principle that should be considered is that explosives and weapons shall be handled and shipped in a manner that will afford optimum protection against accidental ignition or detonation. Danger is always present when explosives are being handled, and more care is required than for other items. An accident with a nonhazardous material may cause a short delay, while the same type of accident with an explosive may cause death and the destruction of equipment and material. Proper unit load construction, truckloading, railcar loading, and intermodal container loading procedures will minimize the danger in shipment. Methods of loading and bracing that do not follow the requirements of this document may result in a catastrophe.

4.2 Approval authority for loads. Each branch of the DoD has activities with the authority to approve loads developed under the requirements herein. These approval authorities are shown in table I. The approval authorities have the authority to develop loads independent of this document for those situations of transport that this document may not cover.

TABLE I. Approval activities.

Branch of Service	Activity
Army	Defense Ammunition Center (DAC)
Navy	NSWC Indian Head Division Detachment Picatinny (Naval PHST Center)
USAF	Armament Directorate
USMC	Program Manager for Ammunitions

4.3 Unit loads. Unit loads are composed of two or more items fixed firmly together to make a single unit generally supported on a pallet or base to facilitate handling with mechanical handling equipment. A unit load could also be as basic as two containers fastened together to create one handling unit. Unit loads for A&E shall be designed to meet the required logistic cycle. Height, width, and weight are key factors that affect the pragmatic use and movement of the loads. A unit load shall be constructed to provide safe and efficient transportation and storage of the items. The unit loads shall also be designed to be compatible with the handling equipment used throughout the logistic flow patterns.

4.4 Truckloads. When Government or commercial trucks transport A&E, a truckload document shall be provided to the shipping activity. The truckload document is a detailed plan that provides instructions for assembling the load, tiedown, blocking, and bracing methods needed to secure it on a truck. Van truckload designs covered in this standard apply to highway movement. Flatbed loads designs using the principles of this standard apply to highway and tactical movement. Tactical loads shall be designed to pass the washboard course.

4.5 Railcar loads. A&E loads transported on the rail system require a railcar load document detailing the loading, tiedown method, blocking, and bracing needed to secure the load in a boxcar or on a flatcar. Significant longitudinal forces occur in rail movement and shall be accounted for the railcar load design. These load plans shall be approved by an activity listed in table I.

4.6 Intermodal container loads. Intermodal container loads are loads that utilize a specially designed container that will facilitate the movement of items by one or more modes of transportation without requiring reloading. These containers are equipped with ISO standard corner fittings to permit ready handling from one mode to another. The most widely used intermodal containers are either 20 or 40 feet long. A&E shipped in intermodal containers shall be secured in a manner to account for these different modes of transportation. If an intermodal load is not intended for rail transport, the load plan shall state that the load is not authorized for rail transport.

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4.7 Documentation of load plans. Load plans developed under this standard shall be documented by U.S. Army drawings (identified in AMC 19-48-75) or U.S. Navy drawings and procedures approved by the activities in 4.2. Where an approved load plan exists for a given item, the loading, blocking, and bracing procedures in the approved load plan shall be followed without exception.

NOTE: Throughout this document, approved methods for loads will be referred to as drawing. Some older Navy methods still exist as MIL-STD-132X-XXX or WR-51 slash numbers. These methods are inactive for new design, but still valid until cancelled.

NOTE: The approval authorities have the right to deviate from methods outlined in this document if proven engineering principles are used and validated by test.

Documentation of approved loads, other outloading resources, and technical assistance can be obtained from the following sources:

Army:

Defense Ammunition Center
Attn: Explosives Safety Engineering Division
1C Tree Road, Building 35
McAlester, OK 74501-9053
DSN 956-8072 or Commercial (918) 420-8072
https://www3.dac.army mil

Navy: Explosive Safety Technical Manual (ESTM) DVD-ROM

Director
Naval Surface Warfare Center
IHEODTD - Picatinny Detachment - Code G12
Bldg. 458, Whittemore Avenue
Picatinny Arsenal, NJ 07806-5000
DSN 880-5203 or Commercial (973) 724-5203
http://www.ih.navy.mil/phst

USAF:

Armament Directorate
AFLCMC/EBHC
643 Elm Lane
Hill Air Force Base, UT 84056-5819
(801) 586-0809
http://www hill.af mil

USMC:

Program Manager for Ammunitions
2200 Lester Street
Quantico, VA 22134
DSN 378-8931 or Commercial (703) 432-8931
Ammo_SupportCenter@usmc.mil
http://www marcorsyscom.usmc mil/am/ammunition

4.8 Procedures for load plan selection.

a. Determine if load plan exists (see 4.7).

b. Contact activities listed in 4.2 for assistance or to request a drawing be developed if a load plan does not exist.

c. For one-time shipments, a modification of a similar item can be used if an activity listed in 4.2 is contacted for approval. (If repeated requests are made for an undocumented load, an item specific load shall be developed.)

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5. DETAILED REQUIREMENTS

5.1 Unit loads. Unit loads shall be designed to meet the logistic requirements anticipated for the load movement and usage. Load requirements for the various DoD activities vary due to the logistic cycle that the loads are transported and stored in. Appendix A details the differences that should be considered when designing these loads.

5.2 Truckloads. The two primary truckload categories are van and flatbed trailer loads. Each category has different requirements for securing the loads in a safe and established manner. Appendix B details the specific requirements for the design of truckloads for A&E items and also provides test requirements which are used to verify the load plans.

5.3 Railcar loads. A&E transported on the rail system shall conform to the rules of the Bureau of Explosives, 49 CFR 174.101 – 174.112, and DoD requirements. Appendix C details the specific methods needed to design a railcar load for A&E.

5.4 Intermodal container loads. Since intermodal container loads can move between several modes of transportation, the loading, securing, and blocking and bracing must meet the overall worst case of each environment. Appendix D details the specific methods needed to design an intermodal load for A&E.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. This standard is intended to be used as a guide in preparing unit loads, truckloads, railcar loads, and intermodal loads for movement of A&E. The purpose of the standard is to establish a standard method for all DoD activities that need to design, document, and transport these loads. Only A&E loads reviewed and approved by each service's appropriate approving authority (see 4.2 and 4.7) constitutes an authorized load. Following this standard alone does not constitute an authorized, approved ammunition or explosive load.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this standard.

6.3 Supersession data. This document supersedes the following standards:

MIL-STD-1320C	30 August 1979	Truckloading of Ammunition and Hazardous Materials
MIL-STD-1322A	26 May 1981	Unit Loads of Ammunition and Explosives for Domestic and Overseas Shipment
MIL-STD-1323	16 January 1979	Unit Loads of Ammunition and Explosives for Underway Replenishment
MIL-STD-1325A	02 March 1976	Railcar Loading of Hazardous Materials
MIL-STD-1386	25 June 1974	Loading of Hazardous Materials in MILVAN Containers

6.4 Subject term (key word) listing.

ISO container

Transportation

6.5 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

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UNIT LOADS OF AMMUNITION AND EXPLOSIVES

A.1 INTRODUCTION

A.1.1 Scope. This appendix contains details for the construction, interpretation, and inspection of unit loads of ammunition, explosives, and associated items for shipping, handling, and storage. Four types of unit loads are covered: domestic, underway replenishment, amphibious, and tactical resupply unit loads. For minimum design and evaluation procedures, use MIL-STD-1660. The information contained in this appendix should be used in the preparation of unit load drawings. This appendix is not a mandatory part of the standard. The information contained herein is intended for guidance only.

A.1.2 Obtain proper procedures. When planning to unitize ammunition or explosives, drawings detailing how a specific item is unitized can be found in several locations which are listed in 4.7.

A.1.3 Unit load descriptions.

A.1.3.1 Basic unit load. A basic (continental United States [CONUS] and outside of the continental United States [OCONUS]) unit load is an assembly of items (in or out of containers) designed to facilitate handling multiple items as a single entity. A basic unit load is limited to land based shipping, handling, and storage. These loads are not approved for transfer-at-sea operations. For the Navy, these loads are called Domestic Unit Loads.

A.1.3.2 Underway replenishment unit load. A unit load that is specifically designed to permit transfer-at-sea operations and which is compatible with shipboard handling and storage procedures. These are sometimes called Fleet Issue Unit Loads.

A.1.3.3 Amphibious unit load. A unit load that is specifically designed to be loaded as assault cargo in ships such as Amphibious Assault Ships (ship class LHA/LHD), Dock Landing Ships (ship class LSD), and Amphibious Transport Docks (ship class LPD) for rapid unloading in specific amphibious operations.

A.1.3.4 Tactical resupply unit load. A unit load specifically designed for resupply using tactical resupply vehicles (e.g., Palletized Loading System [PLS], Logistics Vehicle System [LVS], etc.).

A.2 APPLICABLE DOCUMENTS

A.2.1 General. The documents listed in this section are specified in this appendix. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in this appendix, whether or not they are listed.

A.2.2 Government documents.

A.2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this appendix to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

FEDERAL SPECIFICATIONS

NN-P-71	-	Pallets, Material Handling, Wood, Stringer Construction, 2-Way and 4-Way (Partial)

COMMERCIAL ITEM DESCRIPTIONS

A-A-55057	-	Panels, Wood/Wood Based; Construction and Decorative

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-DTL-15011	-	Pallets, Material Handling, Wood Post Construction, 4-Way Entry

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MIL-DTL-23312 - Pallet, Material Handling, Metal (for Ordnance Items): MK 3 MOD 0 and MK 12 MOD

MIL-PRF-32076 - Unitization of Ammunition

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-1660 - Ammunition Unit Loads

(Copies of these documents are available online at http://quicksearch.dla mil.)

A.2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this appendix to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ARMY DEFENSE AMMUNITION CENTER DRAWINGS

ACV00561 - Unit Load Marking for Shipment and Storage, Ammunition and Explosives

AMC 19-48-4231 - Unitization Procedures for Ammunition and Components Packed in Cylindrical Metal Containers on 4-way Entry Metal Pallets

AMC 19-48-4232 - Unitization Procedures for Ammunition and Components Packed in Metal and Plastic Boxes on 4-way Entry Metal Pallets

(Copies of these documents are available online at https://www3.dac.army mil/DET/order/draworder html.)

CODE OF FEDERAL REGULATIONS (CFR)

49 CFR 172 - Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans

(Copies of this document are available online at http://www.ecfr.gov.)

DEPARTMENT OF DEFENSE PUBLICATIONS

DoD 4140.65-M - Issue, Use, and Disposal of Wood Packaging Material (WPM)

(Copies of this document are available online at www.dtic mil/whs/directives/.)

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

Voluntary Product Standard PS 20-10 - American Softwood Lumber Standard

(Copies of this document are available online at http://gsi nist.gov/global/index.cfm/L1-5/L2-44/A-355.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) DRAWINGS

10001-564200 - Pallet, Material Handling MK 3 MOD 0

10001-2086579 - Pallet, Material Handling MK 12 MOD 0

10001-2645217 - Pallet, Material Handling MK 12 MOD 1

(Copies of these documents are available online on the Conventional Ordnance Resource Program (CORPS) database for authorized personnel. Access to this database must be obtained through the following web site, https://apps.cran nmci.navy mil/AAM/userregistration/UserRegistration.aspx.)

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NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

SW020-AG-SAF-010 - Navy Transportation Safety Manual for Ammunition, Explosives and Related Hazardous Materials

(Copies of this document are available online at https://nll.ahf nmci navy mil, may be requested by phone at 215-697-2626, or may be requested by email at nllhelpdesk@navy mil.)

A.2.3 Non-Government publications. The following documents form a part of this appendix to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL

ASTM D3953 - Standard Specification for Strapping, Flat Steel and Seals

ASTM D4727/D4727M - Standard Specification for Corrugated and Solid Fiberboard Sheet Stock (Container Grade) and Cut Shapes

ASTM D6199 - Standard Practice for Quality of Wood Members of Containers and Pallets

ASTM F1667 - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples

(Copies of these documents are available online at www.astm.org.)

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

ISPM 15 - Guidelines for Regulating Wood Packaging Material in International Trade

(Copies of this document are available online at http://www.maff.go.jp/pps/j/konpozai/pdf/ISPM_15_English_2006.pdf.)

MATERIAL HANDLING INDUSTRY (MHI)

MH1 - Pallets, Slip Sheets, and Other Bases for Unit Loads

(Copies of this document are available online at http://www mhi.org.)

A.2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

A.3 GENERAL GUIDANCE

A.3.1 Types of unit loads. Some requirements unique to the four types of unit loads are listed as follows:

A.3.1.1 Domestic unit load.

a. Maximum weight: 4,000 pounds.

b. Wood pallets (normally).

A.3.1.2 Underway replenishment unit load.

a. Maximum weight: 4,000 pounds.

b. Height requirements: The height of the unit load should be adjusted to maximize stowage density aboard aircraft carriers. Stacking heights for Nimitz Class carriers are 96 inches; older CVN 68 Class carriers are 90 inches. The unit load should be designed with these dimensions in mind. For example, aboard a Nimitz Class carrier, the unit load stacking height should not exceed 48 inches for 2-high or 32 inches for a 3-high stack.

c. Maximum width: 42 inches.

d. Only metal pallets should be used.

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e. Underway replenishment unit loads are intended to be transferred-at-sea by ships during underway replenishment operations, which consist of connected replenishment (CONREP) and vertical replenishment (VERTREP). For VERTREP operations, all unit loads should be qualified and certified safe for all Department of Defense (DoD) rotary wing aircraft helicopter sling loading (HSL) operations by the U.S. Army Natick Research, Development and Engineering Center. A 300 kilovolt (kV) test may be required.

A.3.1.3 Amphibious unit load.

a. Maximum weight: 3,000 pounds.

b. Maximum height: 44 inches.

c. Maximum length and width: 45 by 54 inches.

d. Wood pallets should be used.

A.3.1.4 Tactical resupply load.

a. Weights are usually limited to 2,500 pounds.

b. Nuclear, Biological, and Chemical (NBC) decontamination requirements dictate metal pallets (see AMC 19-48-4231 and 19-48-4232) for these loads.

c. Design goal for height is limited to 54 inches.

d. Length and width goal dictated by the supply vehicle.

A.3.2 Unit load design requirements. All unit loads of ammunition and explosives (A&E) should meet the design requirements of MIL-STD-1660 for transportability, handling equipment compatibility, shape, size, weight, stability, and stacking capability. The Army (DAC) and Navy (Naval PHST Center) activities listed in 4.2 (table I) perform MIL-STD-1660 tests to verify unit load designs.

A.3.2.1 Pallet selection. All palletized domestic and overseas and amphibious unit loads should be designed utilizing preservative treated and ISPM 15 compliant wood pallets. As a goal, metal pallets should be used for all tactical resupply and underway replenishment unit loads.

A.3.2.2 Underhang and overhang. Underhang should not be allowed. Filler dunnage can be used to "fill out" the loads to eliminate underhang. Refer to MIL-STD-1660. Recommended overhang should not exceed 2 inches in any direction. Overhang greater than 2 inches can be allowed depending upon peculiarities of the commodity being unitized and identifiable factors that influence total cost effectiveness throughout the ammunition logistics system.

A.3.2.3 Steel strapping requirements (palletized unit load). Normally a minimum of four straps are required per unit load with two straps running the length of the unit load and two straps running the width of the unit load. Unitized loads (loads not requiring a pallet) should have a minimum of two straps. Table A-I lists the heavy duty strap size authorized for use and the safe working capacity of each strap. The number of straps required will vary due to size of the load in order to capture each item in the unit load (example: smaller boxes may require more than two straps in each direction).

TABLE A-I. Maximum safe working capacities of steel strapping.

Nominal width and thickness size (inches)	Type I, heavy duty (pounds)
¾ × 0.031	725
¾ × 0.035	725
1¼ × 0.031	1,190
1¼ × 0.035	1,190

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A.3.2.3.1 Tiedown strap size. The gross weight of a load, divided by the total number of tiedown straps to be used, determines the weight to be borne by each strap. This weight is compared to the strap capacity listed in table A-I. Strapping which has the same or next higher strength should be used.

A.3.2.3.2 Horizontal strap size. The gross weight of the layer compared with the strap capacities listed in table A-I determines the strapping size required.

A.3.2.4 Steel strapping seal joints. All steel strapping seal joints should be double-notched joints produced and controlled in accordance with the requirements of A.5.

A.3.2.5 Load and stabilizing straps. Load and stabilizing straps are used in some cases to bundle smaller packages together. In general, bundling straps are ignored when calculating the number of tiedown straps packages require.

A.3.2.6 Weight of strapping. In order to estimate the weight of steel strapping, table A-II shows the weight for each strap.

TABLE A-II. Weight of steel strapping.

Strap size (inches)	Weight per foot (pounds)
¾ × 0.031	0.079
¾ × 0.035	0.089
1¼ × 0.031	0.130
1¼ × 0.035	0.147

A.3.2.7 Estimated length of strapping. When designing a unit load, calculate the circumference of the load that the strap will go around and add 18 inches. The 18 inches will allow enough extra strapping needed for the sealing operations.

A.3.3 Material requirements. The material used for the construction of palletized or unitized loads should be as specified in this document and incorporated into individual unit load drawings.

A.3.3.1 Pallets. Four types of pallets are used in the construction of unit loads standard wood pallets (see A.3.3.1.1), standard metal pallets (see A.3.3.1.2), special purpose wood pallets, and special purpose metal pallets (see A.3.3.1.3 and A.3.3.1.4).

A.3.3.1.1 Standard wood pallets. Hardwood pallets should be of standard sizes and meet appropriate specifications as shown in table A-III.

TABLE A-III. Standard wood pallets.

Pallet specification	Deck size (inches)	Pallet type	Maximum capacity (pounds)	Empty pallet weight (pounds)
NN-P-71, Type V, Size 2, Group IV	40 × 48	Stringer Construction	4,000	60
MIL-DTL-15011, Style 1 Class 1	40 × 48	Post Construction	4,000	63
MIL-DTL-15011, Style 1A, Class 1	35 × 45½	Post Construction	4,000	65
MIL-DTL-15011, Style 1B, Class 1	42 × 53	Post Construction	4,000	133

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The standard wood pallets have two or three strapping slots in each pallet. Commercial wood pallets meeting these specs and listed in Department of Defense (DoD) approved documents, such as MHI MH1/9 of MHI MH1, are one source of obtaining these pallets already ISPM 15 compliant. Pallets should also be specified with preservative. Old pallets may not meet these conditions.

A.3.3.1.2 Standard metal pallets. The following standard metal pallets should be used in the construction of unit loads (see table A-IV): The MK 3 and MK 12 pallets are constructed in accordance with MIL-DTL-23312.

TABLE A-IV. Standard metal pallets.

Pallet	Deck size (inches)	Material	Drawing	Maximum capacity (pounds)	Empty pallet weight (pounds)
MK 3 MOD 0	40 × 48	Steel	NAVSEA 10001-564200	4,000	90
MK 12 MOD 0	35 × 45½	Steel	NAVSEA 10001-2086579	4,000	110
MK 12 MOD 1	35 × 45½	Steel	NAVSEA 10001-2645217	4,000	72
19-48-4231	78½ × 29 5/16	Steel	AMC 19-48-4231	4,000	110
19-48-4232	45½ × 35	Steel	AMC 19-48-4232	4,000	99

NOTE:
1. The MK 12 MODs 0 and 1 pallets are functionally interchangeable (see A.3.4.3). Strap threading, height, and weight will vary (see A.3.4.3.1).

A.3.3.1.3 Special purpose wood pallets. Special purpose wood pallets should not be used unless specifically authorized by a drawing. Use of MIL-PRF-32076 may be required for development or production of unit loads on special purpose wood pallets.

A.3.3.1.4 Special purpose metal pallets. Special purpose metal pallets should be specified on individual unit load drawings prepared for each type of ammunition.

A.3.3.1.5 Wood packaging materials (WPMs). All wood pallets and dunnage for unit loads of A&E should meet the requirements of ISPM 15. Wood pallets should be constructed from lumber meeting the requirements of A.3.3.8. Certification markings should be applied to the stringer or block on diagonally opposite sides of the pallet and be of contrasting color and clearly visible. Used pallets should be made compliant in accordance with the procedure outlined in DoD 4140.65-M before reusing or shipping overseas.

A.3.3.2 Palletizing or unitizing adapters.

A.3.3.2.1 Wood palletizing or unitizing adapters. Wood palletizing or unitizing adapters, e.g., caps, cover spacer frames, etc., should be constructed in accordance with the details of each approved drawing.

A.3.3.2.2 Metal palletizing or unitizing adapters. Metal palletizing or unitizing adapters should be as specified on each approved drawing.

A.3.3.3 Steel strapping. All steel strapping should be new (unused) material in accordance with ASTM D3953, flat, Type 1, heavy duty, Finish B, Grade 2 (moderate coating). The size (width and thickness) of strapping should be as specified by each approved drawing. Strapping with bright or slit edges is allowed provided a Finish A overlay is used.

A.3.3.4 Seals. All seals used to join the ends of steel strapping should be in accordance with ASTM D3953, Class H, Finish B, Grade 2, Style I, II, III, or IV. Seals with gritted backing are not permitted. The style of seal should be selected for compatibility with the tensioning and sealing tools being used. The seal class should be compatible to the strapping used.

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A.3.3.5 Nails. All nails used in the construction of unit loads should be in accordance with ASTM F1667 and of the style and length specified by each approved drawing.

A.3.3.6 Staples. All staples used to secure strapping to components of the unit load should be commercial staples sold by strapping manufacturers for use in securing heavy duty strapping of the size (width) strapping being used in accordance with ASTM F1667 5/16- or 1-inch crown width by 3/4-inch leg length for 3/4-inch strapping, Type IV, Style 3 and 1 17/32-inch crown width by 3/4-inch leg length for 1 1/4-inch strapping. Staples on Fleet Issue Unit Loads of ammunition used on aircraft should only be used if absolutely necessary due to Foreign Object Damage (FOD) concerns around aircraft.

A.3.3.7 Edge protectors. All edge protectors should be zinc-coated steel of the standard commercial size for the size of strapping used on the unit load. When fiberboard box items are unitized, fiberboard edge protectors in accordance with ASTM D4727/D4727M, Type CF, weather resistant, Variety DW, Grade V3C can be used.

A.3.3.8 Wood (lumber). Wood (lumber) used in the construction of unit loads (for spacers, battens, fill material, etc.) should be in accordance with Voluntary Product Standard PS 20-10 or ASTM D6199, whichever is required by each approved drawing. When ASTM D6199 is cited, the wood should be Grade 2, Class 2, Group II, III, or IV. Commercial dimensional lumber (dressed softwood) should be considered first. If stronger wood is required for the application, hardwoods can be used. All coniferous wood pallets and containers produced of non-manufactured wood should be constructed from heat treated (heat treated to 132.8 °F [56 °C] for 30 minutes) material. The wood should be certified by an accredited agency recognized by the American Lumber Standards Committee (ALSC) in accordance with non-manufactured wood packing policy and non-manufactured wood packing enforcement regulations.

A.3.3.8.1 Selecting lumber. All unitizing lumber should be selected from sound lumber, free from dry rot, knots, knot holes, checks, or splits which will affect its strength or interfere with proper nailing. Knots, knot holes, checks, splits, or other defects are permitted in lumber as long as they do not impair the strength of the unit load. Reclaimed lumber should also meet the requirements of ISPM 15. Reclaimed dunnage lumber may be used provided the following:

a. There are no splits, cracks, or knots.

b. All nails have been removed. Nail holes are acceptable as long as they have not caused splits in the lumber.

c. The wood remains structurally sound.

d. There is no evidence of rot or decay.

A.3.3.9 Plywood. All plywood used in the construction of unit loads should be in accordance with A-A-55057, industrial plywood, Type A, interior plywood with exterior glue, Grade C-D, or exterior plywood, Grade C-C. The thickness of the plywood should be as required by each approved drawing. If a specified grade is not available, a better interior or an exterior grade may be substituted.

A.3.4 General principles of unitizing or palletizing. The following general principles should be followed for good unit loads and safe work practices:

a. Know the characteristics of the material being unitized and observe all precautions applicable thereto.

b. Use the proper unitizing equipment, materials, and tools.

c. Examine equipment, e.g., pallets, adapters, etc., to ensure that it is, in all respects, completely suitable for use.

d. Follow an approved unitizing or palletizing procedure when assembling a unit load.

e. All components of the unit load (package containers or items, adapters, frames, battens, etc.) should be snug, tight, and squared up.

f. Position strapping around the unit load with applicable battens, adapter frames, edge protectors, etc.

g. Wear leather gloves and eye protection (with side shields) or goggles to prevent injury when performing strapping operations. Rapidly uncoiling strapping may cause injury. Direct strapping away from personnel when cutting strapping under tension.

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h. Tension strapping as tight as possible without breaking the strapping or damaging containers or items, metal adapters, or wood dunnage components. Some crushing of the edges of wood package containers and dunnage components is acceptable so long as there is no cracking or splitting of the wood. All straps should be in one piece.

i. When necessary, staple strapping to wood dunnage components. Do not staple to any containers or lading items.

j. Insensitive munitions requirements may require a specially designed barrier or specific orientation of the munitions. This will be item specific and dictated by the design agent for the weapons system.

k. Inspect all unit loads in accordance with A.6 to verify the suitability of the unit loads for safe and efficient shipping, handling and storage, or stowage.

A.3.4.1 General nailing procedure. The proper application of nails will ensure the necessary holding power without the risk of splitting the lumber and affecting the integrity of the unit loads. Some general rules for nailing which have gained acceptance are listed below.

a. Except when required by approved drawings, end grain nailing should be avoided. Use sufficient nails. Balanced nailing is important. Stagger nails along the piece being nailed. Do not nail along one grain of wood. Whenever possible, drive nails straight; do not toenail unless required by specified construction requirements.

b. Generally, no nail should be driven closer to the end of the piece of lumber than the thickness of that piece, or closer to the edge than half the thickness of the piece holding the nail head.

c. When pieces are of different thicknesses, the nail head should be in the thinner piece.

d. Never nail directly to the items or containers being unitized.

e. Avoid nailing through the strap slots in the pallet.

A.3.4.2 Strap threading for metal pallets (MK 3 and MK 12 MOD 0 and 1). Straps running parallel to the base runner of the pallet should be threaded between the deck wires of the pallet (see figure A-1). The straps at the ends of the pallet should be passed under the bottom of the pallet wires. This provides added strength to hold down the load. Straps running at right angles to the base runner of the pallet should pass under the deck wires.

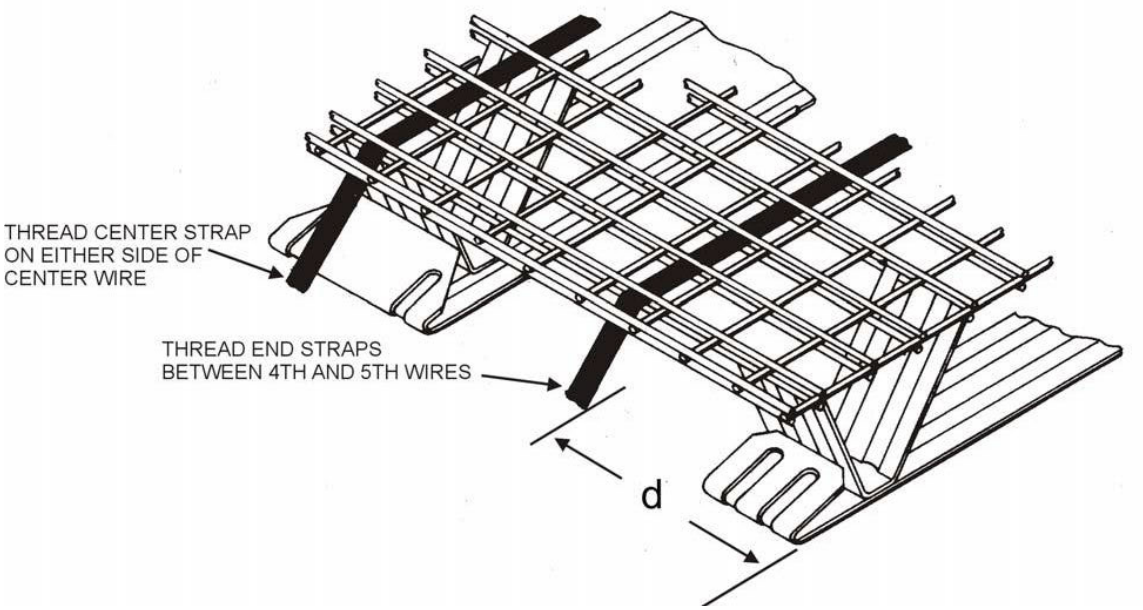

FIGURE A-1. Strap threaded between the deck wires of a pallet.

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A.3.4.3 MK 12 MOD 0 and MK 12 MOD 1 pallets. The MK 12 MOD 0 and MK 12 MOD 1 pallets are interchangeable when constructing unit loads. When substituting pallets, care should be taken to thread the straps between the pallet wires so the straps are the same distance (d) from the edge of the unit load. The location of the straps will be load specific and should be shown on the drawings. Figures A-1 and A-2 show the strap threading difference between the MK 12 MOD 0 and MK 12 MOD 1 pallets.

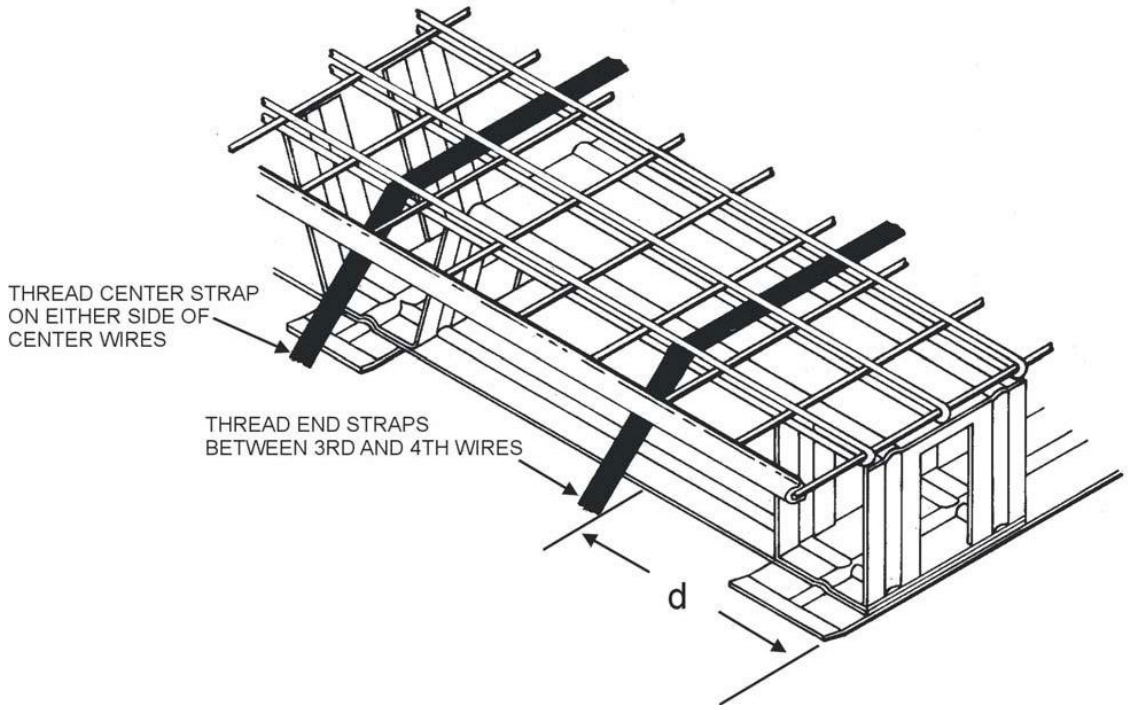

FIGURE A-2. MK 12 MOD 0 pallet (strap threading).

A.3.4.3.1 Strap threading for MK 12 MOD 0 and MK 12 MOD 1 pallets. When threading straps between the deck wires of the MK 12 MOD 1 pallet, the strap should be positioned at the same distance (d) from the edge of the pallet deck as specified for the MK 12 MOD 0 pallet by counting one additional deck wire from the edge of the pallet deck. This variable is illustrated on figures A-1 and A-2 for single pallets and figures A-3 and A-4 for double-pallet unit loads. When a unit load requires double pallets, both pallets should be of the same MOD. When a double-pallet wide unit load is required, straps between the two pallets are used to interconnect the two separate pallets. Two straps are required, one on each end.

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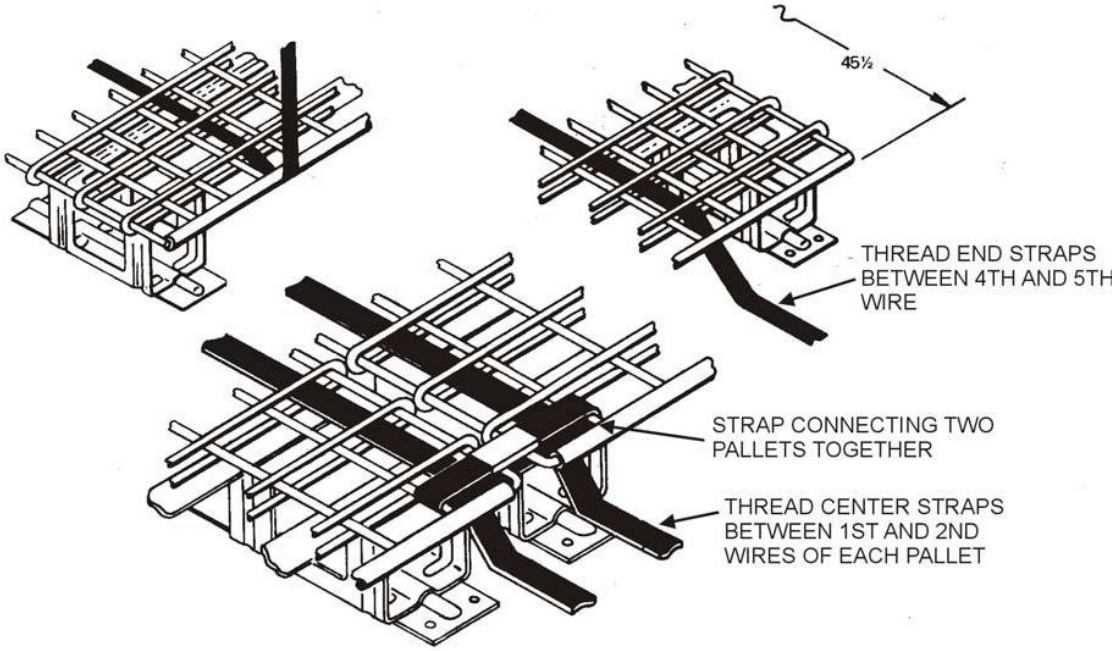

FIGURE A-3. MK 12 MOD 0 pallet (double-pallet strap threading).

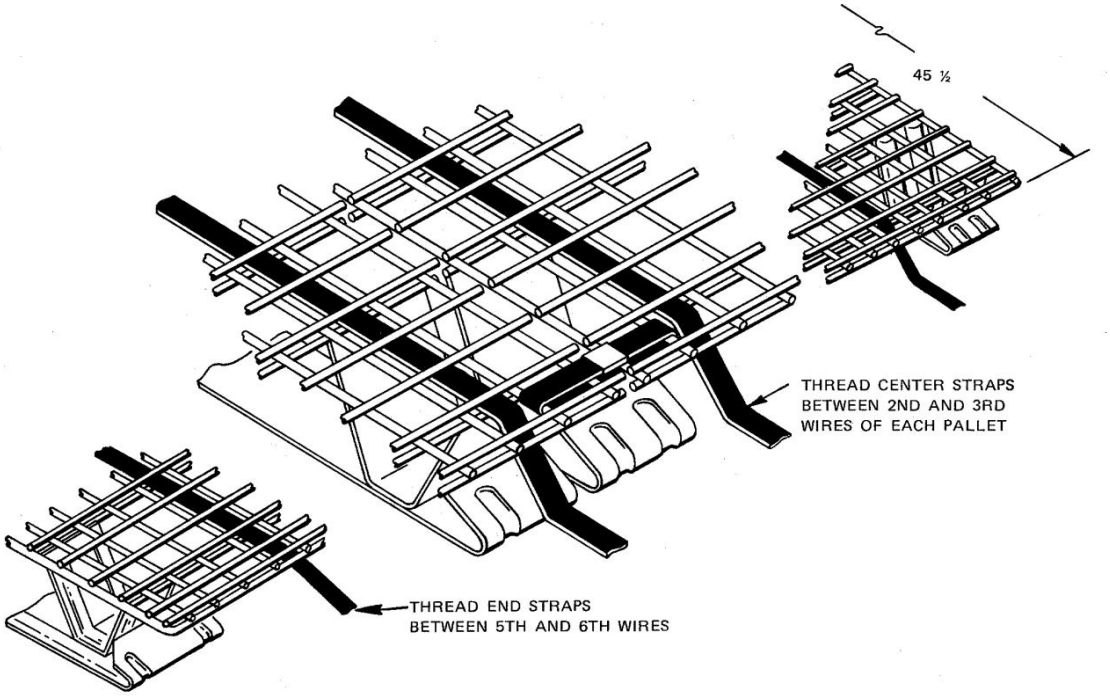

FIGURE A-4. MK 12 MOD 1 pallet (double-pallet strap threading).

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A.3.4.3.2 Pallet height. The MK 12 MOD 1 pallet height is 4¾ inches instead of 5⅛ inches for the MK 12 MOD 0 pallet. When the MOD 1 pallet is used, the overall unit load height will be reduced by ⅜ inch. MIL-DTL-15011 Class 1 pallet heights are 5½ inches.

A.3.5 Unit load marking. In addition to any special marking required by the contract, all unit loads should be marked in accordance with Army Drawing ACV00561 and the following:

a. The unit load gross weight and cube should not be marked on items or containers. These markings should be placed on fiberboard panels or on tags using materials and methods described in Army Drawing ACV00561. If Navy Drawing 6214251 is specified on an existing drawing, use Army Drawing ACV00561 in its place.

b. All unit loads containing explosives or other hazardous materials should be marked and labeled in accordance with SW020-AG-SAF-010 and 49 CFR 172.

A.3.6 Deunitizing (depalletizing) procedures. Safe handling and deunitizing of A&E is achieved by use of the following general procedures:

a. Move the unit load to a clear area near the point of use or strikedown.

b. If required, square up the unit load so that the unitized items will be stable on the pallet when strapping is removed. Where necessary, support items to prevent them from toppling from the pallet. When load is stable, cut strapping.

c. Wear leather gloves and eye protection (with side shields) or goggles to prevent injury when performing strapping operations. Rapidly uncoiling strapping may cause injury. Direct strapping away from personnel when cutting strapping under tension.

d. Remove strapping from the unit load and clear the area of cut straps. Strapping should be folded several times and disposed of in a refuse container or other place where it will not be a hazard to personnel or handling equipment and where reuse of the strapping will be prevented.

e. Remove battens, frames, edge protectors, etc., and clear this material from the working area for possible reuse.

f. Remove contents from the unit load.

g. Return the metal pallets and pallet adapters to the stock system for reuse.

A.4 PARTIAL UNIT LOADS

A.4.1 General. Partial unit loads can be classified as either reduced layer loads or less than full layer loads.

A.4.1.1 Reduced layer unit load. A reduced layer unit load is one that does not maximize the full design of a unit load and has one or more layers removed.

A.4.1.2 Less than full layer unit load. A less than full layer unit load is one that does not have the required commodities to complete a layer. In this situation a filler assembly should be designed to take up the space of the missing commodities. The filler assembly should be as structurally strong as the commodity. Empty boxes (preferably rejects) may be used, provided the boxes are marked as empty and the empties are located on the top layer of the unit load.

A.4.2 Criteria to use for partial unit loads. The use of partial unit loads is to be avoided by filling requisitions/allowances to the nearest full unit load. Where insufficient quantities or operational circumstances dictate less than a full unit load, one partial unit load consisting of one or more complete layers of items or containers may be used. Filler assemblies should be used to fill out layers. Small quantities can be shipped individually.

A.4.3 Partial unit load construction. Except for unit load height (reduced number of layers), the partial unit load should be constructed in accordance with this document or an approved drawing. The height of battens, spacer frames, etc., should be reduced to maintain the same relationship with the top surface of the unit load.

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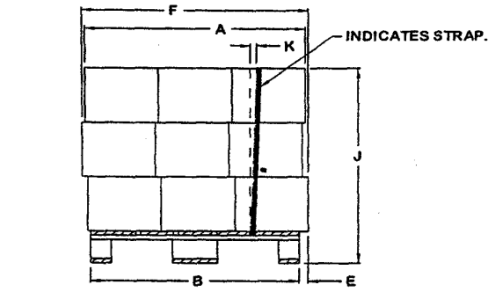
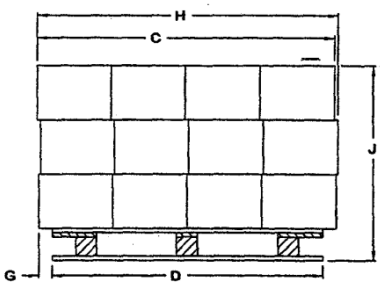
A.5 TOLERANCES FOR UNIT LOAD ASSEMBLY

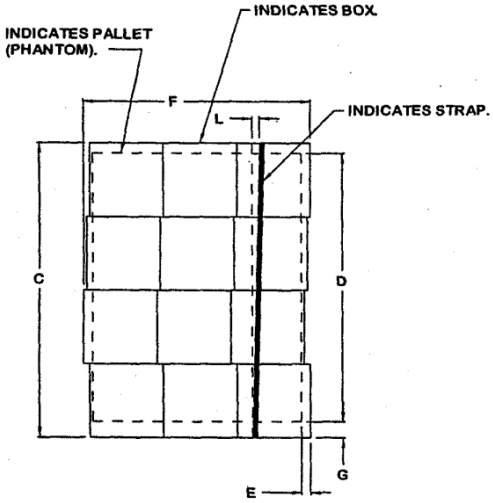
Unit loads should be assembled in a manner to maximize space. Components in the unit load should be positioned in a tight configuration. When stacked, the items should be vertically aligned to the items they are stacked on. Strapping on all sides of the unit load should be straight up and down and not at an angle. Figure A-5 shows allowable tolerances for unit load construction.



UNIT LENGTH VIEW



UNIT WIDTH VIEW



UNIT TOP VIEW

SPECIAL NOTES:

1. DIMENSIONS APPLICABLE TO ALLOWABLE TOLERANCES ARE EXPRESSED IN INCHES AND IDENTIFIED BY LETTERS AS FOLLOWS.

   A = UNIT LENGTH

   B = PALLET LENGTH

   C = UNIT WIDTH

   D = PALLET WIDTH

   E = LENGTHWISE OVERHANG = $\frac{A-B}{2}$ WITH A PLUS OR MINUS 1/2" TOLERANCE FOR EACH LAYER AND FOR EACH STACK

   F = ALLOWABLE UNIT LENGTH = "A" PLUS 1/2" MAXIMUM

   G = WIDTHWISE OVERHANG = $\frac{C-D}{2}$ WITH A PLUS OR MINUS 1/2" TOLERANCE FOR EACH LAYER AND FOR EACH STACK

   H = ALLOWABLE UNIT WIDTH = "C" PLUS 1/2" MAXIMUM

   J = UNIT HEIGHT

   K = VERTICAL STRAP ALIGNMENT = $\frac{J}{40}$ = MAXIMUM INCHES FROM TRUE ALIGNMENT (E.G., IF J = 50", K = $\frac{50"}{40"}$ = 1-1/4" MAX)

   L = TRANSVERSE STRAP ALIGNMENT = $\frac{C}{40}$ = MAXIMUM INCHES FROM TRUE ALIGNMENT (E.G., IF C = 55", L = $\frac{55"}{40"}$ = 1-3/8" MAX)

2. BOX ALIGNMENT TOLERANCES APPLY TO EACH LAYER AND TO EACH STACK RELATIVE TO THE PALLET DECK.

3. STRAPPING TOLERANCES APPLY TO ALL STRAPS AND TO ALL SURFACES WHICH EACH STRAP ENCOMPASSES, I. E., TOP, BOTTOM, AND BOTH SIDES.

FIGURE A-5. Allowable tolerances for assembling units.

A.6 OPERATION AND PRODUCTION CONTROL OF STEEL STRAP JOINT SEALING EQUIPMENT

A.6.1 General. The integrity of a unit load and, therefore, safety of ammunition handling operations, is dependent upon the strength of the steel strapping holding the unit load together. Since the joint seal of each strap on a unit load is the weakest link in the strap, it is necessary to maintain the required tensile strength of each seal joint produced. To do so requires close control over the operation (use) and capability of the seal joint notching equipment.

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A.6.2 Operation (use) of equipment.

A.6.2.1 Hand-operated notch tools. When using hand-operated tools to create notched-seal joints, each seal should be visually inspected to ensure that all of the following conditions are met:

a. The strapping and seals are manufactured to the proper specifications (see A.3.3.3 and A.3.3.4).

b. The ends of both straps joined by the seal are visible on either end of the seal.

c. Each seal consists of two notches which are approximately centered and equally spaced on the seals (see figure A-6).

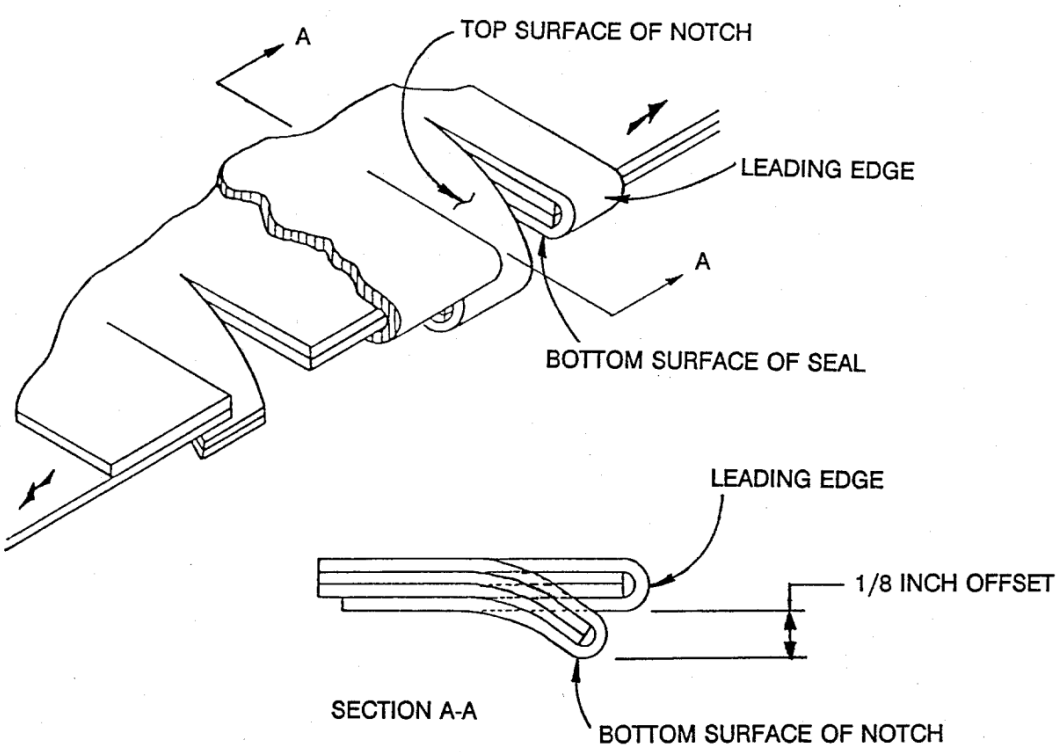

FIGURE A-6. Typical notched-seal joint.

d. The bottom surface of the notch is offset at least ⅛ inch from the bottom surface of the seal or approximately four times the thickness of the strapping (see Section A-A on figure A-6). This condition creates a separation between the leading edge of the notch and the balance of the seal. A properly functioning sealer tool should accomplish this if the person using the tool closes the handles all the way when creating the notch.

A.6.2.2 Power equipment. When using air power tensioning and sealing equipment, the manufacturer's air pressure and lubrication recommendations should be maintained at all times. Each seal should be visually inspected to ensure that A.6.2.1.a through A.6.2.1.d are met.

A.6.2.3 Equipment capability control. Periodic testing of notch tools is no longer a requirement. However, should any doubt arise as to the effectiveness of a particular notch tool, the tool may still be tested in accordance with A.6.2.4 and A.6.2.5.

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A.6.2.4 Test specimen. All test specimens should consist of the same notched-seal strap combination to be used in the production of unit loads. Each test specimen should have unaltered strapping (not bent, notched, etc.) adjoining the notched-seal joint and should be free of any welded joint in the strapping. The length of the test specimen should be at least 18 inches overall and at least 12 inches between the tensile tester grip areas. The joint should be midway between the tester grip areas.

A.6.2.5 Tensile test. Test specimens in accordance with A.6.2.4 should be subjected to a tensile test in a tensile testing machine capable of performing at the loads and speed rate required. Normally, such a device is available in a commercial or Government quality evaluation laboratory. The specimen should be tested in accordance with the following procedure:

a. Place the test specimen in the grips of a calibrated tensile tester so that the load is transmitted axially to the joint of the specimen.

b. Activate the tensile tester and apply the load to the test specimen until it reaches 500 pounds above the minimum value required or until it fails.

c. Record the results as follows:

(1) Failed below 1,900 pounds for ¾ inch or 3,000 pounds for 1¼ inches.

(2) Failed beyond A.6.2.5.a, but before the test limit; i.e., 2,400 pounds for ¾ inch and 3,500 pounds for 1¼ inches.

(3) Failed beyond test limit, see A.6.2.5.b above.

A tensile tester pull rate of approximately 0.2 inch per minute should be used.

A.7 PRESHIPMENT INSPECTION AND REFURBISHMENT REQUIREMENTS FOR UNIT LOADS IN SERVICE

A.7.1 General. This section gives guidelines for preshipment inspection and refurbishment, if necessary, of unit loads of A&E for domestic and overseas shipment to assure the safety and adequacy for handling and shipment after possible degradation over extended periods of storage. It should also be used to determine the adequacy of the WPM for future shipments. Many unit loads of ammunition were prepared before the requirements of ISPM 15. However, DoD 4140.65-M policy requires that shipping activities verify WPM compliance prior to shipping material internationally.

A.7.2 Safety. The safety of A&E handling operations is dependent upon the integrity of the unit load. After extended periods of time or numerous handling operations, the integrity of unit loads can be adversely affected. The condition of each unit load should be inspected and refurbishment performed as necessary to assure the safety of subsequent shipping and handling operations. Details of each situation, such as transportation mode, subsequent handling of the shipment, and the end use (disposition) of the material, should be considered in establishing the functional adequacy in accordance with the guidelines provided in this section. Inspection and refurbishment should be performed as part of the preparation for shipment or transfer of hazardous materials regardless of the condition of the unit load. All accessible areas should be examined to determine the weakest part of the load.

A.7.3 Detailed guidelines.

A.7.3.1 Strap corrosion. Strapping on unit loads should show no reduction in strap width, ragged strap edges, or heavy rust scale with readily visible pitting (scale should be removed in a small area by scraping to inspect for pitting). Strapping showing this kind of questionable strength should be replaced.

A.7.3.2 Strap looseness. Unit load strapping should be inspected for looseness by pulling the side strapping (vertical area) away from the load with a force of 20 pounds and measuring the distance the strap moves away from the unit load (do not measure from the indented area of the load). If it can be moved more than 1½ inches, the strap should be retensioned, or replaced as follows:

a. Steel strapping, which has been applied and tensioned around metal items, containers, metal edge protectors, bomb pallets, metal pallet adapters, or metal hardware on wood containers should not be retensioned, but should be replaced when loose.

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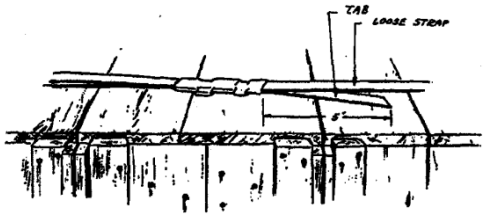
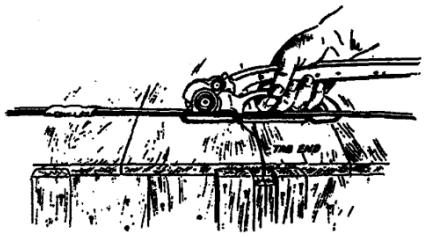
b. Steel strapping, which has been tensioned and sealed on a unit load of wood containers or a unit load where the strapping is around wood adapters or wood edge protectors, may be retensioned by the method shown on figure A-7 provided the strap has at least a 5-inch long tab at the seal. Except for the standard metal pallets, strapping should not have corner bends around any metal objects when this method is used. When retensioning, the corner bends in the strapping should be in the same position they were in when the strapping was originally tensioned. Strapping that has been damaged in any way should not be retensioned but should be replaced. For unit loads without a 5-inch long tab, an 18-inch or longer strap can be used as a splice piece. Cut the loose strap on both sides of the original seal and discard the cutout section. Overlap one end of the original strapping so as to protrude slightly beyond the end of the seal to be used. Position and secure seal to overlapped section with two pair of notches. Using a strapping tool, tension and seal the lengthened strap. The strap splice piece may be cut from a new strap or used strap, provided it is at least as good a quality as the strap to which it is being secured.

c. Only one splice per strap is allowed on unit loads of ammunition.

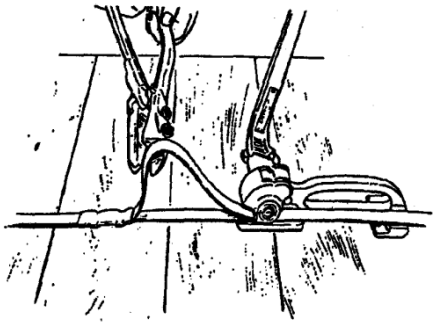
d. When a strap is replaced, spliced, or retensioned, and the other straps on a unit load are not, care should be exercised to ensure that the tension on the affected strap is nearly the same as that of the others.



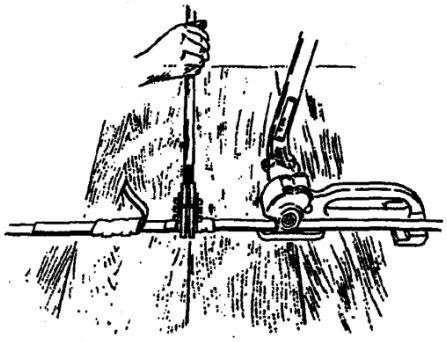
(a) Inspect strapping band for damage and for minimum 5-inch tab length.



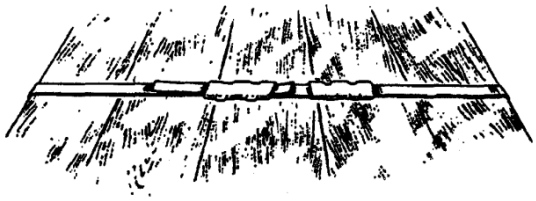
(b) Position feedwheel type tensioner at end of tab and tension strap.



(c) Cut strap loop near existing seal.



(d) Position a snap on seal on the strap and double notch the seal.



(e) Remove tensioner and cut off excess strapping adjacent to original seal.

FIGURE A-7. Strap retensioning.

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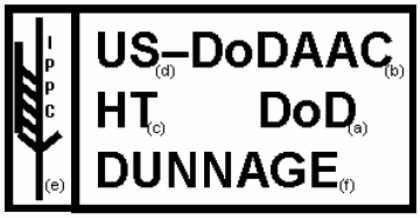
A.7.3.3 Pallets and adapters.

A.7.3.3.1 Special purpose metal pallets. Special purpose metal pallets should be inspected to the extent possible for defects that reduce sturdiness or usability. Pallets with inadequate or missing welds or other signs of damage that will affect their strength or usability should be rejected.

A.7.3.3.2 Metal pallet adapters. Metal pallet adapters should be visually inspected for any defects which reduce sturdiness or usability. Adapters with inadequate or missing welds or other signs of damage that will affect their strength or usability should be rejected.

A.7.3.3.3 Wood pallet adapters. Wood pallet adapters should be visually inspected for defects that reduce sturdiness or usability. Adapters with loose, broken, or missing boards, or protruding or missing nails, should be rejected.

A.7.3.3.4 Wood packaging materials (WPMs). Check WPMs to ensure the materials meet the requirements of ISPM 15. Ensure pallet is marked and all dunnage has visible ISPM 15 marking. This marking should be present, though it is not always required for domestic-only shipments. In some cases, return shipments may have DoD pest-free marking on them. All inspectors or unit load fabricators of unit load with WPMs should have WPM training. The DoD training site as of the publication of this document is https://tarp navsisa navy mil/wpm. Figures A-8 and A-9 show the makeup of DoD component certification markings.



NOTES:

1. The marking “TRADEMARK” (a) represents the logo of the U.S. services that can be displayed under the Department of Defense Activity Address Code (DoDAAC).
2. DoD components certification marking display the letters “US” in bold (d), the packaging activity’s DoDAAC (b), and either “HT,” denoting heat treated WPM, or “MB,” denoting WPM fumigated with Methyl Bromide (c).
3. Item (e) is the approved international symbol for compliant WPM.
4. The marking “DUNNAGE” (f) is used strictly for dunnage; otherwise it is left blank.

FIGURE A-8. Old ISPM 15 marking.

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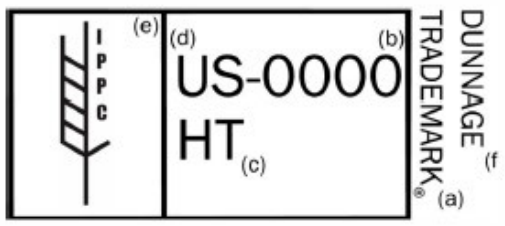

NOTES:

1. The marking “TRADEMARK” (a) represents the logo of the U.S. services that can be displayed under the DoDAAC.
2. DoD components certification marking display the letters “US” in bold (d), the packaging activity’s DoDAAC (b), and either “HT,” denoting heat treated WPM, or “MB,” denoting WPM fumigated with Methyl Bromide (c).
3. Item (e) is the approved international symbol for compliant WPM.
4. The marking “DUNNAGE” (f) is used strictly for dunnage; otherwise it is left blank.
5. In many of the newer commercial markings, the “TRADEMARK” (a) and word “DUNNAGE” (f) may be outside the box. In addition, a facility number replaces the DoDAAC (b).

FIGURE A-9. New ISPM 15 marking.

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TRUCKLOADING OF AMMUNITION AND EXPLOSIVES

B.1 INTRODUCTION

B.1.1 Scope. This appendix establishes the approved methods for the preparation of full-truckload (FTL) and less-than-truckload (LTL) shipments of ammunition, explosives, and associated items. This appendix applies to highway and tactical movement only. It also contains guidance to be followed in all truckloading procedures when specific instructions are not available. Where a drawing exists for a given item, the loading, blocking, and bracing procedures shown in the drawing should be followed without exception for FTL and LTL. This appendix is not a mandatory part of the standard. The information contained herein is intended for guidance only.

B.2 APPLICABLE DOCUMENTS

B.2.1 General. The documents listed in this section are specified in this appendix. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in this appendix, whether or not they are listed.

B.2.2 Government documents.

B.2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this appendix to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

COMMERCIAL ITEM DESCRIPTIONS

A-A-55057	-	Panels, Wood/Wood Based; Construction and Decorative

(Copies of this document are available online at http://quicksearch.dla mil.)

B.2.2.2 Other Government documents, drawings, and publications. The following other government documents, drawings, and publications form a part of this appendix to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ARMY DEFENSE AMMUNITION CENTER DOCUMENTS

Joint Hazard Classification System (JHCS)

TP-94-01	-	Transportability Testing Procedures

(Copies of JHCS are available online at https://www3.dac.army mil. Copies of TP-94-01 are available online at https://www3.dac.army mil/DEV/.)

CODE OF FEDERAL REGULATIONS (CFR)

49 CFR	-	Transportation
49 CFR 105-199	-	Pipeline and Hazardous Materials Safety Administration, Department of Transportation
49 CFR 172	-	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans
49 CFR 177.835	-	Carriage by Public Highway, Class 1 Materials
49 CFR 386	-	Rules of Practice for Motor Carrier, Intermodal Equipment Provider, Broker, Freight Forwarder, and Hazardous Materials Proceedings
49 CFR 393	-	Parts and Accessories Necessary for Safe Operation

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49 CFR 393.100	-	Parts and Accessories Necessary for Safe Operation, Which Types of Commercial Motor Vehicles are Subject to the Cargo Securement Standards of this Subpart, and What General Requirements Apply?
49 CFR 393.108	-	Parts and Accessories Necessary for Safe Operation, How Is the Working Load Limit of a Tiedown, or the Load Restraining Value of a Friction Mat, Determined?
49 CFR 393.110	-	Parts and Accessories Necessary for Safe Operation, What Else Do I Have to Do to Determine the Minimum Number of Tiedowns?

(Copies of these documents are available online at http://www.ecfr.gov.)

DEPARTMENT OF DEFENSE PUBLICATIONS

DD Form 626	-	Motor Vehicle Inspection (Transporting Hazardous Materials)
DoD 4140.65-M	-	Issue, Use, and Disposal of Wood Packaging Material (WPM)

(Copies of these documents are available online at www.dtic.mil/whs/directives/.)

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

Voluntary Product Standard PS 20-10 - American Softwood Lumber Standard

(Copies of this document are available online at http://gsi nist.gov/global/index.cfm/L1-5/L2-44/A-355.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

OP5	-	Ammunition and Explosives Ashore
SW020-AF-HBK-010	-	Motor Vehicle Driver and Shipping Inspector's Handbook for Ammunition, Explosives and Related Hazardous Material
SW020-AG-SAF-010	-	Navy Transportation Safety Manual for Ammunition, Explosives and Related Hazardous Materials

(Copies of NAVSEA OP publications are available from the Naval Ordnance Safety and Security Activity (NOSSA N7), 3817 Strauss Ave., Suite 108, Indian Head, MD 20640-5151. Copies of all other NAVSEA publications are available online at https://nll.ahf nmci navy mil, may be requested by phone at 215-697-2626, or may be requested by email at nllhelpdesk@navy mil.)

U.S. ARMY PUBLICATIONS

AR 740-1	-	Storage and Supply Activity Operations
DA PAM 385-64	-	Ammunitions and Explosives Safety Standards
TM 38-400	-	Joint Service Manual (JSM) for Storage and Materials Handling

(Copies of these documents are available online at http://www.apd.army.mil/.)

U.S. TRANSPORTATION COMMAND (USTRANSCOM)

DTR 4500.9-R - Defense Transportation Regulations

(Copies of this document are available online at http://www.transcom.mil/dtr/dtrHome/.)

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B.2.3 Non-Government publications. The following documents form a part of this appendix to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN ASSOCIATION OF RAILROADS

Intermodal Loading Guide for Products in Closed Trailers and Containers

(Copies of this document are available online at https://www.aarpublications.com/.)

ASTM INTERNATIONAL

ASTM A853	-	Standard Specification for Steel Wire, Carbon, for General Use
ASTM D3953	-	Standard Specification for Strapping, Flat Steel and Seals
ASTM F1667	-	Standard Specification for Driven Fasteners: Nails, Spikes, and Staples

(Copies of these documents are available or online at www.astm.org.)

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

ISPM 15 - Guidelines for Regulating Wood Packaging Material in International Trade

(Copies of this document are available online at http://www.maff.go.jp/pps/j/konpozai/pdf/ISPM_15_English_2006.pdf.)

NATIONAL ASSOCIATION OF CHAIN MANUFACTURERS (NACM)

Welded Steel Chain Specifications

(Copies of this document are available online at http://www nacm.info/welded.php.)

B.2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

B.3 GENERAL GUIDANCE

B.3.1 Load movement. Under normal transportation conditions, the lading is subjected to vertical, lateral, and longitudinal forces that could cause a loosening of the load and may allow some movement of the lading. Blocking and bracing of the lading should be sufficient to control movement that could cause accidental damage to, or ignition or detonation of, the lading. The loads should be secured in a manner to resist these forces.

The forward movement of loads not properly braced is primarily caused by braking of the vehicle on steep descents or by sudden stops. Rearward movement is primarily caused by ascension of steep hills, load rebounds after the sudden application of brakes, or sudden increase of speed. Lateral movement is the result of rounding corners or sharp curves, traveling on high crowned or banked roads, or by swerving. Vertical movement is caused by vibration or traveling over rough terrain.

The Federal Motor Carrier Safety Administration has adopted the following performance requirements of 0.8 force/gravitational force (g) deceleration in the forward direction and 0.5 g acceleration in the rearward and lateral directions, that cargo securement systems should be capable of withstanding, applied separately. These values were chosen based on analysis that indicated that the highest deceleration likely for lightly loaded vehicles with an antilock brake system at optimal performance is in the range of 0.8 – 0.85 g. However, a typical loaded vehicle would not be expected to achieve a deceleration greater than 0.6 g on a dry road. The typical lateral acceleration while driving in a curve or on a ramp at the posted advisory speed is in the range 0.05 – 0.17 g. Loaded vehicles with a high center of gravity roll over at a lateral acceleration above 0.35 g. Lightly loaded vehicles, or heavily loaded vehicles with a lower center of gravity, may withstand lateral acceleration forces greater than 0.5 g. Cargo immobilized or secured in accordance with 49 CFR 393 are considered to meet these requirements.

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B.3.2 Control of load movement considerations. Load movement can be controlled by proper blocking, bracing, and recurrent methods. All loads should be properly distributed in the vehicle lengthwise and crosswise and adequately blocked and braced before the vehicle is moved. Shipping activities are reminded that failure to properly load, block, and brace hazardous materials shipments is in violation of 49 CFR 386 and may subject all personnel involved to civil or criminal penalties.

B.3.2.1 Van trailer considerations.

a. Forward movement in vans can be controlled by placing the lading directly against the front end wall, when weight distribution requirements allow this. Other methods that may be used to control forward movement include: the use of forward blocking assemblies, spacer assemblies, and nailed headers. For vans with rounded front corners, a forward blocking assembly is often required to "square off" the front wall. Forward blocking assemblies are also used to assist in evenly distributing the weight of the load in the van. Nailed headers are the method of choice for those vans with nailable floors.

b. Rearward (aft) movement in vans can be controlled by the use of aft end blocking assemblies, end gates, spacer assemblies, and nailed headers. K-braces or large spacer assemblies may be required for less-than-full-loads. Aft end blocking assemblies are also used to assist in evenly distributing the weight of the load in the van. Nailed headers are the method of choice for those vans with nailable floors. If the space at the rear of the load between the load units and the rear doors measures 1½ inches or less and the van does not have roll-type doors, rear blocking is not required.

NOTE: Rear (aft) blocking assemblies may be replaced with nailed headers at the rear of the load, provided the trailer is configured such as to allow nailing in the area in question.

NOTE: The nailed header method at the rear of the load is required when loading van trailers equipped with roll-up type doors.

c. Lateral movement can be controlled in vans by rails, floating side blocking sway braces between rows, filler assemblies between the rows, or side blocking assemblies between the lading and the side wall of the van. The unblocked space across the width of a load bay should not exceed 1.5 inches total for blocking assemblies. Unblocked space should be avoided wherever possible as 49 CFR 393.100 requires loads to be prevented from movement relative to the vehicle that could affect the stability of the trailer.

B.3.2.2 Flatbed trailers or trucks. Tiedowns should meet 49 CFR 393.110 to ensure friction between the trailer and the lading meets the legal requirement for restraint on flatbed trailers. Ammunition and explosive (A&E) flatbed trailer loads always use wood blocking against the base of the load as a secondary method to protect from the possibility of improperly secured strapping and to help restrain the cargo in case of an accident. Therefore, A&E loads currently use trailers with wooden decks.

a. Rearward (aft) movement restraint consists of nailed headers.

b. Lateral movement restraint consists of nailed side blocking. Sway braces secured to the lading may also be required, depending on how the load units are distributed on the flatbed truck/trailer.

c. Lading on flatbed trucks/trailers requires positive vertical restraint. This restraint should be provided by the use of over-the-load web strapping, steel strapping, or chains. When the lading is more than two rows across the trailer, a purchase board should be used. A purchase board is a board that is added to the strapping or chain board to provide downward force to middle rows. See figure B-1.

d. Bundling of load units may be required as part of a forward, rearward (aft), or lateral load restraint method, depending on the conveyance, the configuration of the lading in the conveyance, or the configuration of the lading itself.

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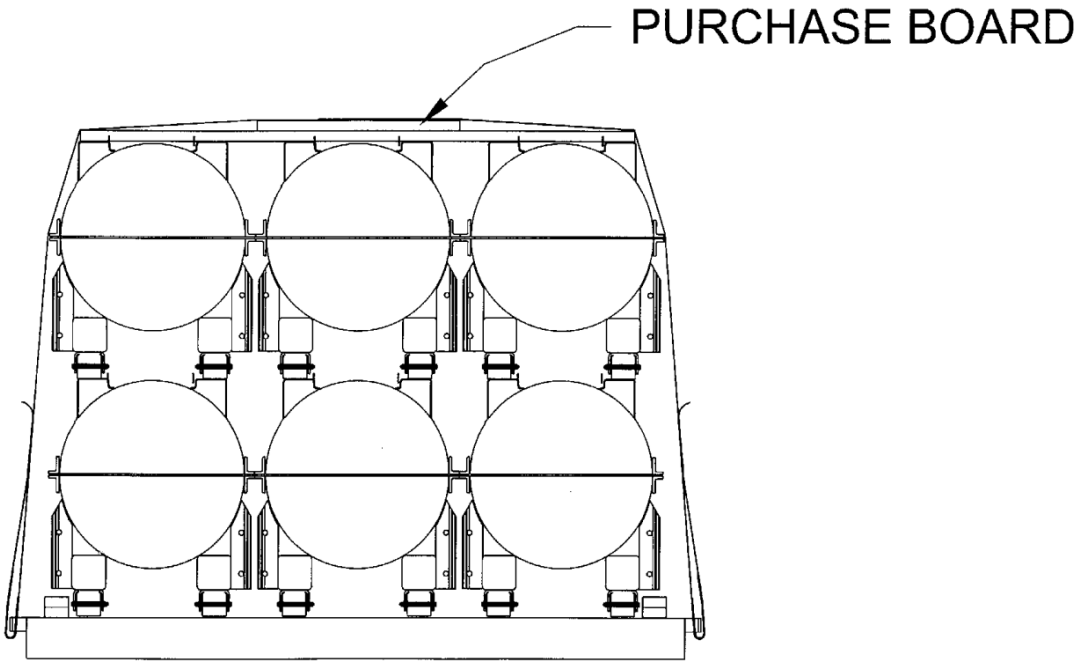

FIGURE B-1. Example purchase board.

B.3.3 Size and weight limitations. The laws governing the size and weight limitations of vehicles are constantly changing. Since the trend is toward longer trailers, greater gross axle weights, and greater gross weights, many published drawings do not reflect these changes. Drawings permitting a greater number of items to be shipped with the resultant heavier gross weights are being revised on an as-needed basis. Newly produced drawings permit loads consistent with the law at the date of issue of the drawing. Shipping activities desiring to ship a greater number of items, load vehicles to a heavier weight, or use equipment other than specified should obtain authorization to deviate from existing requirements from the approval activities listed in 4.2.

B.4 DETAILED GUIDANCE

B.4.1 General. Shipments of explosives and other dangerous articles should comply with all applicable requirements of special and general federal regulations controlling the shipping and transportation of these materials, including publications AR 740-1 (and augments TM 38-400), DA PAM 385-64, OP5, SW020-AG-SAF-010, SW020-AF-HBK-010, DTR 4500.9-R, and 49 CFR. In addition to the federal regulations governing interstate transportation, each state and nearly all municipalities have regulations or ordinances regulating such transportation within their jurisdiction. Shipments should comply with all these requirements.

B.4.2 Preparation of shipment.

B.4.2.1 Obtain proper load procedures. When planning to move A&E by truck, drawings detailing how a specific item is loaded can be found in several locations listed in 4.7. The approval authorities listed in 4.2 may be contacted for technical assistance in developing and implementing a loading procedure.

B.4.2.2 Type of vehicles. The drawing typically depicts the type of trailer used. Depending on the lading, the drawing may or may not specify the following:

a. Type of vehicle required (usually a van or flatbed).
b. The location of the trailer's tandem axles and whether a sliding tandem is required.
c. The length of the trailer (40, 42, 44, 45, 48, or 53 feet).

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d. The weight of equipment, if special equipment is required.

e. The type of trailer floor authorized (wood, metal, including nailable or non-nailable floors).

f. The width of the trailer (96 or 102 inches).

B.4.2.3 Special requirements. The truckloading requirements of a particular drawing may have some special requirements that should be met. These may be:

a. Chains and load binders – These are carrier supplied and should be ordered with the equipment.

b. Web strapping – These are carrier supplied and should be ordered with the equipment.

c. Fire-resistant and waterproof tarpaulins – These are carrier supplied and should be ordered with the equipment.

B.4.2.4 DOT regulations. DOT regulations for the transportation of hazardous materials on public highways by truck are contained in 49 CFR 105-199. DOT regulations require that every vehicle containing any quantity of ammunition or explosives (hazardous materials) be placarded consistent with the hazard classification of the load. These requirements are listed in 49 CFR 172, SW020-AG-SAF-010, or JHCS.

B.4.2.5 Maximum weights. The carrier is responsible for informing the shipper of the maximum gross vehicle weight and maximum gross axle weights permitted in the routing that the Military Traffic Management and Command Transportation Engineering Agency (MTMCTEA) has assigned the shipment. It is the responsibility of the shipper to load the vehicle in such a manner that these maximum weights are not exceeded. These requirements are listed in SW020-AG-SAF-010 and commercial sources (e.g., J. J. Keller).

