

SECURING SYSTEMS



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SECTION

SECTION:5

RESTRAINT SYSTEMS

The goal of a restraint system is to dissipate the impact energy of the load in transit, without incurring damage to the packages or equipment. The systems shown on the following pages perform this function in one of three ways: rigidly, semi-rigidly, or by absorbing energy. While all of the systems indicated in the Restraint Systems Table might meet the performance criteria for each mode, applicability of any system for a particular load will depend on the circumstances of the load. In some instances, a combination of systems may be necessary to achieve adequate restraint. In selecting a system, the shipper must carefully consider which type best suits the needs of the particular load.

TESTING AND EVALUATION

The systems included in this guide have been subjected to testing or trial shipments for use in one or more modes. Some of the testing or trial shipments have been done by consensus groups, some by the Association of American Railroads and some by individual shippers. Each system was tested or used for two different types of loads (drums and mixed load) in each of the applicable transportation environments (rail, highway, and water). Although modifications to some systems were developed through the use of laboratory test data, all systems described have been used in many supervised shipments.

For a discussion of the test methods and/or trial shipment procedures for each mode, see Appendix B.

NOTE: All rail restraint systems listed have been officially approved by the Association of American Railroads (AAR) for interchange movement. Only a sampling of methods approved by the Association of American Railroads is included in this Guide. For further information consult your carrier or the **AAR Intermodal Loading Guide for Product in Closed Trailers and Containers.**

HOW TO USE THIS SECTION

This section describes bracing 'methods' under five types of restraint systems: Rigid Wood A, Rigid Wood B, Energy Absorbing Systems, T-Gates and Rubber Matting/Steel Strapping. It is important to note that a restraint system is a way of securing cargo. A method, as used in this guide, is a restraint system, or combination of systems, used only under the conditions described. For example, Method A(1) uses toe-boards as a restraint system. But this system is only recommended for highway, and for legal sized loads. **Inclusion of a restraint system in this guide does not necessarily mean it is recommended for all modes, or for all types of loads.**

Table 5.1
RESTRAINT SYSTEMS TABLE
X = Areas of Application

METHOD	ROAD		RAIL		WATER	
	DRUMS	MIXED & ALL OTHER LOADS	DRUMS 4-3-4 PATTERN	MIXED LOAD	DRUMS	MIXED & ALL OTHER LOADS
A. Wood Rigid A						
(1) Toe Boards	X	X			X	X
(2) Toe Board with Strapped Section	X	X			X	X
B. Wood Rigid B						
(1) Single Deck	X	X	X	X	X	X
(2) Double Deck - 20' with slotted or protruding door post	X	X	X	X	X	X
C. Energy Absorbing						
(1) Ty-Gard 2000®	X	X	X	X	X	X
(2) Ty-Gard 2000® Double Deck - 20'	X	X	X	X	X	X
(3) Ty-Gard 2000® Intermediate Bulk Containers	X	X	X	X	X	X
D. T Gate						
(1) Single Deck	X	X	X	X	X	X
(2) Double Deck 20'	X	X	X	X	X	X
E. Rubber Matting/Steel Strapping Single Deck	X	X	X	X	X	X



Note for drum shipments: Several of the methods are recommended for drums in a 4-3-4 pattern. This pattern is far more effective at distributing impact forces than drums arranged in a straight line (4-4-4). Be sure the drum pattern used matches the pattern recommended.

Each method covered includes a description of the method, materials used, typical load arrangements and suitable areas of applicability including modes, load size and load type.

Because it is impractical to illustrate all possible loads for each method, the reader may use the methods for loads slightly different than those shown, provided restraint system capabilities are not exceeded.

CAUTION: All typical loads shown are based on 20 foot or 40-foot equipment. Suitable adjustments must be made for other length dimension containers or trailers.

METHOD A(1) TOE BOARDS

FOR HIGHWAY ONLY

DESCRIPTION - Toe Boards - Rigid nailed wood system having many variations with only the basic ones shown. Use good quality dry wood, free from major knots and cross grain and with adequate nailing. Loading to be snug to nose of transit unit with crosswise voids filled or side-braced and no voids in lengthwise direction. The basic configuration of the toe board system is one or more boards placed snugly against the rear of a load and nailed down.

Area of Application

MODE - Highway

LOAD SIZE - Any Legal

LOAD TYPE - Drums

Mixed Load

BILL OF MATERIALS

1. 2" X 4" lumber, cut to size
2. Nails - size and number depends on arrangement of boards
(See Nails and Nailing, Materials Section).

ASSEMBLY

Several different arrangements of toe boards are possible. Some typical arrangements are shown in illustration below.

Although 2" x 4" is the standard size for toe boards, larger sizes can also be used. Normally, nails every 8" in staggered pattern are adequate. For heavier loads, additional hold down cleats are recommended.

Use of boards as side braces or cleats is optional.

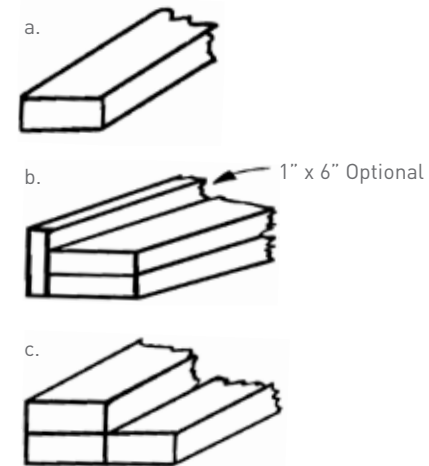


FIGURE 5.2

- a. Single 2" x 4"
- b. 2 - 2" x 4" pieces
- c. 3 - 2" x 4" pieces: For heavy loads

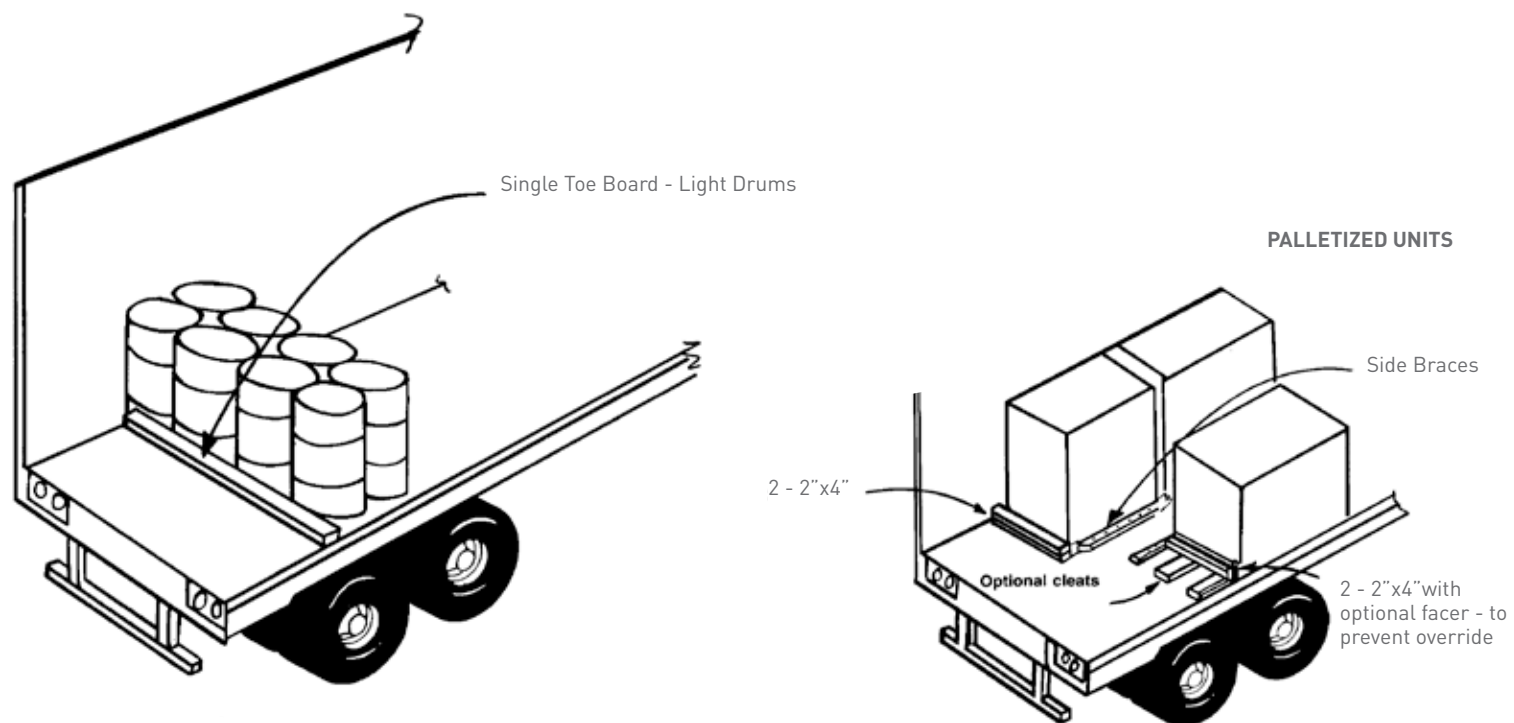
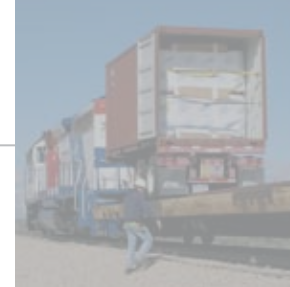


FIGURE 5.3

Typical Uses of Toe Boards

METHOD A(2) TOE BOARD W/ STRAPPED SECTION

FOR OCEAN MODE

DESCRIPTION - Toe Boards with metal strapped section. A rigid system proved by experience for water mode shipment. Useful for single layer loads in 40-foot containers.

