HIGHWAY:RAIL:OCEAN

SHIPPER'S GUIDE TO LOADING AND SECUREMENT

OF PACKAGED DANGEROUS GOODS
IN INTERMODAL EQUIPMENT

Institute of
Packaging
Professionals

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INTRODUCTION

BACKGROUND

Intermodal freight transportation. The movement of freight in intermodal containers, as pioneered in the United States in the mid-to-late 1950's, was initially successful because it avoided freight stowage and labor intensive handling operations at the modal interchanges. Intermodal freight transportation has steadily grown into a dominant means of cargo transportation internationally. It provides shippers with greater choice of routings by rail, highway, and maritime carrier combinations which results in the most efficient service at the least expense. Within today's competitive environment, intermodal freight transportation offers a flexible and evolving response to changing marketing and distribution requirements. The range of forces encountered during intermodal transportation makes the proper loading and securing of containerized freight an important part of shipment preparation. Properly done, the cargo storage capacity of containers is maximized while minimizing the possibility of cargo loss or damage resulting from transportation.

Requirements for the securement of hazardous material or dangerous goods packages in intermodal containers. Hazardous materials (a term intended to be used interchangeably within this guide with its international synonym, "dangerous goods") are substances or materials which have been determined by governments to pose an unreasonable risk to the public's health and safety, property, or the environment when transported in commerce. International and United States regulations provide harmonization of hazardous material standards to both facilitate commerce and maintain an adequate level of safety. These regulations provide a minimum performance standard for blocking and bracing of packaged hazardous materials, requiring shippers to secure containerized hazardous material packages in such a way as to prevent their movement within containers in the rail, highway, or maritime modes of transportation.

PURPOSE AND SCOPE

The guide provides a summary of regulatory requirements for securing hazardous materials (excluding movements incorporating an aviation leg) and presents an overview of the shipping environment. Nothing in this guide is intended to endorse any specific securement system or product nor intended to restrict a shipper's use of other proven methods that meet the requirements of the regulations.

LIMITATIONS

Surface and Maritime Shipper Restrictions. This guide is not for use by hazardous material shippers who utilize an aviation leg in addition to the intermodal surface and/or maritime transportation modes described herein.

Laws and Regulatory Restrictions. This guide should not be considered a complete substitute for any provisions of the Hazardous Materials Transportation Authorization Act of 1994, as amended, or any other applicable statute, or for any standards or regulations promulgated under any federal statute addressing hazardous materials transportation. No guarantee is made as to the completeness or sufficiency of the federal and international standards summarized in this guide. Applicable regulatory standards are periodically modified and may change before this guide is updated. Therefore, relevant provisions of the United States Code and federal regulations should be consulted whenever preparing hazardous materials for transportation to ensure compliance.

Informational Restrictions. No warranty, guarantee, or representation is made by any of the participants in this project as to the correctness or sufficiency of any information and representations contained in this guide. Further, the participants assume no responsibility in connection therewith; nor can it be assumed that all necessary warnings and precautionary measures are contained in this publication, or that other additional information or measures may not be required or desirable because of particular or exceptional conditions or circumstances, or because of applicable federal, state, or local law.

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HOW TO USE THIS GUIDE

Section 1 (Background) summarizes applicable regulations and describes the shipping environments of rail, highway and water shipments. The environments of the modes differ significantly, and knowledge of the forces that will be encountered in each one is essential to good load planning.

Section 2 (Materials) describes the many materials that can be used to protect and secure a load of cargo, and gives instructions on their proper use. The strength of restraining system components, such as straps and webbing, is presented in tabular form. This section should be reviewed carefully, as the bracing methods discussed in Section IV can lose much of their effectiveness if even small components, such as nails, are improperly used.

Section3 (Preloading Preparation) outlines some steps a shipper can take with cargo before loading, to help insure incident-free transport. The section discusses typical packaging problems of which the shipper should be aware, then presents various methods of palletizing cargo.

Section 4 (Loading) describes in detail bracing methods that have been tested and/or approved for one or more modes of transport. Each method is described and illustrated in full, with limitations and conditions on its use and complete assembly instructions.

Section 5 (Securing Systems) takes the reader step-by-step through the loading process, and provides lists of do's and don'ts for load planning and use of dunnage. Special loading problems are discussed and preferred loading patterns for typical loads are illustrated.