NOTE: Users of these tables are cautioned that the various states are constantly changing their size and weight laws and that the table is only accurate as of the date of the table.

B.4.2.6 Motor vehicle inspection. All motor vehicles to be used for the transportation of ammunition or explosives over public highways should be inspected by the shipping activity, using DD Form 626, for compliance with safety regulations prescribed by transportation regulatory bodies and the Department of Defense (DoD). Vehicles noted unsatisfactory on DD Form 626 should not be accepted for loading. Vehicles should not be rejected if deficiencies are corrected before loading. Detailed procedures for load and vehicle inspection, placarding, discrepancy reporting, etc., are contained in DTR 4500.9-R and SW020-AF-ABK-010. Related information may be found in SW020-AG-SAF-010 and SW020-AF-HBK-010.

B.4.2.7 Weighing of vehicles (empty and loaded).

a. Every vehicle that is approved for loading (see B.4.2.6) should be weighed when empty. This provides a tare weight so that it will be possible to determine how much has been loaded on the vehicle. Also, where the tare weight and the weight of the proposed load are added together, it can be determined if the vehicle will exceed the permissible gross vehicle weight. The drawing also may require lightweight vehicles to accommodate heavier loads. Table B-I shows some typical weights for flatbed trailers (these weights are for informational purposes only and will vary from manufacturer to manufacturer). Van trailers run approximately 1,000 to 1,500 pounds higher.

TABLE B-I. Typical weights for flatbed trailers.

Length (feet)	Width (inches)	Trailer weight (pounds)
40	96	1,100
42	96	11,200
45	96	12,500
45	102	13,000
48	96	13,000
48	102	13,500
53	102	14,500

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b. Every loaded vehicle should be weighed prior to its release. This is necessary to verify that the gross vehicle weight and the gross axle weights do not exceed the legal limits imposed by its routing (see B.4.2.5) and DD Form 626. Also, the gross vehicle weight minus the tare weight (less dunnage) is the weight of the lading and provides a check against the given weight of the lading.

B.4.3 Preparing the vehicle. Prior to loading, the vehicle should be swept clean. All protruding nails and obstructions to loading should be removed. Vehicles not meeting inspection requirements should be rejected. All vehicles presented for loading should have been inspected and have a completed DD Form 626.

B.4.4 Loading and unloading of long ordnance items. Each approved truckload drawing should provide detailed instructions for specific items, including long ordnance items. In almost all cases, these documents specify that a flatbed trailer be used for long ordnance items. However, a few do authorize the use of closed equipment when a flatbed trailer is not available and shipment is mandatory. The loading of long ordnance items into a closed van is authorized only when a flatbed trailer is not available and shipment must be made because of military necessity. Blocking, bracing, and tiedowns (where applicable) should be as specified in the appropriate drawing. All activities should truckload long ordnance items as specified by the drawing and as follows:

a. When loading long ordnance items into a closed van, extreme care should be exercised in positioning the item into the conveyance. Approved end handling equipment should be used whenever available. Sliding by pushing or pulling the lading over the floor or deck should be held to a minimum. Long containers should never be stacked in van trailers if they will need to be pushed into or pulled from the trailer.

b. When required to unload long items from a closed van, it may be necessary to pull the item out. Particular care should be exercised to assure that the chain or cable being used has an adequate safe working load for the weight of the item being pulled out and the attachment is secure. Personnel should be cautioned to stand clear of the chain or cable during the pulling process. Do not use fiber or plastic rope for this procedure.

c. Loading of A&E should be in van trailers. They should be designed for loading with common Material Handling Equipment. Van trailers also help prevent public access to the load. Loading containers onto flatbed trailers is also dangerous. Flatbed trailer loading often requires prepositioned blocking, unitizing containers, locating containers against forklift truck masts for movement, and placing the far side of the container flush with the ends of the tines for final placement with the stack elevated slightly above the trailer deck. Use of blocking in far side stake pockets to prevent knocking over existing stacks is also encouraged. Always tarp flatbed trailer loads of ammunition so that the specific type of ammunition shipment cannot be determined. This applies to empty ammunition container loads as well.

B.4.5 Trailer load considerations. Each approved truckloading drawing should provide the correct load pattern for the number of items being shipped and the length of the trailer being loaded. Deviation from the prescribed load pattern could cause uneven weight distribution with possible axle over weight.

B.4.5.1 Weight. The amount of weight that can be shipped is dependent on the laws governing the weight limitations of vehicles discussed in B.4.2.5. The gross vehicle weight in most states should not exceed 80,000 pounds. The tandem axle weights for most states are limited to 34,000 pounds and the single axle weights are limited to 20,000 pounds. The truck tractor-trailer combination should be determined in accordance with the federal bridge weight formula below. Load plans are often prepared to limit axle weights to 32,000 pounds/axle to allow some trailer flexibility and reduce relocation of items at weigh out.

$$W = 500[(LN/N-1) + 12N + 36]$$

Where:

W = maximum weight in pounds that can be carried on a group of two axles to the nearest 500 pounds.

L = spacing in feet between the outer axles of any two or more consecutive axles.

N = number of axles being considered.

B.4.5.2 Length. The length of trailers in use vary and loading activities should be prepared to load any length trailer. The most common van trailer length is 48 feet; however 40-, 42-, 44-, 45-, and 53-foot vans are also available. Alaska, Rhode Island, and the District of Columbia have restrictions on trailers over 48 feet.

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B.4.5.3 Axle location. The location of the trailer's tandem axles is important for the proper weight balance. Some trailers have fixed (nonsliding) axles which are located in the "Western" or "West Coast" setting (at the extreme rear of the trailer). The distance between the rear of the trailer and midway between the two axles of the tandem axles range between 53 and 68 inches. Sliding tandem axles may be required in some cases; however, the tandem axles may be positioned at the extreme rear of the trailer giving a trailer a "Western" setting.

NOTE: When specified in an approved truckload drawing, trailers should have the rear tandem axles located as specified or the gross weights may exceed the maximum permissible weight.

B.4.5.4 Center of gravity (CG). When a van trailer is being loaded to capacity, the length of the trailer determines the load pattern which in turn determines the location of the apparent center of gravity (CG) of the lading. The location of this CG controls how much of the lading's weight will be carried by the trailer's tandem axles and how much will be carried by the tractor's drive axles. Shifting the lading and, thus, the CG forward will put more weight on the tractor's drive axles while shifting the lading aft will put more weight on the trailer's tandem axles.

B.4.5.5 Weight distribution. When designing a truckload with a lading weight of 30,000 pounds, a good rule of thumb is to evenly distribute the weight in/on the trailer between the drive and rear axles. The maximum lading weight for a trailer should be limited to 40,000 pounds. For lading weights over 30,000 pounds, it is recommended that the location of the lading be adjusted to provide an approximate 45 percent forward and 55 percent aft weight distribution between the drive and rear axles (a portion of the weight of the tractor is carried by the drive axle). A distribution different from the recommended 45/55 percent shift should be avoided, since this could cause an unstable trailer load for the carrier.

B.4.5.6 Weight distribution guidance. Figures B-2 and B-3 show the weight distributions factors used to determine how the weight of the load is shared between the rear tandem axles and the drive axles. These factors are based on a kingpin distance at 36 inches from the front wall of the trailer. The distance given in the figures is the distance from the front of the trailer to the CG of the lading. Many states have a restriction on trailers over 48 feet that limit the length from the kingpin to the center of the rear axle or center of rearmost group of axles to 41 feet. This restriction affects trailers greater than 48 feet. Table B-II shows some estimated axle weights for empty tractor-trailers. This is provided for informational purposes only. Tractor and trailer weights vary due to different design and features. Actual weights for the tractor-trailers will need to be determined prior to loading.

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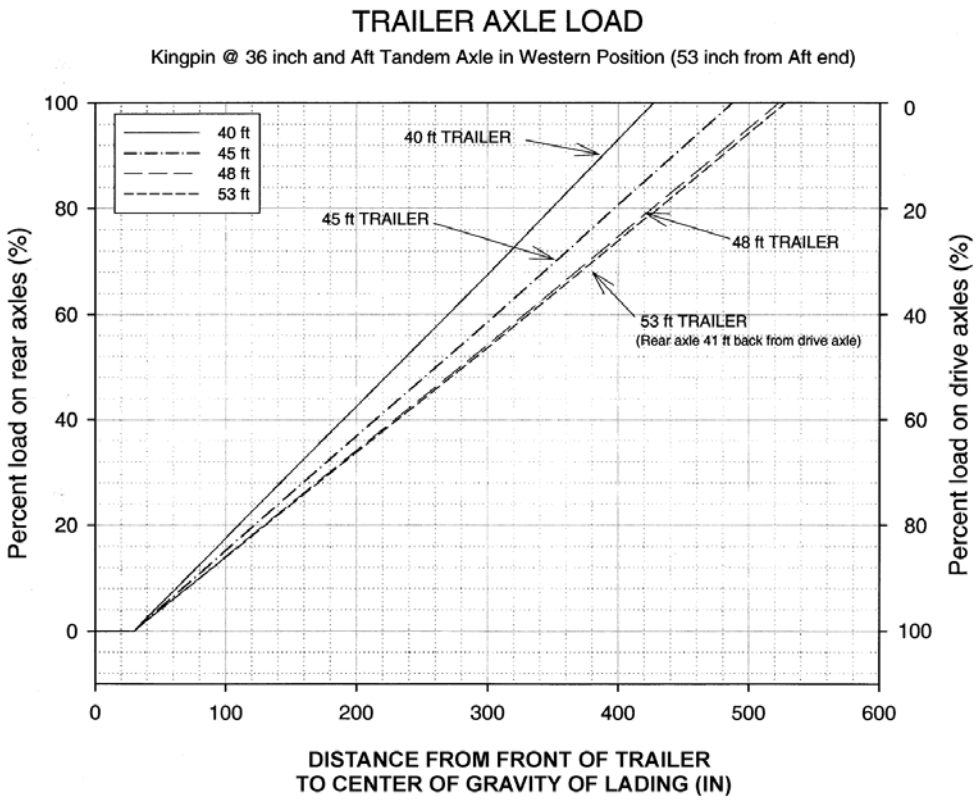

FIGURE B-2 Axle load plot (rear axle 53 inches from aft end of trailer)

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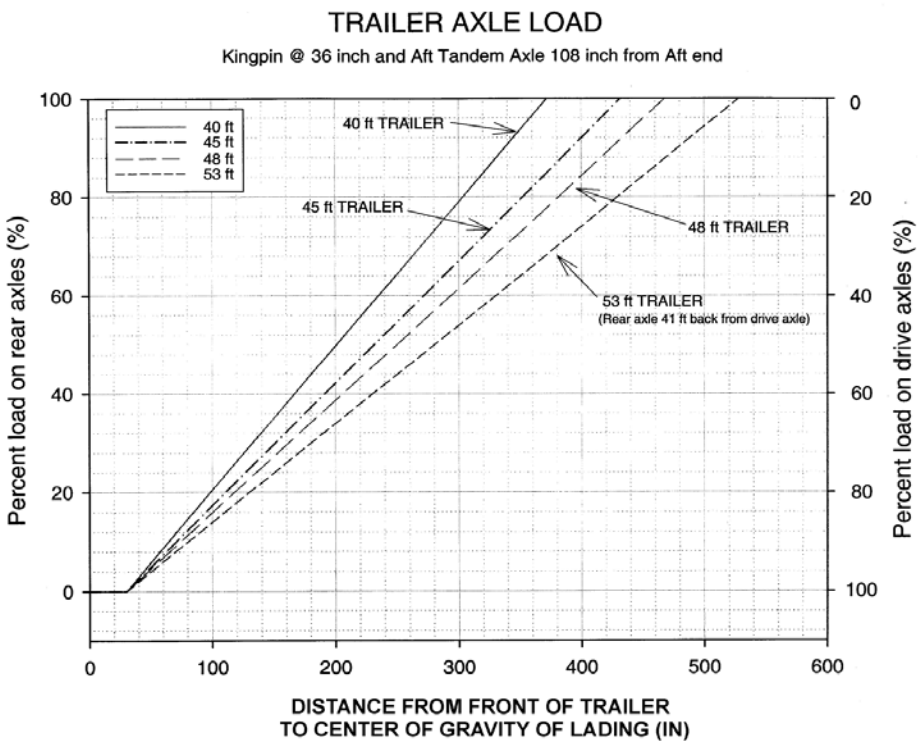

FIGURE B-3 Axle load chart (rear axle 108 inches from aft end of trailer)

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TABLE B-II. Typical axle weights for empty tractor-(van) trailer.

Length of trailer (feet)	Drive axles (pounds)	Trailer axles (pounds)
40	10,750	7,500
45	14,000	8,100
48	16,000	8,500
53	20,000	9,300

B.4.5.7 Trailer width. Trailer overall widths will be either 96 or 102 inches although the usable width will vary with manufacturer. For van trailers, the inside width for a 96-inch wide trailer will usually fall between 92 and 95 inches while the inside width of a 102-inch wide trailer will range from 98 to 101 inches. When using a flatbed trailer, the usable nailing surface for nailed blocking will be reduced by the width of the rub rails/stake pocket framework and any metal framework within the deck. The width of the rub rail/stake pocket framework on one side of the trailer is typically 3 to 4¼ inches while the width of the metal framework within the deck varies.

B.4.5.8 Flatbed trailer issues. Many flatbed trailers have exposed metal beam frame members that are not covered by the wood deck. This needs to be considered when nailed blocking is required. The metal beams are usually 6 inches wide, two per trailer, and are centered approximately at 38 inches.

B.4.5.8.1 Deck height. Flatbed floor deck height is another dimension that varies with trailer design and manufacturer. A typical range is 55 to 60 inches although some trailers are outside this range. The main consideration when loading on a flatbed trailer is to keep the overall height of the combined trailer and load under 13 feet 6 inches from the road surface. This height restriction is imposed by all states in the continental U.S. Due to the heavy nature of most ammunition loads and the multiple hazards associated with loading and placing large stacked items onto flatbed trailers, plans should keep the loaded weight CG as low as practical for any given number of items. Furthermore, loads higher than 90 inches should only be specified on an exceptional basis, keeping maximum loaded trailer height under 12 feet 6 inches. Use of special trailers may be required for tall or bulky items.

B.4.5.8.2 Tiedown angle. To secure the lading to the flatbed, chains or steel/web strapping should be used. This tiedown method is most effective when it is arranged at a steep angle to the deck. As this angle decreases, the downward force on the lading decreases (assuming the tension in the chain/strapping is the same). The tiedown angle, when viewed from the front or rear, should be 30 degrees or greater (see figure B-4).

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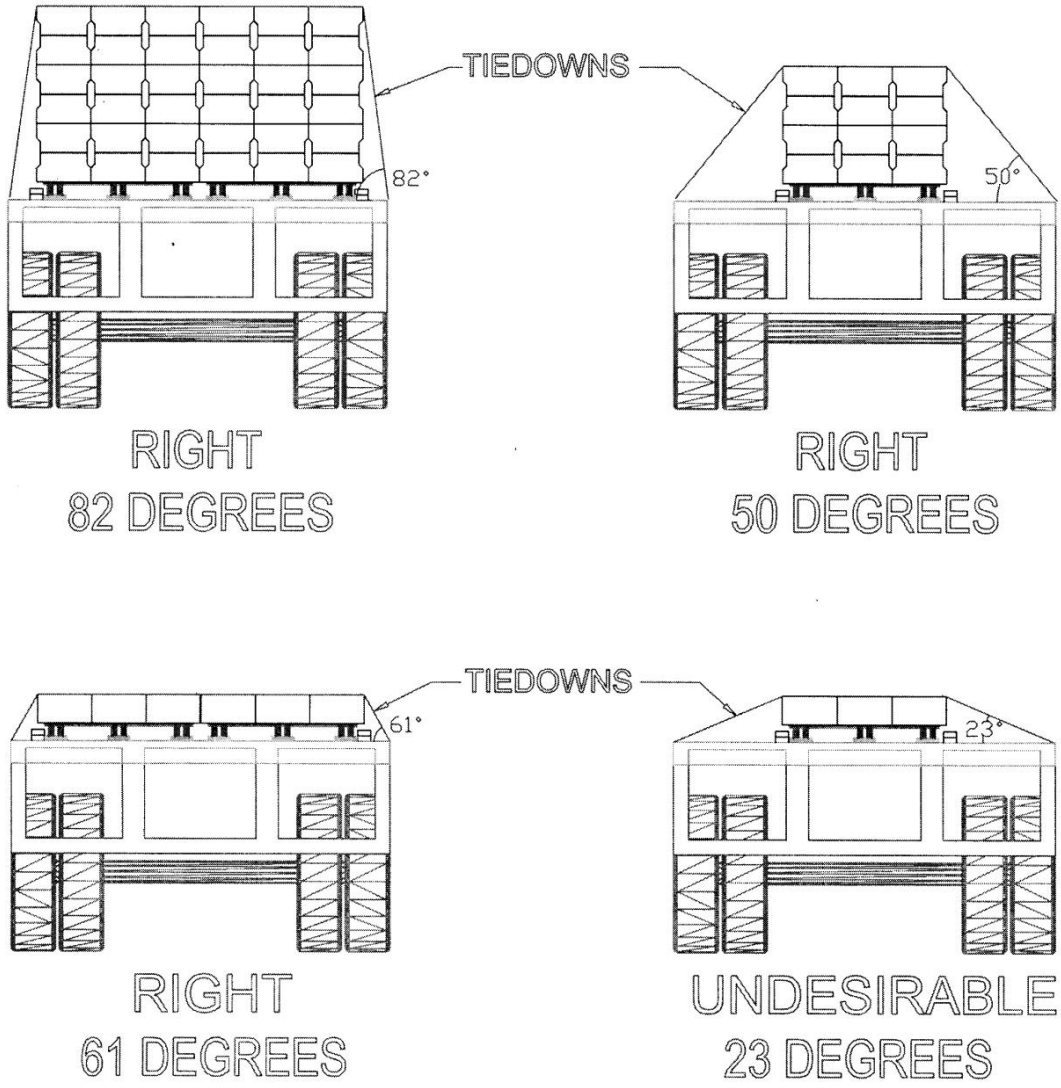

FIGURE B-4. Tiedown angle.

B.4.5.9 Load placement/height considerations. Items to consider when positioning the load are:

a. Balance the load widthwise so that the overall center of mass will be in the center of the trailer (see figure B-5).

b. Do not overload the axles, as detailed in B.4.5.2, and distribute the load lengthwise (see figure B-6).

c. Keep the load as low as possible. A tall load can be unstable. A tall load (of even density) that, when measured across its shorted side, is less than 50 percent of its height may be unstable sideways (see figure B-7).

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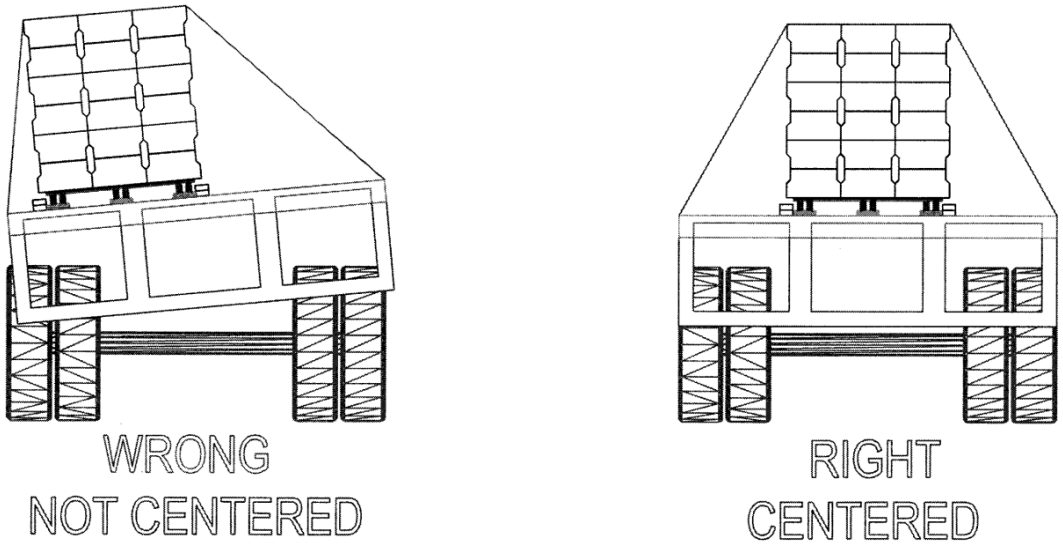

FIGURE B-5. Lateral load placement.

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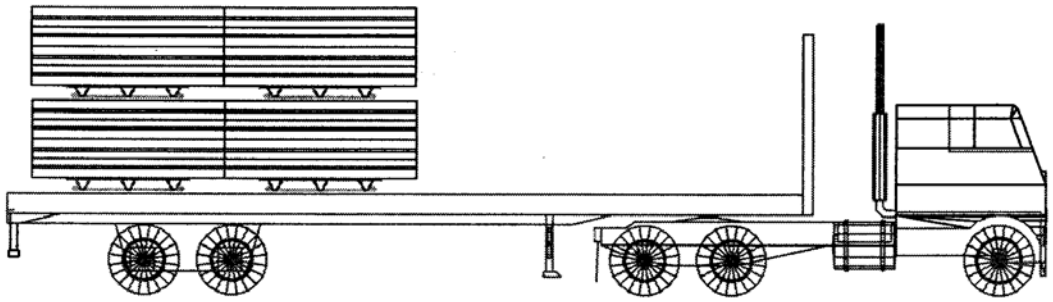
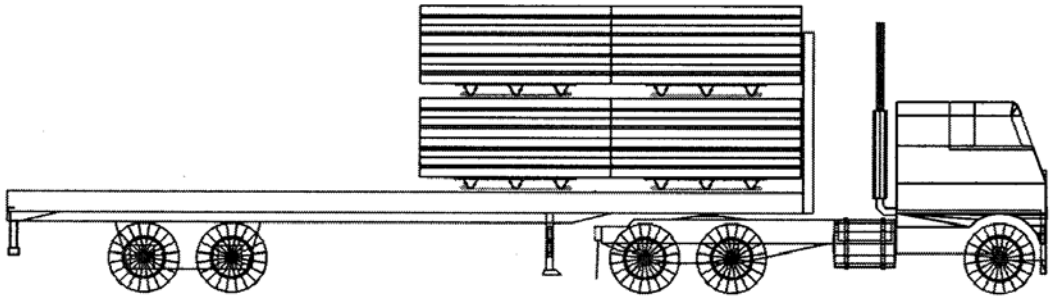
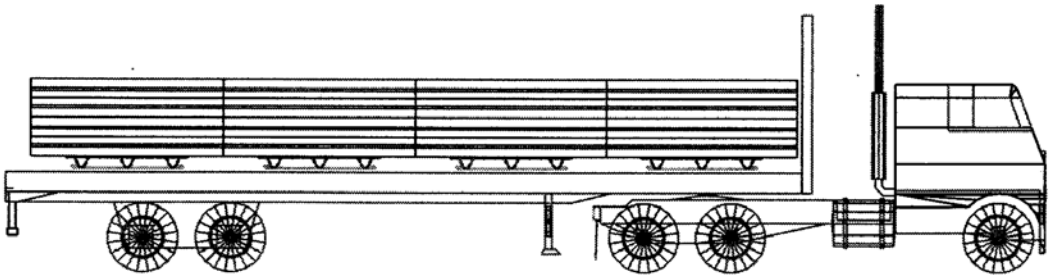


WRONG - COULD OVERLOAD REAR AXLES
AND CREATE A DANGEROUS DRIVING CONDITION



WRONG - COULD OVERLOAD DRIVE AXLES



RIGHT - LOAD IS SHARED BETWEEN ABOUT AXLES

FIGURE B-6. Longitudinal load placement.

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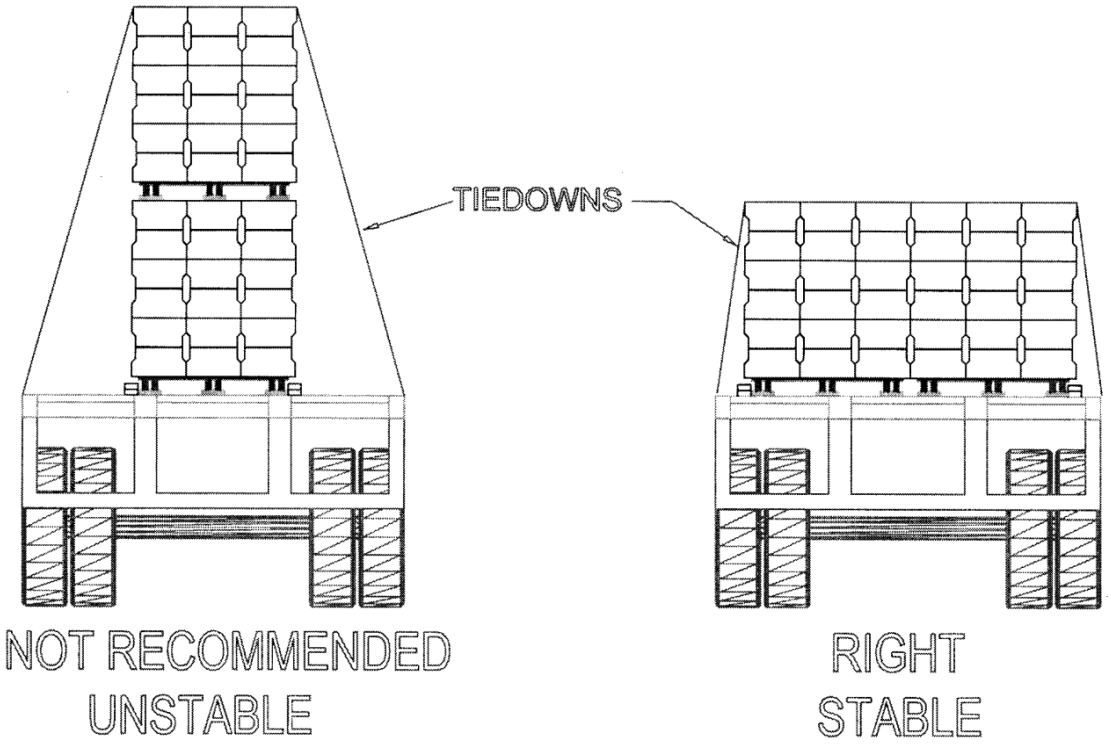

FIGURE B-7. Load stability.

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B.4.6 Lumber.

B.4.6.1 Lumber size. All lumber used should be yard lumber conforming to Voluntary Product Standard PS 20-10. Unless otherwise specifically indicated on each approved drawing, lumber used may be rough or dressed. All lumber procured for use on truckloads should be heat treated to reduce risk of mixing lumber with that required in International Organization for Standardization (ISO) container loading for wood packaging material (WPM). DoD activities should procure and report lumber use in accordance with the requirements of DoD 4140.65-M. See A.7.3.3.4 for more information on WPM. Shipments limited to continental United States (CONUS) do not require ISPM 15 marking each piece of dunnage, but marking allows the most flexibility for reuse of dunnage WPM and may be required in the future. Designs are based upon the dressed sizes indicated in table B-III.

TABLE B-III. Sizes of dressed lumber.

Nominal dimensions (inches)	Actual dimension (inches) softwood	Nominal dimensions (inches)	Actual dimension (inches) softwood
1 × 2	¾ × 1½	2 × 2	1½ × 1½
1 × 3	¾ × 2½	2 × 3	1½ × 2½
1 × 4	¾ × 3½	2 × 4	1½ × 2½
1 × 5	¾ × 4½	2 × 6	1½ × 5½
1 × 6	¾ × 5½	2 × 8	1½ × 7¼
1 × 7	¾ × 6½	2 × 10	1½ × 9¼
1 × 8	¾ × 7½	2 × 12	1½ × 11¼
1 × 10	¾ × 9½	3 × 4	2½ × 3½
1 × 12	¾ × 11½	4 × 4	3½ × 3½

B.4.6.2 Nominal strengths. Strength values for lumber used in dunnaging are based on past experience as to what values have successfully passed tests or trial shipments, rather than on strictly scientific calculations. In order to standardize drawings, however, permitting maximum interchangeability and ability to load trucks anywhere in the U.S., strength values used in the design of truckloading, blocking, and bracing should be conservative. When selecting the size of lumber for blocking and bracing, consideration should be given to the weight, size, and nature of the lading to be secured within the vehicle.

B.4.6.3 Nominal weight. The weight of lumber varies by both the wood species and the moisture content of the wood. For the purpose of estimating the weight of wood dunnage, a nominal weight of 2 pounds per board foot can be used for dressed dimensional lumber. Table B-IV lists some typical weights per board foot.

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TABLE B-IV. Standard lumber dimensions and weight.

Nominal size (inches)	Typical size (inches)	Board feet per foot of length	Weight per foot (pounds)
1 × 2	¾ × 1½	1/16	0.333
1 × 3	¾ × 2½	¼	0.500
1 × 4	¾ × 3½	⅓	0.667
1 × 6	¾ × 5½	½	1.000
1 × 8	¾ × 7¼	⅔	1.333
1 × 10	¾ × 9¼	⅚	1.667
1 × 12	¾ × 11¼	1	2.000
2 × 2	1½ × 1½	⅓	0.667
2 × 3	1½ × 2½	½	1.000
2 × 4	1½ × 3½	⅔	1.333
2 × 6	1½ × 5½	1	2.000
2 × 8	1½ × 7¼	1⅓	2.667
2 × 10	1½ × 9¼	1⅔	3.333
2 × 12	1½ × 11¼	2	4.000
4 × 4	3½ × 3½	1⅓	2.667
4 × 6	3½ × 5½	2	4.000
6 × 6	5½ × 5½	3	6.000

B.4.6.4 Selecting lumber. All blocking and bracing material should be selected from sound lumber, free from cross grain, dry rot, knots, knot holes, checks, or splits which will affect its strength or interfere with proper nailing. Knots, knot holes, checks, and splits or other defects are permitted in lumber as long as they do not impair the strength of the blocking and bracing. Blocking and bracing personnel should take particular care in selecting lumber used in struts, gates, cross bracing, side and center bracing, diagonals, holddowns, and K-bracing by upgrading lumber as necessary. It is usually possible to upgrade any given piece of lumber by picking through lower grades and, unless the required length is too great, cutting out defects (see figure B-8).

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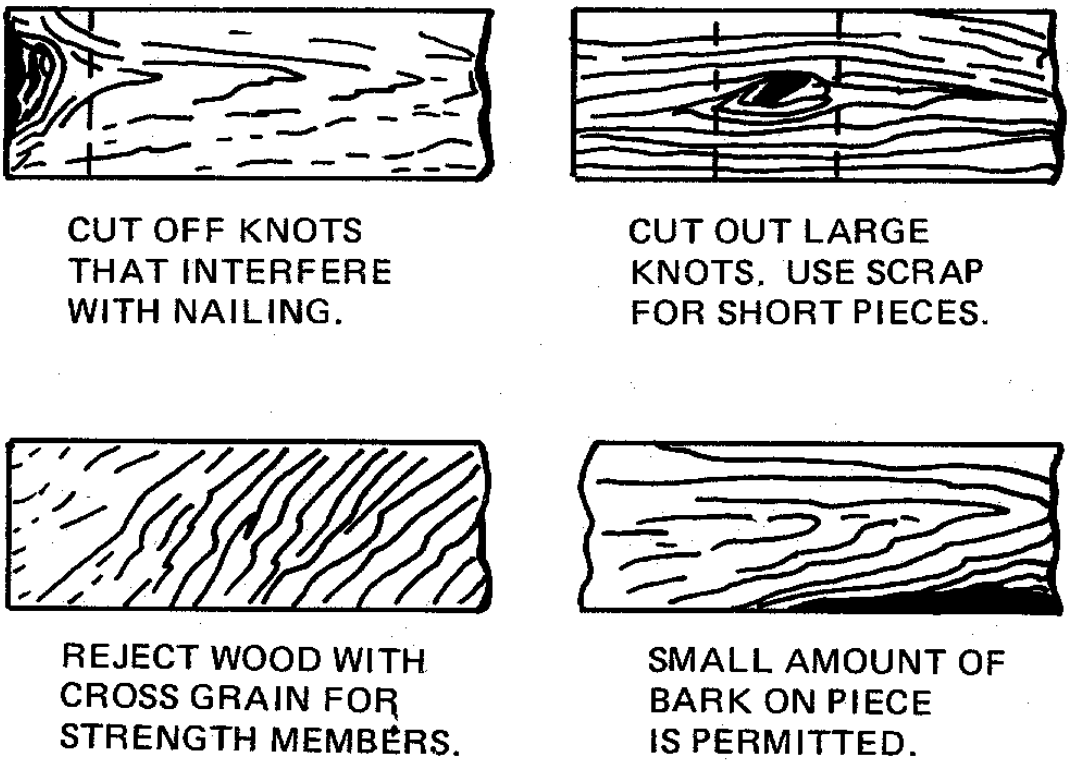

FIGURE B-8. Lumber defects.

B.4.6.4.1 Grade. The minimum grade requirement for dunnaging lumber is No. 2 dimension, rough or finished. Better grades of lumber may be used only when No. 2 dimension is not available or when used lumber of better grades are available for the same or lower cost.

B.4.6.4.2 Reclaimed lumber. Reclaimed dunnage lumber may be used provided there are no splits, cracks, or knots in the wood and all nails have been removed. Nail holes are acceptable as long as they have not caused splits in the lumber. Wood blocking may be reused as follows: when economical, assemblies such as center gated, braces, crib fill, and forward and rear blocking assemblies should be retained as received and may be marked to identify use. Other sound wood blocking may be reused if the wood contains no splits and all nails have been removed or protrusions cut off and the wood meets all other requirements. All WPM should have the appropriate heat treatment marking if required.

B.4.7 Plywood. All plywood used in the construction of truck loads should be in accordance with A-A-55057 or commercial equivalent, Type A interior plywood with exterior glue, Grade C-D, or exterior plywood, Grade C-C. The thickness of the plywood should be as required by each approved drawing. If specified grade is not available, a better interior or an exterior grade may be substituted.

B.4.8 Nails.

B.4.8.1 Nail type. Nails should be common bright nails, in accordance with ASTM F1667. Table B-V gives actual sizes and weights of nails.

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TABLE B-V. Sizes and weights of nails.

Size (d = penny)	Nails	
	Length (inches)	Diameter (inches)
2d	1	0.072
3d	1¼	0.080
4d	1½	0.099
5d	1¾	0.099
6d	2	0.113
7d	2¼	0.113
8d	2½	0.131
9d	2¾	0.131
10d	3	0.1483
12d	3¼	0.1483
16d	3½	0.162
20d	4	0.192

B.4.8.2 Nailing. The proper selection of nails will ensure the necessary holding power without the risk of splitting the lumber and affecting the strength of the dunnage structures. Some general rules for nail selection and application, which have gained general acceptance in blocking and bracing practice, are listed below.

a. All nailing should be into the side grain of the lumber; end grain nailing should be avoided. Balanced nailing is important. Nails should be staggered along the piece being nailed. Do not nail along one grain of wood. Whenever possible, drive nails straight; do not toenail unless called for in the drawing.

b. Nails should be of such length as to give the necessary holding power and sufficiently penetrate into floors or bracing and blocking. To obtain sufficient holding power, nails should be of such length that they nearly penetrate but do not protrude through the timber holding the point of the nail. Nails of a size large enough to cause splitting of the lumber will require pre-drilled nail holes. The general rule of thumb is that the nail should be two times as long as the thickness of the piece holding the head of the nail, but the nail point should not protrude beyond the second piece unless clinching is required.

c. Generally, no nail should be driven closer to the end of a piece of lumber than the thickness of that piece, or closer to the edge than half the thickness of the piece holding the nail head.

d. When pieces are of different thicknesses, the nail head should be in the thinner piece.

e. When the density of the wood dunnage is such that diamond-point nails cause splitting or weakness in the dunnage structures, the nails should be blunted before use.

f. Ideally, nail heads should be set flush with the nailing surface, but if deeper penetration occurs it should not be more than one-eighth the thickness of the piece retaining the head.

g. When driving nails near hazardous materials, extreme care should be taken to ensure that the nails are not directed, or are likely to be deflected, toward or into the packaging or hazardous material.

h. Dunnage should never be nailed directly to the lading.

i. Pieces which are end nailed and which are used as a supporting structure should always be reinforced by cleats.

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B.4.8.3 Floor nailing. When nailing headers, side blocking, and other laminated dunnage members to a conveyance floor, it is recommended to nail as follows:

a. Nail first piece to conveyance floor with one nail every 4 to 12 inches, staggering the nails to increase holding power of dunnage and to help prevent splitting.

b. Nail second piece to first piece with appropriately sized nails every 4 to 12 inches, staggering the nails to the opposite side of the nails in the first piece.

c. If three-high, nail third piece to second piece with appropriately sized nails every 4 to 12 inches, staggering the nails to the opposite side of the nails in the second piece.

d. Nail additional headers or backup cleats behind headers to obtain the desired number of nails and prevent rotation of the header. Backup cleats should be placed opposite skids where possible. Backup cleats may be omitted when supported by actual truckload.

B.4.8.4 Power driven nails. Power driven nails are a common tool when working with wood and are authorized for truckloads. When power driven nails are used, the user needs to verify that the nail diameter and length used are the same size as a common nail (see table B-V). The diameters and lengths of the nail are important for the holding strength of the nails both in shear and withdraw strength.

B.4.9 Steel strapping.

B.4.9.1 Flat strapping. Steel strapping should be flat strapping in accordance with ASTM D3953, Type 1, heavy duty, Finish A, B (Grade 2), or C. Strapping should be dry (unwaxed) strapping. When crimped seals are used, a minimum of two seals, double crimped, should be used. Unwaxed strapping should be used with crimped seals. When notched seals are used, a minimum of one seal, double notched, should be used. Seals should be in accordance with ASTM D3953; Class H, Finish A, B (Grade 2), or C, Style I, II, or IV.

B.4.9.1.1 Strap capacity. The maximum authorized weight of lading per strap is shown in table B-VI. The 2- by 0.044-inch and 2- by 0.050-inch strapping is used for lading tiedowns. The 1¼- by 0.031-inch and 1¼- by 0.035-inch strapping is used for bundling. If 2-inch wide strapping is not available, the 1¼-inch wide strapping can be used for lading tiedowns. The number of straps should be increased to meet the criteria given in B.4.9.3.1. One tiedown is considered a strap that passes over the lading and is attached to both sides of the trailer.

TABLE B-VI. Maximum lading load per strap.

Strap size (inches)	Minimum strap breaking strength (pounds)	Maximum authorized lading weight per strap (pounds)
1¼ × 0.031	4,750	2,200
1¼ × 0.035	4,750	2,200
2 × 0.044	10,600	5,000
2 × 0.050	10,600	5,000

B.4.9.1.2 Crimping/notching strap seals. Strap seals should be carefully crimped/notched to ensure that the joint develops at least 75 percent of the minimum breaking of the strap shown in table B-VI, as required in ASTM D3953.

B.4.9.1.2.1 End-over-end lap joint. When steel strapping is sealed at an end-over-end lap joint, a minimum of one seal with two pair of notches should be used to seal the joint when a notch-type sealer is used. A minimum of two seals, butted together with two pair of crimps per seal should be used to seal the joint when a crimp-type sealer is being used (see figure B-9).

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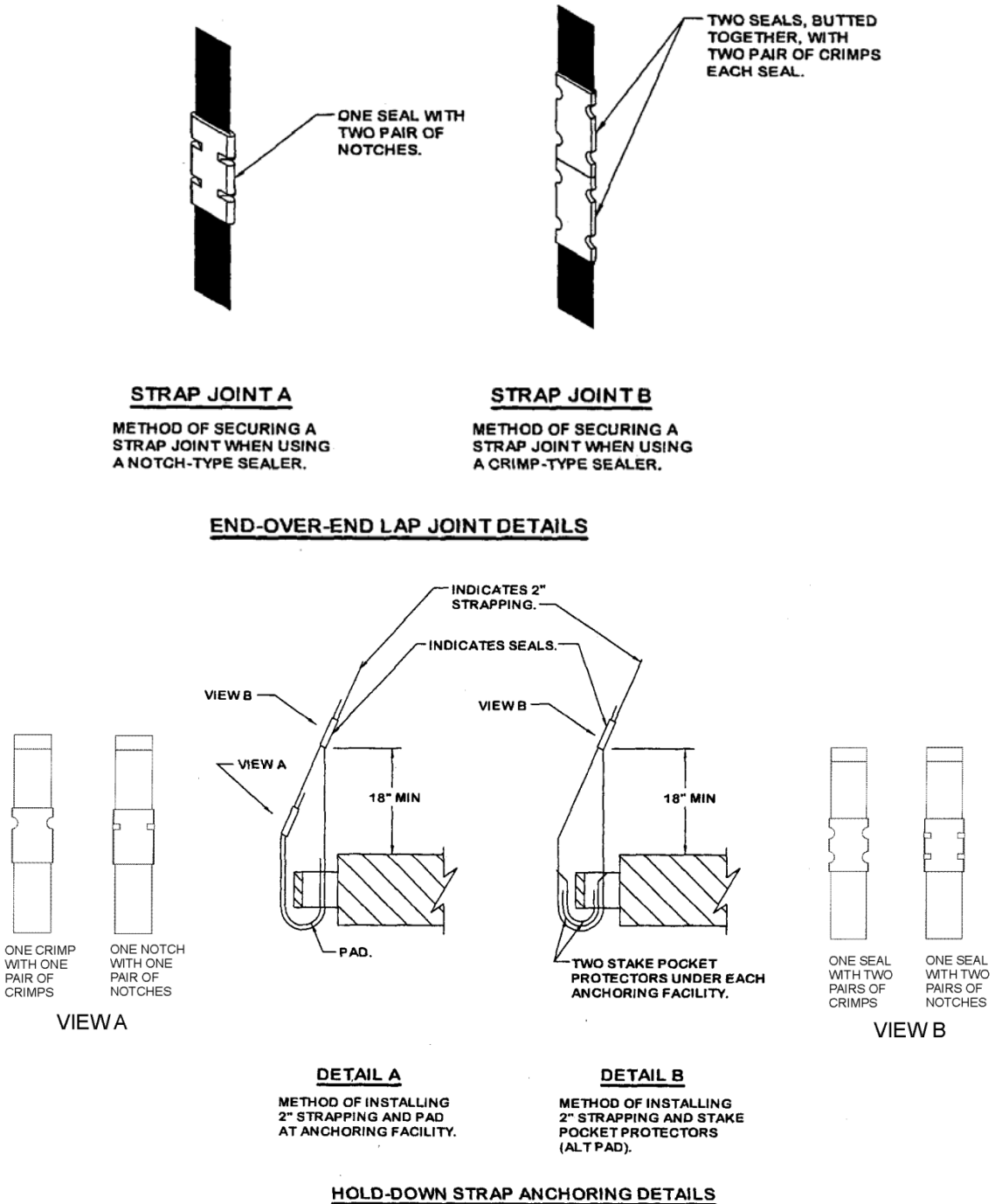

FIGURE B-9. Tiedown strapping.

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B.4.9.1.2.2 Rub rails/stake pocket framework tiedown joint. When steel strapping is sealed at the joint produced when the strap is looped around the rub rails/stake pocket framework and back to itself, a minimum of one seal with two pairs of notches should be used to seal the joint when a notch-type sealer is used. A minimum of one seal with two pairs of crimps should be used to seal this joint when a crimp-type sealer is being used.

B.4.9.1.2.3 Stake pocket pad joint. When steel strapping is looped around the rub rails/stake pocket framework, a short piece of strapping (approximately 18 inches) should be used to protect the load-bearing strap from the possible sharp edges of the framework. This piece of strapping should be secured to the load-bearing strap with one seal and either a single notch or a single crimp. An alternate method for protecting this strapping is to use commercial grade stake pocket protectors (see figure B-9).

B.4.9.2 Weight of strapping. In order to estimate the weight of steel strapping, table B-VII shows the weight for each strap size.

TABLE B-VII. Weight of steel strapping.

Strap size	Weight per foot (pounds)
1¼ × 0.031	0.130
1¼ × 0.035	0.147
2 × 0.044	0.296
2 × 0.050	0.336

B.4.9.3 Tiedown strapping on flatbed vehicles.

B.4.9.3.1 Determining number and size of straps. Determine the total weight of the lading to be strapped down to the vehicle. Divide this number by the maximum load per strap of the strap size proposed to be used (see table B-VI). The result will be the number of straps required. A minimum of two straps per stack, layer, unit load, or single container load should be used. For items longer than 10 feet, use an additional strap for each 10 feet or fraction of 10 feet, if not required by weight alone.

B.4.9.3.2 Application. The approved method of applying tiedown straps is illustrated on figure B-9. It is preferred to position, tension, and double crimp/notch the strap seal(s) at the top of the load, if practicable. The hold down straps should be attached to the rub rail/stake pocket framework first. The two straps should be joined together at the top of the lading.

B.4.9.4 Unitizing containers. When truckloading single containers or unit loads of containers (two or more high), the stack of containers should be strapped together to form a unit that ensures the stacking features are in continuous engagement during the truck transportation. The unitizing of the containers creates a secure stack of containers that will transfer longitudinal or lateral forces through the stack to the blocking and bracing. Depending on the weight and stability of the containers or unit loads' stack, the containers or individual unit loads may need to be separated when they are offloaded since the truckloading unit could be unstable for handling or could be overweight for the material handling equipment. Only the straps that create this truckload unit should be cut. The approved unit load for handling should be separated. An example of how the containers can be unitized is shown on figure B-10. The containers are stacked together using a forklift truck or other suitable hoisting device. The top container is secured to the bottom container with two 1¼- by 0.031-inch steel straps, and the straps secured with two double-crimped, 1¼-inch strap seals or one double-notched, 1¼-inch strap seal. A stack of containers three-high are strapped together securing the bottom container to the center container and the center container to the top container.

NOTE: When loading/unloading vehicles with unitized containers, extra caution should be taken to prevent toppling. Special attention should be given to appropriate backup of outboard containers. Containers that have been unitized for shipping purposes should be deunitized after unloading the vehicle.

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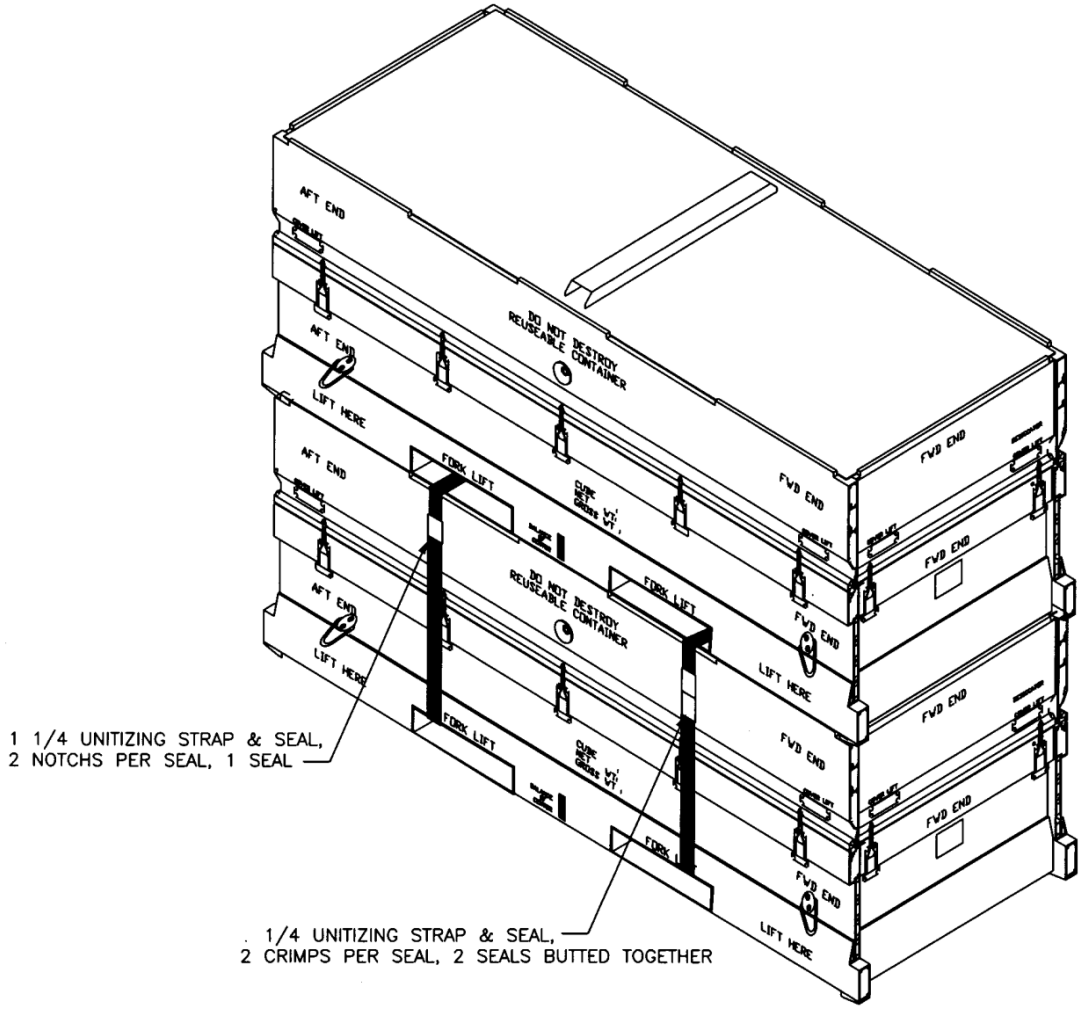

NOTES:

1. Stack one container on top of the other with the stacking features engaged.
2. Thread straps through fork pockets of bottom container and through fork pockets of top container, tension and double-notch or crimp seal(s).

FIGURE B-10. Unitizing containers.

B.4.9.5 Bundling unitizing unit loads.

B.4.9.5.1 Bundling. When the unit load in/on a van or flatbed is more than one layer high, it may be necessary to bundle certain unit loads to prevent longitudinal, lateral, and vertical movement of the lading in the second (or third) layers. Figure B-11 shows the nomenclature for layer, stacks, and row.

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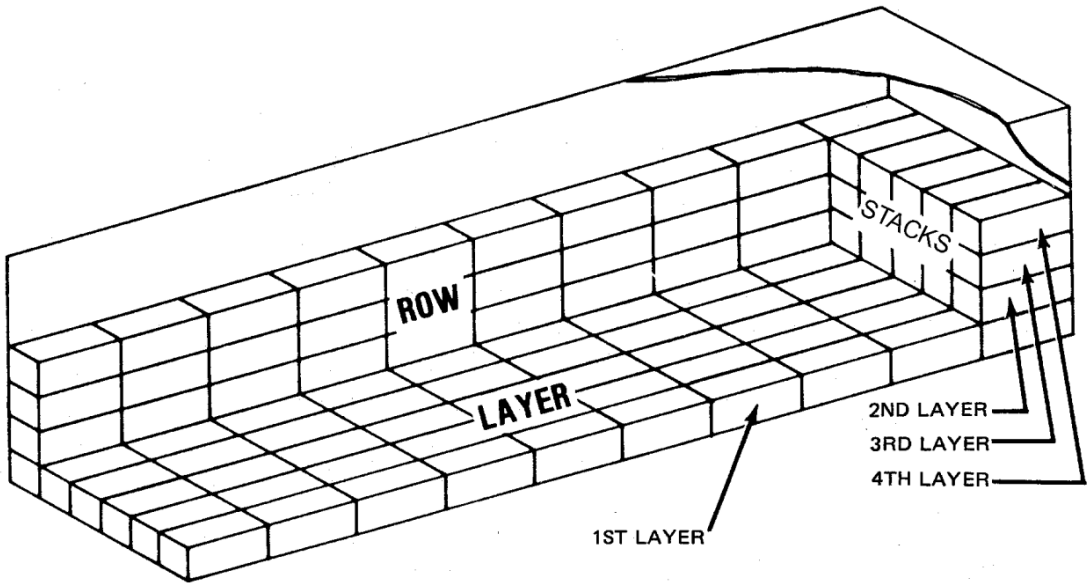

FIGURE B-11. Partial truckload showing nomenclature (layer, stack, and row).

B.4.9.5.2 Layer changes. Two- or three-high stacked unit loads should be bundled as shown on figure B-12. Bundling is necessary where the layers of unit loads change from two layers high to one layer high (three layers high to two layers high) and at the rear of the trailer when the unit loads are stacked two or more high.

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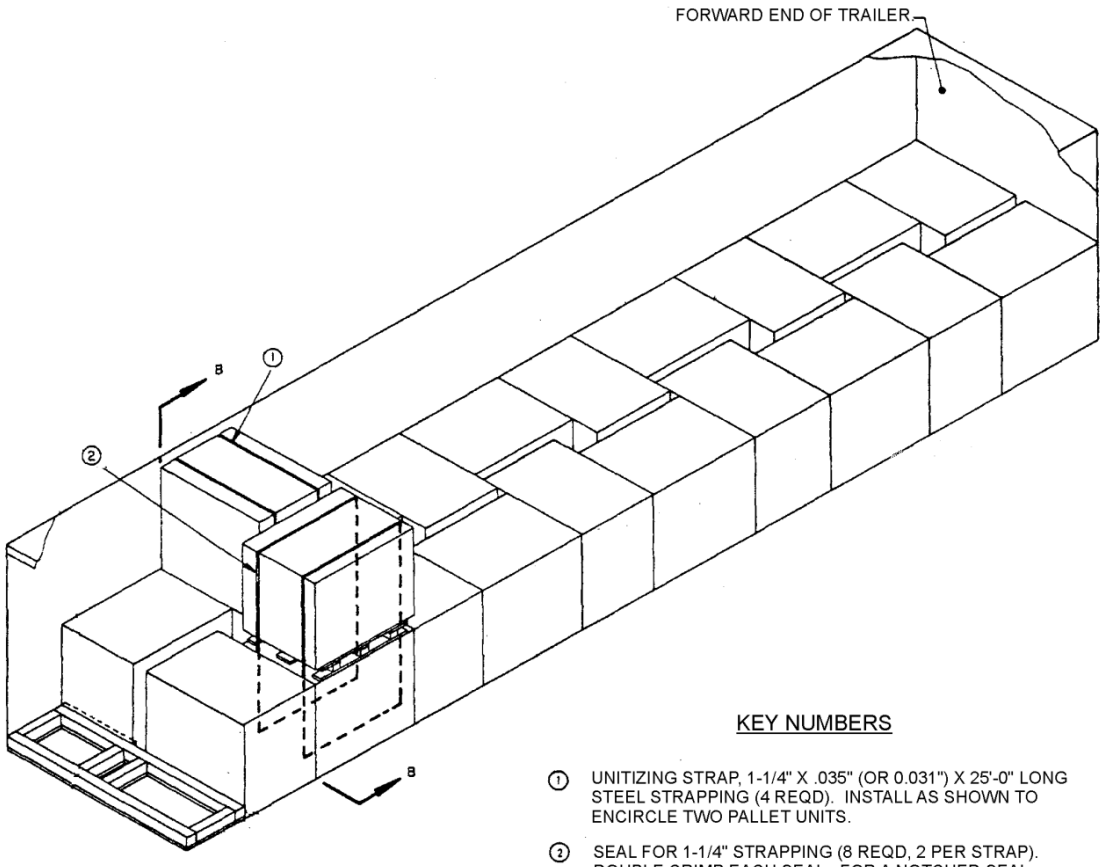
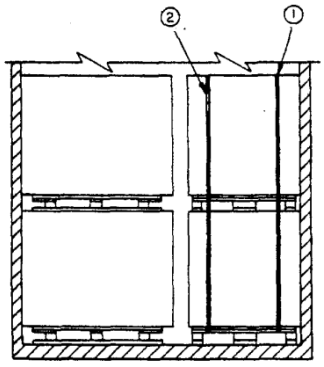


ISOMETRIC VIEW

KEY NUMBERS

① UNITIZING STRAP, 1-1/4" X .035" (OR 0.031") X 25'-0" LONG STEEL STRAPPING (4 REQD). INSTALL AS SHOWN TO ENCIRCLE TWO PALLET UNITS.

② SEAL FOR 1-1/4" STRAPPING (8 REQD, 2 PER STRAP). DOUBLE CRIMP EACH SEAL. FOR A NOTCHED SEAL, 1 SEAL PER STRAP IS REQUIRED. DOUBLE NOTCH THE SEAL.



SECTION B-B

THE UNITIZING STRAP IS OMITTED FROM THE TWO-HIGH STACK ON THE LEFT FOR CLARITY.

FIGURE B-12. Unitizing unit loads.

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B.4.10 Chain and load binders.

B.4.10.1 Number. Chains and load binders may be used to secure lading to a flatbed trailer. The chain should be in accordance with the National Association of Chain Manufacturers' Welded Steel Chain Specifications. One chain and load binder should be used for each 5,000 pounds of lading to be retained. A minimum of two chains and load binders should be used for each bay over 10 feet long for each additional 10 feet or fraction thereof. The method of applying chains and binder is shown on figure B-13. The chain should be attached through the stake pocket.

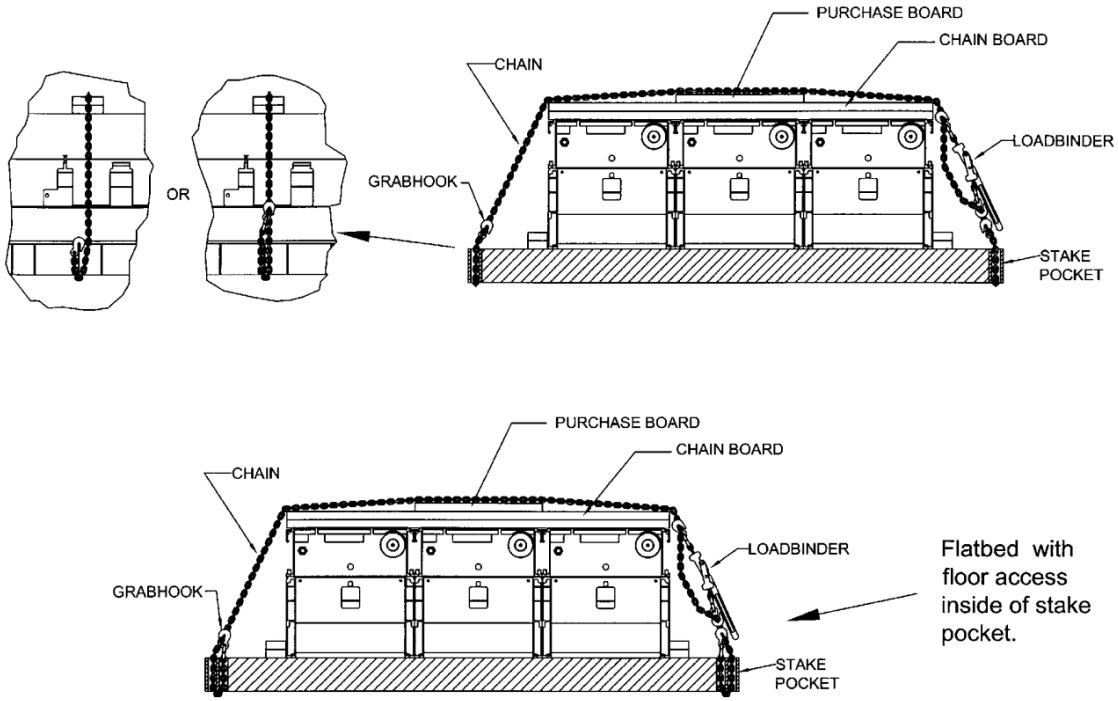

FIGURE B-13. Typical tiedown using chain and loadbinder.

B.4.10.2 Size. All chains should be marked in accordance with the National Association of Chain Manufacturers' Welded Steel Chain Specifications. At least one link in every 36 links should carry the manufacturer's permanent and distinctive mark identifying the grade of the chain. No chain should be used that is not so marked. The following chains are authorized to secure hazardous material to flatbed vehicles.

a. ⅜-inch, Grade 43, High-Test Chain.

b. 5/16-inch, Grade 70, Transport Chain.

c. ⅜-inch, Grade 70, Transport Chain.

d. 5/16-inch, Grade 80, Alloy Steel Chain.

e ⅜-inch, Grade 80, Alloy Steel Chain.

f. In addition to the grade marking described in B.4.10.2.a through B.4.10.2.e, the chain may also carry a letter(s) or symbol identifying the manufacturer of the chain. The presence of the manufacturer's marking is not mandatory.

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B.4.10.3 Grabhooks. The grabhooks on the ends of the chain may be of the following types with grade markings as indicated:

a. Clevis grabhook. ⅜-inch clevis grabhooks do not require grade marking. 5/16-inch alloy clevis grabhooks should carry the manufacturer's grade mark of 7, 70, or 700. The hooks should be used on the appropriate size chain.

b. Closed eye grabhooks. ⅜-inch and 5/16-inch closed eye grabhooks may be used on the appropriate size chain if they are part of a chain assembly which was provided by a chain manufacturer, and the chain assembly carries the correct grade identification mark as specified in B.4.10.2.a through B.4.10.2.e. Closed eye grabhooks that form a part of the assembly are exempt from grade markings.

B.4.10.4 Higher grade. Chain and fitting of a higher grade may be substituted for the specified grade; i.e., Grade 70 Transport Chain and Grade 80 Alloy Steel Chain may be substituted for Grade 43 High-Test Chain, Grade 80 Alloy Steel Chain may be substituted for Grade 70 Transport Chain.

B.4.10.5 Load binders. Load binders should be 5/16- to ⅜-inch size and have a working load limit of 5,400 pounds (minimum breaking strength of 16,200 pounds). Load binders should be secured with 0.0800-inch diameter wire (in accordance with ASTM A853; annealed at finish, black oxide finish, Grade 1006 or better). The binder cannot be reliably secured using the "slack portion of chain." The size of the load binders should be compatible with the size of the chain being used.

B.4.10.6 Inspection. Prior to loading the trailer and during the preloading inspection, the chain fittings and load binders should be inspected for stretch, gouging, bent links, wear, and any other noticeable defects. The inspector should record the results of the inspection on DD Form 626. Any deficiency should be cause for rejection of a chain or load binder.

B.4.10.7 Lading protection. Unless otherwise specified on an approved truckload drawing, the lading should be protected from chain damage by inserting a doubled 2 by 6 by full lading width chain board between the chain and the lading. Chains should be secured to the protected boards by driving a 10d nail through the chain link and bending the nail over the chain. Five nails should be used for each tiedown.

B.4.11 Web strapping. Strap assemblies may be used to secure lading to a flatbed trailer provided that the web-strap assemblies meet the pre-use inspection and design requirements identified in B.4.11.2 and B.4.11.3. Web strapping may be used to secure lading to a flatbed trailer.

B.4.11.1 Working load limit (WLL). The combined working load limit (WLL) (see table B-VIII) of the straps should be equal to or greater than half the total weight of lading in that load bay. A minimum of two straps should be used for each load bay of lading on a trailer. An additional strap should be used for each 10 feet of lading or fraction of 10 feet.

TABLE B-VIII. Web strapping strength.

Strap width (inches)	WLL (pounds)	Minimum breaking strength (MBS) (pounds)
1¾	1,750	5,250
2	2,000	6,000
3	3,000	9,000
4	4,000	12,000

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B.4.11.2 Tiedown. Tiedown attachment points for the web-strap assemblies should be on both sides of the trailer and at the same position (i.e., in direct alignment along the length of the trailer). No part of the web-strap assembly should pass forward or aft of the attachment points as it passes over the lading. The hardware fittings of the web-strap assemblies should be attached to the trailer in such a manner that they will remain in place if slack develops in the strap.

B.4.11.3 Sharp edges. Web-strap assemblies should only be used on smooth surfaces, with the web material laying flat on the lading. If the web strap passes over a sharp edge or irregular surface, which could cause the web material to become punctured, torn, cut, snagged, abraded, or crushed, edge protectors, strapping boards, or scuff sleeves should be used.

B.4.11.4 Loose ends. The loose ends of the webbing should be attached to the web strap itself, not the trailer, in such a manner (i.e., tape, wire-tie, cable tie, etc.) that they will not present a hazard or become damaged during transport.

B.4.11.5 Ratchet handles. Ratchet handles should be in the locked position and winch locking devices should be fully seated in the teeth of the winch.

B.4.11.6 Removable winches. If a removable winch is mounted to the trailer, care should be exercised when attaching the winch to the trailer. If excessive force is exerted on the bolt during tightening, deformation of the winch bracket may occur, causing failure of the tiedown during transport. Removable winches should be mechanically attached to the trailer using a two-bolt system equipped with either jam nuts or retaining wire to prevent loosening during transport.

B.4.11.7 Strap tightness. Drivers should be instructed to periodically check the tightness of the web-strap assemblies and re-tighten, if necessary.

B.4.11.8 Avoiding damage. Web-strap assemblies should not be dragged on the floor, ground, or over an abrasive surface. Tiedowns should not be pulled from under the lading when the lading is resting on the tiedown.

NOTE: Lading should never be placed on top of web strap.

B.4.11.9 Lifting. Web-strap assemblies should not be used for lifting.

B.4.11.10 Storage. Tiedowns should be stored in a dry place and not be exposed to sunlight when not in use.

B.4.11.11 Pre-use inspection criteria for web strap tiedowns. Webbing with any of the following conditions should be cause for rejection (see figure B-14):

a. Acid, alkali, chemical, or heat burns.

b. Melting or charring such as from weld spatter on any part of the web material except as specified in B.4.11.11 f.

c. Cuts, punctures, or tears of any size.

d. Broken or worn stitching in the web material.

e. Crushed web material.

f. Abrasive wear.

NOTE: A strap having frayed ends can be used if the frayed end is trimmed and melted with heat or flame until all strands are seized.

g. Presence of wear indicator threads which have become visible on the web straps. (These are referred to as “red core yarns.”)

h. Knots.

i. Spliced web material.

j. Corrosion of metal fittings.

k. Winches, ratchets, or other metal fittings which are bent, broken, cracked, or otherwise not in their original condition.

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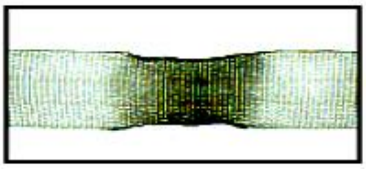
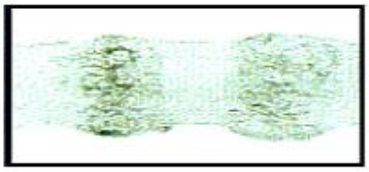
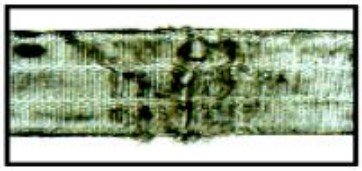
l. Evidence that the web material or the hardware has been damaged and repaired.
m. Anchor provisions with torn, deformed, or broken components or cracked welds.
n. Fading which may indicate ultraviolet (UV) exposure.
o. Staining which may indicate chemical seepage or exposure.



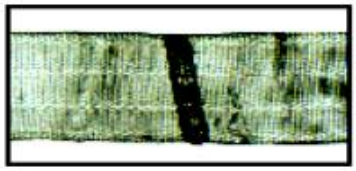
1. ACID, ALKALI, CHEMICAL, OR HEAT BURNS



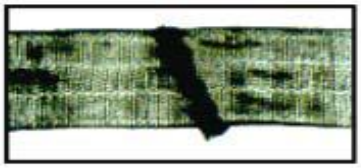
5. CRUSHED WEB MATERIAL



2. MELTING OR CHARRING



6. ABRASIVE WEAR



3a. CUTS

7. WEAR INDICATORS (RED CORE YARNS)

3b. PUNCTURES OR TEARS

8. KNOTS

4. BROKEN OR WORN STITCHING

FIGURE B-14. Web strapping rejection examples.

B.4.11.12 Design configuration and ratings for web strap tiedowns. All web straps and associated hardware should be in accordance with 49 CFR 393.108.

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B.4.11.12.1 Web-strap assemblies. The assembly may be configured from a variety of hardware including webbing, ratchets, winches, flat hooks, grab hooks, chain, and rings. The opening of the hardware fittings should be the proper size and shape to ensure that the fitting will seat properly in the anchorage point or other attachments.

B.4.11.12.2 Splices. The webbing should be of one continuous length (without splicing) and long enough to pass over the load and be attached to the stake pockets or winch on both sides of the trailer.

B.4.11.12.3 Rating. The rating of a web-strap assembly is based upon its Minimum Breaking Strength (MBS). The strength rating is based upon a straight tensile pull. The weakest component of the assembly determines the strength rating, including the point of attachment. The minimum WLL should be one third of the MBS.

B.4.11.12.4 WLL. The WLL should be specified on the strap assembly. A tag or label should be affixed within 18 inches of one end of the assembly which shows the:

a. WLL.

b. Name or trademark of manufacturer.

c. Date of manufacture (month and year).

d. If the WLL is not specified on the strap assembly, then the following WLL (see table B-VIII) should be used as a guide:

(1) Written proof of the minimum breaking strength of the web-strap assembly should be provided by the carrier to the shipping activity if requested.

(2) If the anchor point is inadequate to support the force of the web-strap assembly, then the load rating of the web-strap assembly will be limited to the strength of the anchor point.

NOTE: The strength of the anchor point should be determined and certified by the carrier

B.4.11.13 Controlling forward movement.

B.4.11.13.1 Front wall. Forward movement of the load can be controlled by using a forward blocking assembly. The forward blocking assembly serves to square the front of the van and to distribute longitudinal loading that occurs during transport over the front wall of the van trailer rather than just at the points of contact. The forward blocking assembly design should be compatible with the type and size van used and with the load being shipped. When a van has rounded corners, the forward blocking assembly provides a means of adapting the front of the van to the load. The forward blocking assembly, when properly installed, provides the needed strength for localized pressures. Installation should permit removal as a unit for reuse with future loads when possible.

a. Figure B-15 illustrates a front blocking assembly suitable for a rounded corner van. The lateral piece and load bearing piece are nailed to the verticals. This type of assembly is used when the rounded corners of the van trailer prohibit proper placement of the lading or when it is necessary to spread the load pressure over the entire front wall of the trailer. It is typical of assemblies used at the forward end of a load on a van trailer.

b. Figure B-16 illustrates a type of forward blocking assembly used to fill a space in the front of a van when it is desired to position the lading aft to equalize axle loads. The aft strut ledgers (1) are nailed to the aft verticals (2). The forward strut ledgers (3) are nailed to the forward verticals (4). The horizontals (5) are nailed to the forward verticals (4), and the struts (6) are nailed to the strut cleats (1 and 3) and verticals (2 and 4).

c. Figure B-17 illustrates a third type of forward blocking assembly used with a square nose van to spread the load over the forward wall of the van.

d. Figure B-18 illustrates a fourth type of forward blocking assembly. It can be used when the major “hard point” of the lading is at a low level and support at a higher level is not necessary. The forward crossmember (1) and the aft crossmember (3) are nailed to the verticals (2).

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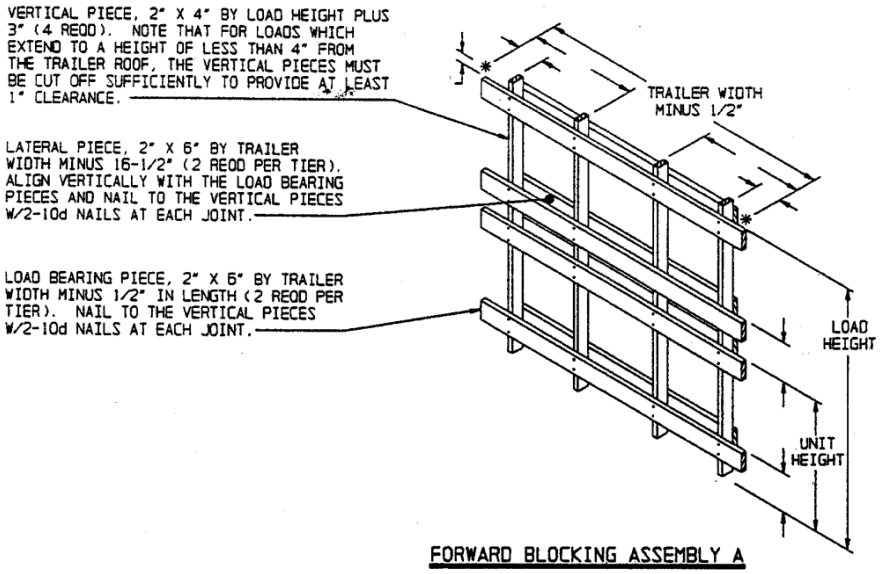
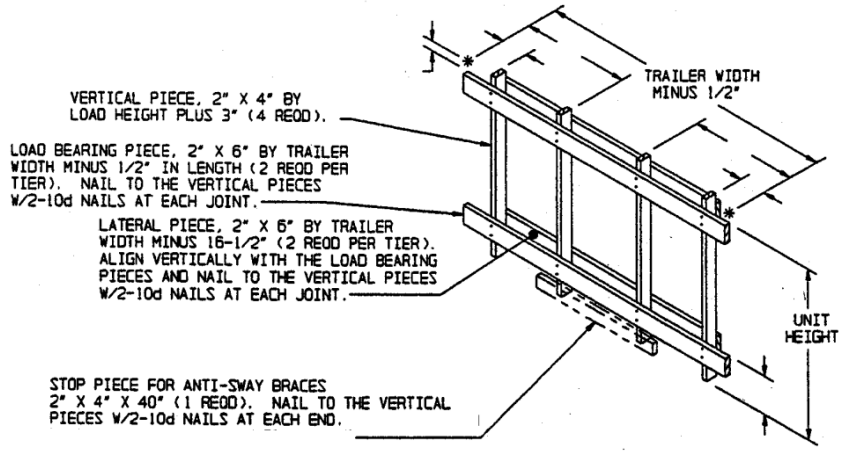


FORWARD BLOCKING ASSEMBLY A

THE FORWARD BLOCKING SHOWN IS APLICABLE FOR A 2-TIER LOAD. THIS ASSEMBLY IS DESIGNED FOR USE AT THE FRONT END OF A TRAILER HAVING ROUNDED CORNERS, AND IS APPLICABLE FOR A CORNER RADIUS OF NOT MORE THAN 6-1/2". IF THE RADIUS IS FROM 6-1/2" TO 8", 2" X 6" VERTICAL PIECES WILL BE USED IN LIEU OF THE 2" X 4" PIECES.