Area of Application

MODE - Ocean Mode Only

LOAD SIZE - Any Legal

LOAD TYPE - Drums

4-3-4 or 4-4-4

Mixed Load

BILL OF MATERIALS (Typical)

- 2" x 4" Floor brace (2)
- Strapping, clips, etc. 1-1/4" x .031" Heavy Duty

Seals of recommended type by Manufacturer

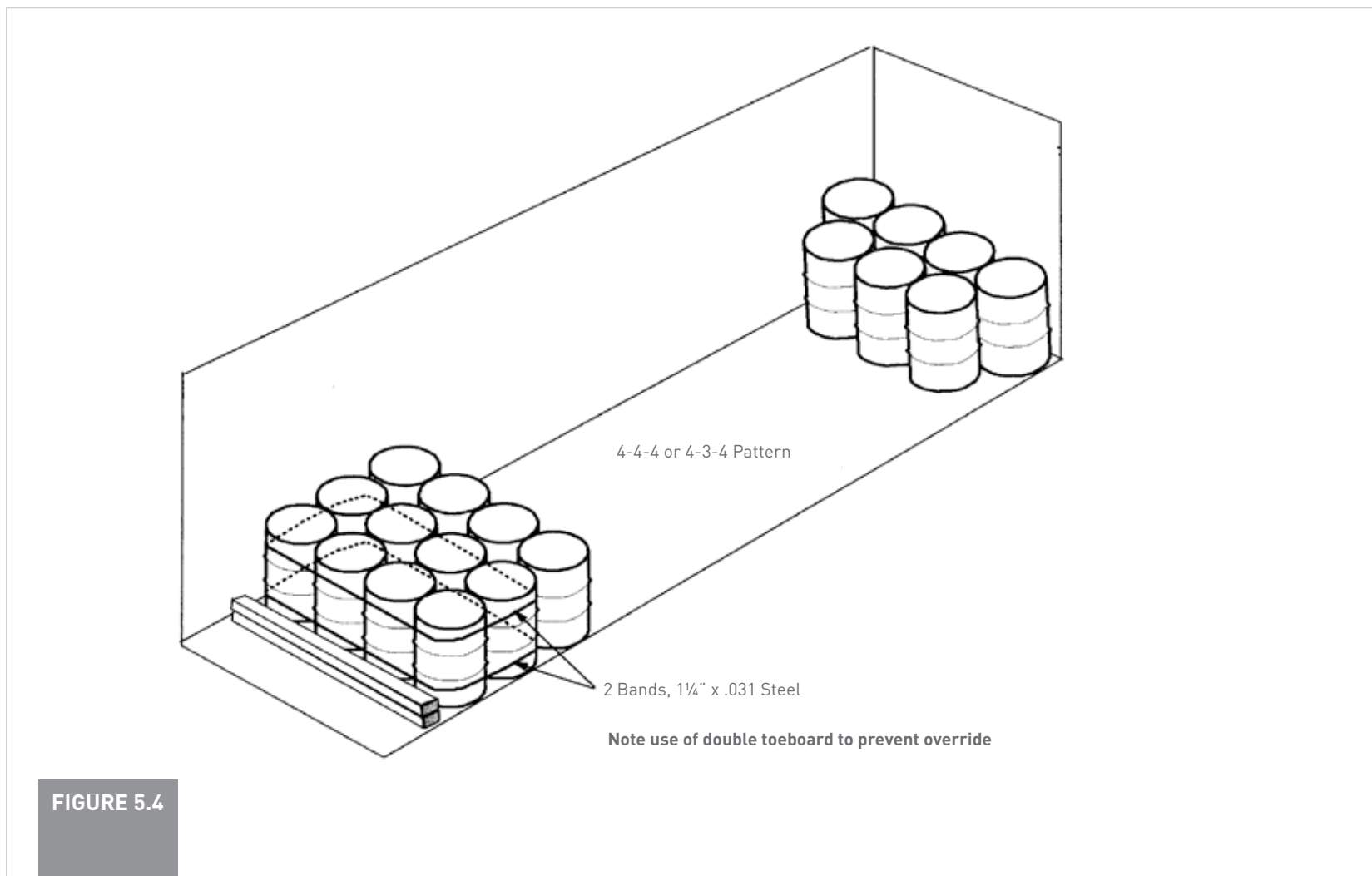


FIGURE 5.4

METHOD B(1) WOOD

SINGLE DECK

DESCRIPTION - Rigid nailed wood bracing system for steel drums or miscellaneous load with drum sections in 4-3-4 pattern in trailer.

Area of Application

MODE - COFC, TOFC

LOAD SIZE - 40,000 lbs.

LOAD TYPE - Drums

4-3-4 pattern, 4-4-4 Drum or Mixed Load in center section

CAUTION: Trailer/container must have brace slot corner posts, or door posts which extend a minimum of 2 ½". Follow load plan carefully except for center section.

BILL OF MATERIALS (typical)

Item	No. of Pieces	Description
A	3	Single layer bulkhead. Nail to trailer/container floor with eight (8) 30d nails (Sketch No. A).
B	2	½" plywood separator, load height x trailer width minus 1".
C	3	Strut assembly (Sketch No. C). Nail to the bulkhead with three (3) 10d nails at each end.
D	3	Strut two (2), 2" x 6" x length cut to fit, laminated and toe-nailed to bulkheads at each end. Laminate with one (1) 10d nail every 6" (2 min.). Toenail to the bulkheads with two (2) 12d nails at each end.
E	3	2" x 6" length cut to fit into brace slots adjacent to corner posts (inside trailer/container width if brace slots are not present). Nail top and bottom pieces to bulkhead with one (1) 10d nail every 12'. Nail other piece to vertical pieces with three (3) 10d nails each joint.