Given the wide range of hazardous materials shipments, it would be impossible for this guide to describe a proper bracing method for each and every one. Instead, the focus has been on the more common types of loads, which together constitute a high percentage of container and trailer shipments. If a shipper has another type of load than that illustrated, he or she may want to add dunnage, separators, or other materials. Care must be taken, however, not to exceed the capabilities of the system being used, nor to violate the principles of good loading that are presented throughout the guide. In the end, the reader must rely on his or her own judgment and experience in using any variation to the methods illustrated here.

BACKGROUND

CONTENTS

SECTION 1

REGULATIONS AND INTERMODAL FORCES

OVERVIEW

General. Regulations and Intermodal Forces (Section I) summarizes applicable hazardous materials transportation requirements for surface (rail and highway) and maritime intermodal shipments. Further, it provides an overview of the different forces encountered in the various intermodal shipping environments. A thorough understanding of these areas is essential in order to properly conduct load planning.

UNITED STATES AND INTERNATIONAL STANDARDS

GENERAL

Regulations governing the transport of packaged hazardous materials for both interstate and intrastate commerce in the United States are published in Title 49 of the Code of Federal Regulations (CFR), Parts 171-180. The requirements for the safe loading and securing of hazardous materials are located in modal specific parts: Part 174 for rail, Part 176 for water, and Part 177 for highway. Additionally, within the constraints imposed by 49 CFR 171.22, shipments where part or all of the transport is by water may use the recommendations contained in the International Maritime Dangerous Goods (IMDG) Code, including the loading and securing standards of Chapter 7.5 of the IMDG Code and the IMO/ILO/UNECE Guidelines for Packing of Cargo Transport Units in the IMDG Code Supplement. Regulatory standards are available as follows:

Sources of Supply for U.S. Hazardous Material Transportation Regulations. Like all other federal regulations, Title 49 CFR Parts 100-185 may be purchased from: Superintendent of Documents, U.S. Government Printing Office, 732 North Capital Street NW, Washington, D.C., 20401 [Phone: (202) 512-1800]. Additionally, the World Wide Web provides information concerning hazardous material transportation requirements, including rulemakings, the current edition of Title 49 CFR Parts 100-185, and other useful information (address: http://hazmat.dot.gov).

Sources of Supply for International Maritime Organization Standards. A comprehensive listing of distributors of International Maritime Organization (IMO) publications, including the IMDG Code, is provided in the IMO Publications Catalogue available through the IMO, 4 Albert Embankment, London SE1 7SR, United Kingdom [Phone: + 44 (0) 20-7735 7611] or sales@imo.org.

SHIPPER RESPONSIBILITIES

Non-compliance with hazardous materials transportation regulations, including loading and securing standards, pose unnecessary risks to the public, property, and the environment. The failure of shippers and carriers to follow these standards may cause or contribute to the severity of transportation accidents which also may result in disruptions to the transportation system and trade. Consequently, the adequate training of workers preparing hazardous material shipments is not only good business practice, it is the law. While 49 CFR 172 Subpart H describes specific training requirements, the key regulation under which all shippers of hazardous materials in the United States must operate – Section 173.1(b) of Title 49 Code of Federal Regulations [49 CFR 173.1(b)] states:

> *A shipment of hazardous material that is not prepared for shipment in accordance with this subchapter may not be offered for transportation by air, highway, rail or water. It is the responsibility of each hazmat employer subject to the requirements of this subchapter to ensure that each hazmat employee is trained in accordance with the requirements prescribed in this subchapter. It is the duty of each person who offers hazardous materials for transportation to instruct each of his officers, agents, and employees having any responsibility for preparing hazardous materials for shipment as to applicable regulations in this subchapter.*

SPECIAL PERMITS

to the hazardous material transportation regulations are issued by the U.S. Department of Transportation through the Pipeline and Hazardous Materials Safety Administration's Office of Special Permits and Approvals. Special Permits are vital to industry, allowing quick implementation of new technology and evaluation of new operational techniques which often increase productivity and enhance transportation safety. Special Permits not only authorize a person to perform a function that is not otherwise allowed by 49 CFR 171-180, but serve as Competent Authority Approval for the United States under the IMDG Code. A detailed explanation of Competent Authority Approvals and Special Permits is found in 49 CFR Part 107. The recommended point of contact is:

U.S. Department of Transportation
Pipeline and Hazardous Materials Safety Administration
Office of Hazardous Materials Special
Permits and Approvals (PHH-31)
East Building, 2nd Floor
1200 New Jersey Avenue, SE
Washington, DC 20590
Phone (202) 366-4535
World Wide Web Address:
www.phmsa.dot.gov/hazmat/regs/sp-a

COMPLIANCE INSPECTIONS

All hazardous material shipments are subject to routine compliance inspections by U.S. Department of Transportation (DOT) administrations including the Federal Highway Administration (FHWA), Federal Railroad Administration (FRA), U.S. Coast Guard (USCG), and Pipeline and Hazardous Materials Safety Administration (PHMSA). Inspectors may detain containers until corrective action is completed and/or initiate civil penalty action for violation of these hazardous materials regulations. Civil penalties can be assessed in amounts up to $55,000 per violation per day. Criminal penalties -- for willful violation of the regulations -- are subject to Title 18, United States Code and/or 5 years imprisonment except in the case of a violation involving death or bodily injury is subject to 10 years. When configuring loads, and the blocking and bracing to secure those loads, keep in mind inspectors may need to visually inspect the shipment. To avoid undue delays, configure the loads such that the contents, and the required labels and markings, can be seen from the doors.

LOADING AND SECUREMENT REQUIREMENTS

The following excerpts of the October 2009edition of Title 49 CFR cover only general loading and bracing requirements for hazardous materials (other than explosives) for shipment by rail, highway, and the water modes. For certain hazard classes, there are additional loading and securement requirements within each modal section of the regulations. Consult the current edition of Title 49 CFR Parts 100-185 (the federal hazardous material transportation requirements for rail, highway, and maritime modes) for updates and specific additional requirements. For questions, use the DOT points of contact listing provided in Appendix A of this guide.

SURFACE (RAIL AND HIGHWAY) REQUIREMENTS

SUMMARY OF RAIL REGULATIONS

A summary of federal transportation regulations for the loading and securement of hazardous material cargoes for rail transportation follows:

49 CFR Part 174, Carriage by Rail Highlights

§174.55 General requirements. (a) Each package containing a hazardous material being transported by rail in a freight container or transport vehicle must be loaded so that it cannot fall or slide and must be safeguarded in such a manner that other freight cannot fall onto or slide into it under conditions normally incident to transportation. When this protection cannot be provided by using other freight, it must be provided

by blocking and bracing. For examples of blocking and bracing in freight containers and transport vehicles, see Bureau of Explosives Pamphlet Nos. 6 and 6C. **Must be loaded, blocked and braced. Each hazmat package must be loaded so that it cannot fall or slide and must be safeguarded so other freight cannot fall or slide into it.**

(b) Each package containing a hazardous material bearing package orientation markings prescribed in Sec. 172.312 of this subchapter must be loaded within a transport vehicle or freight container to remain in the correct position indicated by those markings during transportation. **Comply with orientation markings when securing packages.**

(c) The doors of a freight container or transport vehicle may not be used to secure a load that includes a package containing a hazardous material unless the doors meet the design strength requirements of Specification M-930 (for freight containers) and M-931 (for trailers) in the AAR's specification for "Specially Equipped Freight Car and Intermodal Equipment" (incorporated by reference see 171.7 of this subchapter) and the load is also within the limits of the design strength requirements for the doors.

§174.61 Transport vehicles and freight containers on flatcars.
(a) A transport vehicle, freight container, or package containing a hazardous material must be designed and loaded so that it will not become damaged to an extent that would affect its integrity under conditions normally incident to transportation. Each unit must be secured on a flatcar so that it cannot permanently change position during transit. Packages of hazardous materials contained therein must be loaded and braced as provided by §§174.101, 174.112, 174.115 and 174.55. Placards must be applied when prescribed by Part 172 of this subchapter and Part 174. **Cargo Transport Units must be adequate. TOFC or COFC must be adequately secured on flat car.**