FORWARD BLOCKING ASSEMBLY B

THE FORWARD BLOCKING SHOWN IS APLICABLE FOR A 1-TIER LOAD. THIS ASSEMBLY IS DESIGNED FOR USE AT THE FRONT END OF A TRAILER HAVING ROUNDED CORNERS, AND IS APPLICABLE FOR A CORNER RADIUS OF NOT MORE THAN 6-1/2". IF THE RADIUS IS FROM 6-1/2" TO 8", 2" X 6" VERTICAL PIECES WILL BE USED IN LIEU OF THE 2" X 4" PIECES.

DETAILS

FIGURE B-15. Example forward blocking assembly suitable for rounded front corners.

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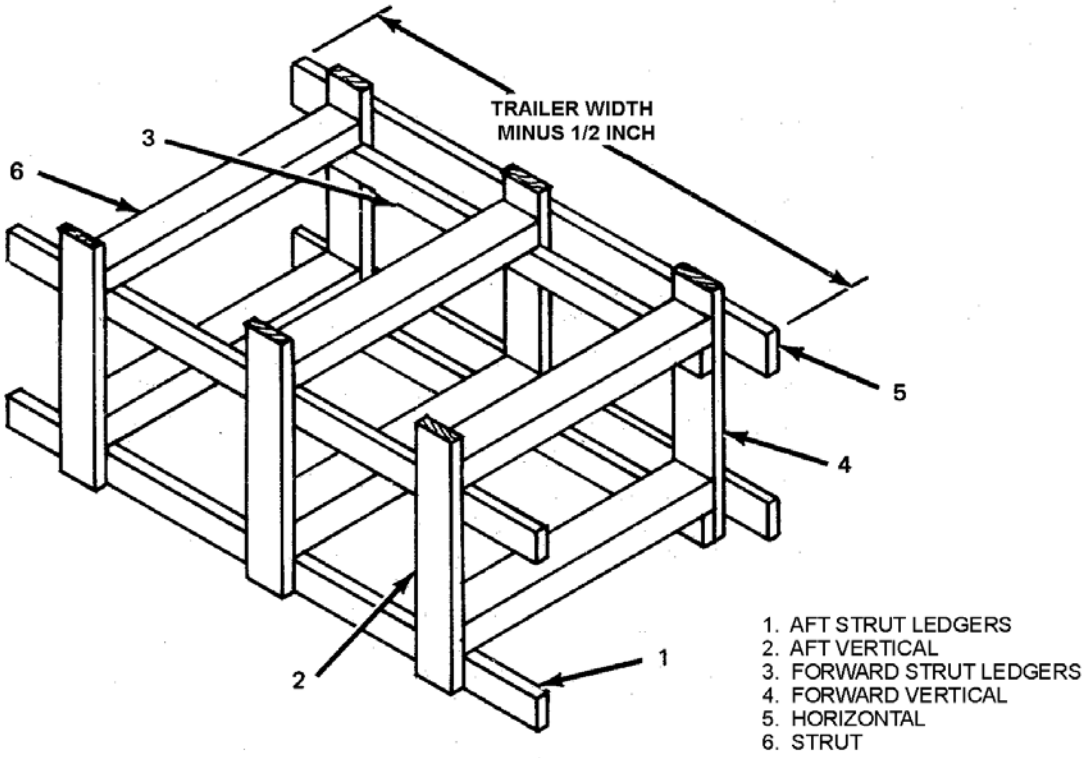

FIGURE B-16. Typical forward blocking assembly used to fill a void.

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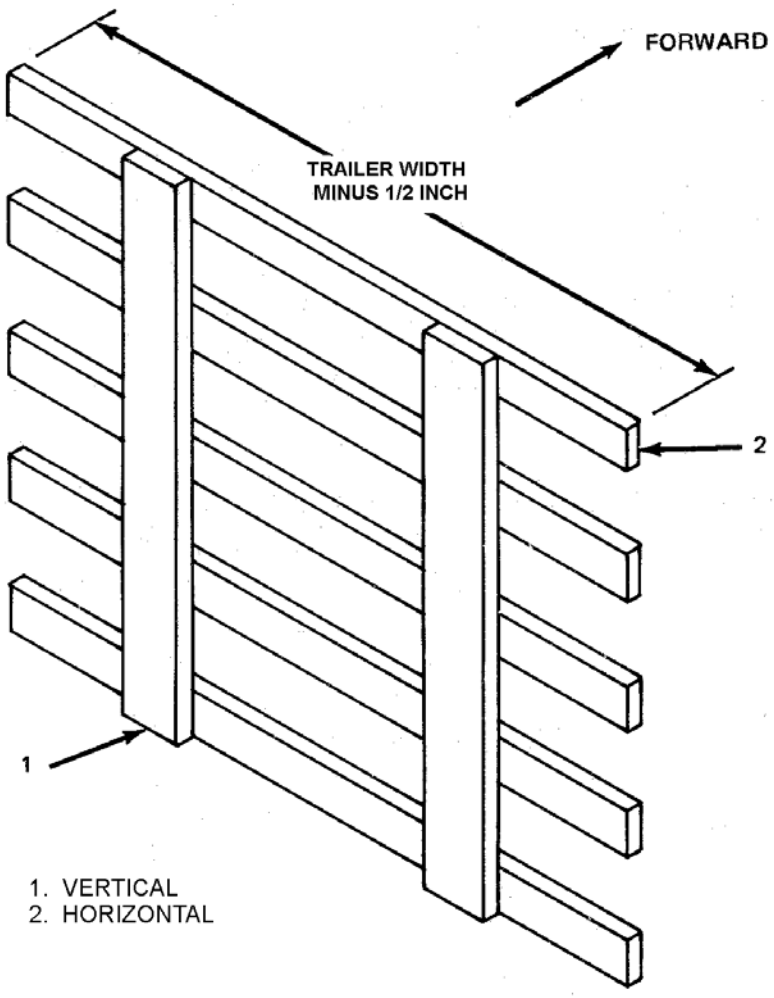

FIGURE B-17. Typical forward blocking assembly for vans with square front corners.

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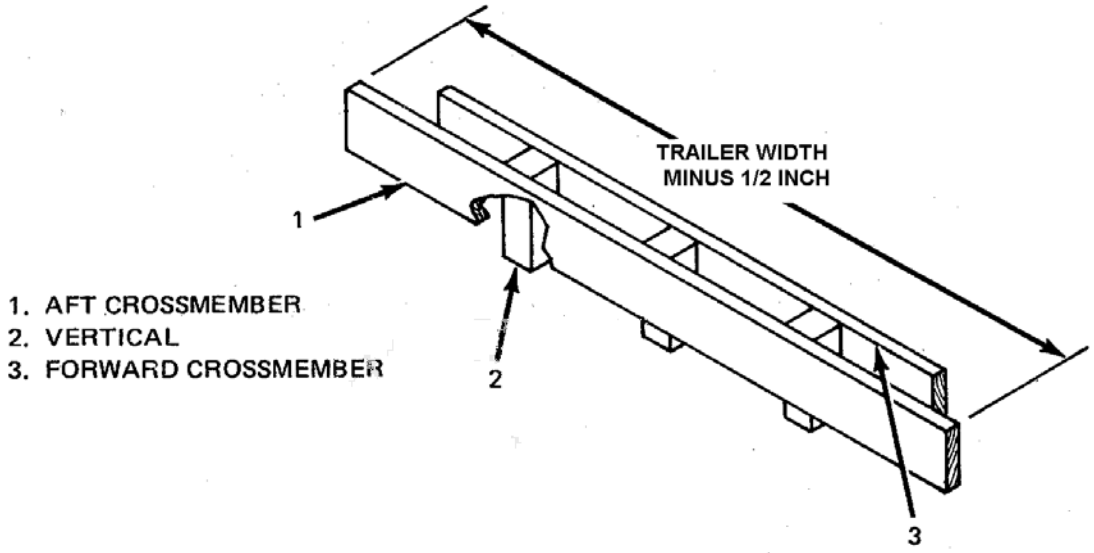

FIGURE B-18. Typical forward blocking assembly for low or rigid lading.

B.4.11.13.2 Selection. Front bulkheads are not necessary in vans with square front ends when the lading will bear uniformly against the front wall so that the loading is distributed evenly over the front wall. Ladings that have unusual configurations that concentrate loads in small areas do require a forward blocking assembly.

B.4.11.13.3 Partial layers. Partial layers of unit loads require special bracing procedures to control forward movement. The approved method of preventing the top layer(s) from sliding forward over the bottom layer is described in B.4.9.4 and B.4.9.5.

B.4.11.13.4 Floor blocking (forward movement).

a. Floor blocking may be used to control the forward movement of lading in van trailers in some cases. The lading vertical CG should be no higher above the forward blocking than 75 percent of the horizontal distance from the CG to the top of the forward blocking. This normally limits floor blocking to unit loads of 30 inches high or less on a 40 by 48 pallet. Unit loads may be secured together with strapping if the resulting unit can remain stable without blocking if the floor is tilted to a 53-degree angle. Nailing into metal flooring is prohibited. In this type of trailer, only “floating” blocking can be used; all nailing should be accomplished within the blocking and never into the metal floor.

b. When nailing the floor blocking to the floor, the strength of the blocking is dependent on the size and number of nails used to secure the blocking to the floor. Headers should be 2- by 6-inch wood doubled. The blocking should be tripled if the lading does not contact the bottom layer. Back up tripled headers with additional headers or cleats to prevent rotation.

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c. Headers have been nailed with either 10d nails on the lower layer and 20d nails in the upper layer or with both layers using the same size nail, either a 10d, 12d, or a 16d. For maximum strength when space is limited, the 10d/20d nail combination is used. The smaller sizes facilitate the use of nail guns to secure the blocking. Since most wood nailing decks are as thin as 1¼ inches, the nails on the bottom layer may have to be slightly angled to fully seat. The 10d/20d nail pair does not lend itself to simple calculations, but the 1,776 pounds per nail pair in table B-IX combines the 10d and 20d nail values of Intermodal Loading Guide for Products in Closed Trailers and Containers (Intermodal Loading Guide). The 10d/10d value of 733 pounds, 12d/12d value of 916 pounds, as well as the 16d/16d value of 956 pounds are also based on the Intermodal Loading Guide. These maximum weight capacities should be used for new van truck loads, ISO container loads, and railcar loads to allow the most modal load flexibility. Flatbed trailers of low loads with strapping less than a 30-degree angle above the deck when looked at from the front should also use these values. When the flatbed trailer strapping, in accordance with 49 CFR 393.110, has an angle above 30 degrees, DoD still requires blocking for A&E. In this case, the nail quantity may be reduced up to one third of the quantity normally required by table B-IX where conditions warrant.

TABLE B-IX. Forward headers nailing chart.

Number of nail pairs 1/	Maximum load weight per 10d/20d nail pair	Maximum load weight per 10d/10d nail pair	Maximum load weight per 12d/12d nail pair	Maximum load weight per 16d/16d nail pair
1	1,776	733	916	956
6	10,656	4,398	5,496	5,736
8	14,208	5,864	7,328	7,648
10	17,760	7,330	9,160	9,560
12	21,312	8,796	10,992	11,472
14	24,864	10,262	12,824	13,384
16	28,416	11,728	14,656	15,296
18	31,968	13,194	16,488	17,208
20	35,520	14,660	18,320	19,120

NOTE:
1/ Increase by one third when using power driven nails of same length but with diameters smaller than those of common nails.

B.4.11.14 Controlling rearward movement.

B.4.11.14.1 Floor blocking. Floor blocking may be used to control rearward movement of the lading. The proper type to use depends upon the amount of space at the rear of the load (distance from lading to trailer doors), the type of floor (all wood, metal with wood nailing strips, or all metal), and the physical characteristics of the lading. To use floor blocking safely, the lading should be of the type that can be blocked at the floor line and does not present any danger of toppling toward the rear. Also, some blocking requires nailing into the trailer floor. Nailing into metal floor trailers is prohibited. In this type trailer, only “floating” blocking can be used; all nailing should be accomplished within the blocking and never into the metal floor.

a. When the distance between the lading and the trailer doors, when closed, is less than 9 inches, solid fill (figure B-19) should be installed between the lading and the doors.

(1) If 1½ inches or less space exists between the lading and the doors when they are closed, no rear blocking is required.

(2) Rear blocking should bear against the lading and the trailer doors with the doors in the closed position. This type of blocking should not be used against a trailer with rollup doors.

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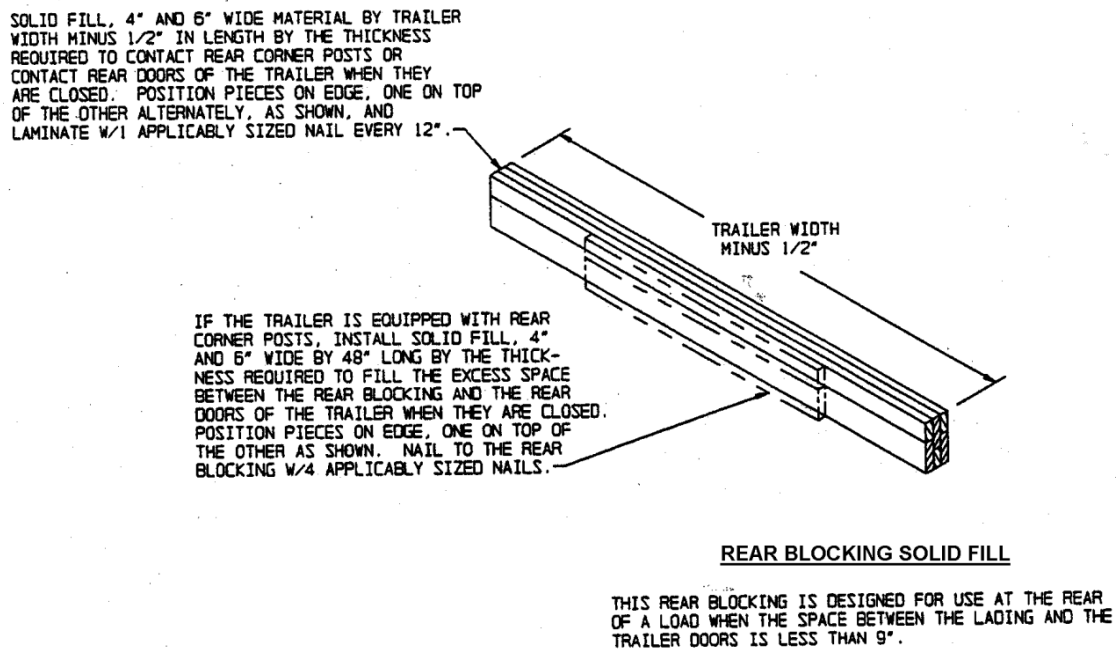

FIGURE B-19. Typical rear blocking assembly (solid fill).

b. When the distance between the lading and the trailer door is 9 to 36 inches, rear blocking assembly (see figure B-20) should be installed between the lading and the doors or an aft header nailed to the floor should be used (see B.4.11.14.1.d).

c. For trailers with non-nailable surfaces, a floating structure can be constructed to transfer any rearward forces to the trailer door. Figure B-21 shows a method that could be used for large distances between the lading and door. Figures B-19 and B-20 are also considered floating assemblies.

d. When the distance between the lading and the door is greater than 36 inches (and the van trailer has a nailable floor), the desirable method of load securement is to use a nailed header to reduce the amount of dunnage required. When nailing the floor blocking to the floor, the strength of the blocking is dependent on the number of nails used to secure the blocking to the floor. As required by the item being blocked, crossmembers (headers) should be doubled or tripled high 2- by 4-inch or 2- by 6-inch material. The header should not contain less than six nail pairs. The strength capacities found in table B-IX should be used. On flatbed trailers, when the strapping, in accordance with 49 CFR 393.110, has an angle above 30 degrees, blocking is not required, but DoD still requires blocking for A&E. The nail quantity may be reduced to one third of the quantity normally required by table B-IX.

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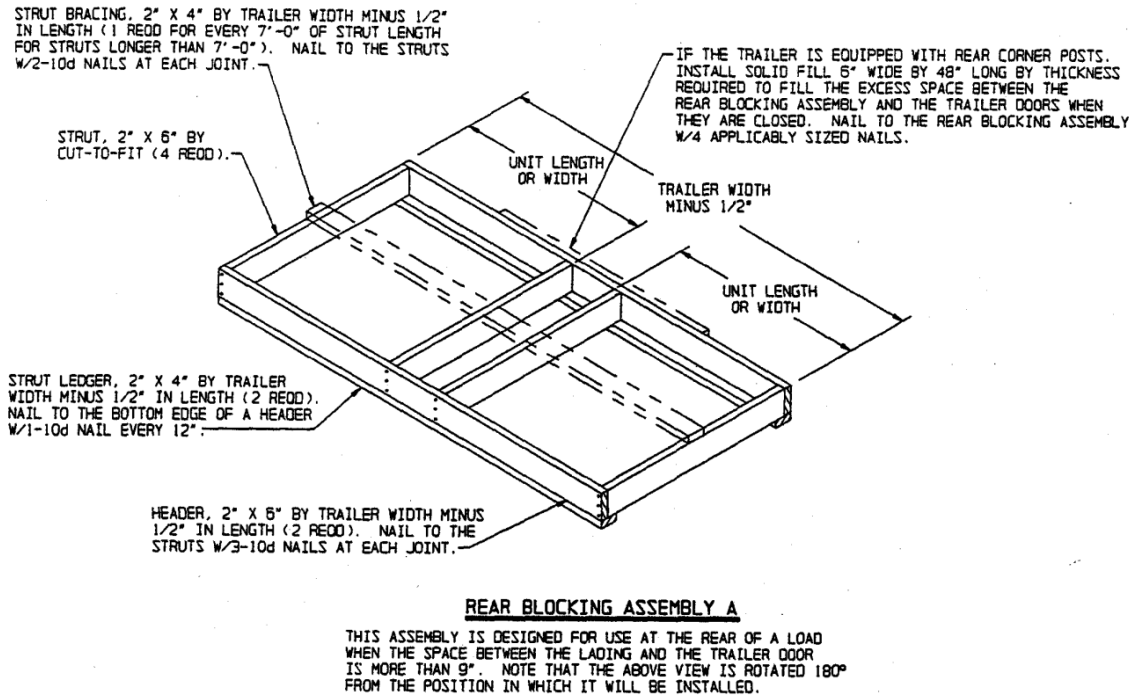

FIGURE B-20. Example rear blocking assembly.

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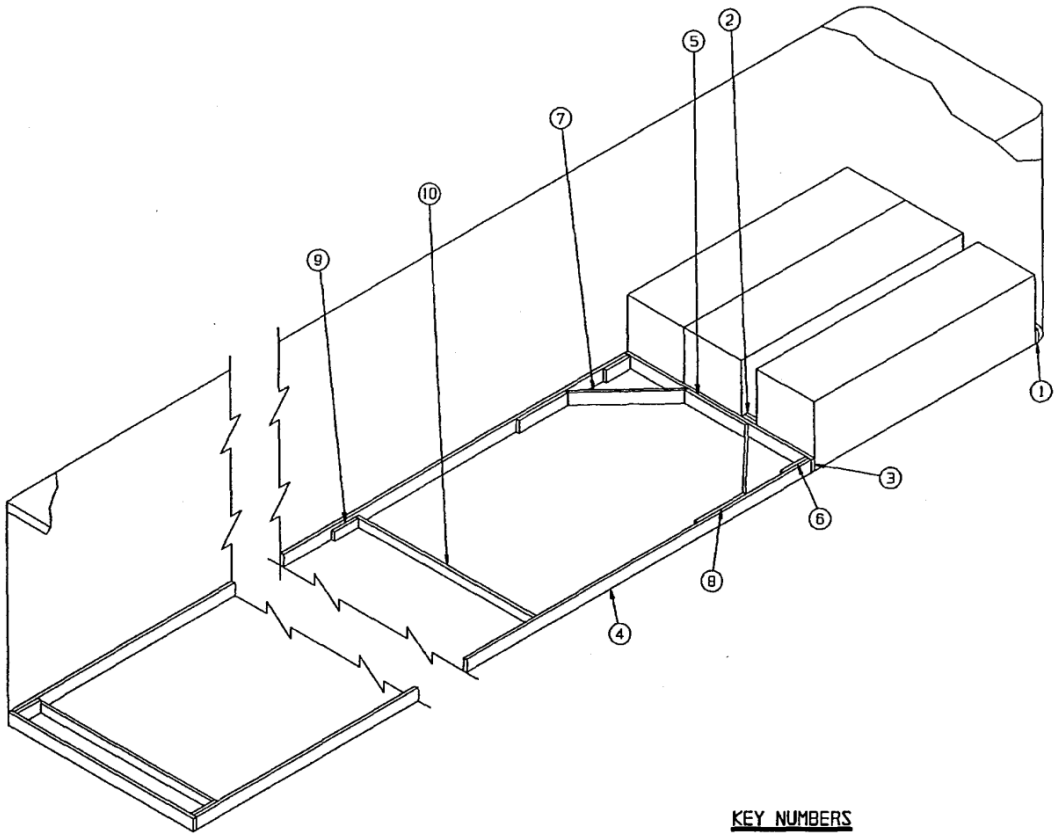

ISOMETRIC VIEW

KEY NUMBERS

① FORWARD BLOCKING (1 REQD).

② BEARING PIECE, 2" X 6" BY DISTANCE BETWEEN CONTAINER SKIDS MINUS 1" (DOUBLED) (1 REQD). NAIL THE FIRST PIECE TO PIECE MARKED ③ W/3-10d NAILS. NAIL THE SECOND PIECE TO THE FIRST IN A LIKE MANNER.

③ HEADER, 2" X 6" BY TRAILER WIDTH (CUT TO FIT) (2 REQD).

④ SIDE STRUT, 2' X 6" BY CUT TO FIT BETWEEN HEADERS MARKED ③ (2 REQD).

⑤ CENTER CLEAT, 2" X 6" X 30" (1 REQD). NAIL TO HEADER PIECE MARKED ③, W/6-10d NAILS.

⑥ POCKET CLEAT, 2" X 6" 12" (4 REQD). NAIL TO SIDE STRUT, PIECE MARKED ④, W\5-10d NAILS. TOENAIL TO THE ADJACENT HEADER PIECE MARKED ③, W/3-12d NAILS.

⑦ DIAGONAL BRACE, 2" X 6" (2 REQD). DOUBLE BEVEL EACH END WITH 45° CUTS. INSTALL AT A 45° ANGLE AS SHOWN AND TOENAIL TO THE ADJACENT HEADER, PIECE MARKED ③, AND SIDE STRUT, PIECE MARKED ④, W/2-16d NAILS AT EACH END.

⑧ BACK-UP CLEAT, 2" X 6" X 24" (2 REQD). NAIL TO A SIDE STRUT, PIECE MARKED ④, W/8-10d NAILS.

⑨ STRUT BRACE RETAINER CLEAT, 2" X 4" X 12" (AS REQD). NAIL TO SIDE STRUT, PIECE MARKED ④, W/3-10d NAILS.

⑩ STRUT BRACE, 2" X 4" BY TRAILER WIDTH MINUS 3" (CUT TO FIT) (MINIMUM OF ONE REQD). NAIL TO PIECES MARKED ⑨ W/2-12d NAILS AT EACH END.

FIGURE B-21. Rear blocking using a floating structure.

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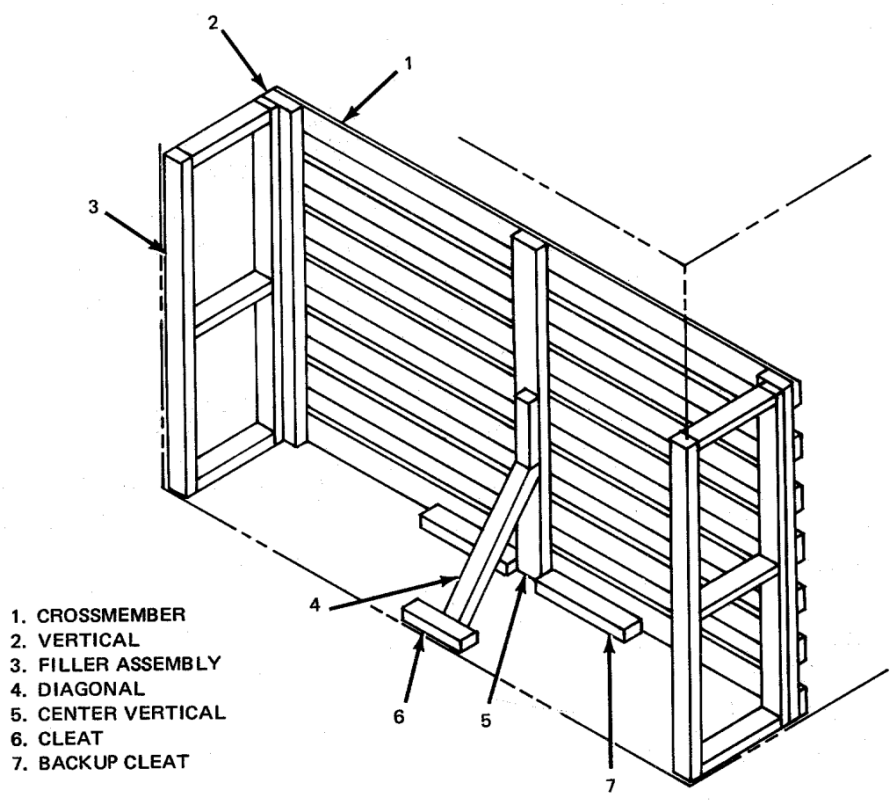
B.4.11.14.2 Rear gate. A rear gate is essential when the lading is of the type that may topple to the rear or the upper layer(s) consists of loose items or palletized loads that cannot be secured adequately to the bottom layer. Depending upon their design, rear gates may be positioned at any point in the vehicle necessary to secure a full or partial load. Gate crossmembers should be located in proper relation to the lading to provide adequate support. The gate, when possible, should be installed so that it may be removed as a unit for reuse with future loads. Figure B-22 illustrates a rear gate suitable for when the lading is 2 or 3 feet from the rear door. Figure B-23 illustrates a rear gate suitable for less than truckloads or other situations where it is not feasible to block to the rear of the vehicle.



NOTES:

1. The gate is constructed of crossmembers (1) and verticals (2 and 5).
2. The space between the gate and the trailer door is filled with preassembled filler assemblies (3) and braced securely in the center by placing a diagonal (4) between the gate's center vertical (5) and the rear door sill.
3. The diagonal (4) is secured at each end by cleats (6).
4. A backup cleat (7) is placed against the bottom gate crossmember on each side of the center vertical (5) securing the gate in position.

FIGURE B-22. Rear gate (2 to 3 feet from rear door).

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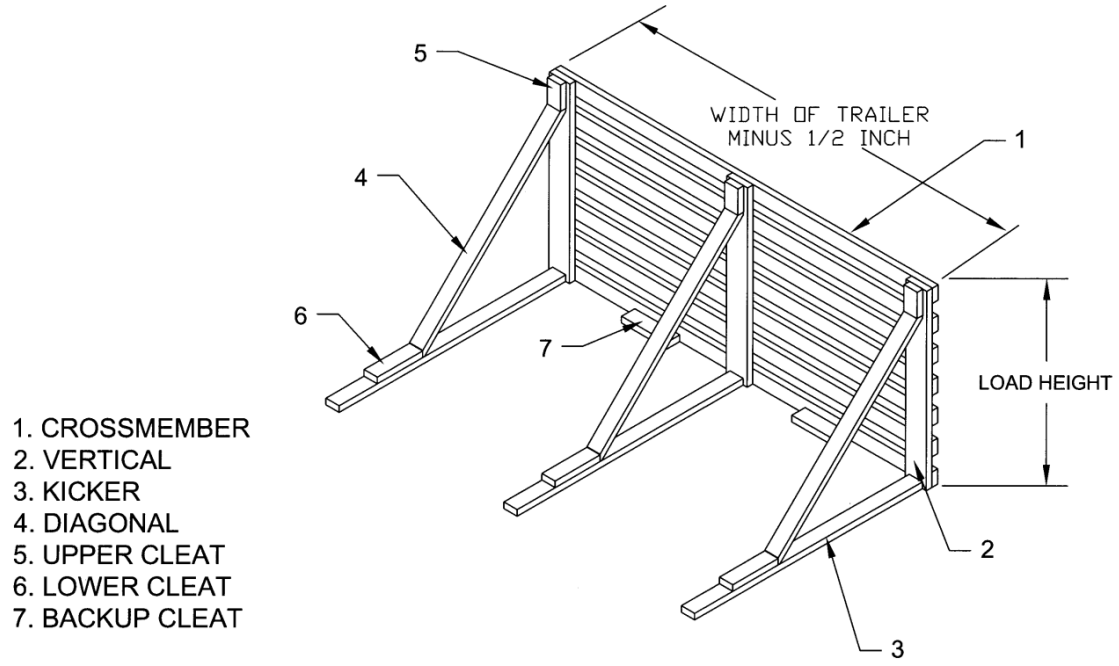

NOTES:

1. Crossmembers (1) are nailed to verticals (2).
2. Kickers (3) are installed against the end verticals, extending toward the door posts for a minimum of 6 feet.
3. Diagonals (4) are placed between the end verticals (2) and kickers (3), and braced at the upper end with upper cleats (5) and at the lower end with lower cleats (6).
4. The gate is braced in the center by placing a diagonal (4) in the center, secured by cleats (6) at each end.
5. A backup cleat (7) is secured to the floor between center uprights and end uprights.

FIGURE B-23. Rear gate (located further than 6 feet from rear door).

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B.4.11.14.3 Partial layers. Partial layers of unit loads require special bracing procedures to control rearward movement. The approved method of preventing the top layer(s) from sliding aft over the bottom layer is described in B.4.9.4 and B.4.9.5. Straps alone could be used to prevent movement in most cases. If doubled 2- by 6-inch stiffeners of the unitized loads are used, they should be positioned toward the rear of the trailer.

B.4.11.14.4 Nailed side blocking. Side blocking is used to control lateral motion in the first layer of the lading and only when the trailer has a nailable floor (it cannot be used when the trailer has metal floors). The side blocking is nailed to the floor against the lading and runs parallel to the longitudinal axis of the trailer. Figure B-24 shows side blocking installed against a unit load of propellant charges. The side blocking will be doubled with 2- by 4-inch or 2- by 6-inch material, if space permits. Nailing should be with 10d, 12d, or 16d nail pairs in each layer. Each load bay should have doubled or tripled side blocking on each side. Use the same nail strength capacities found in table B-IX. For side and end blocking in van trailers, the lading vertical CG should be no more than 173 percent of the horizontal distance to the top of the blocking. It should remain stable when the floor is tilted to a 30-degree angle. Containers and unit loads may need to be secured together by strapping to meet this requirement. On flatbed trailers, when the strapping, in accordance with 49 CFR 393.110, has an angle above 30 degrees, blocking is not required, but DoD still requires it for A&E. The nail quantity may be reduced to one third of the quantity normally required by table B-IX.

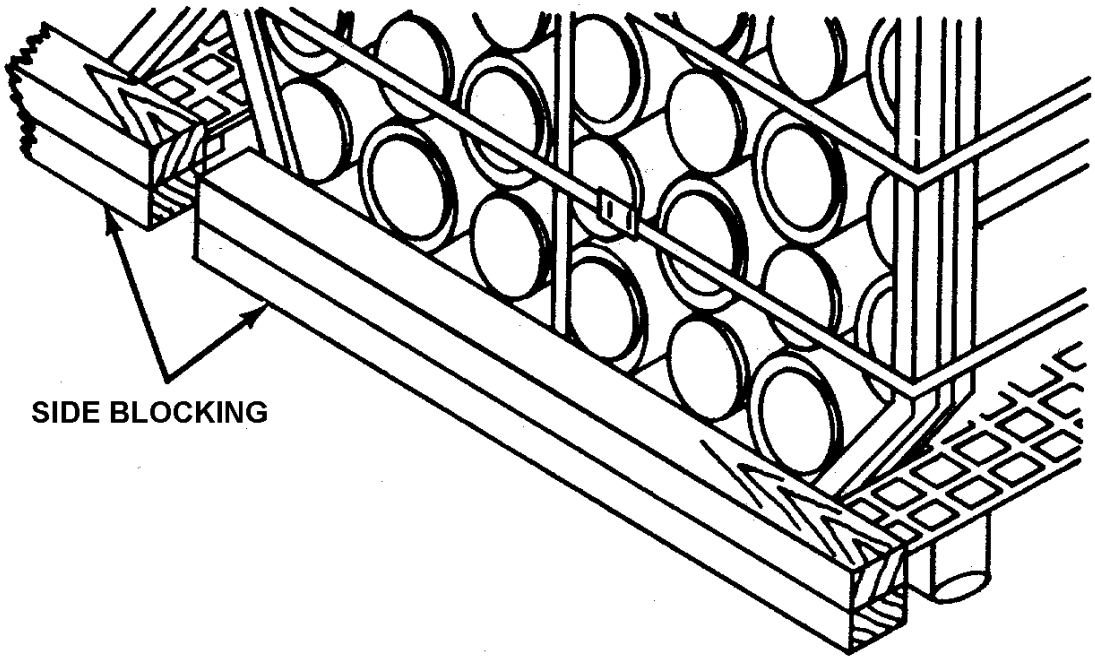

FIGURE B-24. Side blocking.

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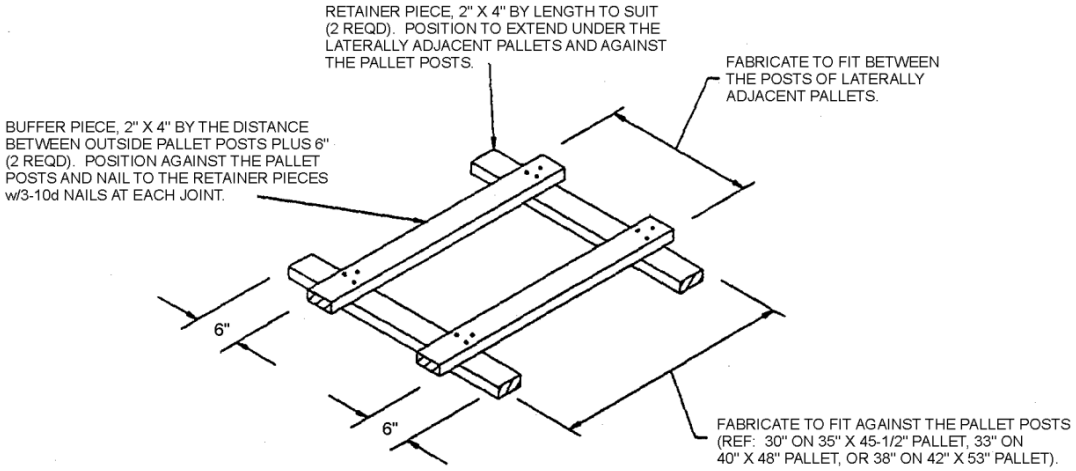
B.4.11.14.5 Anti-sway brace. An anti-sway brace should be used between rows of lading to hold them against the side walls of the trailer and control lateral motion. They are generally used in the second (and third) layers; however, they should also be used for the first layer in lieu of nailed side blocking when a van has a non-nailable floor.

a. Figure B-25 shows the most commonly used type of anti-sway brace. It is supported and held in place by the pallets of the unit loads (or the fork pockets of containers). This type can also be used for preventing lateral motion in the first layer of the load when the van has non-nailable (metal) floors since it does not require nailing into the floor. This type of sway brace should be fabricated in place. It cannot be prefabricated.



ANTI-SWAY BRACE

IF DESIRED, THE ANTI-SWAY BRACE CAN BE PARTIALLY PRE-ASSEMBLED; ONE BUFFER PIECE CAN BE NAILED TO BOTH RETAINER PIECES. THE LONG ENDS OF THE ASSEMBLY CAN BE INSTALLED INTO THE FORKLIFT OPENING OF A LOADED PALLET PRIOR TO POSITIONING THE LATERALLY ADJACENT PALLET.

FIGURE B-25. Typical anti-sway brace.

b. Figures B-26 and B-27 show two types of anti-sway braces used on top of the lading. The anti-sway brace is supported by its support pieces on top of the lading and should be secured in place, usually by twist-tying with 0.0800-inch diameter wire (ASTM A853; annealed at finish, black oxide finish, Grade 1006 or better).

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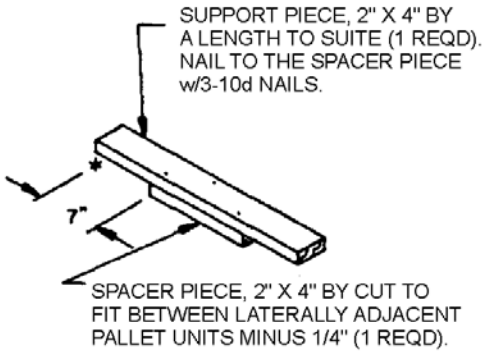
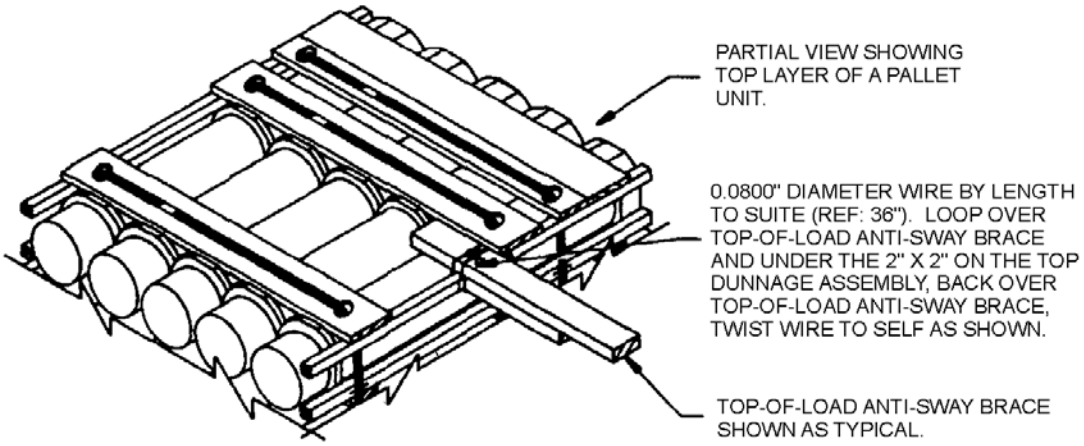


TOP-OF-LOAD ANTI-SWAY BRACE



TIE WIRE APPLICATION

DETAILS

FIGURE B-26. Detailed top-of-load anti-sway brace.

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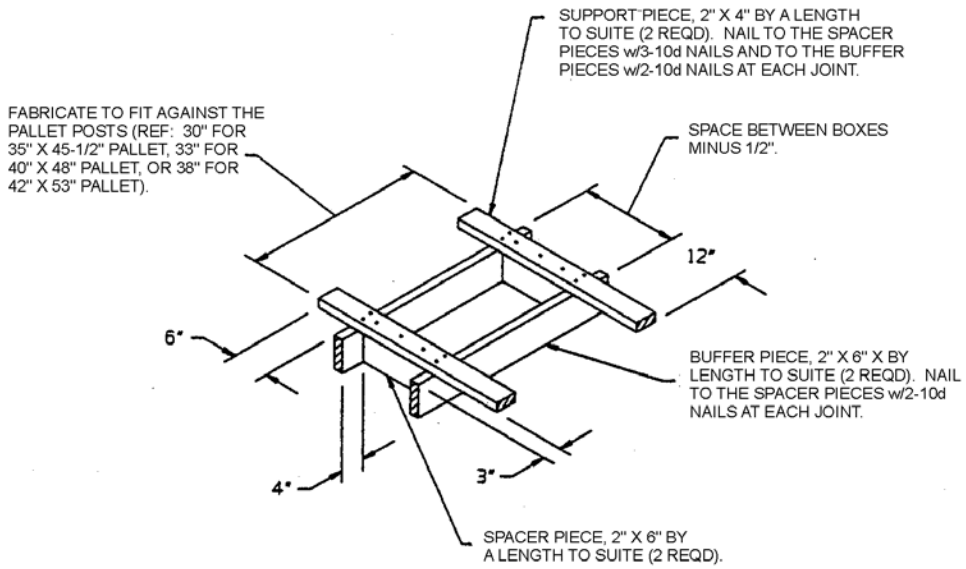
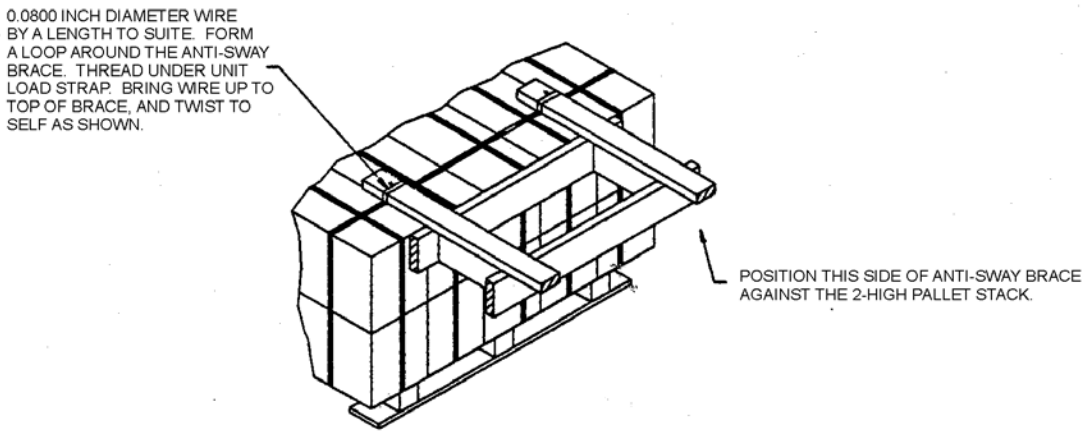


TOP-OF-LOAD ANTI-SWAY BRACE



TIE WIRE APPLICATION

FIGURE B-27. Top-of-load anti-sway brace.

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B.4.11.14.6 Filler assemblies. When the lateral void between units of lading is too small to install sway braces, a filler assembly may be used. The assembly should be prefabricated and slid into the void. The thickness of the material or the design may be varied so that the assembly fills the void. Figure B-28 shows examples of filler assemblies for one-high and two-high layers of lading.

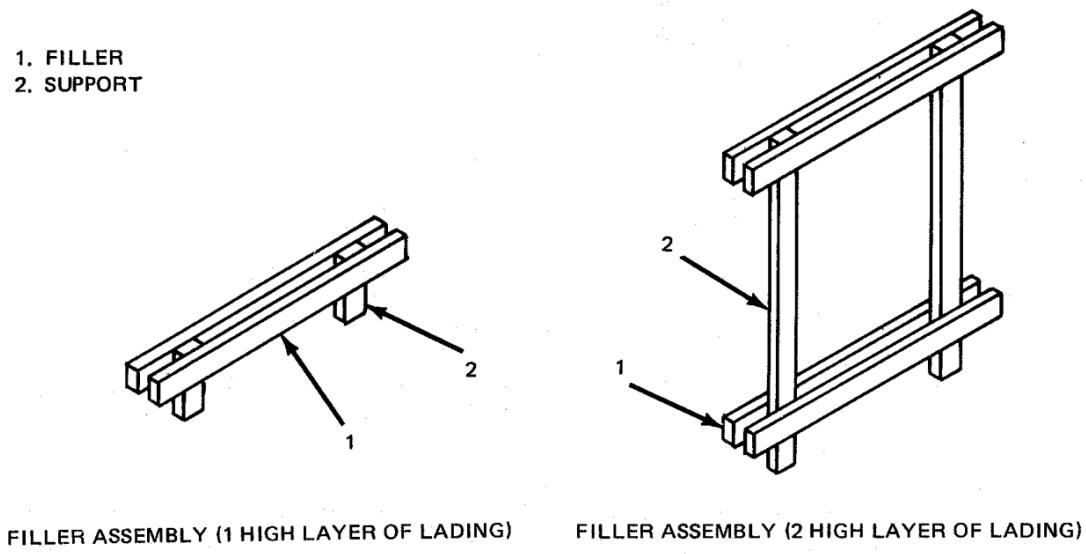

FIGURE B-28. Typical crib filler assemblies.

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B.4.11.15 Intermediate gates. Intermediate gates may be used as necessary in mixed loads to separate containers or units of different weight, size, and type. Gates may be used between a unit of heavy, strong containers and lighter, weak units when subjected to load pressures that might cause crushing. Intermediate gates should be floating and not secured to floor or walls. Figure B-29 shows a typical intermediate gate.

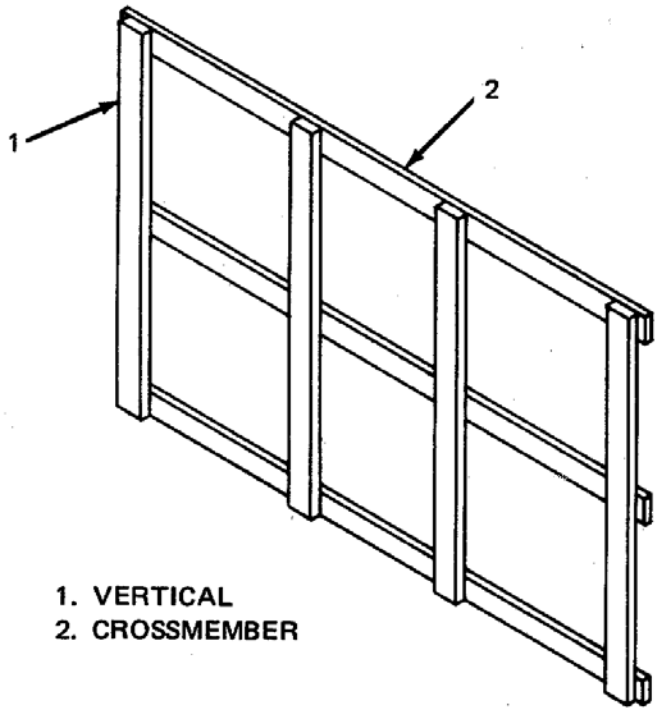

FIGURE B-29. Typical intermediate gate.

B.4.11.16 Stepdown loads. A stepdown load (shown on figure B-30) may be used to distribute the weight of the lading within a vehicle to prevent exceeding the permissible gross axle weights. It may also be used to prevent the fore or aft motion of a partial layer. The stepping down of the load is achieved by the use of a riser (2); the height of the riser should be half the height of the unit or container being braced. In some cases, the item or container being loaded may be utilized as a riser, each row securing the adjacent row. However, in most instances, the riser should be fabricated from lumber. The dimensions and weight of the riser will depend on the size and weight of the units making up the load and on the vehicle being used. A forward blocking assembly (1) is installed to square up the nose of the vehicle and to provide even distribution of weight. A rear gate (3) is installed at the rear of the lading to prevent rearward load movement and to provide a tight, secure load. The methods of achieving the stepdown load described herein are to be considered typical and adapted to other loads as applicable.

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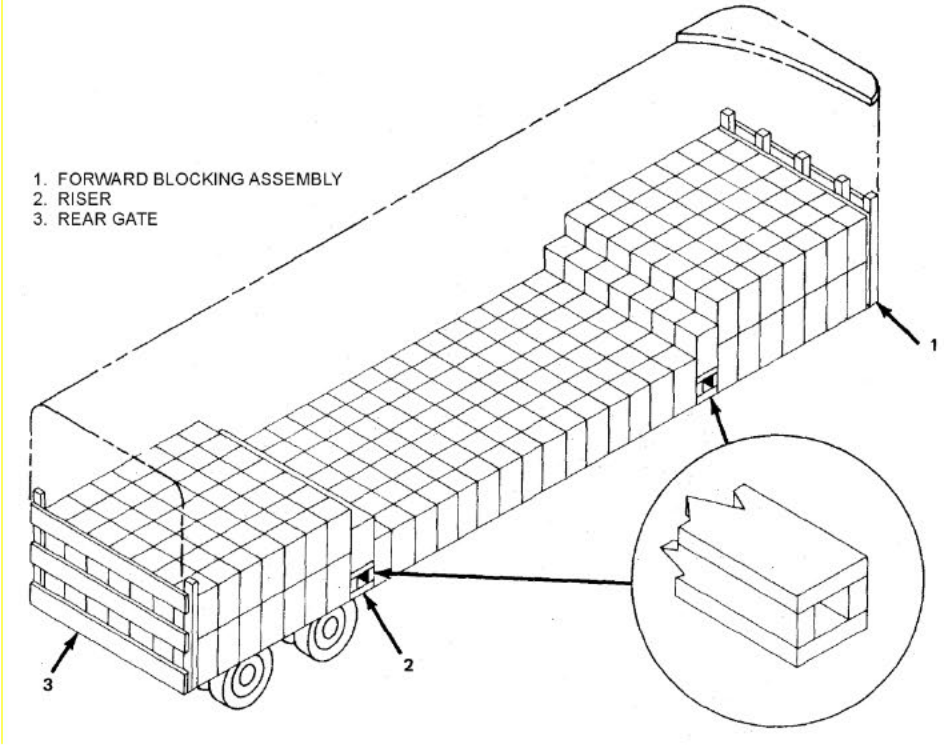

FIGURE B-30. Stepdown loads.

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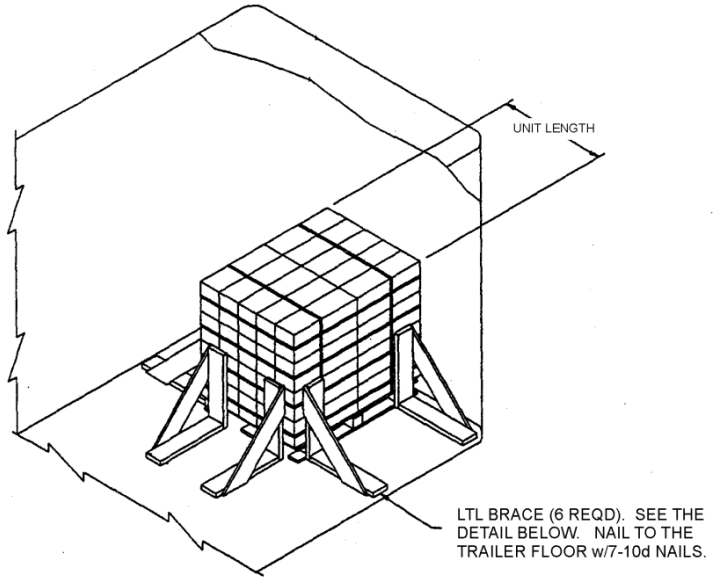
B.4.11.17 LTL braces. For LTL loads, an LTL brace can be used to secure the lading. The bracing can be used on all four sides of the lading. An LTL brace, as shown on figure B-31, will support 2,000 pounds of lading in the longitudinal direction. Not less than two LTL braces should be used on each side.



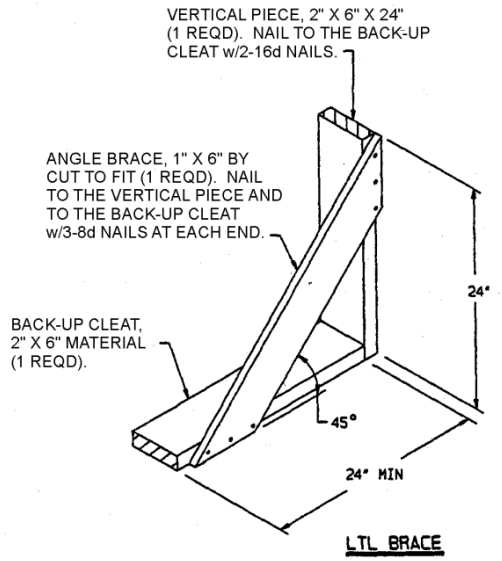


FIGURE B-31. LTL brace.

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B.4.12 Dunnaging flatbed trailers.

B.4.12.1 Difference from flatbed trailers. The basic difference between the loading of flatbed trailers and the loading of van-type trailers is that, on flatbeds, all lengthwise, crosswise, and vertical forces should be restrained without the assistance of end or side walls. Because of this, the fundamental concept is to hold the load in position on the flatbed trailer with blocking and to hold the load down with tiedowns.

B.4.12.2 Arrangement of lading. When loading a flatbed trailer, the lading is arranged in stacks and located so that the permissible gross axle weights are not exceeded. All of the lading should be within the perimeter of the trailer.

B.4.12.3 Securing stacks. Lading on a flatbed trailer should be held together to form a good solid stack that will not shift during highway movement. This is accomplished by unitizing or bundling the lading and holding the top of the stack together with straps.

B.4.12.3.1 Unitizing containers. When containers are placed one on top of the other, the strapping together of this vertical grouping is called unitizing containers. This is required to maintain interlocking of the stacking features during highway movement. Containers should be unitized as described in B.4.9.4. When adequate handling equipment is available, containers may be unitized prior to loading them on the trailer. If the handling equipment is not adequate, the containers should be loaded onto the trailer one at a time and then unitized. Some newer containers have a mechanical interface unique to the container design that allows these containers to be unitized. If this is provided, no strapping is required.

B.4.12.3.2 Bundling of unit loads. When unit loads are placed one on top of the other, the strapping together of this vertical stack is called bundling of the unit loads. The bundling of the unit loads ties the top unit load to the bottom preventing the top unit load from moving in respect to the bottom unit load. Unit loads should be bundled as described in B.4.9.5. Bundling is sometimes called unitizing in some plans.

B.4.12.3.3 Bundling straps. A stacking of containers, unit loads, or other lading two or more wide and two or more high should be strapped together with a minimum of two 1¼-by 0.031-inch or 1¼- by 0.035-inch straps. These straps encircle the top layer of the lading, binding the top of the stacks together (see figure B-32). One-high stacks do not require bundling straps.

B.4.12.4 End blocking. An end header is placed across the end of the lading to restrain the load (see figure B-32). End blocking is two or three pieces high depending upon the end configuration of the lading skids. Use table B-IX to calculate nail quantity.

B.4.12.5 Side blocking. Side blocking (2- by 4-inch or 2- by 6-inch material) is placed against the skids or against the sides of the bottom container in the stack and near its ends. They are doubled and usually positioned parallel to the length of the container, and are not placed against the end crossmember (see figure B-32). Items shipped on flatbed trailers can be side blocked with a single height member provided the surface of the blocked item is flush to the flatbed deck.

Under certain situations, the trailer's steel floor beams may prevent nailing and positioning of side blocking as prescribed in B.4.12.5 or the approved truckload drawing. In these cases, other adequate blocking procedures may be used. One method considered adequate is to increase side blocking size to 2 by 6 and position side blocking (space permitting) at right angles to the lading, nailing it to the trailer floor beyond the steel beam. Another method would be to increase the prescribed width of the side blocking so that it extends sufficiently beyond the metal area to permit nailing.

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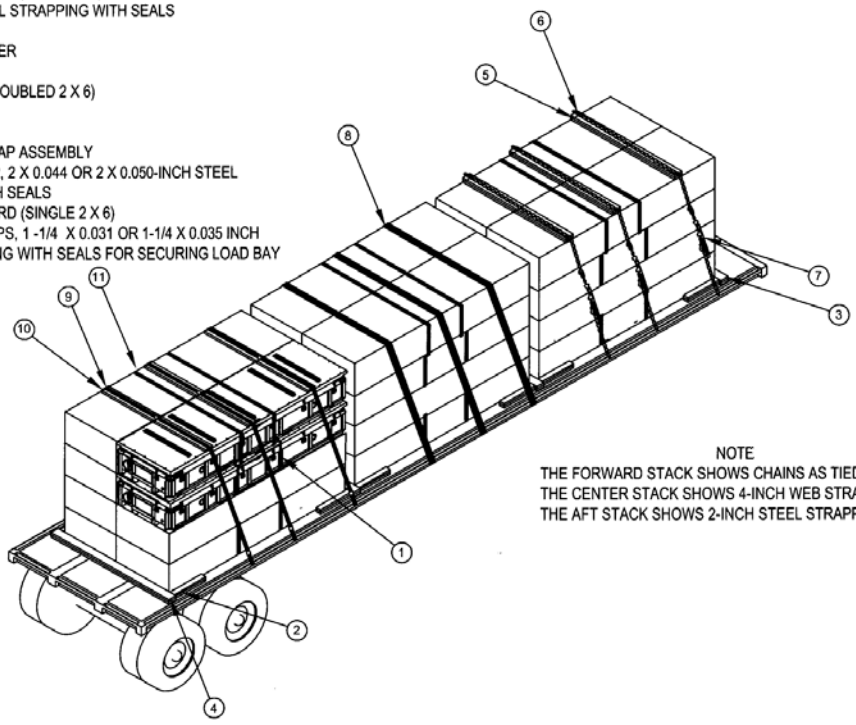
1. BUNDLING STRAPS (UNIT LOAD), 1-1/4 X 0.031 OR 1-1/4 X 0.035 INCH STEEL STRAPPING WITH SEALS
2. SIDE BLOCKING
3. FORWARD HEADER
4. REAR HEADER
5. CHAIN BOARD (DOUBLED 2 X 6)
6. CHAIN
7. LOAD BINDER
8. 4-INCH WEB STRAP ASSEMBLY
9. TIEDOWN STRAP, 2 X 0.044 OR 2 X 0.050-INCH STEEL STRAPPING WITH SEALS
10. STRAPPING BOARD (SINGLE 2 X 6)
11. BUNDLING STRAPS, 1 -1/4 X 0.031 OR 1-1/4 X 0.035 INCH STEEL STRAPPING WITH SEALS FOR SECURING LOAD BAY



NOTE
THE FORWARD STACK SHOWS CHAINS AS TIEDOWNS.
THE CENTER STACK SHOWS 4-INCH WEB STRAP ASSEMBLY AS TIEDOWNS.
THE AFT STACK SHOWS 2-INCH STEEL STRAPPING AS TIEDOWNS.

FIGURE B-32 Typical flatbed load

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B.4.12.6 Tarpaulins. Explosives (other than black powder) and such inert items that might appear to be explosive in nature to the public may only be transported on flatbed trailers if fire-resistant and waterproof tarpaulins completely conceal the lading in accordance with 49 CFR 177.835. This includes containerized items.

B.4.12.6.1 Drawings. For sake of clarity, drawings showing loads that require a tarpaulin do not show the load covered with a tarpaulin. Usually a "NOTE" in a prominent area adjacent to the isometric drawing informs the user that a fire-resistant and waterproof tarpaulin should cover the load.

B.4.12.6.2 Wing damage. When applying tarpaulins, it is almost always better to cover the load before applying the tiedowns. This permits the tarpaulin to fit snugly around the containers with a minimum amount of void under the tarpaulin, thereby making it less susceptible to wind damage.

B.4.12.7 Tiedowns. All loads on flatbed trailers should be tied down with 2- by 0.044-inch or 2- by 0.050-inch steel strapping, approved chain (see B.4.10.2) and load binders (see B.4.10.2) or web strapping. The steel strapping and chain are interchangeable on a 1-to-1 basis. A load may have a chain and a strap on the same trailer. Each load bay should have a minimum of two tiedowns. One tiedown is considered a strap or chain that passes over the lading and is attached to both sides of the trailer. This is referred to as an indirect tiedown. For commodities longer than 20 feet, a minimum of three tiedowns (see B.4.11.14.2) should be used and for commodities longer than 30 feet, a minimum of four tiedowns should be used.

B.4.12.7.1 Application procedure. Steel straps should be applied as specified in B.4.9.2. Chain and load binders should be applied as specified in B.4.10. Web strapping should be applied as specified in B.4.11.

B.4.12.7.2 Direct tiedowns. When slings or chains are connected to the trailer and then directly attached to the lading, this is called a direct tiedown. When the lading has tiedown fittings or some other sturdy attachment points and the rest of the structure is too fragile to use an indirect tiedown method, the direct tiedown method should be considered. When direct tiedowns are used, the aggregate WLL of the slings should not be less than the weight of the lading.

B.4.13 Sample loads. Figure B-32 shows the basic principles of flatbed dunnaging. The forward load bay illustrates the correct application of chain and load binders. The center load bay illustrates the correct application of 4-inch web strapping. The aft load bay illustrates the correct application of the 2- by 0.050-inch steel strapping. Figure B-33 shows the basic principles of van trailer dunnaging.

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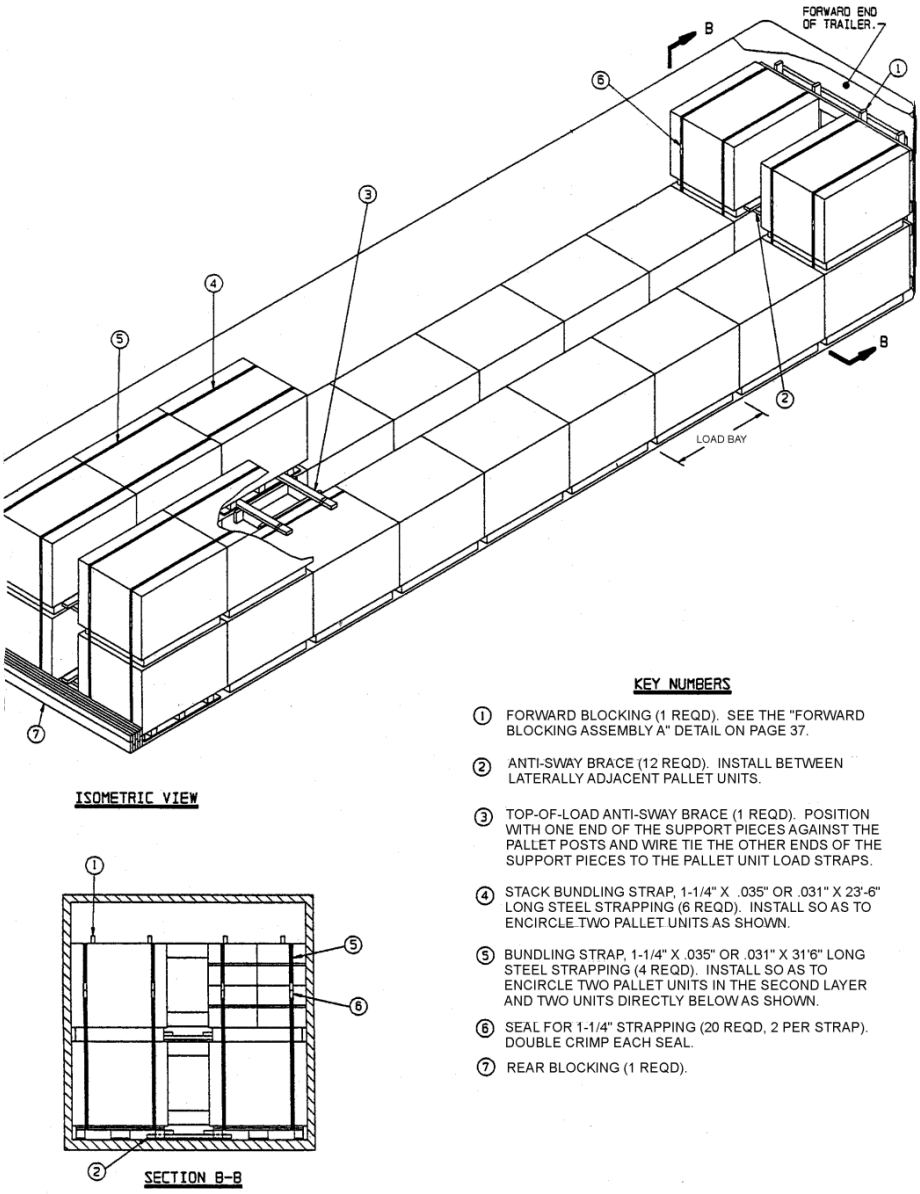

FIGURE B-33. Sample van trailer load.

B.5 PROCESS TO CONSTRUCT A TRUCKLOAD

a. Gather information on the item to be shipped, such as size, weight, CG, insensitive munitions concerns (does the item need to be positioned in a specific configuration to meet requirements for insensitive munitions), hazard class, etc.

b. Determine if the item will be shipped on a van trailer or a flatbed. Length and handling capabilities will determine if an item can be loaded in a van. Also, specific security concerns can require the item be shipped in a closed van. Determine how big (length and width) a trailer is needed.

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c. Determine, based on size and weight, how many items can be shipped. The lading, blocking, and bracing should not exceed 40,000 pounds.

d. Create a layout plan for the load. Consider the configuration of the item. Is it better to arrange the item with the long surface forward to aft? Does an insensitive munitions issue exist for the item? This will dictate a certain configuration.

e. How will the load be secured? Determine the appropriate method to use. If a flatbed trailer is used, determine how many straps or chains are needed to secure the load.

f. Based on this conceptual layout, determine if the drive or trailer axles will be overloaded. The CG of the load will need to be calculated and figures B-2 and B-3 used to determine the percent of load that will be carried by each axle. If axles are within 2,000 pounds of the allowable axle weight, reconfigure the layout plan.

g. Document how to configure and secure the load. Obtain drawings showing how the load will look and details on how to construct the load.

B.6 TRUCKLOAD EVALUATION

B.6.1 General. This section covers the test procedures of A&E configured for highway movement only. This section is intended to give an overview of the testing required for loads of A&E for highway movement only. Test procedures are prescribed in the Defense Ammunition Center Test Procedure 94-01 (TP 94-01).

B.6.2 Truck and trailer road hazard test. Truck and trailer road hazard tests should be coordinated with approval authorities. Significant deviations from previously approved blocking and bracing procedures should be subjected to the following tests:

a. Test load (specimen). The test load is prepared using the same blocking and bracing method specified in the outloading procedures proposed for use with the munitions. The truck used in the test should be inspected to assure its adequacy for munitions transport. Items used to build the load should be inert (nonexplosive). The weight and physical characteristics of the load configuration should simulate to the live (explosive) ammunition provided for in the outloading procedure; i.e., weights, physical dimensions, CG, materials, etc. The ammunition packages used should duplicate that of the live ammunition.

b. Hazard course. This test requires the truck load to be driven over a 200-foot long segment of concrete-paved road that consists of two series of railroad ties projecting approximately 6 inches above the level of the road surface. This hazard course should be traversed two times (see figure B-34) for each test.

(1) The first series of ties consists of six ties spaced on 10-foot centers and alternately positioned on opposite sides of the road centerline for a distance of 50 feet.

(2) Following the first series of ties, a paved roadway of 75 feet separates the first and second series of railroad ties.

(3) The second series of ties consists of seven ties spaced on 8-foot centers and alternately positioned on opposite sides of the road centerline for a distance of 50 feet.

(4) The test load should be driven across the hazard course at speeds that would produce the most violent vertical and side-to-side rolling reaction obtainable in traversing the hazard course (approximately 5 mph).

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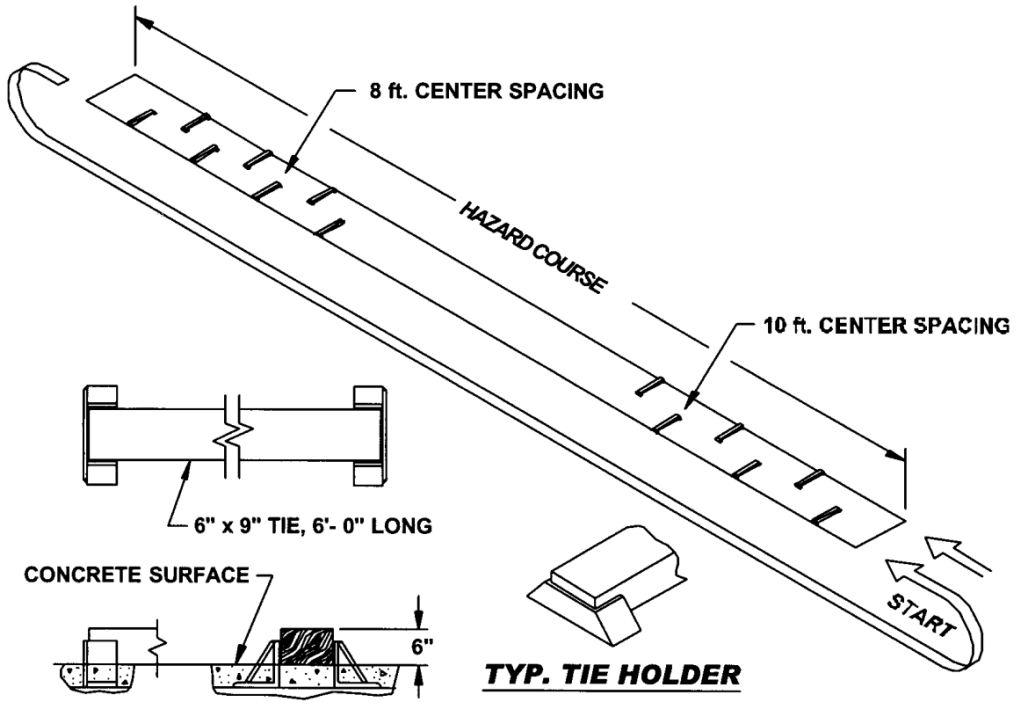

FIGURE B-34. Hazard course diagram.

c. Road trip. Using a suitable truck/tractor and trailer, the truckload should be driven/towed for a total distance of at least 30 miles over a combination of roads surfaced with gravel, concrete, or asphalt. Test routes should include curves, corners, railroad crossings, cattle guards, and stops and starts. The test vehicle should travel at the maximum speed suitable for the particular road being traversed, except as limited by legal restrictions.

d. Panic stops. This step provides the truck load to be subjected to three full airbrake strops while traveling in the forward direction and one in the reverse direction while traveling down a 7-degree grade. The first three stops should be at 5, 10, and 15 mph, while the stop in the reverse direction should be at approximately 5 mph.

e. Hazard course. Following the road trip and panic stops, the hazard course should be again traversed two times.

f. Washboard course (optional). Using a suitable truck/tractor, the truckload should be towed/driven over the washboard course (figure B-35) at a speed which produces the most violent response in the particular test load (as indicated by the resonant frequency of the suspension system beneath the load). The washboard course should be constructed as shown on figure B-35.

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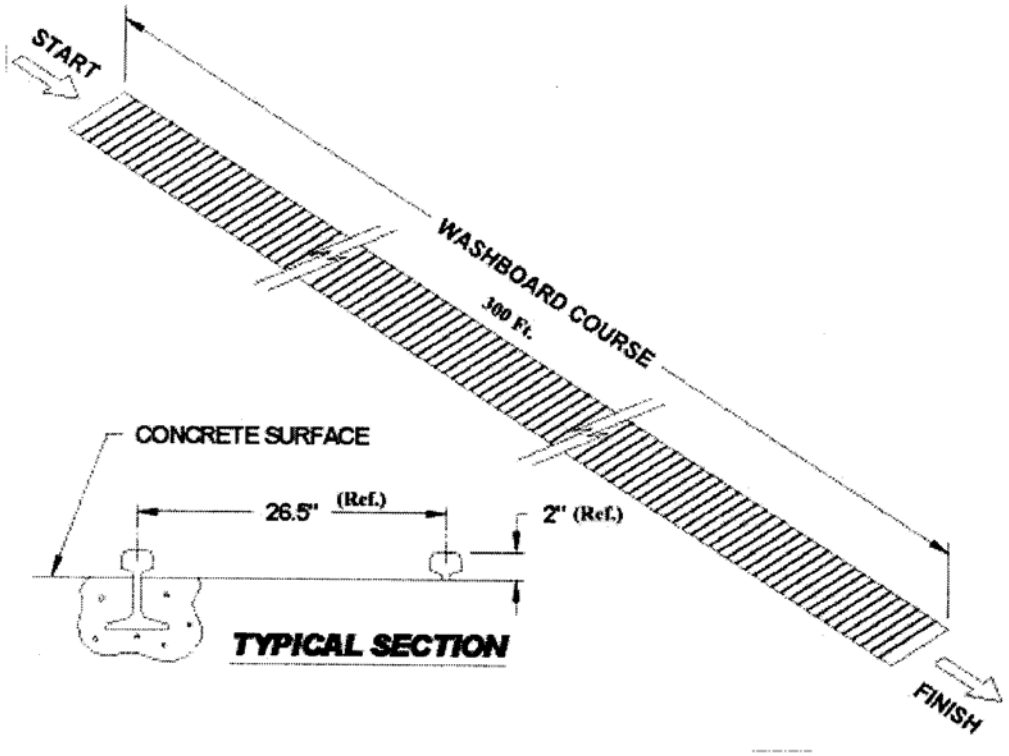

FIGURE B-35. Washboard course.

B.6.3 Data collection. The test load (specimen) should be instrumented as determined by the test engineer, or as requested by the test sponsor, to determine movement forces, velocities, and accelerations. The data collected should be suitable for use in investigating causes for failure and as criteria for design when developing new procedures. At the discretion of the test engineer, or as requested by the test sponsor, blocking and bracing and other dunnage members subject to failure, may be instrumented at critical points with strain gages, load cells, and displacement gages.