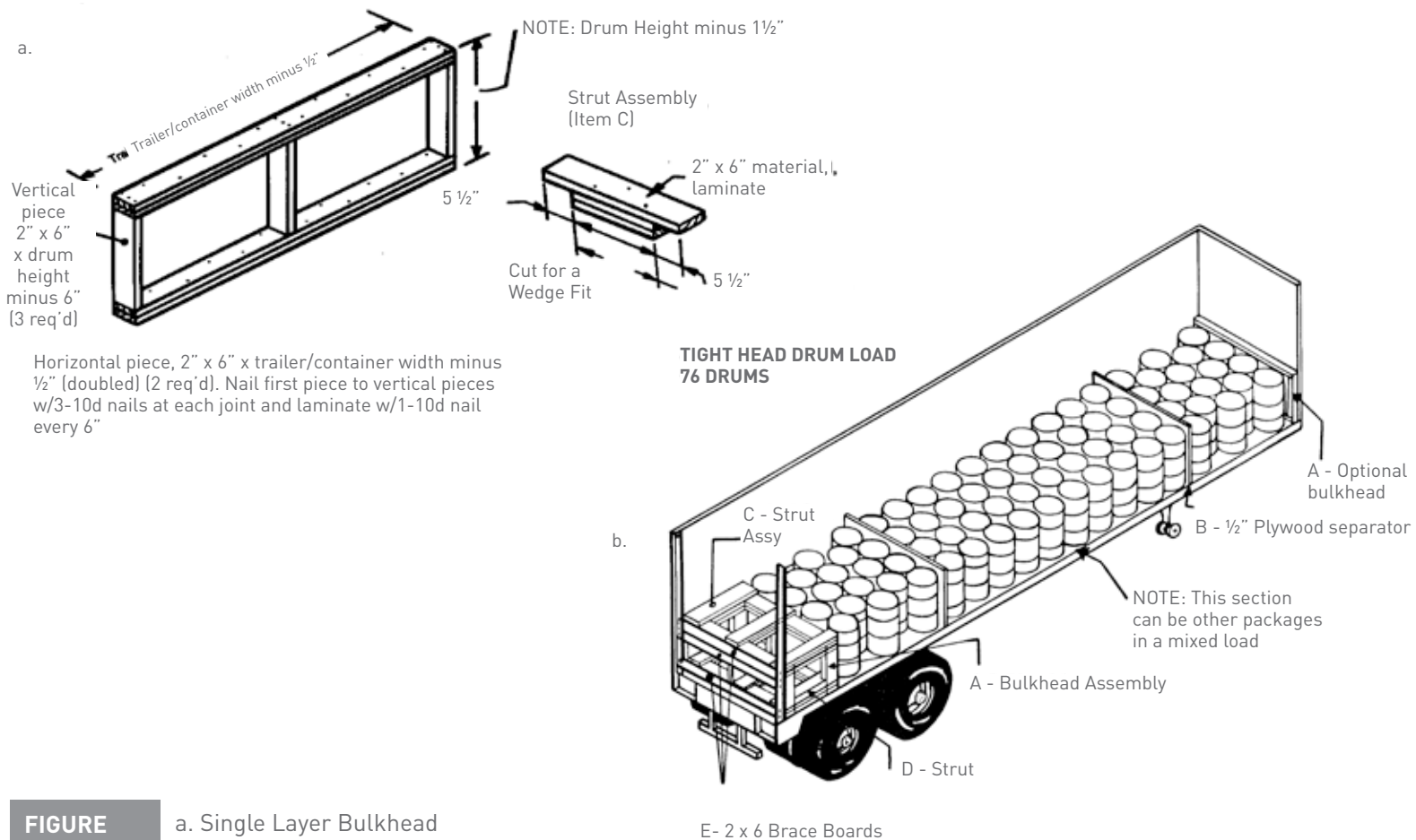
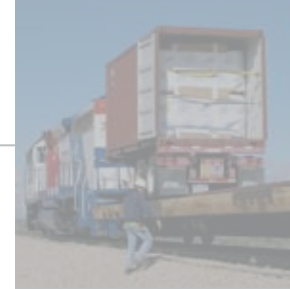


FIGURE 5.5A & 5.5B

a. Single Layer Bulkhead
b. Tight Head Drum Load

METHOD B(2) WOOD DOUBLE DECK CONTAINER

DESCRIPTION: Double deck rigid restraining system for 55 gallon steel drums or mixed load in 20-ft. container.

CAUTION: Container must have 2 ½" protruding or slotted door posts or brace slots adjacent to corner post. Follow load pattern for drums exactly as shown.

Note: A system using 'T' Gates for drums as an alternate to this system and is shown under Method D(2).

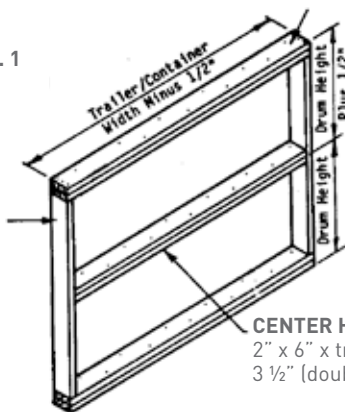
BILL OF MATERIALS (typical)

ITEM	No. of Pieces	
A	1	Two layer bulkhead (Sketch No. 1). Nail to the trailer container floor with eight (8) 30 d nails. (Rear bulkhead required, additional to fill void.)
B	2	Plywood decking - ½" x container width minus ½" x length as required.
C	1	Separator - ½" plywood x load height x container width minus 1".
D	3	Horizontal fill - 6" wide x 30" long x thickness required. Nail to bulkhead and/or nailing piece with three (3) 10d nails.
E	2	Nailing piece - 2" x 6" x 30". Nail to bulkhead with three (3) 10dnails.
F	2	Vertical fill - 6" x bulkhead height x thickness required. Nail to bulkhead with three (3) 10d nails.
G	5	Retainer piece - 2" x 6" x length to fit into brace slots adjacent to corner posts (inside container width if brace slots are not present). Nail to bulkhead horizontal pieces with one (1) 10d nail every 12", or to vertical pieces with three (3) 10d nails at each end.



- a. Top/bottom horizontal piece, 2" x 6" x trailer/container width minus 1/2" (Doubled) [2req'd]. Nail first piece to vertical pieces, nail second piece to first and laminate.

SKETCH NO. 1
Two Layer Bulkhead (Item A)



VERTICAL PIECE
2" x 6" x load height minus 5 1/2" (2 req'd). Nail to each center horizontal piece.

CENTER HORIZONTAL PIECE
2" x 6" x trailer/container width minus 3 1/2" (doubled) (1 req'd) laminate.

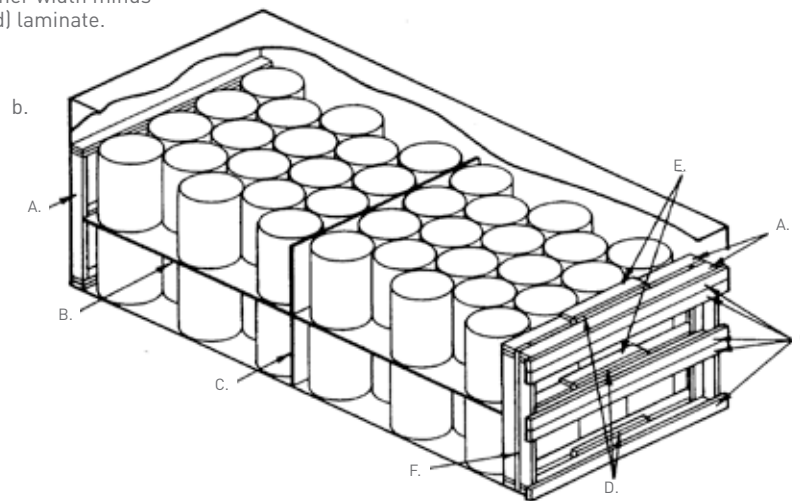


FIGURE 5.6 & 5.7

METHOD C(1) - TY-GARD 2000® SINGLE DECK

DESCRIPTION - Laminated fabric bulkhead restraining system-semi-rigid (Ty-Gard).

Specifications Ty-Gard 2000® - polyester base 16" roll goods, minimum strength of 600 lb./inch of width, anchored by high shear adhesive to transit equipment wall. Special tools required.

CAUTION: Use only in equipment with horizontal plywood walls or refrigerated unit. or for corrugated steel wall containers follow contour of side wall.

Area of Application

MODES - Highway & Water (with 4' glue area)
Rail (with 5' glue area)

LOAD LIMIT

Highway - 15,000 lb./band
Water - 10,000 LB/band
Rail - 8,800 LB/band

LOAD TYPE - ALL

BILL OF MATERIALS (typical) - per barrier

Barrier Material – Two 10-ft. lengths of Ty-Gard per band (5ft adhesive pre applied) and one 5ft Ty-Patch strip Ty-Tools
Include short wrench, long wrench, tensioning pin and bonding roller.

*Follow manufacturer's/supplier's instructions on installation of barriers.

Installation of Each Band

1. Cut two 10' strips of Ty-Gard and one 5ft length of Ty-Patch. for each barrier required. Determine position of barriers in the container and leave at least 12" between adhesive line and end of lading. Apply Ty-Gard to sidewall using the bonding roller.



**FIGURE
5.8**

Install Barrier



2. After loading is complete, Overlap pre-positioned Ty-Gard across the front of the lading. Place the 'clothespin' tool over the overlapped fabric and tension using the short and long wrenches

3. Apply 5ft Ty-Patch. Remove wrenches and pull out clothespin. Tape the finished barrier to present sag if the load is compressed by nose and impacted.

