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 ¾-inch leg length for ¾-inch strapping, Type IV, Style 3 and 1 17/32-inch crown width by ¾-inch leg length for 1¼-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.

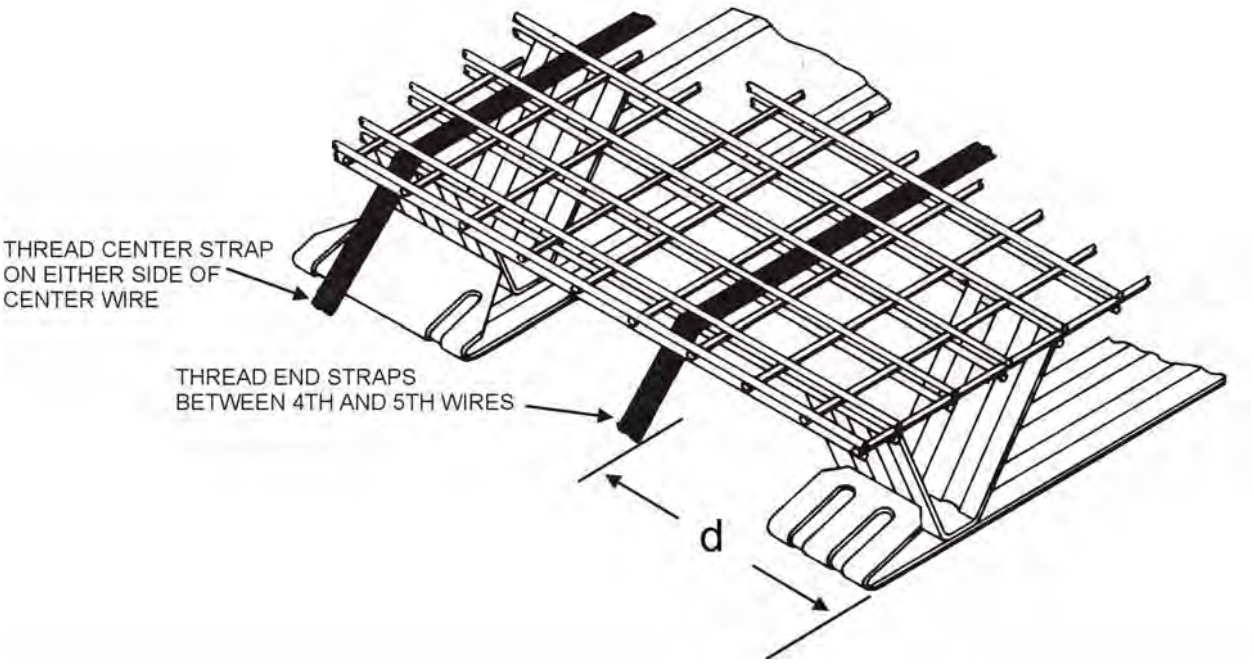

FIGURE A-1. Strap threaded between the deck wires of a pallet.

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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.

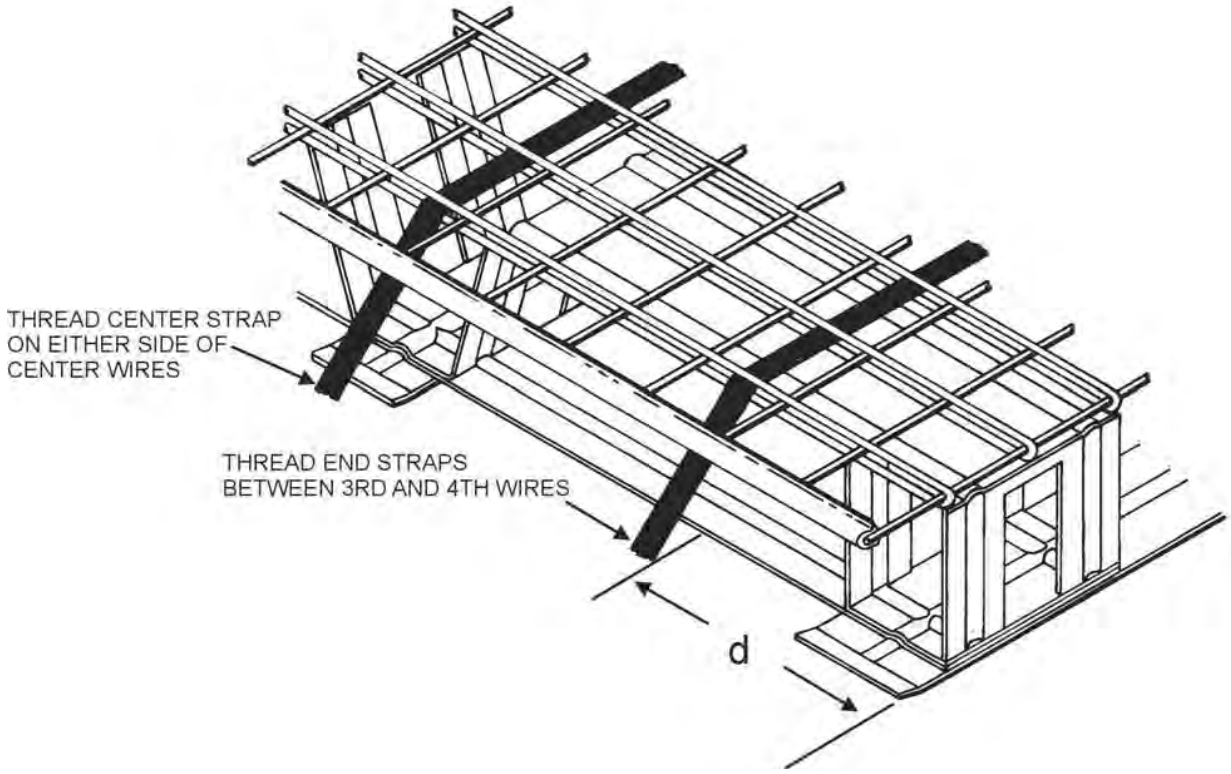

FIGURE A-2. MK 12 MOD 0 pallet (strap threading).

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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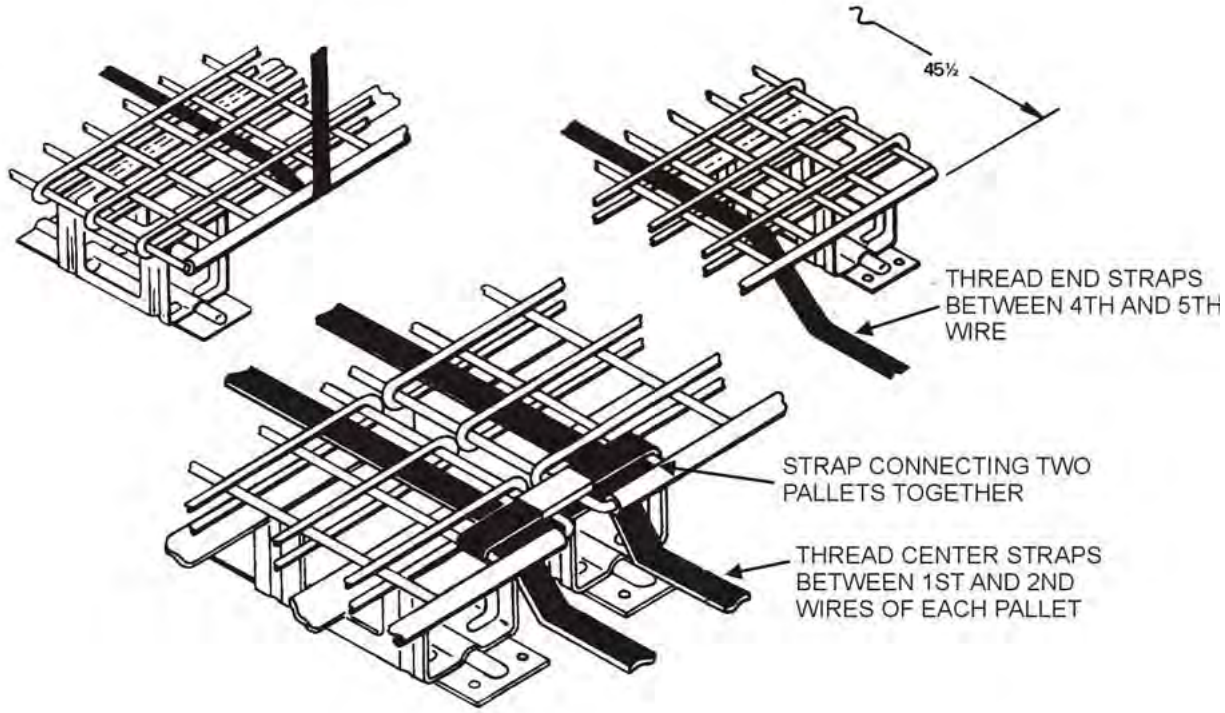

FIGURE A-3. MK 12 MOD 0 pallet (double-pallet strap threading).

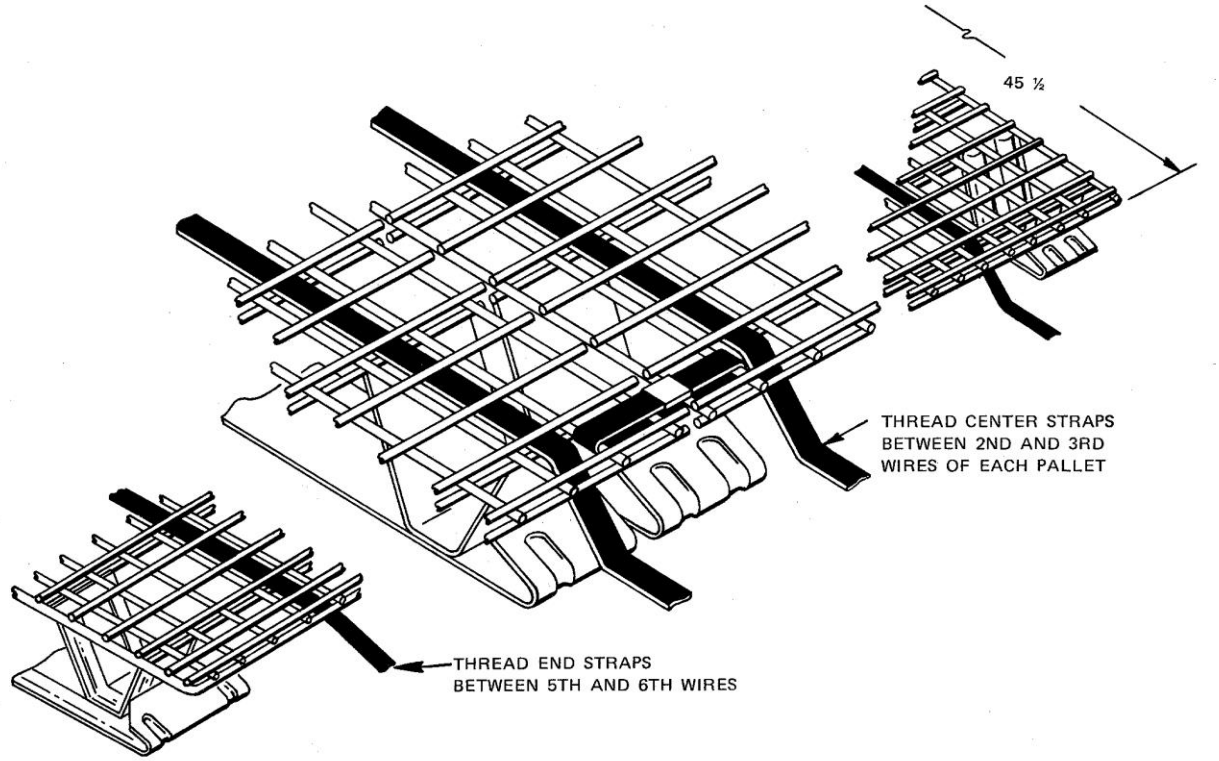

FIGURE A-4. MK 12 MOD 1 pallet (double-pallet strap threading).

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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.

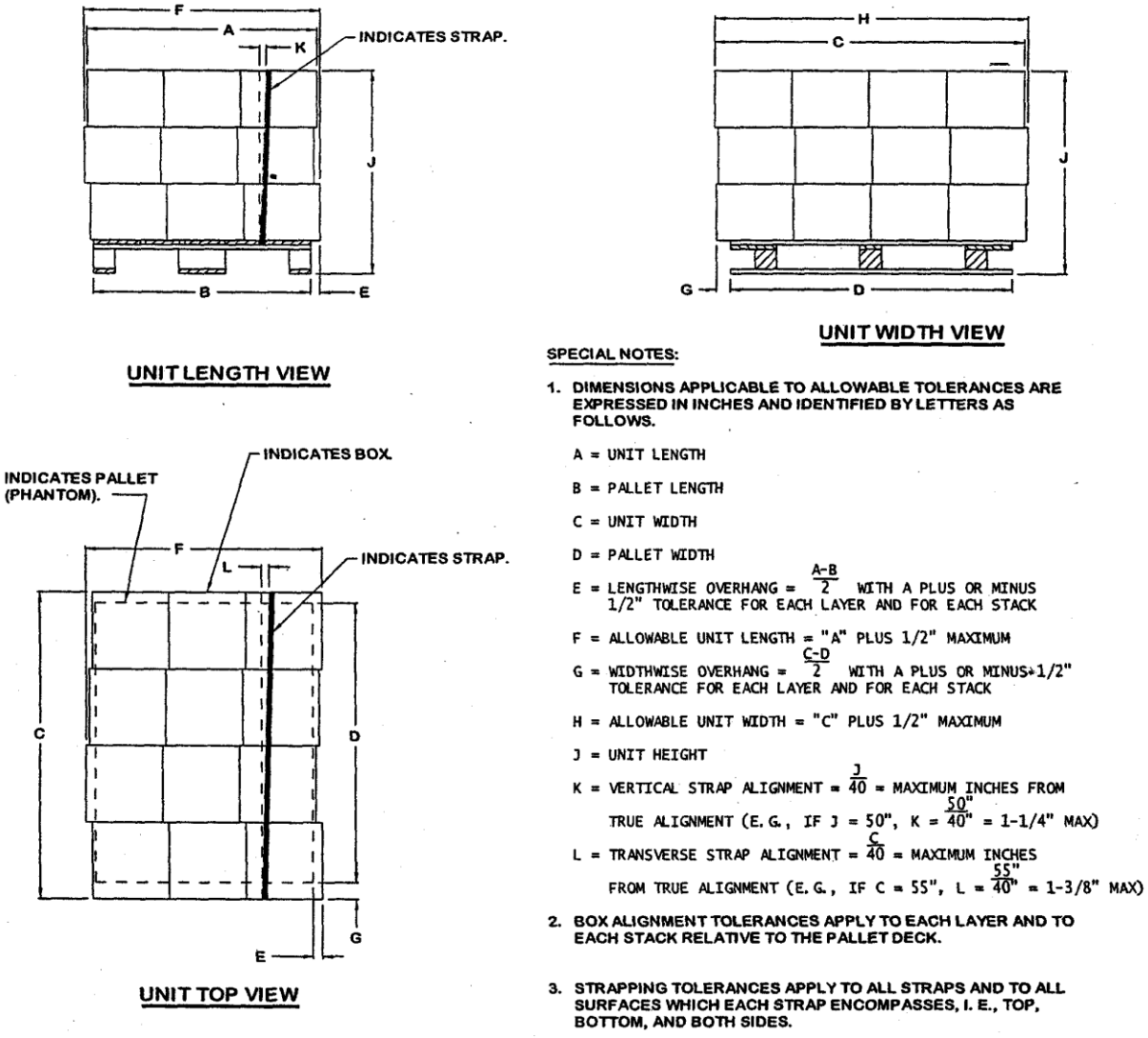

FIGURE A-5. Allowable tolerances for assembling units.

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).

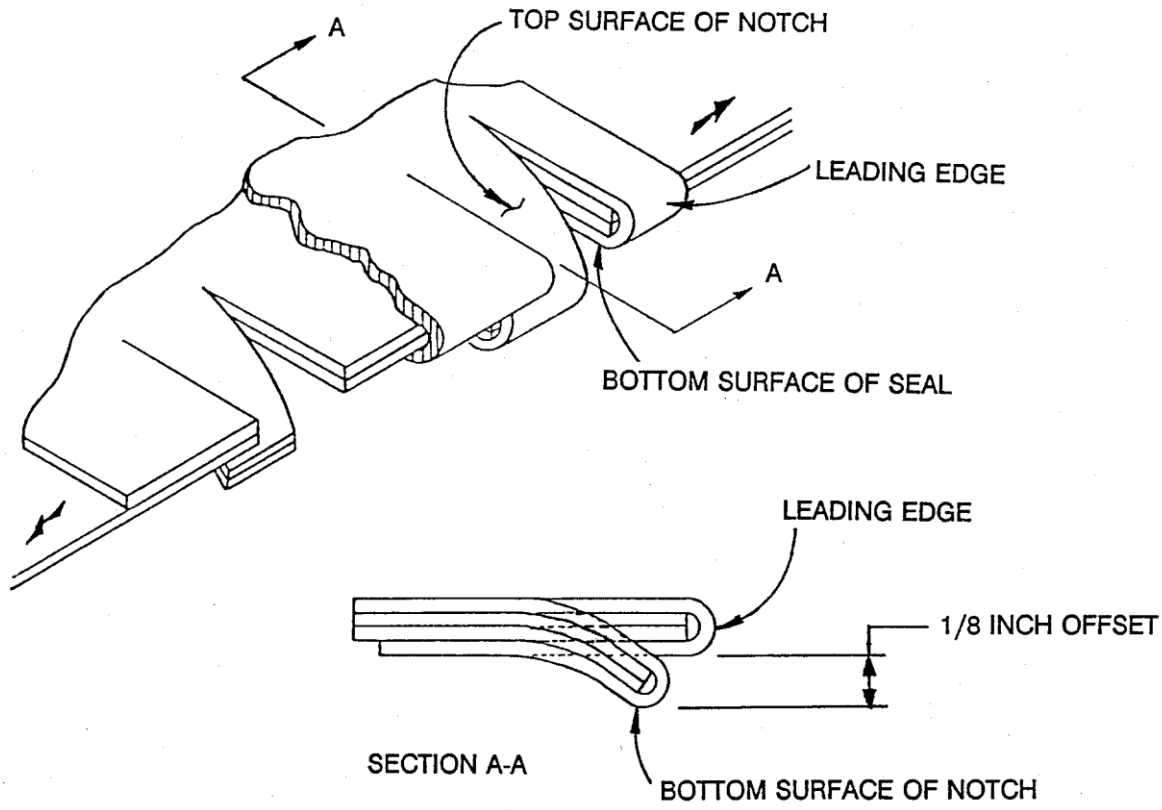

FIGURE A-6. Typical notched-seal joint.

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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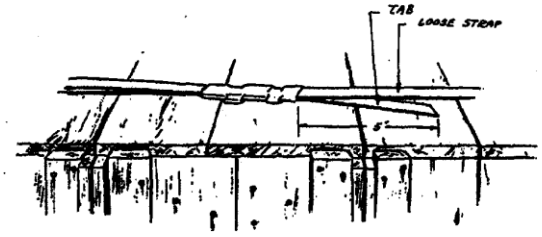
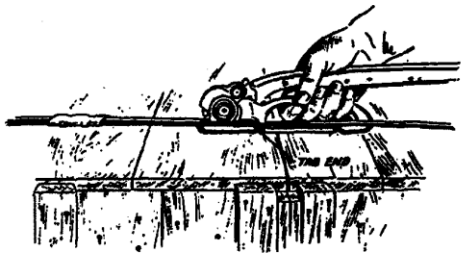
b. Steel strapping, which has been tensioned and sealed on a unit load of wood containers or a unit load where the strapping is around wood adapters or wood edge protectors, may be retensioned by the method shown on figure A-7 provided the strap has at least a 5-inch long tab at the seal. Except for 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.

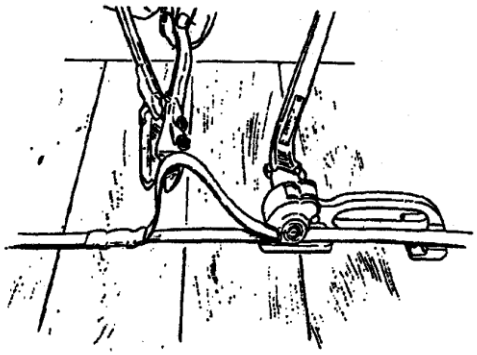
d. When a strap is replaced, spliced, or retensioned, and the other straps on a unit load are not, care should be exercised to ensure that the tension on the affected strap is nearly the same as that of the others.



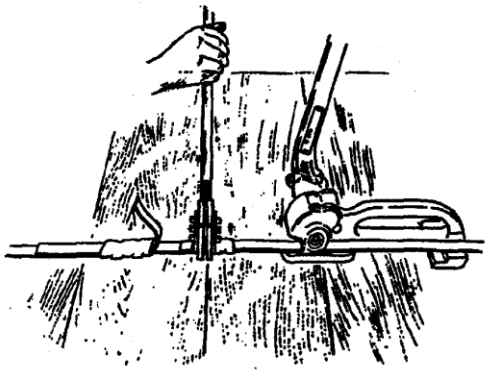
(a) Inspect strapping band for damage and for minimum 5-inch tab length.



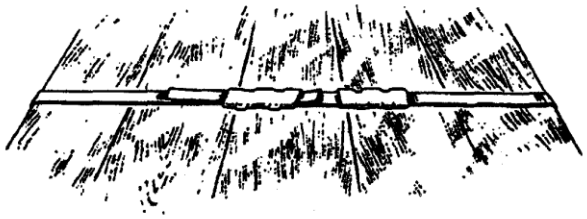
(b) Position feedwheel type tensioner at end of tab and tension strap.



(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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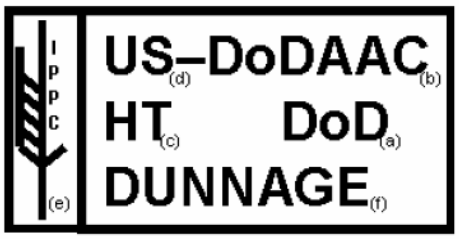
A.7.3.3 Pallets and adapters.

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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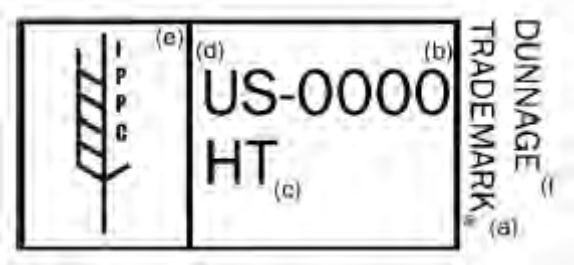

NOTES:

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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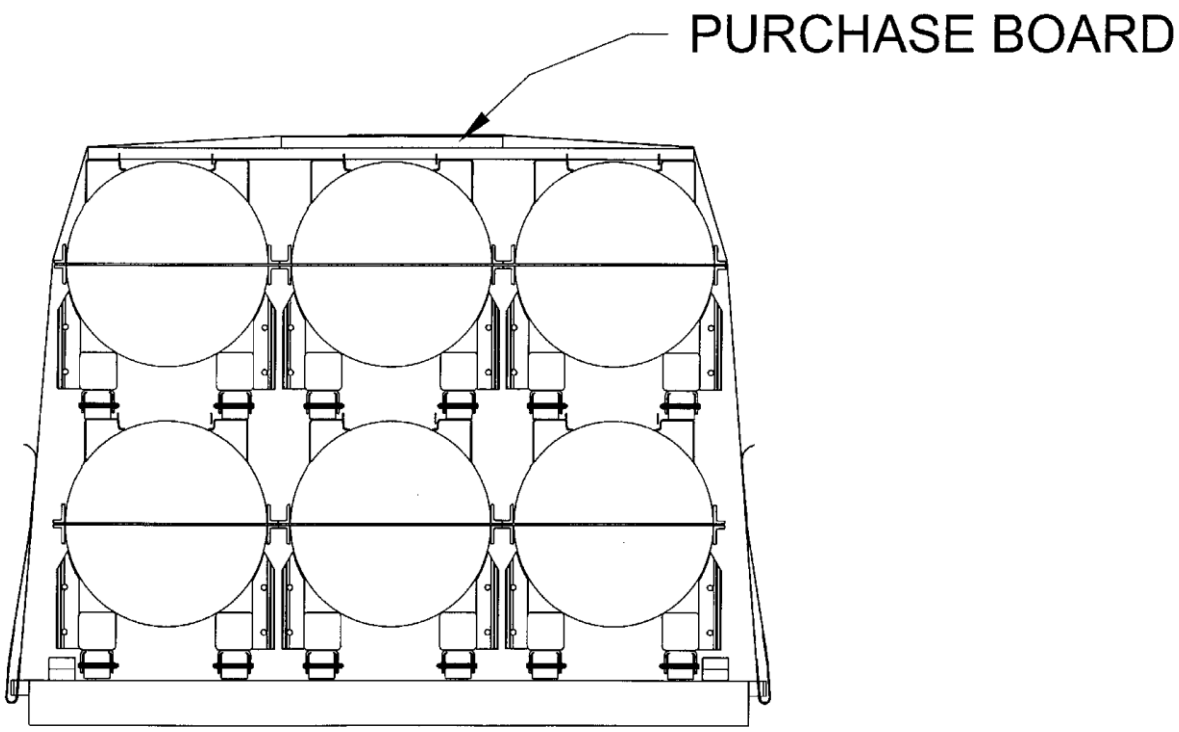

FIGURE B-1. Example purchase board.