B.6.4 Failure criteria. At the conclusion of each test, or at any time deemed necessary by the test engineer, the load should be examined. Excessive shifting of contents, loosening, or breaking of load restraints or blocking and bracing, deformation of tiedown fittings, or any visible damage to the items in the load or their packaging, or any other discernible damage which could render the item being shipped unsuitable/unsafe for its intended use, should constitute failure. Normally, testing should be stopped when it becomes apparent that the load will fail; however, the test may be continued until complete failure if the test engineer and test sponsor determine that usable data will be developed and safety of personnel and equipment integrity will not be violated.

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RAILCAR LOADING OF AMMUNITION AND EXPLOSIVES

C.1 INTRODUCTION

C.1.1 Scope. This appendix contains general guidance for the preparation of full and less than carload shipments of ammunition, explosives, propellants, and weapon system components. It also contains guidance to be followed in all carloading procedures when specific instructions in the form of drawings do not exist (for example, mixed carloads). The drawings contain specific instructions primarily for carloading ammunition normally shipped in large quantities. This appendix is not a mandatory part of the standard. The information contained herein is intended for guidance only.

C.1.2 Application. This appendix is limited to the preparation for shipment of material by or to the Department of Defense (DoD) only. It does not apply to interplant shipments of material that are not Government owned.

C.2 APPLICABLE DOCUMENTS

C.2.1 General. The documents listed in this section are specified in this appendix. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in this appendix, whether or not they are listed.

C.2.2 Government documents.

C.2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this appendix to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

FEDERAL SPECIFICATIONS

NN-P-71	-	Pallets, Material Handling, Wood, Stringer Construction, 2-Way and 4-Way (Partial)

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-DTL-15011	-	Pallets, Material Handling, Wood Post Construction, 4-Way Entry

(Copies of these documents are available online at http://quicksearch.dla mil.)

C.2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this appendix to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ARMY DEFENSE AMMUNITION CENTER DOCUMENTS

Joint Hazard Classification System (JHCS)

(Copies of this document are available online at https://www3.dac.army mil.)

ARMY DEFENSE AMMUNITION CENTER DRAWINGS

AMC 19-48-8691	-	Loading and Bracing (CL & LCL) in Boxcars of JSOW (AGM-154) Missiles Packed in CNU-575/E Shipping and Storage Containers

(Copies of this document are available online at https://www3.dac.army mil/DET/order/draworder html.)

CODE OF FEDERAL REGULATIONS (CFR)

49 CFR 172	-	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans

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49 CFR 172.504	-	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans, General Placarding Requirements
49 CFR 174	-	Carriage by Rail
49 CFR 174.104	-	Carriage by Rail, Division 1.1 or 1.2 (Explosive) Materials; Car Selection, Preparation, Inspection, and Certification

(Copies of this document are available online at http://www.ecfr.gov.)

DEPARTMENT OF DEFENSE PUBLICATIONS

DoD 4140.65-M - Issue, Use, and Disposal of Wood Packaging Material (WPM)

(Copies of this document are available online at www.dtic mil/whs/directives/.)

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

Voluntary Product Standard PS 20-10 - American Softwood Lumber Standard

(Copies of this document are available online at http://gsi nist.gov/global/index.cfm/L1-5/L2-44/A-355.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

SW020-AG-SAF-010 - Navy Transportation Safety Manual for Ammunition, Explosives and Related Hazardous Materials

(Copies of this document are available online at https://nll.ahf nmci navy mil, may be requested by phone at 215-697-2626, or may be requested by email at nllhelpdesk@navy mil.)

U.S. TRANSPORTATION COMMAND (USTRANSCOM)

DTR 4500.9-R - Defense Transportation Regulations

(Copies of this document are available online at http://www.transcom.mil/dtr/dtrHome/.)

C.2.3 Non-Government publications. The following documents form a part of this appendix to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN ASSOCIATION OF RAILROADS

Open Top Loading Rules Manual

(Copies of this document are online at https://www.aarpublications.com/.)

ASTM INTERNATIONAL

ASTM A853	-	Standard Specification for Steel Wire, Carbon, for General Use
ASTM D3953	-	Standard Specification for Strapping, Flat Steel and Seals
ASTM D4727/D4727M	-	Standard Specification for Corrugated and Solid Fiberboard Sheet Stock (Container Grade) and Cut Shapes
ASTM F1667	-	Standard Specification for Driven Fasteners: Nails, Spikes, and Staples

(Copies of these documents are available online at www.astm.org.)

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BUREAU OF EXPLOSIVES (BOE) PUBLICATIONS

BOE-6000 - Hazardous Materials Regulations Tariff

(Copies of this document are available online at http://www.boepublications.com.)

UBM GLOBAL TRADE

The Official Railway Equipment Register

(Copies of this document are available online at http://www railresource.com/.)

C.2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

C.3 GENERAL GUIDANCE

C.3.1 General. This section covers the general guidance for the safe transportation of ammunition and explosives (A&E) by railcar. Detailed guidance is contained in C.4.

C.3.2 Drawings. Specific instructions pertaining to the loading of specific ordnance items are contained in approved drawings. These drawings are individually numbered and titled and can be obtained from the activities listed in 4.7. Where a drawing exists, the loading, blocking, and bracing procedures shown in the drawing should be followed without exception for full or less than full carload shipments. When no drawing exists, or the hazard classification of the items to be shipped is not known, the following subparagraphs should apply in the order listed.

C.3.2.1 Determination of hazard classification. The hazard classification of the lading should be determined prior to the release of any carloading plan in accordance with the Department of Transportation (DOT) Regulations, 49 CFR 172, SW020-AG-SAF-010, or the JHCS.

NOTE: The DOT regulations are constantly being revised. The Hazardous Material Regulations Tariff No. BOE-6000 contains the DOT regulations and is periodically republished with current changes and updated requirements. Shipping activities should subscribe to this tariff to assure availability of the latest issue.

In addition to explosives, flammable materials, oxidizing materials, corrosive liquids, poisons, and radioactive materials are also covered by the DOT regulations. In determining whether or not an item is explosive or dangerous, consult SW020-AG-SAF-010, BOE-6000, or the JHCS.

For clarification with the definition of dangerous or nondangerous, the Naval Ordnance Safety and Security Activity (NOSSA) (Code N714) or U.S. Army Defense Ammunition Center (DAC) may be contacted for appropriate advice.

WARNING: Explosives or dangerous materials should not be shipped unless the proper DOT hazard classification has been assigned.

CAUTION: New explosives, except samples for laboratory examination, may not be legally shipped unless the Bureau of Explosives (BOE) or the DoD has classified it under the provisions of the DOT regulations, 49 CFR 174.

C.3.2.2 Loading plan. Loading plans should be obtained from the activities listed in 4.2.

C.3.2.3 Testing and design. Specific testing of carloads will not be required if the blocking, bracing, etc., is in substantial conformity with existing rules and regulations. The approval authorities and the BOE will determine if a load plan will require testing. When directed, testing of carloads should be in accordance with the requirements of BOE-6000.

C.3.2.4 Design criteria for railcar loading. Carloading blocking and bracing should be designed to withstand car impact speeds of 8.1 mph with due regard to lateral sway in transit. For A&E, the design should be such that the load will not have any movement that might cause damage to the lading during transit.

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C.3.2.5 Carloading principles. Sound carloading can be achieved in practice only by careful observation of all of the following basic principles:

a. The characteristics of the material being loaded should be known and all precautions should be observed.

b. The proper carrier equipment for the material being loaded should be used. Specifically, cars certified for explosives should be used. The carrier should understand the purpose for which the equipment will be used. It is not recommended to use cars larger than necessary.

c. Carrier equipment should be examined upon receipt to ensure that it is, in all respects, completely suitable for loading the cargo.

d. Defective railcars furnished by carriers should be refused and, if required, reported to NOSSA (Code N714).

e. All of the reference documents applicable to the material being carloaded should be used. The drawings and C.2 list the materials which are applicable to specific problems.

f. The appropriate drawing specifications and established design principles should be followed in order to block and brace the cargo completely and properly.

g. Configuration of loads and dunnaging should be determined.

h. Sequence of loading should be determined.

i. Containers or pallet units should fit tightly against car walls, dunnage, and against each other.

j. The car should be loaded with weight evenly distributed forward/aft and side-to-side.

k. Adequate doorway protection for the car should be provided (see C.4.6.8 and C.4.6.9).

l. Equipment should not be loaded beyond the load limit.

m. Overall clearance dimensions should be within the limits for unrestricted interchange, especially for open-top carloads.

n. Close supervision and inspection of the carloading is essential to ensure compliance with all rules and regulations.

o. In transit, railcars are subjected to severe longitudinal and lesser lateral and vertical shock forces. These forces are induced while coupling cars, humping them in marshaling yards, and in long trains traveling at relatively high speeds. Blocking and bracing should be adequate to restrain the load against any movement relative to the car that might cause damage to the lading during shipment.

p. Floating loads that move relative to the car are not approved for ammunition, explosives, or dangerous article shipments.

C.4 DETAILED GUIDANCE

C.4.1 General. A&E shipments are initiated in accordance with the procedures established by current area logistics plans, as approved by the activities listed in 4.2.

In addition to the federal laws governing interstate transportation, each state and nearly all municipalities have laws or ordinances regulating such transportation within their jurisdiction. Shipments should comply with all of these requirements.

NOTE: When planning to move A&E materials by rail, approved drawings and procedures should be used. Failure to do this can result in safety issues, undue delays in shipping schedules, and increased costs due to improper use of equipment and loading crews. If no drawing exists, the approval authorities listed in 4.2 should be contacted.

C.4.2 Selecting a car. A car that is sufficient in size for the load should be selected. The car-selecting procedures outlined herein are applicable to all railcar shipments of the DoD material. Only a car of the type and capacity required for the specific shipment should be selected. The control, operation, and accountability for boxcars used for the transportation of ammunition, explosives, and other hazardous material is the responsibility of Military Traffic Management and Command Transportation Engineering Agency (MTMCTEA). Railcars should be selected in accordance with the requirements of DTR 4500.9-R. The type of car selected will be determined by the cargo to be transported and loading method to be used.

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C.4.2.1 Type required. Select a car of the type required, for example, a 50-foot, single-door boxcar or a 60-ton flatcar. Cars larger than required should not be selected. Table C-I lists typical railcar characteristics.

On shipments for A&E, be certain to stipulate a car suitable for explosives. Suitability is defined in detail in 49 CFR 174. Cars selected should be inspected for compliance with the requirements of these regulations before loading. Cars which do not meet the requirements of the regulations should be rejected (for flatcars, see C.4.7.2.3).

WARNING: Only properly inspected, certified, and placarded closed railcars of not less than 80,028 pounds (36,300 kilograms) capacity with steel underframes, friction draft gear, air brakes, hand brakes, and roller bearings which are in condition for service should be used for transporting Class/Division 1.1 and 1.2 explosives. Railcars used to transport Class/Division 1.1 through 1.3 explosives may not have any type of lighted heater or open-flame device, or any apparatus using an internal combustion engine for its operation. Class/Division 1.1 through 1.3 explosives should be shipped in a closed car or container car that is in good condition, does not permit the entry of sparks, and has a solid roof structure. Wood floored railcars should be equipped with spark shields in accordance with 49 CFR 174.104. Shipments containing only Class/Division 1.4 explosives should be shipped in any closed railcar or closed container in good condition. Shipments of Class/Division 1.3 and 1.4 explosives do not require car certificates; however, they should be placarded in accordance with 49 CFR 172.504.

C.4.2.2 Size required. Cars of capacity and size sufficient to carry the shipment authorized should be selected. Typical car capacities and sizes are shown on figures C-1 and C-2. Where a minimum car length, width, or door width is required, this should be stipulated. For generally unrestricted rail movement in North America, the height and width of a loaded railcar should remain within the limitations of the Association of American Railroads (AAR) Outline Diagram for Single Loads, Without End Overhang, on Open-Top Cars (AAR diagram) (see figure C-3). For foreign rail movement, countries vary on the height and width requirements and should be checked prior to designing a load for a specific country. Figure C-4 (this is also known as the “gararit international de chargement” or GIC) shows the flatcar/load clearance for most of Europe and figure C-5 shows the dimensions for the Korean rail system. If the proposed lading is over 40 feet long, 8 feet high, and 8 feet wide, contact the nearest MTMCTEA for guidance. When rail shipment over foreign rails is contemplated, the dunnaging should be similar but modified to suit the cars used.

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TABLE C-I Typical railcar characteristics

Type railcar and designation, if any [1/]	Typical deck dimensions length by width ft (mm) (in)	Typical [2/] load limit lb (kg)	Typical deck height above top of rail ft (mm) (in)	Approximate number available [3/]	Notes
Flatcars ITTX and similar	89 × 8 5 (27,127 × 2,591) (1,068 × 102)	140,000 (63,500)	3 50 (1,067) (42)	1,000 [4/]	4-axle, cushioned draft gear flatcar equipped with ⅜-inch chains Chains have working load limit of 9,000 pounds Also equipped with special adjustable and foldaway pedestals
Flatcars TTDX and similar	89 × 8 5 (27,127 × 2,591) (1,068 × 102)	140,000 (63,500)	3 50 (1,067) (42)	300	4-axle, cushioned draft gear flatcar equipped with ½-inch chains Chains have working load limit of 13,750 pounds and are proof tested to 27,500 pounds
Flatcars OTTX and similar	60 × 10 5 (18,288 × 3,200) (720 × 126)	144,000 (63,300)	3 75 (1,143) (45)	1,800 [4/]	4-axle, cushioned draft gear flatcar equipped with ⅜-inch chains Chains have working load limit of 9,000 pounds
Flatcars HTTX and similar	60 × 10 5 (18,288 × 3,200) (720 × 126)	146,000 (66,200)	3 75 (1,143) (45)	900 [4/] (784)	4-axle cushioned draft gear flatcar equipped with heavy-duty tiedowns Equipped with ½-inch chains with working load limit of 13,750 pounds
Flatcars MTTX and similar	60 × 10 5 (18,288 × 3,200) (720 × 126)	148,000 (67,100)	3 50 (1,067) (42)	950 [4/]	4-axle, basic multipurpose cushioned draft gear flatcar with plain wood deck, but no chains
Flatcars DODX 40000-series	68 × 10 4 (20,726 × 3,175) (816 × 125)	298,000 (135,200) (140-ton nominal capacity)	14 08 (1,245) (49)	566	Heavy duty, 6-axle, cushioned draft gear flatcar with ½-inch chains
Flatcars DODX 41000-series	68 × 10 5 (20,726 × 3,200) (816 × 126)	180,000 (81,600)	4 17 (1,270) (50)	256	4-axle, steel-deck, cushioned draft gear flatcar equipped with ½-inch chains with working load limit of 13,750 pounds and lift-up container pedestals
Flatcars DODX 42000-series	89 × 9 5 (27,127 × 2,896) (1,068 × 114)	164,000 (74,400)	4 25 (1,295) (51)	334	4-axle, steel-deck, cushioned draft gear flatcar equipped with ½-inch chains with working load limit of 13,750 pounds and lift-up container pedestals
Flatcars, others (cushioned and standard draft gear)	89 3 × 8 5 to 51 3 × 10 0 (27,228 × 2,591 to 15,645 × 3,200) (1,072 × 102 to 616 × 126)	100,000 to 140,000 (45,400 to 63,500)	4 17 (1,270) (50)	widely available [5/]	Flatcars may have standard or cushioned draft gear
Boxcars	50 5 × 9 6 to 86 5 × 9 12 (15,392 × 2,920 to 26,365 × 2,896) (606 by 115 to 630 × 114)	100,000 to 160,000 (45,400 to 72,600)	4 17 (1,270) (50)	widely available [5/]	Boxcars may have standard or cushioned draft gear
Gondolas	46 0 × 9 6 to 52 5 × 9 5 (14,021 × 2,920 to 16,002 × 2,896) (552 × 115 to 630 × 114)	140,000 to 200,000 (63,500 to 90,700)	4 17 (1,270) (50)	widely available [5/]	Gondolas may have standard or cushioned draft gear

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TABLE C-I Typical railcar characteristics – Continued

Type railcar and designation, if any [1/]	Typical deck dimensions length by width ft (mm) (in)	Typical [2/] load limit lb (kg)	Typical deck height above top of rail ft (mm) (in)	Approximate number available [3/]	Notes
COFC (container on flatcar railcars)	suitable for 20- and 40-foot ISO containers	limited by container	variable	32,660	Of these, 12,872 are double-stack cars typically used in special service not available in all areas
TOFC (trailer on flatcar railcars)	suitable for semitrailers up to: 53 (16,150) (636)	140,000 (63,503)	3 75 (1,143) (45)	widely available [5/]	Suitable only for semitrailers with 2-inch (50 8-mm) kingpins Many are only suitable for 102-inch (2,590 8-mm) wide semitrailers

NOTES:

1/ Lettering appearing on the sides of all freight cars identifying ownership, such as marks including TTX for TTX Company (formerly Trailer Train Company), DODX for Department of Defense (MTMC Deployment Support Command), or BNSF (identifying cars of the Burlington Northern Santa Fe railroad company) The "X" denotes private ownership as differentiated from railroad ownership The first letters used with TTX are arbitrary designations used to differentiate various car types

2/ Load limit is the maximum weight that can be loaded on a railcar For railcars meeting standard AAR design criteria, the load limit is equal to the maximum allowable gross weight on the rails (determined by axle and wheel size) less the light weight of the railcar Load limit is stenciled on every freight car in conjunction with the capacity and light weight stenciling and is abbreviated LD LMT

3/ Data source - The Official Railway Equipment Register

4/ For the TTX company railcars, the number given denotes the total number of flatcars that have that or a similar designation The number in parentheses denotes the number of flatcars that meet Note 3 in the Trailer Train Company section of the The Official Railway Equipment Register Note 3 states, "These 60-ft flatcars are capable of carrying 90% of the load limit over a centered 15 ft " This means these railcars can transport tanks weighing up to about 64 8 tons (58,786 kg)

5/ The term "widely available" means that railcars of this type are abundant; however, a specific car may not be readily available

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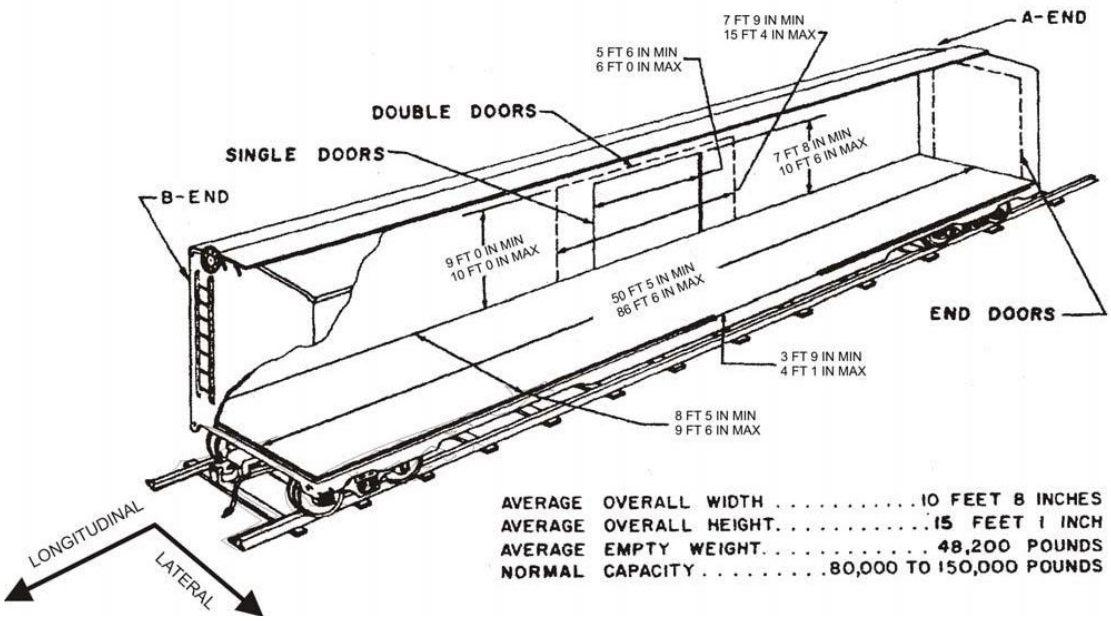

FIGURE C-1. Typical boxcar dimensions.

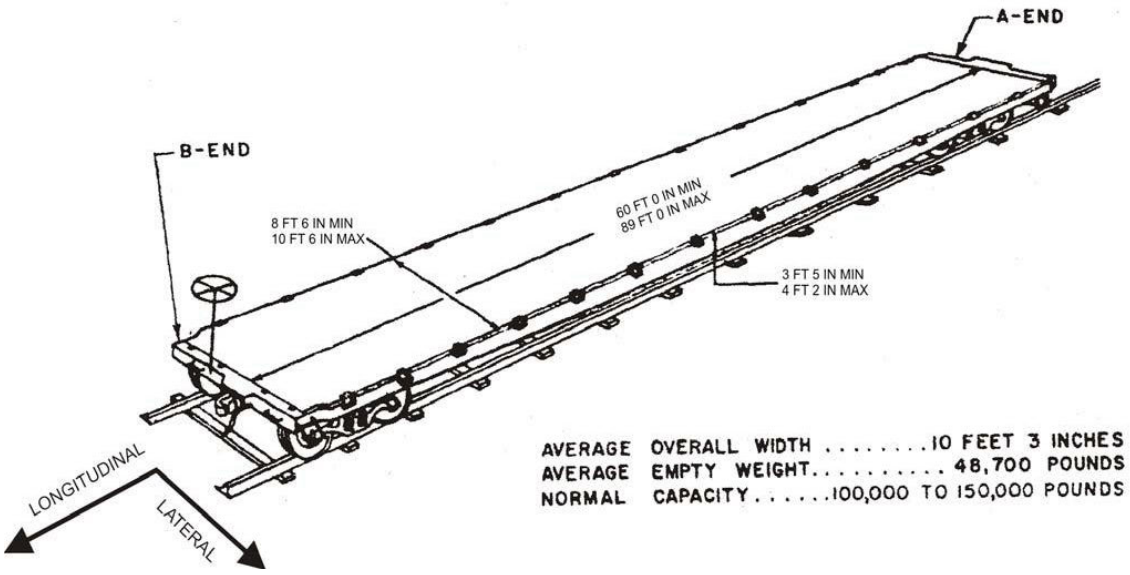

FIGURE C-2. Typical flatcar dimensions.

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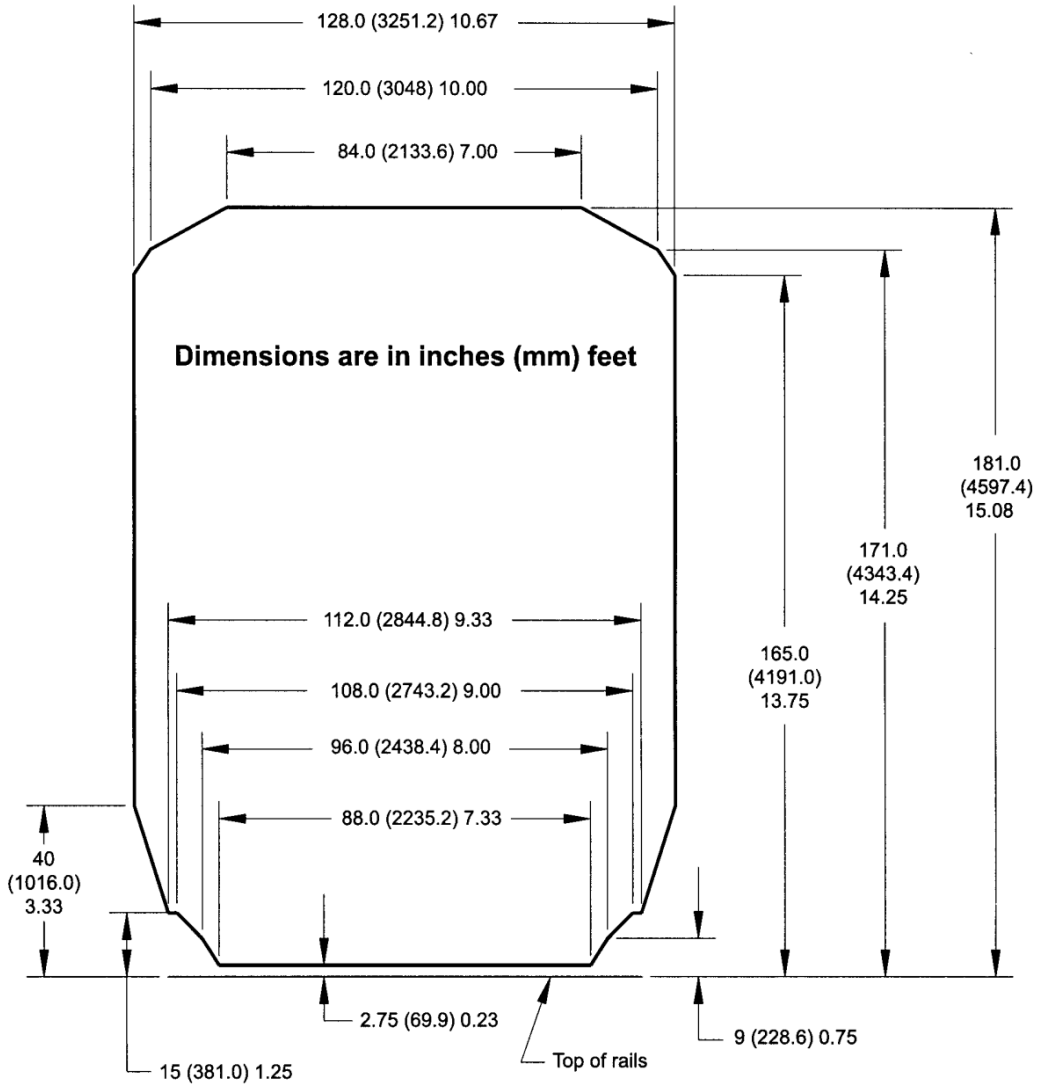

FIGURE C-3. AAR outline diagram of single loads, without end overhang, on open-top cars (AAR diagram).

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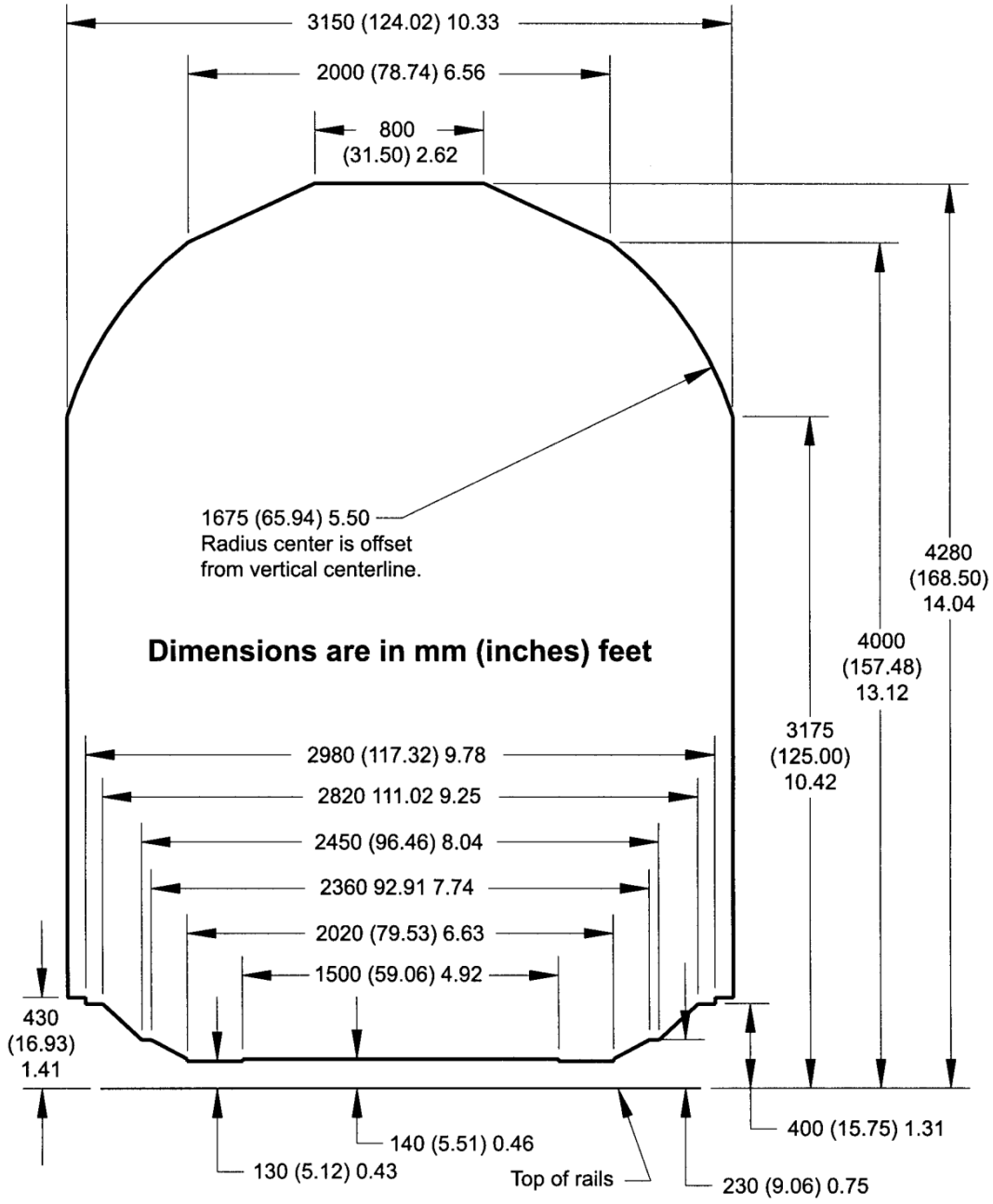

FIGURE C-4. International load gage diagram.

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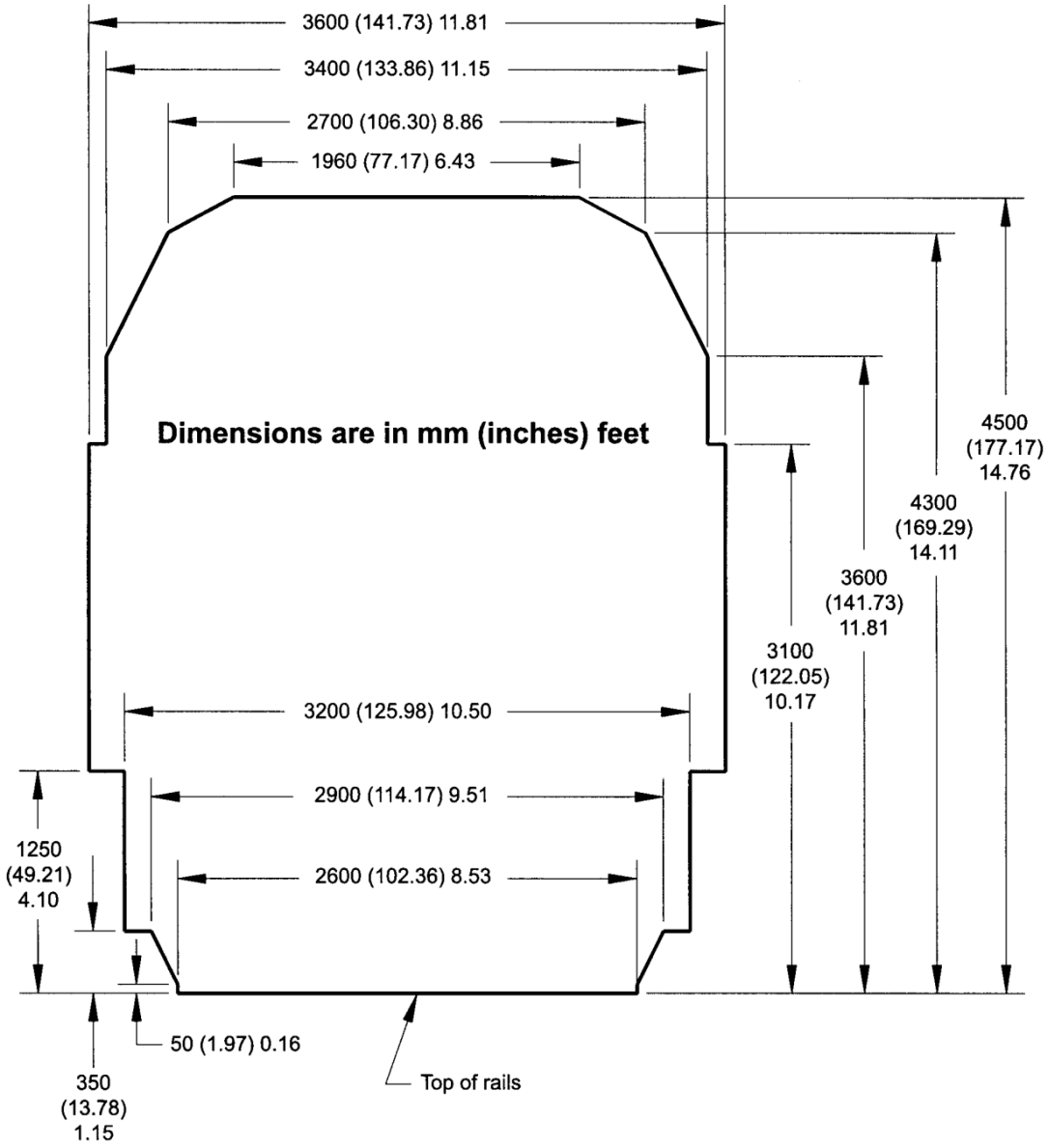

FIGURE C-5. Korean rail clearance diagram.

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C.4.2.2.1 Rules. The following rules on overall weight and weight distribution limitations should be adhered to (see figure C-6).

a. The weight of load in or on a car should not exceed the load limit stenciled on car.

b. The weight on one truck should not exceed one-half of the load limit stenciled on car.

c. The percentages of stenciled load limits, as shown on figure C-6, should not be exceeded for loads located between truck centers, measured lengthwise of car, unless car owner has otherwise designated by note in the "official equipment register" that these percentages may be changed.

d. Weight of material loaded in either end between truck centers and end of car should not exceed 15 percent of stenciled load limit for cars built prior to January 1, 1966 and 25 percent for cars built subsequent to January 1, 1966.

e. For proper distribution of weight crosswise of car, the load should be located so that the weight along both sides of car is about equal for the entire length of the load.

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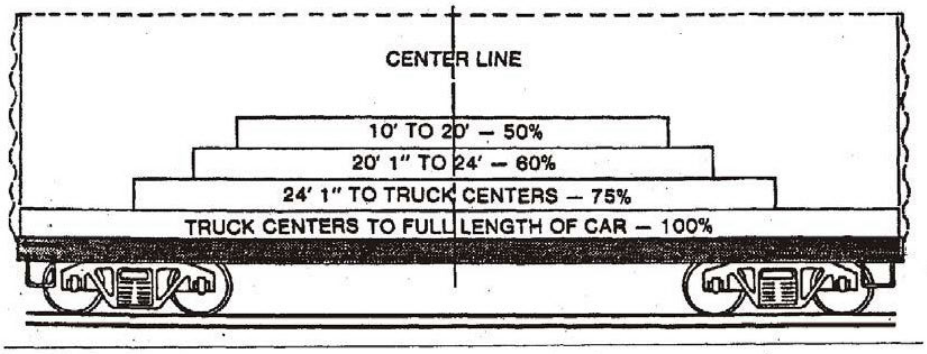
BOXCARS OTHER THAN STAGGERED DOUBLE-DOOR CARS BUILT PRIOR TO 1966

GENERAL RULES - CLOSED CARS

Length of Load	
10 ft. to 20 ft.	50%
20 ft. 1 inch to 24 ft.	60%
24 ft. 1 inch to truck centers	75%
Truck centers to full length of car	100%



For staggered double-door box cars built prior to 1966, the percentages listed in Rule 4(A) will be as shown below:

Length of Load	Inside Length of Car 40 ft.	50 ft.
10 ft. to 20 ft.	40%	35%
20 ft. 1 inch to 24 ft.	45%	40%
24 ft. 1 inch to truck centers	75%	75%
Truck centers to full length of car	100%	100%

FLAT CARS WITH BOTH FISH-BELLY CENTER AND FISH-BELLY SIDE SILLS AND ALL FLAT CARS BUILT AFTER 1 JANUARY 1965

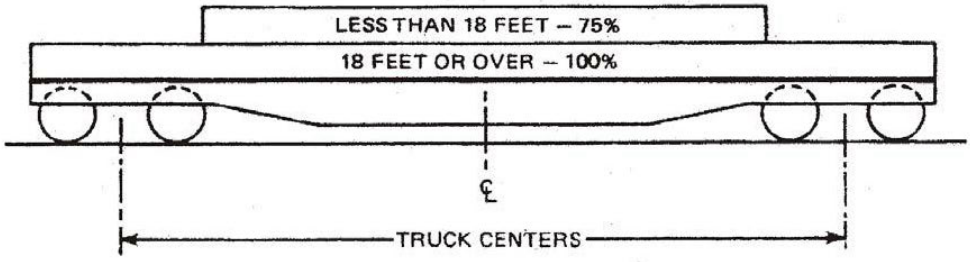


FIGURE C-6. Maximum weight distribution permitted in or on cars (sheet 1 of 2).

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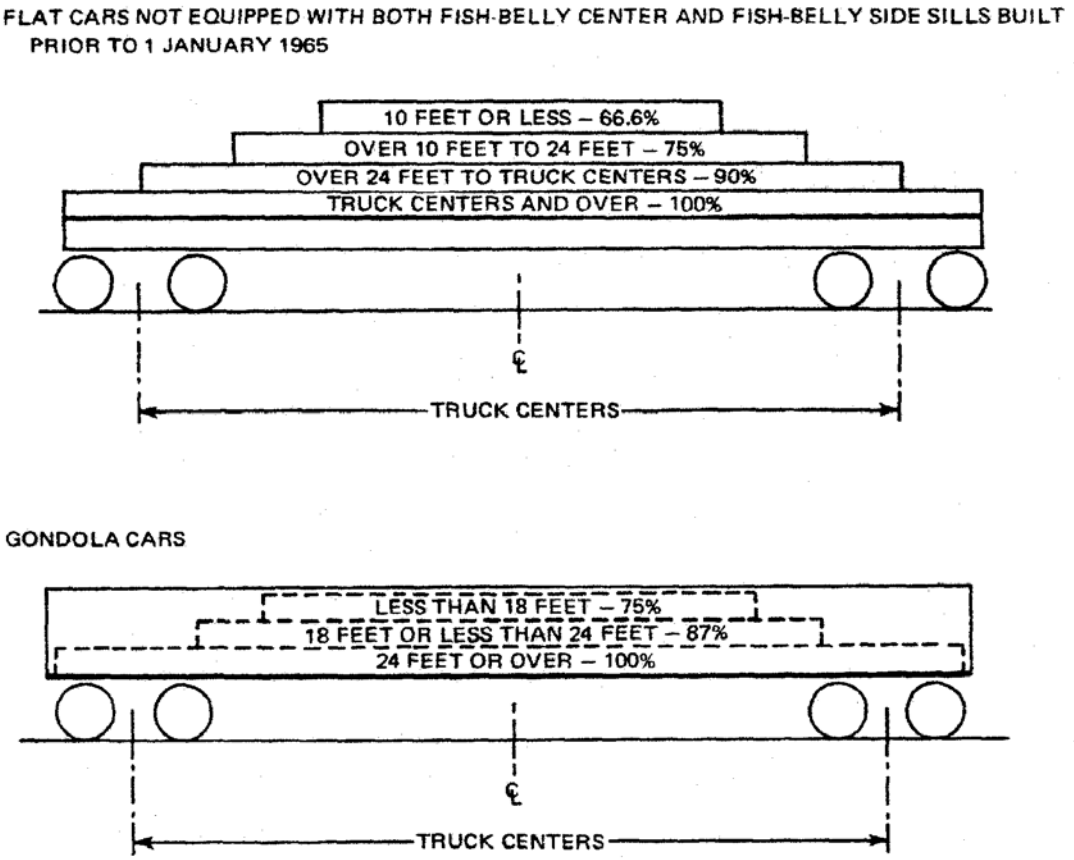

FIGURE C-6. Maximum weight distribution permitted in or on cars (sheet 2 of 2) – Continued.

C.4.2.2.2 Door sizes. Special attention should be paid to car door sizes to permit loading of large items such as missile containers. The nominal 50- and 86-foot carloadings shown in the drawings are based on an assumed minimum 6-foot wide door. Standard 60-foot long commercial cars have 8- or 10-foot wide doors while most 60-foot automobile cars have staggered 15-foot doors. For long items, a double-door box car should be used.

WARNING: Should less than carload or mixed carload shipments be contemplated, observe the compatibility rules of 49 CFR 174.

C.4.3 Guiding procedures for loading railcars. The loading procedure given in the drawings and the instructions contained in this section should be followed. When a drawing does not exist, the approval authorities listed in 4.2 should be contacted. Read the procedures and consider the following:

a. End blocking should be installed, if needed.

b. Loading should begin in one end of the car.

c. As soon as the first layer of a stack is in place, lengthwise side blocking should be installed, if needed. As additional layers of a stack are placed, sway bracing should be installed, if needed.

d. Containers or pallet units should fit tightly against car walls, dunnage, or each other, or both, as applicable.

e. After the first bay is in place, crossmembers or separator gates should be positioned, as applicable. In DF Type cars, the load jack should be used to snug the crossmembers firmly against the load.

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f. Loading should continue in the foregoing manner up to the doorway area. This procedure should be repeated in the other end of the car. Both ends may be loaded simultaneously.

g. Loading should be completed in doorway area as required.

h. In DF Type cars, doorway members should be installed as required and crossmembers should be completely installed. If not a DF Type car, center gate structure should be installed as required.

i. In car with mechanical dunnaging systems, all unused equipment should be secured.

j. Doorway protection should be installed when required.

k. Shipping documents should be attached to dunnage near door.

l. A complete inspection of all blocking and bracing for exact conformity with the drawing requirements should be made. If the load is a Class 1.1 explosive, the inspection should be conducted in the company of a qualified representative from the originating carrier.

m. Doors should be closed, locked, and strap-type DoD numbered car seals should be applied.

n. Required DOT placards should be applied to outside of car and, if a load is a Class 1.1 explosive, car certificate should be executed and attached to car immediately adjacent to the explosive placard.

o. Bill of lading describing the material should be filled out using DOT nomenclature in accordance with SW020-AG-SAF-010 or DTR 4500.9-R.

C.4.4 Dunnage materials.

C.4.4.1 Purpose. The purpose of dunnaging in carloading DoD material is to prevent longitudinal, lateral, and vertical motion of the lading relative to the car that might cause damage to the lading during shipment. When a drawing does not exist contact the approval authorities in 4.2 for availability. This document can provide general principles to follow, but any load plan should be approved by the authorities listed in 4.2. These authorities will provide technical assistance or appropriate drawings upon request. When a drawing does exist, the dunnage should be constructed and installed in accordance with the drawing and the general principles contained in this section.

C.4.4.2 Materials. Dunnaging materials, in cars which are not specially equipped cars, may consist of lumber, steel, nails, spikes, bolts, strapping and seals, wall anchors, plywood, fiberboard, and other materials, as appropriate. In specially equipped cars, dunnaging equipment consists of mechanisms, which attach to receptacles in the side wall, to retain the lading in bays. Some commercial cars include cross gates (load divider bulkheads) which serve to compartmentalize the load bays. They may also have movable side panels, which can act as sway bracing. In DF-type cars, the special equipment is limited to the cross bracing members and associated movable side rails. Hence, in numerous cases, it is necessary to use other dunnaging materials to ensure a safe load.

C.4.4.3 Lumber. All lumber used should be yard lumber in accordance with Voluntary Product Standard PS 20-10. Lumber used may be rough or dressed. All lumber procured for use on railcar loads should be heat treated to reduce risk of mixing lumber with that required in International Organization for Standardization (ISO) container loading for wood packaging material (WPM). DoD activities should procure and report lumber use in accordance with DoD 4140.65-M. See A.7.3.3.4 for more information on WPM. Shipments limited to continental United States (CONUS) do not require marking each piece of dunnage, but marking allows the most flexibility for reuse of dunnage WPM. Designs are based upon the dressed sizes indicated in table C-II. Where ammunition is loaded on open cars only spruce (eastern Sitka, Tamarack, and white), fir (Douglas), larch (western), hemlock (western), or pine (dense southern yellow, longleaf, slash, or loblolly) should be used. See B.4.6 for nominal lumber sizes, weight, selection, and reclamation criteria.

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TABLE C-II. Sizes of dressed lumber.

Nominal dimensions (inches)	Approximate dimensions (inches)
1	¾
1¼	1
1½	1¼
2	1½
3	2½
4	3½
5	4½
6	5½
NOTE: 1. Finished size not specified in grading rules.	

C.4.4.3.1 Selecting lumber. The minimum requirement for dunnaging material is common lumber No. 2 dimension (exception, southern yellow pine No. 3 grade dimension), rough or finished. Better grades of lumber should be used only when common No. 2 is not available or when used lumber of better grades is available for the same or lower cost. Lumber without defects, as shown on figure C-7, should be used.

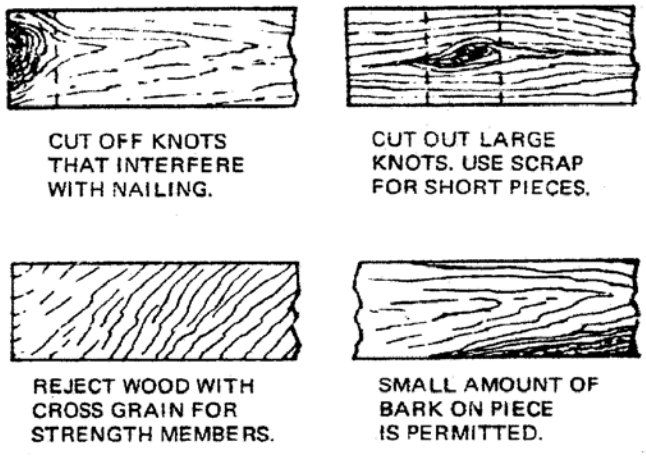

FIGURE C-7. Lumber defects.

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C.4.4.4 Fasteners. Fasteners are nails, spikes, and bolts. Nails should be common steel nails in accordance with ASTM F1667. Spikes should be round wire spikes in accordance with ASTM F1667. Table C-III gives actual sizes and weights of nails and spikes.

TABLE C-III. Sizes and weights of nails and spikes.

Size (d = penny)	Nails		Weight (number of nails/pound)	Spikes		Weight (number of spikes/pound)
	Length (inches)	Diameter (inches)		Length (inches)	Diameter (inches)	
2d	1	0.0720	850	---	---	---
3d	1¼	0.0800	540	---	---	---
4d	1½	0.0990	290	---	---	---
5d	1¾	0.0990	250	---	---	---
6d	2	0.1130	170	---	---	---
7d	2¼	0.1130	150	---	---	---
8d	2½	0.1310	100	---	---	---
9d	2¾	0.1310	92	---	---	---
10d	3	0.1483	66	---	---	---
12d	3¼	0.1483	61	---	---	---
16d	3½	0.1620	47	---	---	---
20d	4	0.1920	30	---	---	---
30d	4½	0.2070	23	---	---	---
40d	5	0.2253	17	5	0.2625	13
50d	5½	0.2437	14	5½	0.2830	10
60d	6	0.2625	11	6	0.2830	8
7 inch	---	---	7	7	5/16	7
8 inch	---	---	6	8	3/8	6
9 inch	---	---	5	9	3/8	5
10 inch	---	---	4	10	3/8	4

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C.4.4.4.1 Penetration. Nails should be of such length as to give the necessary holding power and ample penetration into car walls, floors, or other bracing and blocking. To obtain the most holding power, nails should be of such length that they nearly penetrate, but do not protrude through, the lumber holding the point of the nail. Nails of a size large enough to cause splitting of the lumber require pre-drilled nail holes. The general rule of thumb is that the nail should be two times as long as the thickness of the piece holding the head of the nail, but the nail point should not protrude beyond the second piece unless clinching is required. Recommended sizes consistent with this rule of thumb are given in table C-IV.

TABLE C-IV. Recommended nail and bolt sizes.

Nominal thickness of member holding head (inches)	**Nominal thickness of member holding point (inches)**					
	1	**2**	**3**	**4**	**5**	**6**
1	4d 6d	6d 10d [1/]	12d	16d	16d	16d
2	---	10d	20d	40d	40d 60d	40d 60d
3	---	20d Bolt	40d	60d 6 inch	7 inch	8 inch
4	---	Bolt	Bolt	Bolt or 7 inch	Bolt or 8 inch	Bolt or 9 inch
5	---	Bolt	Bolt	Bolt	Bolt or 9 inch	Bolt or 10 inch
6	---	Bolt	Bolt	Bolt	Bolt	Bolt or 10 inch

NOTE:
[1/] If clinched.

C.4.4.4.2 Direction. All nailing or bolting should be into the side grain of the lumber; end grain nailing should be avoided. Balanced nailing is important. Nails should be staggered along the piece being nailed. Do not nail along one grain of the wood. Whenever possible, nails should be driven straight; do not toenail unless called for in the drawings.

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C.4.4.4.3 Sheathing. Wooden sheathing of steel frame, single-sheathed cars is usually 1½ to 1¾ inches thick; and, in double-sheathed cars, the inside sheathing is usually ¾ or ⅞ inch thick. Side wall cleats most commonly used are 2- by 4-inch material. Nails driven through these cleats into the sheathing should not protrude through the sheathing; 10d nails should be used, or the side walls can be built up by nailing supplemental 1-inch lining using 6d nails, as shown on figure C-8.

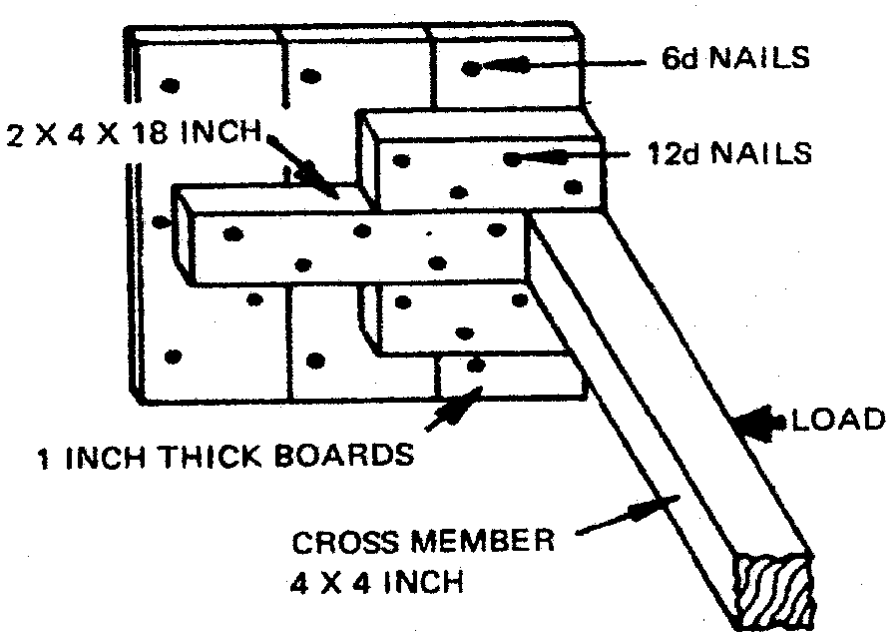

FIGURE C-8. Nailing cleats to side walls using supplemental 1-inch lining boards.

C.4.4.5 Strapping. All steel strapping used in carloading should be new (unused) material in accordance with ASTM D3953. Strapping (except for doorway protection strapping) should be in accordance with ASTM D3953; flat strapping, Type 1, heavy duty, Finish A, B (Grade 2), or C. The size (width and thickness) of strapping should be as specified by the drawing. Splicing to obtain strapping length should be prohibited. Heavy-duty strapping should be used in all carloading procedures, whether closed (boxcar) or open-top (flatcar). All seals used to join the ends of strapping should be in accordance with ASTM D3953; Class H, Finish A, B (Grade 2), or C, double-notch type, Style I, II, or IV. The style of seal used should be selected for compatibility with the tensioning and sealing tools being used. Seal width should be the proper width for the size of strapping being used.

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C.4.4.5.1 Unwaxed. All heavy duty strapping should be dry (unwaxed) strapping. When a crimped seal is used, the seal joint should consist of two seals each double crimped. If a notched-seal is used, the seal joint should consist of one seal double notched. Heavy duty strapping, sizes 1¼ and 2 inches used for load securements on flatcars, should be marked to indicate manufacturer's or supplier's name and the letters "AAR" to show compliance with the requirements of the AAR Open Top Loading Rules Manual (see figure C-9).

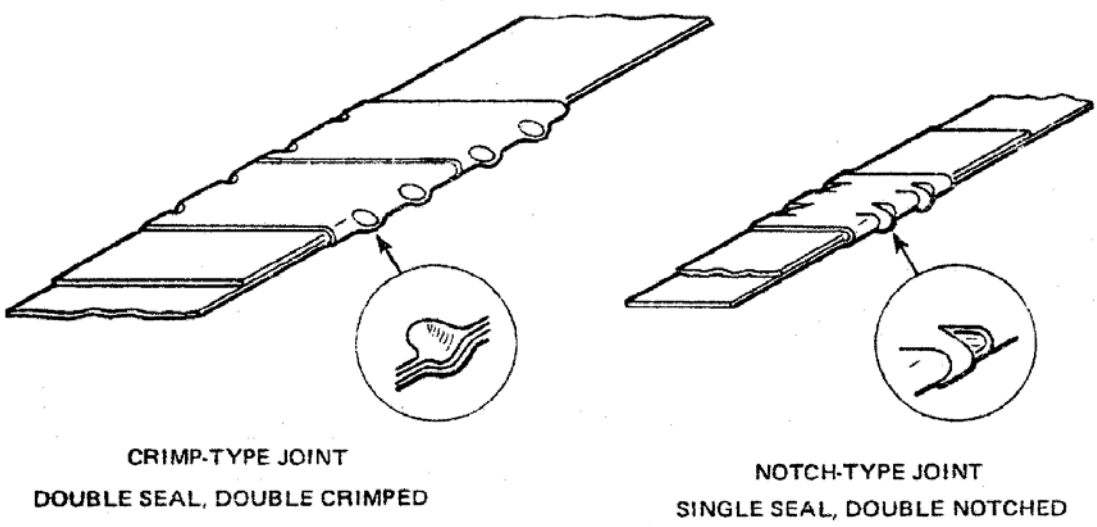

FIGURE C-9. Types of strap joints.

C.4.4.5.2 Load per strap. The recommended maximum loads per strap are shown in table C-V. Strapping requirements for flatcar loads should be in accordance with C.4.7.4 through C.4.7.4.3.2.

TABLE C-V. Maximum load allowed per strap.

Strap size (inches)	Load (pounds)
1¼ × 0.031	2,100
1¼ × 0.035	2,100
2 × 0.044	4,800
2 × 0.050	4,800

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C.4.4.5.3 Tools. Periodic testing of notch tools should be in accordance with current AAR rules.

C.4.4.5.4 Inspection of notched-seal joints. When using notched-seal joints, each seal should be inspected to ensure that all of the following conditions are met:

a. The strapping and seals are manufactured to the proper specifications (see C.4.4.5).

b. The ends of both straps joined by the seal are visible on either end of the seal.

c. Each seal consists of two notches which are approximately centered and equally spaced on the seals (see figure C-10).

d. The bottom surface of the notch is offset at least ⅛ inch from the bottom surface of the seal; or approximately four times the thickness of the strapping (see section A-A on figure C-10). This condition creates a separation between the leading edge of the notch and the balance of the seal. A properly functioning sealer tool should accomplish this if the person using the tool closes the handles all the way when creating the notch.

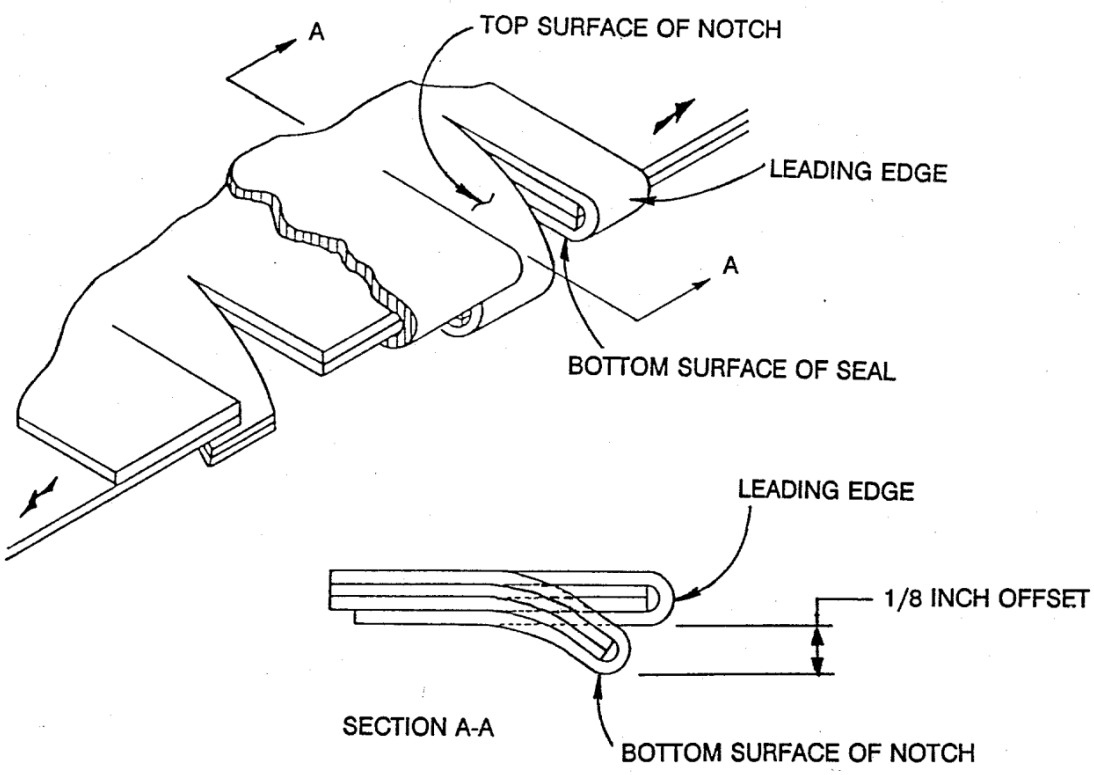

FIGURE C-10. Typical notched-seal joint.

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C.4.4.5.5 Inspection of crimped-seal joints. When using crimped-seal joints, each seal should be inspected to ensure that all of the following conditions are met:

a. The strapping and seal are manufactured to the proper specifications (see C.4.4.5).

b. The ends of both straps joined by the seal are visible on either end of the seal.

c. Each seal consists of two crimps that are approximately centered and equally spaced on the seals.

C.4.4.5.6 Power equipment. When using power tensioning and sealing equipment, the manufacturer's air pressure and lubrication recommendations should be maintained at all times. Each seal should be visually inspected to ensure the conditions of subparagraphs a through d of C.4.4.5.4 and subparagraphs a through c of C.4.4.5.5 are met.

C.4.5 Dunnaging in cars equipped with dunnage free systems. The mechanical dunnage system is designed to eliminate the excessive use of expendable dunnage materials, and reduce loading and unloading time. The inside dimensions of the DF Type boxcar are: length, 50 feet 6 inches between end walls; width, 8 feet 11 inches between wall members; and height, 10 feet at the eaves. Each car contains, as standard equipment, 168 detachable wall members, 10 doorway members, 60 crossmembers, and one load jack. In addition, each side wall is equipped with three fixed wall members, a series of vertical plates, a series of plywood panels stenciled with height marks, and vertical half plates located in the car doorways (see figure C-11). When loading DF Type boxcars, the load should be divided into sections (bays). Each bay, which may contain one or more stacks, should be retained by crossmembers. Crossmembers should be positioned against strong areas of the lading that are capable of carrying the longitudinal forces. Sufficient crossmembers should be used to retain the load in each bay. Unless otherwise specified in the drawing, crossmember capacity for fully distributed loads and loads on the third points of the crossmember is 3,000 pounds. For loads on the center third of the crossmember, the capacity is 2,000 pounds. A check should be made to be sure both ends of all crossmembers are securely locked into the wall members. The vertical distance should be left between wall members to allow room for the installation of crossmembers as shown on figure C-12.

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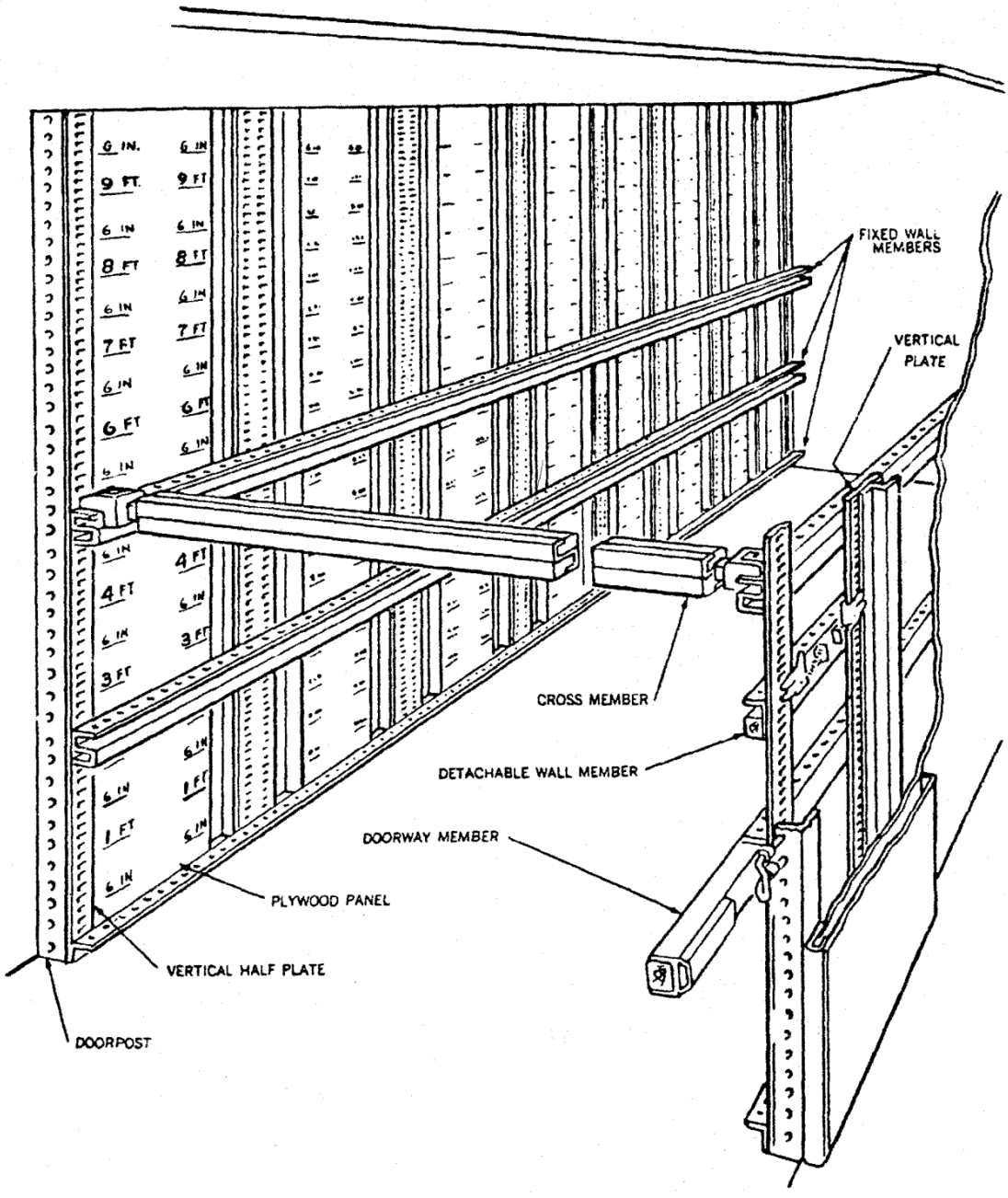

FIGURE C-11. Pin-type loader, showing mechanical bracing system.

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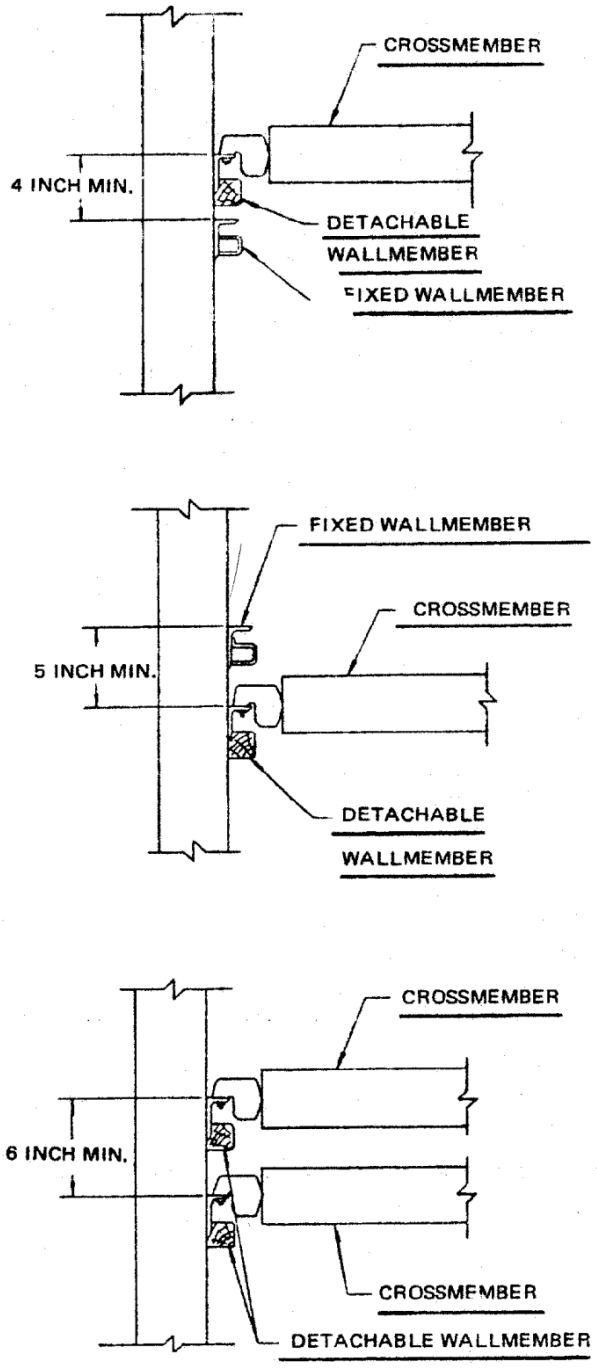

FIGURE C-12. Vertical distance between wall members.

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C.4.6 Dunnaging design and procedure in closed cars. The basic blocking and bracing design and procedures given here are intended to provide general instructions for the design of individual components of an overall system of blocking and bracing for a specific type of car. The fundamental concept is to consider the railroad car as an oversized package and to secure the freight in the car so that it is solidly and firmly a portion of the overall package.

C.4.6.1 Length. It is not practical to provide detailed length dimensions for fabricated cross car components since there is a wide variation in inside car dimensions. It is normal practice to allow the shoring crew foremen to order specific lengths to be cut for the specific car being loaded. When shipping explosives in all steel boxcars, bore ammunition should not contact the interior of the all steel boxcars. On certain pallet loads (e.g., bombs, mines, or bagged propellant charges in tanks), ammunition may overhang the pallet and can contact the interior of all steel boxcars. These loads should be shipped in boxcars with interior wood sheathing, if possible. However, if this type of car is not available, an all steel car may be used provided, where ammunition touches steel end walls, they are lined with dimensional lumber (minimum 1-inch nominal) or ½-inch plywood, and where ammunition touches steel side walls they are lined with dimensional lumber (minimum 1-inch nominal) ¼-inch plywood, ⅛-inch hardboard, or solid fiberboard. Solid fiberboard is the most economical for lining side walls and as a minimum requirement, should be in accordance with ASTM D4727/D4727M. The lining should be installed in such a manner that it will not shift during transit. Lining is not required between metal pallets/pallet adapters or ammunition in metal containers and the interior of all steel boxcars.

C.4.6.2 End blocking assembly. When end walls are bowed, filler pieces or shim material should be nailed to the end-of-car bulkhead as necessary so that the end-of-car blocking assembly will bear as much as possible on the bowed end wall. A typical installation is shown on figure C-13. Sometimes an end-of-car blocking assembly is necessary for distributing concentrated loads over the end of the car, for such items as uncrated bombs or projectiles. End wall dunnaging may be nailed to the end wall of the boxcar.

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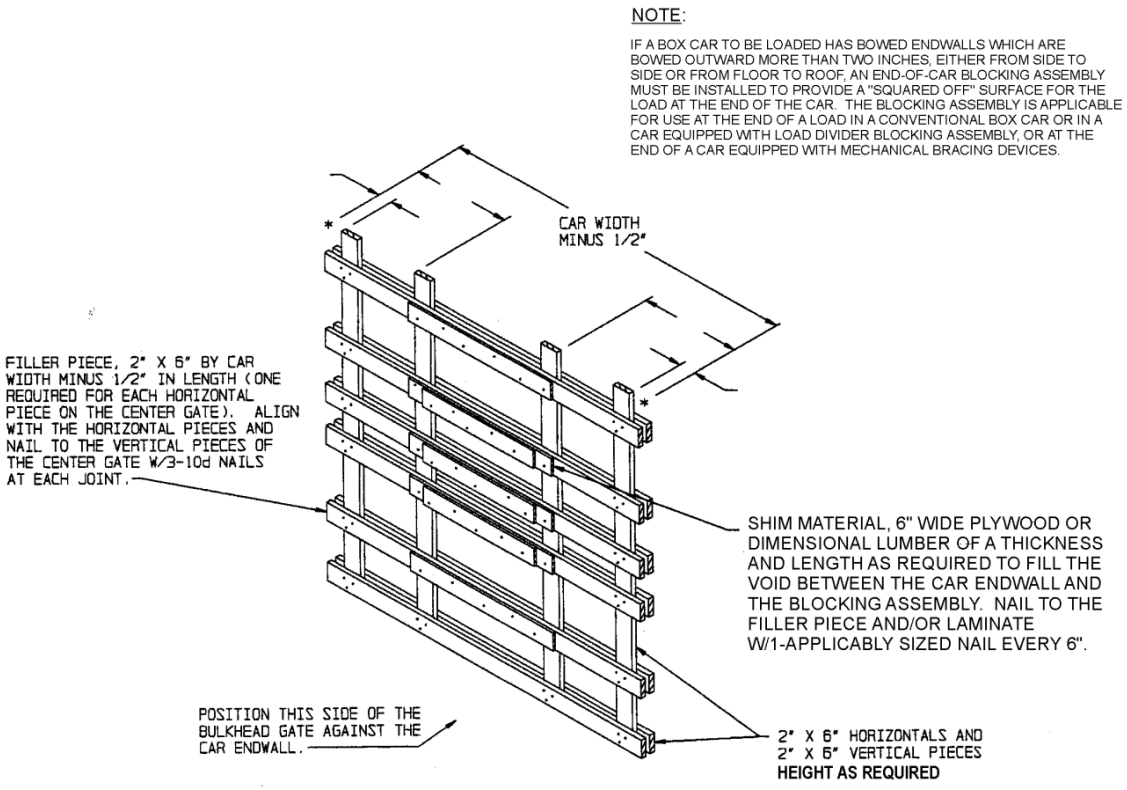

FIGURE C-13. Typical end-of-car bracing assembly.

C.4.6.3 Sway bracing. Sway bracing should be used to prevent lateral movement of the lading as a result of side sway of the car. It should be installed between rows of lading used when lading does not completely fill the car crosswise. Various forms of sway bracing may be used. The most common forms are described in C.4.6.3.1 through C.4.6.3.4.

C.4.6.3.1 Side blocking. Side blocking is members nailed or unnailed to the car floor after the load is put into place and snugged into position. The side blocking should run parallel to the long dimension of the car and should be of at least 2- by 4-inch lumber. The use of side blocking is shown on figure C-14. Table C-VI shows the length of blocking and nails needed for the lading (crib fill, sway brace, filler assembly).