*Follow manufacturer's/supplier's instructions on installation of barriers. See; <http://www.ty-gard.com/install.html>



FIGURE
5.9

Tension Barrier



FIGURE
5.10

Secure Patch

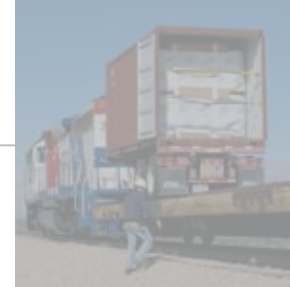
TYPICAL TY-GARD LOADS

A. RAIL MODE TOFC/COFC - 5' Glue Area upto 78 DRUMS

Holding Power per band is 8,800 lbs. Max. **Other Loads Acceptable**—See Section 4 - Load Planning

LOADING

1. 55-gallon drums are placed in a 4-3-4 recessed pattern or 4-4-4 pattern.
2. The load is divided into sections so as not to exceed 8,800 per band.
3. The last stack in each section is to contain 3 drums as shown below or must use a plywood bulkhead behind the Ty-Gard.
4. Each section is secured by two 16-inch wide strips of Ty-Gard. Ty-Gard is bonded to the side walls (per manufacturers' instructions) with a glueline at least 60 inches long and at least 24 inches back from face of load.
5. Close and seal using Ty-Patch for each section in accordance with manufacturers' instructions.



B. Marine Mode - 5' Glue Area

Load holding power per band is 10,000 lbs.

Ty-Gard 2000

See figure 5.11

C. Highway - 4' Glue Area

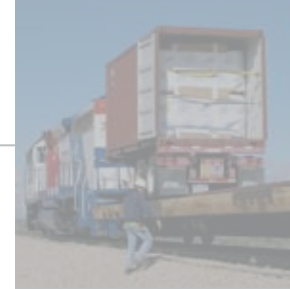
Load holding power per band is 15,000 lbs.
(30,000 lb. per 2 band gate)

Typical loads as shown in Figure 5.12 but with
one barrier (gate)



**FIGURE
5.12**

4-3-4 Drumload
Typical load of hazardous
material in 55 gallon drums



**FIGURE
5.13**

Mixed Load
Typical mixed load of
hazardous materials

D. Other Applications

Follow load limits/band of previous examples

1.

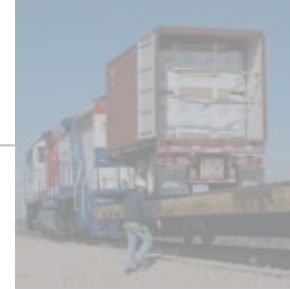


2.



FIGURE
5.14

- 1. Single Tier
- 2. Double Tier



3.



4.



**FIGURE
5.15**

3. Partial Second Tier
4. Single Tier Rail

5.



6.



FIGURE
5.16

5. Centered SecondTier
6. Centered Single Tier



SECURING SYSTEMS

METHOD C(2) - TY-GARD 2000®

DOUBLE TIERED

Specifications

Ty-Gard 2000® - polyester base 16" roll goods, minimum strength of 600 lb./inch of width, anchored by high shear adhesive to transit equipment wall. Special tools required.

Area of Application

MODES - Highway/Water

LOAD LIMIT Highway - 15,000 lb./band

Water - 10,000 LB/band **Rail** - 8,800 LB/band

BILL OF MATERIALS (typical) - per gate (5 ft. long glue area)

Barrier Material – Two 10-ft. pre-glued lengths of Ty-Gard and one 5-ft strip of Ty-Patch. Ty-Tool Kit includes long and short wrenches, tensioning tool and bonding roller. *Follow manufacturer's/supplier's instructions on installation of barriers.

*See <http://www.ty-gard.com/install.html>

This load may contain double-decked drums loaded in a 4-4 pattern (with the last stack only containing drums three wide) or bin pallets or any palletized product two layers high. Any combination of product mix is acceptable.

Use of this loading method is limited to 20-foot ISO containers.

Illustration No. 5.17

1. Loads containing 78 drums can be loaded in ten stacks using a 4-4 pattern or eleven stacks using a 4-3-4 pattern. If using a 4-4 pattern the nose section is secured after the fifth stack. If using a 4-3-4 pattern, secure the nose section after the sixth stack. See Sketches 1 and 2 of the Illustration. Use ½" thick plywood, or equivalent as a separator between each layer. The separator material runs the full width of the container and the full length of the load.
2. If a 4-4 pattern is used, the last stack in the container will have three drums in each layer as shown in Sketch 1. Plywood sheets are not required at the end of the layers.
3. If a 4-3-4 pattern is used, the last stack in the container will have four drums in each layer as shown in Sketch 2. For securement of the rear of the load a ½" thick plywood sheet, 6' in length with width equal to the height of the drums is position on its side edge and centered behind the last stack of each layer (2 required). Secure the plywood sheet in the top layer to the drums with tape or strips of patch material. The plywood sheets are between the drums and the fabric barriers. This helps keep the the last stack of drums in place.
4. Secure each section of the load using two 16" wide Ty-Gard barriers per layer. Each barrier is attached to the



side walls of the container (per manufacturer's instructions) with an adhesive strip at least 60" long and positioned 30" in from the rear of the load. When used with containers with corrugated side walls, follow the contour of the corrugations.

5. Tension and seal all fabric barriers in accordance with the manufacturer's instructions.

NOTE: These load patterns and securement applications can be used for lesser numbers of drums.

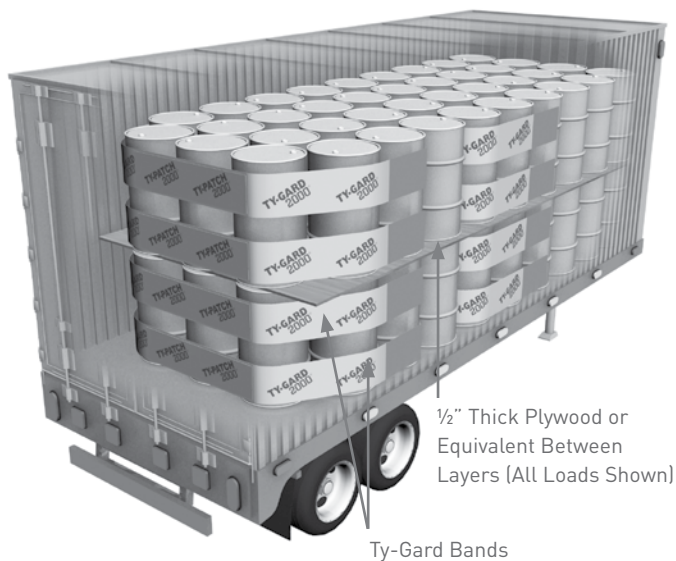


FIGURE 5.17

Sketch 1 - 78 Drum Load, 4-4 Pattern
78 Tight Head 55 Gallon Steel or Plastic Drums in Two Layers Secured by Ty-Gard in a 20' ISO Container



FIGURE 5.18

Sketch 2 - 78 Drum Load, 4-3-4 Pattern

METHOD C(3) - TY-GARD 2000® INTERMEDIATE BULK CONTAINERS

DESCRIPTION - This bracing method is for use with intermediate bulk container for liquids. The intermediate bulk container is sized to fit the dimensions of its pallet and is secured to the pallet. This method uses laminated fabric bulkheads attached to the side walls of the trailer.

Specifications

Ty-Gard 2000® - polyester base 16" roll goods, minimum strength of 600 lb./inch of width, anchored by high shear adhesive to transit equipment wall. Special tools required.

CAUTION: Use only in equipment with horizontal plywood walls.

BILL OF MATERIALS (typical) - per gate (5 ft. long glue area)

Barrier Material – two 10 ft. lengths of Ty-Gard per band (2-3 bands per gate, see Figure 5.19)

Adhesive or adhesive strips (length as required)*

Tools – Ty-Tool Kit includes long and short wrench, tensioning tool and bonding roller.

*Follow manufacturer's/supplier's instructions on installation of barriers.

*See <http://www.ty-gard.com/install.html>

Area of Application

MODES - Highway & Water (with 4' glue area)

Rail (with 5' glue area)

LOAD LIMIT

Highway - 15,000 lb./band

Water - 10,000 LB/band

Rail - 8,800 LB/band

LOAD TYPE - ALL

The intermediate bulk containers are loaded in a pinwheel pattern in two rows, one against each side wall, starting at the nose of the trailer as shown in the illustration. Corrugated fiberboard or honeycomb void fillers are used to fill crosswise voids between the rows.

If an incomplete second layer is loaded, it is positioned in the center of the trailer to maintain proper weight distribution. Separator sheets (1/2" plywood or equivalent material) are used between the bottom and top layers.