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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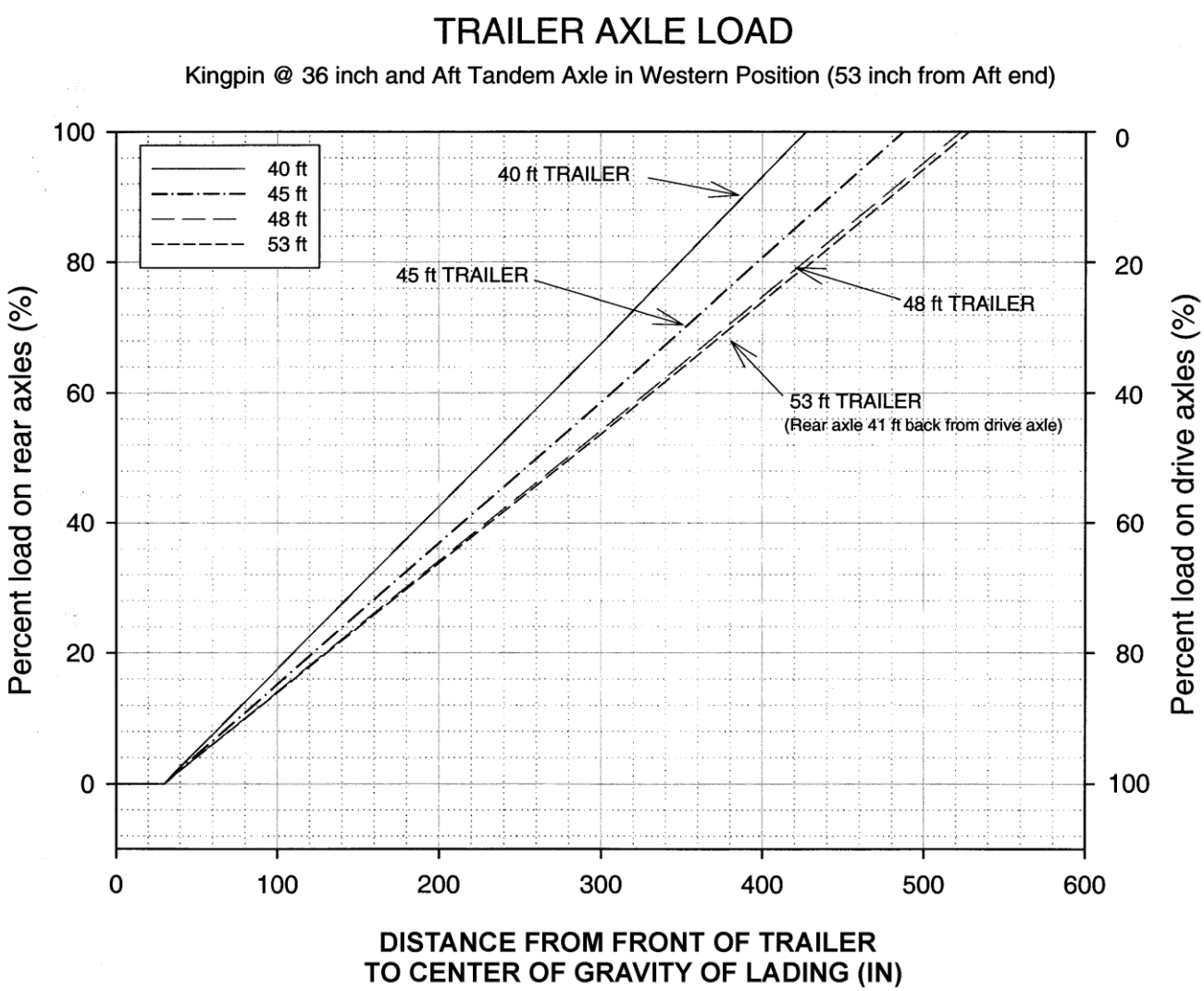

FIGURE B-2. Axle load plot (rear axle 53 inches from aft end of trailer).

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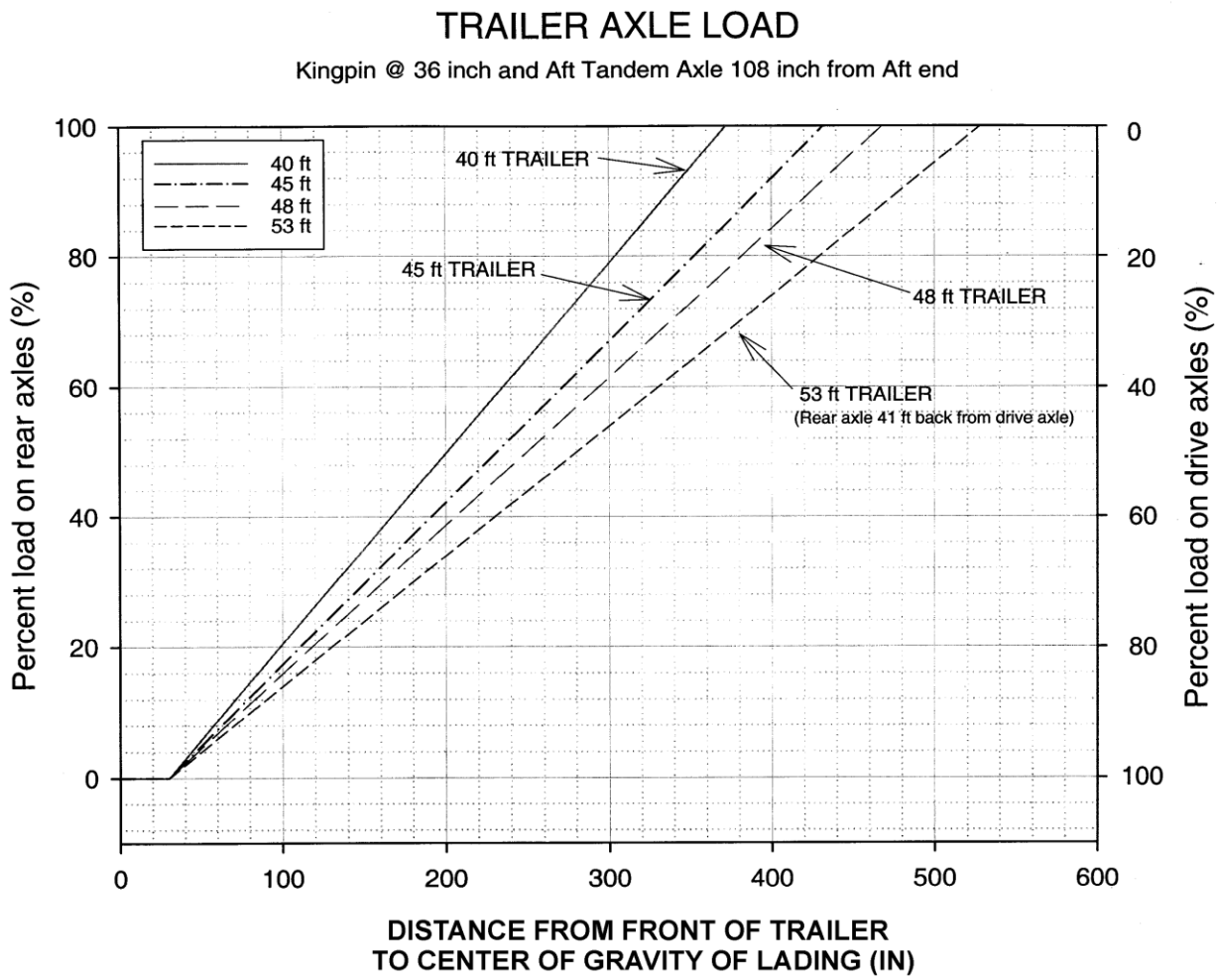

FIGURE B-3. Axle load chart (rear axle 108 inches from aft end of trailer).

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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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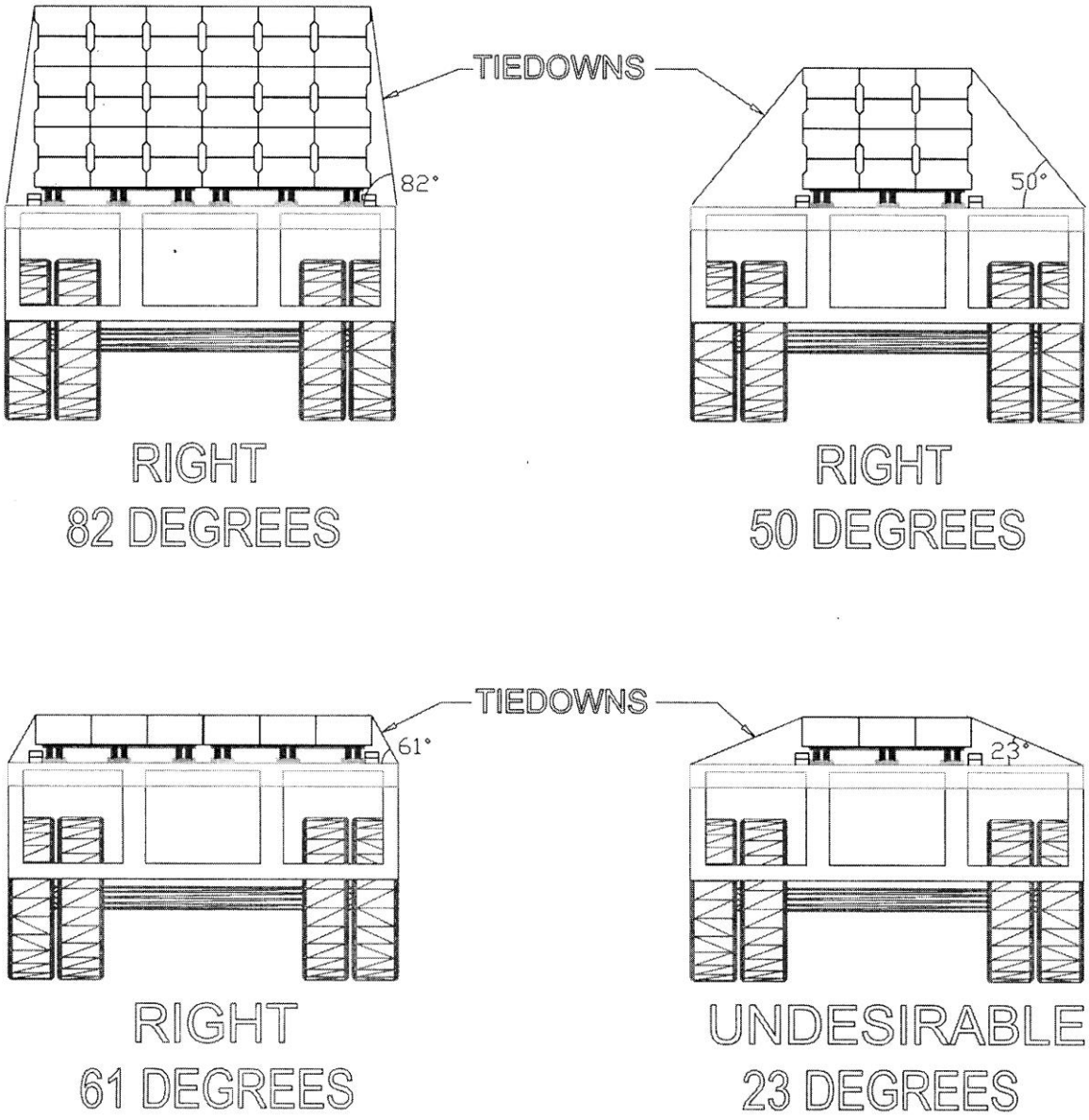

FIGURE B-4. Tiedown angle.

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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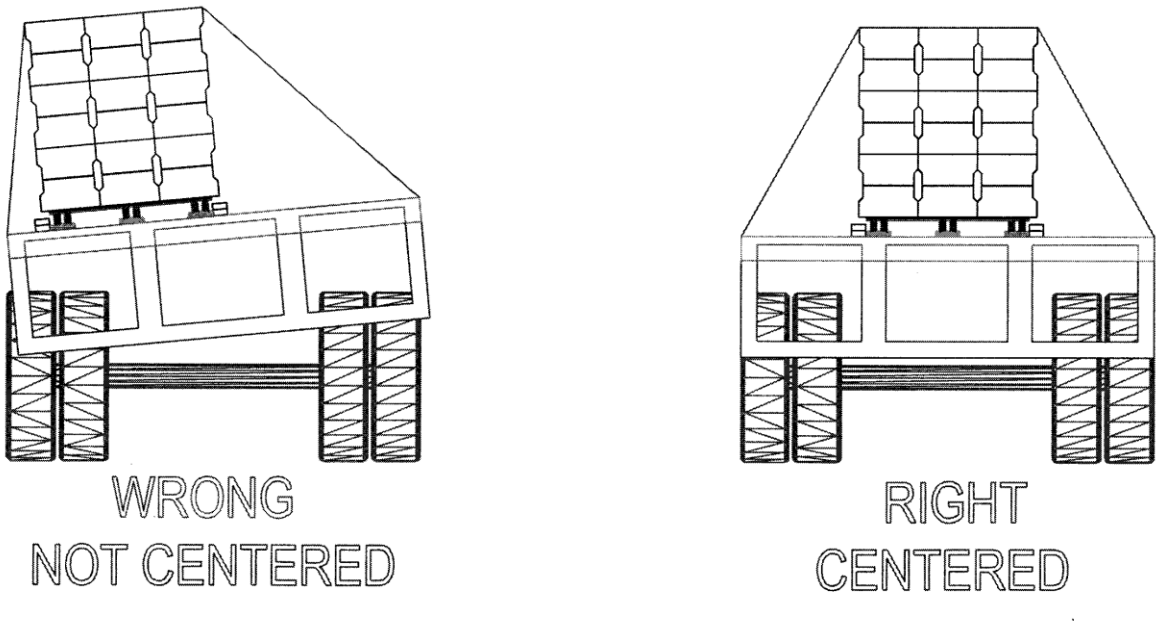

FIGURE B-5. Lateral load placement.

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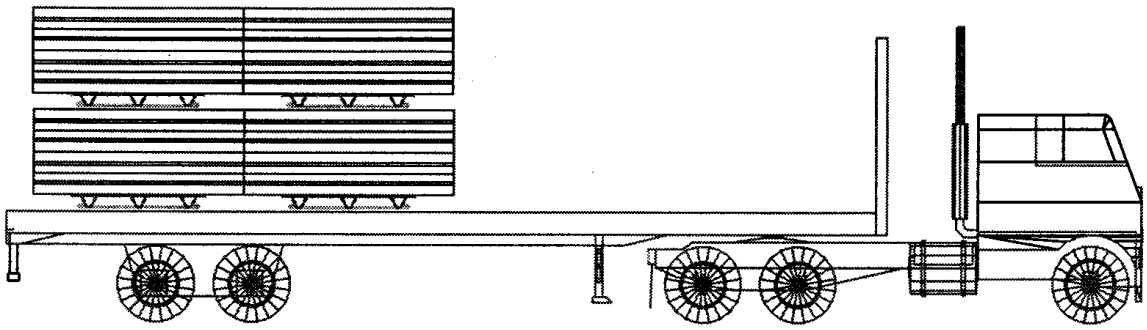
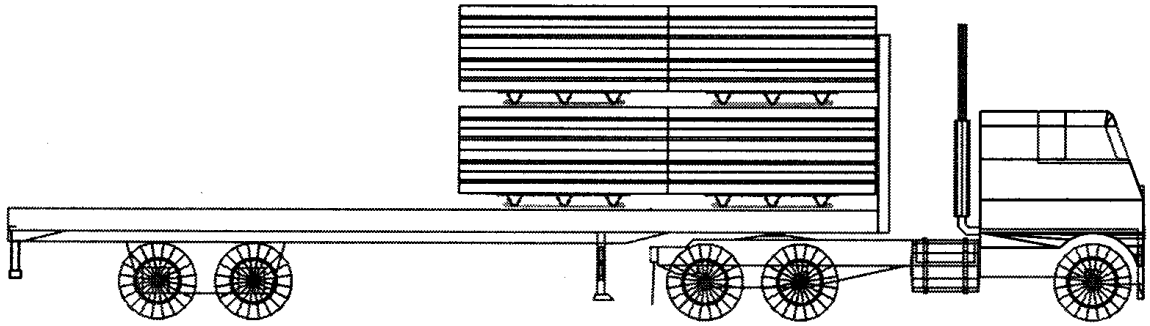
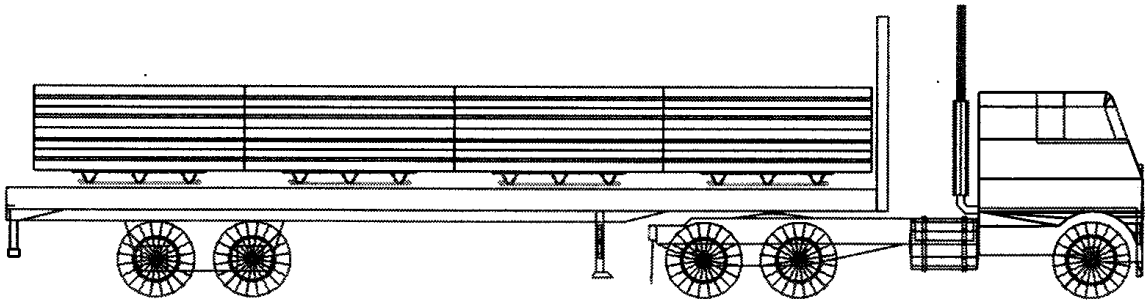


WRONG - COULD OVERLOAD REAR AXLES
AND CREATE A DANGEROUS DRIVING CONDITION



WRONG - COULD OVERLOAD DRIVE AXLES



RIGHT - LOAD IS SHARED BETWEEN ABOUT AXLES

FIGURE B-6. Longitudinal load placement.

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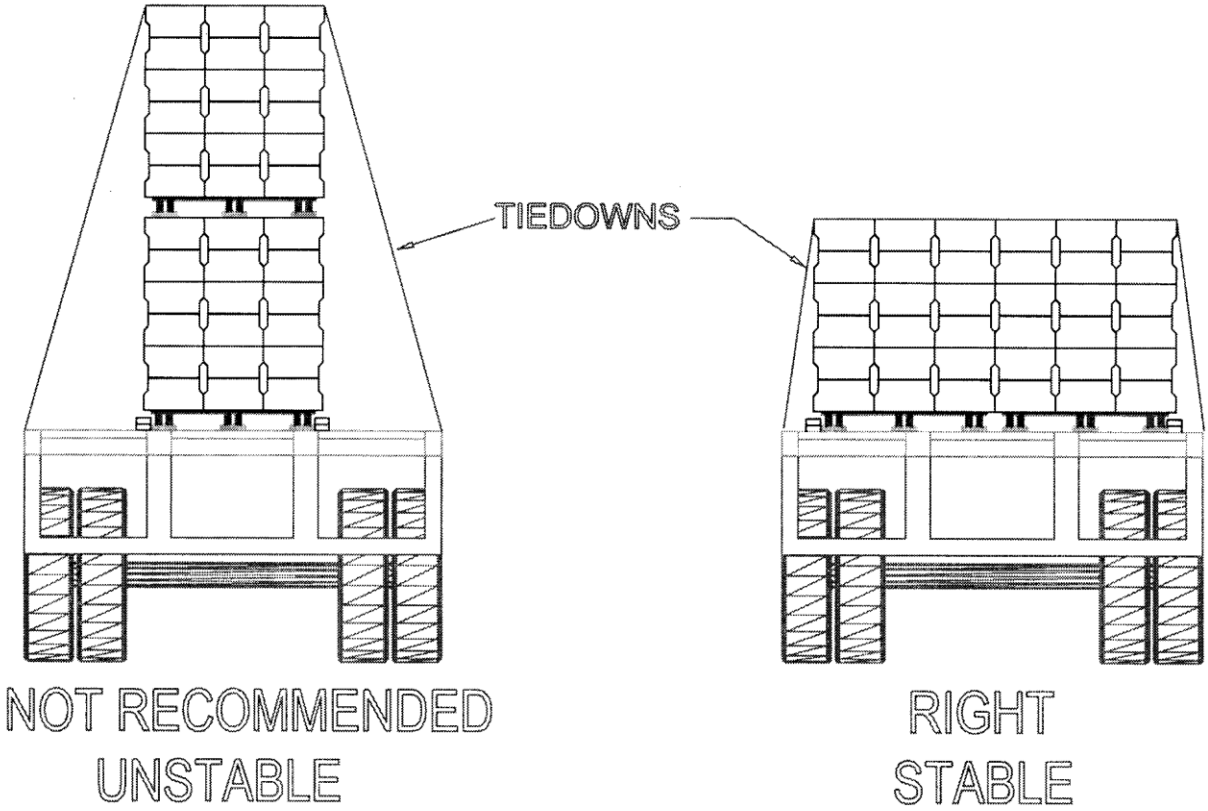

FIGURE B-7. Load stability.

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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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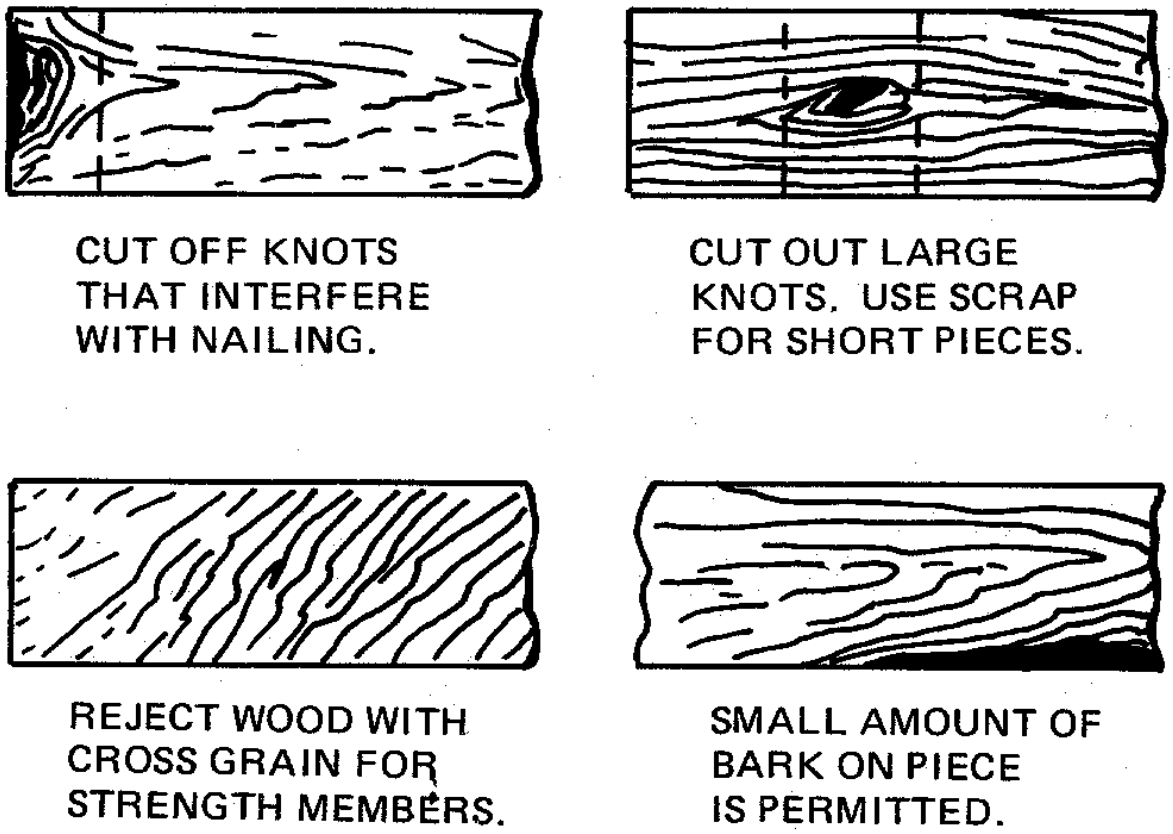

FIGURE B-8. Lumber defects.