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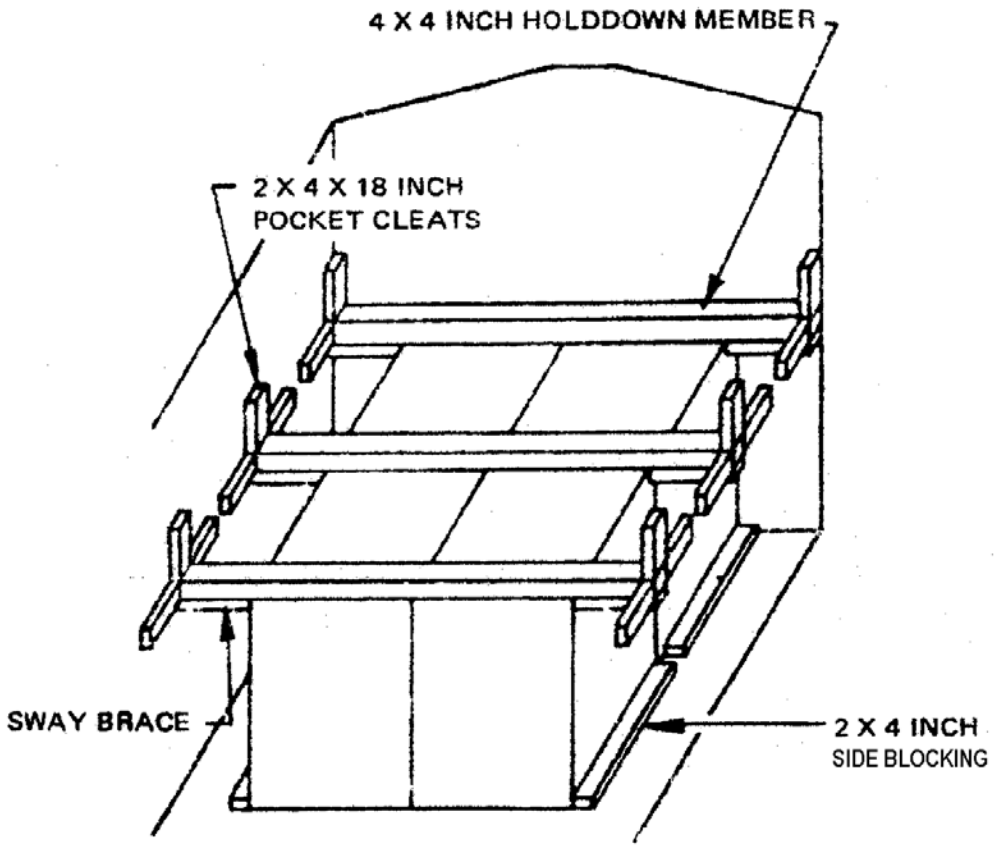

FIGURE C-14. Holddowns with top-of-the-load sway bracing, with nailed side blocking.

TABLE C-VI. Nailed side blocking capacities in a boxcar.

Number of double side blocks	Nails	Position in relation to load side	Load unit (pounds)
2, 18″ long	5	parallel	5,000
2, 24″ long	6	parallel	8,000
2, 30″ long	8	parallel	12,000
2, 36″ long	9	parallel	18,000
2, 42″ long	11	parallel	27,000
2, 48″ long	12	parallel	35,000
2, 18″ long	3	perpendicular	5,000
2, 24″ long	5	perpendicular	8,000
2, 30″ long	6	perpendicular	12,000

NOTE:
1. Nail first piece with 20d nails, nail second piece with 30d nails.

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C.4.6.3.2 Lateral bracing. The construction of lateral bracing is similar to strut-type center gate assembly, except that lateral bracing should be placed lengthwise in the car, either along the centerline or along the car wall. Lumber used in the lateral bracing is usually less robust than that used in longitudinal bracing, since lateral forces are never as great as longitudinal forces in a car. Typical lateral bracing is shown on figure C-15.

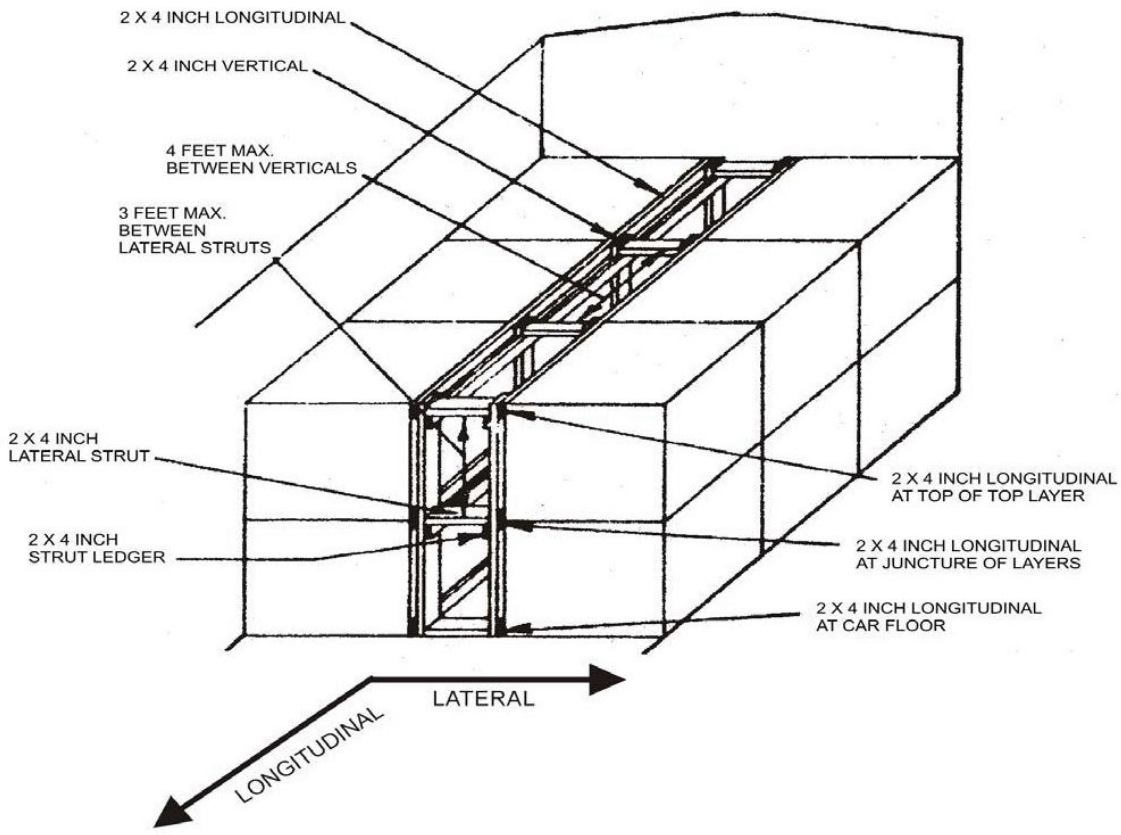

FIGURE C-15. Crib fill assembly.

C.4.6.3.3 Anti-sway bracing. For sway bracing of pallets or containers in a railcar with a nailable floor, the first layer should be braced with side blocking nailed to the floor against the lading or crib fill/crib fill assemblies between the ladings. For second and additional layers, frames should be placed between pallet units or containers to prevent movement. These frames, made from stringers and crossmembers, are called anti-sway bracing. Anti-sway bracing uses less lumber than crib filled assemblies. The frames should be inserted under pallet decks as shown on figure C-16 or in container forklift pockets. The width of the frame should be 1 inch less than the distance between the pallet posts or container forklift pockets. For loads in a car with non-nailable floors, anti-sway bracing will consist of two types: an assembly that floats at the floor level and an assembly that interfaces with the pallet or container forklift opening.

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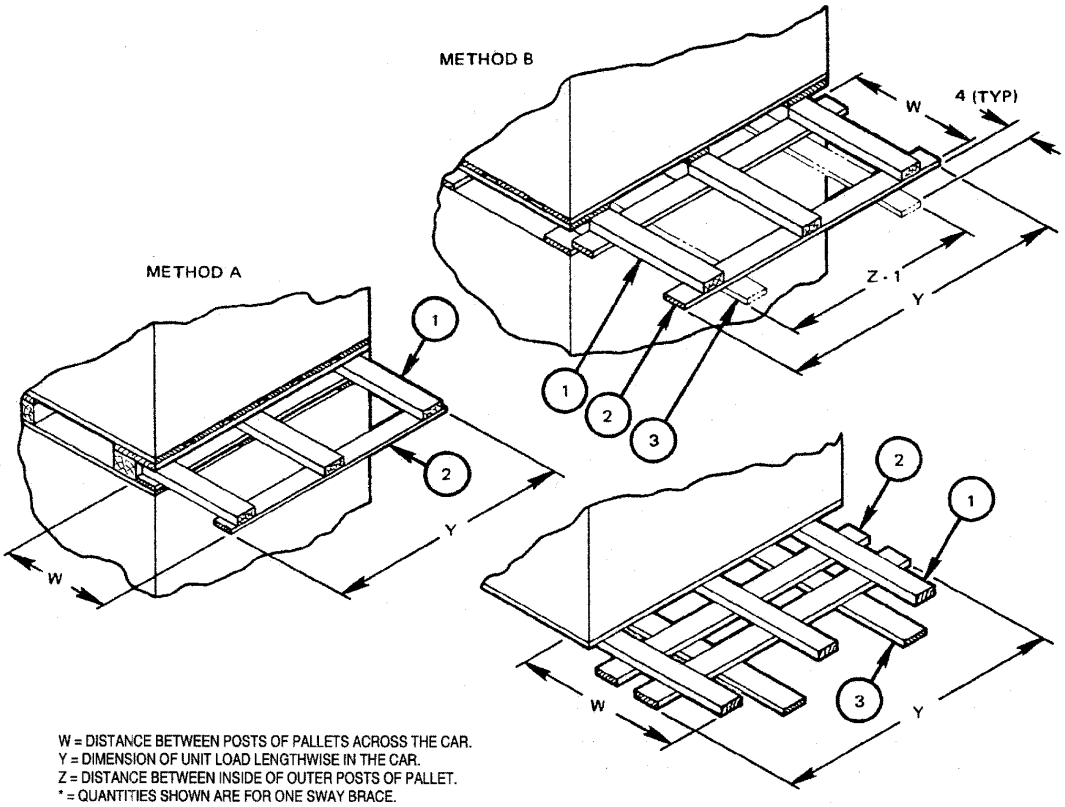
SWAY BRACE
FABRICATION AND INSTALLATION OF SWAY BRACING

THE SWAY BRACE CONSISTS OF A FRAME MADE UP OF ITEMS 1 AND 2 OR OF THE FRAME AND FRAME SUPPORTS, ITEM 3. THE FRAME IS FABRICATED BY NAILING STRINGERS (ITEM 2) TO CROSS MEMBERS (ITEM 1) WITH THREE 10d NAILS, CLINCHED, EACH JOINT. THE CROSS MEMBERS MUST BE POSITIONED AGAINST POSTS OF ADJACENT PALLETS.

WHEN USING METHOD A, THE FRAME IS FABRICATED AND SLID INTO PLACE BETWEEN PALLETS AS SHOWN. IF CENTER GATE MEMBERS ARE NOT LOCATED SO THAT THEY RETAIN THE FRAMES IN POSITION A SUITABLE LENGTH 2 X 4 MEMBER, WHICH WILL RETAIN THE FRAMES, MUST BE NAILED TO THE GATE WITH 10d NAILS.

WHEN USING METHOD B, FRAME SUPPORTS (ITEM 3) ARE INSERTED BETWEEN PALLET POSTS AS SHOWN. THE FRAME IS FABRICATED AND POSITIONED BETWEEN PALLETS ON TOP OF FRAME SUPPORTS. STRINGERS (ITEM 2) ARE NAILED TO SUPPORTS (ITEM 3) WITH ONE 6d NAIL EACH JOINT.



W = DISTANCE BETWEEN POSTS OF PALLETS ACROSS THE CAR.
Y = DIMENSION OF UNIT LOAD LENGTHWISE IN THE CAR.
Z = DISTANCE BETWEEN INSIDE OF OUTER POSTS OF PALLET.
* = QUANTITIES SHOWN ARE FOR ONE SWAY BRACE.
** = WHEN USING THIS METHOD, PIECE 1 WILL BE 2 X 6.

PALLET	LONGITUDINAL DIMENSION OF PALLET PLACED CROSSWISE IN THE CAR	LONGITUDINAL DIMENSION OF PALLET PLACED LENGTHWISE IN THE CAR
MK 12	METHOD A**	METHOD B
MK 3	METHOD A	METHOD B**
MIL-P-15011 (WOOD)	METHOD A	METHOD B*
NN-P-71 (WOOD)	METHOD A	METHOD B*

CONFIGURATION OF SWAY BRACE FRAME FOR UNIT LOADS WITH OVERHANG THAT INTERFERES WITH NAILING TO SUPPORT PIECE.

PIECE NO.	DESCRIPTION	SIZE	NO. PCS REQD	NAIL TO	NUMBER NAILS	SIZE
3	FRAME SUPPORT	1 X 4 X (W + 8)	2	SEE 2		
2	SPACER STRINGER	1 X 4 X Y	2	1, 3	SEE NOTE ABOVE	
1	CROSS MEMBER	2 X 4 X W	3	SEE 2		
LIST OF MATERIALS AND NAILING DATA						

FIGURE C-16. Types of anti-sway bracing.

C.4.6.3.4 Top-of-load anti-sway bracing. Top-of-load anti-sway bracings should be at the top of the load. This location has no opening in the lading that will retain the braces. Top-of-load anti-sway bracing should be secured with wire ties to prevent movement of the bracing. Figure C-17 shows this type of anti-sway bracing.

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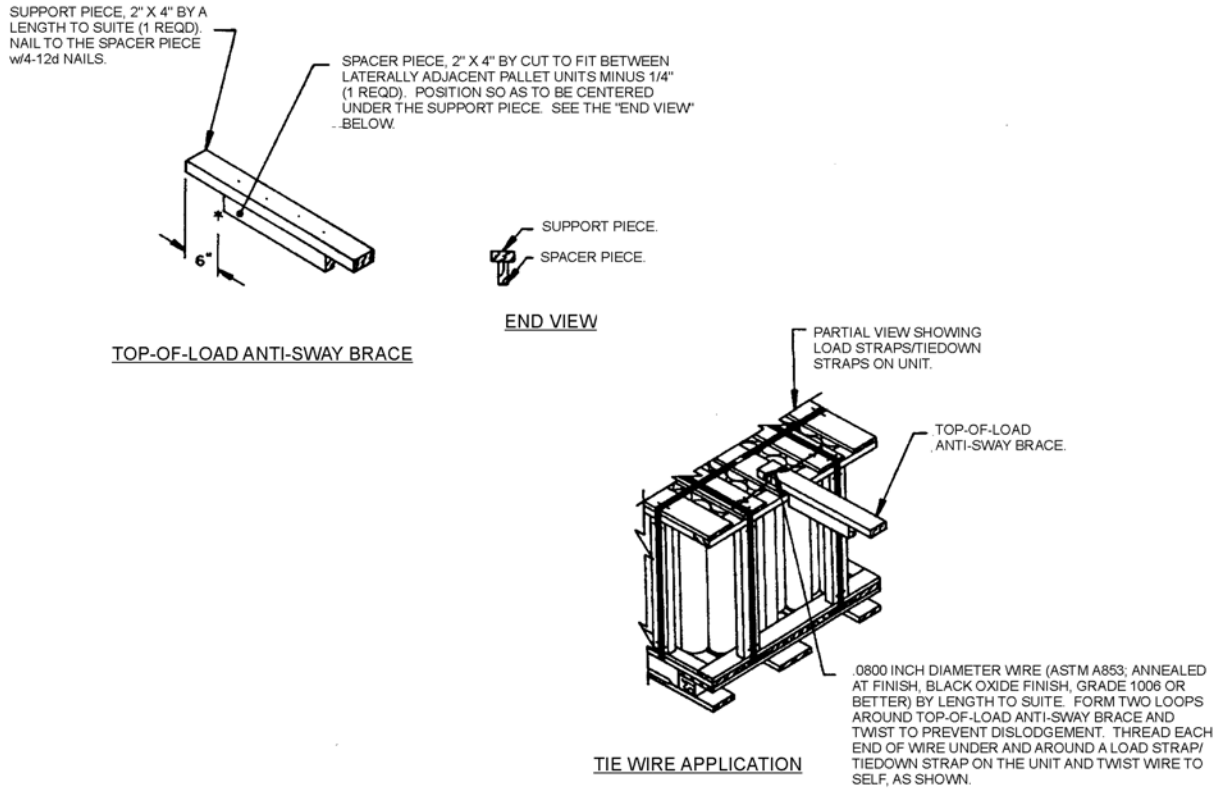

FIGURE C-17 Typical top-of-load anti-sway bracing

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C.4.6.4 Separator gates. Separator gates should be used to reduce longitudinal voids in the load and for distributing the load from one bay to the next. Typical separator gates are shown on figure C-18.

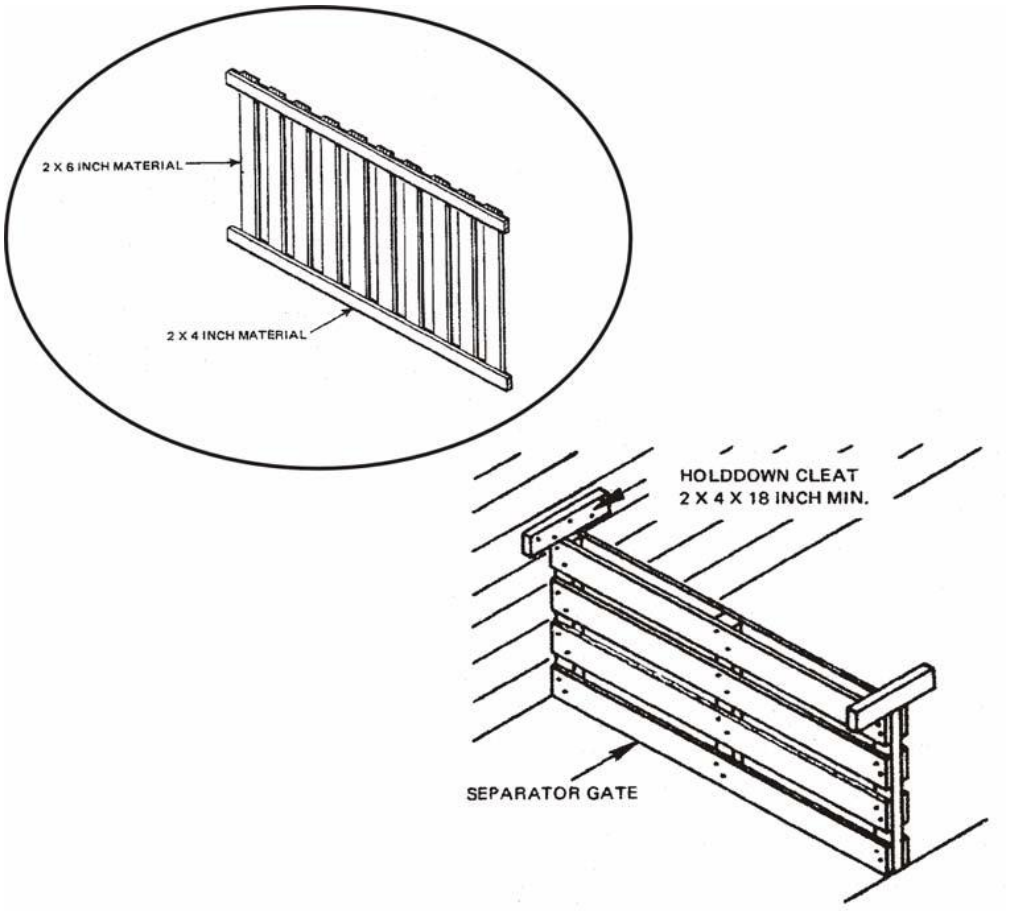

FIGURE C-18. Typical separator gates.

C.4.6.5 Center gates. Center gates should be used to take up the space in the doorway area of the car to prevent a shift in the load and also to permit the ready removal of lading. There are three basic types of center gate structures: solid fill type, strut-type, and strut-type with tie strut bracing (see figure C-19). When space at the center of the car is less than 20 inches, a solid fill center gate should be used, providing the height of the gate allows for driving in solid fill (approximately 48 inches). Strut-type center gates should be used when the longitudinal space at center of car is 20 inches or more. When struts exceed 48 inches in length, horizontal and vertical strut bracing should be added. Strut bracing should be required for every 48 inches of strut length. Split gates (gates that do not span the width of the railcar) may be used provided the gates are adequately retained from lateral and vertical movement.

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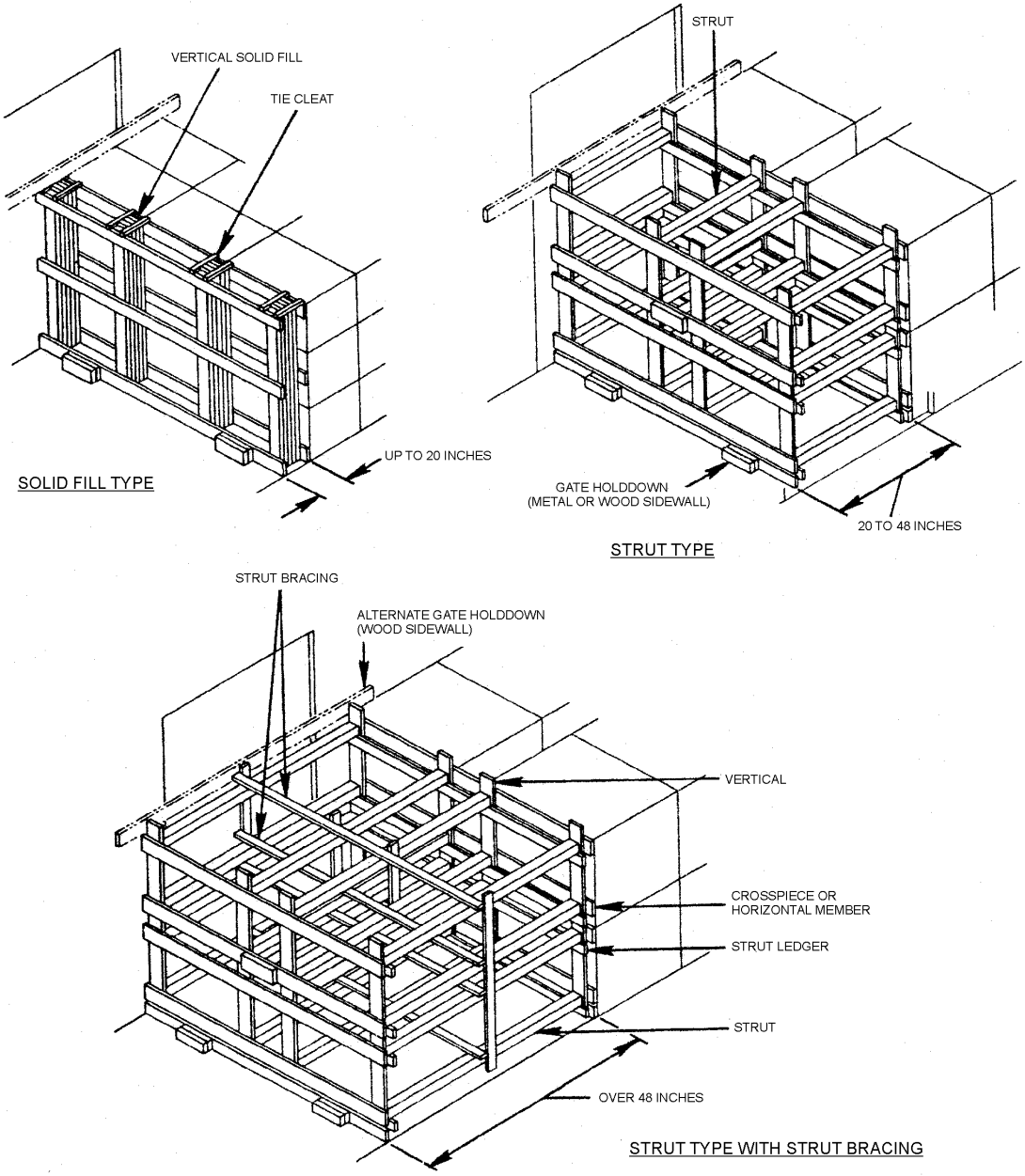

FIGURE C-19. Typical center blocking.

C.4.6.5.1 Verticals. The length of center gate verticals should be equal to the height of the load. A minimum of four verticals should be used, and they should be located in line with appropriate surfaces (hard spots) of the unit loads, containers, or items comprising the carload. For solid fill gates, outside verticals should be at least 2 inches in from ends of horizontal members to permit space for tie cleats which are nailed in place last to prevent the solid fill from being dislodged.

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C.4.6.5.2 Horizontals. The length of horizontal members of the center gate should be 1 inch less than the inside width of the car. Locate horizontals at or near the top and bottom of the load and in line with appropriate surfaces of the load. For palletized unit loads, locate the bottom horizontal 4 inches above the floor. For lightly constructed or fiberboard containers, use solid faced gates. The amount of nails required depends on the size of vertical and horizontal members.

C.4.6.5.3 Strut ledgers. Strut ledgers are used to support struts in proper position. The length of strut cleats may be 1 inch less than the inside width of car but should always be long enough to extend past the outside verticals. Strut ledgers are normally 2- by 4-inch members; but, when struts must be located closer to car floor, 2- by 2-inch members may be used. Three 10d nails should be nailed at each joint with the verticals. No strut ledgers should be used on solid fill gates.

C.4.6.5.4 Struts. Struts are normally 4- by 4-inch members. Double 2- by 6-inch struts may be used in place of single 4- by 4-inch members. When double 2- by 6-inch struts are used, laminate with one 10d nail every 6 inches. When installing struts, the members should be cut slightly longer than the space between gate verticals and hammered in place to make a wedge-tight fit. Toenail to gate verticals with two 12d nails at each end. Struts should not be nailed to car floor or walls. The size, number, and positioning of struts used in a center gate structure should be carefully determined by the following factors:

a. Struts should be located against the strong points of the lading, aligned with horizontals and verticals wherever possible.

b. Intermediate struts should be as equally spaced as alignment permits.

c. Use sufficient struts to distribute load evenly.

d. Never use less than four sets of struts across the width of the car.

e. Never use less than eight struts.

f. The number and size of struts should be sufficient so that the load per strut never exceeds 500 pounds per square inch. A strut should be braced vertically and laterally every 4 feet.

C.4.6.5.5 Strut bracing. When the length of struts exceeds 48 inches, horizontal and vertical strut bracing should be nailed at the midpoints of the struts as shown on figure C-19. Strut bracing prevents buckling of the struts. Strut bracing should be nailed to struts with three 10d nails at each joint.

C.4.6.5.6 Center gate holddown. Center gates should be prevented from riding upward by means of gate holddowns. Gate holddowns are principally of two types. One type consists of 2- by 6-inch by door width +48-inch members positioned across the doorway area just above the center gate and bearing on it. These members should be nailed to the side wall (each side of the doorway with five 10d nails). In addition, holddown cleats at least 18 inches long should be nailed to the holddown members (five 10d nails per cleat) above the gates to increase the bearing area. This type of holddown may only be used in boxcars with wood side walls. The second type of holddown consists of cleats nailed to the gates in such a manner that, when finally positioned, the center gate assembly is trapped under the lading thereby preventing upward movement relative to the lading. The cleats may be doubled or tripled so that that a minimum of 1½ inches are trapped under the lading. Each cleat should have at least three 10d nails holding it. This type of holddown may be used in boxcars with either wood or metal side walls (see figure C-19).

C.4.6.5.7 Center gates. Center gates should never be nailed to car floors, walls, holddowns, or doorway protection but should be left free to move with the load in the event slight shifting occurs. When no doorway protection is required, the gate should be prevented from moving laterally against the doors by an appropriate dunnaging method (e.g., cleat or retainer piece).

C.4.6.5.8 Limitations. The maximum space to be filled by a center gate blocking assembly or structure should not exceed 9 feet, 6 inches. Carloads should be designed not to exceed this limitation. If this cannot be done, end bracing or partial layer bracing should be used, as described in C.4.6.6 and C.4.6.7.

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C.4.6.6 End bracing. End bracing may be used for bracing less than carload shipments. This method of bracing should not be used in lieu of a center gate blocking assembly or structure when the size of shipment will permit the use of center gate assemblies. Figures C-20 and C-21 illustrate typical end bracing used for loads not exceeding the weights stated. Sound, straight-grain lumber should be selected for diagonal braces. The angle which diagonal braces make with the floor should not exceed 45 degrees nor be less than 30 degrees. Adequate nailing is essential to this type of bracing, and good nailing practices should be used. When cars with nailable steel floors are used, the floor cleats should be extended to ensure that eight staggered nails can be driven through each floor cleat.

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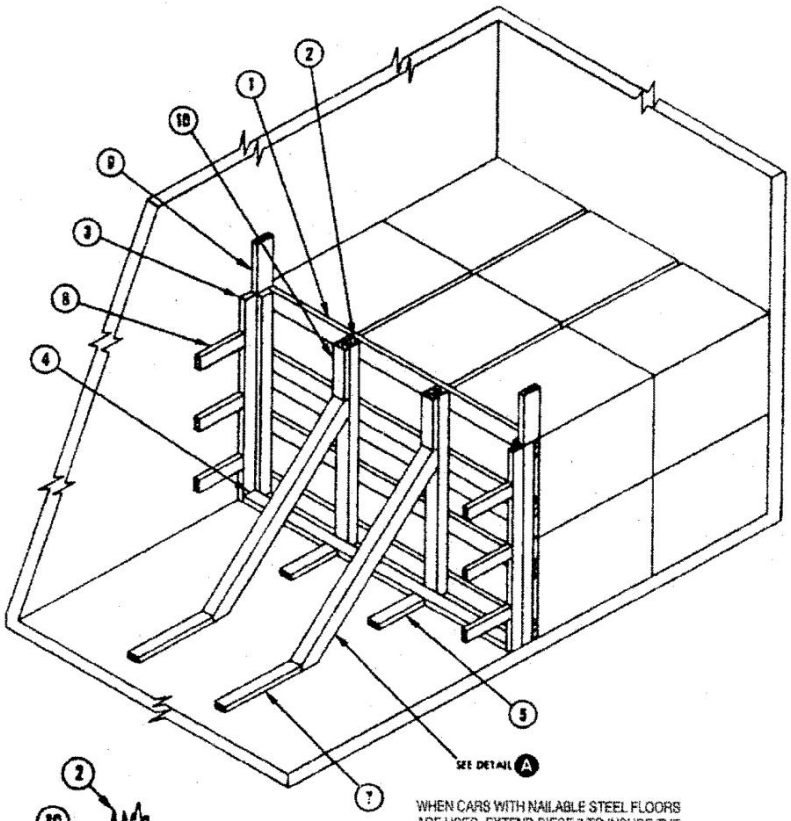

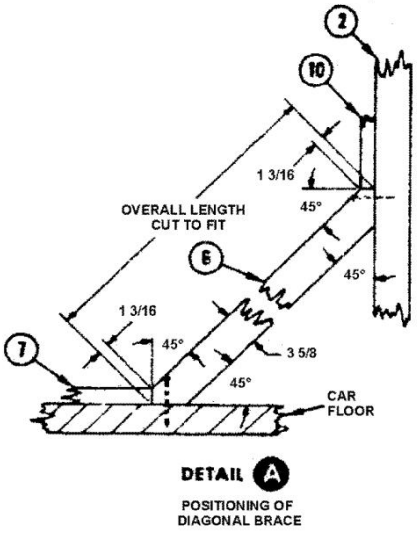

DETAIL A
POSITIONING OF DIAGONAL BRACE

PIECE NO.	DESCRIPTION	SIZE	NO. PCS. REQD	NAIL TO	NAILS NUMBER	NAILS SIZE
10	UPPER CLEAT	2 X 4 X CUT TO FIT	2	2	4	10d
9	HOLD DOWN CLEAT	2 X 6 X 18	2	CAR WALL	6	10d
8	SIDE WALL BACK-UP CLEAT	2 X 4 X 18	6	CAR WALL	4	10d
7	FLOOR CLEAT	2 X 4 X 30 MIN.	2	CAR FLOOR	5	20d
6	DIAGONAL BRACE	4 X 4 X CUT TO FIT	2	2, CAR FLOOR	2/END	20d
5	FLOOR BRACE CLEAT	2 X 4 X 18	2	CAR FLOOR	4	20d
4	LATERAL FLOOR BRACE	2 X 4 X CAR WIDTH – 3 ¼	1	CAR FLOOR	2/FT.	20d
3	VERTICAL BACK-UP	2 X 4 X LOAD HEIGHT	2	CAR WALL	2/FT.	10d
2	END BRACE VERTICAL	4 X 4 X LOAD HEIGHT	4	SEE 1	--	--
1	END BRACE HORIZONTAL	2 X 6 X CAR WIDTH	4 MIN.	2	3/JOINT	10d

LIST OF MATERIALS AND NAILING DATA

FIGURE C-20. End bracing for less than carload shipments up to 5,000 pounds.

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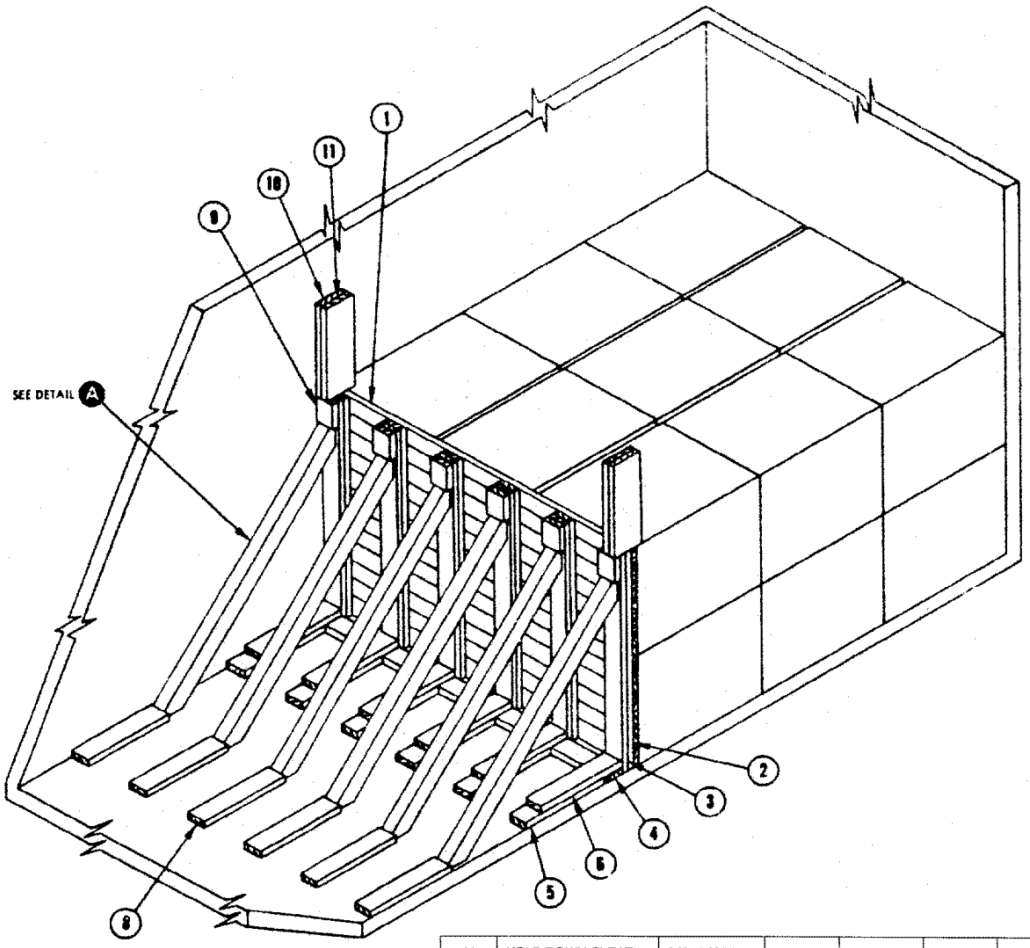
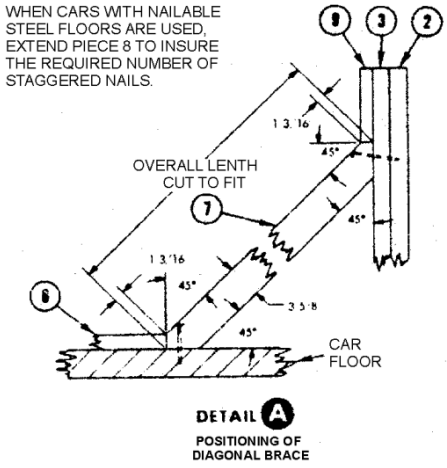


WHEN CARS WITH NAILABLE STEEL FLOORS ARE USED, EXTEND PIECE 8 TO INSURE THE REQUIRED NUMBER OF STAGGERED NAILS.



DETAIL A
POSITIONING OF DIAGONAL BRACE

PIECE NO.	DESCRIPTION	SIZE	NO. PCS. REQD	NAIL TO	NAILS NUMBER	NAILS SIZE
11	HOLD DOWN CLEAT	2 X 10 X 30	2	10	15	10d
10	HOLD DOWN CLEAT	2 X 10 X 30	2	CAR WALL	15	10d
9	UPPER CLEAT	2 X 6 X 8	6	3	5	10d
8	FLOOR CLEAT	2 X 6 X 30	6	CAR FLOOR	8	20d
7	DIAGONAL BRACE	4 X 4 X CUT TO FIT	6	3, CAR FLOOR	2/END	20d
6	TOP CLEAT	2 X 6 X 30	6	4, 5	8	20d
5	FLOOR BRACE CLEAT	2 X 6 X 30	6	CAR FLOOR	8	20d
4	LATERAL FLOOR BRACE	2 X 6 X CAR WIDTH	1	CAR FLOOR	2/FT.	20d
3	END BRACE VERTICAL	2 X 6 X LOAD HEIGHT	6	2	2/FT.	10d
2	END BRACE VERTICAL	2 X 6 X LOAD HEIGHT	6	SEE 1	--	--
1	END BRACE HORIZONTAL	2 X 6 X CAR WIDTH	TO LOAD HEIGHT	2	2/JOINT	10d

LIST OF MATERIALS AND NAILING DATA

FIGURE C-21. End bracing for less than carload shipments from 5,000 to 30,000 pounds.

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C.4.6.7 Partial layer bracing. Partial layer bracing of palletized unit loads, skidded unit loads, and unitized containers should be required when a layer has a doorway area void greater than the maximum area allowed for center blocking assemblies or structures. Partial layer procedures applicable for boxcars with nailable side walls differ from those for boxcars with metal side walls.

C.4.6.7.1 Diagonals. Partial layers may be braced with lumber as shown on figures C-22 through C-25. Diagonal members should be positioned so that the angle between the wall and the diagonal does not exceed 45 degrees nor be less than 30 degrees. The ends of diagonals should be double beveled to provide good bearing against bracing members and cleats. Horizontal wall cleats should span a minimum of two side-wall car posts and should be secured to the side wall with three nails driven into each post with the remaining nails called for in the nailing data equally spaced. Obviously, this type of partial layer bracing may not be used in boxcars with metal side walls.

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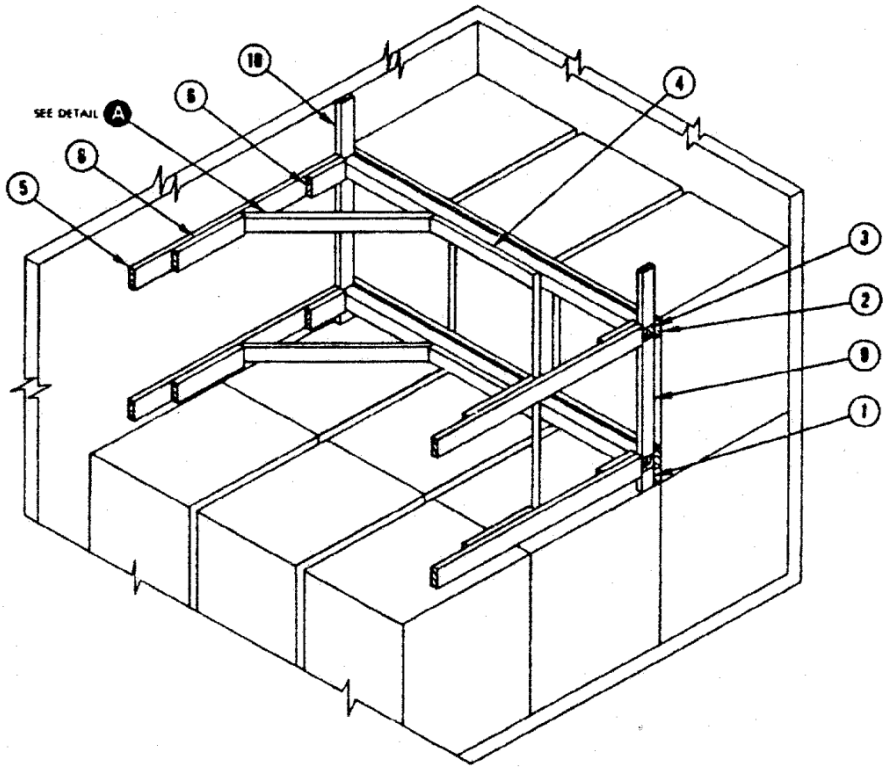

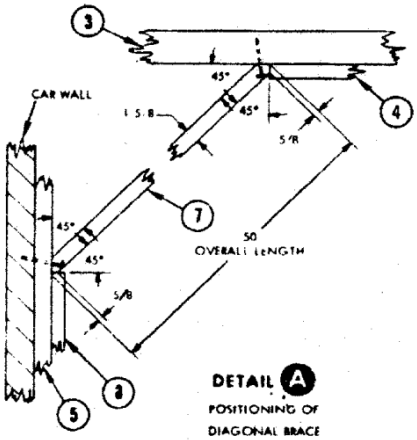

PIECE NO.	DESCRIPTION	SIZE	NO. PCS. REQD	NAIL TO	NAILS NUMBER	NAILS SIZE
10	UPPER WALL CLEAT	2 X 4 X 18	2	CAR WALL	4	10d
9	INTERMEDIATE WALL CLEAT	2 X 4 X CUT TO FIT	2	CAR WALL	4	10d
8	HORIZONTAL BACK-UP CLEAT	2 X 6 X 24	4	5	8	16d
7	DIAGONAL BRACE	2 X 4 X 50	4	3, 5	1/END	16d
6	HORIZONTAL POCKET CLEAT	2 X 6 X 12	4	5	4	16d
5	HORIZONTAL WALL CLEAT	2 X 6 X 72	4	CAR WALL	16	10d
4	CENTER CLEAT	2 X 4 X 36	2	3	7	16d
3	CROSS BRACE	4 X 4 X CAR WIDTH	2	SEE 2	--	--
2	CROSS BRACE STIFFENER	2 X 6 X CAR WIDTH	2	3	2/FT.	12d
1	LOWER WALL CLEAT	2 X 4 X 6	2	CAR WALL	3	10d

LIST OF MATERIALS AND NAILING DATA

FIGURE C-22. Partial layer bracing up to 8,000 pounds.

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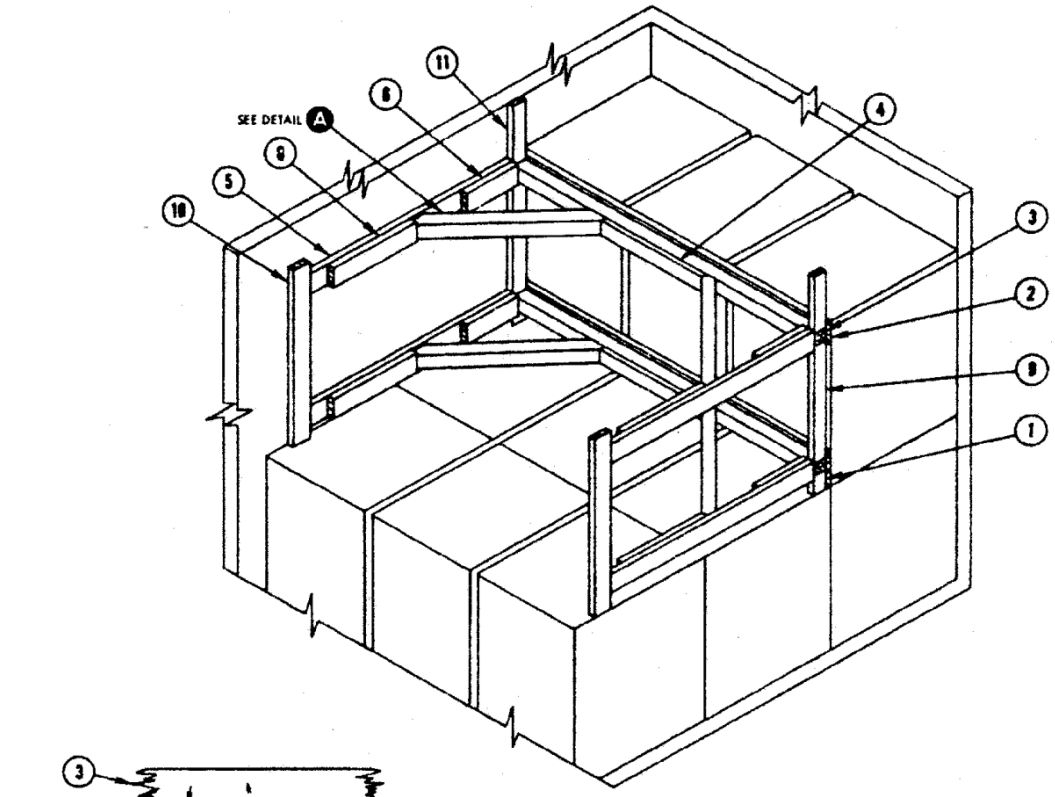

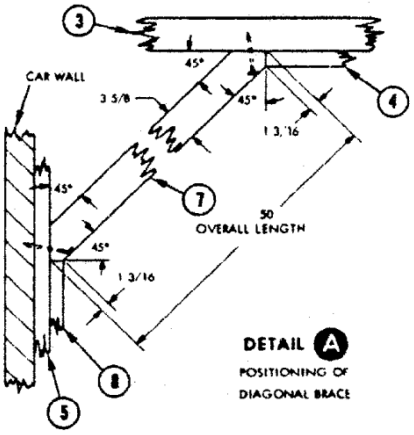

DETAIL A
POSITIONING OF DIAGONAL BRACE

PIECE NO.	DESCRIPTION	SIZE	NO. PCS. REQD	NAIL TO	NUMBER NAILS	SIZE NAILS
11	UPPER WALL CLEAT	2 X 4 X 18	2	CAR WALL	4	10d
10	VERTICAL BACK-UP CLEAT	2 X 6 SLIGHTLY ABOVE LOAD	2	CAR WALL	8	10d
9	INTERMEDIATE WALL CLEAT	2 X 4 X CUT TO FIT	2	CAR WALL	4	10d
8	HORIZONTAL BACK-UP CLEAT	2 X 6 X 30	4	5	14	16d
7	DIAGONAL BRACE	4 X 4 X 50	4	3, 5	1/END	60d
6	HORIZONTAL POCKET CLEAT	2 X 6 X 18	4	5	7	16d
5	HORIZONTAL POCKET CLEAT	2 X 6 X 72	4	CAR WALL	16	10d
4	CENTER CLEAT	2 X 4 X 36	2	3	7	16d
3	CROSS BRACE	4 X 4 X CAR WIDTH	2	SEE 2	--	--
2	CROSS BRACE STIFFENER	2 X 6 X CAR WIDTH	2	3	2/FT.	12d
1	LOWER WALL CLEAT	2 X 4 X 6	2	CAR WALL	3	10d

LIST OF MATERIALS AND NAILING DATA

FIGURE C-23. Partial layer bracing 8,000 to 14,000 pounds.

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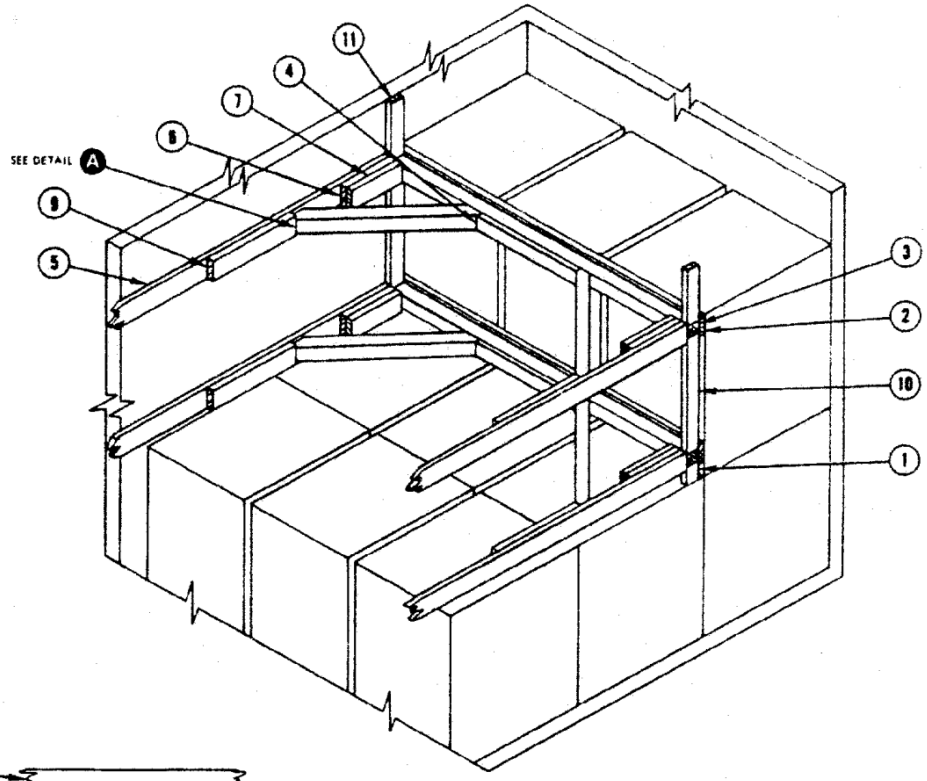

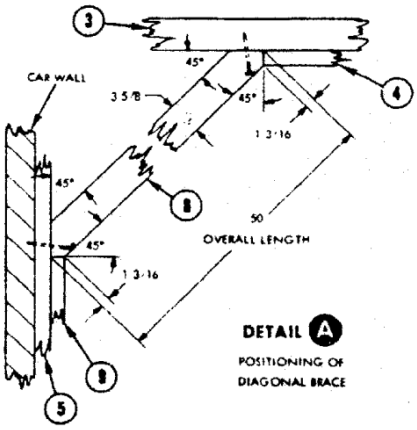

PIECE NO.	DESCRIPTION	SIZE	NO. PCS. REQD	NAIL TO	NAILS NUMBER	NAILS SIZE
11	UPPER WALL CLEAT	2 X 4 X 18	2	CAR WALL	4	10d
10	INTERMEDIATE WALL CLEAT	2 X 4 X CUT TO FIT	2	CAR WALL	4	10d
9	HORIZONTAL BACK-UP CLEAT	2 X 6 X 30	4	5	14	16d
8	DIAGONAL BRACE	4 X 4 X 50	4	3, 5	1/END	60d
7	HORIZONTAL POCKET CLEAT	2 X 6 X 18	4	6	7	16d
6	HORIZONTAL POCKET CLEAT	2 X 6 X 18	4	5	7	16d
5	HORIZONTAL WALL CLEAT	2 X 6 X EXTEND ACROSS DOOR	4	CAR WALL	40	10d
4	CENTER CLEAT	2 X 4 X 36	2	3	7	16d
3	CROSS BRACE STIFFENER	4 X 4 X CAR WIDTH	2	SEE 2	--	--
2	CROSS BRACE	2 X 6 X CAR WIDTH	2	3	2/FT	12d
1	LOWER WALL CLEAT	2 X 4 X 6	2	CAR WALL	3	10d

LIST OF MATERIALS AND NAILING DATA

FIGURE C-24. Partial layer bracing 14,000 to 20,000 pounds.

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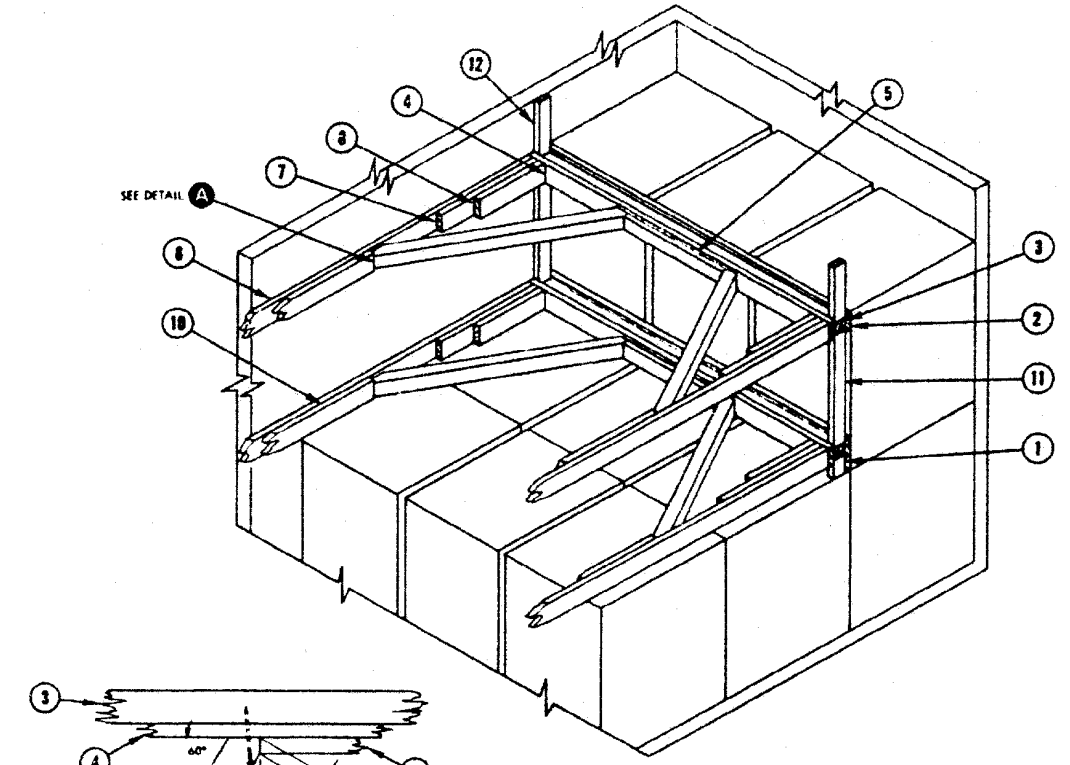

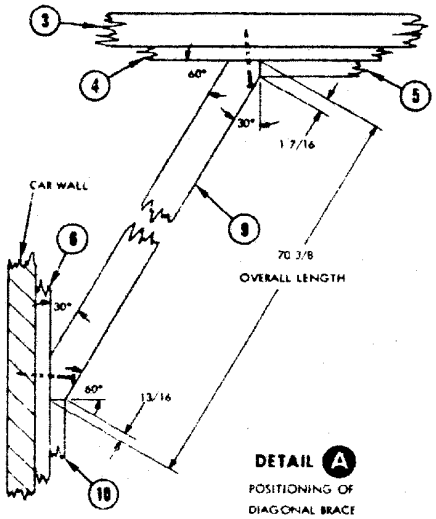

PIECE NO.	DESCRIPTION	SIZE	NO. PCS. REQD	NAIL TO	NUMBER NAILS	SIZE NAILS
12	UPPER WALL CLEAT	2 X 4 X 18	2	CAR WALL	4	10d
11	INTERMEDIATE WALL CLEAT	2 X 4 X CUT TO FIT	2	CAR WALL	4	10d
10	HORIZONTAL BACK-UP CLEAT	2 X 6 X EXTEND ACROSS DOOR	4	6	18	16d
9	DIAGONAL BRACE	4 X 4 X 70 3/8	4	4, 6	1/END	60d
8	HORIZONTAL POCKET CLEAT	2 X 6 X 24	4	6	7	16d
7	HORIZONTAL POCKET CLEAT	2 X 6 X 36	4	5	10	16d
6	HORIZONTAL WALL CLEAT	2 X 6 EXTEND ACROSS DOOR	4	CAR WALL	40	10d
5	CENTER CLEAT	2 X 4 X 36	2	3	7	16d
4	CROSS BRACE STIFFENER	2 X 6 X CAR WIDTH	2	3	2/FT.	12d
3	CROSS BRACE	4 X 4 X CAR WIDTH	2	SEE 2	--	--
2	CROSS BRACE STIFFENER	2 X 6 X CAR WIDTH	2	3	2/FT.	12d
1	LOWER WALL CLEAT	2 X 4 X 6	2	CAR WALL	3	10d

LIST OF MATERIALS AND NAILING DATA

FIGURE C-25. Partial layer bracing 20,000 to 25,000 pounds.

C.4.6.7.2 Partial layers. Partial layer procedures applicable to boxcars with metal side walls are also applicable to boxcars with wood side walls. The three procedures that have been tested and approved for use are partial layer retention procedures using a unit load on a half-height riser, partial layer retention procedures using knee bracing, and partial layer retention procedures using vertical members and strapping. Typical procedures are shown on figures C-26, C-27, and C-28.

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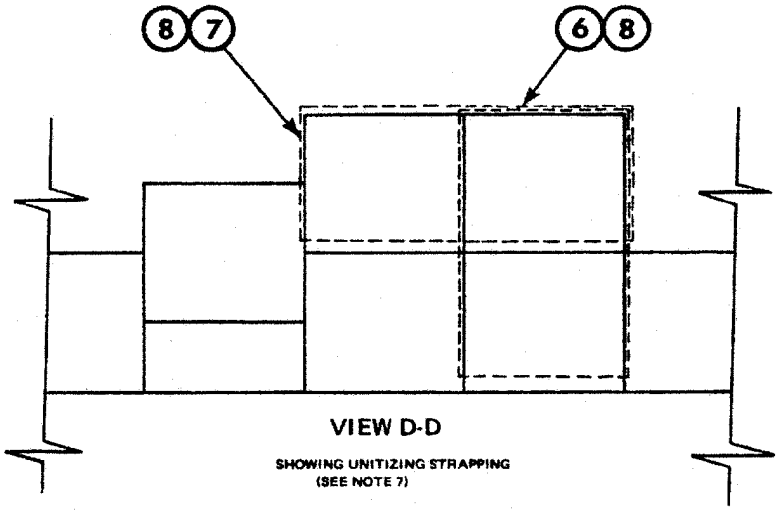
PARTIAL LAYER RETENTION PROCEDURES USING A UNIT LOAD ON A HALF-HEIGHT RISER

1. THESE PROCEDURES MAY BE USED TO RETAIN AN UPPER PARTIAL LAYER. THE WEIGHT RETAINED IN EACH LAYER ROW MUST NOT EXCEED 8000 POUNDS. THESE TYPICAL PROCEDURES DEPICT TWO ROWS WITH THE SAME NUMBER OF UNIT LOADS RETAINED IN EACH PARTIAL LAYER ROW. THESE PROCEDURES ARE ALSO APPLICABLE TO CARLOADS HAVING OTHER THAN TWO PARTIAL UPPER LAYER ROWS (1, 3, OR MORE ROWS) AND TO CARLOADS HAVING DISSIMILAR NUMBERS OF UNIT LOADS IN THE PARTIAL UPPER LAYER ROWS.
2. CARLOADS THAT DO HAVE DISSIMILAR NUMBERS OF UNIT LOADS IN THE PARTIAL UPPER LAYER ROWS MUST NOT EXCEED THE WEIGHT LIMITATIONS FOR LONGITUDINAL AND CROSSWISE DISTRIBUTION AS REQUIRED BY THIS STANDARD AND THE ASSOCIATION OF AMERICAN RAILROADS (AAR) GENERAL RULES COVERING LOADING OF CARLOAD SHIPMENTS OF COMMODITIES IN CLOSED CARS.
3. EACH STACK MUST HAVE ADEQUATE SWAY BRACING IF THE CROSSWISE VOID EXCEEDS 6 INCHES. CARLOADS HAVING DISSIMILAR NUMBERS OF UNIT LOADS IN THE PARTIAL UPPER LAYER ROWS MUST HAVE THE LONG ROWS SWAY BRACED SO THAT THE LATERAL FORCES ARE CARRIED INTO THE SIDE WALL OF THE CAR (SEE C-3.6.3.4 FOR SWAY BRACING PROCEDURES.)
4. ONLY APPROVED UNIT LOADS OF ITEMS IN STRONG METAL OR WOOD BOXES/CONTAINERS THAT WHEN PALLETIZED/UNITIZED HAVE A FULLY DISTRIBUTED HARD SURFACE ON AT LEAST TWO OPPOSITE VERTICAL SIDES MAY BE RETAINED BY THESE PROCEDURES (EXAMPLE: SMALL ARMS BOXES, WOOD BOXES, ETC.)
5. UNIT LOADS MADE UP OF ITEMS WITH IRREGULAR SHAPES AND THOSE THAT REQUIRE PALLET ADAPTERS TO SQUARE UP THE LOAD MAY NOT BE RETAINED BY THESE PROCEDURES (EXAMPLE: PROJECTILES IN MK 11 ADAPTER UNCRATED DEPTH CHARGE CASE MK 9.)
6. ITEMS THAT ARE PACKED IN BOXES/CONTAINERS THAT ARE NOT STRONG ENOUGH TO CARRY THE LONGITUDINAL FORCES, TO WHICH THESE PROCEDURES SUBJECT THE UNIT LOAD, WITHOUT RESULTING DAMAGE TO THE UNIT LOAD MAY NOT BE RETAINED BY THESE PROCEDURES (FIBERBOARD BOXES, POLYSTYRENE CONTAINERS, WIRE BOUND CRATES, ETC.).
7. THE TWO STACKS OF THE PARTIAL LAYER ROW NEXT TO THE UNIT LOAD ON THE HALF-HEIGHT RISER MUST BE UNITIZED BY STEEL STRAPPING. (SEE VIEW D-D.) IF ONLY ONE STACK IS BEING HELD BY THE UNIT LOAD ON THE HALF-HEIGHT RISER IT MUST BE UNITIZED BY VERTICAL STRAPPING ONLY.



VIEW D-D

SHOWING UNITIZING STRAPPING (SEE NOTE 7)

*USE 2 X 4 AND 2 X 6 MATERIAL AS REQUIRED TO OBTAIN 1/2 UNIT LOAD HEIGHT ± 2.

SWAY BRACING OMITTED FOR CLARITY. SEE 5.9.3.4 FOR DETAILS OF SWAY BRACING PROCEDURES.

PIECE NO.	DESCRIPTION	SIZE	NO. PCS. REQD	NAIL TO	NUMBER NAILS	SIZE
8	SEAL	1 ¼	2 PER STRAP	--	--	--
7	LONGITUDINAL STRAPPING	1 1/4 X .035 X TO SUIT	2 PER ROW	--	--	--
6	VERTICAL STRAPPING	1 1/4 X .035 X TO SUIT	2 PER ROW	--	--	--
5	DECK PIECE	2 X 6 X Y	3	3 1	-- 7	-- 10d
4	LONGITUDINAL SUPPORT TIE PIECE	2 X 4 X H	4	3	2 PER JOINT	10d
3	LONGITUDINAL SUPPORT PIECE	2 X 6 X X	SEE NOTE	--	--	--
2	LATERAL SUPPORT TIE PIECE	2 X 4 X H	4	1	2 PER JOINT	10d
1	LATERAL SUPPORT PIECE	2 X 6 X W	SEE NOTE	3, 4	3 PER JOINT	20d

LIST OF MATERIALS AND NAILING DATA

FIGURE C-26. Partial layer retention up to 8,000 pounds (sheet 1 of 2).

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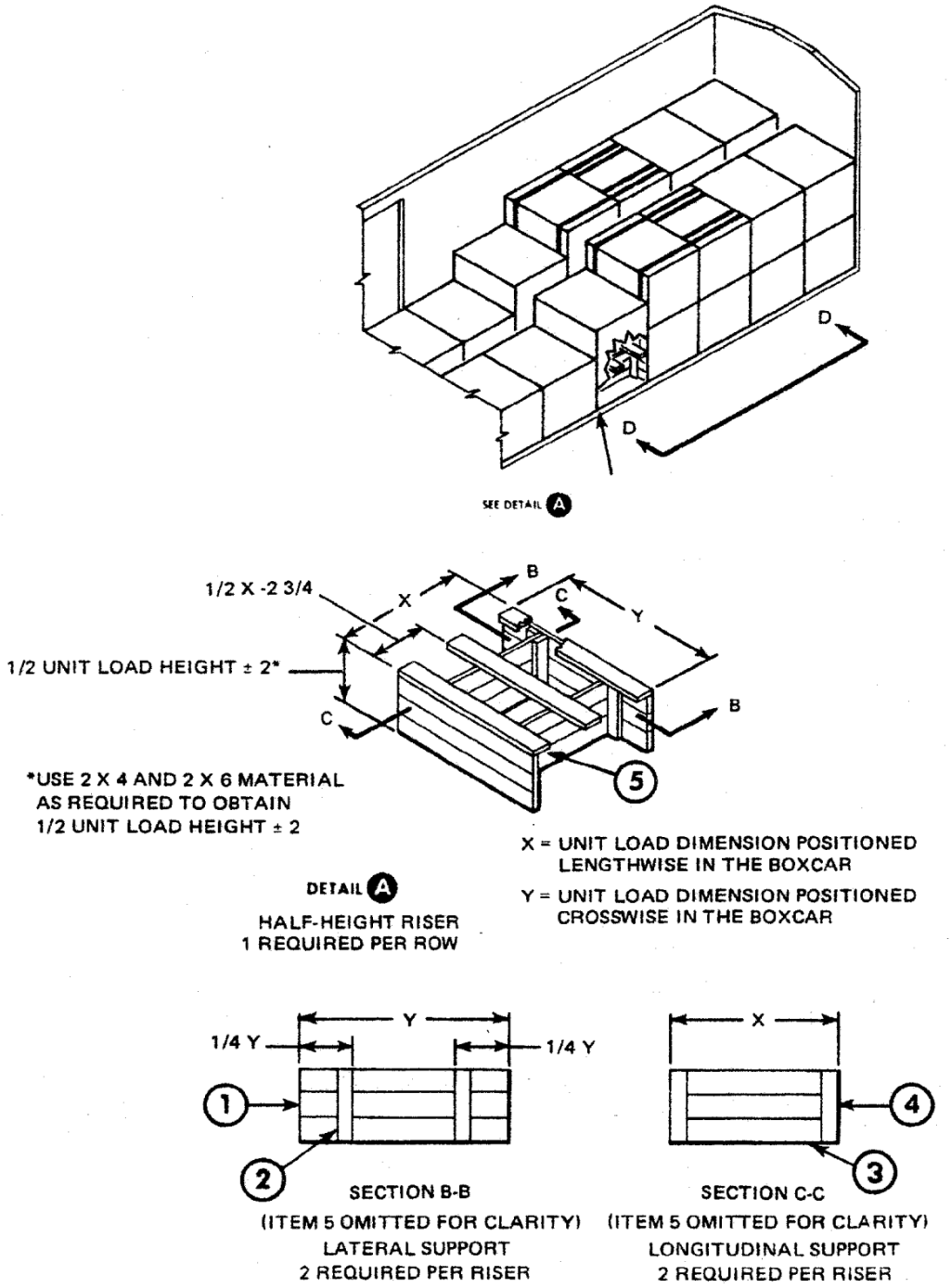

FIGURE C-26. Partial layer retention up to 8,000 pounds (sheet 2 of 2) – Continued.

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PARTIAL LAYER RETENTION PROCEDURES
USING KNEE BRACING

1. KNEE BRACING PROCEDURES MAY BE USED TO HOLD PARTIAL LAYERS HAVING A WEIGHT NOT IN EXCESS OF 24,000 POUNDS EACH END OF THE BOXCAR.
2. A MINIMUM OF 1 TIE-DOWN STRAP MUST BE INSTALLED FOR EACH LOWER LAYER UNIT LOAD LOCATED BETWEEN THE LOWER ENDS OF THE LONG DIAGONALS EACH END OF THE CAR. MAXIMUM DISTANCE BETWEEN TIE DOWNS MUST NOT EXCEED 48 INCHES.
3. CENTER GATE AREA OF LOWER LAYER SHALL NOT EXCEED 48 INCHES.
4. DIAGONAL PIECES 12 AND 15, MUST FORM 60° ANGLE WITH THE VERTICAL MEMBER A 30° ANGLE WITH THE HORIZONTAL MEMBER ±5°. (SEE DETAIL E.)
5. UNIT LOADS HAVING A HEIGHT GREATER THAN 38 INCHES SHALL HAVE A LONG DIAGONAL HOLDDOWN CLEAT (PIECE 17) 12 INCHES IN LENGTH AND UNIT LOADS HAVING A HEIGHT 36 INCHES OR LESS SHALL HAVE A LONG DIAGONAL HOLDDOWN CLEAT (PIECE 17) 8 INCHES IN LENGTH.

*H = HEIGHT OF UNIT LOAD
**8 INCHES FOR UNIT LOADS 36 INCHES HIGH OR LESS
***W = DISTANCE BETWEEN UNIT LOADS IN ADJACENT ROWS

PIECE NO.	DESCRIPTION	SIZE	NO. PCS. REQD	NAIL TO	NUMBER NAILS	SIZE
25	CROSS BRACE	4 X 4 X W***	AS REQD	SEE 24	--	--
24	SPACER	2 X 4 X W***	AS REQD	25	4	16d
23	SUPPORT PIECE	2 X 4 X (W + 12)***	AS REQD	24	4	16d
				11	2 EACH END	8d
22	SEAL	1 1/4 INCH	2 PER STRAP	--	--	--
21	HOLD DOWN STRAP	1 1/4 X .035 X LENGTH TO SUIT	AS REQD	SEE NOTE 2		
20	STRAPPING BOARD	2 X 6 X (DISTANCE BETWEEN U.L. + 18)	AS REQD	19	5	10d
19	STRAPPING BOARD	2 X 6 X (DISTANCE BETWEEN U.L. + 18)	AS REQD	18	5	10d
18	CROSS BRACE	2 X 6 X CAR WIDTH – 12	AS REQD	16	3 PER JOINT	16d
17	HOLD DOWN CLEAT	2 X 6 X 12**	8	14	5	16d
16	BACK-UP CLEAT	2 X 6 X CUT TO FIT	4	13	2 PER FOOT	10d
15	LONG DIAGONAL BRACE	4 X 4 X 2 (H – 13 1/2)*	8	13 & 14	2 EACH END	16d
14	HOLD-DOWN CLEAT	2 X 6 X (H – 11 1/2)*	8	2	12	10d
13	BACK-UP CLEAT	2 X 6 X CUT TO FIT	4	11	2 PER FOOT	10d
12		4 X 4 X 20	8	2 & 11	2 EACH END	16d
11	BEARING PIECE	2 X 6 X CUT TO FIT	16	SEE 11	--	--
10	STRUT	4 X 4 X WEDGE FIT	8	5	2 PER JOINT	16d
9	CENTER GATE HOLD DOWN	2 X 4 X CUT TO FIT	4	8	2 PER FOOT	16d
8	CENTER GAGE HOLDDOWN	2 X 4 X CUT TO FIT	4	7	2 PER FOOT	10d
7	HOLD DOWN MEMBER	2 X 4 X CAR WIDTH – 1	2	5	3 PER JOINT	10d
6	CENTER GATE STRUT CLEAT	2 X 4 X CAR WIDTH – 1	4	5	3 PER JOINT	10d
5	CENTER GATE VERTICAL	2 X 6 X (H – 10)*	8	SEE 4	--	--
4	CENTER GAGE HORIZONTAL	2 X 6 X CAR WIDTH – 1	4	5	3 PER JOINT	10d
3	SPACER	2 X 6 X CUT TO FIT	8	2	2 PER FOOT	10d
2		2 X 6 X 2 H	8	SEE 1	--	--
1	KNEE BRACE GATE HORIZONTAL	2 X 6 X CAR WIDTH – 1/2	10	2	3 PER JOINT	10d

LIST OF MATERIALS AND NAILING DATA

FIGURE C-27. Partial layer retention up to 24,000 pounds (sheet 1 of 3).

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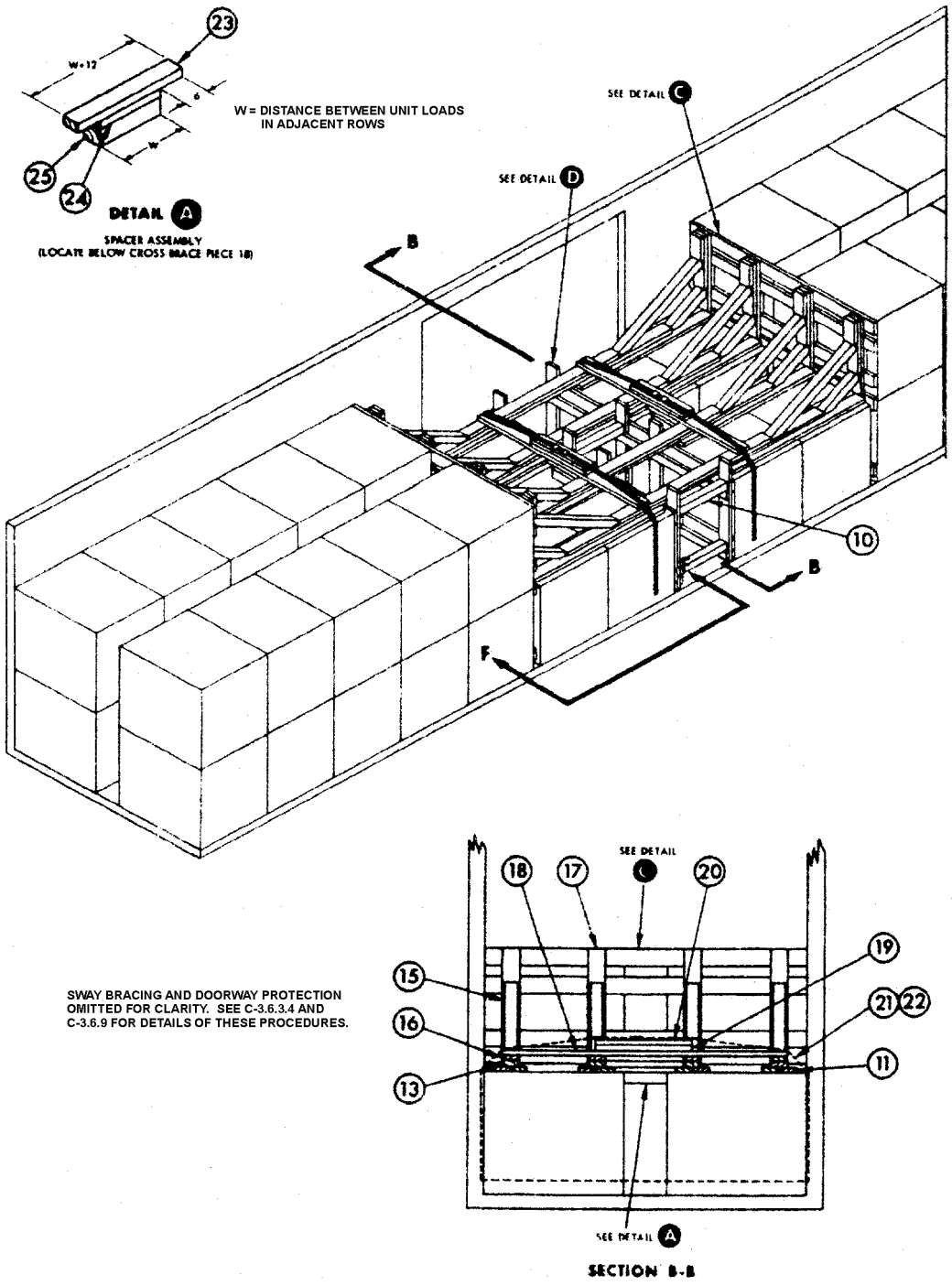

FIGURE C-27. Partial layer retention up to 24,000 pounds (sheet 2 of 3) – Continued.