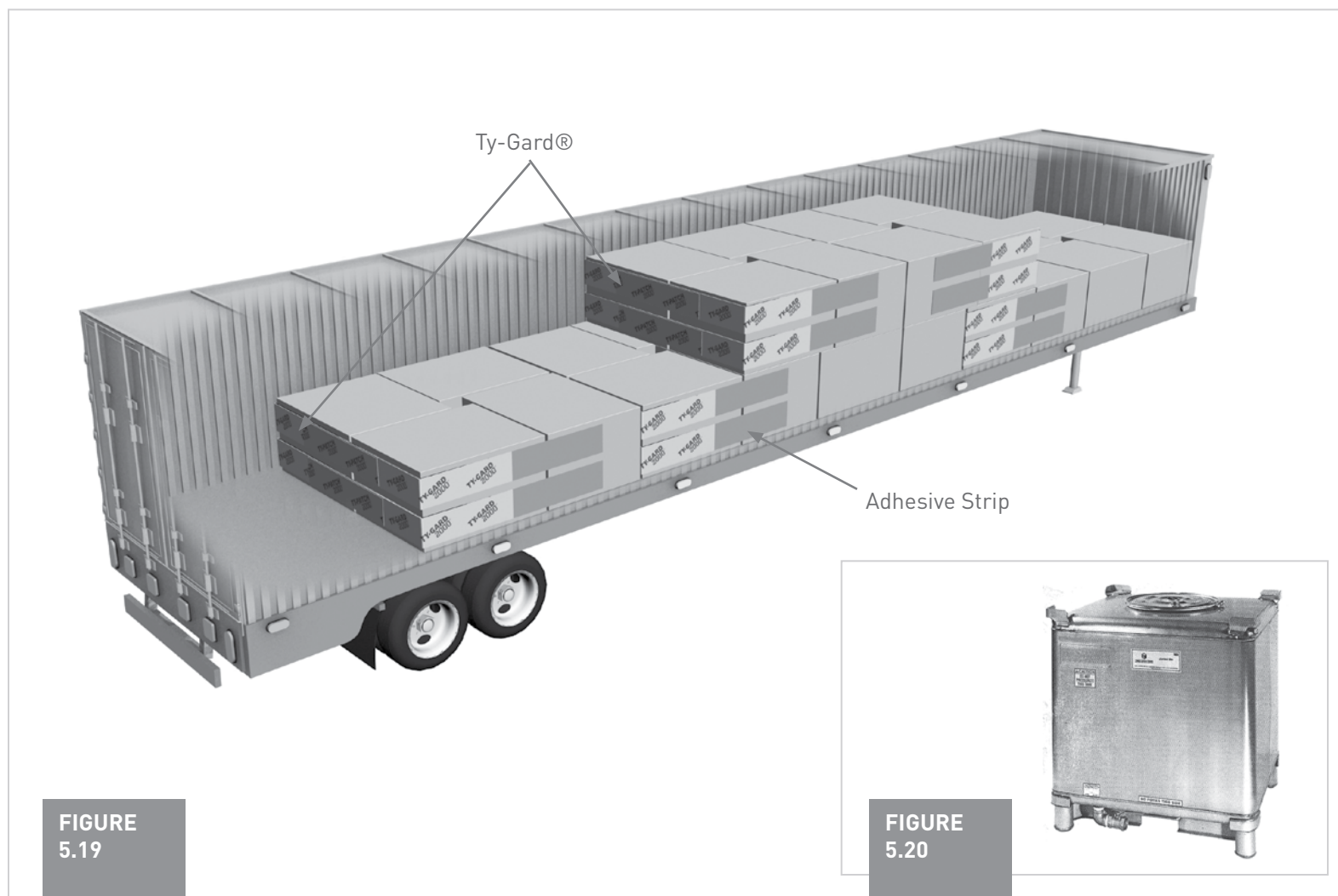
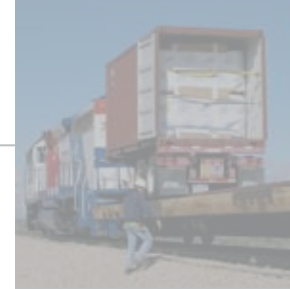


FIGURE
5.19



FIGURE
5.20

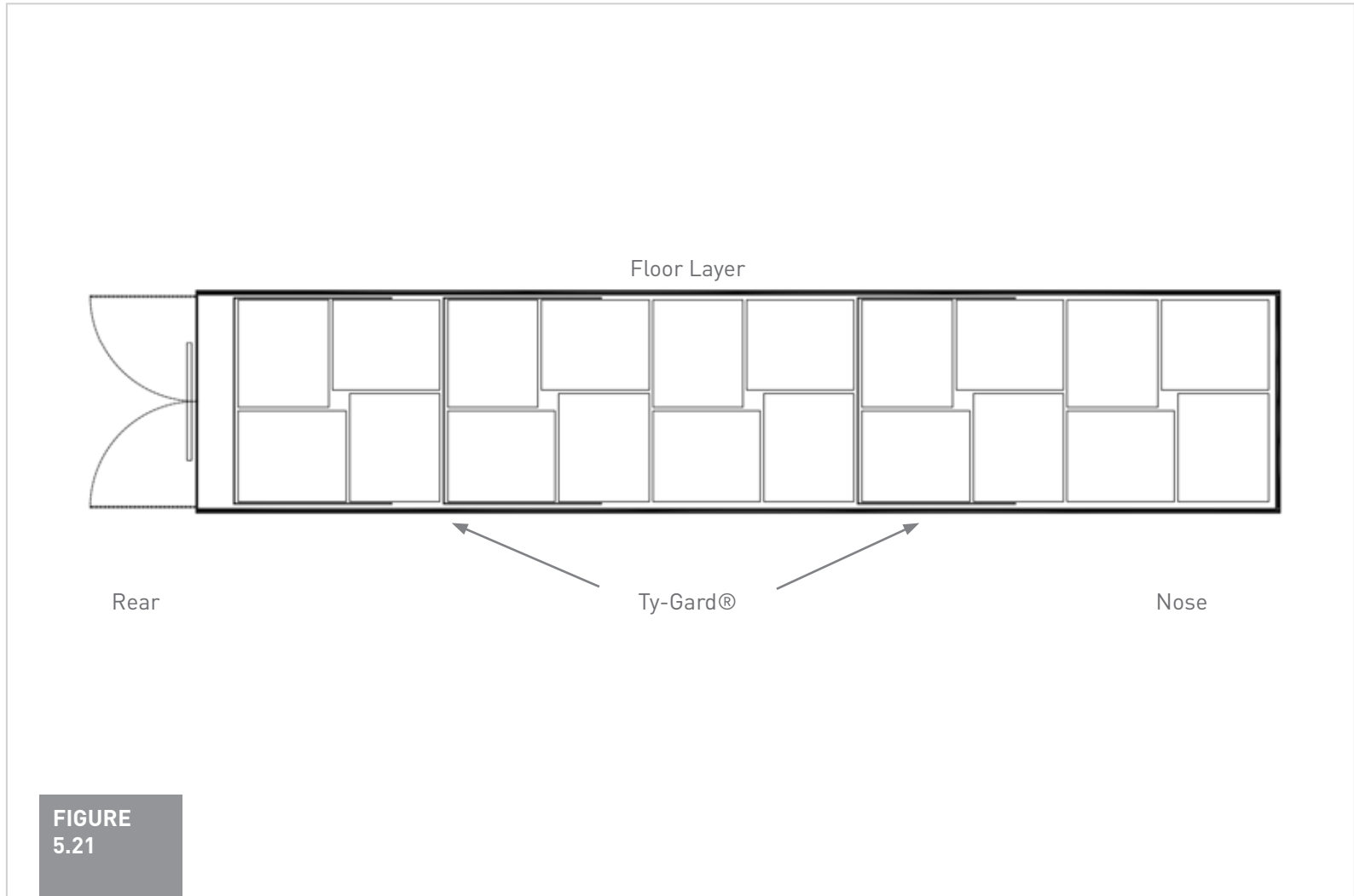
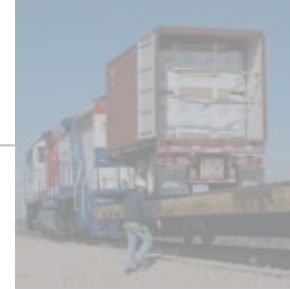


FIGURE 5.21



I.B.C's (Intermediate Bulk Containers)



FIGURE
5.22

METHOD D(1) - 'T' GATES SINGLE DECK

DESCRIPTION: 'T' Gates - rigid bulkhead designed to fit doorpost slots or vertical brace slots of transport equipment. Not suitable where door posts are flush with walls.

'T' Gate Beams may be inserted into slotted doorposts at rear of container to restrain packages. Use minimum 2" x 4" lumber, free of knots or other strength impairing defects, of suitable length to fit snugly between doorposts. Use a sufficient number of bulkheads to prevent lading from contacting rear doors. When necessary, use a wooden bulkhead and spacers to fill voids to 'T' Gate.