§174.63 Portable tanks, IM portable tanks, intermediate bulk containers, cargo tanks, and multi-unit tank car tanks. (a) A carrier may not transport a bulk packaging (e.g., portable tank, IM portable tank, intermediate bulk container, large packaging, cargo tank, or multi-unit tank car tank) containing a hazardous material in container-on-flatcar (COFC) or trailer-on-flatcar (TOFC) service except as authorized by this section or unless approved for transportation by the Associate Administrator for Safety, FRA. **Applies to bulk packages that can be loaded into freight containers and transport vehicles. Requires FRA approval if the conditions of 174.63 (b) or (c) cannot be met.**

(b) A bulk packaging containing a hazardous material (including IM 101 and IM 102 when appropriate according to dimensions and weight distribution) may be transported in a fully closed transport vehicle or fully closed freight container provided it is properly

secured with a restraint system that will prevent it from changing position, sliding into other packages, or contacting the side or end walls (including doors) under conditions normally incident to transportation.

(c) When not transported in conformance with and subject to paragraph (b) of this section, a bulk packaging may be transported in COFC service or TOFC service subject to the following conditions as applicable: **(1)** The bulk packaging contains a material packaged in accordance with §§173.240, 173.241, 173.242, or 173.243 of this subchapter; **(2)** The tank and flatcar conform to requirements in AAR 600 of the AAR Specifications for Tank Cars, entitled "Specification for Acceptability of Tank Containers"; **(3)** For TOFC Service, the trailer chassis conforms to requirements in paragraphs 3, 4, 5, and 6 of AAR Specification M-943 "Container Chassis For TOFC Service" of the AAR specification for "Specially Equipped Freight Car and Intermodal Equipment"; **(4)** For COFC service, the container support and securement systems conform to requirements in Specification M-952 "Intermodal Container Support and Securement for Freight Cars", of the AAR specification for "Specially Equipped Freight and Intermodal Equipment"; **(5)** If transported in a well car- **(i)** The tank is not in a double-stacked configuration (i.e., no freight container or portable tank is placed above or below the tank); and **(ii)** The tank is transported in the well with its outlet valve facing outward towards the end of the well and away from any adjacent tank or container; and **(6)** All securement fittings shall be fully engaged and in the locked position, provided; however, if the tank is transported in a well car, it must be loaded into a well appropriate for the length of the container and any void filling device present must be secured in its designed appropriate position.

(d) An approval in effect on February 28, 1991 for the transportation of portable tanks or IM portable tanks in TOFC or COFC service expires on the date stated in the approval letter or June 15, 1995, whichever is later.

SUMMARY OF HIGHWAY REGULATIONS

A summary of federal transportation regulations for the loading and securement of hazardous material cargoes for highway transportation follows:

49 CFR Part 177, Carriage by Public Highway Highlights

§177.804 Compliance with Federal Motor Carrier Safety Regulations. Motor carriers and other persons subject to this part shall comply with 49 CFR parts 383, and 390 through 397 (excluding §397.3 and 397.9) to the extent those regulations apply. **Compliance with 49 CFR 383 and 390-397 are required.**

§177.834 General requirements. (a) Packages secured in a vehicle. Any package containing any hazardous material, not permanently attached to a motor vehicle , must be secured against shifting, including relative motion between packages, within the vehicle on which it is being transported, under conditions normally incident to transportation. Packages having valves or other fittings must be loaded in a manner to minimize the likelihood of damage during transportation. **Packages of hazardous materials must be secured against movement and package valves and fittings must be protected.**

SURFACE SEGREGATION REQUIREMENTS

Hazardous materials transported by rail or highway must not be loaded or stored together in the same cargo transport unit except as provided by 49 CFR 174.81 (rail) or 177.848 (highway). In cases of a multi-modal shipment where segregation requirements differ, the shipper should use the most restrictive standard. In particular, if the shipment will include a maritime leg, use the maritime segregation requirements which are generally more stringent than corresponding surface requirements. (See Maritime Requirements in this section for a more complete discussion of maritime segregation requirements).