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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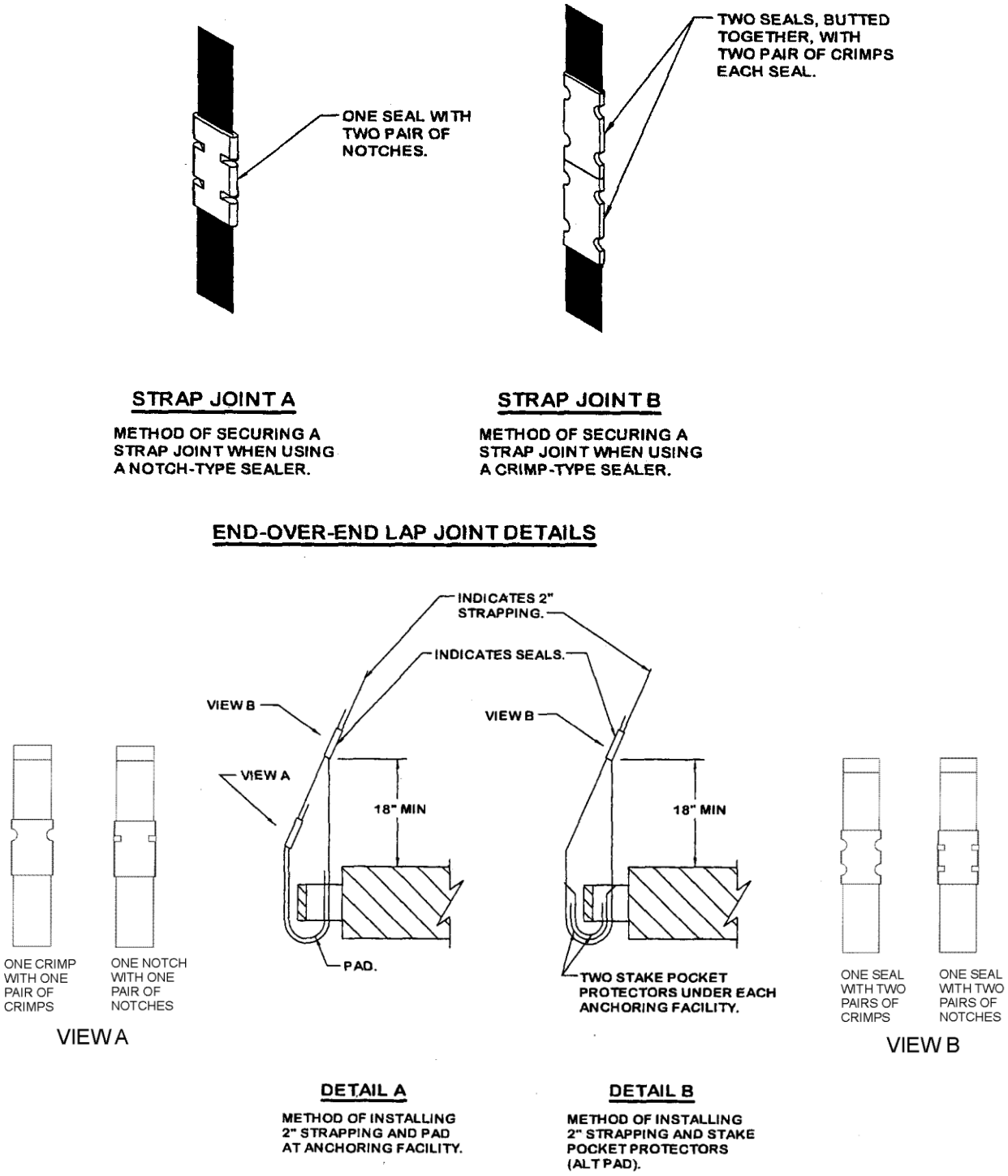

FIGURE B-9. Tiedown strapping.

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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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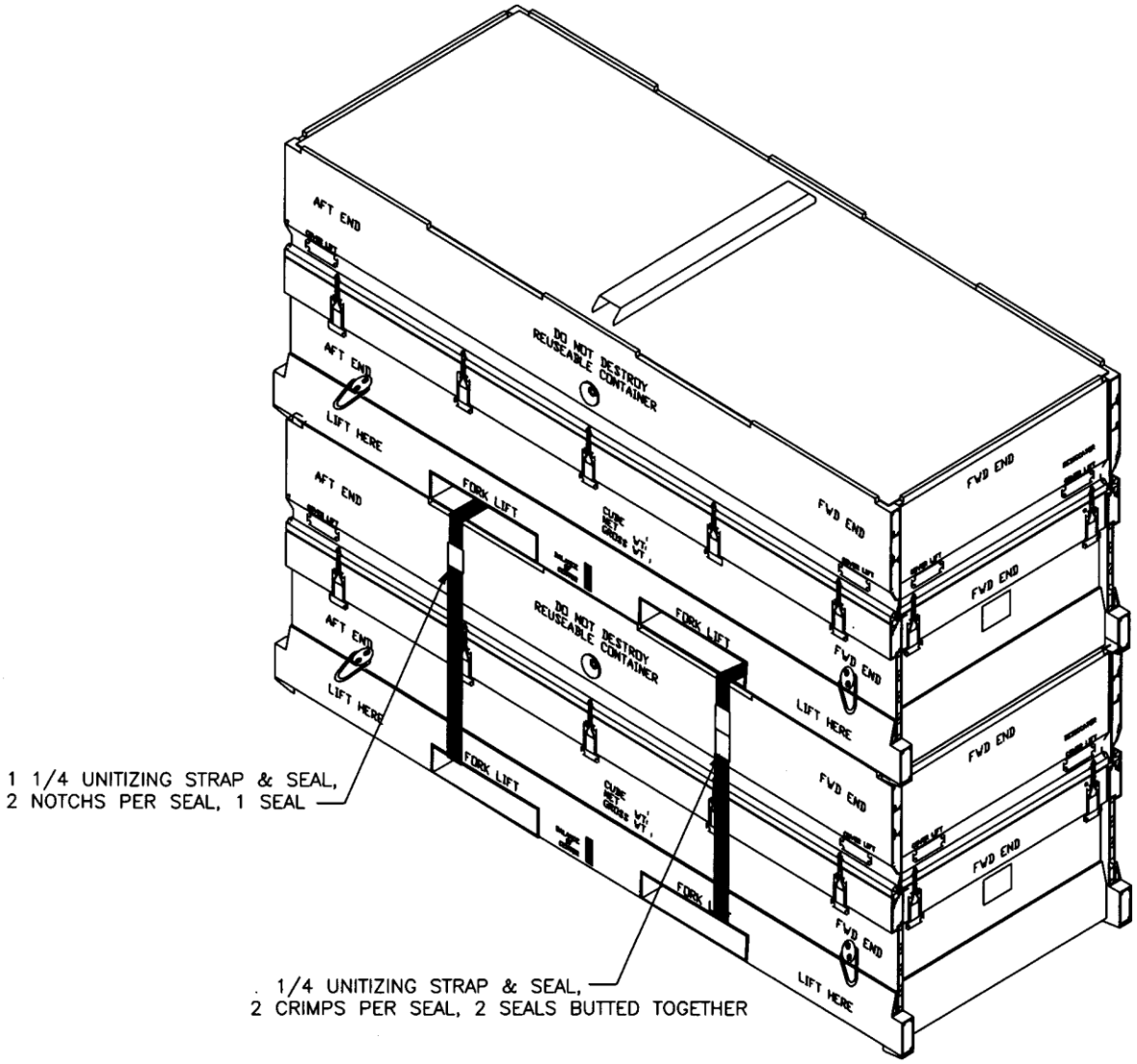

NOTES:

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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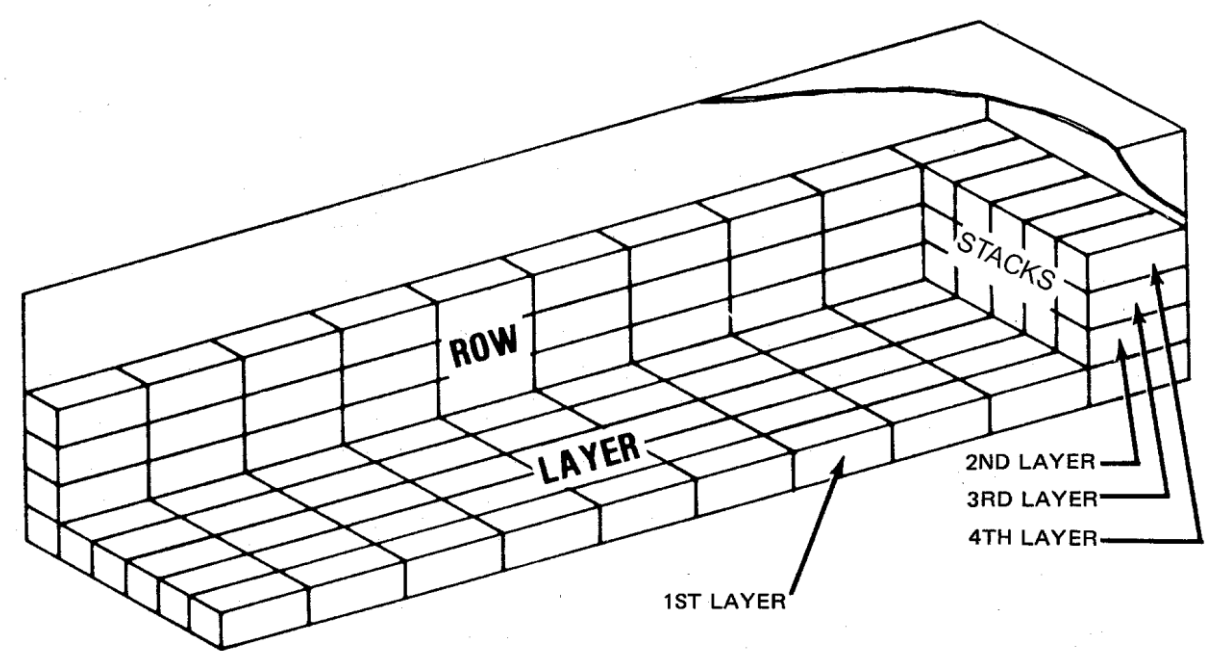

FIGURE B-11. Partial truckload showing nomenclature (layer, stack, and row).

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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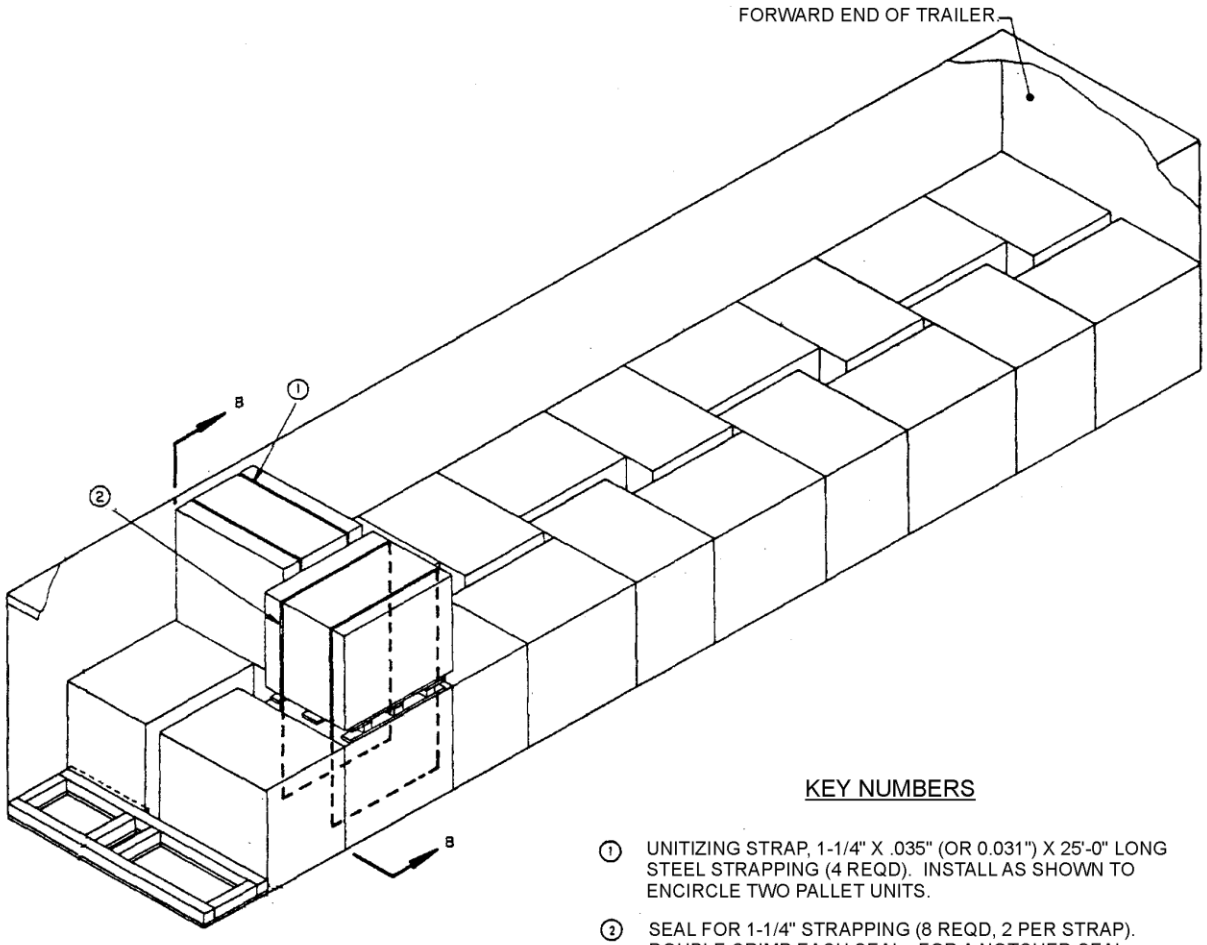
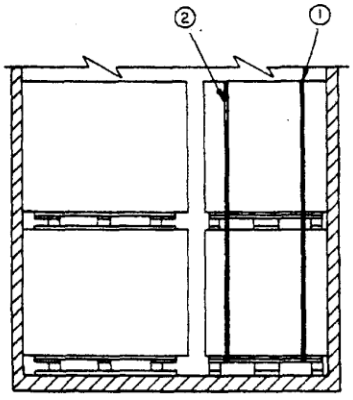


ISOMETRIC VIEW

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.

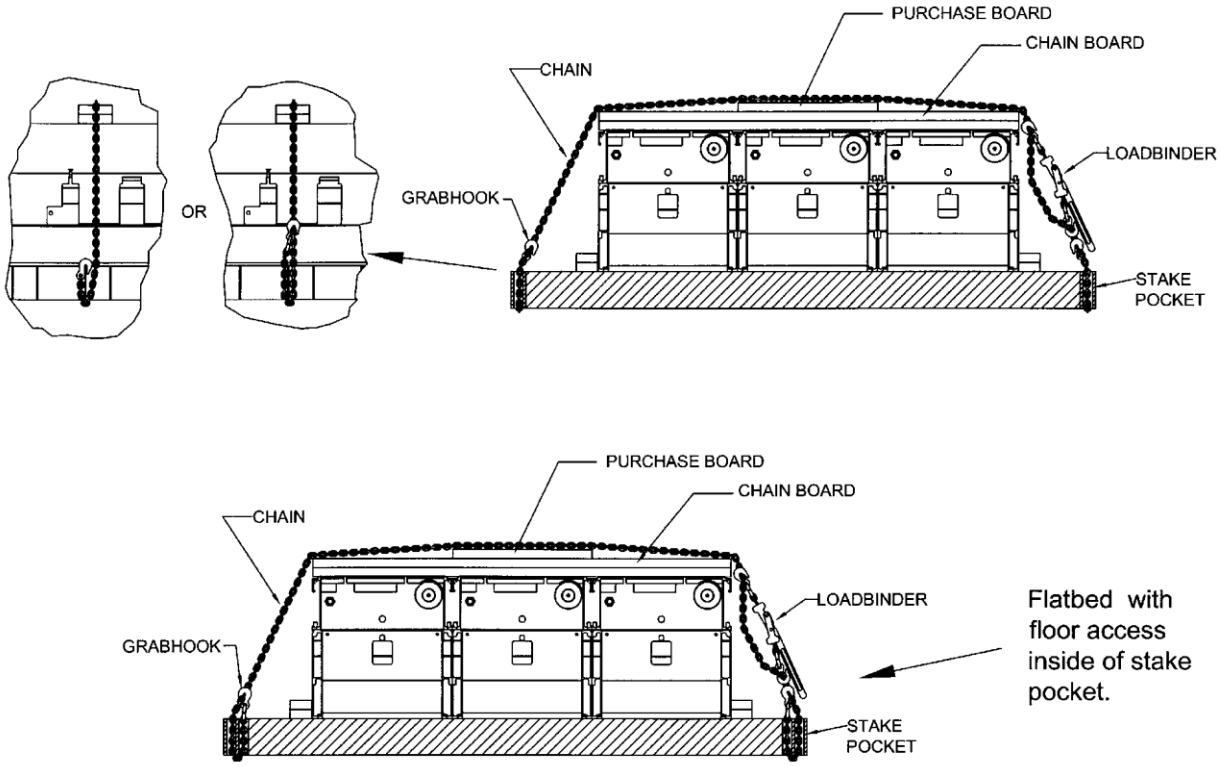

FIGURE B-13. Typical tiedown using chain and loadbinder.

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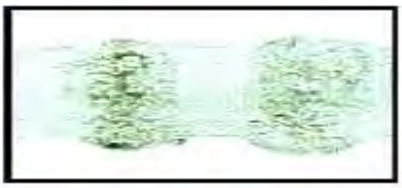
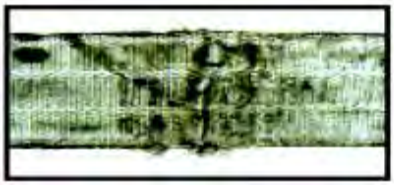
l. Evidence that the web material or the hardware has been damaged and repaired.
m. Anchor provisions with torn, deformed, or broken components or cracked welds.
n. Fading which may indicate ultraviolet (UV) exposure.
o. Staining which may indicate chemical seepage or exposure.

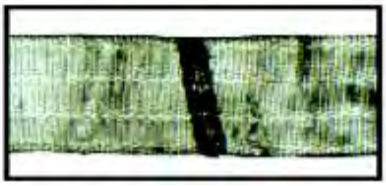
1. ACID, ALKALI, CHEMICAL, OR HEAT BURNS



5. CRUSHED WEB MATERIAL

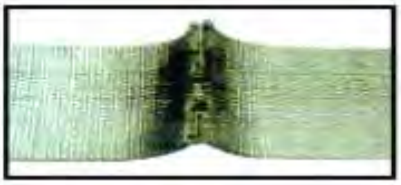


2. MELTING OR CHARRING



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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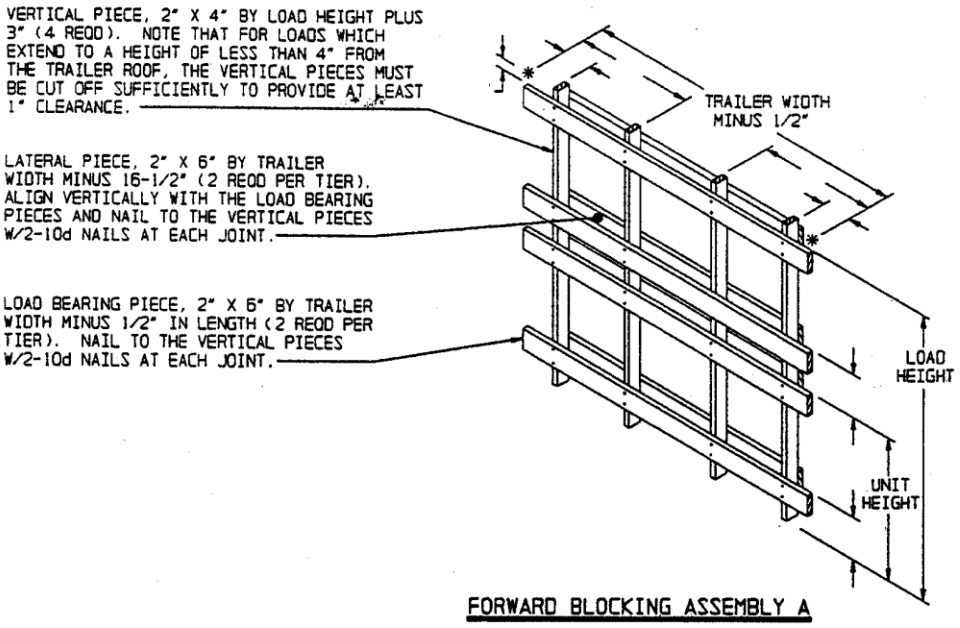
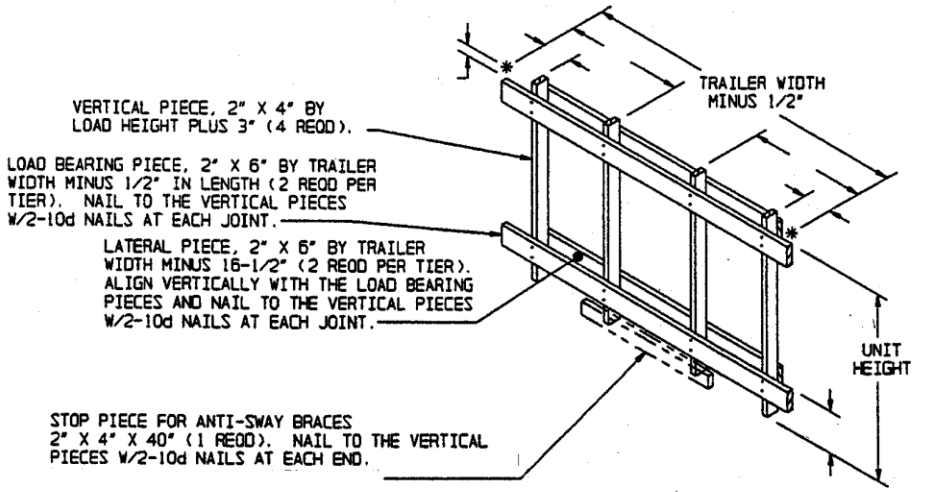


FORWARD BLOCKING ASSEMBLY A

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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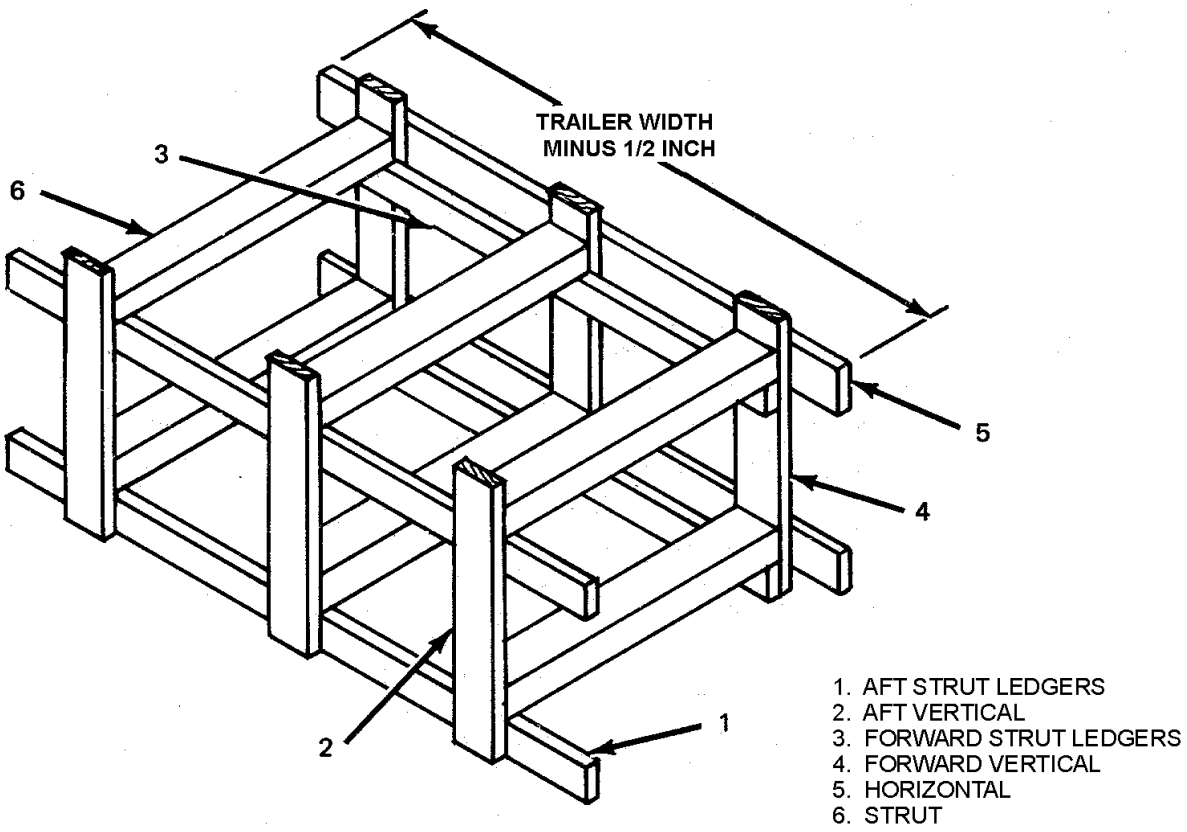

FIGURE B-16. Typical forward blocking assembly used to fill a void.