BILL OF MATERIALS (typical) - To be developed for each load type.

Area of Application

MODE - All

LOAD SIZE - Legal Limit

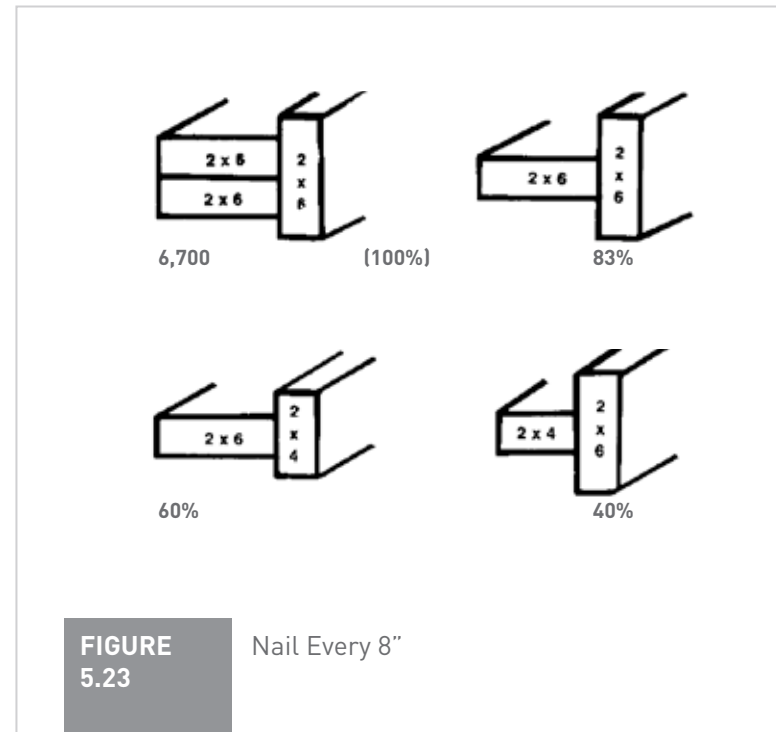
LOAD TYPE - Drums

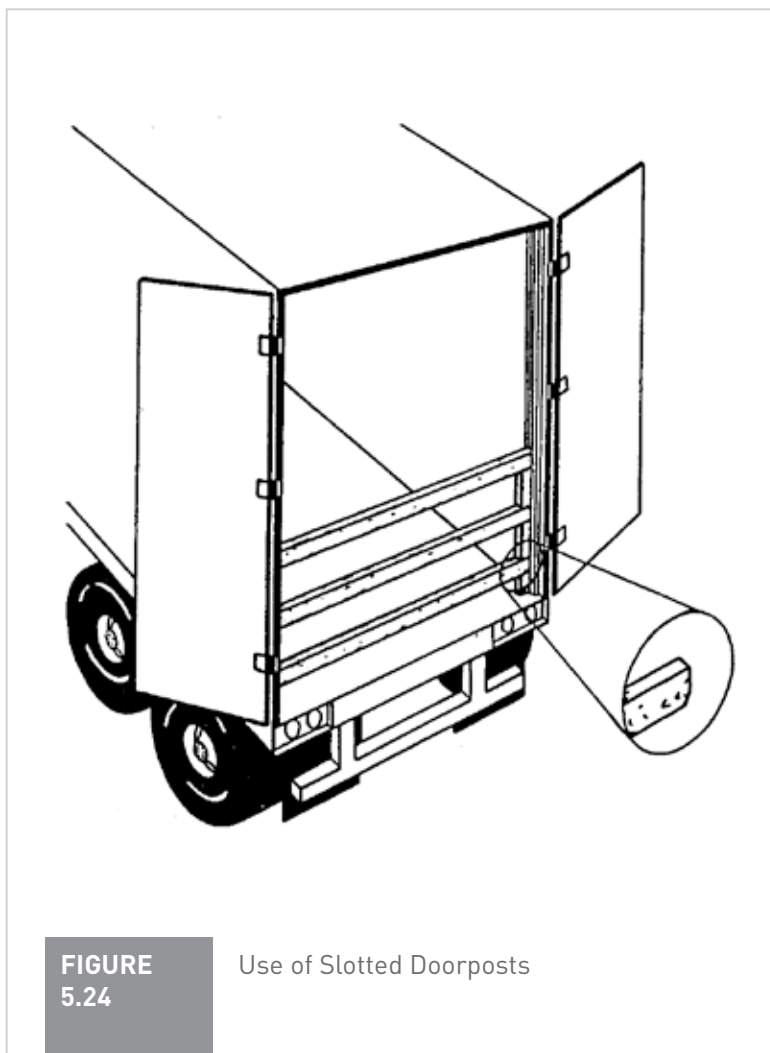
4-3-4 Mixed

FOR RAIL - To select the proper number of 'T' Gate Beams for a particular load divide the load weight of the deck (or layer) to be restrained by 6,700 based on 3 board 2 x 6 beam. Relative strength of other construction is as follows:

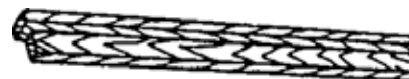
RELATIVE STRENGTH OF 'T' BARS (Useable)

Load must be made tight and filler bulkheads installed as needed to fill space within 6" of 'T' gates. Use bulkhead to spread load on packages. See Method 2(a) or 2(b) for typical bulkhead and filler construction. May be faced with plywood as needed for certain packages.





Insert 2" x 4" or 2" x 6" in groove to Separate 'T' Gates as needed. Toenail Verticals to horizontals.



'T' Beam method of reinforcing. Shown backwards for clarity.

1" Miter corners to simplify dropping in slot.