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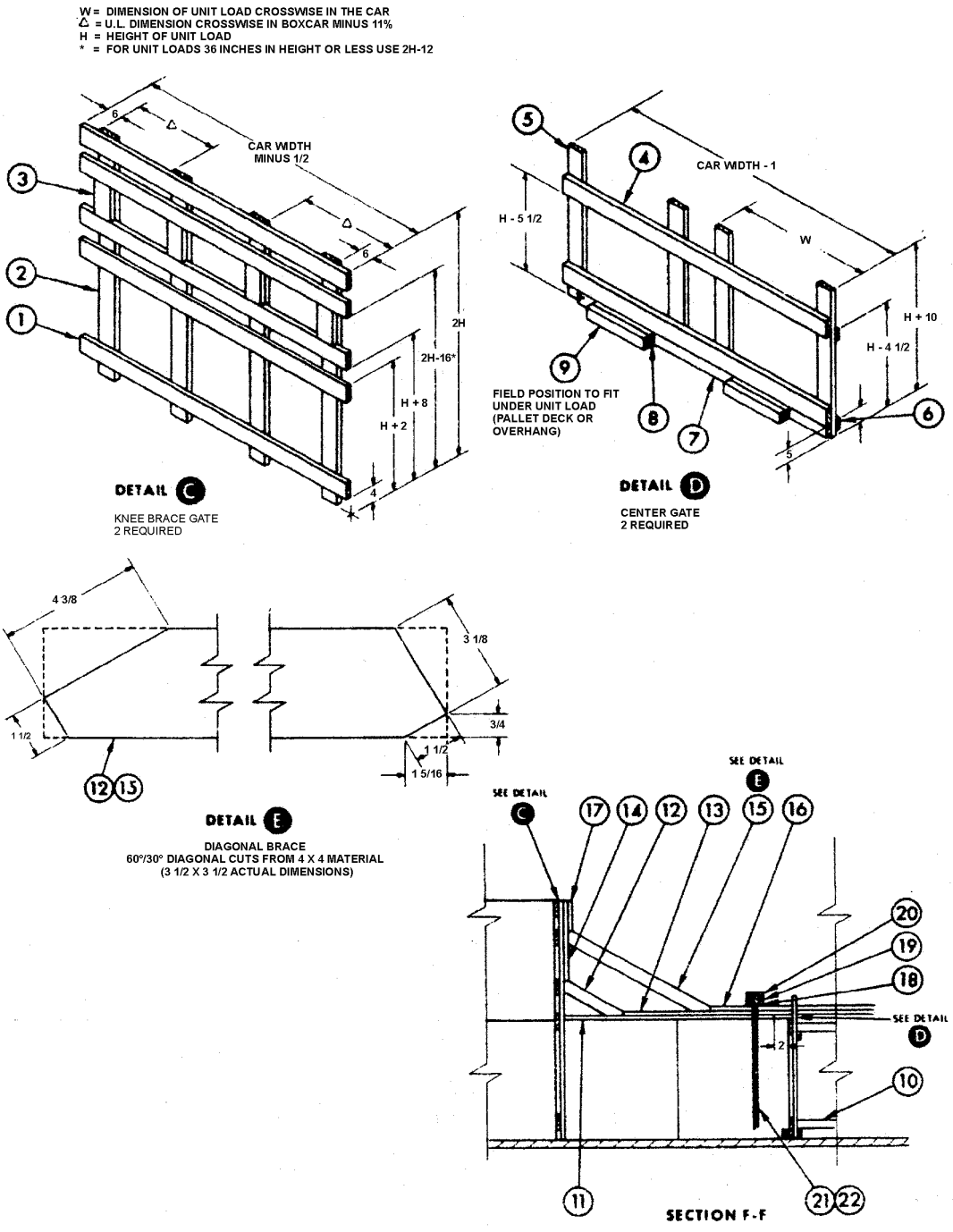

FIGURE C-27. Partial layer retention up to 24,000 pounds (sheet 3 of 3) – Continued.

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**PARTIAL LAYER RETENTION PROCEDURES
USING VERTICAL MEMBERS AND STRAPPING**

1. THE WEIGHT AND HEIGHT OF THE UPPER PARTIAL LAYER TO BE RETAINED DETERMINES THE SIZE AND QUANTITY OF VERTICAL MEMBERS REQUIRED TO RETAIN THE LOAD. THE AMOUNT OF LOAD WHICH MAY BE RETAINED BY EACH VERTICAL DEPENDS ON THE DIMENSIONS OF THE VERTICAL AND THE HEIGHT IT EXTENDS ABOVE THE TOP OF THE FULL LOWER LAYER. THIS HEIGHT WILL NORMALLY BE THE HEIGHT OF THE UNIT LOAD BEING RETAINED. A MINIMUM OF TWO VERTICALS MUST BE USED FOR EACH UPPER LAYER ROW BEING RETAINED. THE TABULATION BELOW SHOWS THE AMOUNT OF LOAD WHICH MAY BE RETAINED BY EACH VERTICAL USED. THE WEIGHT RETAINED IN EACH ROW OF UPPER PARTIAL LAYER MUST NOT EXCEED 8000 POUNDS.
2. A PARTIAL LAYER RETAINING FRAME IS CONSTRUCTED BY NAILING BUFFER MEMBERS TO THE VERTICALS TO DISTRIBUTE THE LONGITUDINAL FORCES OVER STRONG AREAS OF THE UNIT LOADS CONTACTED BY THE FRAMES. THE AMOUNT AND TYPE OF BUFFER MEMBERS REQUIRED DEPENDS ON THE CRUSHING STRENGTH OF THE UNIT LOAD AND ITS ABILITY TO CARRY THE LONGITUDINAL FORCES.
3. TWO 1-1/4-INCH STRAPS ARE REQUIRED TO HOLD A PARTIAL LAYER RETAINING FRAME IN POSITION. THE CONFIGURATION OF THE UNIT LOAD DETERMINES HOW AND WHERE STRAPS ARE POSITIONED.

CAUTION

UNIT LOADS THAT ARE WEAK IN AREAS WHERE THE VERTICALS MUST BE POSITIONED AND THAT CANNOT BE SUFFICIENTLY STRENGTHENED BY ADDING BUFFER BOARDS (EXAMPLES: WIRE BOUND CRATES, POLYSTYRENE BOXES, ETC.) AND UNIT LOADS OF AMMUNITION ITEMS IN CARTRIDGE TANKS SHOULD NOT BE RETAINED IN THIS MANNER.

HEIGHT OF UNIT LOAD (INCHES)	MAXIMUM LOAD PER VERTICAL (POUNDS)	
	4 X 4	4 X 6[1]
27	1745	3492
30	1570	3143
33	1428	2857
36	1309	2619
39	1208	2418
42	1122	2245
45	1047	2095

[1]Two 2 x 6 verticals laminated with 10d nails (two per foot) and with a 1 x 4 face board nailed to the outer edge with 6d nails (one per foot) may be substituted in place of 4 x 6 verticals.

FIGURE C-28. Partial layer retention with vertical members and strapping (sheet 1 of 2).

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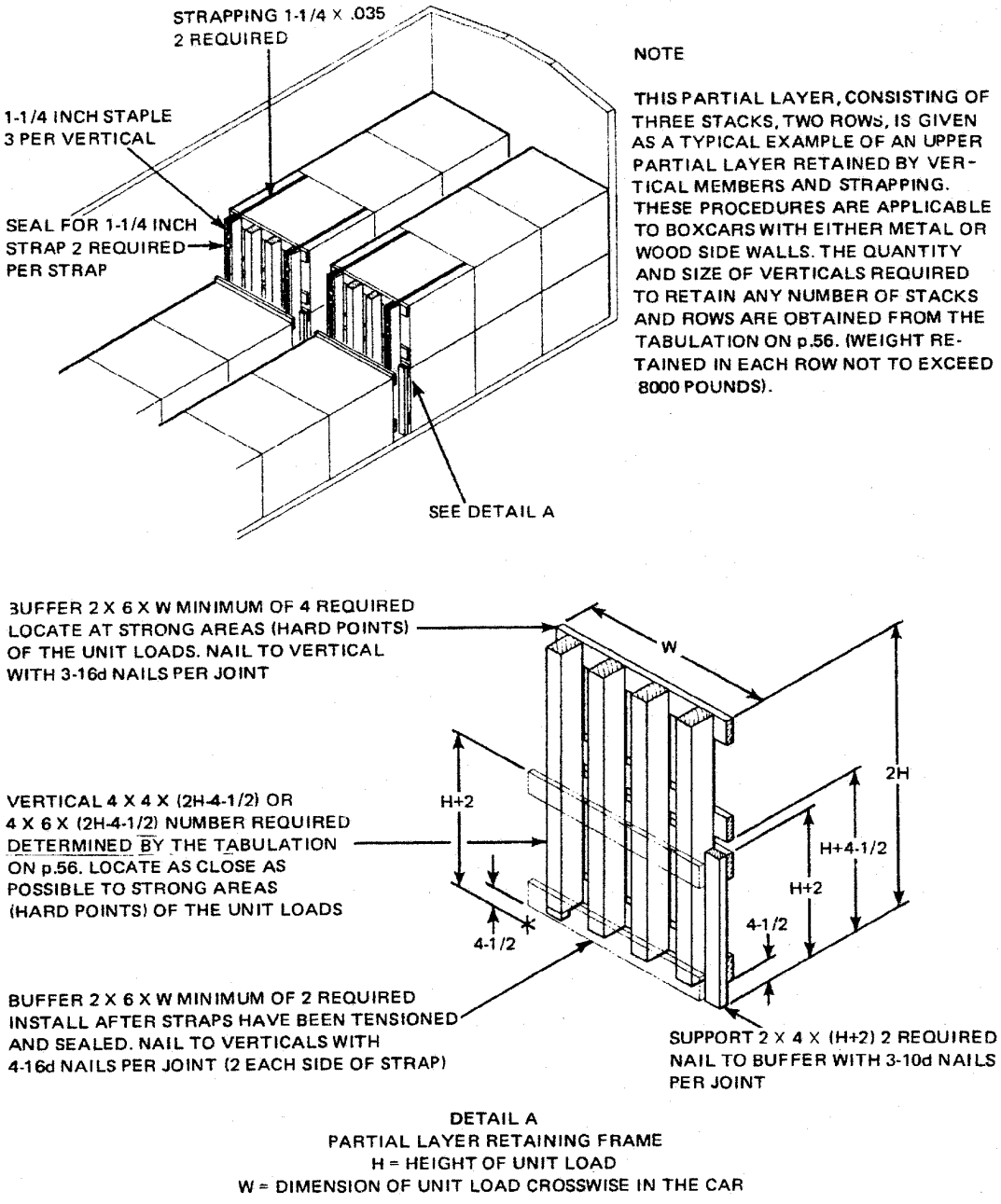

DETAIL A
PARTIAL LAYER RETAINING FRAME
H = HEIGHT OF UNIT LOAD
W = DIMENSION OF UNIT LOAD CROSSWISE IN THE CAR

FIGURE C-28. Partial layer retention with vertical members and strapping (sheet 2 of 2) – Continued.

C.4.6.7.3 Knee brace assemblies. Knee brace assemblies can be used to secure partial loads. The floor of the car should have a nailable floor. One knee base assembly is adequate for retaining a maximum load of not more than 8,500 pounds (see figures C-29 and C-30).

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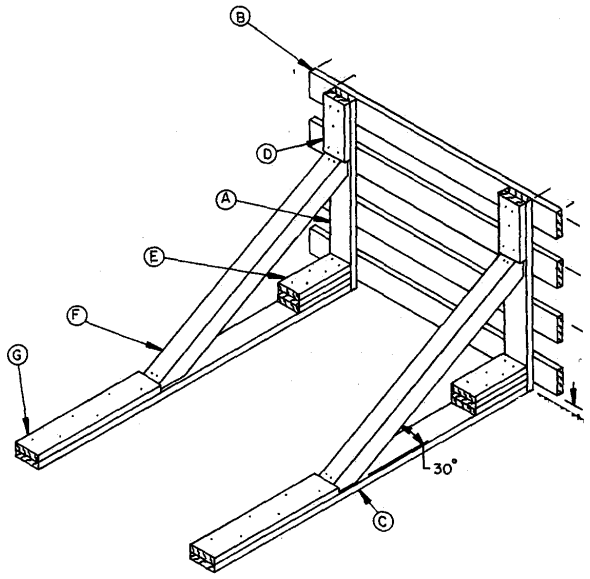
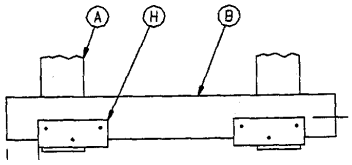


KNEE BRACE ASSEMBLY



VIEW A

KEY LETTERS

(A) VERTICAL PIECE, 2" X 6" DIMENSION REQUIRED (2 REQD).

(B) HORIZONTAL PIECE, 2" X 6" X 48" (AS REQD). NAIL TO THE VERTICAL PIECES w/3-10d NAILS AT EACH JOINT.

(C) FLOOR CLEAT, 2" X 6" BY LENGTH TO SUITE (.87 OR 7/8 TIMES LENGTH OF PIECE MARKED (F), PLUS 30") (2 REQD). ALIGN WITH A VERTICAL PIECE AND NAIL TO THE CAR FLOOR w/1-16d NAIL EVERY 8".

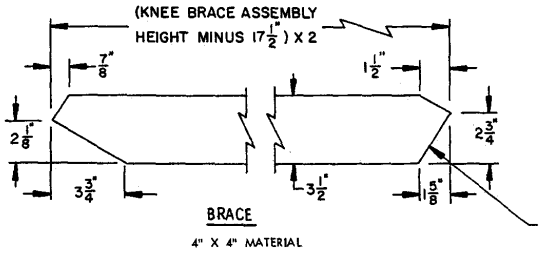
(D) HOLD-DOWN CLEAT, 2" X 6" X 16" (2 REQD). NAIL TO A VERTICAL PIECE w/5-10d NAILS.

(E) POCKET CLEAT, 2" X 6" X 12" (TRIPLED) (2 REQD). NAIL THE FIRST PIECE TO THE FLOOR CLEAT, PIECE MARKED (C), w/4-16d NAILS. NAIL THE SECOND AND THIRD PIECES IN A LIKE MANNER AND TOENAIL THE THIRD PIECE TO THE VERTICAL PIECE, PIECE MARKED (A), w/2-16d NAILS.

(F) BRACE, 4" X 4" BY CUT TO FIT (KNEE BRACE ASSEMBLY HEIGHT MINUS 17-1/2", TIMES 2) (2 REQD). SEE THE DETAIL AT LEFT FOR BEVEL CUTS REQUIRED. TOENAIL TO THE VERTICAL PIECE AND TO THE FLOOR CLEAT, PIECES MARKED (A) AND (C), w/2-16d NAILS AT EACH JOINT.

(G) BACK UP CLEAT, 2" X 6" X 30" (2 REQD). NAIL TO THE FLOOR CLEAT, PIECE MARKED (C), w/6-40d NAILS.

(H) HOLD-DOWN CLEAT, 2" X 4" X 9" (DOUBLED (2 REQD). NAIL THE FIRST PIECE TO A HORIZONTAL PIECE w/3-10d NAILS. NAIL THE SECOND PIECE TO THE FIRST IN A LIKE MANNER. SEE VIEW A.



BRACE
4" X 4" MATERIAL

THE BRACE MUST BE INSTALLED SO THAT THE BEARING SURFACE WILL BE IN CONTACT WITH THE VERTICAL PIECE MARKED (A).

FIGURE C-29. Typical LCL load using knee brace method of partial layer bracing.

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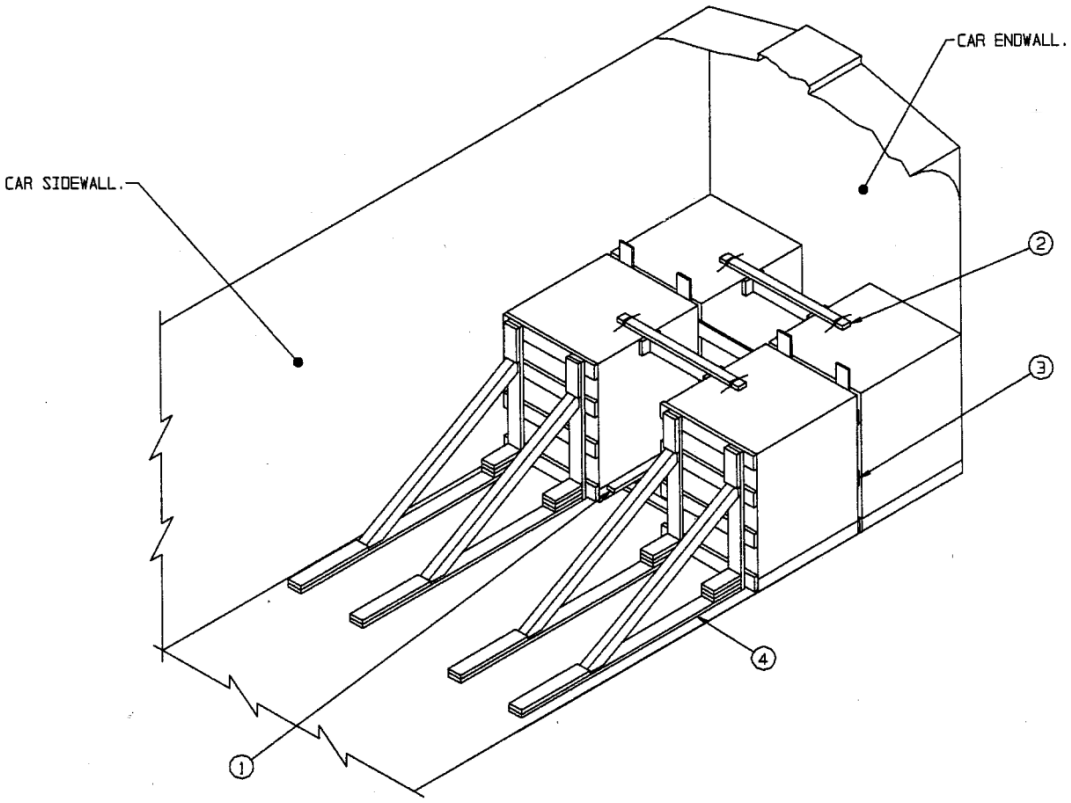

FIGURE C-30. Typical LCL load using knee brace.

C.4.6.8 Floor blocking. Floor blocking should be placed tightly against the load and nailed securely to the car floor. Typical floor blocking arrangements are shown on figure C-31. Floor blocks are at least nominal 2 by 4 inches. Where the blocking butts against a container skid or load skid, the floor block should be at least as thick as the skid member. Cross blocking should extend the full width of the load and should be provided with backup cleats of the same nominal thickness. Backup cleats should be placed in line with skid members. Backup cleats should extend over three or more floorboards to ensure proper nailing and should be at least 18 inches long. Table C-VII shows the number of backup cleats and nails needed for the load.

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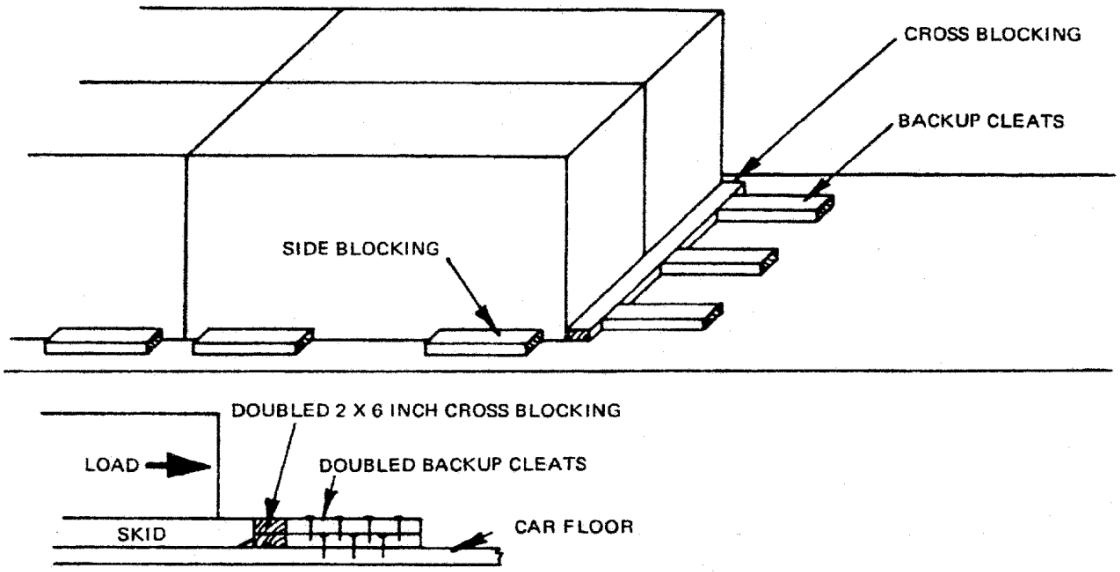

FIGURE C-31. Floor blocking.

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TABLE C-VII. Blocking strength (boxcar).

Number of backups	Nails	Max weight with header (pounds)	Max weight without header (pounds)
2, 30″ long	6	9,000	7,700
3, 30″ long	6	13,000	11,100
4, 30″ long	6	17,500	14,500
5, 30″ long	6	22,000	18,800
6, 30″ long	6	26,000	22,300
2, 36″ long	7	10,000	9,000
3, 36″ long	7	15,500	13,000
4, 36″ long	7	20,000	17,500
5, 36″ long	7	25,500	22,000
6, 36″ long	7	31,000	26,000
2, 42″ long	9	13,000	10,000
3, 42″ long	9	20,000	15,500
4, 42″ long	9	26,500	20,000
5, 42″ long	9	33,000	25,500
6, 42″ long	9	40,000	31,000

NOTES:

1. Backups (2 by 6 inches doubled).
2. Nail first piece with one 16d nail every 5 inches, nail second piece with one 40d nail every 5 inches.
3. Headers will be car width or 3 inches each end beyond backups. Nail with one nail every 8 inches.

C.4.6.9 Doorway protection. Whenever more than half of a pallet or container extends into the doorway area, suitable doorway protection should be provided. The purpose of doorway protection is to ensure that the load does not damage or jam the door and also to ensure that, even though the door may not be jammed, lading does not fall when the door is opened. Methods of applying doorway protection in cars with wooden doorposts and with steel-jacketed doorposts are shown on figure C-32. For cars with steel thresholds, a floor strip should be cut slightly longer and wedged tightly in place as shown on figure C-32. Cross boards should be spaced on the uprights so that they prevent the load from moving laterally in the doorway area.

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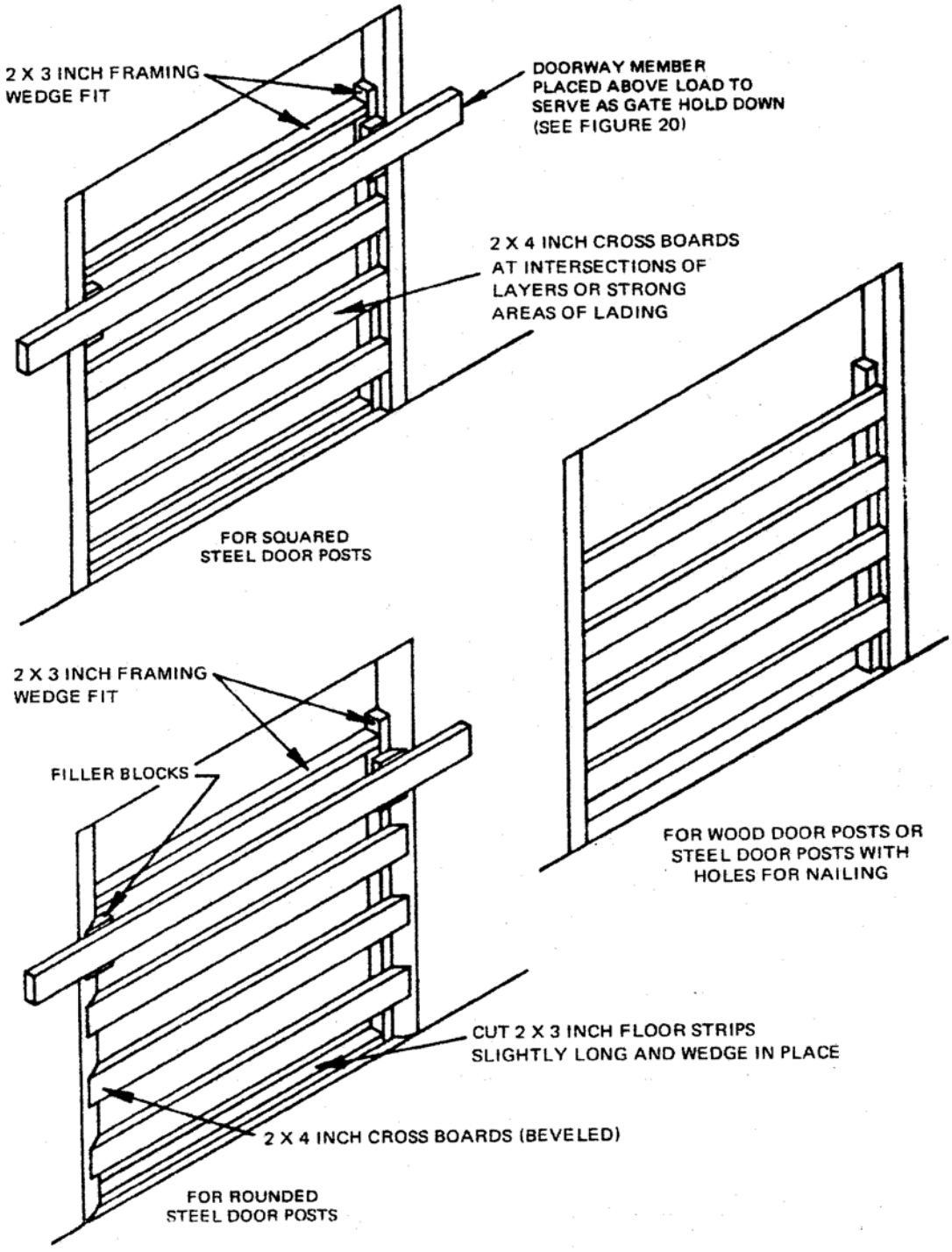

FIGURE C-32. Doorway protection.

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C.4.6.10 Doorway protection for cars equipped with plug-type doors. Each side of a plug-door boxcar may be equipped with a single plug door, double plug doors, or one plug door and one conventional door. Dunnage material should not be nailed to any plug door unless the door is provided with an adequate nailing strip; then dunnage may be nailed to the nailing strip when required. Stacks in the doorway that place a distributed load against the door should be unitized with two laterally applied 1¼-inch steel straps per stack, each tensioned and sealed with two double-crimped seals (see figure C-33). The doorway area should be spanned with 2- by 6-inch members in all areas where the load results in concentrated forces against the door, thereby distributing these forces over the plug inner surface. If lumber of sufficient length to span plug doors is not available, random length material, doubled and spliced, but with joints of splices offset, may be used.

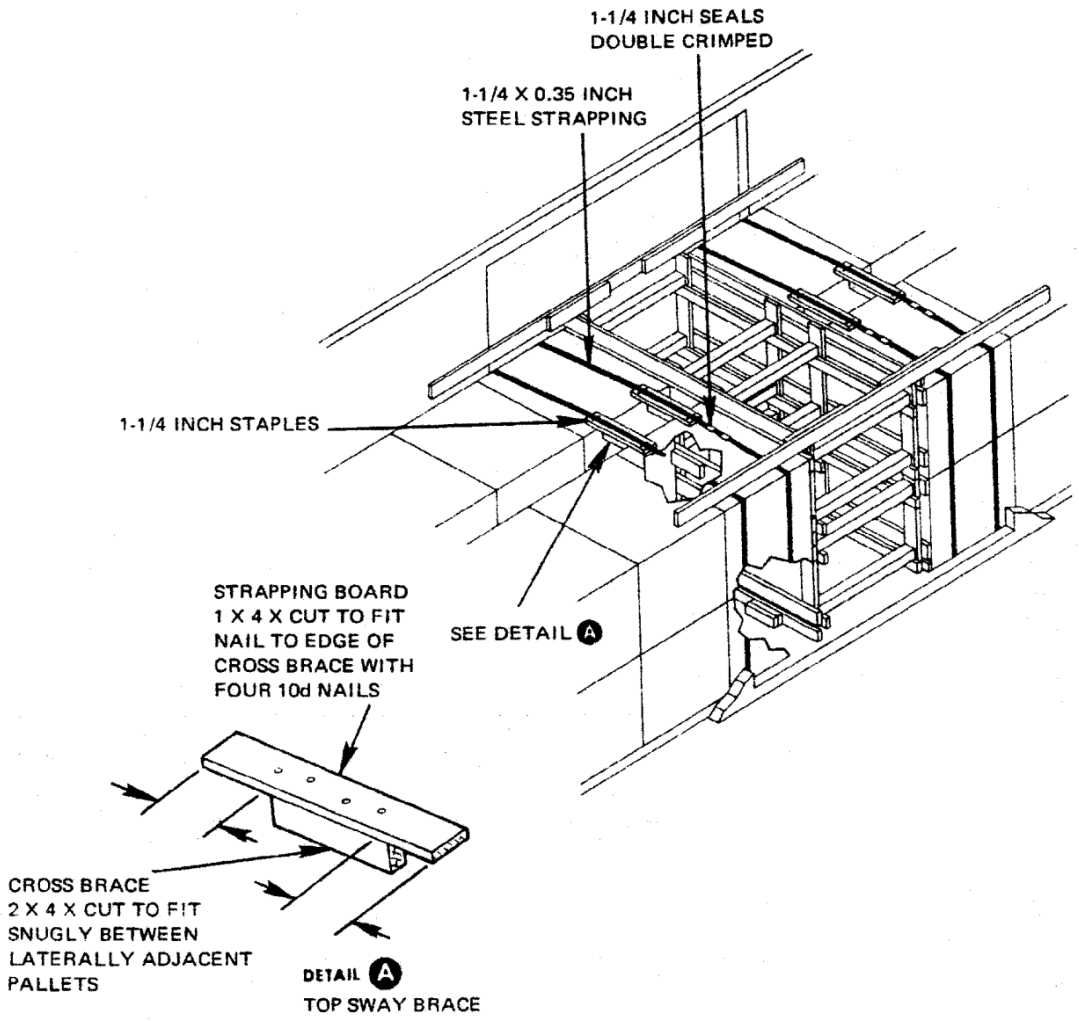

FIGURE C-33. Doorway protection, strapping method.

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C.4.7 Dunnaging design and procedure on flatcars.

C.4.7.1 Concept. The loading, blocking, and strapping procedures described herein for flatcars are intended to provide general instructions for use when no drawings exist. The basic differences between the loading of flatcars and the loading of boxcars is that, on flatcars, all lengthwise, crosswise, and vertical forces should be restrained without the assistance of end walls or side walls. Because of this, the fundamental concept is to hold the load in position on the car platform with blocking and to hold the load down with strapping. Strapping tension increases the friction between the load and the car and adds to the blocking.

C.4.7.2 Arrangement of load. In planning the layout of the load on a flatcar, the items should be loaded into load groups, for example, four containers wide by three containers high. The number of containers in a stack should be determined by considering the stability of the stacked items and the clearance required as shown on figures C-3, C-4, or C-5. Determine the number of containers across the width of the car from the width of the item and the width of the car available or to be ordered, allowing for the width of anti-chafing boards, side blocking, and at least a 3-inch clearance from the edge of the platform. Determine the number of load groups along the length of the car from the length of the item and the length of the car available to be ordered, allowing for the length needed for intermediate blocking, end blocking, and about a 6-inch clearance from the end of the platform. Consideration should also be given to the number of tiedown straps required and the stake pockets available. The total weight of the carload should not exceed the load limit of the car, and the weight distribution of the load should not exceed the limitations of figure C-6, except with specific authority from the carrier.

C.4.7.2.1 Load groups. When more than one layer of containers is loaded, containers should be strapped or bolted together to form a load group. Lengthwise and crosswise displacement should be prevented with strapping, bolting, or appropriate blocking, tie rods, plates, or similar devices. Anti-skid plates should be used between stacked wooden containers. The weight of a load group should be no more than 35,000 pounds. When there is more than one stack across the width of the car, the stacks should be strapped together so that the group of containers is an integral unit. Anti-chafing boards or frames should be placed between the stacks when required to prevent containers from rubbing against each other, thereby assuring a tightly bound load.

C.4.7.2.2 Placement of load groups. In planning the placement of load groups on a flatcar, the location of the side stake pockets on the car should be taken into consideration since tiedown strapping should be fastened through stake pockets. Normally, stake pockets are positioned 42 inches on centers. The number of side stake pockets, therefore, depends upon the length of the car (see table C-VIII). Side stake pockets may be inset or may extend beyond the edge of the platform. The load groups should be positioned so that stake pockets will be available for the required tiedown strapping and so that there is sufficient space between the groups for the required intermediate blocking. A long container that has a center of gravity toward one end should be positioned so that the center of gravity is toward the lengthwise center of the car. Occasionally, car floor space may be saved and the car load increased by the use of pre-positioned blocking nailed to the car floor and located under the containers so that it butts against strong areas of the container and retains it from longitudinal or lateral movement.

TABLE C-VIII. Number of stake pockets on typical flatcars.

Number of stake pockets on a side	Length of car
11	40 feet 6 inches to 41 feet 0 inch
12	41 feet 6 inches to 42 feet 6 inches
13	45 feet 0 inch to 46 feet 6 inches
14	47 feet 0 inch to 50 feet 6 inches
15	52 feet 0 inch to 53 feet 6 inches
17	60 feet 0 inch

C.4.7.2.3 Ordering cars. Only cars with sound floors should be used. Cars with steel floor ends or exposed steel bolsters, or both, should not be used.

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C.4.7.3 Blocking. Blocking pieces are normally 2 by 6 inches in size and in 6-inch increments of length. Blocking pieces should always be at least two layers thick, but three or more thicknesses may be used if additional height is needed to properly bear against the load. The length of the blocking pieces for intermediate blocking, side blocking, and end blocking depends upon the weight of the load. Each load group should be adequately blocked in accordance with the guidance in this section, and the total amount of blocking should be sufficient for the total carload weight.

C.4.7.3.1 Nailing of blocking. The strength of the blocking pieces is directly dependent upon the number of nails in each piece. One nail should be used for every 6 inches of length or fraction thereof. For doubled blocking, use 30d nails in the first layer and 60d nails or spikes in the second layer. For side blocking, 30d nails may be used in both layers. When three or more layers of blocking are needed, use 30d nails in the first layer and 60d nails or spikes in each successive layer. For cross blocking, 8-inch spacing of nails is permitted.

C.4.7.3.2 Cross blocking. Cross blocking pieces, or headers, serve to distribute the load more evenly over the width of the car. While they obviously add strength to the blocking arrangement, their strength is not counted upon when determining the amount of end or intermediate blocking needed.

C.4.7.3.3 End blocking or intermediate blocking. End or intermediate blocking pieces should be placed against cross blocking either at the ends of the last stacks or between the stacks. Blocking should be aligned with containers or container skids. The number and length of end or intermediate blocking required depends upon the weight of the load group and the strength values given in tables C-IX, C-X, and C-XI.

C.4.7.3.4 Side blocking. Side blocking pieces should be placed against the skids or against the sides of the bottom container in a stack near its ends. They are usually doubled and positioned parallel to the length of the container and are not normally placed against the cross blocking pieces. The number and length of side blocking pieces required depends upon the weight of the load group and the strength values given in table C-XII.

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TABLE C-IX. Blocking strength (2 by 6 doubled).

Number of backups	Nails	Max weight with header (pounds)
2, 30″ long	8	12,000
3, 30″ long	8	18,000
4, 30″ long	8	24,000
5, 30″ long	8	30,000
6, 30″ long	8	36,000
2, 36″ long	9	14,000
3, 36″ long	9	21,000
4, 36″ long	9	28,000
5, 36″ long	9	35,000
2, 42″ long	11	17,000
3, 42″ long	11	25,000
4, 42″ long	11	35,000
2, 48″ long	12	20,000
3, 48″ long	12	30,000
4, 48″ long	12	40,000

NOTES:

1. Backups (2 by 6 inches doubled).
2. Nail first piece with one 20d nail every 4 inches, nail second piece with one 50d nail every 4 inches.
3. Headers should be car width or 3 inches each end beyond backups. Nail with one nail every 5 inches.

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TABLE C-X. Blocking strength (2 by 6 tripled).

Number of backups	Nails	Max weight with header (pounds)
2, 30″ long	8	10,000
3, 30″ long	8	15,000
4, 30″ long	8	20,000
5, 30″ long	8	25,000
6, 30″ long	8	30,000
2, 36″ long	9	12,000
3, 36″ long	9	18,000
4, 36″ long	9	24,000
5, 36″ long	9	30,000
6, 36″ long	9	36,000
2, 42″ long	11	15,000
3, 42″ long	11	22,500
4, 42″ long	11	30,000
5, 42″ long	11	37,500
6, 42″ long	11	45,000

NOTES:

1. Backups (2 by 6 inches tripled).
2. Nail first piece with one 20d nail every 4 inches, nail second piece with one 50d nail every 4 inches, nail third piece with one 50d nail every 4 inches.
3. Headers should be car width or 3 inches each end beyond backups. Nail with one nail every 5 inches.

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TABLE C-XI. Blocking strength (2 by 6 quadrupled).

Number of backups	Nails	Max weight with header (pounds)
2, 30″ long	8	8,000
3, 30″ long	8	12,000
4, 30″ long	8	16,000
5, 30″ long	8	18,000
6, 30″ long	8	22,000
2, 36″ long	9	9,000
3, 36″ long	9	13,500
4, 36″ long	9	18,000
5, 36″ long	9	22,500
6, 36″ long	9	27,000
2, 42″ long	11	11,000
3, 42″ long	11	16,500
4, 42″ long	11	22,000
5, 42″ long	11	27,500
6, 42″ long	11	33,000
2, 48″ long	12	12,000
3, 48″ long	12	18,000
4, 48″ long	12	24,000
5, 48″ long	12	30,000

NOTES:

1. Backups (2 by 6 inches quadrupled).
2. Nail first piece with one 20d nail every 4 inches, nail second piece with one 50d nail every 4 inches, nail third piece with one 50d nail every 4 inches, nail fourth piece with one50d nail every 4 inches.
3. Headers should be car width or 3 inches each end beyond backups. Nail with one nail every 5 inches.

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TABLE C-XII. Nailed side blocking capacities (flatcar).

Number of pieces	Nails	Position in relation to load side	Load unit (pounds)
2, 18″ long	5	parallel	5,000
2, 24″ long	6	parallel	6,000
2, 30″ long	8	parallel	8,000
2, 36″ long	9	parallel	9,000
2, 42″ long	11	parallel	11,000
2, 48″ long	12	parallel	12,000
2, 18″ long	3	perpendicular	5,000
2, 24″ long	5	perpendicular	8,000
2, 30″ long	6	perpendicular	10,000

NOTES:

1. Backups (2 by 6 inches doubled).
2. Nail first piece with 20d nails, nail second piece with 30d nails.

C.4.7.4 Strapping. When a load group consists of several stacks of containers, strapping should be used to band each stack, to tie together the top layers of containers of the stacks in each group, and to stay the load group to the flatcar, as shown on figure C-34. Whenever possible, the strapping should be spaced evenly along the length of the containers. All seals should be double-crimped.

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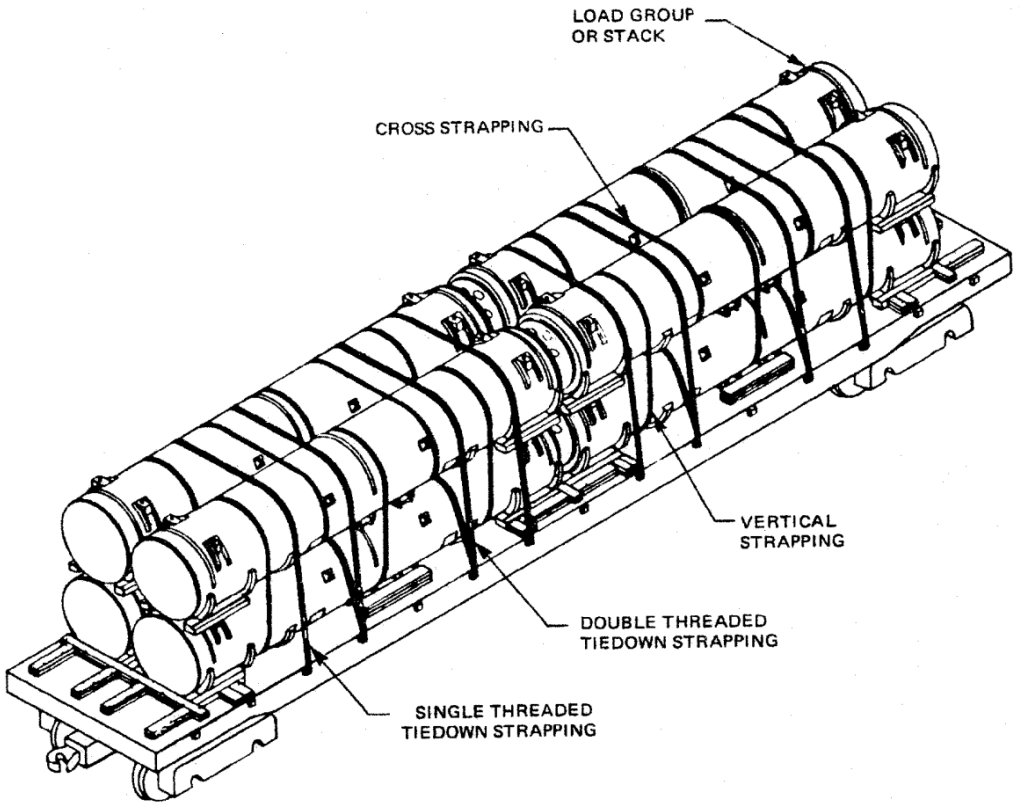

FIGURE C-34. Typical method of strapping containers to a flatcar.

C.4.7.4.1 Vertical strapping. Each row of each stack should be banded with 1¼- by 0.035-inch steel straps. The number of straps required depends upon the weight of the containers being strapped together and the length of the containers. One strap should be used for every 8,000 pounds, two straps for containers over 8 feet in length, and three straps for containers over 16 feet in length.

C.4.7.4.2 Cross strapping. The top layer of containers in each load group should be banded together with 1¼- by 0.035-inch steel straps. The number of straps required depends upon the weight of containers being strapped together and the length of the containers. One strap should be used for every 8,000 pounds and at least two straps for containers over 16 feet in length.

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C.4.7.4.3 Tiedown strapping. Load groups should be securely stayed to the platform of the flatcar using 2- by 0.050-inch steel straps marked with the letters "AAR" and with the manufacturer or distributor's name, abbreviated name, registered trade mark, or symbol. All tiedown strapping should have two seals, and each seal should be double crimped. Tiedown straps should be anchored to stake pockets, wherever possible. When this is not possible, anchor points should be of sufficient width to receive a 2-inch strap. Swivel ring-type anchor devices should not be used. Stake pockets should be padded with a stake pocket pad made of 2- by 0.050-inch strap positioned under and sealed to the tiedown strap with one seal. Alternatively, two commercial stake pocket protectors under each stake pocket may be used. Edge protectors should be used under tiedown strapping at the top edges of containers or similar items with sharp edges.

C.4.7.4.3.1 Number. The number of straps required depends upon the weight of the load group and a factor given in table C-XIII. This factor is related to the length of the container and the type of shock mounting of the item within the containers, as follows:

a. Hard item mounting includes bolting and similar rigid mounting of the item within the container.

b. Semi-hard item mounting includes hard rubber mounts, shear mounts, and similar devices which permit limited and damped movements of the item within the container.

c. Soft item mounting includes springs, cushioning, material, and other devices and materials which permit significant and repeated movements of the item within the container.

TABLE C-XIII. Factor for determining number of tiedown straps.

Type of item mounting	Container length	
	Under 10 feet	Over 10 feet
Hard	2.0	1.2
Semi-hard	2.4	1.6
Soft	3.0	2.2

C.4.7.4.3.2 Determining number. To determine the minimum number of tiedown straps required, divide the weight of the load group by 8,000 and then multiply by the appropriate factor in table C-XIII. For fractional results, the next highest number of straps should be used.

C.4.7.4.3.3 Anchor points. When there are an insufficient number of anchor points for the number of tiedown straps required, the strap should be double threaded over the load as follows: thread the strap up through the stake pocket on one side of the car, over the top of the next-to-last layer of containers, down to and through the stake pocket on the opposite side of the car, and back over the top of the load where it is tensioned and doubled sealed.

C.4.7.5 Placards. For explosive loads, placards should be placed on placard boards centrally located on both ends and both sides of the car. If the car is not so equipped, 6- by 24-inch placard boards should be nailed to two 2- by 4- by 24-inch uprights, which should be nailed to dunnage with four 10d nails in each upright.

C.5 EXAMPLE RAILCAR LOAD PLAN

C.5.1 Example railcar load plan. Army Drawing 19-48-8691 is an example load plan for railcar shipment of missile containers.

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C.6 RAILCAR LOAD EVALUATION

C.6.1 Scope. This section covers impact testing of railcar loads of ammunition, explosives, and other dangerous articles (AEDA). This section is intended to establish standard procedures for the railcar impact tests of carloads or less than carloads of unique items of lading and new methods of dunnaging.

C.6.2 Test load (specimen). The test load is prepared using the same blocking and bracing methods specified in the outloading procedures proposed for use with the munitions. The railcar used in the test should be inspected to assure its adequacy for munitions transport. Items used to build the load should be inert (nonexplosive). The weight and physical characteristics of the load configuration should be identical to the live (explosive) ammunition provided for in the outloading procedure; i.e., weights, physical dimensions, center of gravity, materials, etc. The ammunition packages used should duplicate that of the live ammunition.

C.6.3 Railcar impact test. When, in the opinion of the activities listed in 4.2 and the BOE, a proposed carload is considered unique because of the characteristics of the load, structural features of the lading, or the carloading procedures, a railcar impact test should be conducted to prove the safety and adequacy of the proposed carloading plan. Impact tests should be coordinated with MTMCTEA, BOE, and the activities listed in 4.2. The following paragraph gives a brief description of this test.

C.6.3.1 Rail impact test. The test load or vehicle should be positioned in/on a railcar. Equipment needed to perform the test includes the specimen (hammer) car, five empty railroad cars (or equivalent to 250,000 pounds) connected together to serve as the anvil, and a railroad locomotive. These anvil cars are positioned on a level section of track with air and hand brakes set and with the draft gears compressed. The locomotive unit should pull the specimen car away from the anvil cars, push the specimen car toward the anvil at a predetermined speed, and disconnect from the specimen car approximately 50 yards away from the anvil cars, which should allow the specimen car to roll freely along the track until it strikes the anvil. This should constitute an impact. Impacting should be accomplished at speeds of 4, 6, and 8.1 mph in one direction and at a speed of 8.1 mph in the opposite direction. The tolerance for the speeds is +0.5 mph, -0 mph Impact speeds should be determined by using an electronic counter to measure the time required for the specimen car to traverse a specific distance (figure C-35) immediately prior to impact. Between impacts, the anvil railcars should be inspected and the brakes reset if necessary.

C.6.3.2 Failure. Upon completion of tests, there should be no damage to the contents, toppling, or movement of the load likely to produce damage to the contents or to railroad equipment.

C.6.4 Test acceptance criteria. There should be no change in the original physical and functional characteristics of the contained components or assemblies. There should be no indication of any transmission of excessive vibration or shock stresses to any component or assembly. Negligible material damage to the packaging system, such as chipped paint, minute dents, or scratches, should not be deemed to be sufficient cause for rejection.

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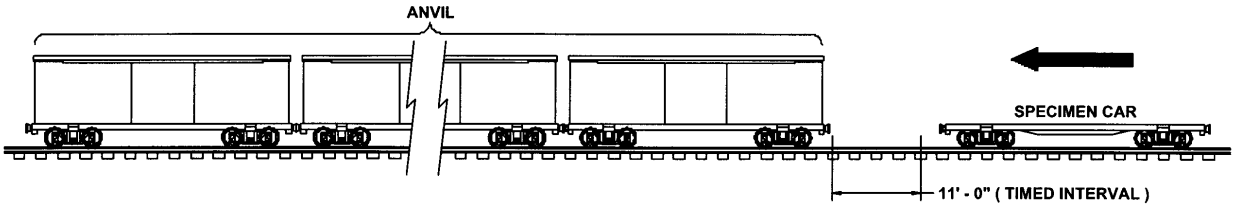
ASSOCIATION OF AMERICAN RAILROADS (AAR)
STANDARD TEST PLAN



4 BUFFER CARS (ANVIL)
WITH DRAFT GEAR COMPRESSED
AND AIR BRAKES IN A SET POSITION

ANVIL CAR TOTAL WT. 250,000 LBS (APPROX)

SPECIMEN CAR IS RELEASED BY
SWITCH ENGINE TO ATTAIN:

IMPACT NO. 1 @ 4 MPH
IMPACT NO. 2 @ 6 MPH
IMPACT NO. 3 @ 8.1 MPH

THEN THE CAR IS REVERSED AND RELEASED
BY SWITCH ENGINE TO ATTAIN:

IMPACT NO. 4 @ 8.1 MPH

FIGURE C-35 Railcar impact test

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LOADING OF AMMUNITION AND EXPLOSIVES IN INTERMODAL CONTAINERS

D.1 SCOPE

D.1.1 Scope. This appendix establishes the approved methods for loading and dunnaging hazardous materials in intermodal containers. This appendix is not a mandatory part of the standard. The information contained herein is intended for guidance only.

D.2 APPLICABLE DOCUMENTS

D.2.1 General. The documents listed in this section are specified in this appendix. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in this appendix, whether or not they are listed.

D.2.2 Government documents.

D.2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this appendix to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

COMMERCIAL ITEM DESCRIPTIONS

A-A-52029 - Container, Cargo, Side Opening

A-A-52032 - Container, Cargo, End Opening

A-A-52033 - Container, Cargo, Open-Top, Half Height

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-138 - Guide to Container Inspection for Commercial and Military Intermodal Containers

(Copies of these documents are available online at http://quicksearch.dla mil.)

D.2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this appendix to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ARMY DEFENSE AMMUNITION CENTER DOCUMENTS

Joint Hazard Classification System (JHCS)

(Copies of this document are available online at https://www3.dac.army mil.)

ARMY DEFENSE AMMUNITION CENTER DRAWINGS

AMC 19-48-4153 - Loading and Bracing with Wooden Dunnage in End Opening Containers of Boxed Ammunition and Components on 4-way Entry Pallets and Skid Bases

AMC 19-48-4906 - Loading and Bracing Procedures for Ammunition Loaded on Container Roll in/out Platform (CROP) – Basic Procedures

DA-116 - Aft End Load Restraint in End Openings ISP Containers Using Universal Load Retainers, Door Post Vertical Retainers, or Welded Load Retainers

(Copies of other Army Defense Ammunition Center drawings are available online at https://www3.dac.army mil/DET/order/draworder.html.)

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CODE OF FEDERAL REGULATIONS (CFR)

49 CFR 174.101	-	Carriage by Rail, Loading Class 1 (Explosive) Materials
49 CFR 393.100	-	Parts and Accessories Necessary for Safe Operation, Which Types of Commercial Motor Vehicles Are Subject To the Cargo Securement Standards of this Subpart, and What General Requirements Apply?

(Copies of these documents are available online at http://www.ecfr.gov.)

DEPARTMENT OF DEFENSE PUBLICATIONS

DoD 4140.65-M	-	Issue, Use, and Disposal of Wood Packaging Material (WPM)

(Copies of this document are available online at www.dtic mil/whs/directives/.)

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

Voluntary Product Standard PS 20-10	-	American Softwood Lumber Standard

(Copies of this document are available online at http://gsi nist.gov/global/index.cfm/L1-5/L2-44/A-355.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

SW020-AG-SAF-010	-	Navy Transportation Safety Manual for Ammunition, Explosives and Related Hazardous Materials

(Copies of this document are available online at https://nll.ahf nmci navy mil, may be requested by phone at 215-697-2626, or may be requested by email at nllhelpdesk@navy mil.)

D.2.3 Non-Government publications. The following documents form a part of this appendix to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN ASSOCIATION OF RAILROADS

Intermodal Loading Guide for Products in Closed Trailers and Containers

(Copies of this document are available online at https://www.aarpublications.com/.)

ASTM INTERNATIONAL

ASTM D3953	-	Standard Specification for Strapping, Flat Steel and Seals
ASTM D5728	-	Standard Practices for Securement of Cargo in Intermodal and Unimodal Surface Transport
ASTM F1667	-	Standard Specification for Driven Fasteners: Nails, Spikes, and Staples

(Copies of these documents are available online at www.astm.org.)

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

ISPM 15	-	Guidelines for Regulating Wood Packaging Material in International Trade

(Copies of this document are available online at http://www.maff.go.jp/pps/j/konpozai/pdf/ISPM_15_English_2006.pdf.)

D.2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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D.3 GENERAL GUIDANCE

D.3.1 General. This section covers the general guidance for the safe transportation of Department of Defense (DoD) hazardous materials in intermodal containers.

D.3.2 Container general descriptions.

D.3.2.1 Typical end-opening steel container (see figure D-1). The most common type of freight container is the general purpose dry cargo type that completely encloses its contents by permanent steel structures and provides cargo loading access through end-opening doors. Typical steel containers can be 10, 20, 30, or 40 feet long by 8 or 8½ feet high. The standard width of an intermodal container is 8 feet. The walls of a typical steel container are usually constructed of corrugated sheet steel panels that are welded to the main structural steel top and bottom side rails and end frames. The end frames are fitted with standard corner fittings (steel castings) at all eight corners that are welded to the four corner posts, top and bottom side and front rails, and rear door sill and header. The roof is usually constructed of either flat or corrugated sheet steel panels welded to the top side and end rails and door header and may have roof bows for support. The doors are usually either shaped steel frame with steel panels or plymetal (steel faced wood) panels fitted with locking and anti-rack hardware and weather-proof seals (gaskets). The flooring may be soft or hard laminated woods, planking, plywood, or composition material either screwed or bolted to the floor cross members. The floor cross members may be box, C, Z, or I shaped steel beams bolted or welded to the bottom side rails. Some containers are configured with all-steel flooring or a combination of wood and steel. An intermodal freight container is primarily all-steel flooring or a combination of wood and steel. An intermodal freight container is primarily handled via connection with its internationally standard corner fittings; however, many steel containers are also provided with empty and loaded capacity forklift pockets to improve container handling versatility. Performance specifications for a typical end-opening steel container are provided by A-A-52032.

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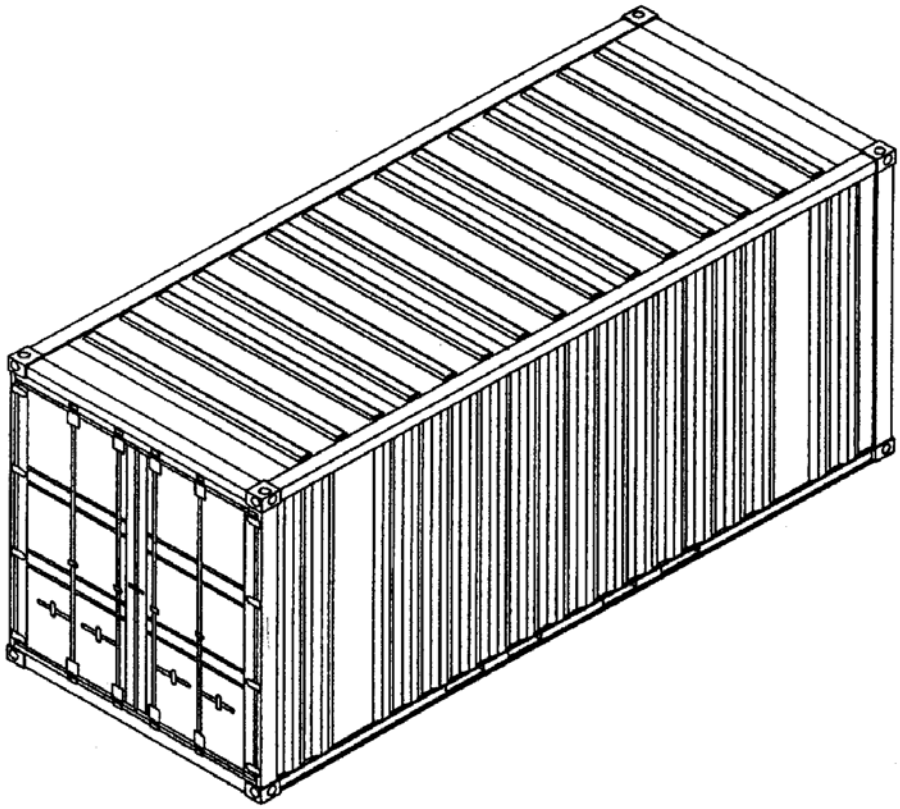

FIGURE D-1. Typical end-opening steel container.

D.3.2.2 Typical end-opening aluminum container (see figure D-2). A typical end-opening aluminum container, often referred to as an aluminum/steel container, usually has steel end frames and structural steel or extruded aluminum side rails. The end frames are fitted with standard corner fittings (steel castings) at all eight corners. The walls are constructed of either interior or exterior intermediate aluminum posts to which sheet aluminum is riveted or welded. The inside walls usually have a plywood liner either riveted to the intermediate posts or over top the sheet aluminum. The door panels are either aluminum post and sheet construction or plymetal (metal faced wood) construction and are fitted with steel locking and anti-racking hardware and weather-proof seals (gaskets). Roof bows, that support the aluminum roof panels, are usually aluminum extrusions that are bolted, riveted, or welded to the top rails. The floor cross members may be box, C, Z, or I shaped beams of either steel or aluminum that are bolted, riveted, or welded to the bottom side rails. The flooring may be soft or hard laminated woods, planking, or plywood either screwed or bolted to the floor cross member. The nominal dimensions and many construction details are otherwise similar to those of steel end-opening containers.

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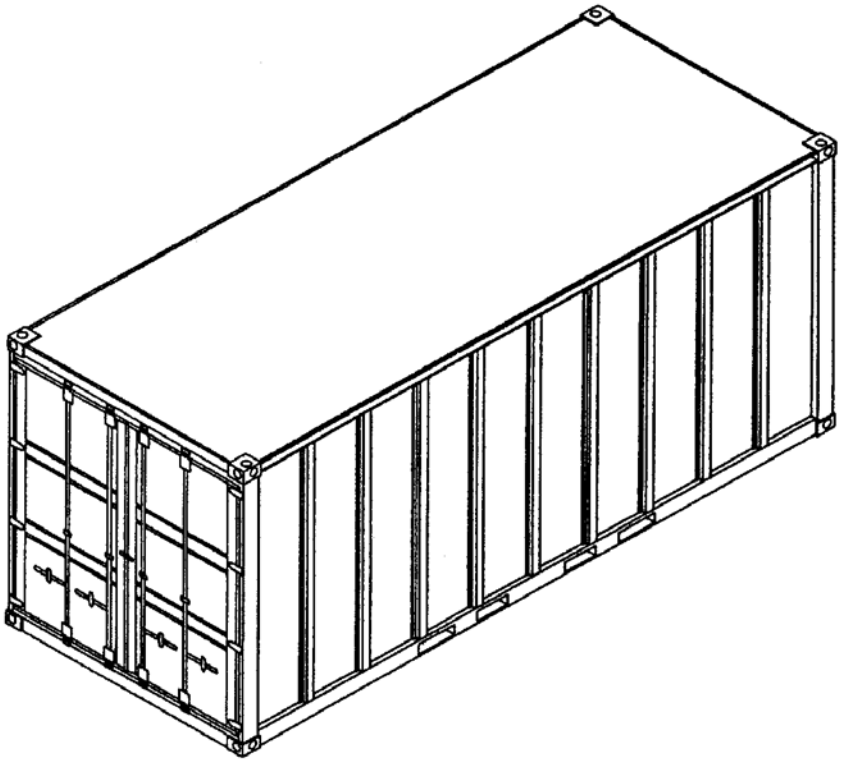

FIGURE D-2. Typical end-opening aluminum container.

D.3.2.3 Typical end-opening fiberglass reinforced plywood (FRP) container (see figure D-3). A typical end-opening FRP container is usually constructed of structural steel framing; fitted with standard corner fittings (steel castings) at all eight corners; and has FRP panels on the side walls, front end wall, and roof. Normally there are no roof bows used to support the roof panel. The FRP panels are usually imbedded in mastic, to provide water tightness, and are riveted to the top and bottom rails and the corner posts. The door panels are also constructed of FRP and are fitted with steel locking and anti-rack hardware and weather-proof seals (gaskets). The floor cross members may be box, C, Z, or I shaped beams. The flooring may be soft or hard laminated woods, planking, or plywood either screwed or bolted to the cross members. The nominal dimensions around many construction details are otherwise similar to those of steel end-opening containers.

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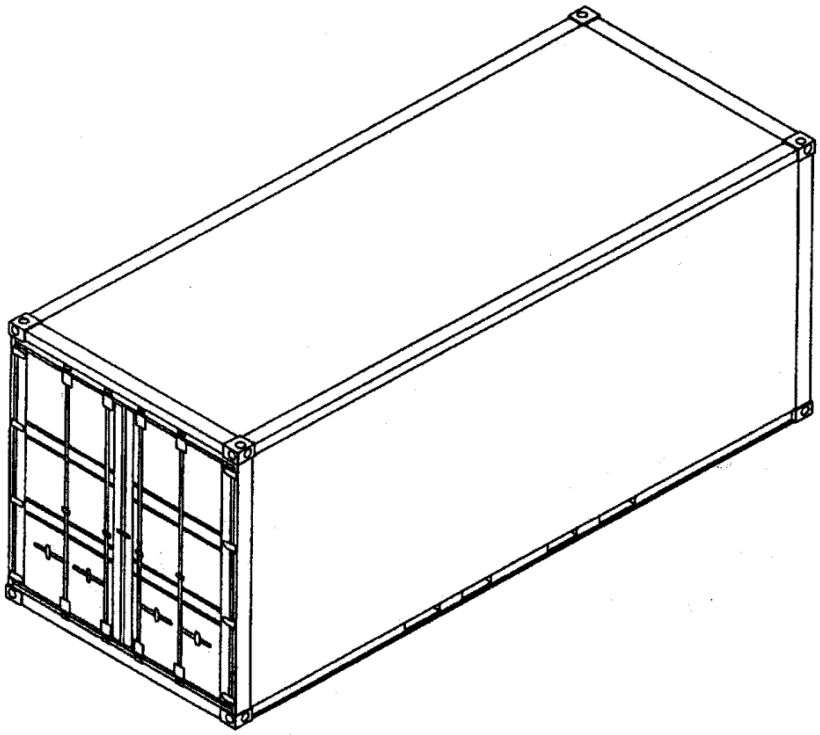

FIGURE D-3. Typical end-opening FRP container.

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D.3.2.4 Typical side-opening container (see figure D-4). A side-opening container is similar in many respects to a typical steel end-opening container except there are doors on the side to provide access to the cargo space and the bottom side rails usually have a deeper profile. There may or may not be doors in the end frame of the container. Performance specifications for a typical side-opening container are provided in A-A-52029.

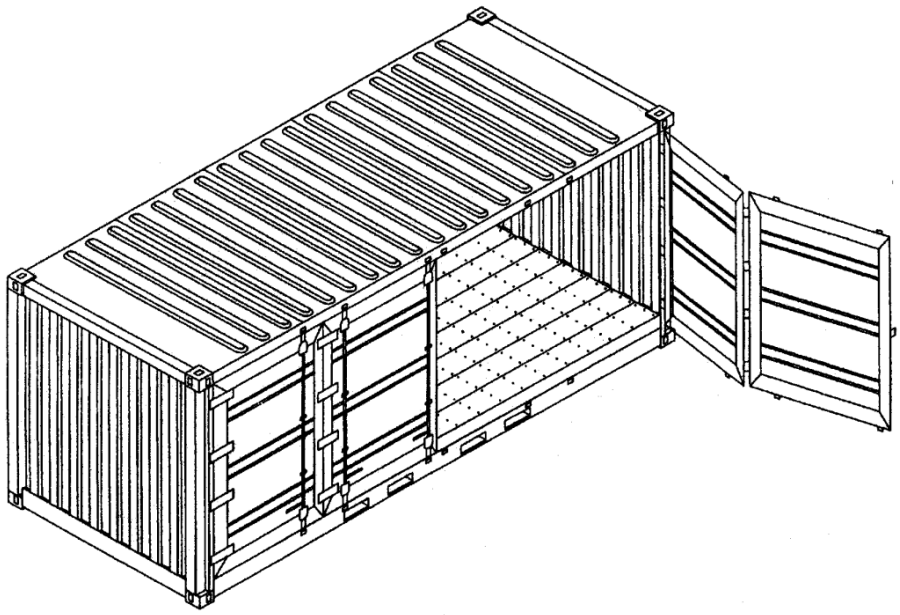

FIGURE D-4. Typical side-opening container.

D.3.2.5 Typical open-top container (see figures D-5 and D-6). An open-top container is similar in all respects to a typical steel container except it has no rigid roof, but instead has a flexible or removable cover. The removable cover (tarp) is usually made of canvas or reinforced vinyl material and is supported on movable or removable roof bows. The tarp has reinforced eyelets in the perimeter that fit nest over corresponding loops welded to the top rails of the container. The tarp is secured by a plastic sheathed wire rope threaded through the welded steel loops. An open-top container may also have a movable or removable door header to facilitate access to the cargo. In some open-top containers, the end door opens downward to function as a loading ramp. Some open-top containers have all steel floors. Three typical heights for open-top containers are 4 feet 3 inches high (half high), 5 feet 8 inches high (two-thirds high), and 8 feet 6 inches (full high). Performance specifications for a typical half-high open-top container are provided in A-A-52033.

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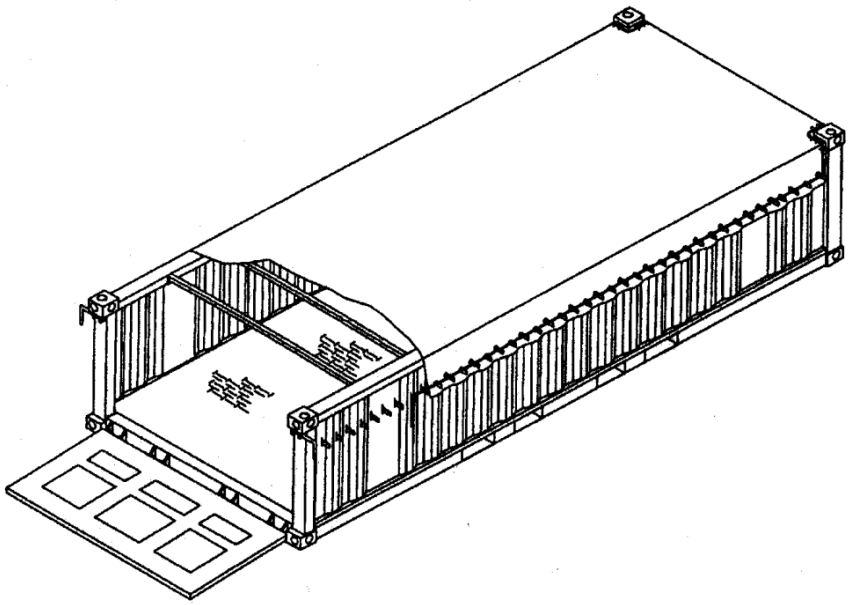

FIGURE D-5. Typical ½-high open-top container.

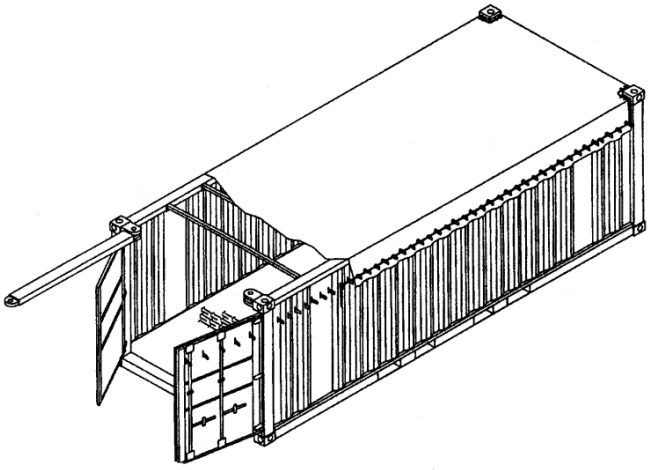

FIGURE D-6. Typical ⅔-high open-top container.

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D.3.2.6 Typical flatrack container (see figure D-7). The nominal dimensions and many construction details of a flatrack container are similar to those of a typical steel container except it does not have rigid side walls or a roof structure. A flatrack container is configured with eight internationally standard corner fittings, a substantial platform (understructure), and two end wall assemblies that may either be of fixed construction or folding design. Flatracks used to ship ammunition must have paneled end walls. Components of the flatrack container such as the lower rails of the platform and the corner posts of the end wall assemblies are of a heavier construction than the corresponding components of a closed type container. Stake pockets (stanchions) and cargo tiedown provisions are usually provided along the side rails to facilitate blocking and bracing of cargo. The flooring is usually either soft or hard wood planking that is specially treated and either screwed or bolted to the cross members. The planking may be intentionally configured with gaps between boards to allow drainage. A flatrack container does not provide weather protection.

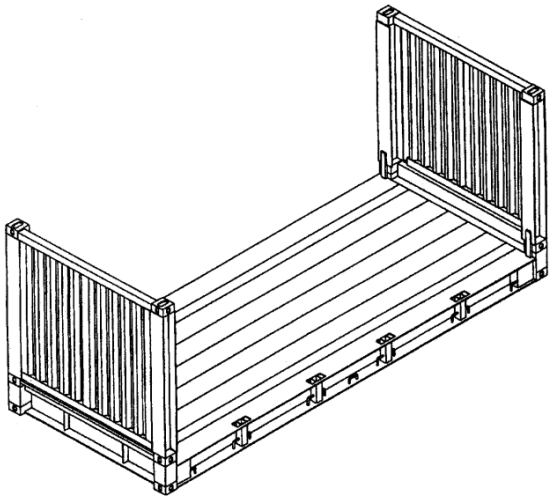

FIGURE D-7. Typical flatrack container.

D.3.2.7 MILVAN (see figure D-8). A MILVAN is an intermodal freight container with nominal dimensions of 8 feet wide by 20 feet long. A MILVAN can be a Type I (8 feet high with plywood liner), Type II (8 feet high with mechanical restraint system), Type III (8½ feet high with plywood liner), or Type IV (8½ feet high with mechanical restraint system). Only Types II or IV of MILVANs may be used to transport hazardous material. The inside of the container measures 91¾ inches wide, 87 inches high, and 131 inches long. The door opening at the rear of the container measures 83½ inches high by 89½ inches wide. New loads should not be designed for MILVANs as they are no longer being procured.