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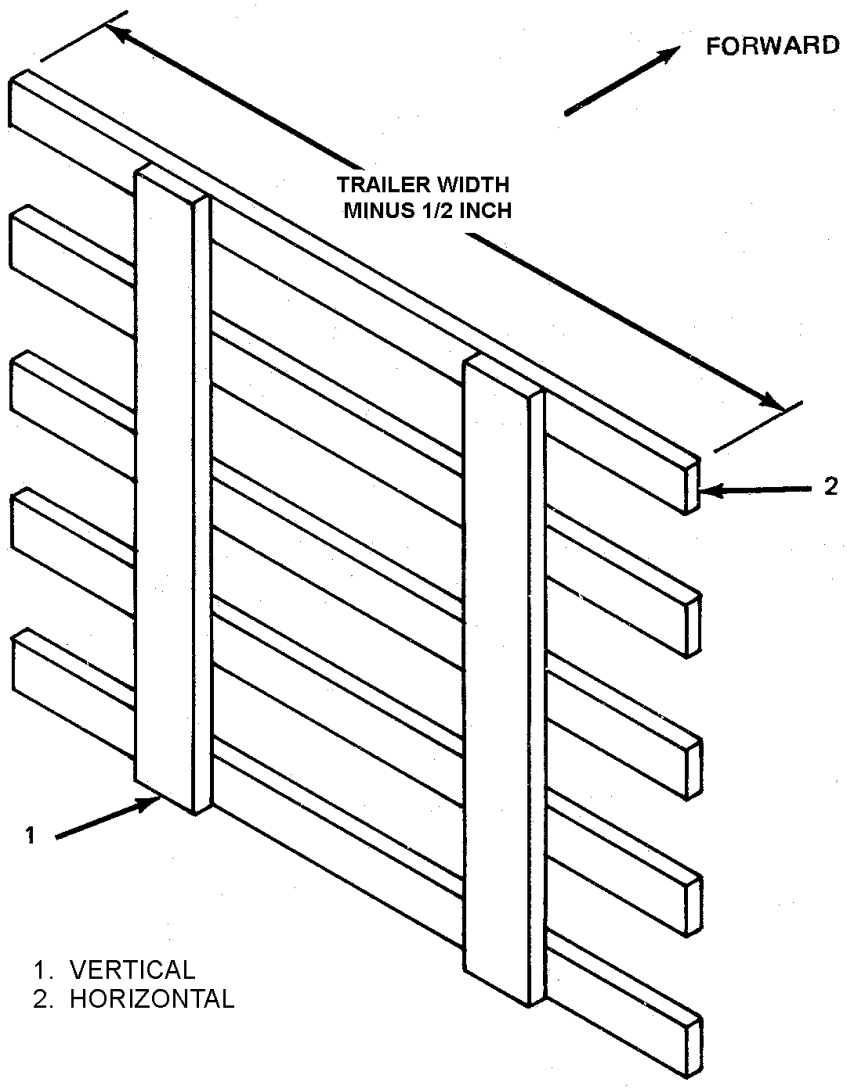

FIGURE B-17. Typical forward blocking assembly for vans with square front corners.

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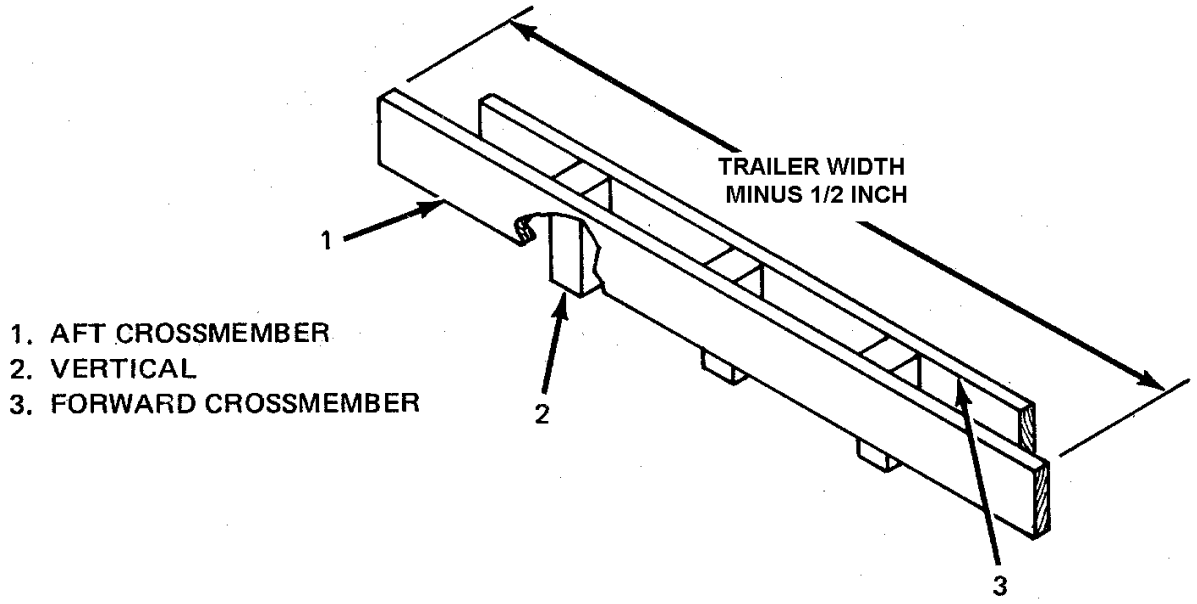

FIGURE B-18. Typical forward blocking assembly for low or rigid lading.

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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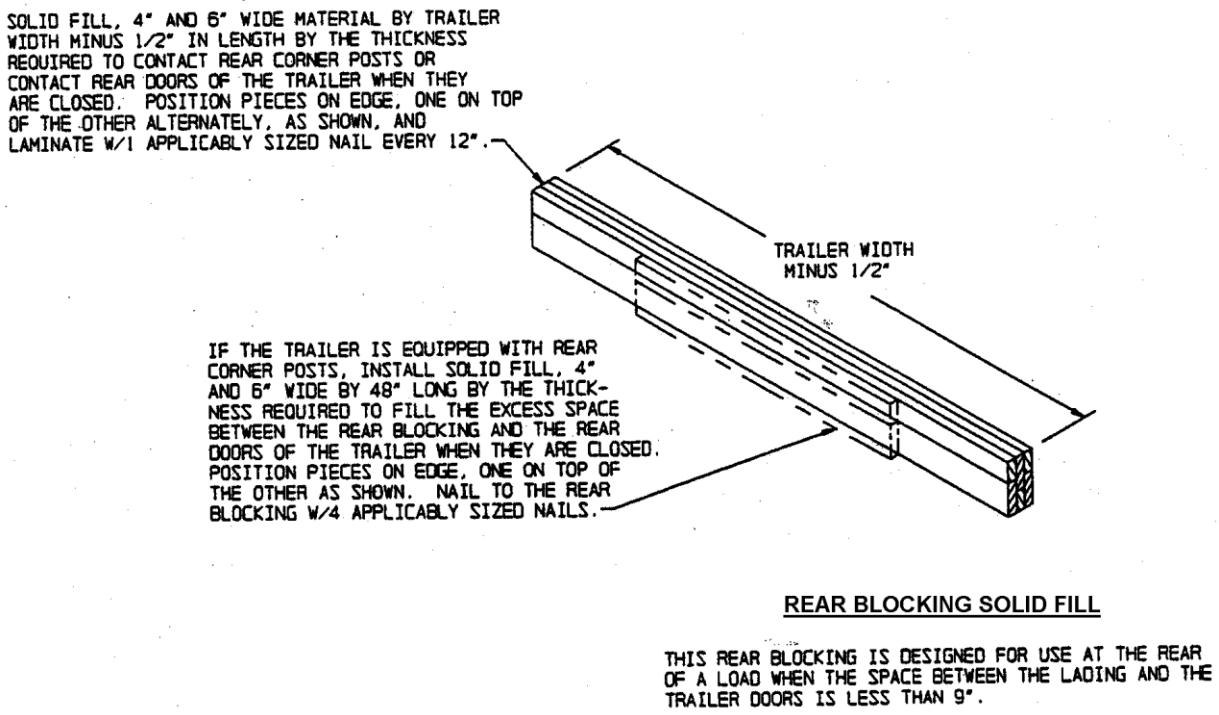

FIGURE B-19. Typical rear blocking assembly (solid fill).

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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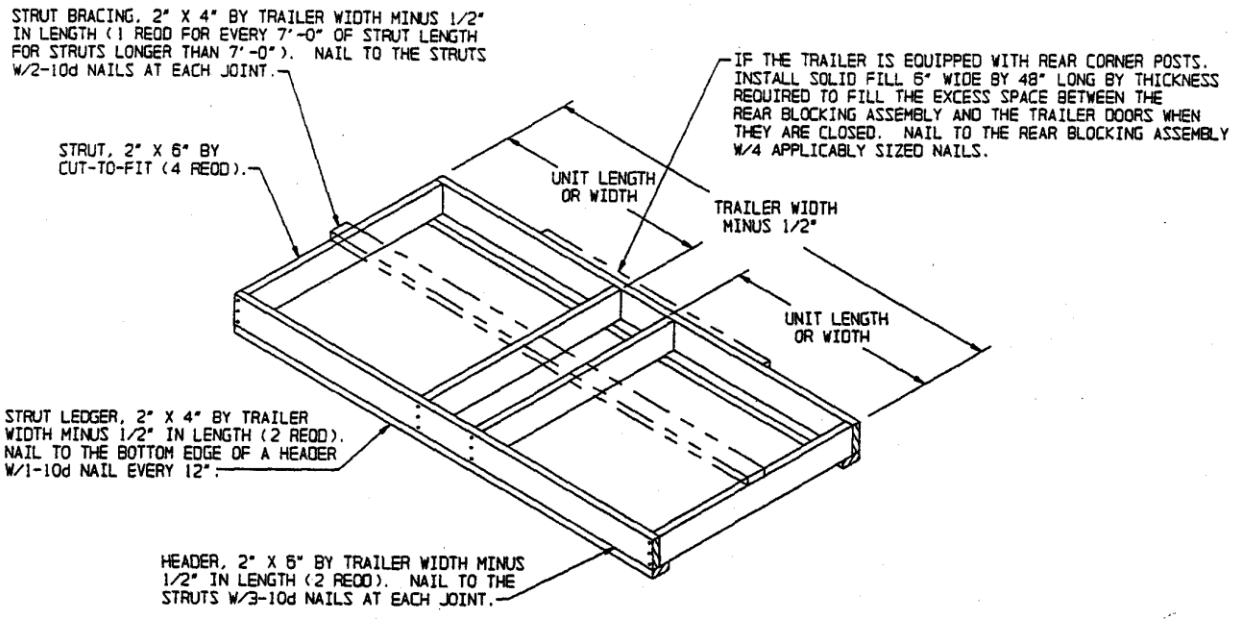

FIGURE B-20. Example rear blocking assembly.

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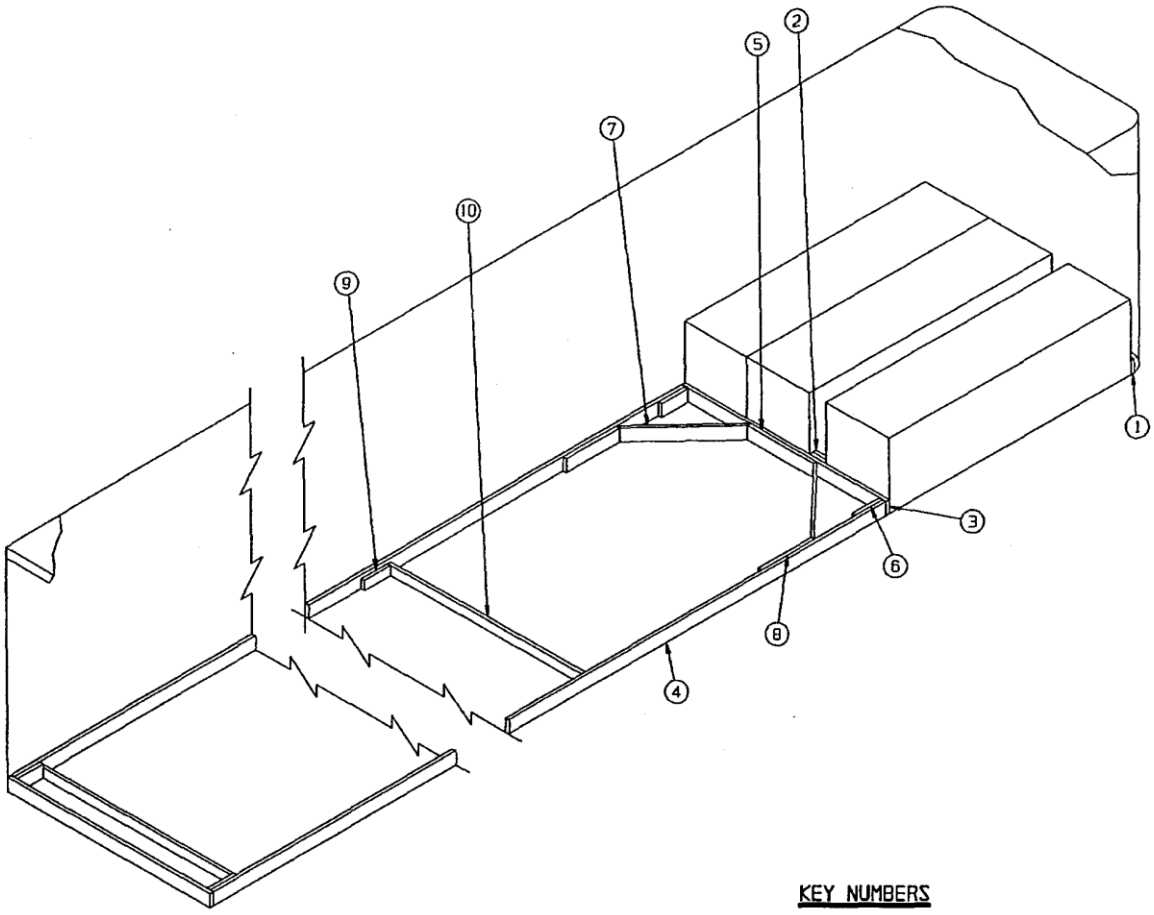

KEY NUMBERS

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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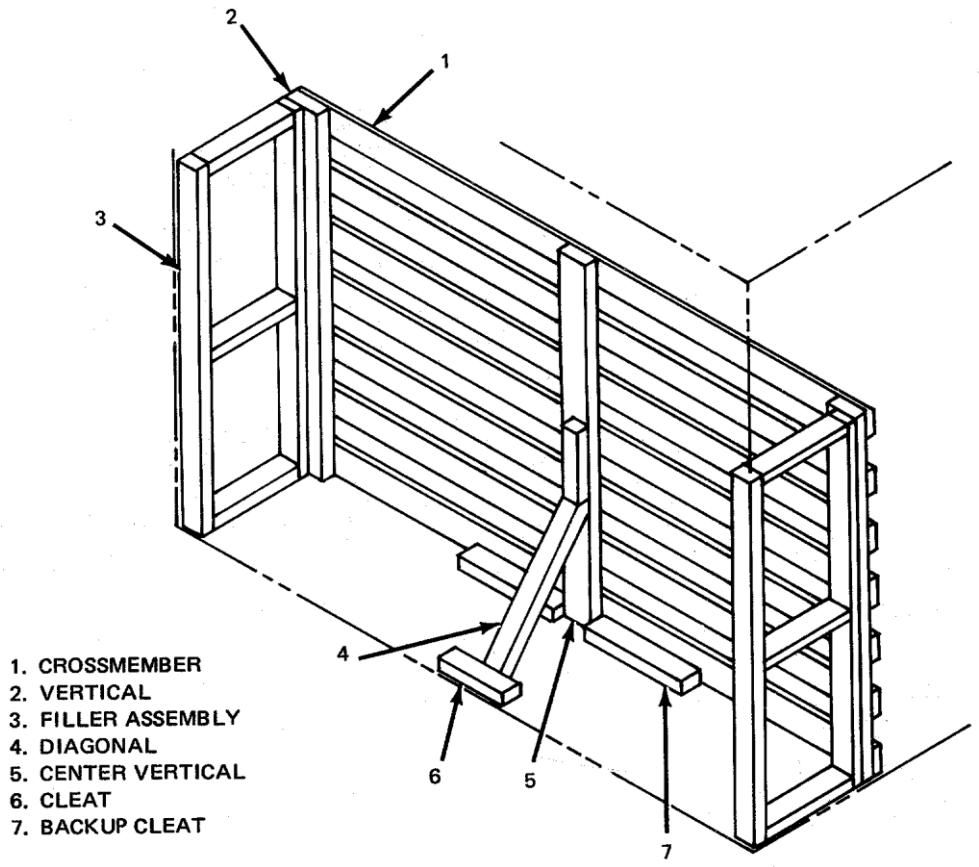
B.4.11.14.2 Rear gate. A rear gate is essential when the lading is of the type that may topple to the rear or the upper layer(s) consists of loose items or palletized loads that cannot be secured adequately to the bottom layer. Depending upon their design, rear gates may be positioned at any point in 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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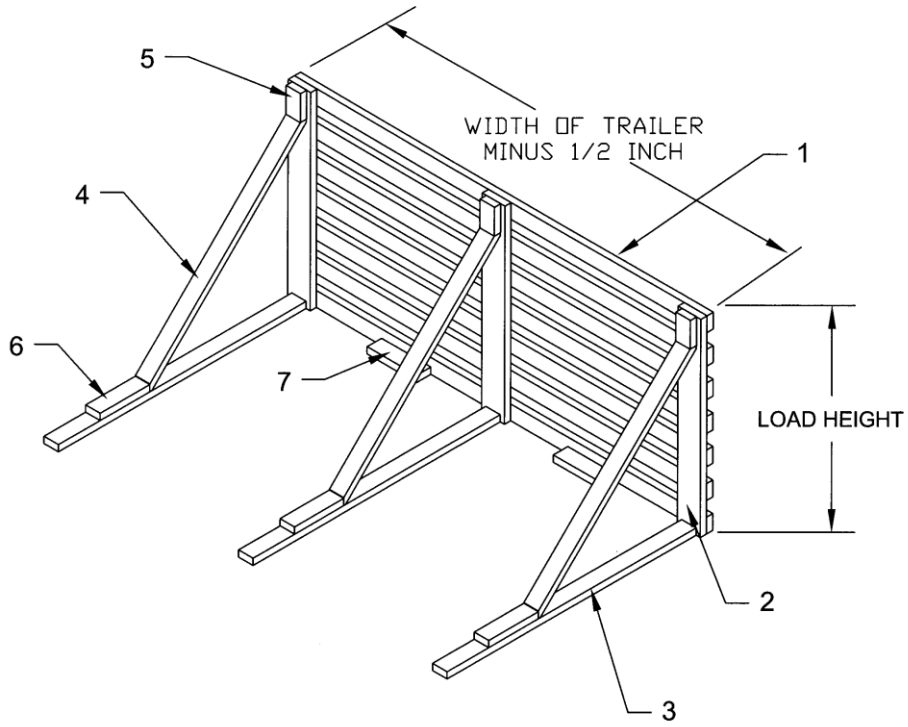

1. CROSSMEMBER
2. VERTICAL
3. KICKER
4. DIAGONAL
5. UPPER CLEAT
6. LOWER CLEAT
7. BACKUP CLEAT

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.

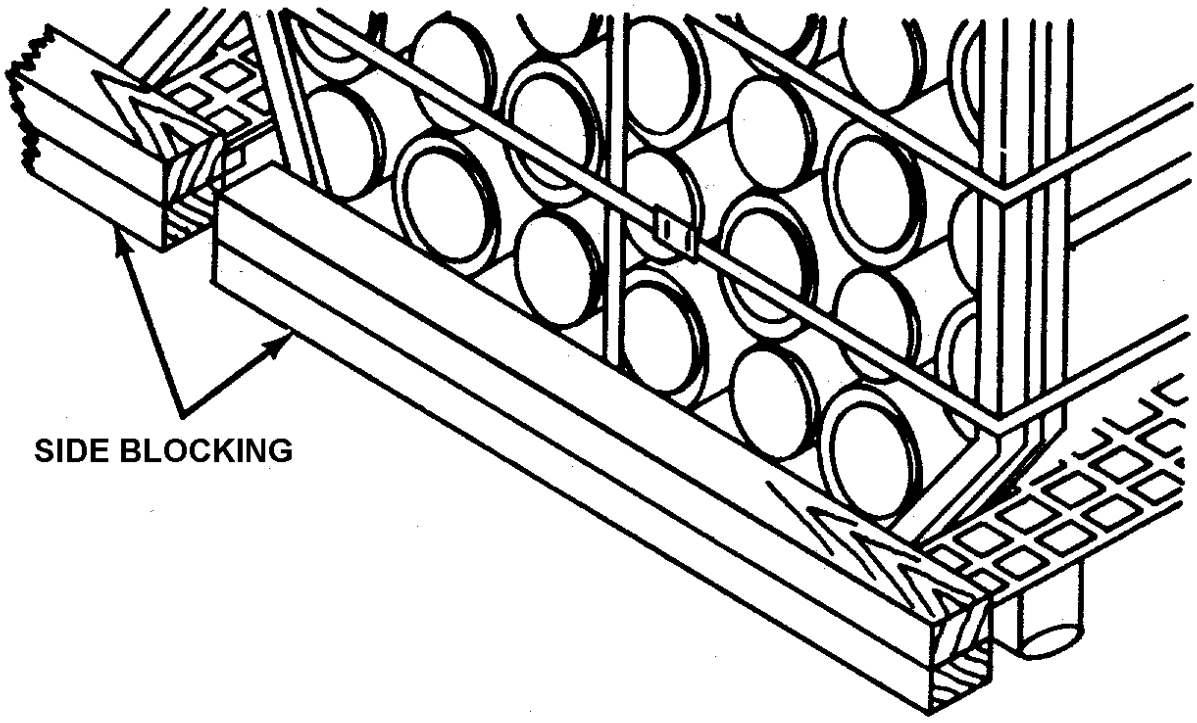

FIGURE B-24. Side blocking.