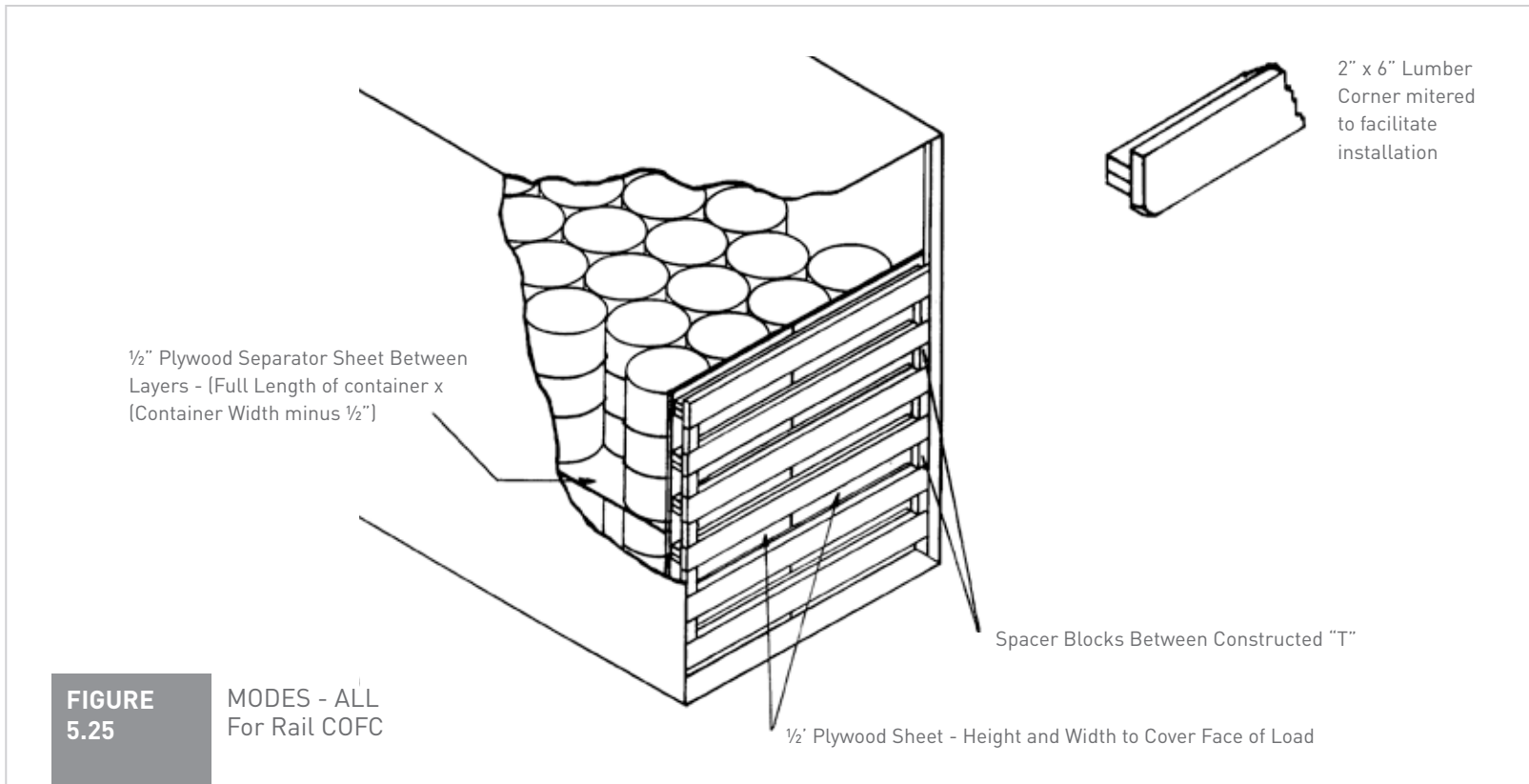
FIGURE
5.24

Use of Slotted Doorposts

METHOD D(2) - 'T' GATES DOUBLE DECK

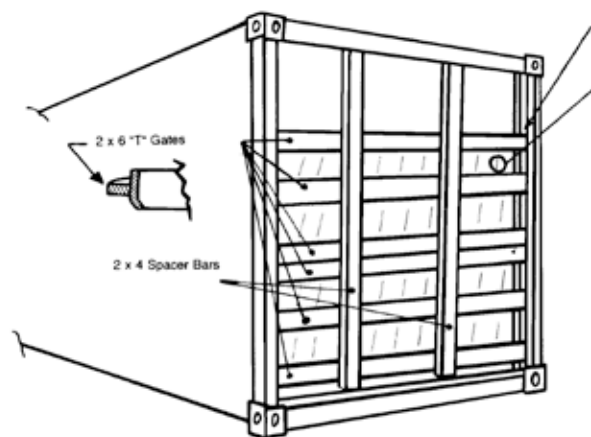
Rail Application – 78 Drums

DESCRIPTION – This loading is for 55-gallon steel or plastic tight head drums in two layers in a 20-ft. ISO container. Steel drums loaded in this method must be designed to fit in the ISO container in the required load pattern without rolling hoops override (recommended maximum outside diameter of 585mm or 23.03".) Up to 78 drums can be loaded in a 4-3-4 or 4-4 pattern



**FIGURE
5.25**

MODES - ALL
For Rail COFC

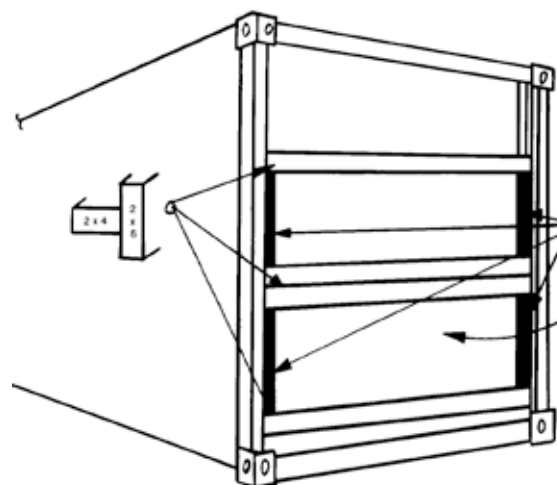


Fit 'T' gates to doorpost slots

Use load makeup as 2(b) (Nested Drum 4-3-4)

Fill void to drums with spacer bulkheads or pallets

Note: This is an alternate to same load as in Method 2(b)



Spacers

Fill voids to load with spacer bulkheads or pallets

FIGURE 5.26

MODES - ALL
For Rail COFC

FIGURE 5.27

MODES - Highway or Water
For Highway or Water Mode

METHOD E(1) - RUBBER MATTING/ STRAPPING

DESCRIPTION - This method uses ¼" masticated rubber matting and steel or polyester cord strap to restrain 55 gallon steel drums in a 3-4-3 pattern.

Area of Application

MODES - TOFC ONLY (method for trailers only)

Masticated rubber mats ¼" thick by 61½" wide by the full length of the load plus 18". Weight 17 grams per cubic inch average. Steel strapping 1¼"x 0.031" or 1¼" polyester cord strap (ASTM Type IA, Grade 4).

NOTE: Mat is a minimum of 61½" wide, and a minimum of 18" longer than the load. Adjust the length to suit each load.

ASSEMBLY

Lay the rubber matting down the center of the trailer floor as the drums are loaded.

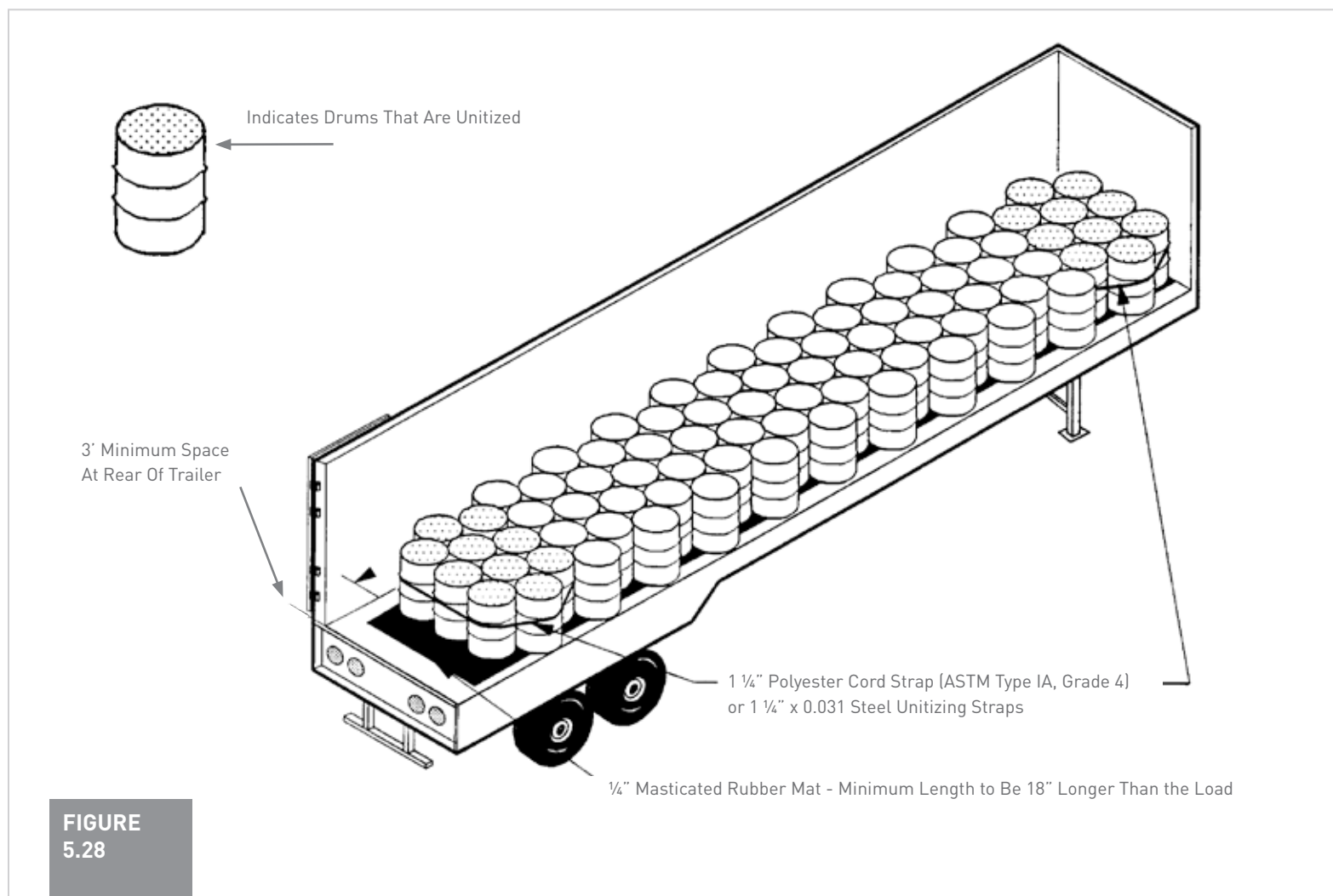
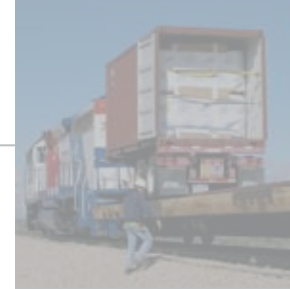
Load the first three rows into the trailer in a 3-4-3 pattern

Unitize the drums with one strap. Use tape or strap stays to prevent strap from slipping down on drums.