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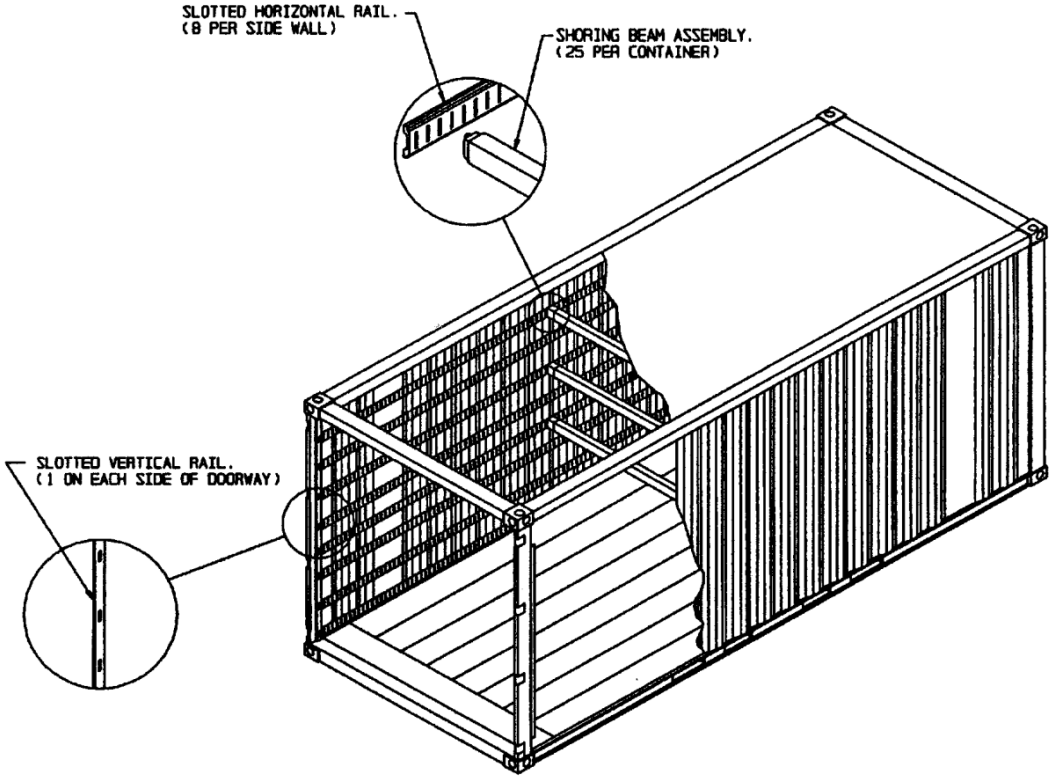

FIGURE D-8. Mechanical restraint system for MILVAN.

D.3.2.7.1 Rails. The rails of the mechanical load-bracing system are welded to the left and right side walls of the MILVAN container at eight different heights from the container floor (5, 16, 28, 38, 48, 60, 72, and 83 inches). Each rail contains 114 slots on 2-inch centers into which load-bracing beam assemblies (crossmembers) are secured from side-to-side across the container. Each container is equipped with 25 crossmembers. The forward end of the container is lined with plywood as is the interior surface of the doors. The floor is of wooden planking fastened to structural steel beams extending from side to side.

D.3.3 Load shifting. Care should be taken to assure that the overall load is secured in such a way that none of its incremental parts can shift during transit. Under normal transportation conditions, loads are subjected to forces exerted vertically, laterally, and longitudinally. Consequently, loads should be blocked and braced within the intermodal container to prevent shifting under these forces.

D.3.3.1 Highway loads. Forces exerted upon loads during transit occur in varying degrees and from different causes, depending on the mode of travel. On highways, longitudinal forces exerted in the forward direction are caused primarily by braking on steep descents or by sudden stops. Forces exerted in a rearward direction are caused primarily by ascension of steep hills or load rebound after a sudden application of braking. Lateral forces occur when rounding corners or sharp curves, when traveling on high-crowned or banked roads, and when swerving. Vertical forces are caused by vibration traveling over rough terrain.

D.3.3.2 Rail loads. On railways, longitudinal forces are much more severe than those occurring laterally and vertically. Longitudinal forces are induced while coupling cars, humping them in marshalling yards, and by changes of slack within a long train. Some lateral forces are experienced when rounding curves but to a much lesser degree. Similarly, vertical forces are primarily limited to vibration.

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D.3.3.3 Ship loads. Forces exerted upon loads aboard ships can be severe in all directions, particularly during transit in rough seas. Both longitudinal and vertical forces are induced primarily by a movement of the ship called pitch; whereas lateral forces are induced by a movement called roll. At sea, forces occur randomly, simultaneously, and over a wide range of magnitudes.

D.3.3.4 Load factors. These load factors meet or exceed the g levels specified in ASTM D5728. As a guide, these forces can be summarized in each of the following directions (relative to the longitudinal axis of the vehicle) by multiplying the load weight by the g levels below:

a. Downward – 1.80 g

b. Longitudinal – 1.80 g

c. Lateral – 1.0 g

D.3.4 Prevention of load shifting. Load movement is prevented by careful application of the following fundamental principles:

a. A loading plan should be developed in which the commodity to be shipped will be distributed systematically throughout the intended stowage area within the intermodal container.

b. Each individual item to be shipped should be placed in such a manner that the overall load will be tight.

c. The proper dunnage components and structures should be utilized to block and brace the load so that forces exerted during transit will not cause the load to move in any direction.

D.3.4.1 Tight loads. If the load is not tight, or is out of alignment, or is improperly distributed, the load might shift when subjected to the forces existent during transit. When the load is tight, properly aligned, and evenly distributed, the use of dunnage, such as crossmembers, filler assemblies, separator gates, sway braces, hold-down assemblies, and various dunnage pieces properly placed and fastened will prevent load movement in any direction.

D.3.4.2 Forward restraint. Forward movement of lading is prevented by crossmembers fastened across the forward end of a bay in the intermodal container. The crossmembers serve as a bulkhead which allows even distribution of load pressures across the forward end of the bay, as well as providing a strong bearing surface which squares the forward end of the load.

D.3.4.3 Wood blocking. Longitudinal and lateral movement can be prevented by blocking installed at the base of unit loads within the overall load pattern. Side blocking, for example, of adequate lumber stock cut to appropriate size and fastened to the container floor so as to bear against the base of the load will serve to prevent shifting. Vertical movement is prevented by tomming the load with hold-down assemblies constructed to suit the load configuration and held in place by structures positioned to take a vertical load, by the crossmember itself or other methods (see D.3.5).

D.3.5 Shipping modes. Intermodal containers are used for transporting hazardous materials in several different shipping modes, as follows:

a. Public highway

b. Nonpublic roads, such as depot roads

c. Rail

d. Water

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D.3.5.1 Public highway. Intermodal containers are authorized for transport of hazardous materials over public highways when assembled on an intermodal chassis or on suitable commercial equipment. Both should be pulled by a tractor of adequate capacity. The containers may be shipped in various configurations, depending primarily upon its gross weight when loaded. For instance, a loaded 20-foot intermodal container may be transported over public highways on a 20-foot intermodal chassis; or two 20-foot intermodal containers may be transported over a 40-foot coupled intermodal chassis. The chassis should be equipped with double-bogies regardless of the gross weight of the load. Trailerized in this manner, the intermodal container/chassis may be pulled by either a single-drive-axle or double-drive-axle tractor, depending upon load weight. Intermodal containers, as previously indicated, can also be shipped on commercial equipment providing the equipment is of appropriate capacity to safely accommodate the gross weight of the container(s) and the securement devices which fasten the container to the chassis meet the requirements of 49 CFR 393.100.

NOTE: The net weight in single containers on an intermodal chassis with double-bogies is limited to 34,000 pounds. The net weight with two containers on coupled intermodal chassis with double-bogies is limited to 18,000 pounds per container.

D.3.5.2 Rail. Intermodal containers may be shipped by railcar in either of two ways, container on flatcar railcars (COFC) or trailer on flatcar railcars (TOFC). Only the intermodal chassis is approved for shipping the intermodal container TOFC. The regulations of the Department of Transportation (DOT) require that the efficiency of both the bracing of the lading in the container and the securement of the container or the intermodal chassis on the railcar be determined by actual impact testing. Therefore:

a. All drawings which provide instructions for loading hazardous materials in intermodal containers intended for shipment by COFC or TOFC should state, “APPROVED FOR RAIL SHIPMENT” or indicate this is a similar prominent manner.

b. Intermodal containers may be shipped only on those COFC railcars that meet the requirements of 49 CFR 174.101.

c. Intermodal containers on intermodal chassis may be shipped only on those TOFC railcars that meet the requirements of 49 CFR 174.101.

d. When shipping the TOFC, the following configurations are authorized:

(1) One container on 20-foot intermodal chassis equipped with double-bogies.

(2) Two containers on 40-foot coupled intermodal chassis equipped with double-bogies. The 40-foot configuration, the container/chassis should be placed at the B-end of the TOFC railcar. The rear end of the 40-foot unit will overhang the end of the car if it is placed at the A-end. Twenty-foot and 40-foot units can be loaded on the same car.

D.3.5.3 Water. Intermodal containers are designed for shipment by water primarily aboard containerships. These ships have specially constructed holds with cell guides and decks with special fittings for stowage of containers. Transfer of the container between piers and containerships should be accomplished by specially designed handling equipment.

D.3.6 Shipping regulations. When planning to load and ship hazardous materials in intermodal containers, consideration should be given to type, size, weight, and the DOT hazard classification of the intended loading.

D.3.6.1 Hazard classification. In determining the DOT hazard classification for an intended lading, the aforementioned tariffs or SW020-AG-SAF-010 should be referred to. If the hazard classification of the item is not clear after consulting these references, it can be obtained by contacting the NOSSA, Washington, DC, or the JHCS.

D.4 DETAILED GUIDANCE

D.4.1 Preloading inspection of intermodal containers. Prior to loading, intermodal containers should be swept clean, all protruding nails should be removed, and qualified personnel should perform the following inspection procedures:

a. Inspect weather seals of doors for damage or distortion.

b. Check the doors for loose, worn, or damaged hinges, latches, levers, bolts, nuts, and pins, and document holder.

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c. Check steel roof, sides, ends, and doors for holes, tears, and punctures.

d. For MILVAN only: Inspect the general condition of the mechanical bracing systems. Assure that all 25 crossmembers are present. Inspect belt rails for firm attachment to side wall and any condition that would prevent proper attachment of a crossmember. Examine crossmembers for distortion and condition of end fittings that would prevent proper engagement in the rails.

e. Inspect the general condition of the corner fittings, corner parts, and structural rail members for deformation or otherwise unserviceable conditions.

f. Inspect painted surfaces for deterioration from damage and exposure.

g. Inspect the floor to make sure it is tight and free of holes. Inspect the floorboards and threshold plate for warped, broken, or any damaged condition.

h. MIL-HDBK-138 should be referred to for further inspections and procedures.

D.4.2 Loading procedure. Hazardous materials usually are loaded into intermodal containers in the form of palletized unit loads designed for handling by forklift trucks. The load pattern for unit loads of a given commodity should be determined prior to loading, with the type, size, and weight of the unit loads being of prime importance. The means most commonly used to determine load pattern within the intermodal container are:

a. Balance. Center of balance should be within 12 inches, in either direction, of the midpoint of the container.

b. Weight. The maximum weight of the lading depends on the shipping modes involved. For most cases the public highway will restrict the weight of lading. For highway transportation, the lading should not exceed 40,000 pounds.

D.4.2.1 Detailed instructions. The detailed instructions given in the drawings should be followed for loading and dunnaging intermodal containers. Each sheet provides instructions for loading a particular kind of unit load. These instructions include illustrations which clearly show the load pattern and dunnaging of the unit loads. Also provided are data concerning the unit load and the overall container load, such as dimensions, weights, cube, hazard classification, and a list of the materials required for accomplishing the required blocking and bracing, including nails, strapping, lumber, etc.

D.4.3 Dunnage materials. Dunnaging materials in intermodal containers should be equipped with a mechanical load-bracing system consisting of crossmembers, which are provided with the container, lumber, fasteners, strapping, and occasional pieces of plywood used as shims and spacers. Specially designed dunnaging should be approved by the activities listed in 4.2.

D.4.3.1 Lumber. All lumber used should be yard lumber conforming to Voluntary Product Standard PS 20-10. All wood packaging material (WPM), including new stock, should meet the United Nations (UN), International Plant Protection Commission (IPCC) restrictions regarding solid WPM, in accordance with the requirements of ISPM 15. The following heat treatment process has been approved by the American Lumber Standards Committee (ALSC) and should be used for all non-manufactured WPM. WPM should be constructed from heat treated (HT) (HT to 132.8 °F [56 °C] for 30 minutes) lumber and certified by an accredited agency recognized by the ALSC in accordance with WPM policy and WPM enforcement regulations (http://www.alsc.org). All WPM should include certification markings in accordance with the ALSC standards and should be placed in an unobstructed area that will be readily visible to inspectors. The certification marking should be applied in a visible location on at least two sides of a WPM product or assembly. On dunnage, the marking should be applied to the opposite surfaces of each piece in a location that will be visible (if possible) when the dunnage is placed in the load to enable inspectors to verify WPM's compliance without unloading or unstuffing the container. DoD activities should follow the WPM compliance requirements of DoD 4140.65-M, which includes supply chain processes, management controls, and training requirements. Reclaimed dunnage lumber may be used provided there are no splits, cracks, or knots in the wood and all nails have been removed. Nail holes are acceptable as long as they have not caused splits in the lumber and the wood remains structurally sound.

WARNING: Failure to comply with the requirements of this WPM restriction may result in refusal, destruction, or treatment of materials at the point of entry, possibly causing unacceptable delay in delivery of needed parts.

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D.4.3.2 Fasteners. Nails should be used as fasteners for dunnaging hazardous material unit loads in intermodal containers. Nails should be in accordance with ASTM F1667, Type I, Style 10, common-bright, unless otherwise indicated on the drawing. The proper selection of nails will ensure the necessary holding power without the risk of splitting the lumber and affecting the integrity of the dunnage structures. Some general rules for nail selection and application, which have gained general acceptance in dunnaging practice, are listed below.

a. All nailing should be into the side grain of the lumber; end grain nailing should be avoided. Plenty of nails should be used. Balanced nailing is important. Nails should be staggered along the piece being nailed. Do not nail along one grain of wood. Whenever possible, drive nails straight; do not toenail unless called for in the drawing.

b. Nails should be of such length as to give the necessary holding power and ample penetration into floors or bracing and blocking. To obtain the most holding power, nails should be of such length that they nearly penetrate but do not protrude through the timber holding the point of the nail. Nails should not be so large as to cause splitting. The general rule of thumb is that the nail should be three times as long as the thickness of the piece holding the head of the nail, but the nail point should not protrude beyond the second piece unless clinching is required. Intermodal Loading Guide values from table B-IX should be used when nailing to container floor.

c. Generally, no nail should be driven closer to the end of a piece of lumber than the thickness of that piece, or closer to the edge than half the thickness of the piece holding the nail head.

d. When pieces are of different thicknesses, the nail head should be in the thinner piece.

e. When the density of the wood dunnage is such that diamond-point nails cause splitting that could weaken the dunnage structures, the nails should be blunted before use.

f. Ideally, nail heads should be set flush with the nailing surface, but if deeper penetration occurs, it should not be more than one-eighth the thickness of the piece retaining the head.

g. When driving nails near hazardous materials, extreme care should be taken to ensure that the nails are not directed, or are likely to be deflected, toward or into the packaging or hazardous material.

h. Dunnage should never be nailed directly to the lading.

i. Pieces which are end nailed and which are used as a supporting structure should always be reinforced by cleats.

D.4.3.3 Strapping. Steel strapping should be used as dunnage in intermodal containers primarily for tomming unit loads so that effects of vertical forces will not cause load movement. Steel strapping should also be used to secure the lading to flat-rack containers.

D.4.3.3.1 Material. All steel strapping should be new (unused) material in accordance with ASTM D3953. Strapping should be Type I (heavy-duty) (flat), Finish A, B (Grade 2), or C. The size (width and thickness) of strapping should be as specified by the drawing. All strapping should be dry (unwaxed) strapping.

D.4.3.3.2 Seals. All seals used to join the ends of steel strapping should be in accordance with ASTM D3953. Seals should be Class H (heavy duty), Finish A, B (Grade 2), or C, Style I, II, or IV. The style of seal used should be selected for compatibility with the tensioning and sealing tools being used. Seal width should be the proper width for the size of strapping being used.

D.4.3.3.3 Joints. All strap joints should consist of either two seals butted together with two pair of crimps per seal or one seal with two notches. Splicing to obtain strapping length should not be permitted.

D.4.3.3.3.1 Hand-operated notch tools. When using hand-operated tools to create notched-seal joints, each seal should be visually inspected to ensure that all of the following conditions are met:

a. The strapping and seals are manufactured to the proper specifications (see D.4.3.3.1 and D.4.3.3.2).

b. The ends of both straps joined by the seal are visible on either end of the seal.

c. Each seal consists of two notches which are approximately centered and equally spaced on the seals.

d. The bottom surface of the notch is offset at least ⅛ inch from the bottom surface of the seal; or approximately four times the thickness of the strapping. This condition creates a separation between the leading edge of the notch and the balance of the seal. A properly functioning sealer tool should accomplish this if the person using the tool closes the handles all the way when creating the notch.

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D.4.3.3.3.2 Power equipment. When using power tensioning and sealing equipment, the manufacturer's air pressure and lubrication recommendations should be maintained at all times. Each seal should be visually inspected to ensure that D.4.3.3.3.1.a through D.4.3.3.3.1.d are met.

D.4.3.3.4 Authorized weight of lading per strap. The maximum authorized weight of lading per strap is shown in table B-VI. The 2- by 0.044-inch and 2- by 0.050-inch strapping is used for lading tiedowns. The 1¼- by 0.031-inch and 1¼- by 0.035-inch strapping is used for bundling. If 2-inch wide strapping is not available, the 1¼-inch wide strapping can be used for lading tiedowns. The number of straps should be increased to meet the criteria given in D.4.3.5.1. One tiedown is considered a strap that passes over the lading and is attached to both sides of the trailer.

D.4.3.3.5 Crimping/notching strap seals. Strap seals should be carefully crimped/notched to ensure that the joint develops at least 75 percent of the minimum breaking of the strap shown in table B-VI, as required in ASTM D3953.

D.4.3.3.5.1 End-over-end lap joint. When steel strapping is sealed at an end-over-end lap joint, a minimum of one seal with two pair of notches should be used to seal the joint when a notch-type sealer is used. A minimum of two seals, butted together with two pair of crimps per seal should be used to seal the joint when a crimp-type sealer is being used (see figure D-9).

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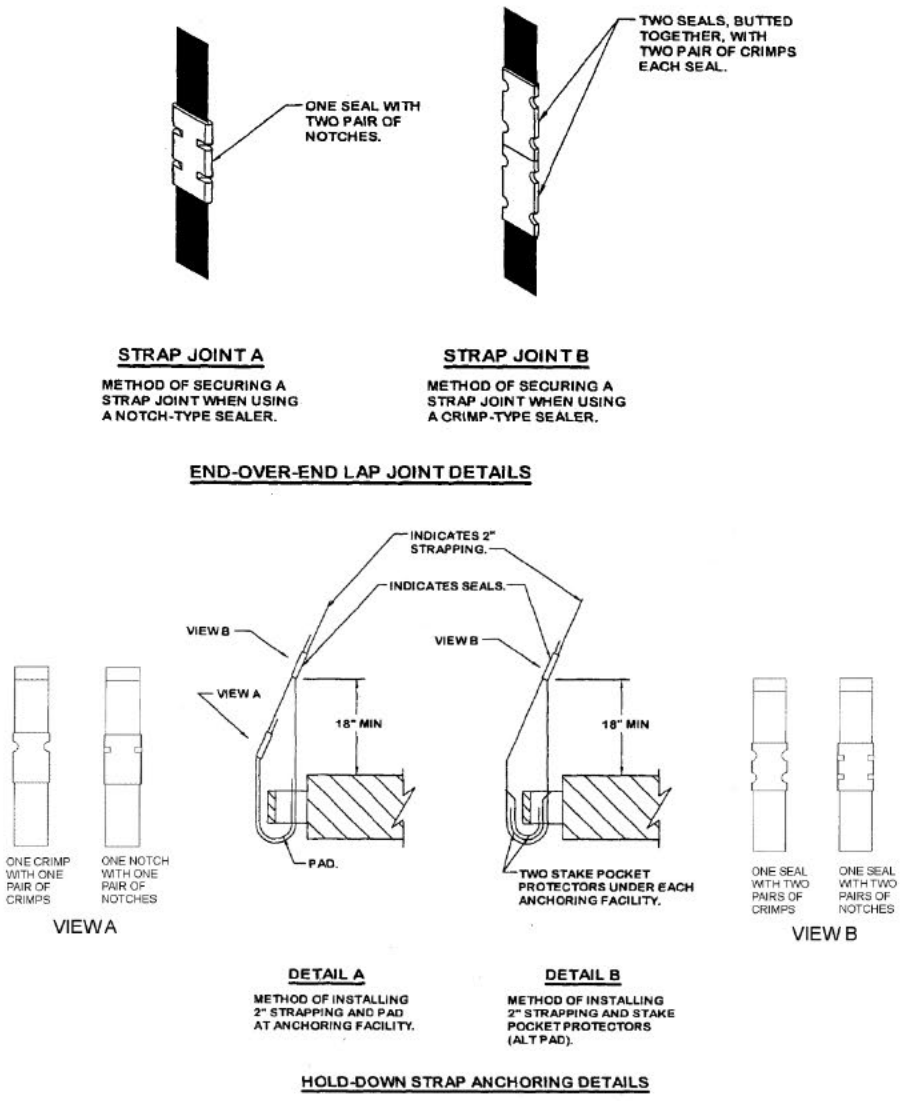

FIGURE D-9. Tiedown strapping.

D.4.3.3.5.2 Flat-rack attachment points. When steel strapping is sealed at the joint produced when the strap is looped around the flat-rack attachment points and back to itself, a minimum of one seal with two pair of notches should be used to seal the joint when a notch-type sealer is used. A minimum of one seal with two pair of crimps should be used to seal this joint when a crimp-type sealer is being used.

D.4.3.3.5.3 Flat-rack strap interface. When steel strapping is looped around the flat-rack attachment member or flat-rack outer edge, a short piece of strapping (approximately 18 inches) should be used to protect the load-bearing strap from the possible sharp edges of these interfaces. This piece of strapping should be secured to the load-bearing strap with one seal and either a single notch or a single crimp (see figure D-9).

D.4.3.4 Weight of strapping. See table B-VII to estimate the weight of steel strapping.

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D.4.3.5 Tiedown strapping on vehicles.

D.4.3.5.1 Determining number and size of straps. The total weight of the lading to be strapped down to the vehicle should be determined. Divide this number by the maximum load per strap of the strap size proposed to be used (see table B-VI). The result will be the number of straps required. A minimum of two straps per bay, layer, unit load, or single container load should be used. An additional strap should be used for each additional portion of 10 feet length for lading over 10 feet long.

D.4.3.5.2 Application. The approved method of applying tiedown straps is illustrated on figure D-9. It is preferred to position, tension, and double crimp/notch the strap seal(s) at the top of the load, if practicable. The hold down straps should be attached to the rub rail/stake pocket framework first. The two straps should be joined together at the top of the lading.

D.4.4 Dunnage structures. The dunnage structures described in the following paragraphs are recommended for blocking, bracing, and tomming unit loads of hazardous materials in intermodal containers. Illustrations show the manner in which the structures are fabricated, identify their component parts, and display their application. Detailed dimensions of the structures and wood sizes are not provided since there is a wide variation in dimensions, as dictated by the size, weight, and configuration of the lading. Dunnage structures should be constructed and installed in intermodal containers in accordance with instructions provided in applicable drawings.

D.4.4.1 Crossmembers for MILVAN containers. Crossmembers are a part of the mechanical load-bracing system of MILVAN containers, 25 being supplied with each container, and as such are the only dunnage structures not requiring fabrication. These metal members span the width of the container at eight different heights at any of 114 locations along the length of the container which suits the desired load pattern. End fittings of the crossmembers should lock securely into slots in belt rails mounted 5, 16, 28, 38, 48, 60, 72, and 83 inches above the floor on the container sides. The slots, numbering 114 in each belt rail, should be spaced 2 inches on-center, thus affording a wide range of crossbeam positions in the horizontal plane. Crossmembers should always be installed in opposite slots of the corresponding belt rails.

D.4.4.1.1 Longitudinal restraint. Primarily, crossmembers are used across the forward and rearward sides of each unit load stack to prevent longitudinal movement of the loads. Crossmembers should be installed in accordance with directions given in the applicable drawing, which specifies the number of crossmembers to be used and the positions, vertically and horizontally, where the crossmembers should be installed in the intermodal container. Placement of the unit loads, which is described in the drawings, may occur in any of three typical applications, as follows:

a. The load(s) evenly distributed across the full length of the crossmember, as shown on figure D-10.

b. The load(s) bearing along the central portion of the crossmember for a length approximately equal to one half the width of the container, as shown on figure D-11.

c. The load(s) bearing on the end portions of the crossmember along lengths approximately one third the width of the container, as shown on figure D-12.

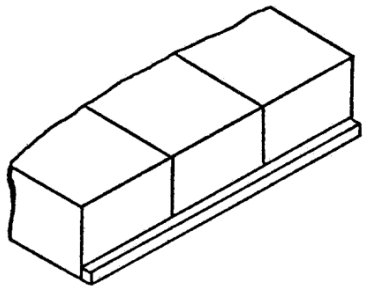

FIGURE D-10. Load(s) evenly distributed across full length of crossmember.

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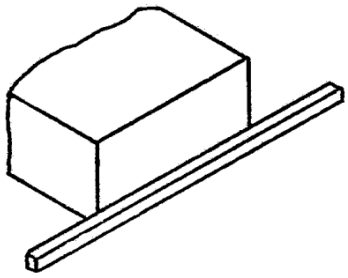

FIGURE D-11. Load(s) concentrated in central portion of crossmember, one-half container width.

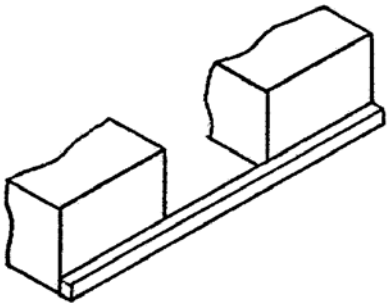

FIGURE D-12. Load(s) concentrated on end portions of crossmember, one-third container width.

D.4.4.1.2 Load rating. The maximum allowable load rating for crossmembers varies with the type of load application and the weight of the load. If a load rating for a single crossmember is exceeded, double crossmembers should be employed. Similarly, when the load rating for a double crossmember is exceeded, triple crossmembers should be used. Figure D-13 shows each of the fundamental load applications and the maximum allowable load ratings for single, double, and triple crossmembers. Double and triple crossmembers should have filler between each member and should be secured with wire ties at not less than three locations.

CAUTION: When positioning crossmembers, make a visual check to ensure that the crossmembers are locked securely in place.

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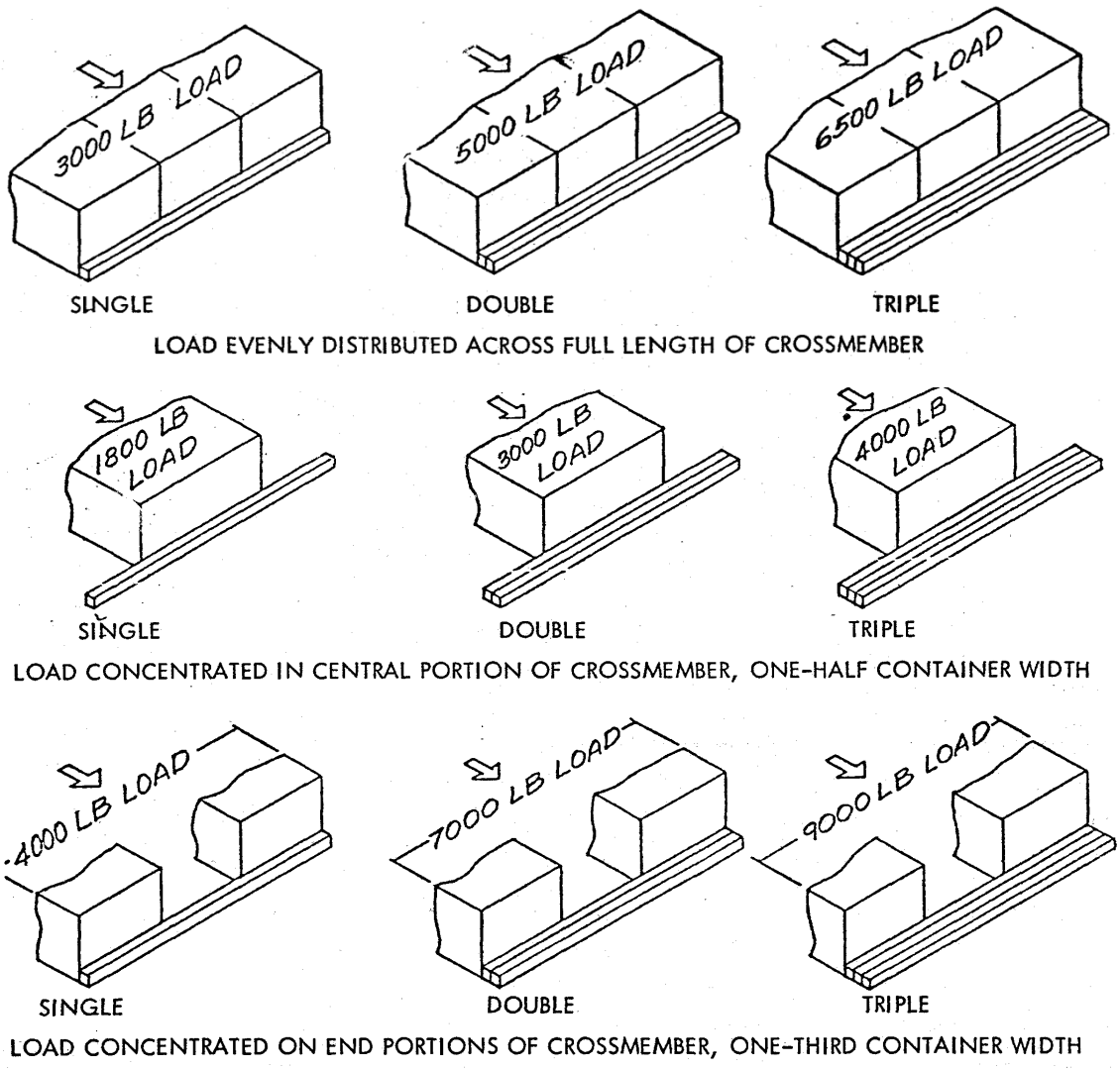

FIGURE D-13. Maximum allowable load ratings for single, double, and triple crossmembers.

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D.4.4.1.3 Voids. When a space between a crossmember and adjacent unit loads or adjacent dunnage structures exceeds 1 inch, fill material of suitable length and thickness should be used to shim the void. The fill material should be wire-tied to the crossmember in a manner similar to that shown on figure D-14.

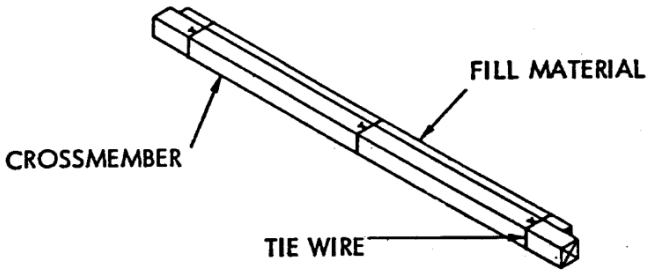

FIGURE D-14. Fill material.

D.4.4.1.4 Hold-downs. Crossmembers also are used as hold-down devices to prevent upward movement of the unit loads. This application of crossmembers is described under tomming (see D.4.5.2.2).

D.4.4.2 Separator gate. Separator gates (see figure D-15) are prefabricated dunnage structures of 1- by 6-inch or 2- by 6-inch stock, placed against crossmembers to provide bearing surfaces for unit loads whose hard points (designed bearing surfaces of the load) do not coincide with the heights at which crossmembers can be installed. For example, the hard points of the Fleet Issue Unit Load for General Purpose Bomb MK 83 (1,000 pound), shown on figure D-16, are along the sides and backs of the pallet's top and bottom frames. Dunnage or adjacent unit loads should not be made to bear between the frames against the strapping or the commodity. Crossmembers alone, being limited to heights of 5, 16, 28, etc., inches, do not provide bearing surfaces for the loads hard points, which are approximately 6 and 18 inches high. Consequently, a properly constructed separator gate placed between the load and the crossmembers, offers bearing surfaces which coincide fully with the load's hard points and thereby effectively distribute longitudinal forces.

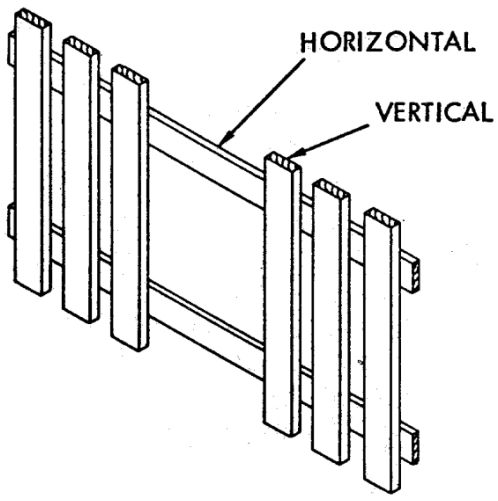

FIGURE D-15. Typical separator gate.

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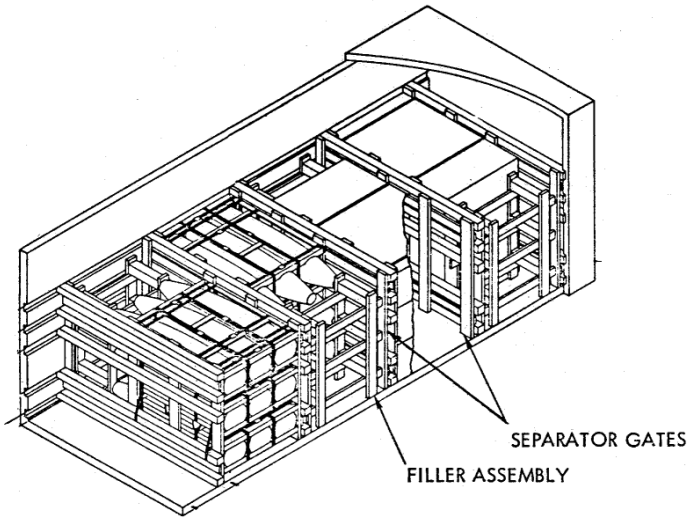

FIGURE D-16. Dunnage design and load pattern, general purpose bomb MK 83 unit loads, showing use of separator gates and filler assembly.

D.4.4.2.1 Gates. Separator gates should also be used to provide bearing surfaces for unit loads with bearing points which overhang the pallets. Figure D-17 shows Fleet Issue Unit Load for MK 82 MOD 2 Bomb (500 pound) stowed so that the bomb noses bear against the vertical members of a separator gate. At the aft end of the stack, a similar separator gate should provide bearing surfaces which accommodate the unit load's hard points at the upper frame, lower frame, and saddle and in line with the bases of the bombs.

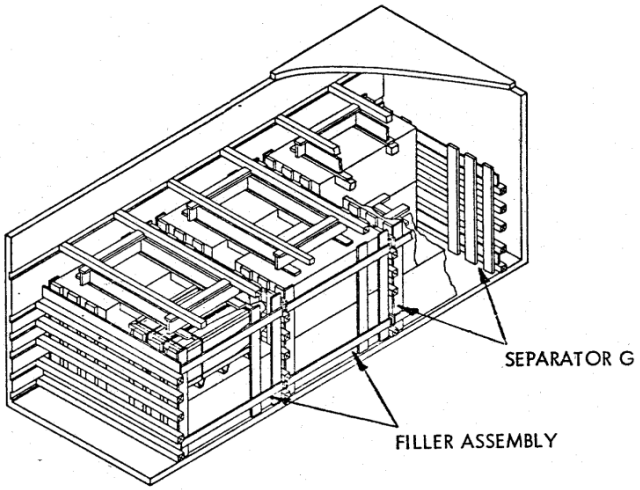

FIGURE D-17. Dunnage design and load pattern, general purpose bomb MK 82 (thermally protected) unit loads, showing use of separator gates and filler assembly.

D.4.4.2.2 Sheet. A sheet of ½-inch plywood cut to suit should also be used to serve the same function as a separator gate, as shown on figure D-18. Such dunnage is called a separator.

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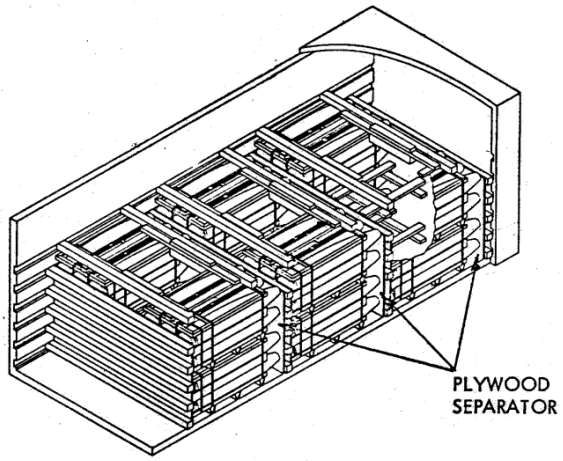

FIGURE D-18. Dunnage design and load pattern, general purpose bomb MK 82 unit loads, showing use of plywood separators.

D.4.4.3 Sway-brace assembly. Sway-brace assemblies are frame-like dunnage structures placed in lateral void spaces between unit loads or between a unit load and a side wall of the intermodal container to prevent lateral movement of the lading. Sway braces can be of the between-the-pallet type and placed in voids between unit loads so that the loads are blocked at their bases; or they can be of the strut-type and placed in voids between unit loads or the container wall so that the loads are blocked at their sides along a line approximately half their height. Figures D-19 and D-20 show typical examples of each type of sway-brace assembly.

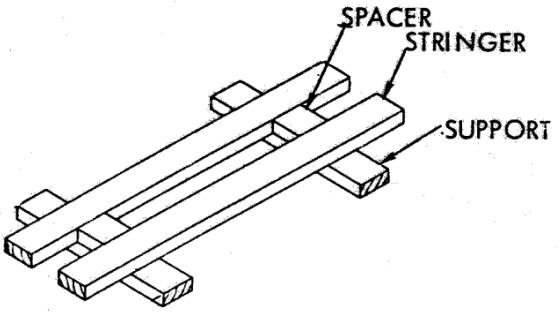

FIGURE D-19. Typical between-the-pallet sway-brace assembly.

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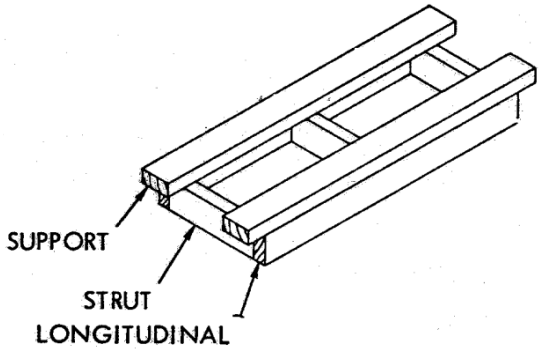

FIGURE D-20. Typical strut-type sway-brace assembly.

D.4.4.3.1 Stringers. The between-the-pallet type usually is constructed of 2- by 4-inch lumber with stringers providing bearing surfaces for the unit loads at hard points along the bases or pallets. The stringers should be cut to lengths which are consistent with the longitudinal dimensions of the void space. Spacers between the stringers should be cut to lengths which allow the structure to fit within 1 inch between the unit loads. The supports should be cut to lengths which permit their insertion between the base of the load (pallet platform) and the pallet runners. Figure D-21 illustrates the application of the between-the-pallet type sway-brace assembly.

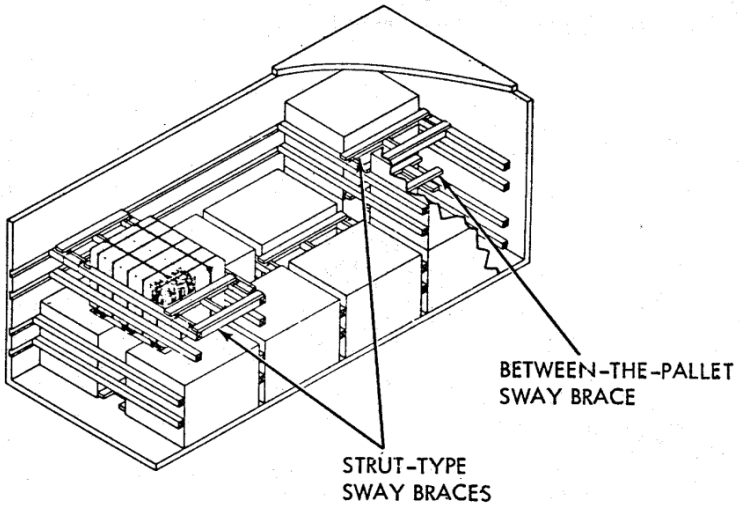

FIGURE D-21. Dunnage design and load pattern, 20 mm cartridge, showing use of between-the-pallet and strut-type sway braces.

D.4.4.3.2 Struts. The strut-type sway braces are constructed to be supported at each end by an intermodal container crossmember and to fit within 1 inch between the unit load and the container wall. Bearing surfaces are along the outer edges of the sway-brace supports and the longitudinals. The supports usually are of 2- by 6-inch lengths cut to span and rest squarely upon the intermodal container crossmembers, as shown on figure D-21. The longitudinals and spacers normally are of 2- by 4-inch lumber, the longitudinals should be cut to fit between the intermodal container crossmembers and the struts (also called crossmembers) should be cut so as to properly situate the longitudinals and supports between the unit loads or the container wall.

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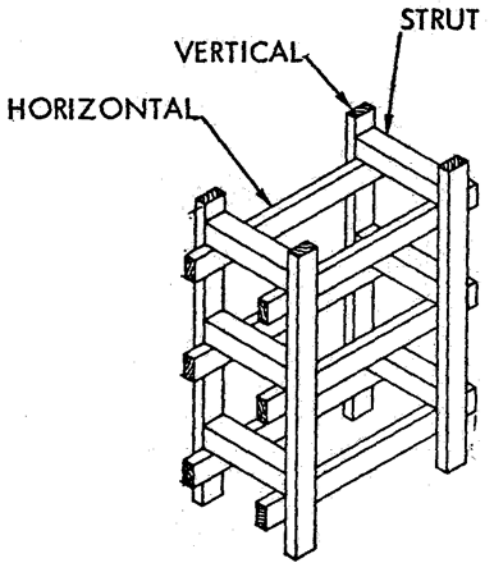
D.4.4.4 Filler assembly. Filler assemblies are dunnage structures fabricated to fill voids between the unit load(s) and a side wall of the intermodal container, providing bearing surfaces for hard points located between the upper and lower extremities of the load(s). Figure D-22 shows the construction details of a typical filler assembly, which should consist of six horizontals and four verticals, cut from either 2- by 4-inch or 4- by 4-inch stock, depending on the weight of the load(s). The four verticals provide bearing surfaces for the load(s) and the intermodal container side wall. The horizontals should be cut to lengths which allow the filler assembly to fit in the void to within 1 inch of its longitudinal dimension. The six struts should be cut so that the assembly's verticals fill the lateral void space. One inch slack should be permitted.



NOTE:

1. Filler assemblies should be constructed to provide load-bearing surfaces that are at right angles to the load or any narrow surface they bear against.

FIGURE D-22. Typical filler assembly.

D.4.4.4.1 Filler. Figure D-16 shows a filler assembly constructed for blocking lateral movement of palletized unit loads of 1,000-pound bombs. In this case, the hard points of the loads are the bomb noses, and, as shown, the filler-assembly verticals provide bearing surfaces for each outboard bomb. Figure D-22 shows a filler assembly constructed to block loads from within a void space of considerably less volume. In this instance, the verticals provide bearing surfaces corresponding with the outer edges at the end of the loads. Figure D-23 shows an example from an actual drawing.

D.4.4.4.2 Side wall. Figure D-17 shows a filler assembly (also called side wall frame), which is simpler and lighter in construction. Fabricated of 1- by 6-inch verticals and 1- by 4-inch horizontals, this dunnage structure should be assembled and installed so as to fill the void space within 1 inch of its length and width.

D.4.4.5 Hold-down assembly. Hold-down assemblies are dunnage structures used for securing unit loads so that they cannot move upwards, a process called tomming. Because hold-down assemblies primarily are used for tomming, construction details and application of these structures are specified in D.3.5.

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D.4.4.6 Side blocking (nailed). Nailed side blocking are wood members nailed longitudinally to the intermodal container floor and made to bear against a unit load so as to prevent lateral movement of the load, as shown on figure D-24. Usually cut from 2- by 4-inch lumber, side blocking should be of double thickness, with the first piece nailed to the container floor and the second piece nailed to the first in a like manner. Determine required nail quantity in accordance with table B-IX.

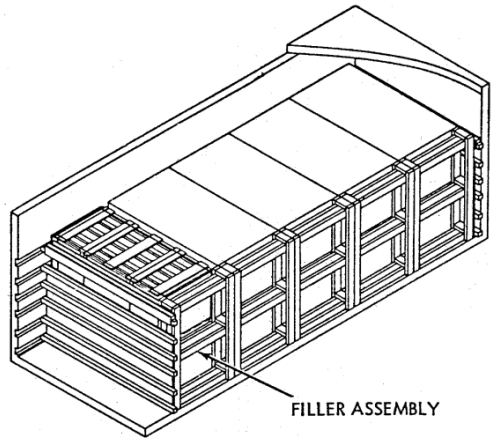

FIGURE D-23. Dunnage design and load pattern, fin assembly MAU-93/B for MK 82 bomb, showing use of filler assembly.

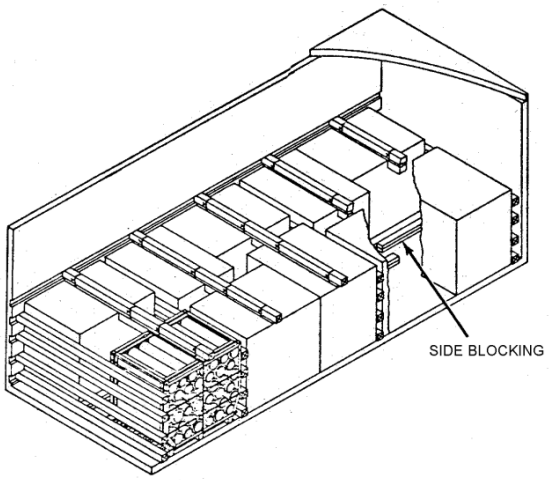

FIGURE D-24. Dunnage design and load pattern, D-inch/54 cartridge, showing use of side blocking.

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D.4.5 Tomming. Intermodal container loads (except inert, CG Class I through II-H and boxed unitized ammunition) which are destined for shipment by water, should be tommed. Tomming is accomplished by the use of steel straps, hold-down assemblies with crossmembers, or crossmembers alone, whichever is specified in the applicable drawing.

D.4.5.1 Straps. Figure D-25 shows tomming with steel straps. Each unit should be strapped to intermodal crossmembers, fore and aft, with the hold-down straps running over the tops of the loads, looped around the crossmembers, and secured with seals. The diagram on figure D-26 shows a typical hold-down strapping configuration and the attachment points where seals should be fastened. Each end of a hold-down strap should be secured so that at least one other crossmember is between the seal and the strap-encircled crossmember, the strap always being between the load and the intermediate crossmember(s). At each end, a hold-down strap should be secured with one seal crimped with two pairs of notches, or they should be secured with two seals butted together and crimped with two pairs of notches per seal. The maximum allowable weight of loads tommed with one 1¼-inch wide by 0.035-inch thick steel strapping is 7,000 pounds.

WARNING: Tomming with steel straps should be accomplished in strict accordance with instructions provided in the applicable drawing.

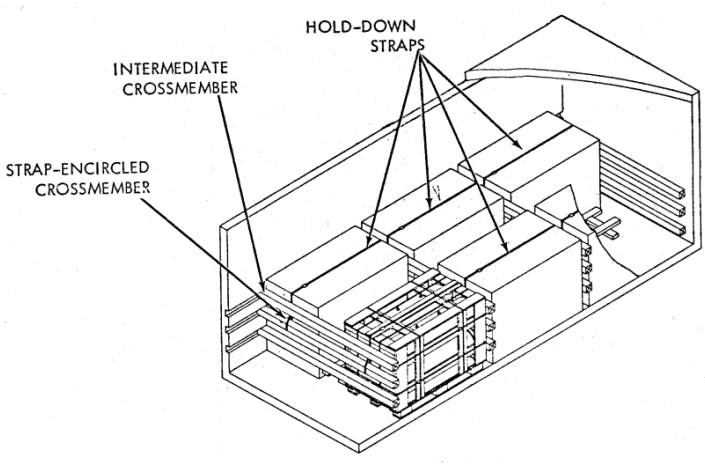

FIGURE D-25. Dunnage design and load pattern, rocket launcher LAU-61/A, LAU-68/A, or LAU-69/A showing use of strapping for hold-downs.

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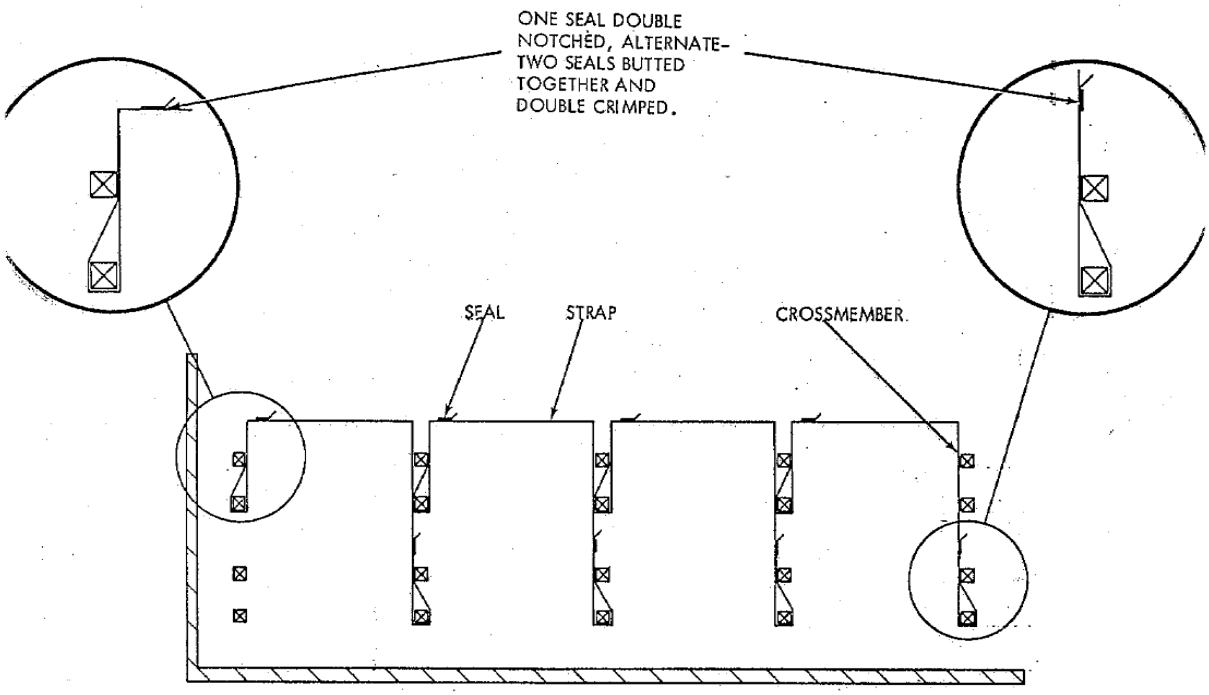

FIGURE D-26 Typical hold-down strapping configuration and attachment points

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D.4.5.2 Hold-down. Hold-down assemblies should be made to fit between the tops of the unit loads and intermodal crossmembers. They may be frame-like in construction, or, more simply, they may be fabricated of a wooden shim or shims, tied with wire to an intermodal crossmember.

D.4.5.2.1 Frame. The frame-type hold-down assembly is shown on figure D-27. Ordinarily, the tie pieces should be cut from 2- by 4-inch lumber. The thickness of the hold-downs and shims, which provide bearing surfaces between the lading and the bottom surface of the crossmembers, should be determined by the amount of clearance between the crossmembers and the top of the lading. The retainer prevents fore and aft motion. Figure D-28 illustrates the application of a frame-type hold-down assembly. Depending on the clearance space between the loads and the crossmembers, various sizes of lumber should be used. In every case, however, all frame-type hold-down assemblies should be constructed so that, when installed, not more than ½-inch clearance exists between the assemblies and the bottom surfaces of the crossmembers.

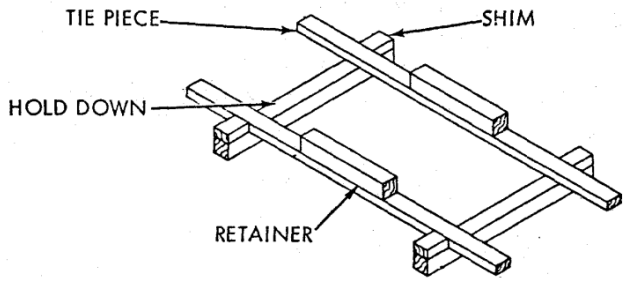

FIGURE D-27. Typical frame-type hold-down assembly.

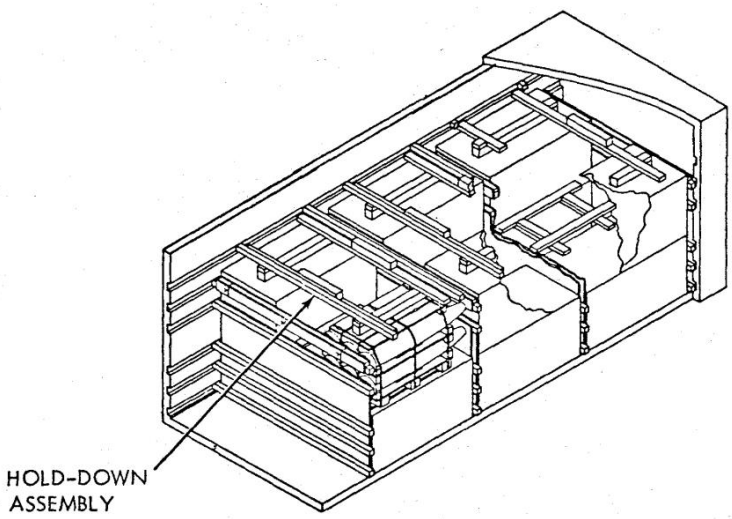

FIGURE D-28. Dunnage design and load pattern, general purpose MK 82 (500 pounds) bomb, showing use of hold-down assemblies.

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D.4.5.2.2 Location. Intermodal crossmembers can be used for tomming if the top surface of the lading is within 3 inches of the bottom of an installed crossmember. The maximum allowable clearance between the top surfaces of the lading and the bottom of the hold-down crossmember should not exceed ½ inch. If the clearance is greater than ½ inch, a shim, or shims, of suitable thickness should be wire-tied to the crossmember to attain this tolerance (see figure D-29). The maximum allowable weight of loads tommed with one hold-down crossmember is 7,000 pounds. When this weight is exceeded, two (or more) crossmembers should be used. See figure D-30 for use of single and double crossmembers as hold-downs.

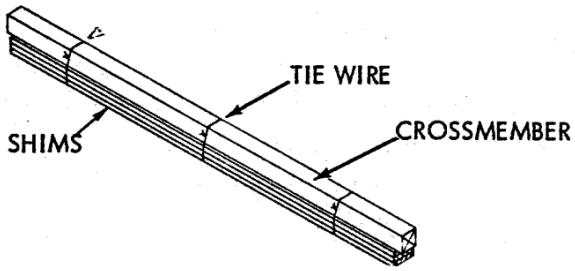

FIGURE D-29. Typical crossmember hold-down assembly.

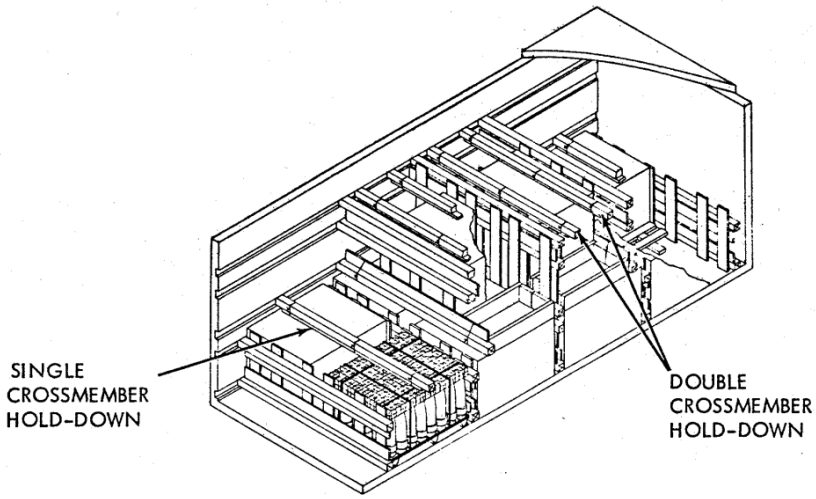

FIGURE D-30. Dunnage design and load pattern, 5-inch/54 projectiles, showing use of crossmembers for hold-downs.

D.4.6 Dunnaging considerations for commercial intermodal container.

D.4.6.1 Bulk intermodal containers. The dunnaging structures described in the following paragraphs are recommended for blocking and bracing in a standard commercial intermodal container. The bulk of intermodal containers have no mechanical bracing system or tiedown attachments inside the container. Detailed assemblies designed to fill up the voids in the containers and to prevent the lading from moving should be used. Some dimensions will need to be adjusted in the field since there is a wide variation in container dimensions.

D.4.6.2 Position. When loading an intermodal container it is important to position the lading so as to achieve a tight fit (tight against the dunnage assemblies). The unblocked space across the width of a load bay should not exceed 1½ inches. Excessive slack can be eliminated from a load by laminating additional pieces of appropriate thickness to the longitudinal pieces on a center fill assembly.

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D.4.6.3 Reduced quantity. Whether a container is full or loaded with a reduced quantity of lading units, the lengthwise center of gravity of the load should be within 12 inches, in either direction, of the midpoint of the container.

D.4.6.4 Vertical members. Vertical members of the fill and end wall assemblies should be the height of the container minus ½ inch. Extending these members to this height will prevent the vertical movement of the assemblies.

D.4.6.5 Nailing. Dunnaging material should not be nailed to the container floor or wall. All nailing should be within the dunnage material. A staggered nailing pattern should be used whenever possible when nails are driven into joints of dunnage assemblies or when laminating dunnage. Additionally, the nailing pattern for an upper piece of laminated dunnage should be adjusted as required so that a nail for that piece will not be driven through, onto, or right beside a nail in a lower piece.

D.4.6.6 Forward blocking assemblies. The forward blocking assembly consists of horizontal beams and vertical beams used to transmit the forces developed by the lading during shipment to the strong areas of the front wall of the container, specifically the corner posts (see figure D-31).

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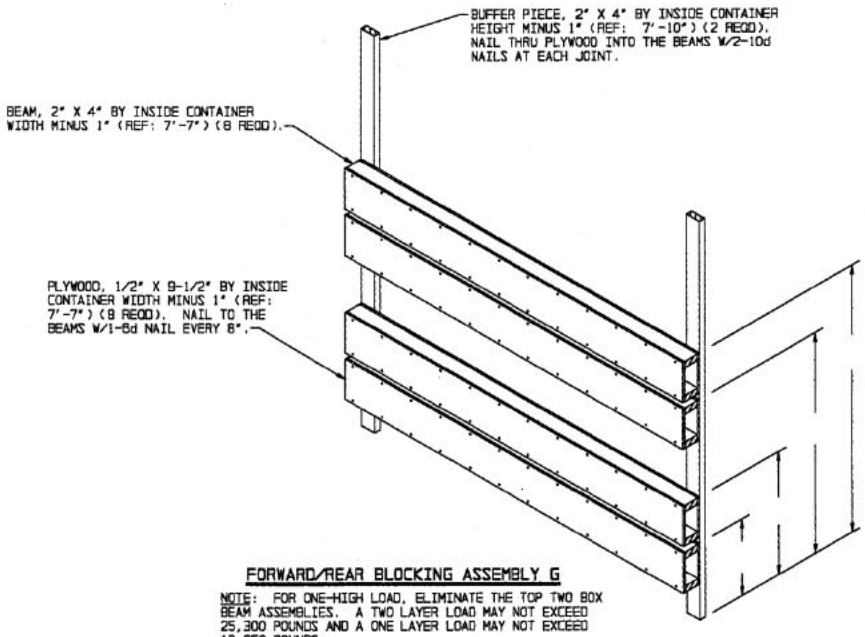
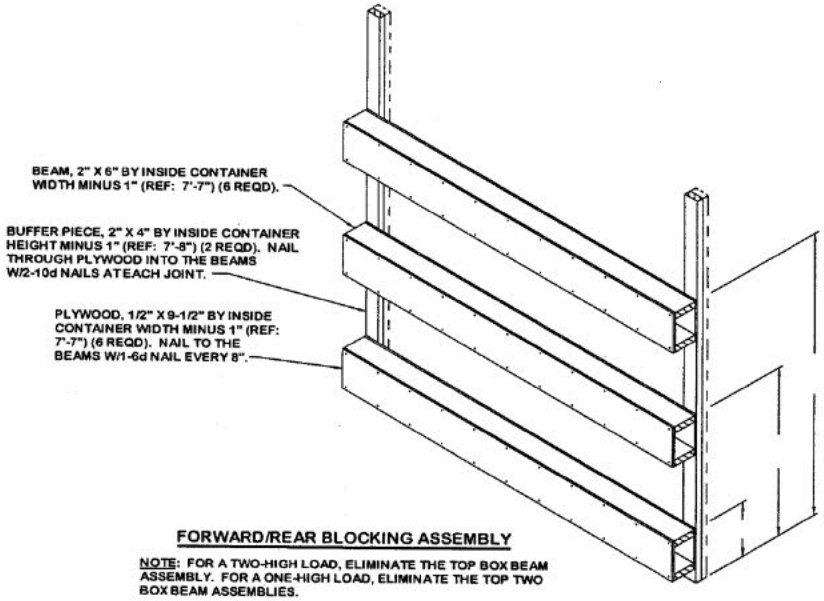


FORWARD/REAR BLOCKING ASSEMBLY G

NOTE: FOR ONE-HIGH LOAD, ELIMINATE THE TOP TWO BOX BEAM ASSEMBLIES. A TWO LAYER LOAD MAY NOT EXCEED 25,300 POUNDS AND A ONE LAYER LOAD MAY NOT EXCEED 12,650 POUNDS.



FORWARD/REAR BLOCKING ASSEMBLY

NOTE: FOR A TWO-HIGH LOAD, ELIMINATE THE TOP BOX BEAM ASSEMBLY. FOR A ONE-HIGH LOAD, ELIMINATE THE TOP TWO BOX BEAM ASSEMBLIES.

FIGURE D-31. Examples of forward/rear blocking assemblies (sheet 1 of 2).

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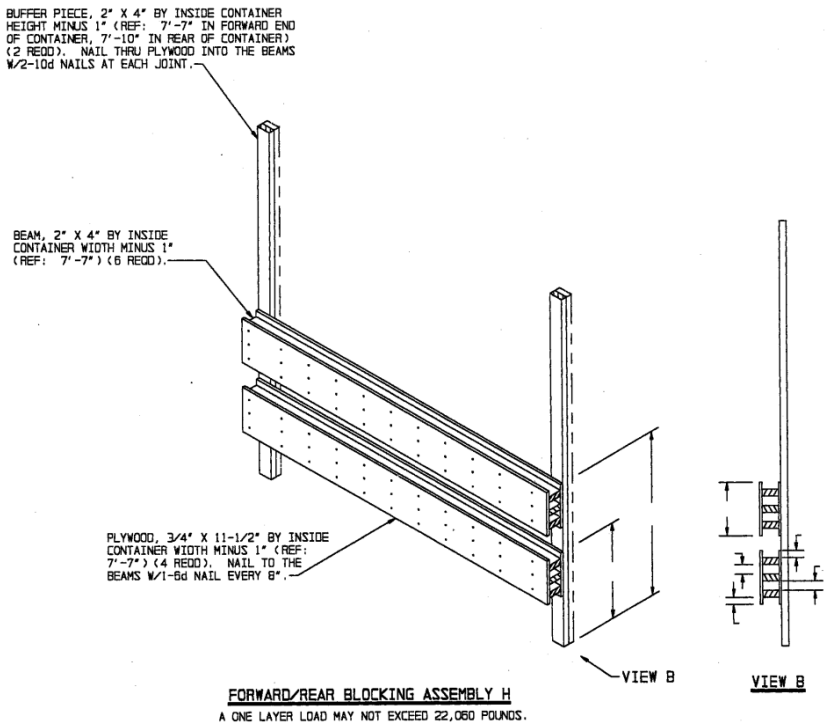
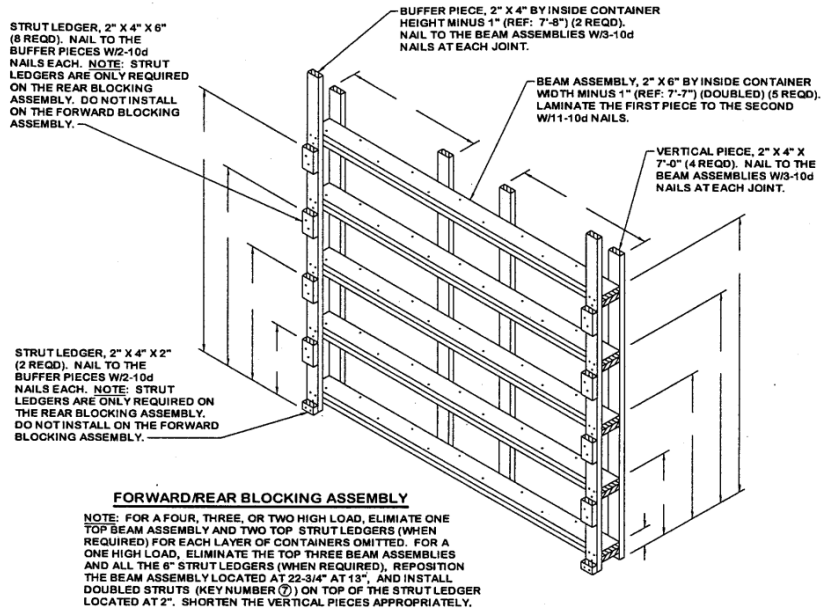


FORWARD/REAR BLOCKING ASSEMBLY H

A ONE LAYER LOAD MAY NOT EXCEED 22,060 POUNDS.



FORWARD/REAR BLOCKING ASSEMBLY

NOTE: FOR A FOUR, THREE, OR TWO HIGH LOAD, ELIMIATE ONE TOP BEAM ASSEMBLY AND TWO TOP STRUT LEDGERS (WHEN REQUIRED) FOR EACH LAYER OF CONTAINERS OMITTED. FOR A ONE HIGH LOAD, ELIMINATE THE TOP THREE BEAM ASSEMBLIES AND ALL THE 6" STRUT LEDGERS (WHEN REQUIRED), REPOSITION THE BEAM ASSEMBLY LOCATED AT 22-3/4" AT 13", AND INSTALL DOUBLED STRUTS (KEY NUMBER ⑦) ON TOP OF THE STRUT LEDGER LOCATED AT 2". SHORTEN THE VERTICAL PIECES APPROPRIATELY.

FIGURE D-31. Examples of forward/rear blocking assemblies (sheet 2 of 2) – Continued.

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D.4.6.6.1 Corners. In some containers there is a slot at the corners of the forward wall. Pieces of dunnage material should be laminated to the buffer pieces on the forward blocking assembly to provide a flat surface for buffer pieces. A piece of 2 by 4 (lumber), 2 by 3 (lumber), or special width piece cut-to-fit can be used. This fill piece should be nailed with one appropriately sized nail every 12 inches. Some containers are equipped with "tie-bars" in the corner slot, which precludes the use of a full height fill piece. When "tie-bars" are present, the fill pieces should be installed in segments designed to fit between the "tie-bars" vertically. The fill piece(s) should not be required when the corner positions of the container forward wall are smooth and flat. Dunnage assembly should not come into contact with the container forward wall. Only the corner posts of the container should be used for forward longitudinal blocking.

D.4.6.7 Rear blocking assembly. The rear blocking assembly should consist of horizontal beams and vertical members similar to the forward blocking assembly. This assembly should be used to prevent the lading from moving towards the doors during shipment and to transfer the forces developed by the lading during shipment to the strong areas (corner posts) at the rear of the container (see figure D-31).

D.4.6.7.1 Existing assembly design. The front/rear blocking assemblies should be designed to hold up to the forces that the lading could transfer to the assembly. Since the assemblies transfer the load to the container corners, the center of the assembly will usually see the greatest forces. Army Drawing 19-48-4153 provides many different front and rear blocking assemblies and gives maximum allowable loads each assembly will restrain.

D.4.6.8 Side fill assemblies. The side fill assemblies should consist of wood members nailed together to form an assembly that contacts the lading and the container side wall at the strong areas of each. This form of blocking should be required to more uniformly distribute the lateral forces developed by the lading during shipment onto the container side walls and to fill any lateral void between the lading and the walls of the container (see figure D-32).

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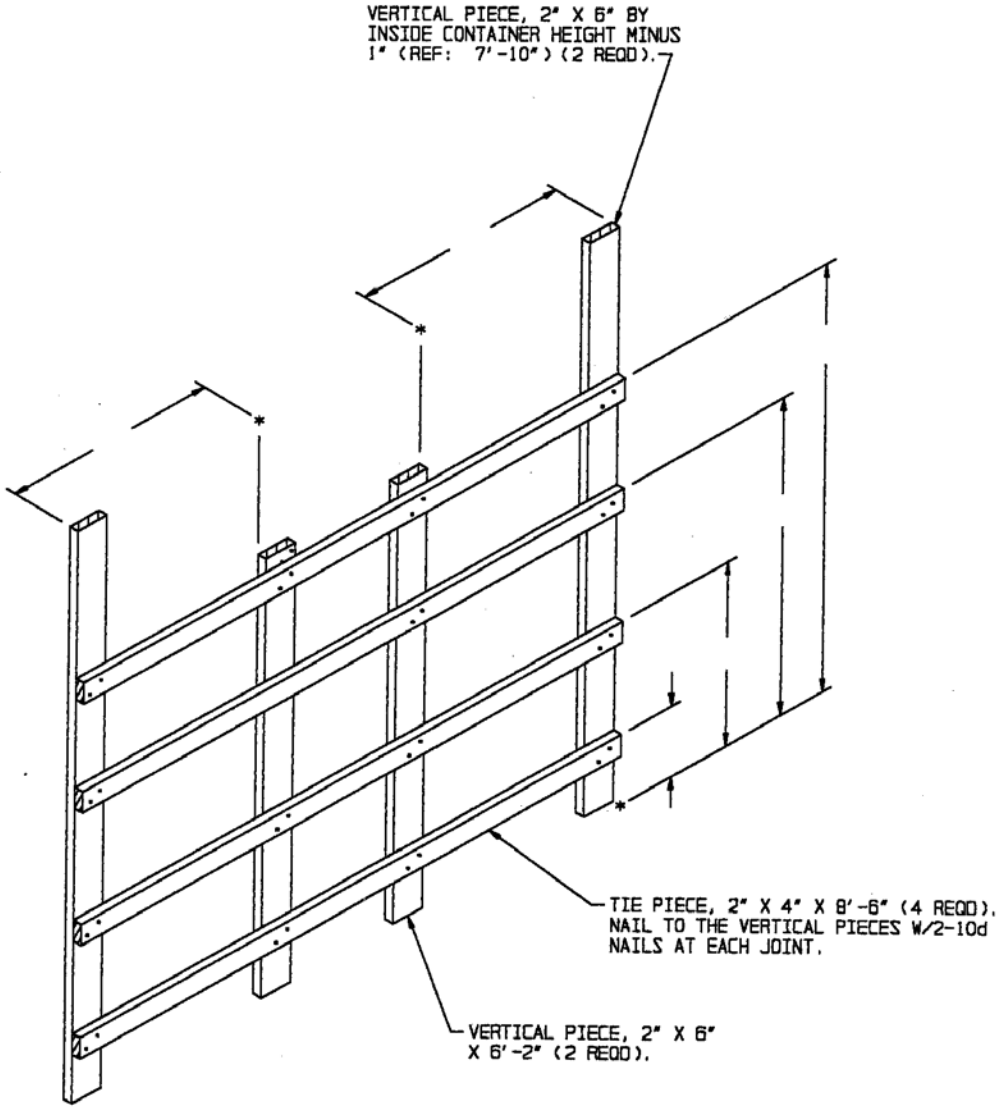

FIGURE D-32. Examples of side fill assemblies (sheet 1 of 2).