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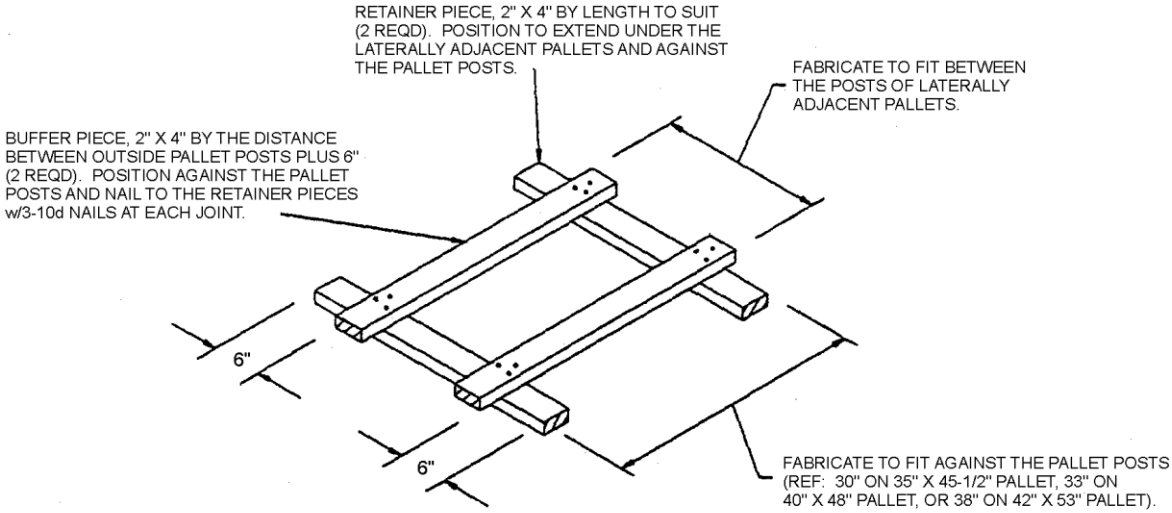
B.4.11.14.5 Anti-sway brace. An anti-sway brace should be used between rows of lading to hold them against the side walls of the trailer and control lateral motion. They are generally used in the second (and third) layers; however, they should also be used for the first layer in lieu of nailed side blocking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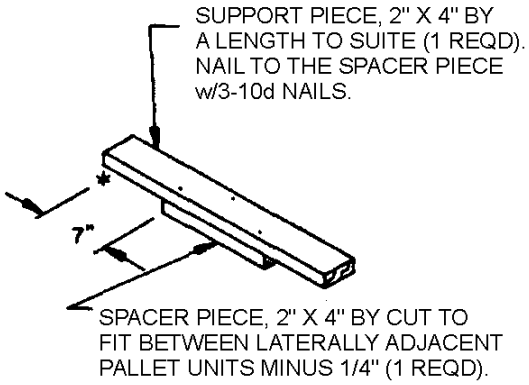
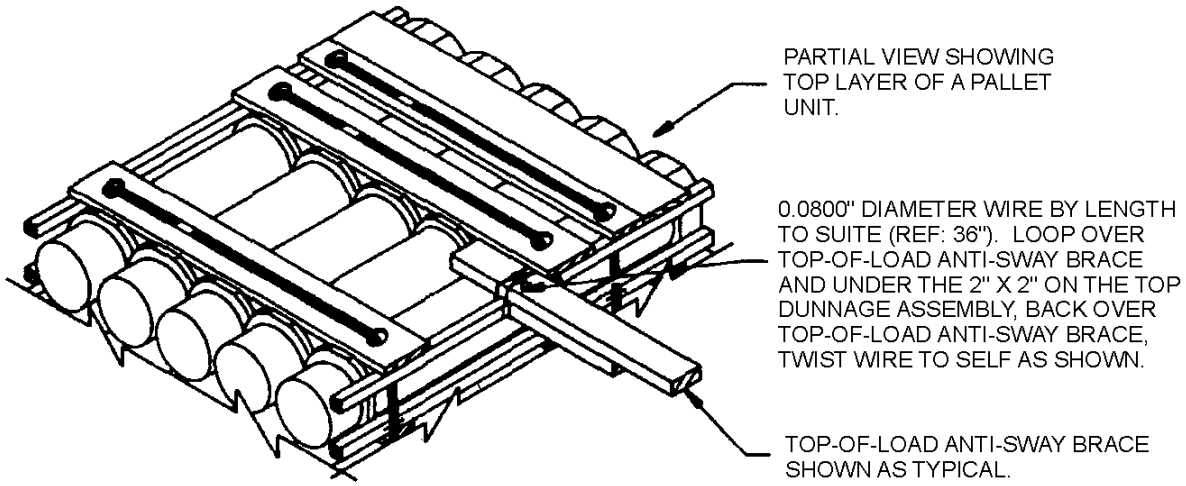


TOP-OF-LOAD ANTI-SWAY BRACE



TIE WIRE APPLICATION

DETAILS

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

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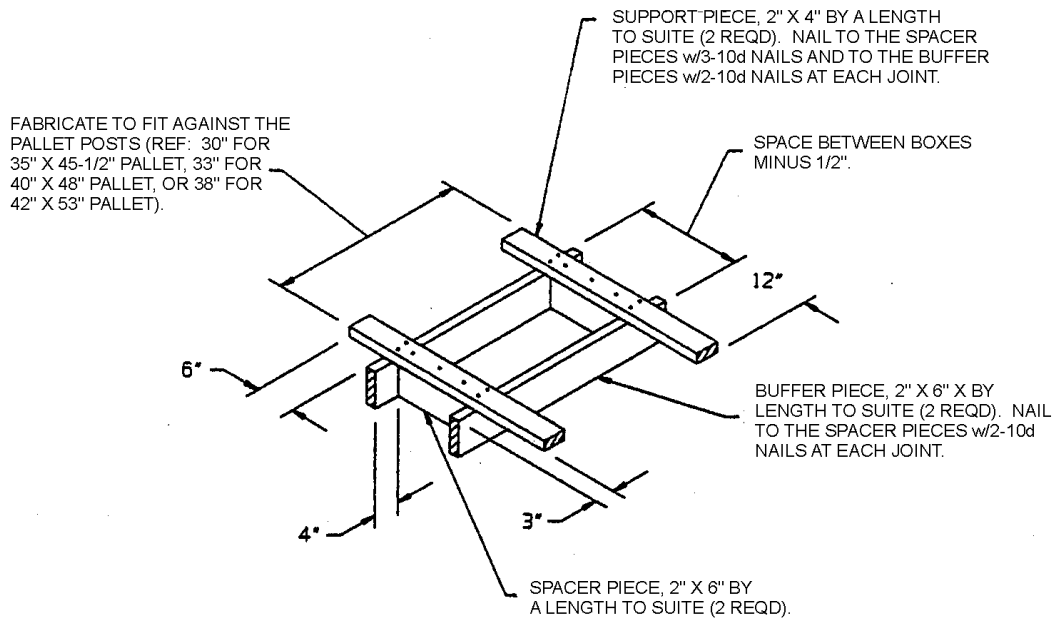
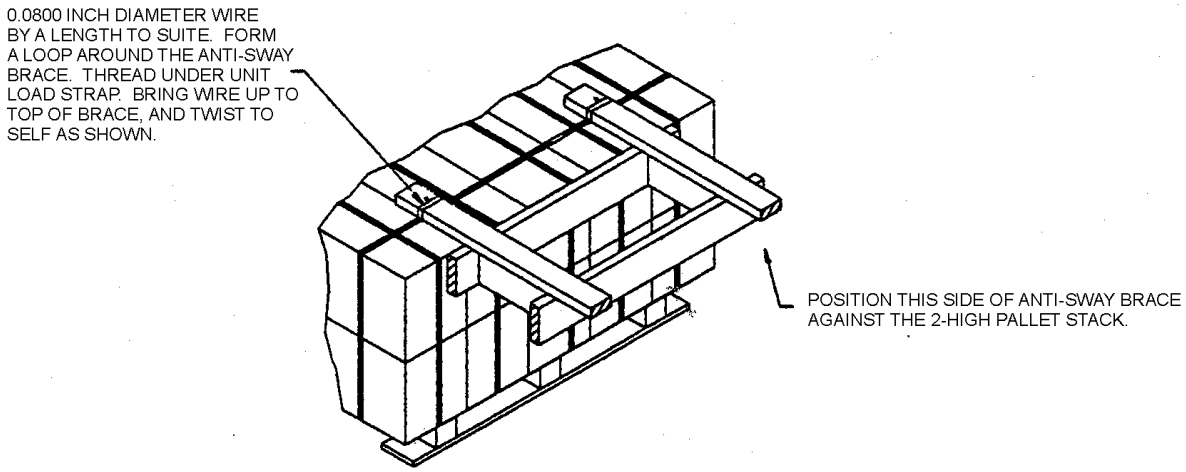


TOP-OF-LOAD ANTI-SWAY BRACE



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.

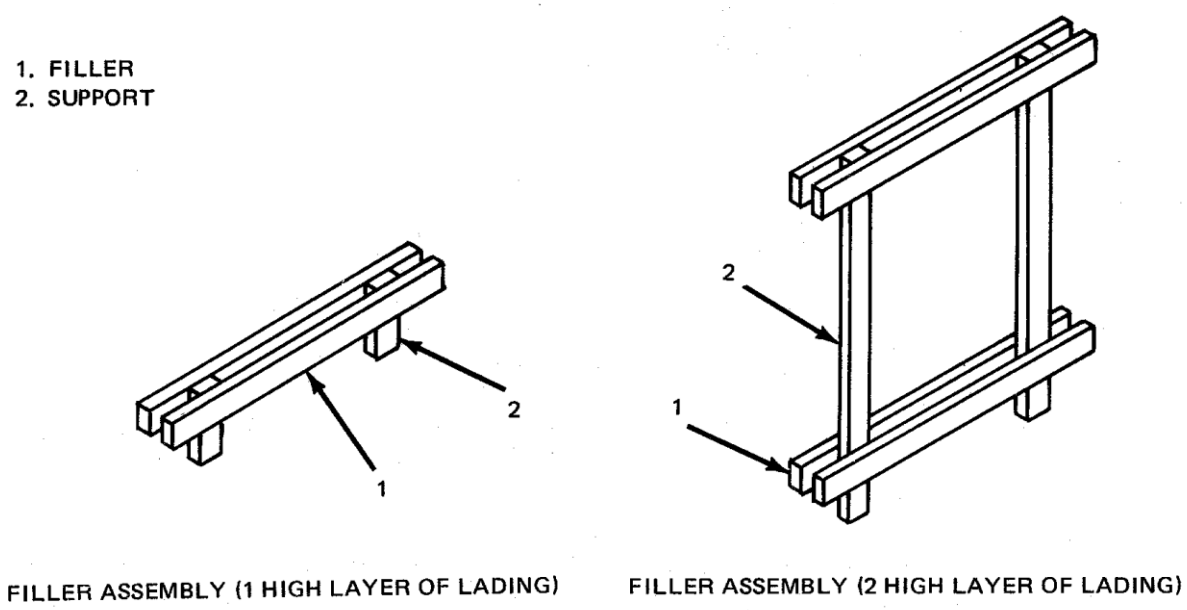

FIGURE B-28. Typical crib filler assemblies.

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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.

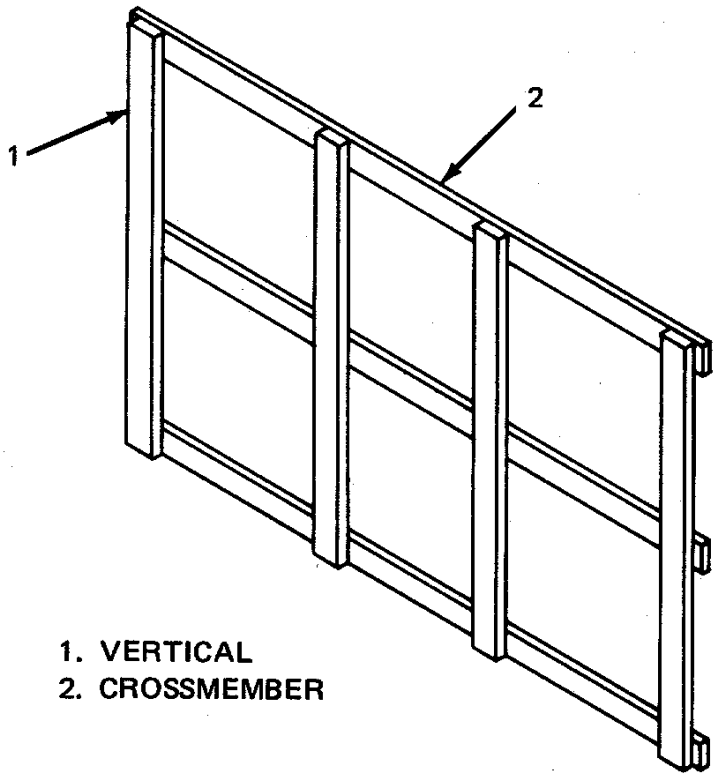

FIGURE B-29. Typical intermediate gate.

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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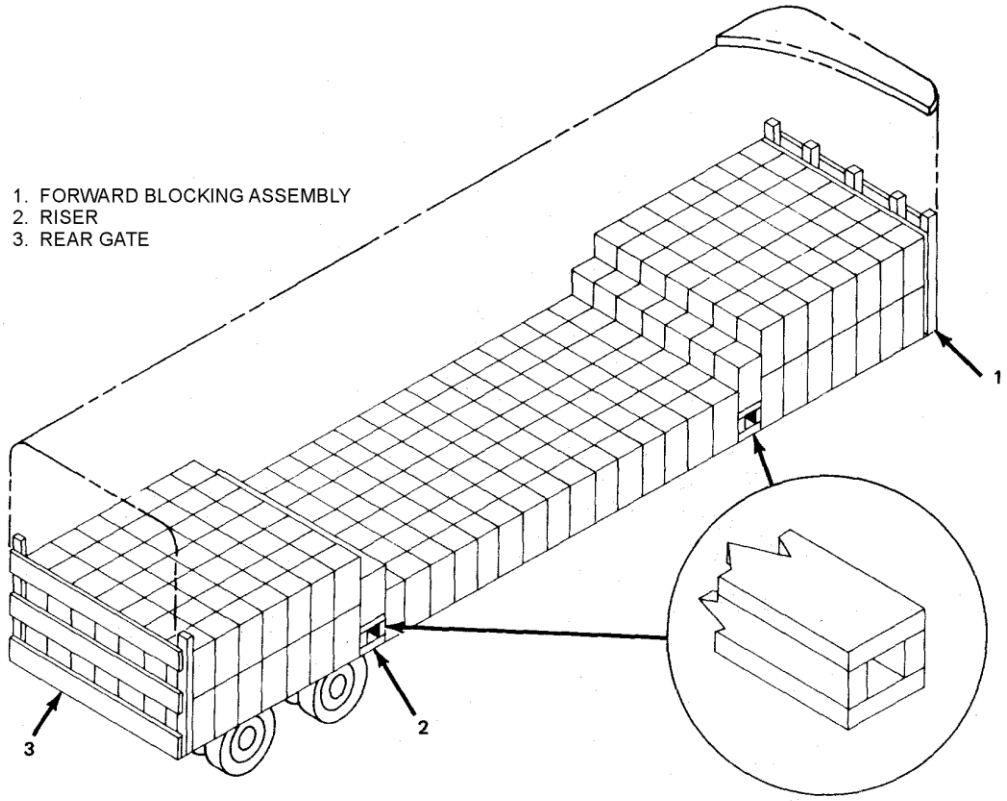

FIGURE B-30. Stepdown loads.

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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.

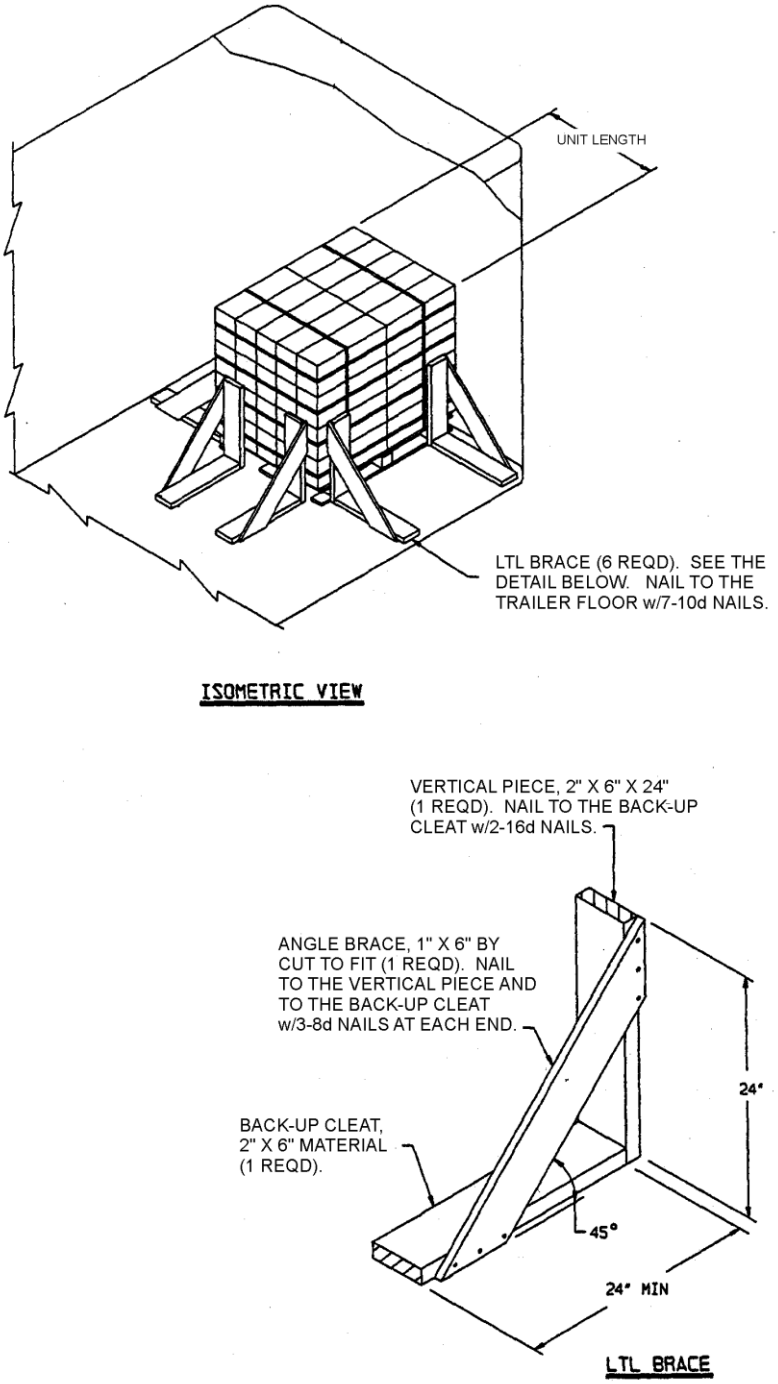

FIGURE B-31. LTL brace.

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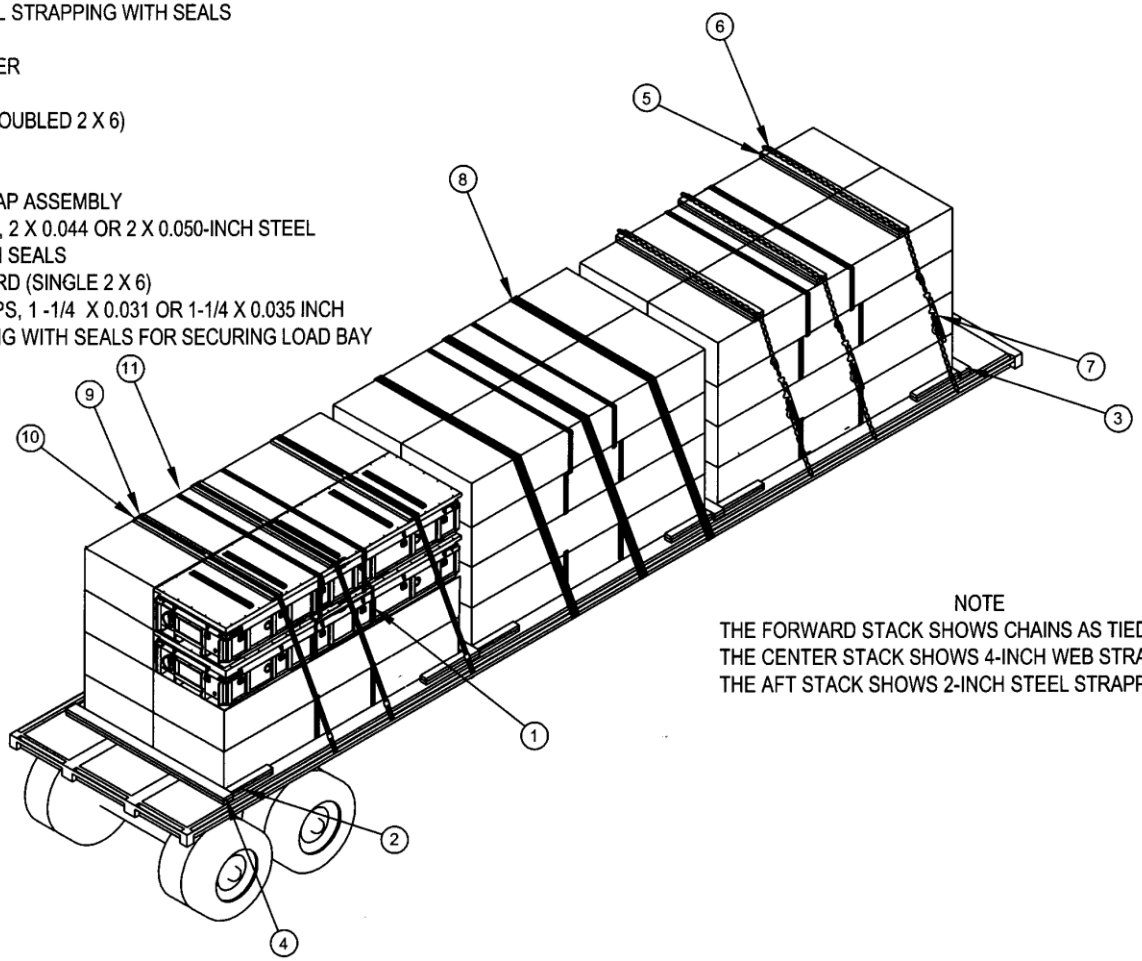
1. BUNDLING STRAPS (UNIT LOAD), 1-1/4 X 0.031 OR 1-1/4 X 0.035 INCH STEEL STRAPPING WITH SEALS
2. SIDE BLOCKING
3. FORWARD HEADER
4. REAR HEADER
5. CHAIN BOARD (DOUBLED 2 X 6)
6. CHAIN
7. LOAD BINDER
8. 4-INCH WEB STRAP ASSEMBLY
9. TIEDOWN STRAP, 2 X 0.044 OR 2 X 0.050-INCH STEEL STRAPPING WITH SEALS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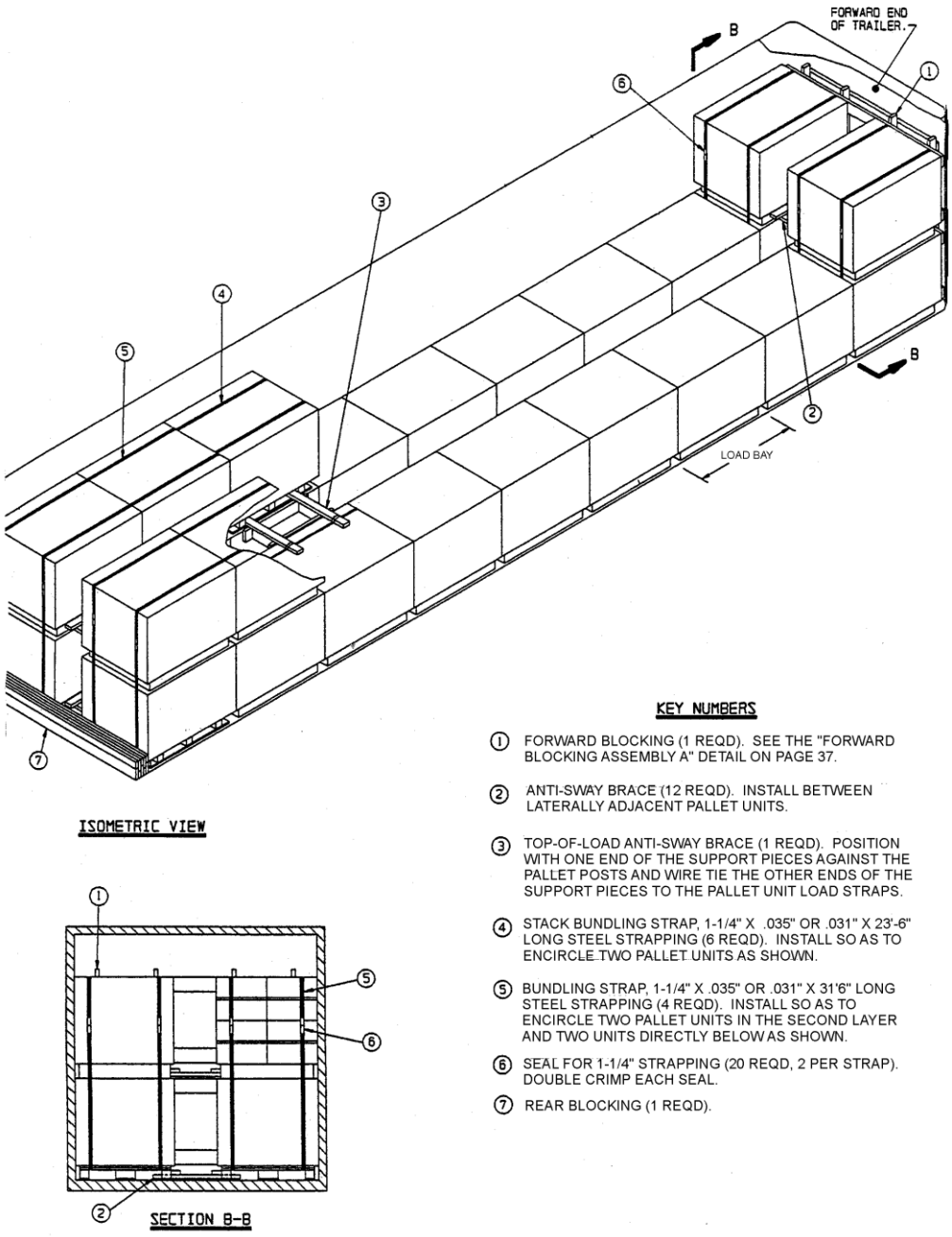

FIGURE B-33. Sample van trailer load.

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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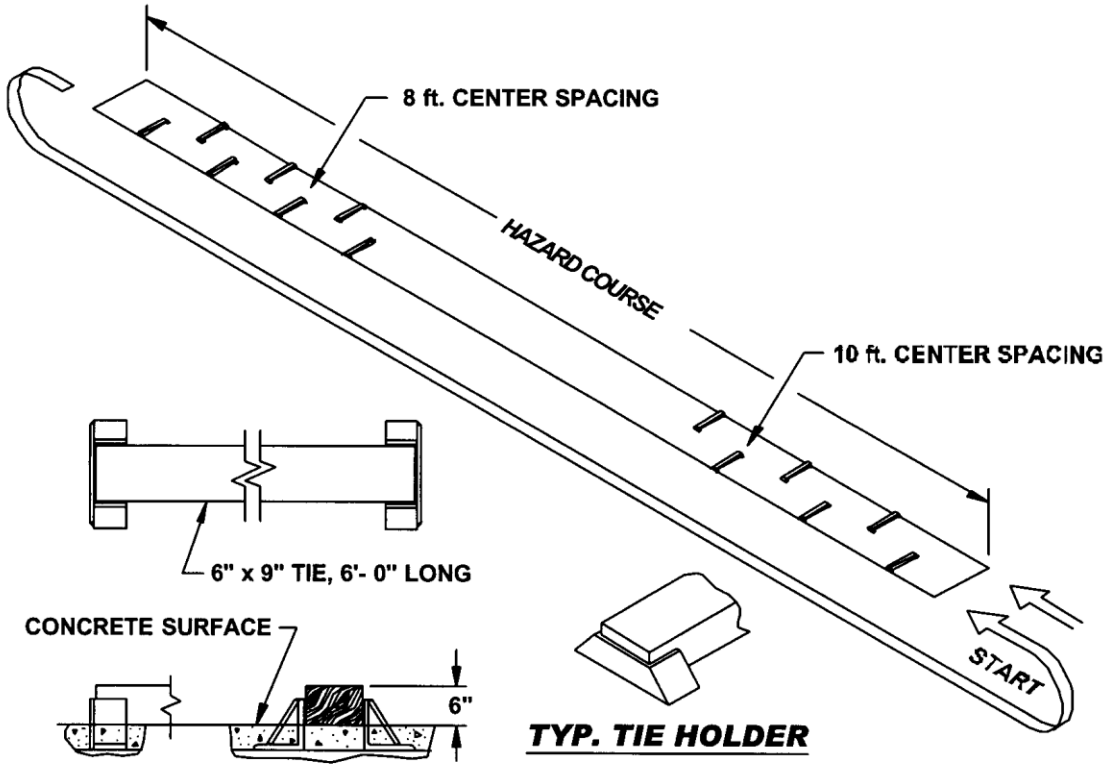

FIGURE B-34. Hazard course diagram.