Continue loading drums (3-4-3) until the end of the load.

Unitize the last three rows of drums with one strap Use tape or strap stays to prevent slipping.

Leave a minimum of 3 feet of space between the back of the load and the trailer door.



**FIGURE
5.28**

METHOD E(2) - CORDSTRAP

Method 1-1 – 80 (only) tight head steel, 55 gallon drums in two layers secured with twenty two straps (1.25” wide polyester composite Cordstrap CC-105), fourteen buckles and one heat treated mitred 2”X4” in 20ft containers.

This method is for eighty (80) tight head steel drums loaded in a 20’ dry container. **The load limit for this system must not exceed 40,000 lbs.** The method of bracing involves restraint of the drums by use of **1¼” Wide Polyester Composite Cord Strap CC – 105** attached to the container D-rings and attached to other cord strap applications by use of CB10 metal buckles. (Follow the manufacturer’s instructions for buckle application) One 2”x4”x74” long wood board with ends cut at 45° angles is used at the rear of the container. During testing, horizontal straps were tensioned to approximately 1,438 Force Pounds with a pneumatic tensioner having a 90 psi air supply. **If using a CT 32PN pneumatic tensioner, it should be operated at no more than 100 PSI at which the tension is maximized at approximately 1,700 lbs.**

*ISO 1496, Annex F specifies lashing and anchor point strengths of 500kg and 1000kg respectively.

The use of this system must not exceed these limitations.

*Use drum protectors to prevent damage to drums caused by narrow strap surface area.

*Only approved for 80 drums. Hence there is not an approved configuration for a lesser number of drums

Illustration No. 5.29

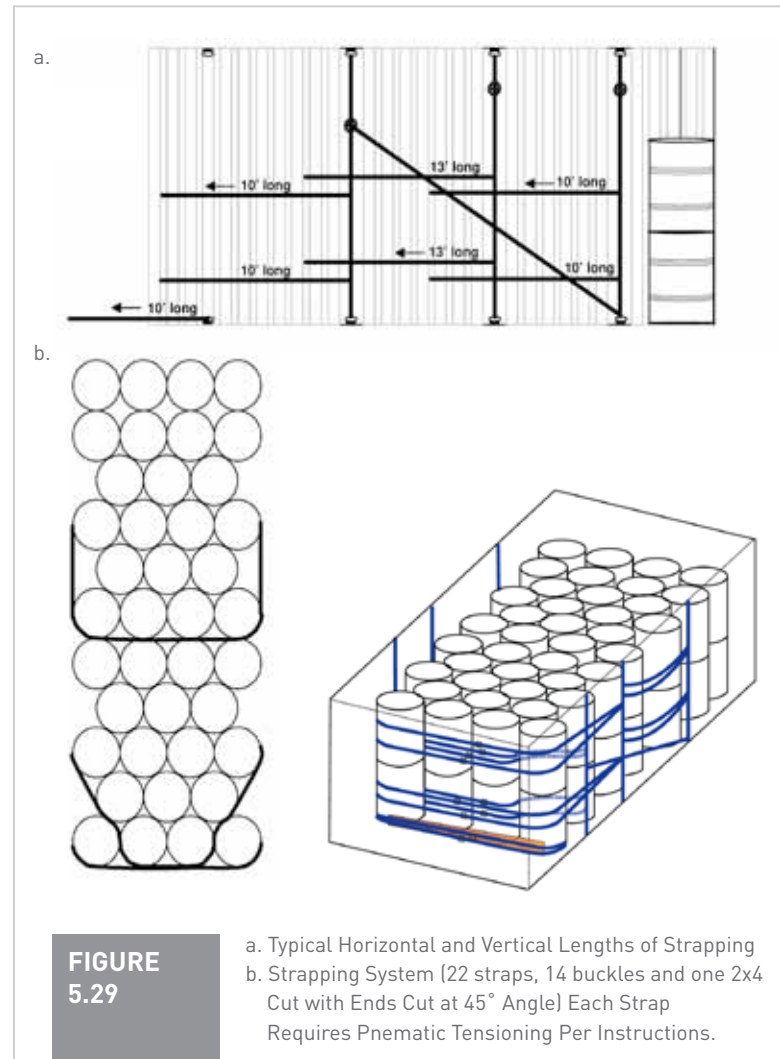
1. Select containers that are equipped with suitable D-rings at locations consistent with the load plan. It is the shipper’s responsibility to inspect and assure that the D-rings are in sound condition and that the load does not exceed the capacity of the D-rings for the container being loaded.
2. Install vertical cordstraps and buckles using the container’s D-rings:
 - 1st set located ~ 6 feet from the front of the load, with buckle above load height.
 - 2nd set located ~ 11 feet from the front of the load, with buckle above load height.
 - 3rd set located ~ 14 feet from the front of the load, with buckle positioned in the middle of the run. Protect the buckle from contact with adjacent drums.
 - Always make sure the strap is flat to the surface; avoid making a spiral turn. **Note:** A pneumatic tensioner may be used to tension the verticals while recognizing the force limitations of the D-rings. A hand held windlass tensioner may also be used.
3. Install a diagonal cordstrap and buckle from the bottom D-ring of the 1st vertical set, to the buckle of the 3rd vertical set. Do this to both sides.



4. On 1st set of vertical strap:
 - Loop a new horizontal run approximately 10 feet long around the vertical strap and position/tape it in place about 1½ feet from the floor for the bottom layer of drums.
 - Loop a similar 10 feet run and position/tape it about 4½ feet from the floor for the top layer drums.
 - Temporarily hold the ends of these lengths with tape or magnets to the side of the container.
 - Repeat for the other side of the container.
5. On 2nd set of vertical strap:
 - Loop a new horizontal run approximately 13 feet long around the vertical strap and position/tape it in place about 1½ feet from the floor for the bottom layer of drums.
 - Loop a similar 13 feet run and position/tape it about 4½ feet from the floor for the top layer drums.
 - Temporarily hold the ends of these lengths with tape or magnets to the side of the container.
 - Repeat for the other side of the container.
6. On 3rd set of vertical strap:
 - Loop a new horizontal run approximately 10 feet long around the vertical strap and position/tape it in place about 1½ feet from the floor for the bottom layer of drums.
 - Loop a similar 10 feet run and position/tape it about 4½ feet from the floor for the top layer drums.
- Temporarily hold the ends of these lengths with tape or magnets to the corner of the container.
- Repeat for the other side of the container.
7. Proceed to load the bottom and top layers of the first six stacks of drums in a 4-4-3-4-3-4 pattern. Use ¼" plywood or equivalent horizontal separators as needed.
8. After the sixth stack of drums is added:
 - Pull the ends of the top cordstrap installed on the 1st set of vertical straps from both sides together. Connect the ends with the buckles and **use the pneumatic tensioner** to secure the top layer of drums. Pull the ends of the bottom cordstrap installed on the 1st set of vertical straps from both sides together. Connect the ends with the buckles and **use the pneumatic tensioner** to secure the bottom layer of drums.

Note: Always spread the two horizontal straps on each drum layer out towards the rolling hoops. This will help to spread the load over the strongest part of the drum.
9. Proceed to load the drums in a 4-3-4-3-2 pattern for the bottom and top layers. Use ¼" plywood or equivalent horizontal separators as needed. The last row should consist of two drums that are positioned in the middle.
10. Loop a cordstrap approximately 10 feet long from the bottom rear D-ring and position it for securing a 2"x4"x74" long wood board. Do this to both sides.
11. After the last row of drums is added:

12. Pull the ends of the top cordstrap installed on the 3rd set of vertical straps from both sides together. Connect the ends with the buckles and **use the pneumatic tensioner** to secure the top drum layer.
13. Pull the ends of the bottom cordstrap installed on the 3rd set of vertical straps from both sides together. Connect the ends with the buckles and **use the pneumatic tensioner** to secure the bottom layer.
14. Load the remaining four drums at each corner of the container.
15. After the last corner drums are loaded:
 - Pull the ends of the top cordstrap installed on the 2nd set of vertical straps from both sides together. Connect the ends with the buckles and **use the pneumatic tensioner** to secure the top drum layer.
 - Pull the ends of the bottom cordstrap installed on the 2nd set of vertical straps from both sides together. Connect the ends with the buckles and **use the pneumatic tensioner** to secure the bottom layer.
16. Place a 2"x4"x74" long wood board (ends cut at 45° angle) upright on edge on the floor against the center floor drums and pull the ends of the cordstraps from both sides together. Connect the ends with the buckles and **use the pneumatic tensioner** to secure the board in position.





SECURING SYSTEMS