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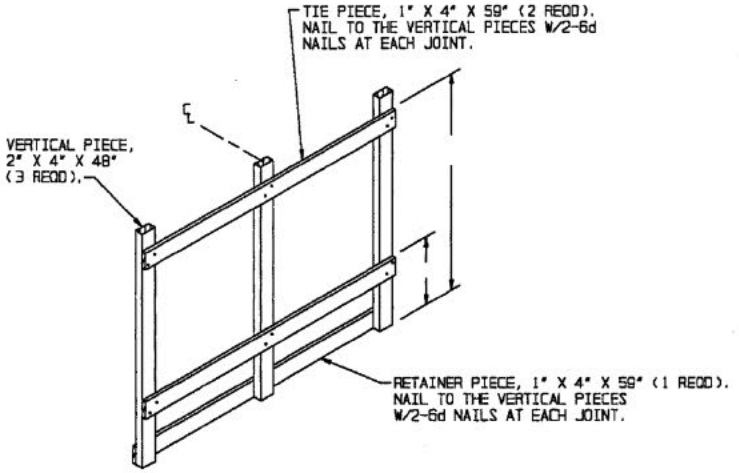
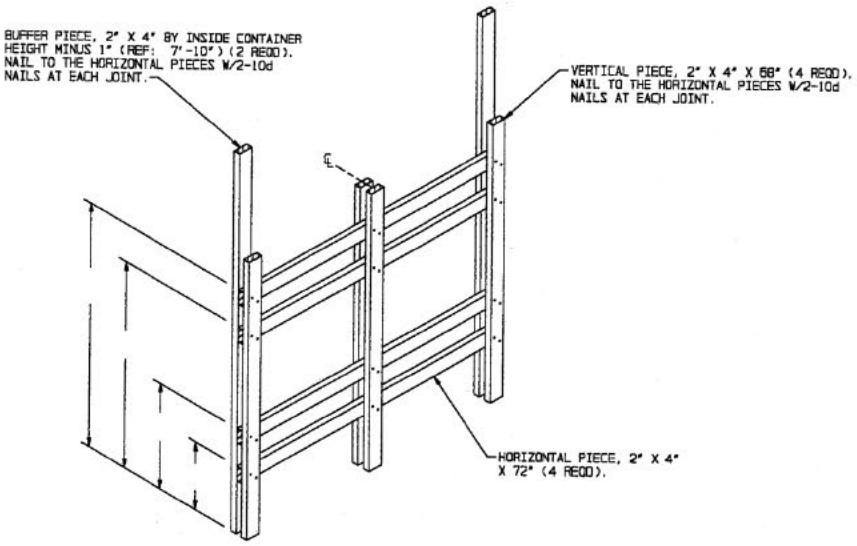


SIDE FILL ASSEMBLY B



SIDE FILL ASSEMBLY C
FOR A ONE HIGH LOAD, REDUCE THE VERTICAL PIECES
TO 34" AND ELIMINATE THE TOP TWO HORIZONTAL PIECES.

FIGURE D-32. Examples of side fill assemblies (sheet 2 of 2) – Continued.

D.4.6.9 Door post vertical. The door post vertical is a wood vertical member with a series of small blocks, called strut ledges, nailed to it (see figure D-33). The door post vertical should interface with the corner posts of the container.

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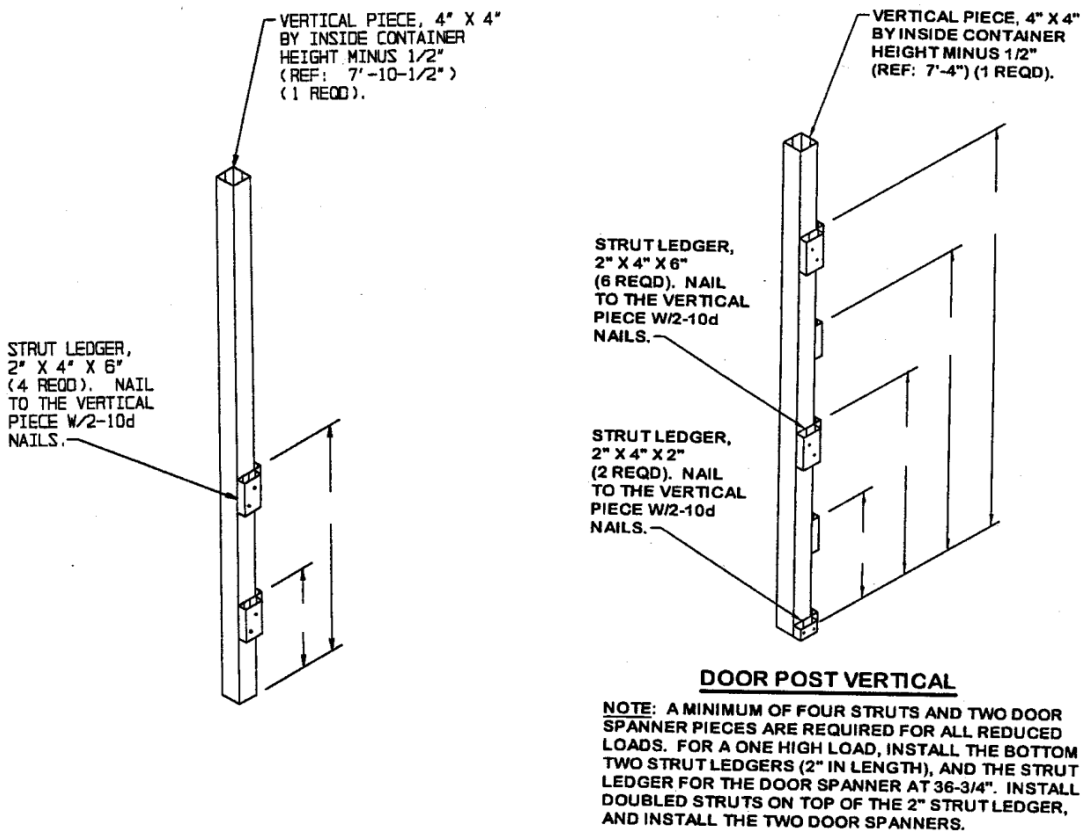

FIGURE D-33. Example of door post verticals.

D.4.6.10 Aft end load restraint. The aft end load restraint is a device that interfaces between the wood blocking and bracing and the door-end corner posts of an end-opening International Organization for Standardization (ISO) container. Three different types of aft end load restraint can be used, Door Post Vertical (DPVR), Universal Load Restraint (ULR), or Welded Load Retainers. These interfaces are necessary because container doors are not designed to withstand movement of a load of ammunition during intermodal transport without damage (see figure D-34). Army Drawing DA-116 describes the use and fabrication of these devices.

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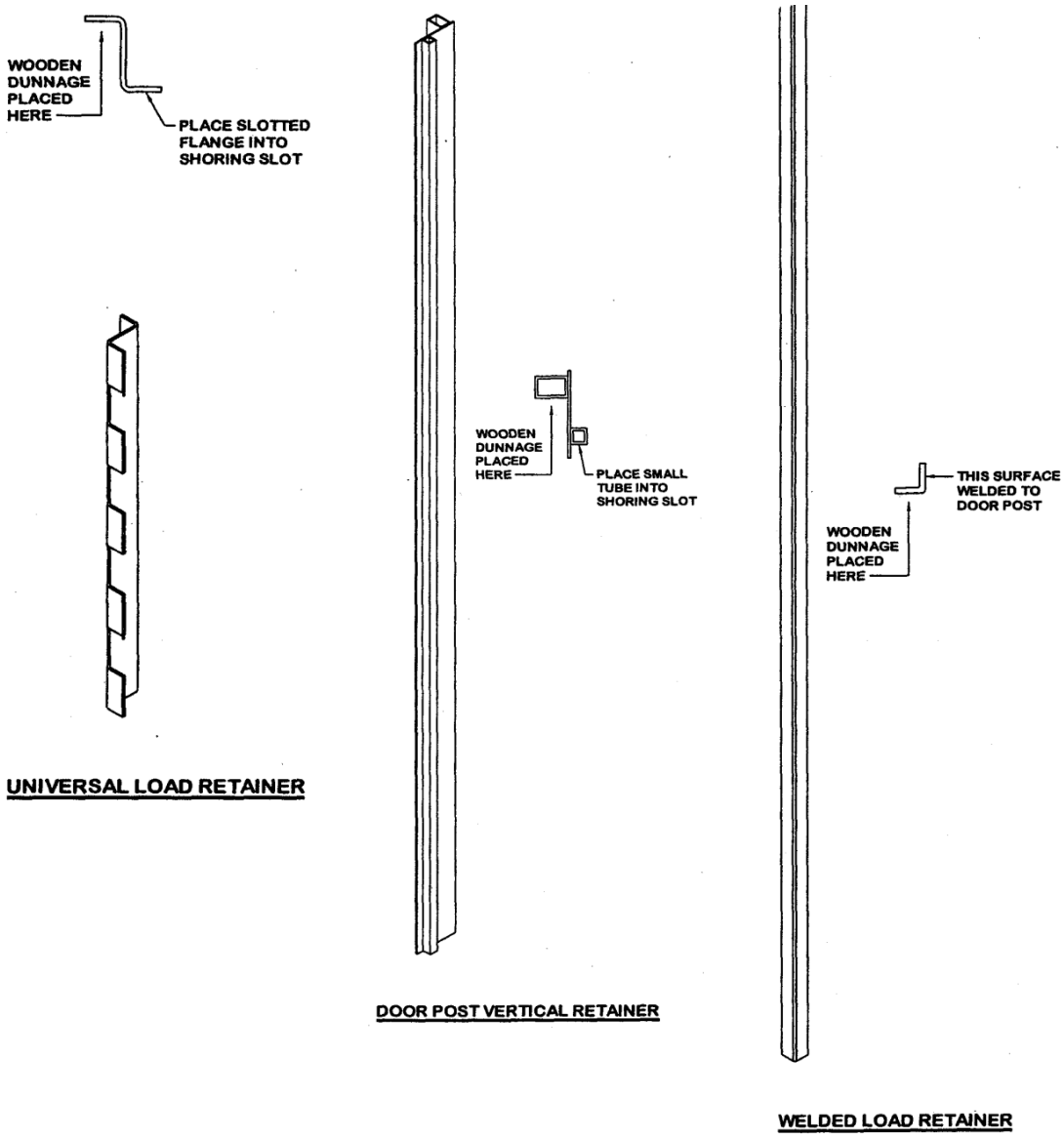

FIGURE D-34. Aft end load restraint.

D.4.6.11 Fill material/assemblies. Voids should be eliminated to create a tight fit and to prevent the lading from moving. The fill material/assemblies should be strong enough to resist the lateral or longitudinal forces the lading generates during movement (see figure D-35).

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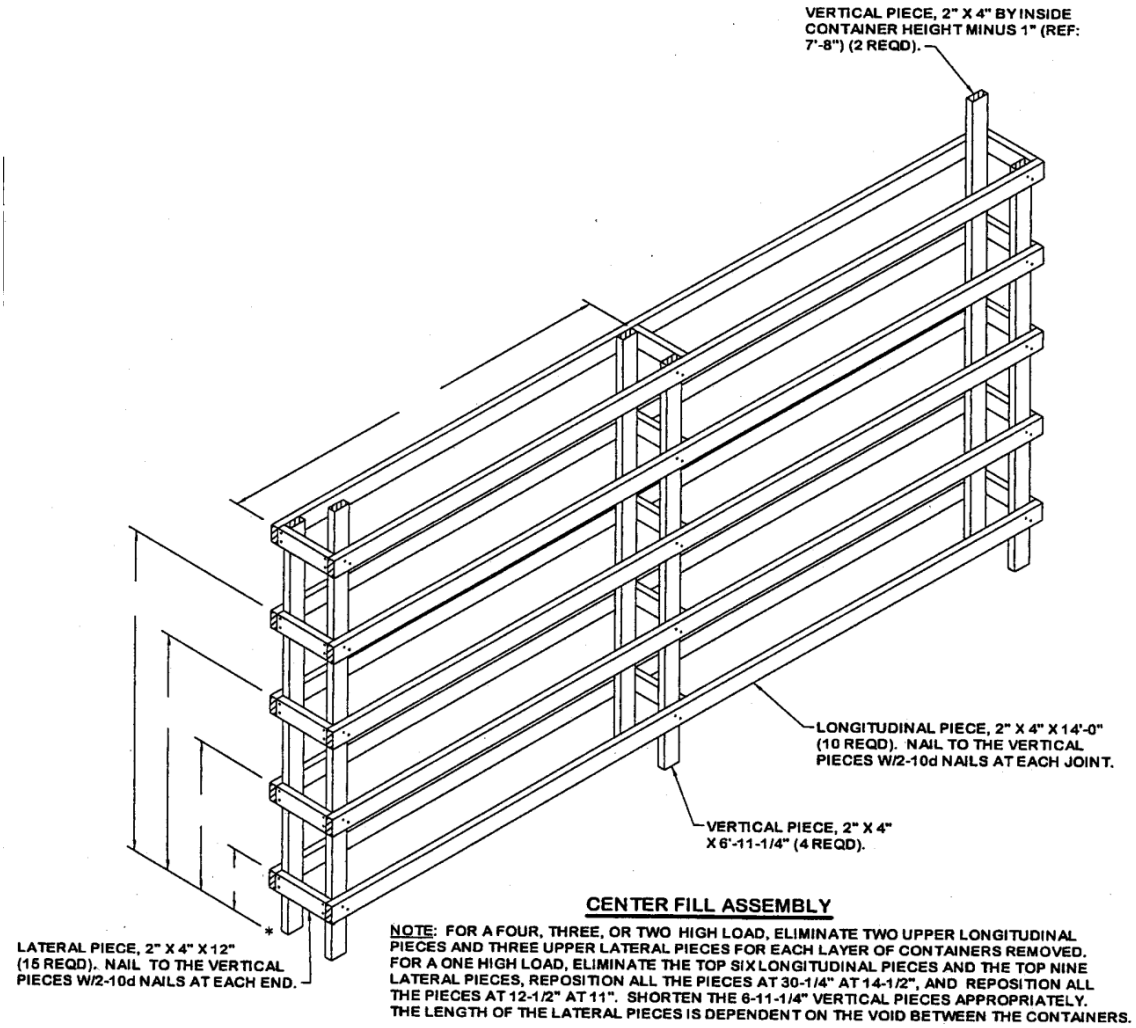

FIGURE D-35. Examples of fill assemblies (sheet 1 of 2).

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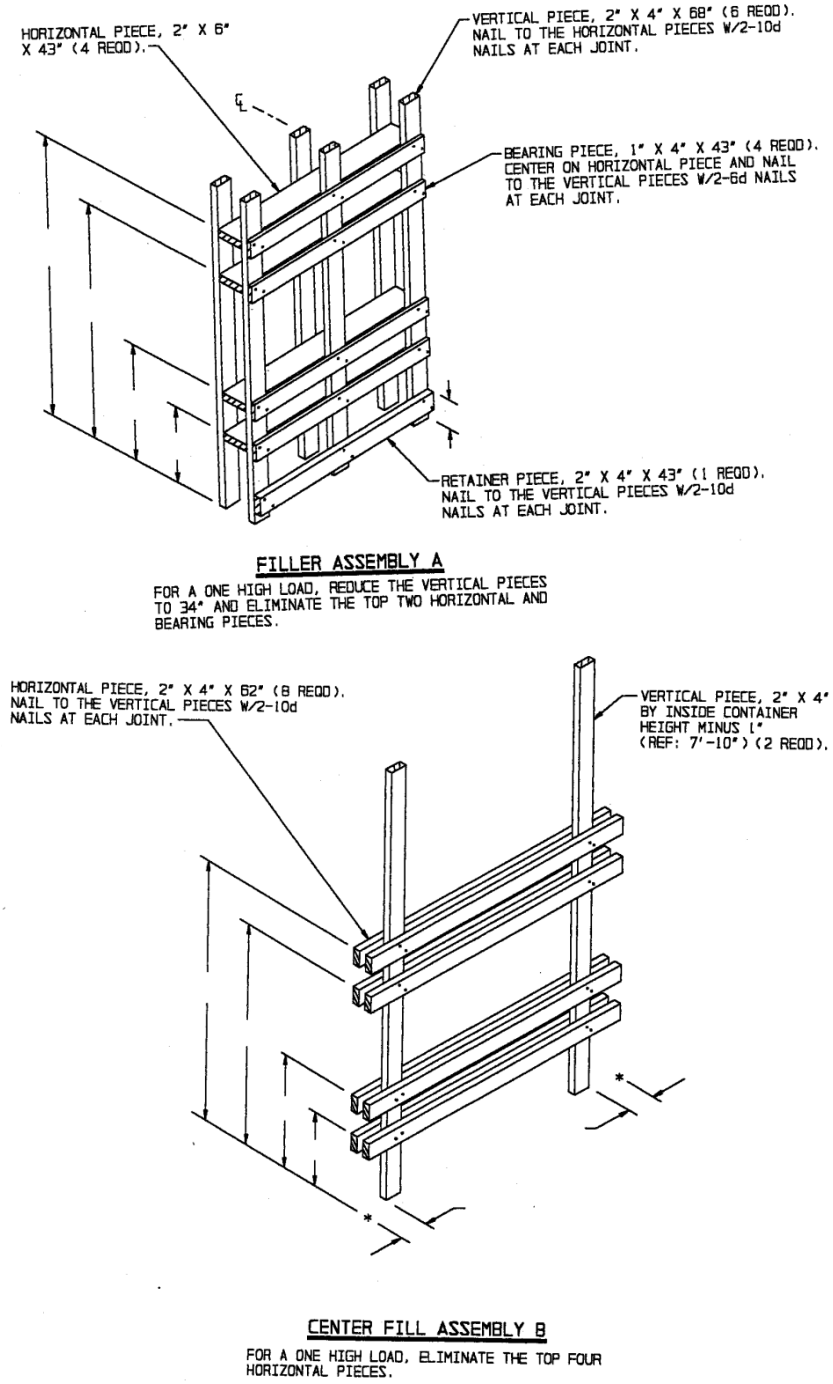

FIGURE D-35. Examples of fill assemblies (sheet 2 of 2) – Continued.

D.4.6.12 Strut assemblies. Strut assemblies should be used to transfer the load from the forward/rear blocking assemblies to the door vertical posts (see figure D-36).

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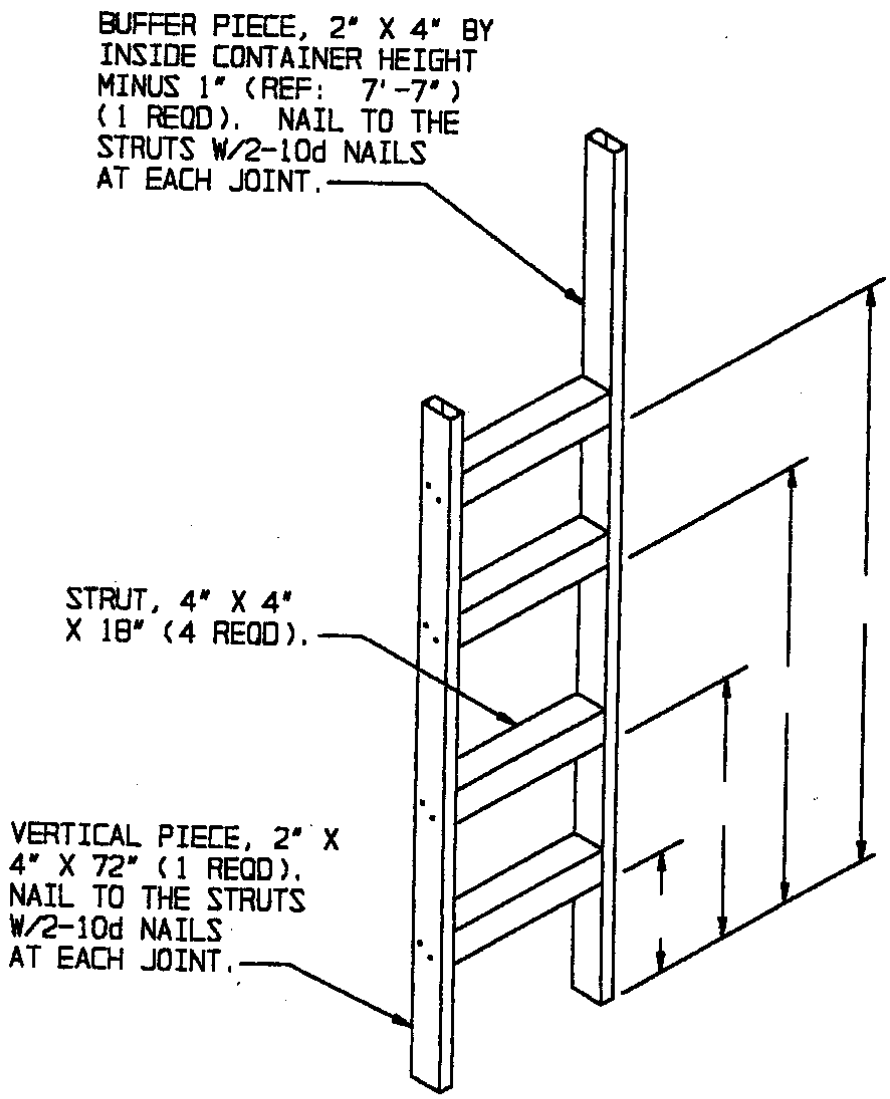

FIGURE D-36. Examples of strut assemblies (sheet 1 of 3).

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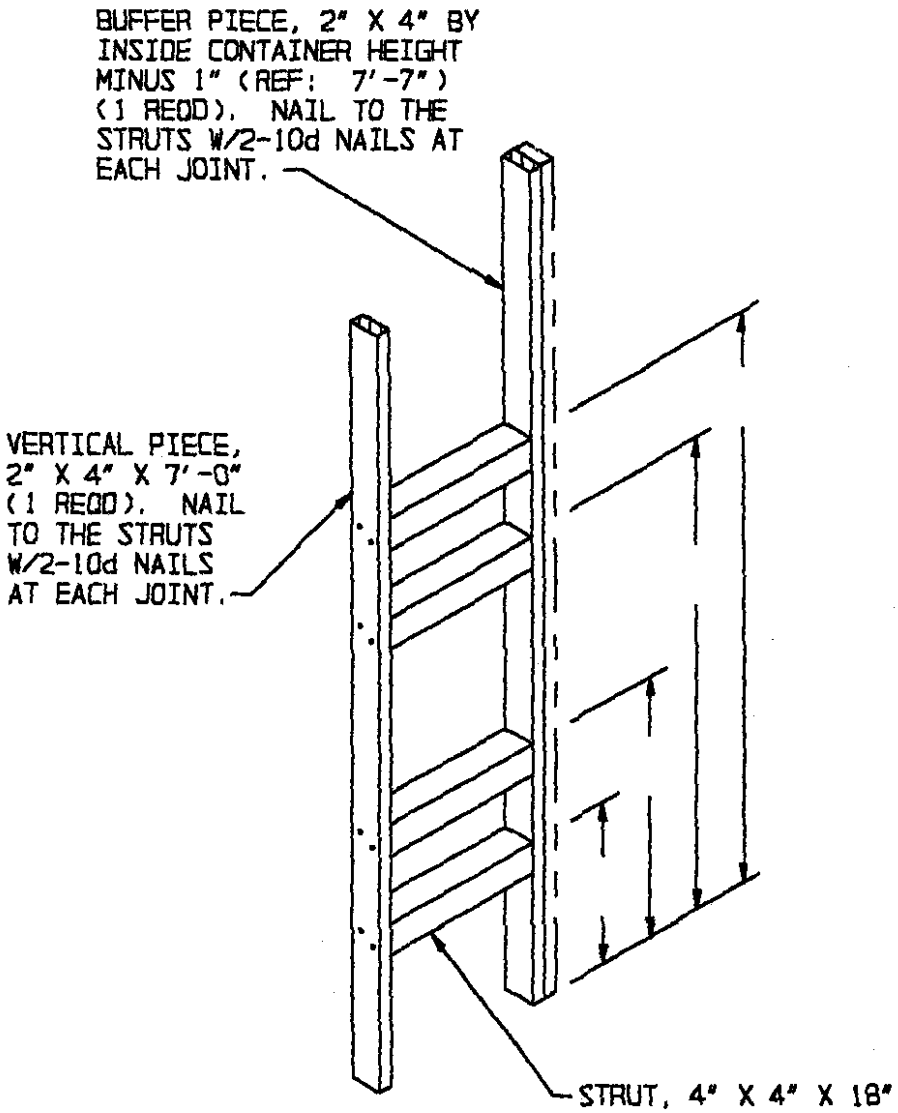

FORWARD STRUT ASSEMBLY D

FOR A ONE HIGH LOAD, REDUCE THE VERTICAL PIECE TO 35" AND ELIMINATE THE TOP TWO STRUTS.

FIGURE D-36. Examples of strut assemblies (sheet 2 of 3) – Continued.

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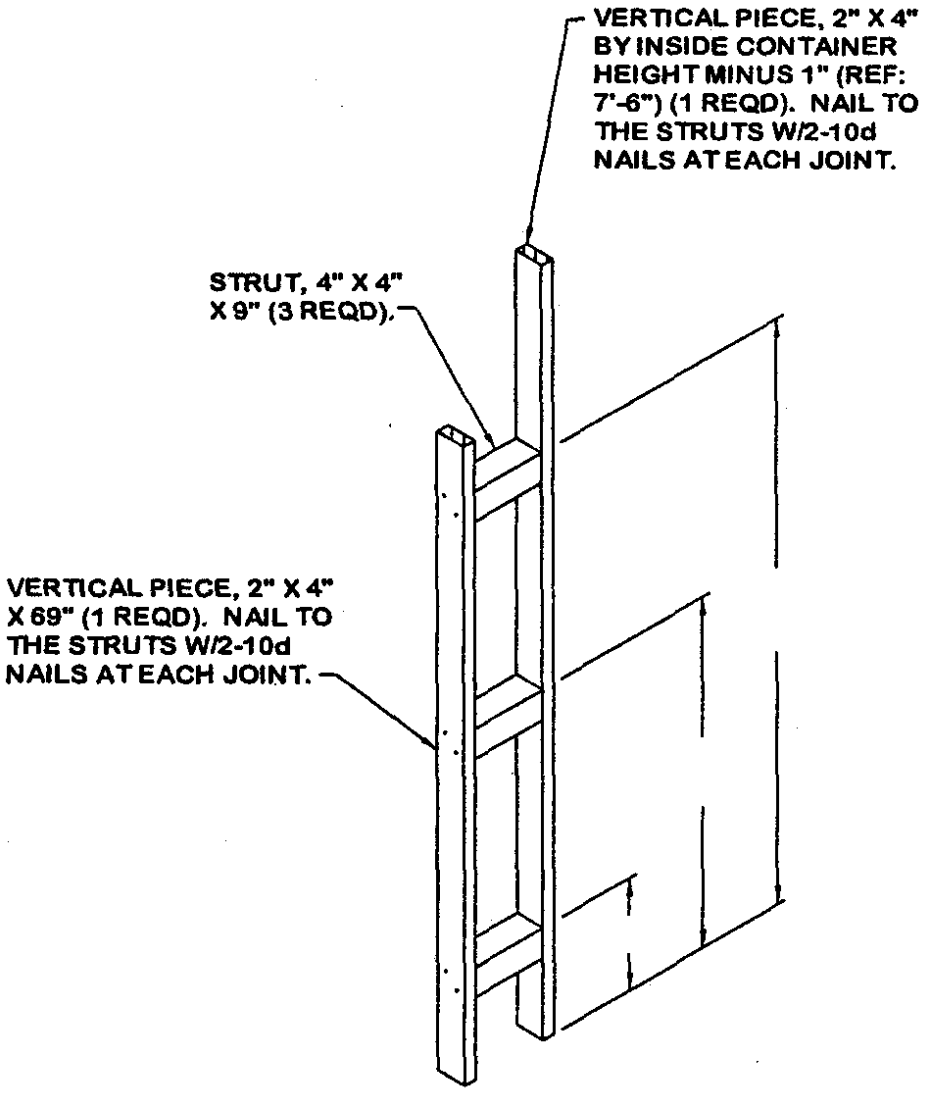

FIGURE D-36. Examples of strut assemblies (sheet 3 of 3) – Continued.

D.4.6.13 Door spanner. Door spanners should be used to firmly fix the door post vertical members to the side of the containers. These spanners should be cut slightly oversize so that they provide a drive fit. The ends of the spanners are usually bevel cut to assist in the installation (see figure D-37).

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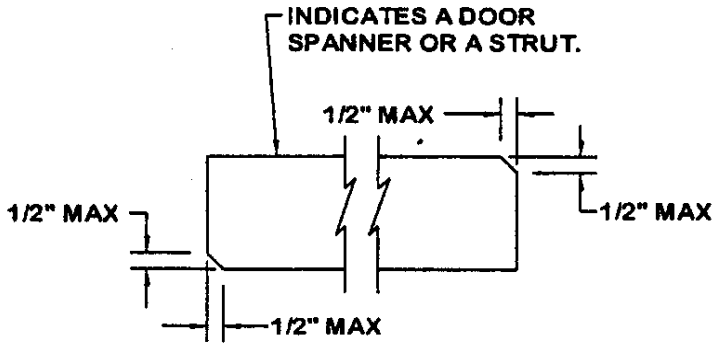

BEVEL-CUT

IF DESIRED, EACH END OF A DOOR SPANNER OR A STRUT MAY BE BEVEL-CUT AS SHOWN ABOVE TO FACILITATE THE ACHIEVEMENT OF A TIGHT END OF LOAD FIT.

FIGURE D-37. Door spanner bevel-cut.

D.4.6.14 Railroad shipments. Requirements cited within the Association of American Railroads (AAR) Intermodal Loading Guide for Products in Closed Trailers and Containers should apply when the shipments moves by trailer/container-on-flatcar (T/COFC). Special T/COFC notes are:

a. A loaded container should be on a chassis equipped with two bogie assemblies when being moved in TOFC service.

b. The unit load limit of a T/COFC railcar should not be exceeded, nor should a car be loaded so that the truck under one end of the car carries more than one-half of the load limits for the car.

D.4.6.15 Chassis. During intrastate or interstate moves by motor carrier, a proper chassis or modified flatbed trailer should be used to preclude violation of one or more “weight laws.”

D.4.6.16 Mechanical bracing systems. Commercially available mechanical bracing systems are available to secure lading in commercial intermodal containers. These systems can be used provided the approval authorities, listed in 4.2, certify the mechanical bracing system and the load plan meets the testing requirements of D.4.

D.4.6.17 Example procedure for preparing an end-opening commercial intermodal load.

a. Prefabricate forward/aft blocking assemblies, forward strut assemblies, fill assemblies, and door post assemblies.

b. Install forward strut assemblies and spreader pieces.

c. Install forward blocking assemblies.

d. Load lading. Ensure lading is tight.

e. Install fill material/assemblies as needed. Ensure tight fit.

f. Install rear-blocking assemblies.

g. Install door post verticals.

h. Install upper-most and lower-most door spanner pieces.

i. Install required struts.

j. Install the remaining required door spanner pieces.

See figures D-38 to D-40 for examples of commercial intermodal loads.

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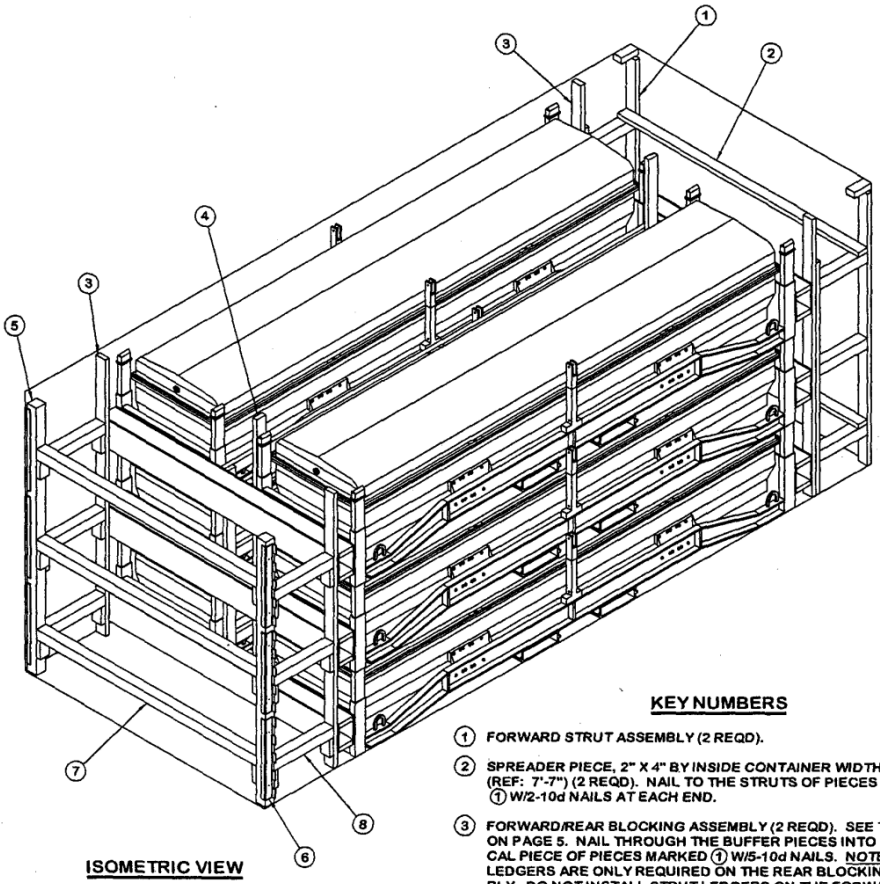

KEY NUMBERS

1. FORWARD STRUT ASSEMBLY (2 REQD).
2. SPREADER PIECE, 2" X 4" BY INSIDE CONTAINER WIDTH MINUS 1" (REF: 7'-7") (2 REQD). NAIL TO THE STRUTS OF PIECES MARKED (1) W/2-10d NAILS AT EACH END.
3. FORWARD/REAR BLOCKING ASSEMBLY (2 REQD). SEE THE DETAIL ON PAGE 5. NAIL THROUGH THE BUFFER PIECES INTO THE VERTICAL PIECE OF PIECES MARKED (1) W/5-10d NAILS. NOTE: STRUT LEDGERS ARE ONLY REQUIRED ON THE REAR BLOCKING ASSEMBLY. DO NOT INSTALL STRUT LEDGERS ON THE FORWARD BLOCKING ASSEMBLY.
4. CENTER FILL ASSEMBLY (1 REQD).
5. DOOR POST VERTICAL (2 REQD).
6. UNIVERSAL LOAD RETAINER (6 REQD, 3 PER SIDE). NAIL THROUGH THE HOLES INTO THE DOOR POST VERTICAL W/2-10d NAILS.
7. DOOR SPANNER, 4" X 4" MATERIAL CUT TO A LENGTH THAT WILL PROVIDE A DRIVE FIT (REF: 7'-1-1/4") (3 REQD). TOENAIL TO THE DOOR POST VERTICAL W/2-12d NAILS AT EACH END.
8. STRUT, 4" X 4" BY CUT-TO-FIT (REF: 22-7/8") (6 REQD). TOENAIL TO THE BUFFER PIECES OF THE REAR BLOCKING ASSEMBLY AND TO THE DOOR POST VERTICAL W/2-12d NAILS AT EACH END.

FIGURE D-38. Intermodal load of missile containers.

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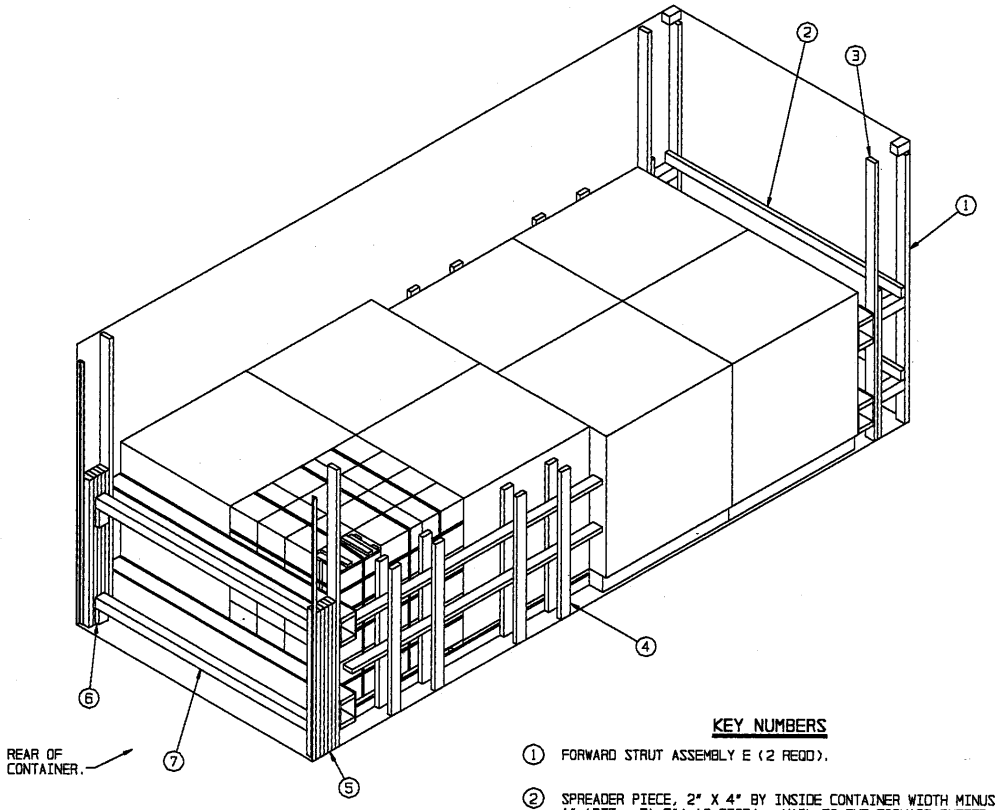

KEY NUMBERS

① FORWARD STRUT ASSEMBLY E (2 REQD).

② SPREADER PIECE, 2" X 4" BY INSIDE CONTAINER WIDTH MINUS 1" (REF: 7'-7") (2 REQD). NAIL TO THE FORWARD BUFFER PIECES OF PIECE MARKED ① W/2-10d NAILS AT EACH END.

③ FORWARD/REAR BLOCKING ASSEMBLY J (2 REQD). SEE THE DETAIL ON PAGE 43 AND THE "ALTERNATIVE FORWARD/REAR BLOCKING ASSEMBLY" ON PAGE 80. NAIL THROUGH THE BUFFER PIECES INTO THE VERTICAL PIECES OF PIECE MARKED ① W/5-10d NAILS.

④ SIDE FILL ASSEMBLY E (2 REQD).

⑤ FILL MATERIAL, 4" WIDE BY 48" LONG MATERIAL (AS REQD). NAIL THE FIRST PIECE TO THE REAR BLOCKING ASSEMBLY W/4 NAILS OF A SUITABLE SIZE (10d FOR 2" THICK MATERIAL). NAIL EACH ADDITIONAL PIECE TO THE PREVIOUS PIECE IN A SIMILAR MANNER. NOTE: MULTIPLE PIECES MAY BE LAMINATED TOGETHER FIRST AND THEN TOENAILED TO THE REAR BLOCKING ASSEMBLY.

⑥ STRUT LEDGER, 2" X 4" BY 5" OR 6" (4 SHOWN - OPTIONAL). INSTALL IF DESIRED TO AID IN THE INSTALLATION OF SPANNER PIECES. NAIL TO THE FILL MATERIAL W/2-10d NAILS.

⑦ DOOR SPANNER, 4" X 4" MATERIAL, CUT TO A LENGTH THAT WILL PROVIDE FOR A DRIVE FIT (REF: 7'-1-3/8") (2 REQD). TOENAIL TO THE FILL MATERIAL W/2-12d NAILS AT EACH END.

FIGURE D-39. Intermodal load of unit loads of ammunition.

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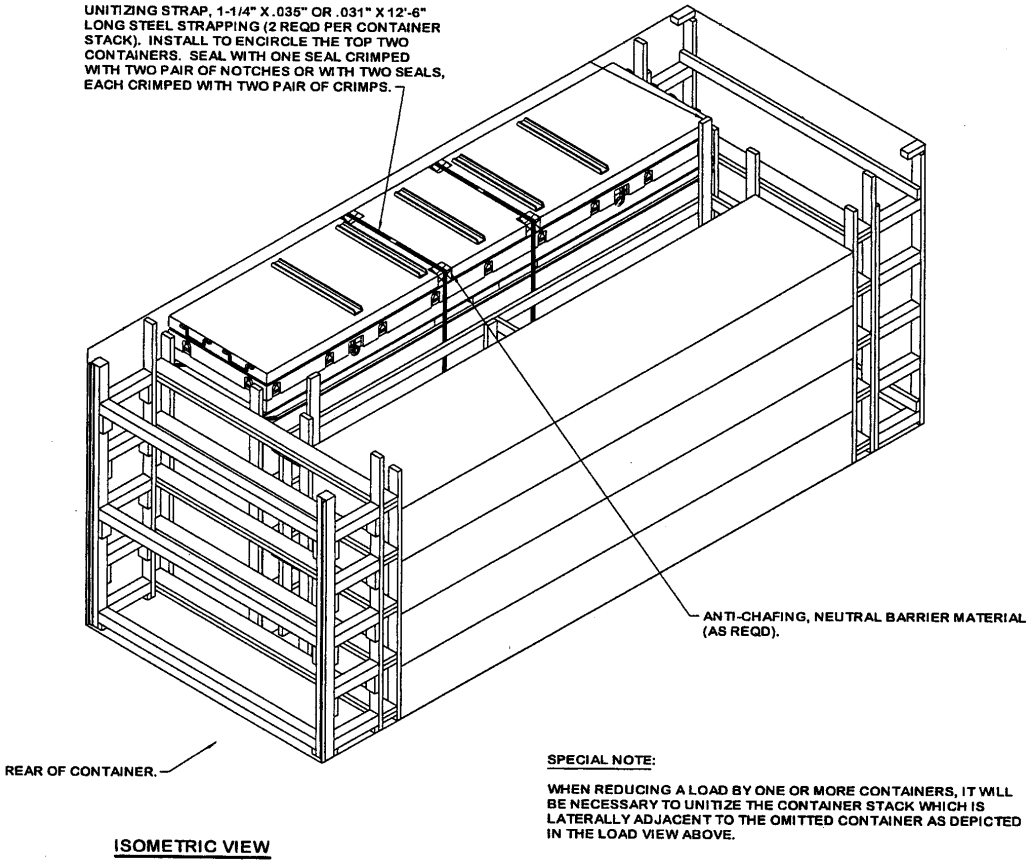

FIGURE D-40. Less than full load of missile containers.

D.4.7 Using specialized container roll-in/out platforms. Container roll-in/out platforms (CROP) are specially designed platforms used to improve the efficiency of loading and unloading end-opening steel dry 20-foot commercial intermodal containers. These platforms have a footprint of the interior envelope of a 20-foot container and are easily loaded and secured to the inside corners of the containers. The platforms provide common tiedown features that allow the use of strapping to secure the lading. Army Drawing 19-48-4906 describes the detailed procedures for loading and bracing ammunition loads on these platforms.

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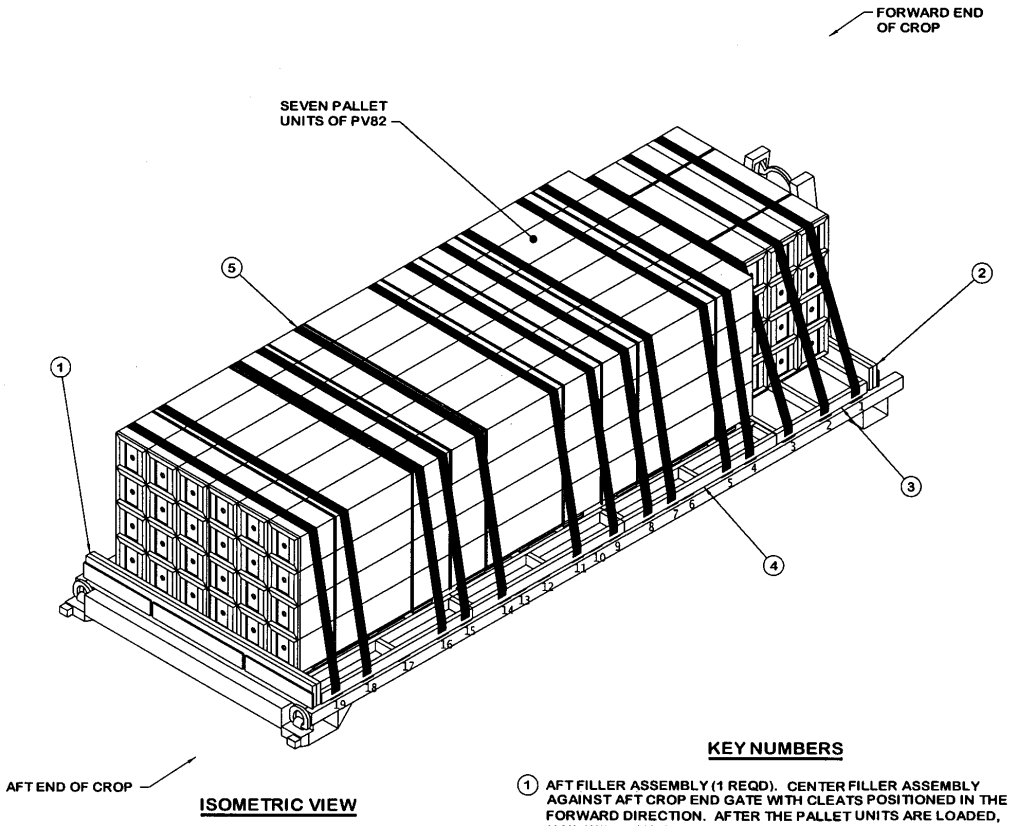

ISOMETRIC VIEW

KEY NUMBERS

(1) AFT FILLER ASSEMBLY (1 REQD). CENTER FILLER ASSEMBLY AGAINST AFT CROP END GATE WITH CLEATS POSITIONED IN THE FORWARD DIRECTION. AFTER THE PALLET UNITS ARE LOADED, NAIL W/2-12d NAILS THRU THE SLOTS IN THE AFT CROP END GATE INTO THE AFT FILLER ASSEMBLY. LEAVING THE NAIL HEADS PROTRUDING THRU THE SLOTS TO PROVIDE LAT· ERAL RESTRAINT.

(2) FORWARD FILLER, 1" OR 2" X 8" X 7'-4" (AS REQD). LAMINATE BOARDS W/8 NAILS OF SUITABLE SIZE (10d NAILS FOR 2" THICK MATERIAL). POSITION FILLER PIECE AGAINST THE FORWARD CROP END GATE AND CENTER ON THE CROP. AFTER THE PALLET UNITS ARE LOADED, NAIL THROUGH THE HOLES IN THE FORWARD CROP END GATE W/2-12d NAILS INTO THE FORWARD FILLER PIECE, LEAVING THE NAIL HEADS PROTRUDING THROUGH THE HOLES TO PROVIDE LATERAL AND VERTICAL RESTRAINT.

(3) SPACER ASSEMBLY (2 REQD). POSITION THE ASSEMBLIES AT THE FORWARD END OF THE CROP ON EACH SIDE OF THE LATERAL PALLET UNIT. NOTE: NAIL THROUGH THE STRAP ATTACHMENT SLOTS OF THE WEB STRAPS INTO THE SPACER ASSEMBLIES AT TIEDOWN ANCHOR LOCATIONS 1 AND 3 ON EACH SIDE OF THE CROP W/1-10d PARTIALLY DRIVEN NAIL AND BEND OVER SIDE OF HOOK.

(4) SIDE SPACER ASSEMBLY (6 REQD). SEE DETAIL ON PAGE 5. POSITION THE ASSEMBLIES AGAINST THE PALLET UNITS ON EACH SIDE OF THE CROP AS SHOWN. NOTE: NAIL THROUGH THE STRAP ATTACHMENT SLOTS OF THE WEB STRAPS INTO THE SPACER ASSEMBLIES AT TIEDOWN ANCHOR LOCATIONS 4, 8, 9, 14, 16, AND 19 ON EACH SIDE OF THE CROP W/1-10d PARTIALLY DRIVEN NAIL AND BEND OVER SIDE OF HOOK.

(5) HOLD-DOWN STRAP, 3-INCH WIDE WEB STRAP TIEDOWN ASSEMBLY FOR CROP (14 REQD). INSTALL EACH HOLD-DOWN STRAP TO EXTEND FROM THE DESIGNATED TIEDOWN ANCHOR ON ONE SIDE OF CROP, OVER THE TOP OF THE PALLET UNITS TO THE CORRESPONDING TIEDOWN ANCHOR ON THE OPPOSITE SIDE OF THE CROP. ALIGN SCUFF SLEEVES OVER ALL SHARP EDGES AND FIRMLY TENSION STRAP.

FIGURE D-41. Example of crop load of missiles.

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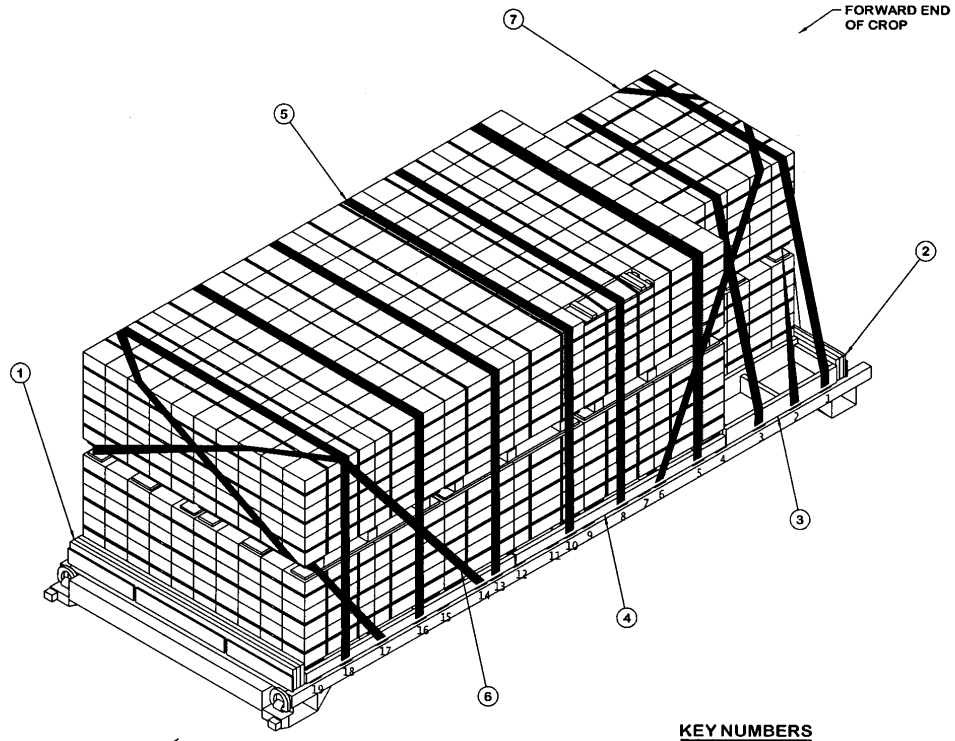

ISOMETRIC VIEW

(KEY NUMBERS CONTINUED)

(6) AFT END RESTRAINT STRAP, 3-INCH WIDE WEB STRAP TIEDOWN ASSEMBLY FOR CROP (2 REQD). INSTALL STRAPS FROM THE FOURTEENTH AND EIGHTEENTH TIEDOWN ANCHOR ON ONE SIDE OF THE CROP AT AN ANGLE AROUND THE CORNER POSTS OR OVER THE PALLET UNITS (AS APPLICABLE) ON THE SECOND LAYER AND BACK DOWN TO THE OPPOSITE (FOURTEENTH TO SEVENTEENTH AND SEVENTEENTH TO FOURTEENTH) TIEDOWN ANCHOR ON THE OPPOSITE SIDE OF THE CROP. ALIGN SCUFF SLEEVES OVER ALL SHARP EDGES AND FIRMLY TENSION STRAP.

(7) FORWARD END RESTRAINT STRAP, 3-INCH WIDE WEB STRAP TIEDOWN ASSEMBLY FOR CROP (2 REQD). INSTALL STRAPS FROM THE SECOND AND SIXTH TIEDOWN ANCHOR ON ONE SIDE OF THE CROP AT AN ANGLE AROUND THE CORNER POSTS OR OVER THE PALLET UNITS (AS APPLICABLE) ON THE SECOND LAYER AND BACK DOWN TO THE OPPOSITE (SECOND TO SIXTH AND SIXTH TO SECOND) TIEDOWN ANCHOR ON THE OPPOSITE SIDE OF THE CROP. ALIGN SCUFF SLEEVES OVER ALL SHARP EDGES AND FIRMLY TENSION STRAP.

KEY NUMBERS

(1) AFT FILLER ASSEMBLY (1 REQD). CENTER AGAINST AFT CROP END GATE WITH THE CLEATS FACING FORWARD AND, AFTER THE PALLET UNITS ARE LOADED, NAIL W/2-12d NAILS THRU THE SLOTS IN THE AFT CROP END GATE INTO THE AFT FILLER ASSEMBLY, LEAVING THE NAIL HEADS PROTRUDING THRU THE SLOTS TO PROVIDE LATERAL RESTRAINT.

(2) FORWARD FILLER, 1" OR 2" X 8" X 7'-4" (AS REQD). LAMINATE EACH PIECE TO THE PREVIOUS PIECE W/8 NAILS OF A SUITABLE SIZE (10d NAILS FOR 2" THICK MATERIAL). CENTER AGAINST FORWARD CROP END GATE AND, AFTER THE PALLET UNITS ARE LOADED, NAIL W/2-12d NAILS THRU THE HOLES IN THE FORWARD CROP END GATE INTO THE FORWARD FILLER PIECES, LEAVING THE NAIL HEADS PROTRUDING THRU THE HOLES TO PROVIDE LATERAL AND VERTICAL RESTRAINT.

(3) SPACER ASSEMBLY (2 REQD). POSITION THE SPACER ASSEMBLY AGAINST THE FORWARD PALLET UNIT ON EACH SIDE OF THE CROP. NAIL THROUGH THE FORWARD STRUT OF EACH ASSEMBLY INTO THE FORWARD FILLER W/2-10d NAILS. AFTER THE HOLD-DOWN STRAPS ARE INSTALLED, NAIL THROUGH THE STRAP ATTACHMENT SLOTS OF EACH HOLD-DOWN STRAP INTO THE SPACER ASSEMBLIES W/1-10d NAIL PARTIALLY DRIVEN AND BENT OVER SIDE OF HOOK.

(4) SIDE BLOCKING, 2" X 4" X 6'-10" (4 REQD). POSITION THE SIDE BLOCKING AGAINST THE PALLET UNITS ON BOTH SIDES OF THE CROP AS SHOWN. AFTER THE HOLD-DOWN STRAPS ARE INSTALLED, NAIL THROUGH THE STRAP ATTACHMENT SLOTS OF EACH HOLD-DOWN STRAP INTO THE SIDE BLOCKING W/1-10d NAIL PARTIALLY DRIVEN AND BENT OVER SIDE OF HOOK.

(5) HOLD-DOWN STRAP, 3-INCH WIDE WEB STRAP TIEDOWN ASSEMBLY FOR CROP (8 REQD). INSTALL EACH HOLD-DOWN STRAP TO EXTEND FROM THE DESIGNATED TIEDOWN ANCHOR ON ONE SIDE OF CROP, OVER THE TOP OF THE PALLET UNITS, TO THE CORRESPONDING TIEDOWN ANCHOR ON THE OPPOSITE SIDE OF THE CROP. ALIGN SCUFF SLEEVES OVER ALL SHARP EDGES AND FIRMLY TENSION STRAP.

(CONTINUED AT LEFT)

FIGURE D-42. Example of crop load of ammunition.

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D.4.8 Intermodal container load inspection. Load inspection should be performed by qualified personnel as the unit loads are placed and dunnaged bay-by-bay. Inspection should determine if the lading is loaded and secured in strict accordance with the applicable drawing. Upon satisfactory inspection of the load and its dunnage, shipping documents should be attached inside the intermodal container in an accessible location. The container doors should be closed and sealed. Appropriate placards should be attached to the outside of the intermodal container for the intended mode of transportation.

D.5 INTERMODAL LOAD EVALUATION

D.5.1 General. This section covers road hazard testing and impact testing of intermodal container loads of hazardous materials. This section is intended to establish standard procedures for the following:

a. Road hazard tests of intermodal container loads for unique items of lading and new dunnaging methods.

b. Railway impact tests of intermodal container loads for unique items of lading and new dunnaging methods.

D.5.2 Intermodal container road testing. When, in the opinion of approval authorities of 4.2, a proposed container load is considered unique because of features of the lading or the loading procedures, a road hazard test should be conducted to prove the safety and adequacy of the proposed container loading procedures.

D.5.2.1 Test load (specimen). The test load is prepared using the same blocking and bracing methods specified in the outloading procedures proposed for use with the munitions. The intermodal container, used in the test, should be inspected to assure its adequacy for munitions transport. Items used to build the load should be inert (nonexplosive). The weight and physical characteristics of the load configuration should be identical to the live (explosive) ammunition provided for in the outloading procedure; i.e., weights, physical dimensions, center of gravity, materials, etc. The ammunition packages used should duplicate that of the live ammunition.

D.5.3 Railway impact test. When, in the opinion of approval authorities of 4.2 and the Bureau of Explosives, a proposed intermodal container load intended for transportation via TOFC or COFC is considered unique because of the characteristics of the load, structural features of the lading, or the lading procedures, a railway impact test should be conducted to prove the safety and adequacy of the proposed loading plan. Impact tests should be coordinated with Military Traffic Management and Terminal Services, NAVORDSYSCOM, Bureau of Explosives, and the activities listed in 4.2.

a. The test load (intermodal container) should be positioned in/on a railcar.

b. The loaded container should be positioned on a container chassis or on a COFC railcar and securely locked in place using the twist locks at each corner, as applicable.

c. The container chassis should be secured to a railcar.

d. Equipment needed to perform the test includes the specimen (hammer) car, five empty railroad cars (or equivalent to 250,000 pounds) connected together to serve as the anvil, and a railroad locomotive.

e. These anvil cars are positioned on a level section of track with air and hand brakes set and with the draft gears compressed.

f. The locomotive unit should pull the specimen car several hundred yards away from the anvil cars, push the specimen car toward the anvil at a predetermined speed, and disconnect from the specimen car approximately 50 yards away from the anvil cars, which should allow the specimen car to roll freely along the track until it strikes the anvil. This should constitute an impact.

g. Impacting should be accomplished at speeds of 4, 6, and 8.1 mph in one direction and at a speed of 8.1 mph in the opposite direction.

h. The tolerance for the speeds is +0.5 mph, -0 mph. Impact speeds should be determined by using an electronic counter to measure the time required for the specimen car to traverse a specific distance (see figure D-43) immediately prior to impact.

i. Between impacts, the anvil railcars should be inspected and the brakes reset if necessary.

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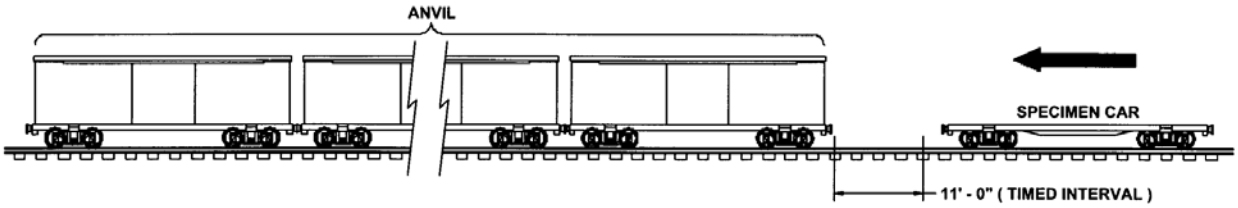
ASSOCIATION OF AMERICAN RAILROADS (AAR)
STANDARD TEST PLAN



4 BUFFER CARS (ANVIL)
WITH DRAFT GEAR COMPRESSED
AND AIR BRAKES IN A SET POSITION

ANVIL CAR TOTAL WT. 250,000 LBS (APPROX)

SPECIMEN CAR IS RELEASED BY
SWITCH ENGINE TO ATTAIN:

IMPACT NO. 1 @ 4 MPH
IMPACT NO. 2 @ 6 MPH
IMPACT NO. 3 @ 8.1 MPH

THEN THE CAR IS REVERSED AND RELEASED
BY SWITCH ENGINE TO ATTAIN:

IMPACT NO. 4 @ 8.1 MPH

FIGURE D-43 Railcar impact test

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D.5.4 Road test procedures.

a. Hazard course. This test requires the intermodal load secured to an approved intermodal chassis to be driven over a 200-foot long segment of concrete-paved road that consists of two series of railroad ties projecting approximately 6 inches above the level of the road surface. This hazard course should be traversed two times (see figure D-44) for each test.

(1) The first series of ties consists of six ties spaced on 10-foot centers and alternately positioned on opposite sides of the road centerline for a distance of 50 feet.

(2) Following the first series of ties, a paved roadway of 75 feet separates the first and second series of railroad ties.

(3) The second series of ties consists of seven ties spaced on 8-foot centers and alternately positioned on opposite sides of the road centerline for a distance of 50 feet.

(4) The test load should be driven across the hazard course at speeds that would produce the most violent vertical and side-to-side rolling reaction obtainable in traversing the hazard course (approximately 5 mph).

b. Road trip. Using a suitable truck/tractor and trailer, the intermodal load should be driven/towed for a total distance of at least 30 miles over a combination of roads surfaced with gravel, concrete, or asphalt. Test route should include curves, corners, railroad crossings, cattle guards, and stops and starts. The test vehicle should travel at the maximum speed suitable for the particular road being traversed, except as limited by legal restrictions.

c. Panic stops. This step provides the intermodal load to be subjected to three full airbrake stops while traveling in the forward direction and one in the reverse direction while traveling down a 7-degree grade. The first three stops are at 5, 10, and 15 mph, while the stop in the reverse direction is of approximately 5 mph.

d. Repeat. Following the road trip and panic stops, the hazard course is again traversed two times.

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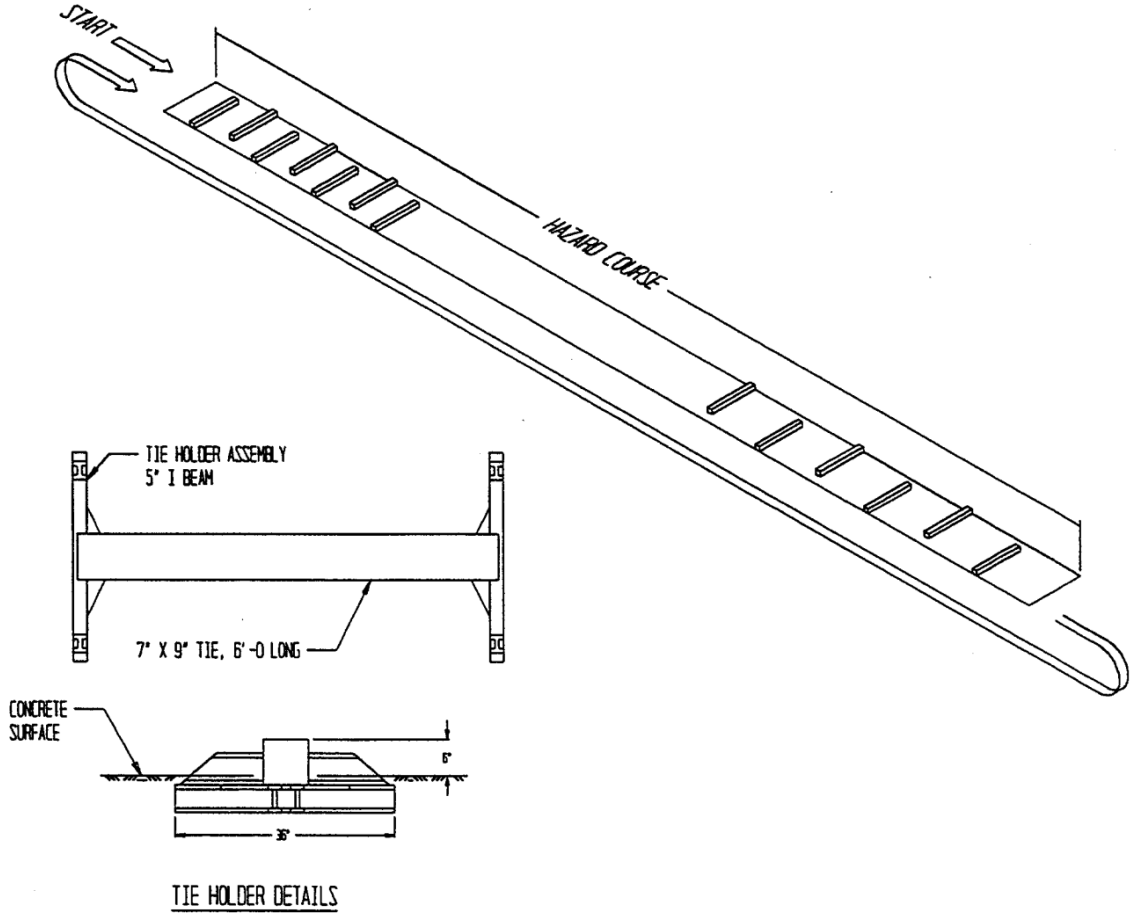

FIGURE D-44. Hazard course.

D.5.5 Shipboard transportation simulation (8-foot wide by 20-foot long containers only). The test load (intermodal load) should be positioned onto the Shipboard Transportation Simulator (STS) and securely locked in place using the cam lock at each corner. Using the procedure detailed in the operating instructions, the STS should begin oscillating at an angle of 30±2 degrees, either side or center and a frequency of 2 cycles-per-minute (30±2 seconds total roll period). This frequency should be observed for apparent defects that could cause a safety hazard. The frequency of oscillation should then be increased to 4 cycles-per-minute (15±1 second roll period) and the apparatus operated for 2 hours. If an inspection of the load does not indicate an impending failure, the frequency of oscillation should be further increased to 5 cycles-per-minute (12±1 second-cycle time), and the apparatus operated for 4 hours. The operation does not necessarily have to be continuous; however, no change or adjustments to the load or load restraints should be permitted at any time during the test. After once being set in place, the test load (specimen) should not be removed from the apparatus until the test has been completed or is terminated.

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D.5.5.1 80-degree tilt test (see figure D-45). This test should be employed as an alternate to test method D.5.5, and is required when the intermodal container is physically incompatible with the STS. The test load (specimen) should be positioned on level terrain with the bottom corner fittings resting on timbers so the entire container is supported solely by the bottom corner fittings. The timbers should be oriented parallel to the end rails of the container and extend 2 feet beyond the corner fittings on each side. Using two mobile cranes and appropriate rigging, the container should be rotated (tilted) using the bottom corner fittings on one side of a fulcrum. The rigging (sling) of one crane should be attached to the top corner fittings on the opposite side. The tilting should be accomplished by lifting the bottom corner fittings with the first crane so the container rotates about the opposite bottom corner. Lifting/rotating by the first crane should be continued until the center of gravity passes over the fulcrum, at which point the second crane should provide support to the container and lower the container to the 80±2-degree position. Rotation should be accomplished smoothly at a slow speed so the container side wall is subjected only to the static force of the interior load. The crane booms should be adjusted to maintain a rear vertical suspension of the rigging at all times. In the case of end-opening type containers, at least one door (lower side of tilted container) should be closed and fastened throughout the test. The container should be held in the tilted position for a minimum of 2 minutes. At which time, observations of both the container structure and the interior load should be made. When the test is completed, the container should be returned to its upright position using the same manner and care in handling.

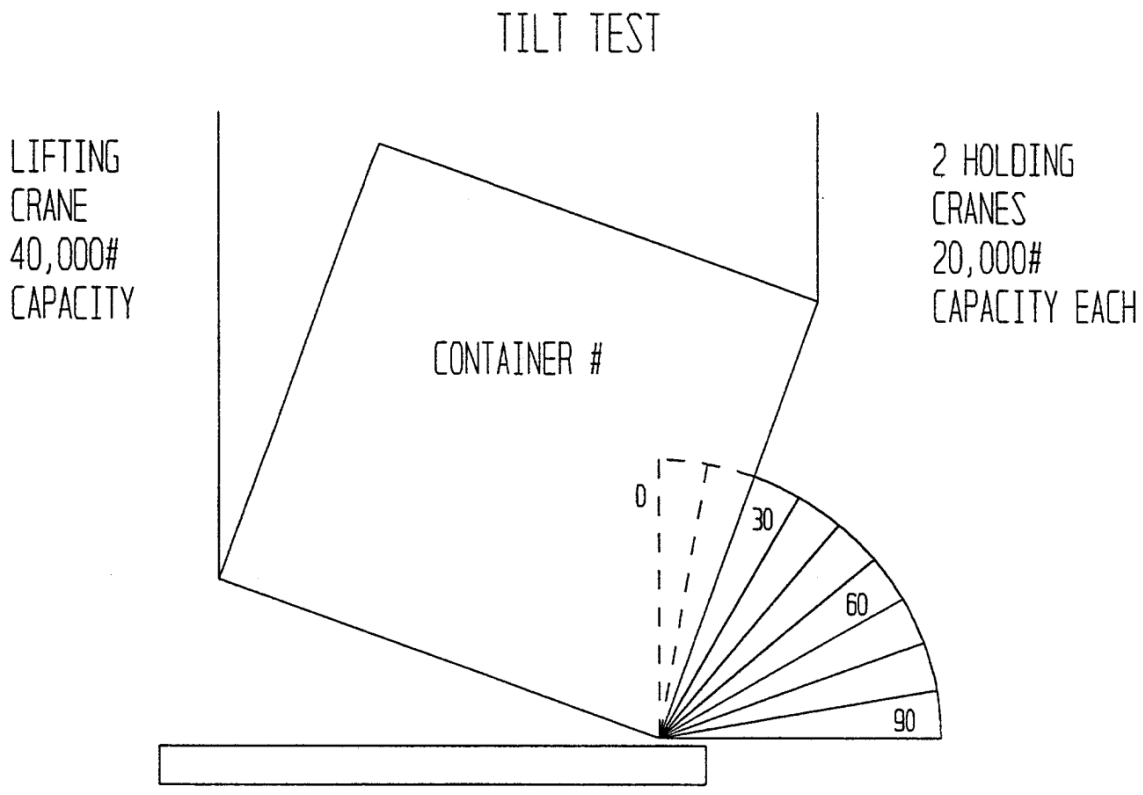

FIGURE D-45. Intermodal tilt test.

D.5.6 Washboard course (optional). Using a suitable truck/tractor, the intermodal container loaded on an approved chassis should be towed/driven over the washboard course (see figure D-46) at a speed which produces the most violent response in the particular test load (as indicated by the resonant frequency of the suspension system beneath the load). The washboard course should be constructed as shown on figure D-46.

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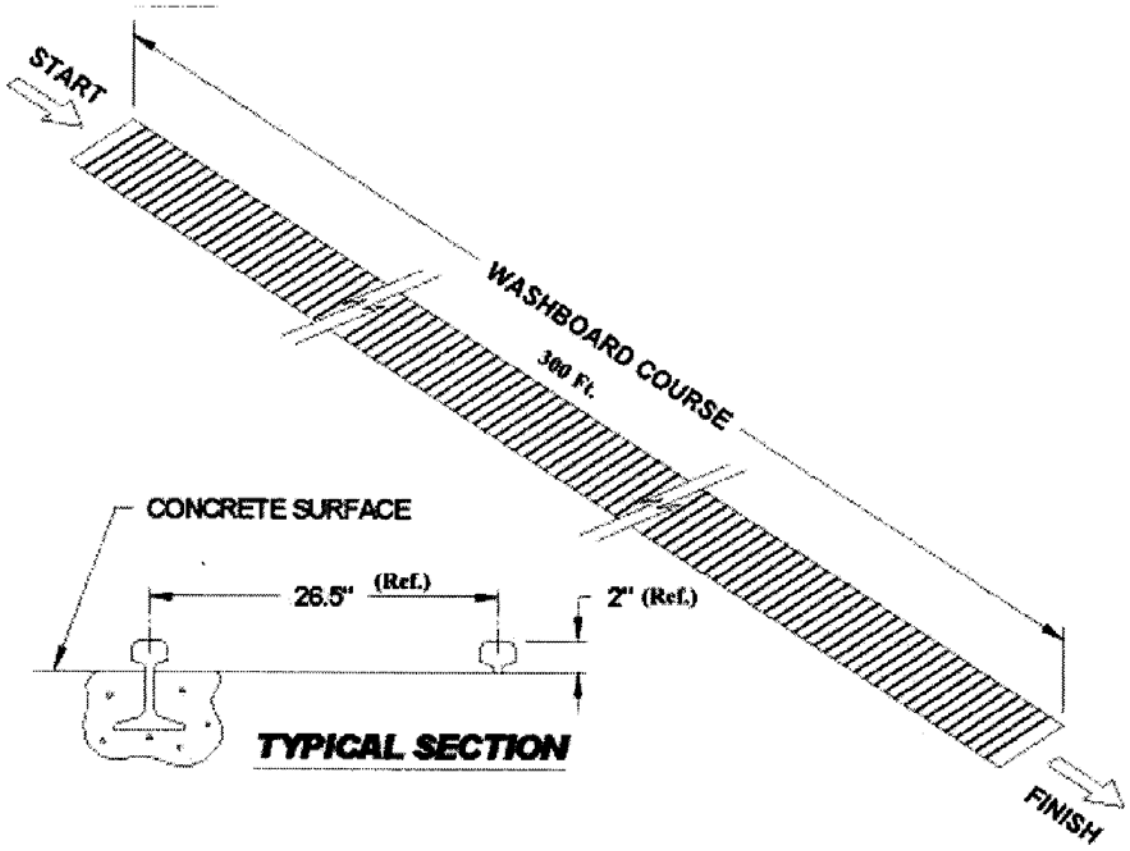

FIGURE D-46. Washboard course.

D.5.7 Acceptance criteria. Upon completion of the tests, there should be no damage to the lading, dunnage, or container and no movement of the lading that is likely to produce damage to the dunnage or container.

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Custodians:
Army – AV
Navy – OS
Air Force – 99
DLA – GS

Review activities:
Army – MI
Navy – AS, MC, SA, SH
Air Force – 11, 69, 70
DLA – CC, CT, DH, DM, GS3, GS7, IS, PS, SS
NGA – MP

Preparing activity:
Navy – OS
(Project 8140-2013-014)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla mil.