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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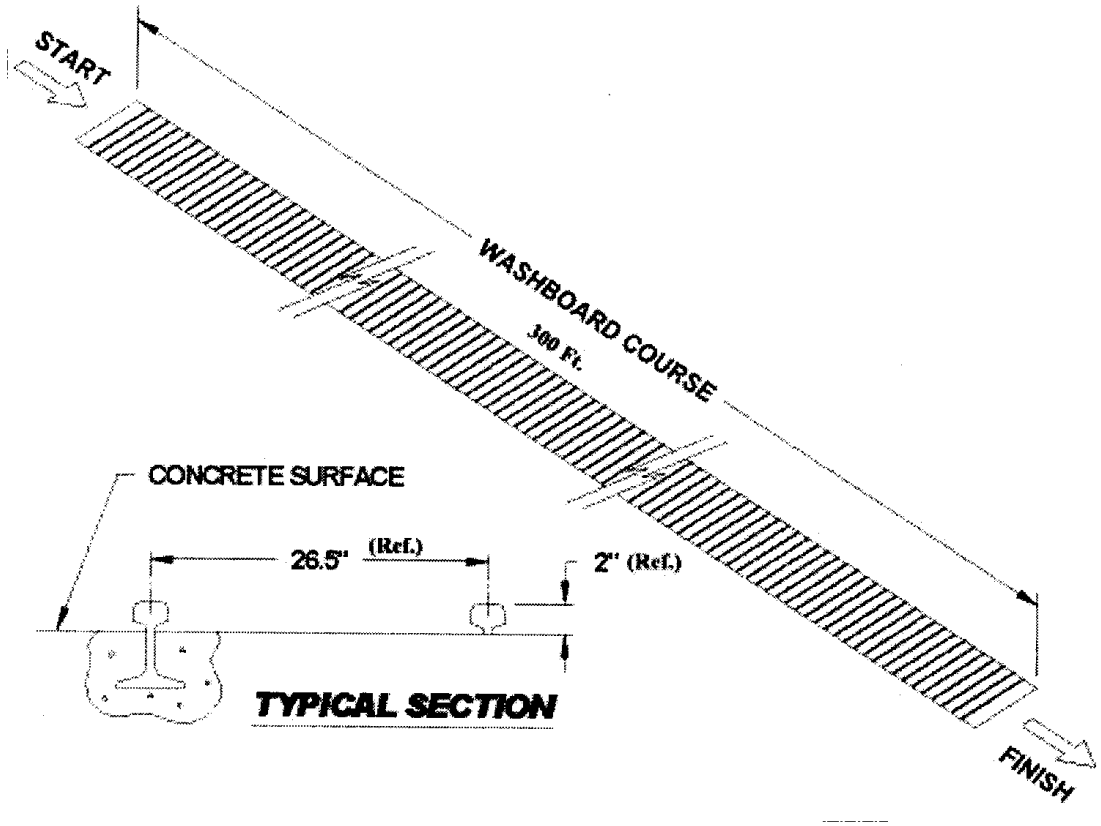

FIGURE B-35. Washboard course.

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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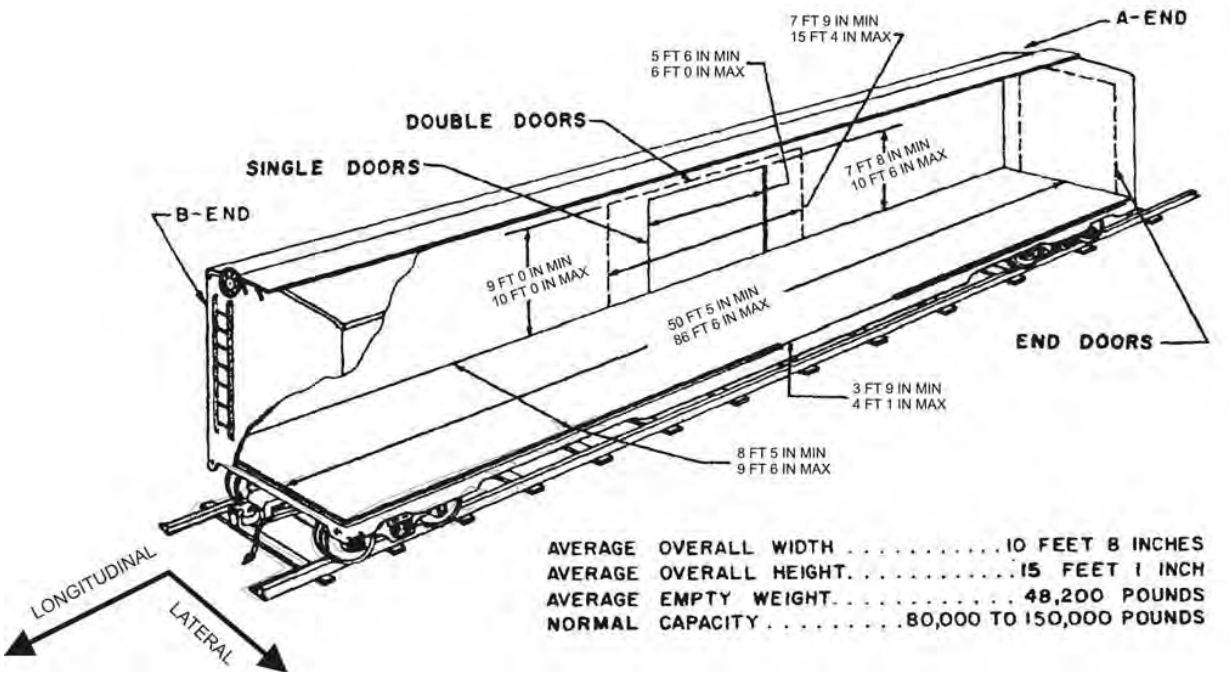

FIGURE C-1. Typical boxcar dimensions.

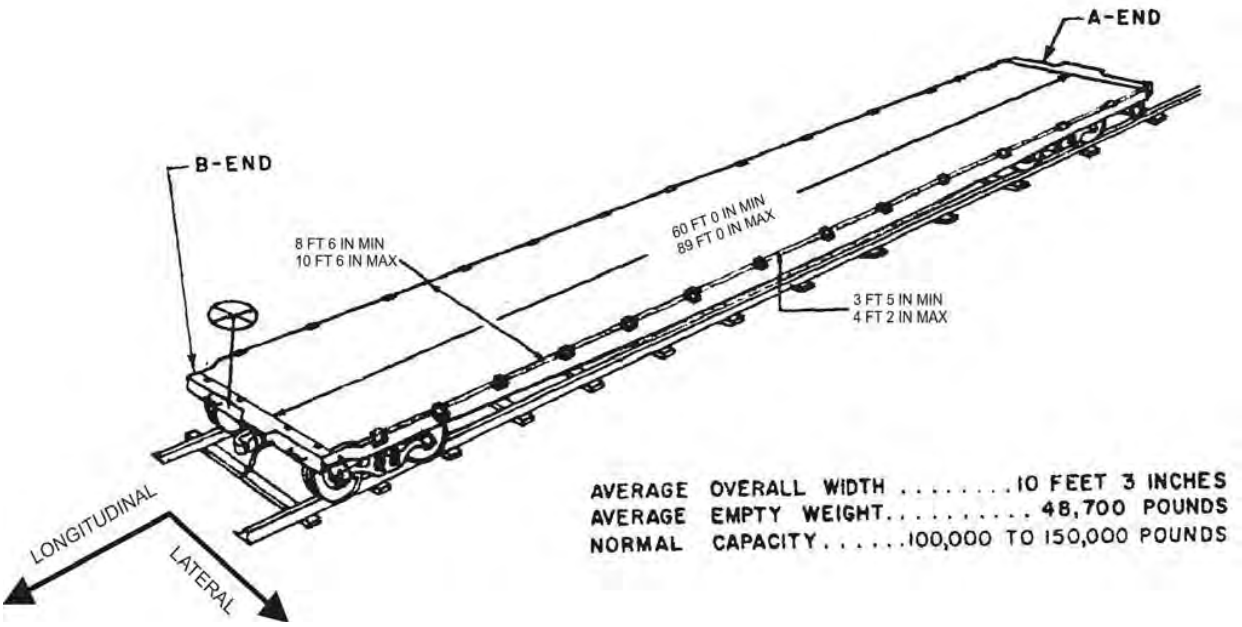

FIGURE C-2. Typical flatcar dimensions.

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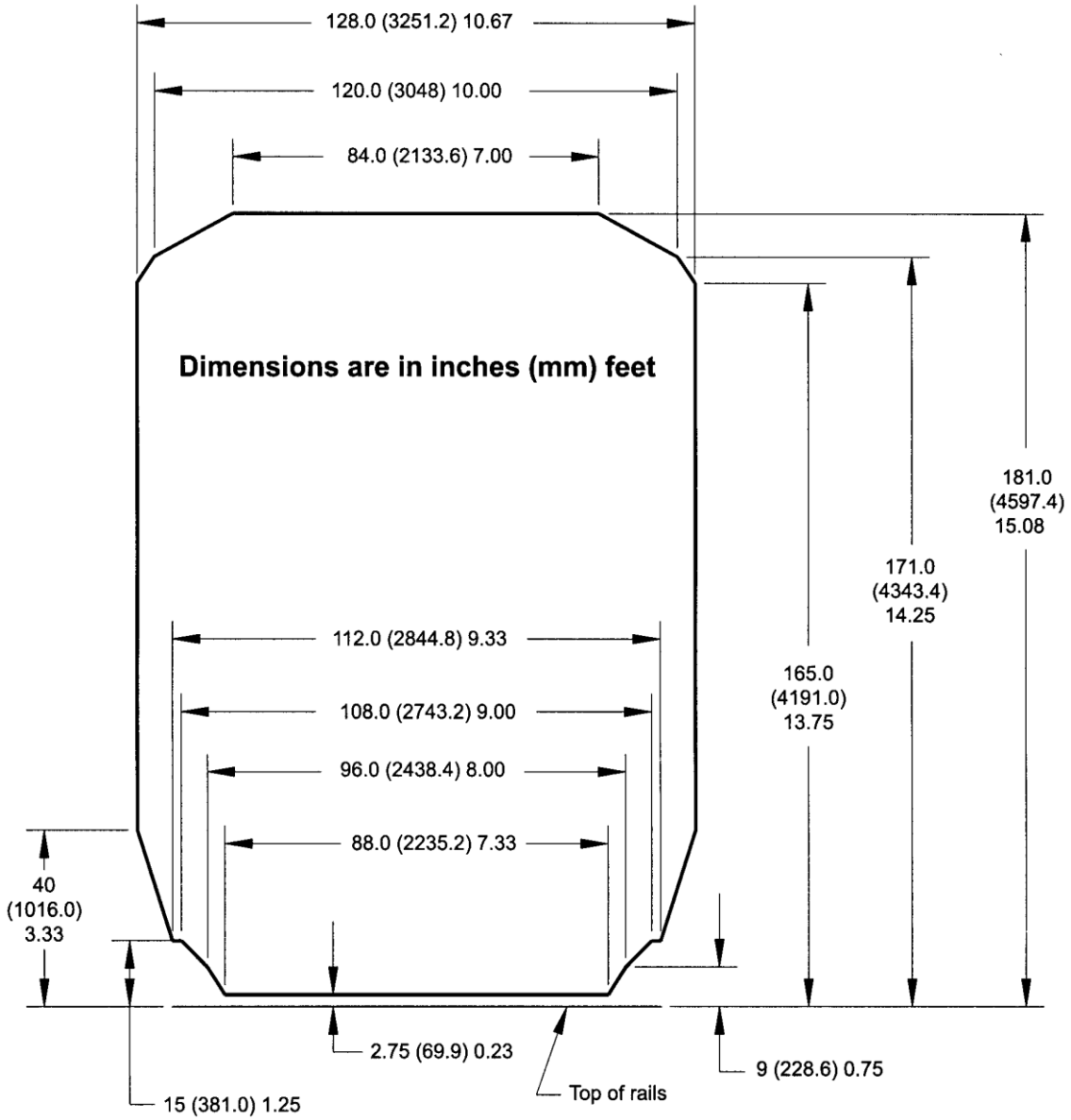

FIGURE C-3. AAR outline diagram of single loads, without end overhang, on open-top cars (AAR diagram).

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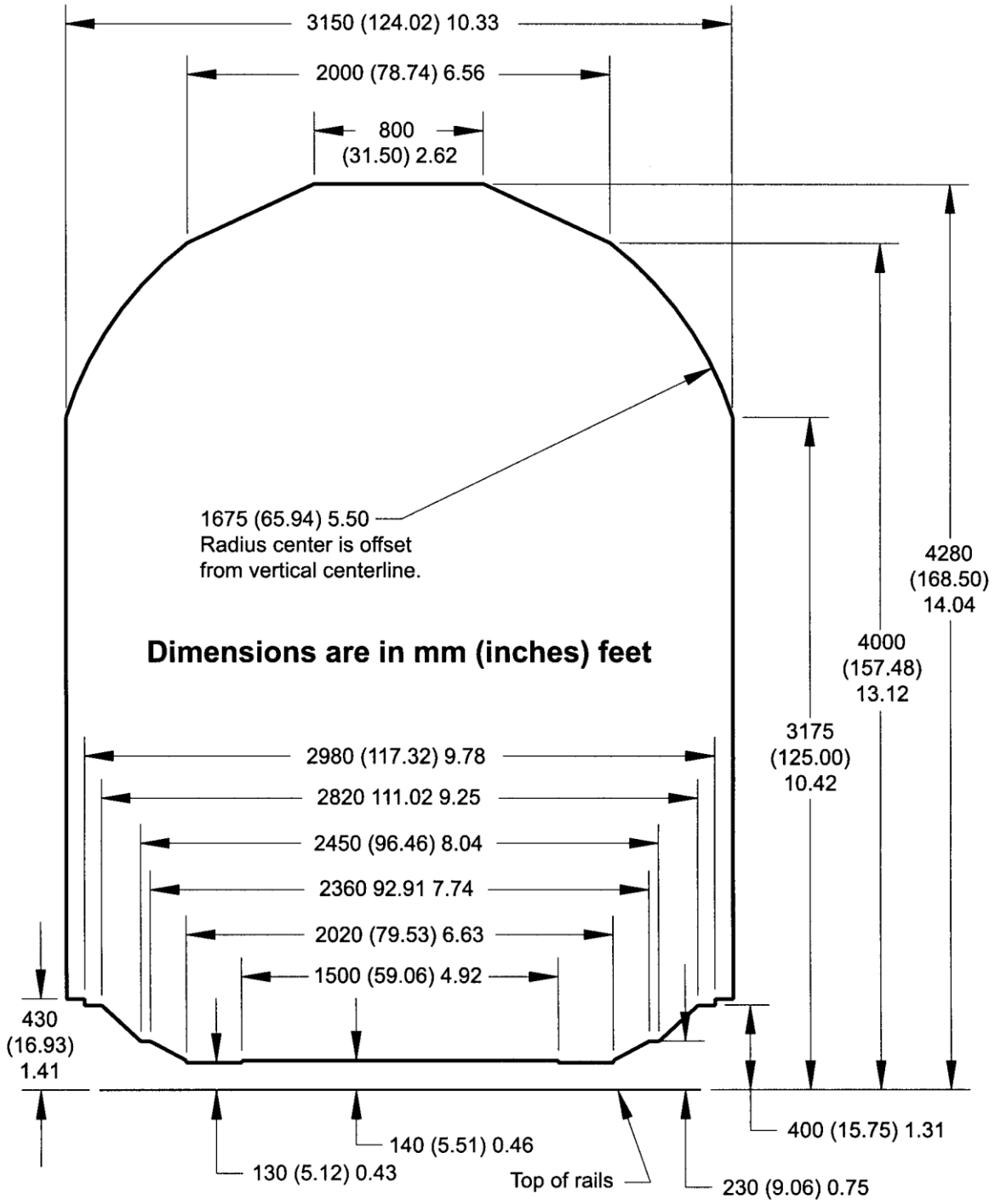

FIGURE C-4. International load gage diagram.

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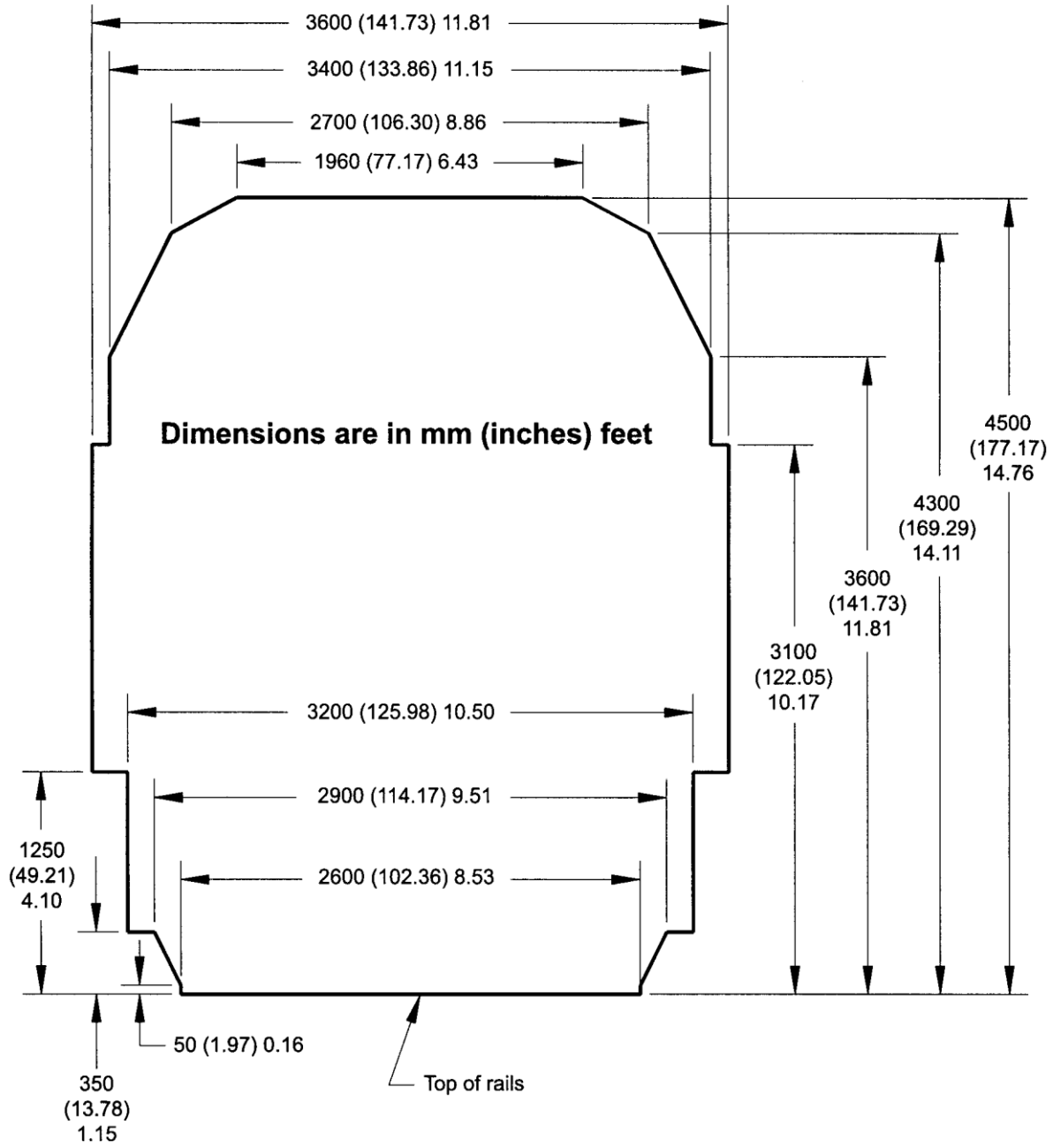

FIGURE C-5. Korean rail clearance diagram.

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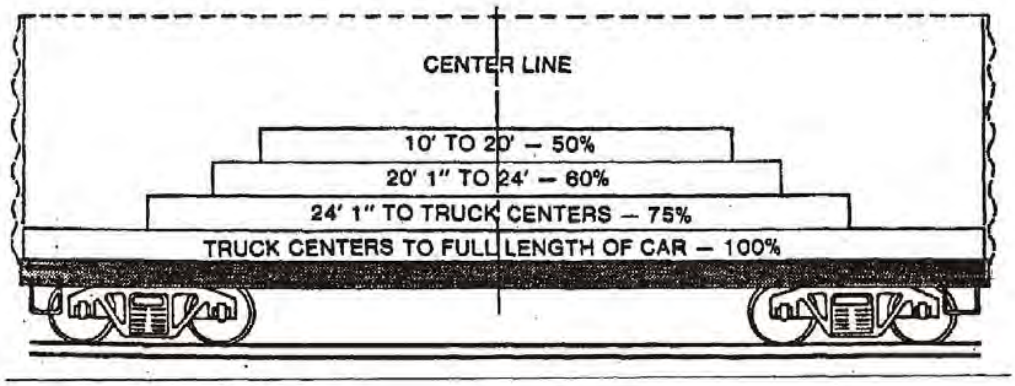
BOXCARS OTHER THAN STAGGERED DOUBLE-DOOR CARS BUILT PRIOR TO 1966

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

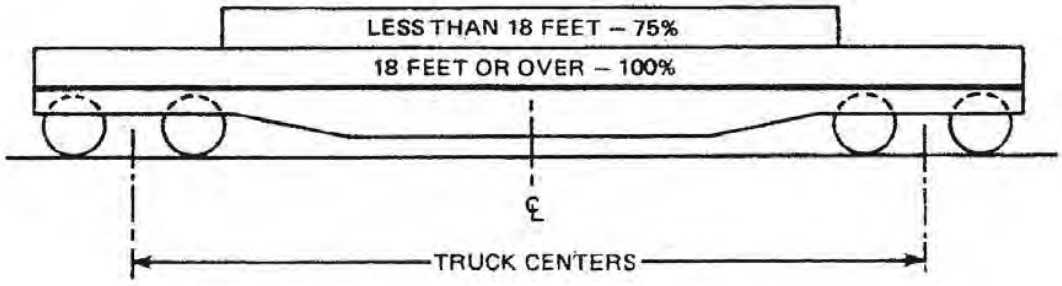


FIGURE C-6. Maximum weight distribution permitted in or on cars (sheet 1 of 2).

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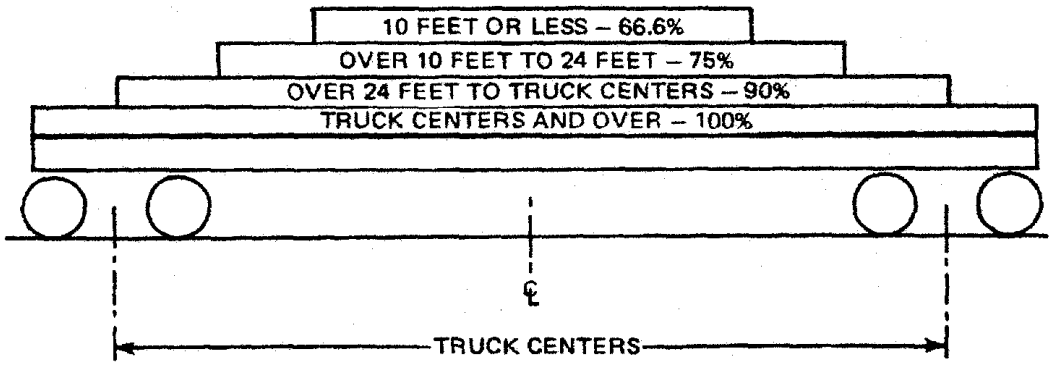
FLAT CARS NOT EQUIPPED WITH BOTH FISH-BELLY CENTER AND FISH-BELLY SIDE SILLS BUILT PRIOR TO 1 JANUARY 1965



GONDOLA CARS

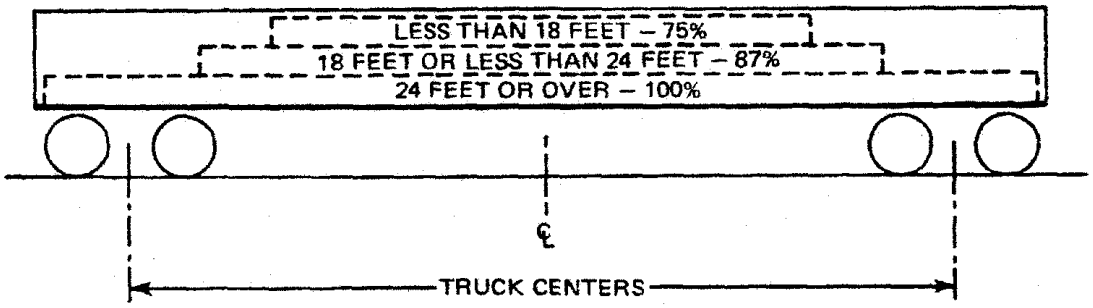


FIGURE C-6. Maximum weight distribution permitted in or on cars (sheet 2 of 2) – Continued.

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.

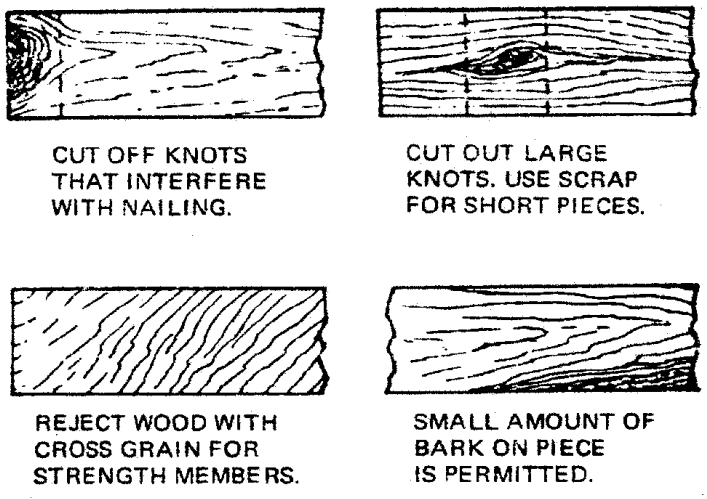

FIGURE C-7. Lumber defects.

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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.

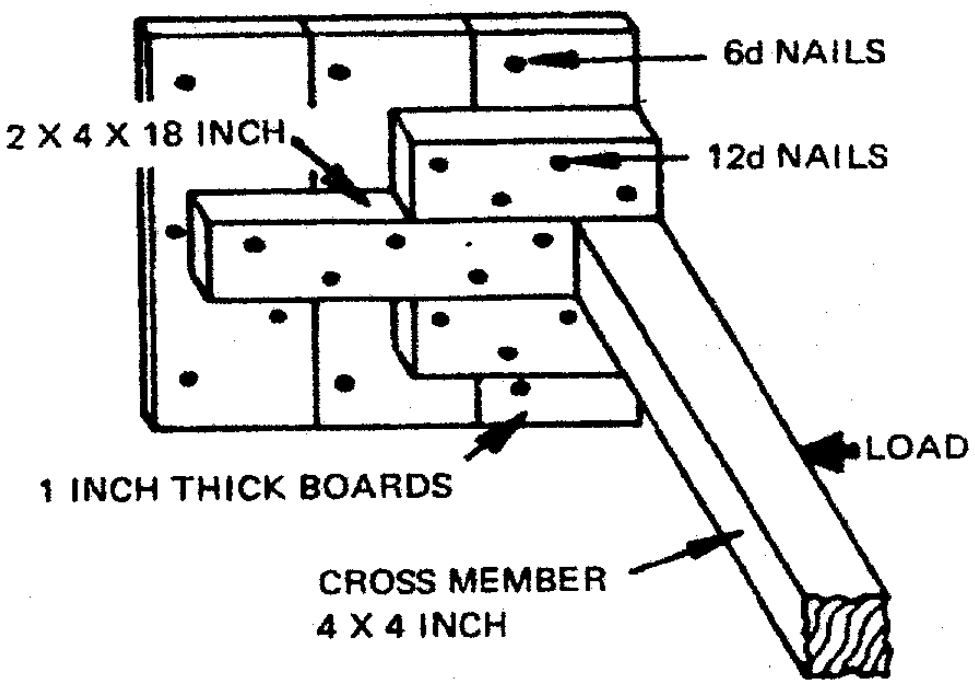

FIGURE C-8. Nailing cleats to side walls using supplemental 1-inch lining boards.

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).

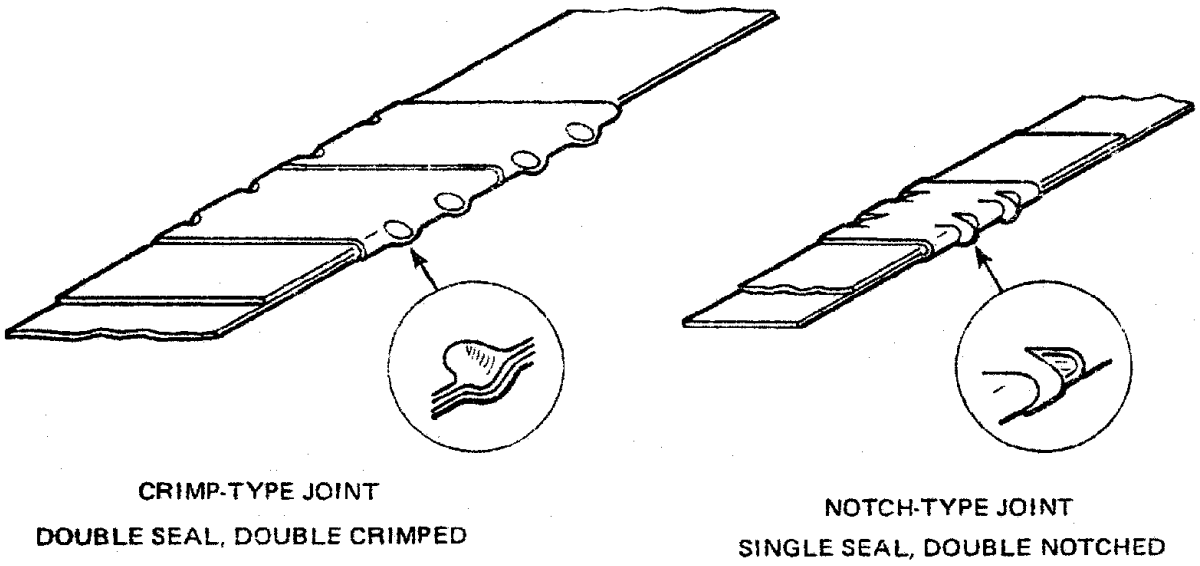

FIGURE C-9. Types of strap joints.

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.

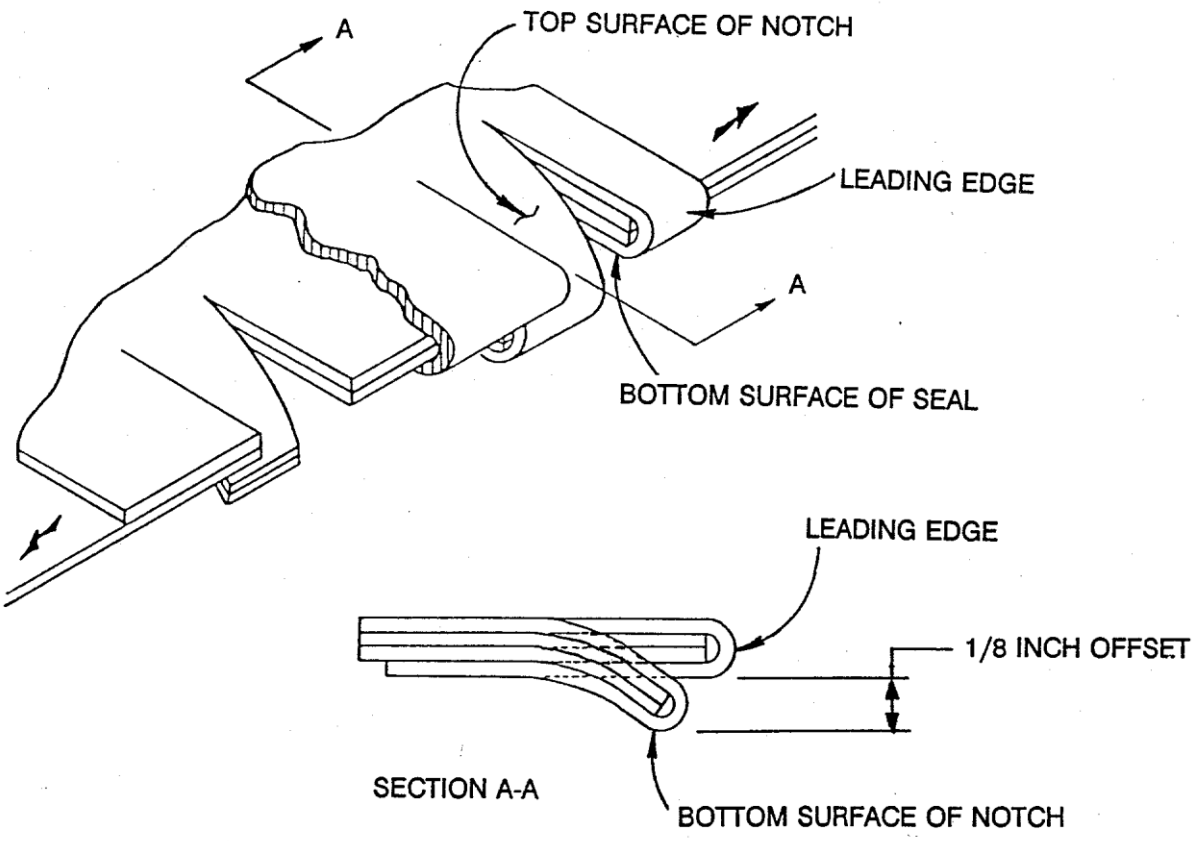

FIGURE C-10. Typical notched-seal joint.

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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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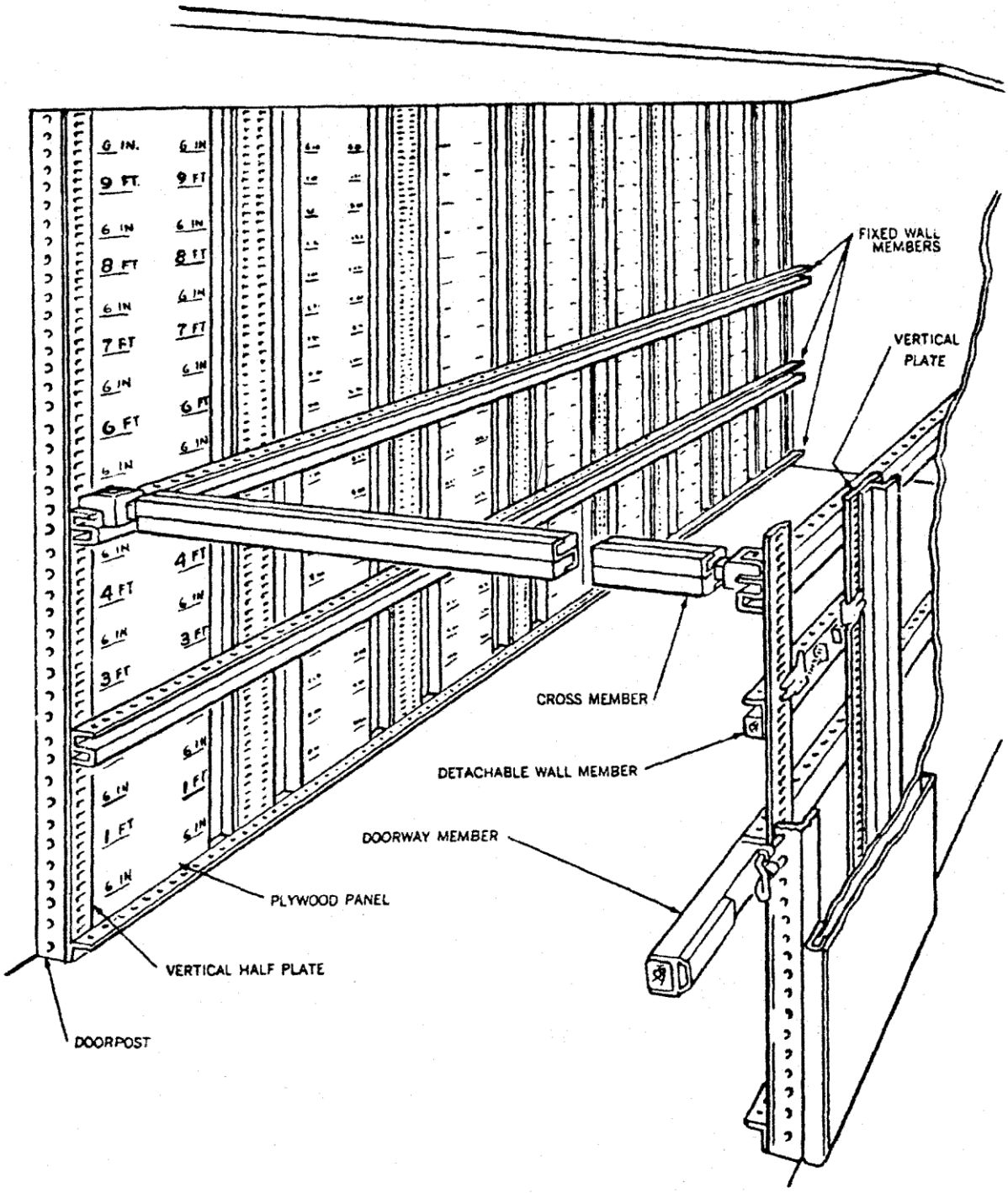

FIGURE C-11. Pin-type loader, showing mechanical bracing system.

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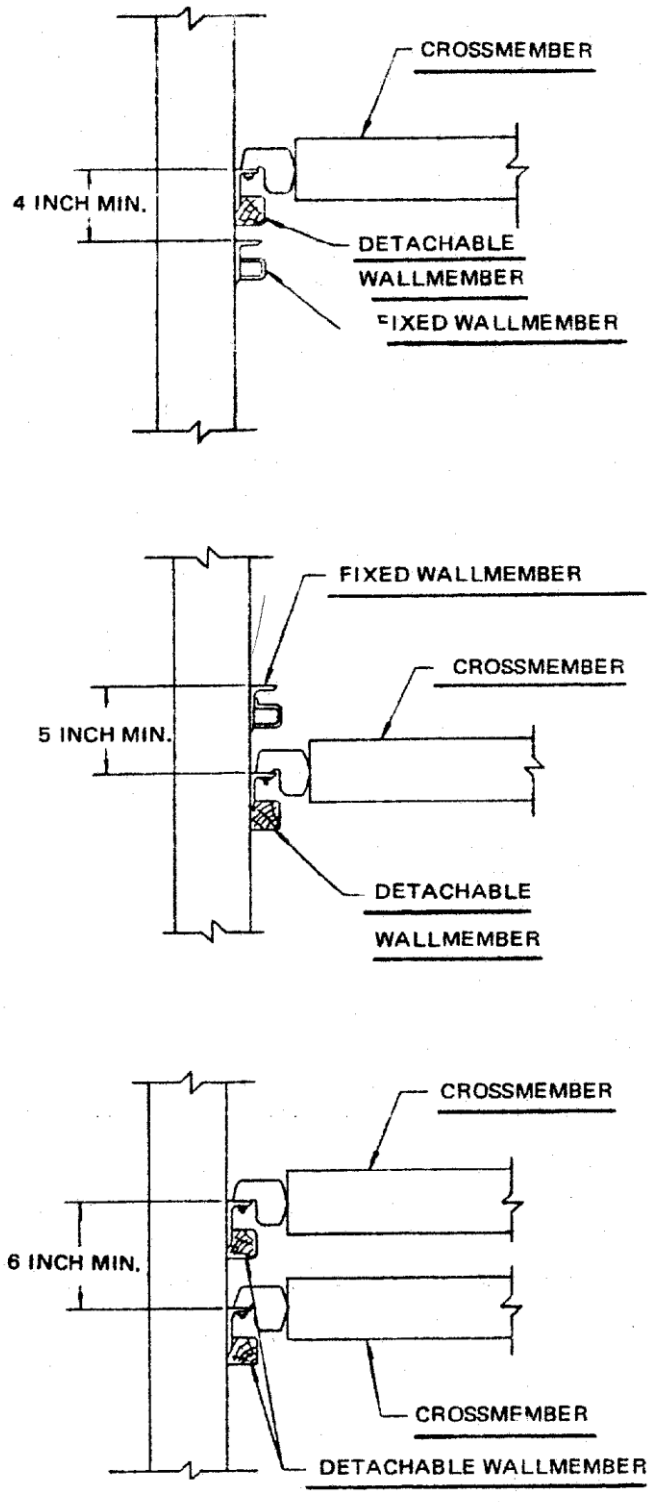

FIGURE C-12. Vertical distance between wall members.

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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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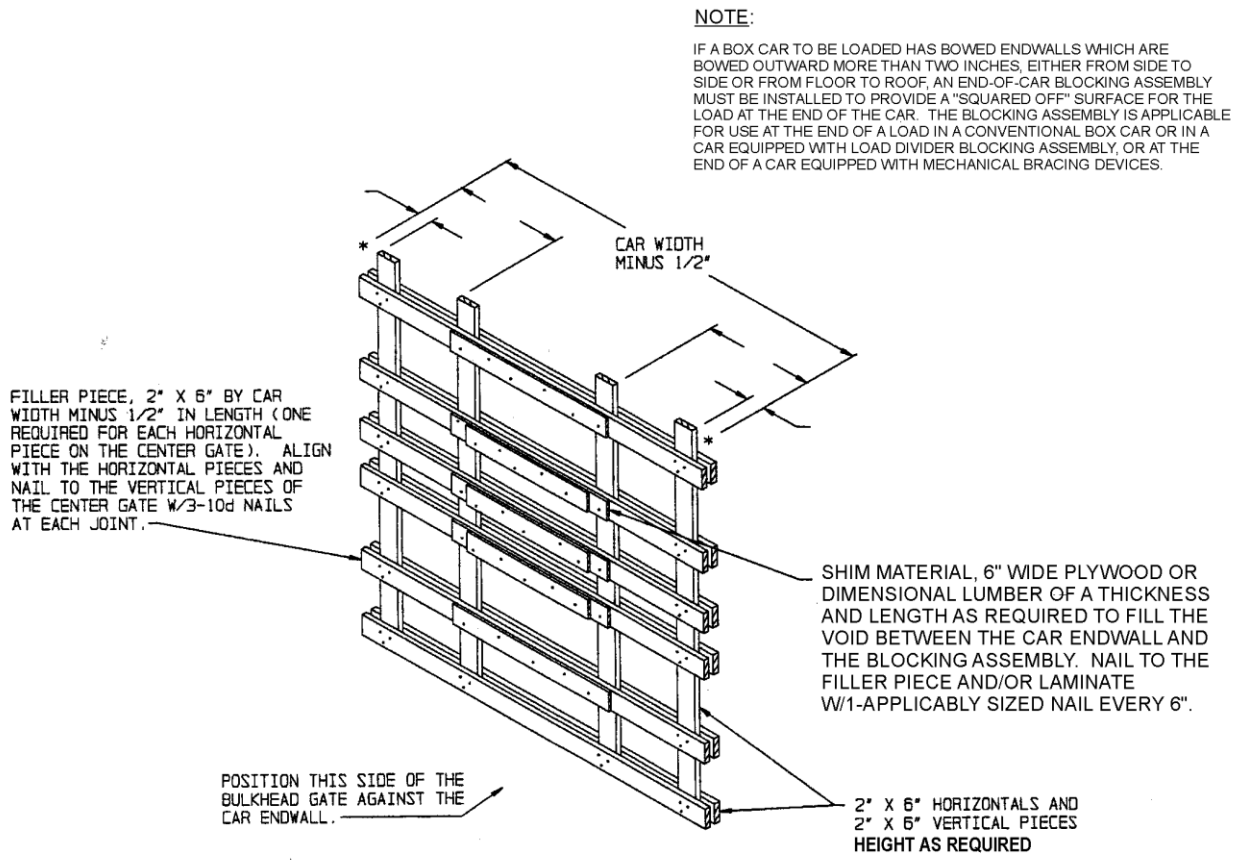

FIGURE C-13. Typical end-of-car bracing assembly.

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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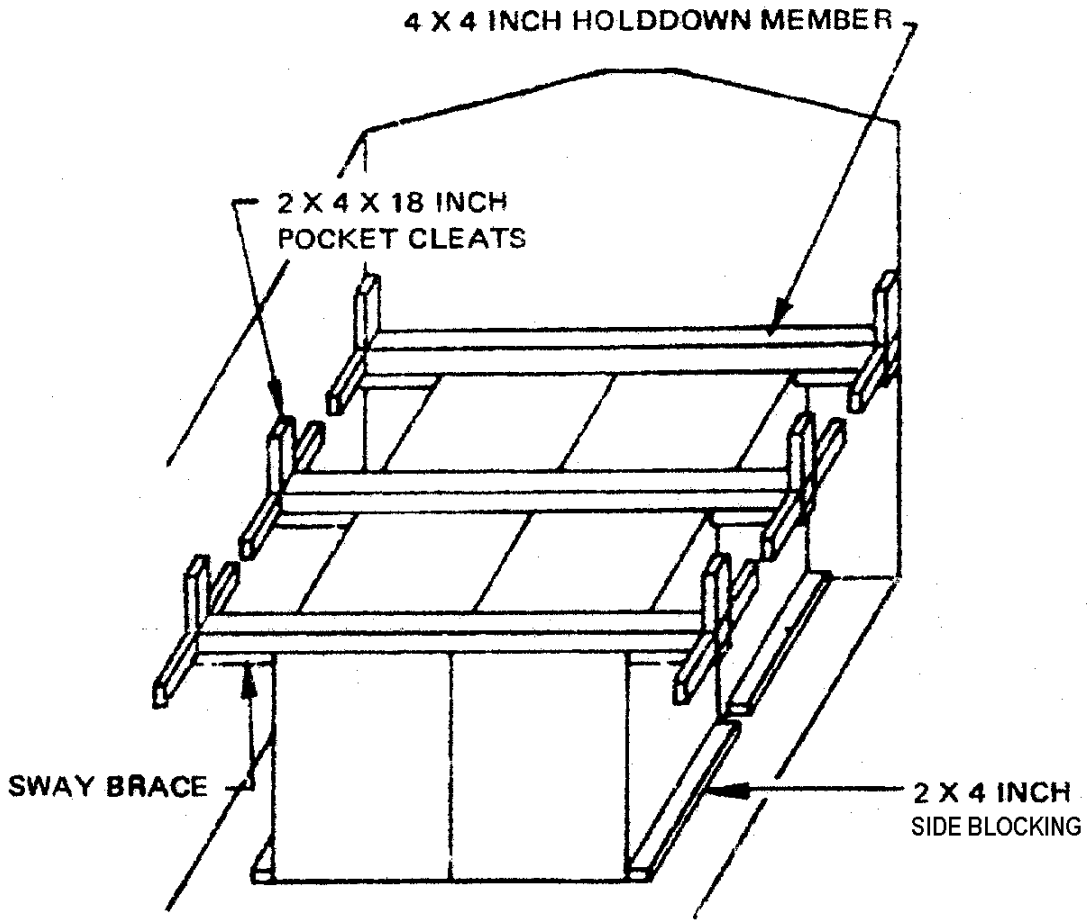

FIGURE C-14. Holddowns with top-of-the-load sway bracing, with nailed side blocking.

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.

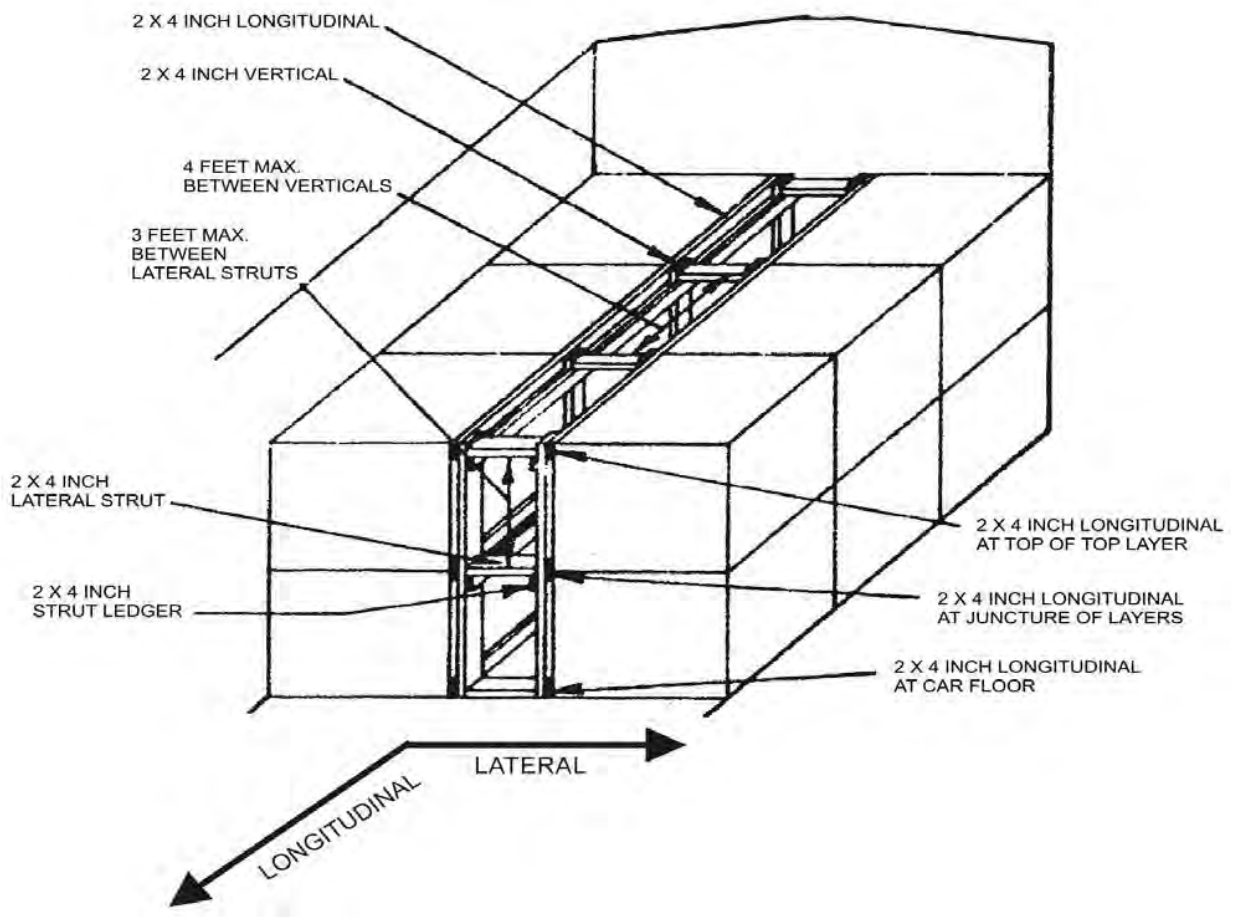

FIGURE C-15. Crib fill assembly.

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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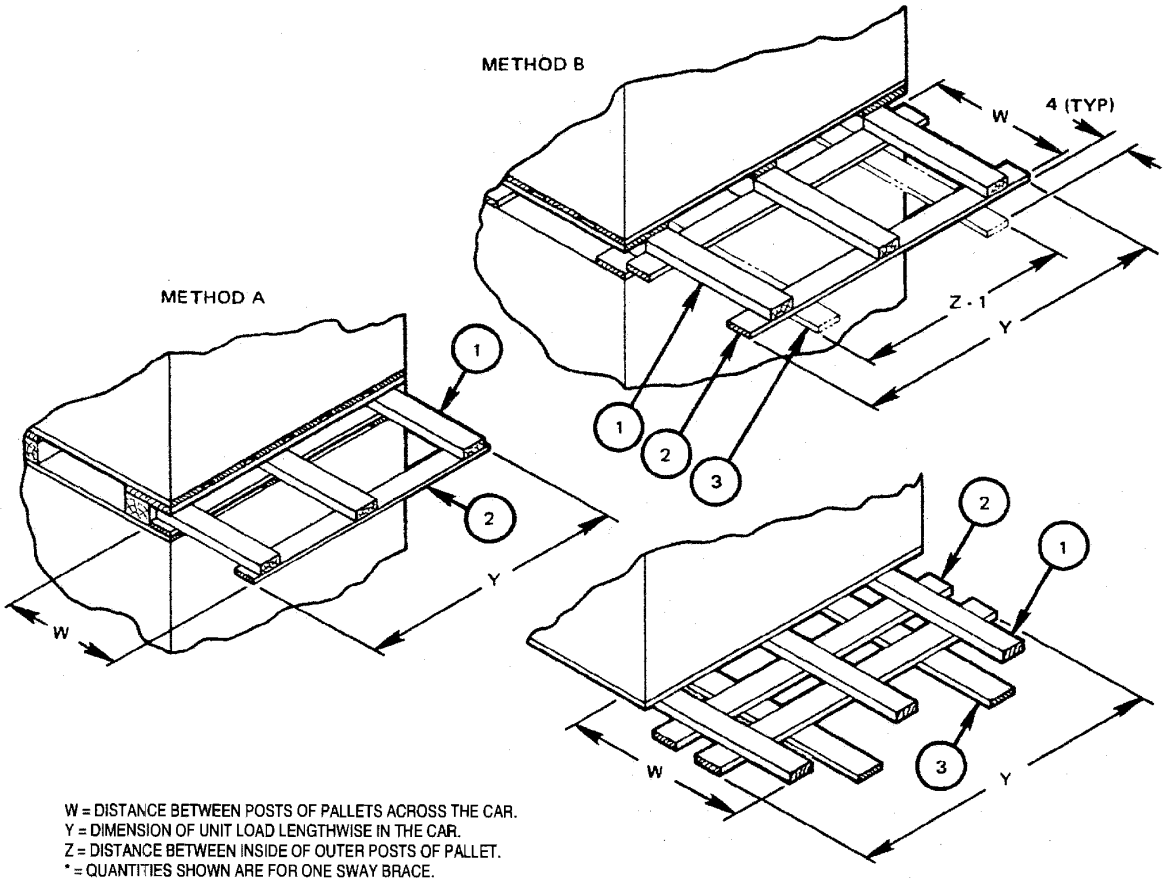
SWAY BRACE
FABRICATION AND INSTALLATION OF SWAY BRACING

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	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		
					NAILS	

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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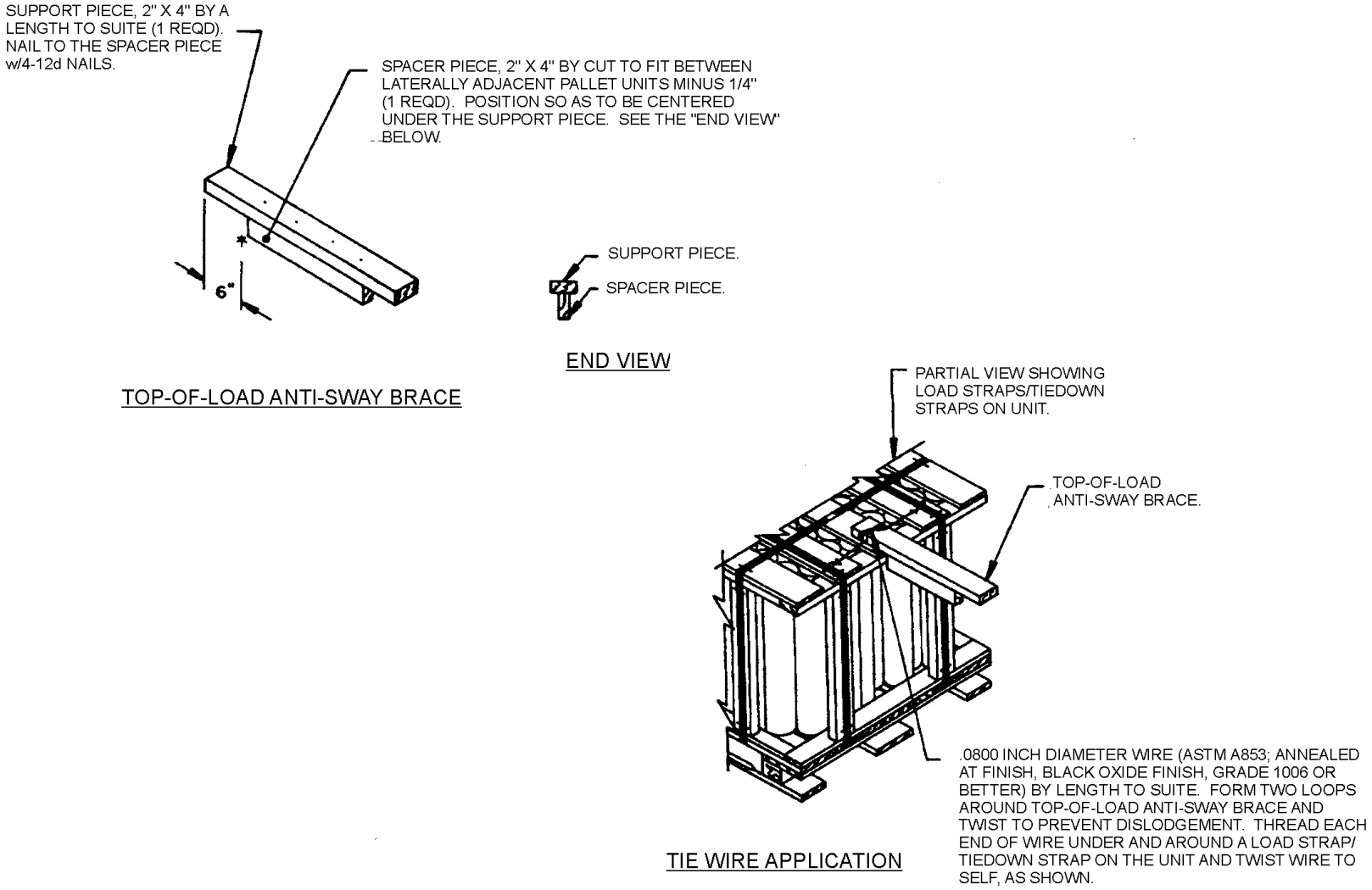

FIGURE C-17. Typical top-of-load anti-sway bracing.

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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.

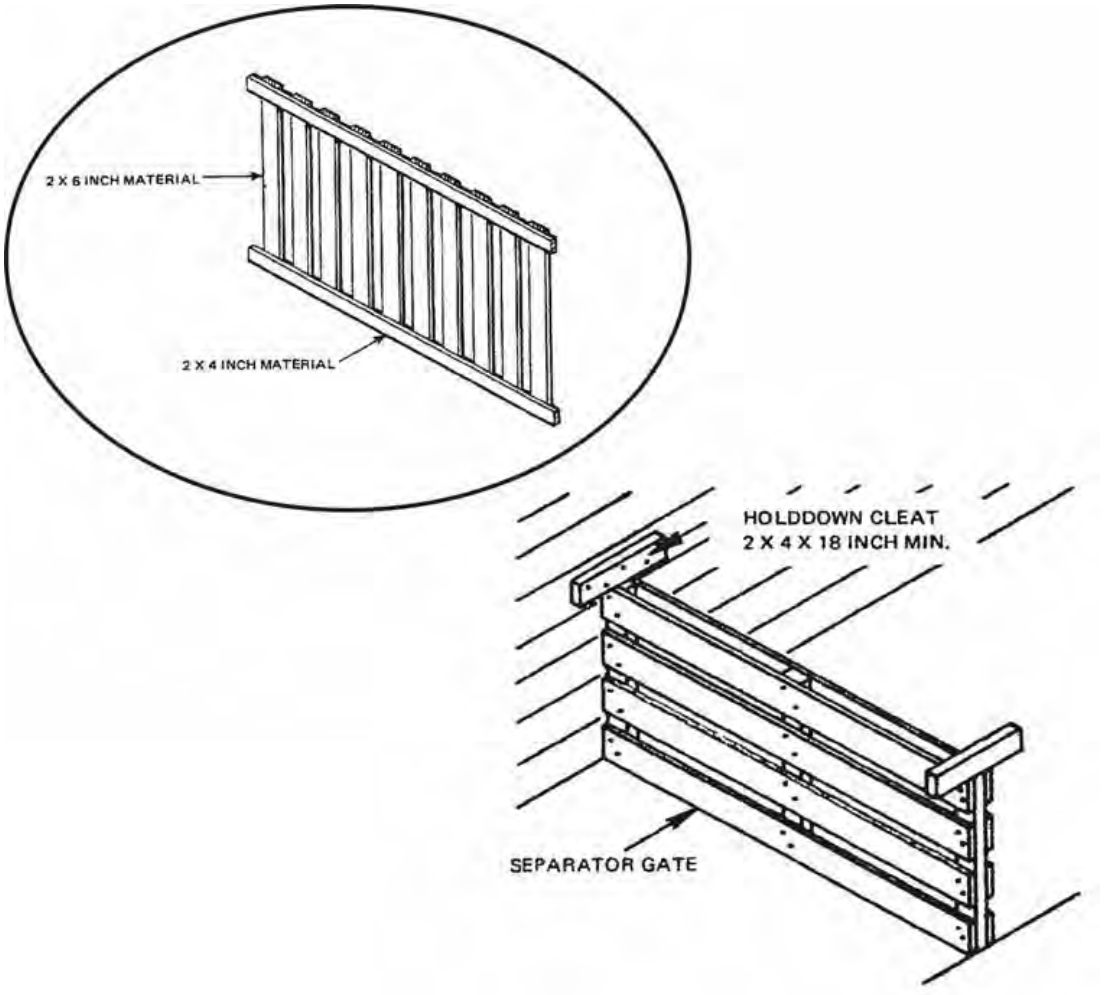

FIGURE C-18. Typical separator gates.

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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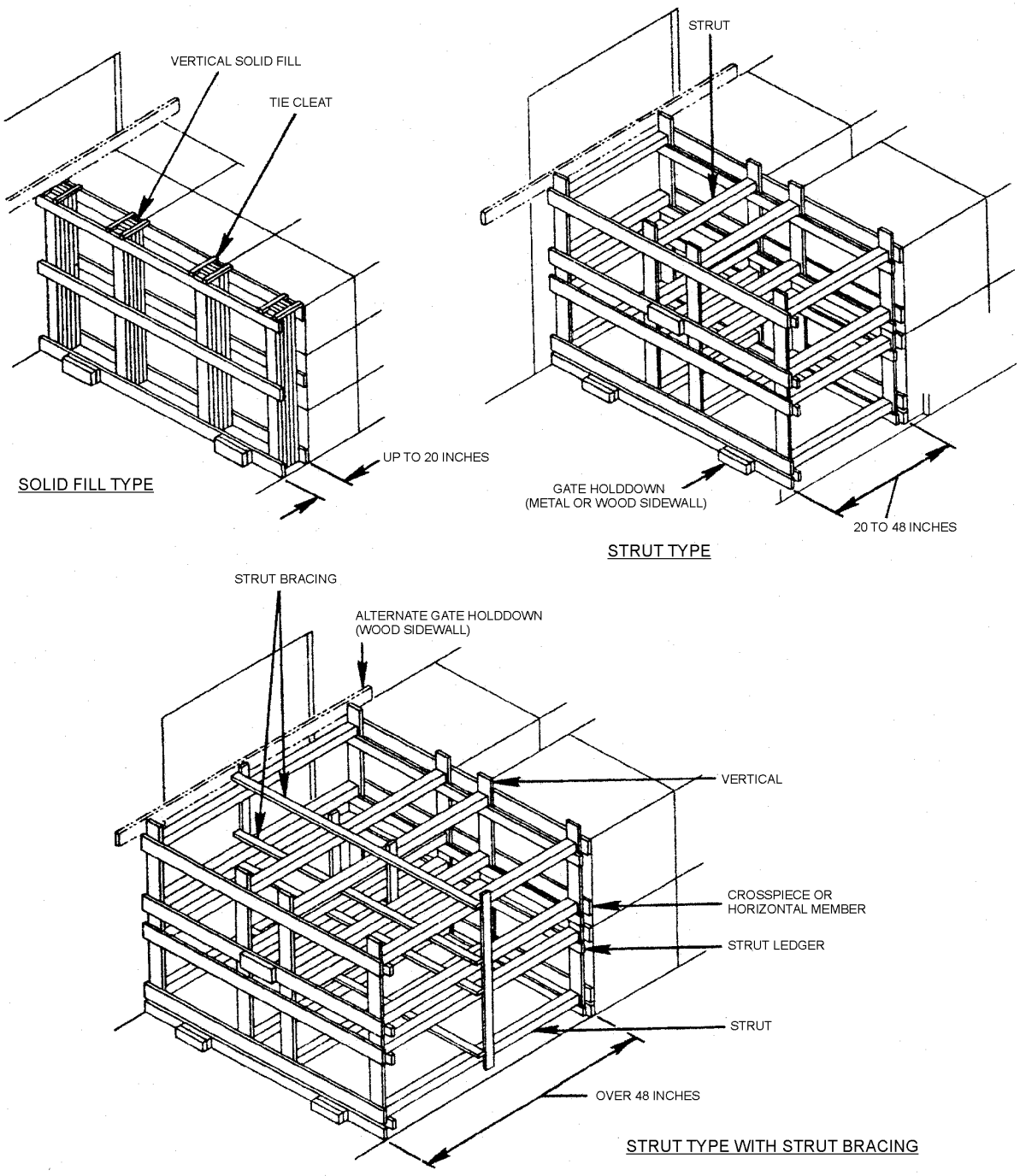

FIGURE C-19. Typical center blocking.

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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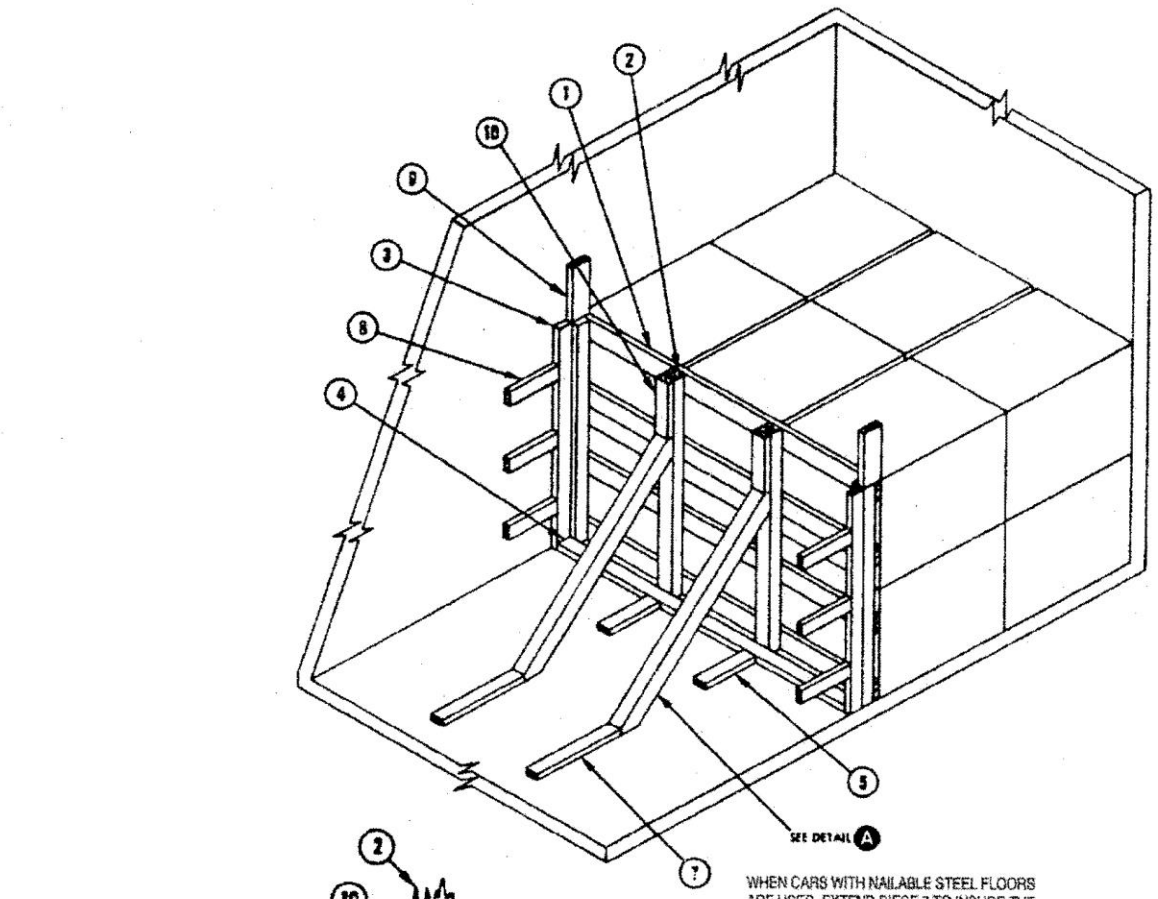

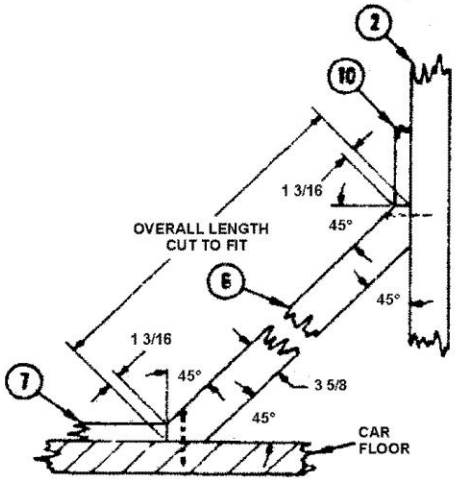

DETAIL A
POSITIONING OF DIAGONAL BRACE

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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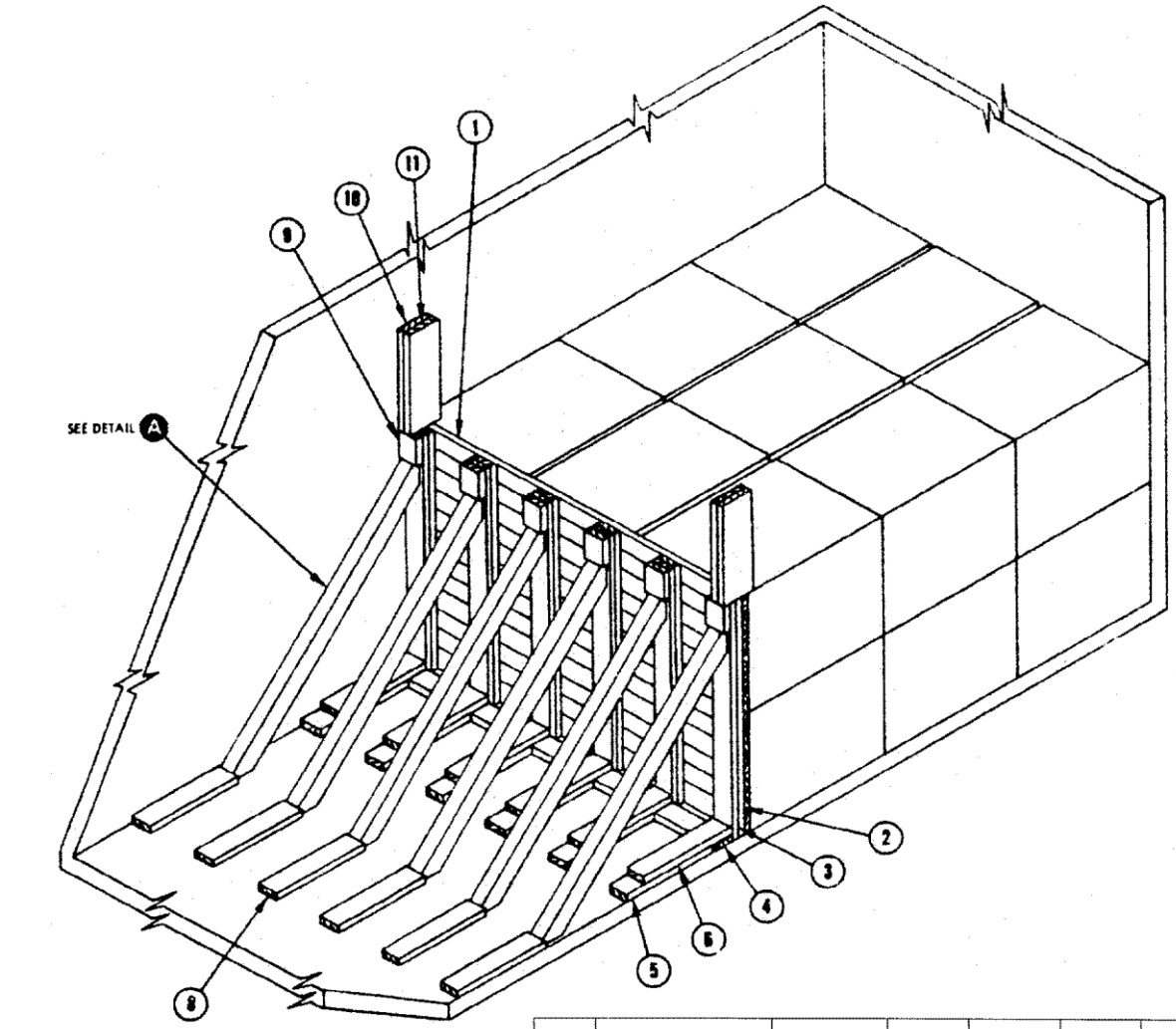
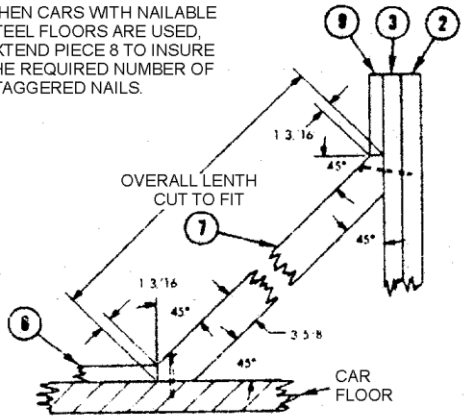


WHEN CARS WITH NAILABLE STEEL FLOORS ARE USED, EXTEND PIECE 8 TO INSURE THE REQUIRED NUMBER OF STAGGERED NAILS.



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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