MARITIME REQUIREMENTS

Shipments of hazardous materials by vessel within the jurisdiction of the United States must comply with the requirements found in Title 49, Code of Federal Regulations. However, Title 49 authorizes the use of the IMDG Code under the criteria described in 49 CFR 171.22. While the Federal hazardous materials regulations in Title 49 CFR generally agree with the IMDG Code recommendations for the transport of dangerous goods aboard vessels, there are differences. 49 CFR §§171.22, 171.23, 171.25 and 176.11 set forth the specific conditions and limitations under which hazardous materials may be transported by vessel in the United States under the provisions of the IMDG Code in lieu of Title 49 requirements. Note that although 49 CFR 171.22 is titled "Authorization And Conditions For The Use Of International Standards And Regulations" the provisions of 49 CFR §§171.23 and 171.25 may be applied when all or part of the transport is by vessel, including domestic vessel transport and rail or highway movement, which also includes a maritime transport leg. Because of the wide recognition and application of the IMDG Code in international maritime transport by both foreign Administrations and vessel operators, it is recommended that it be followed whenever an import or export shipment is being planned.

INTERNATIONAL REQUIREMENTS

SOLAS. The International Convention for the Safety of Life at Sea, 1974 (SOLAS), as amended, deals with various aspects of maritime cargo transportation including: Regulation 3 of Part A of Chapter VII of SOLAS prohibits the carriage of dangerous goods in packaged form except in accordance with the provisions of the IMDG Code.

Competent Authority Designation for the United States. Within the IMDG Code, allowance is made in certain situations for approvals, permits or certificates to be issued by the Competent Authority of a member government. Competent Authority designations for the IMDG Code are listed in Chapter 7.9of Volume I. The Competent Authority designated for the United States is the Associate Administrator for Hazardous Materials Safety (PHH-1), Pipeline and Hazardous Materials Safety Administration, U.S. Department of Transportation.
The recommended point of contact is:

U.S. Department of Transportation
Pipeline and Hazardous Materials Safety Administration
Office of International Standards (PHH-70)
East Building / PHH-70
1200 New Jersey Avenue, S.E.
Washington, D.C. 20590-0001
Phone: (202) 366-0656
World Wide Web Address: www.hazmat.dot.gov/

U.S. Coast Guard Assistance: In addition, the following office may be contacted to facilitate Competent Authority actions:
U.S. Coast Guard
Hazardous Materials Standards Division (CG-3PSO-3)
2100 Second Street SW
Washington, D.C. 20593-0001
Phone: (202) 372-1420 or (202) 372-1426

Other International Maritime Publications. A comprehensive listing of distributors of International Maritime Organization (IMO) publications, including the IMDG Code, is provided in the *IMO Publications Catalogue* available through the IMO, 4 Albert Embankment, London SE1 7SR, United Kingdom

Email: info@imo.org; Fax: +44 207587 3120.

SUMMARY OF MARITIME REGULATIONS

A summary of federal and international transportation regulations for the loading and securement of hazardous material cargoes for maritime transportation follows:

49 CFR Part 176, Carriage by Vessel (IMDG Code Reference Highlights)

§176.27(c) Certificate. (1) A person responsible for packing or loading a freight container or transport vehicle containing hazardous materials for transportation by a manned vessel in ocean or coastwise service, must provide the vessel operator, at the time the shipment is offered for transportation by vessel, with a signed container packing certificate, at a minimum that- (i) The freight container or transport unit is serviceable for the materials loaded therein, contains no incompatible goods, and is properly marked, labeled or placarded, as applicable; and (ii) When the freight container or transport unit contains packages, those packages have been inspected prior to loading, are properly marked, labeled or placarded, as applicable; are not damaged; and are properly secured. **Volume I: Section 5.4.2 Container/ Vehicle Packing Certificate Requirement.**

(2) The certification may appear on a shipping paper or on a separate document as a statement such as "It is declared that the packing of the container has been carried out in accordance with the applicable provisions of [of 49 CFR], [of the IMDG Code], or [of 49 CFR and the IMDG code]."

§176.69 General stowage requirements for hazardous materials. (d) Packages of hazardous materials must be secured and dunnaged to prevent shifting in any direction. Vertical restraints are not required if the shape of the package and the stuffing pattern preclude shifting of the load. (e) Packages of hazardous materials must be braced and dunnaged so that they are not likely to be pierced by the dunnage or crushed by a superimposed load.

§176.76 Transport vehicles, freight containers, and portable tanks containing hazardous materials. (a) Except as provided in paragraphs (b) through (f) of this section, hazardous materials authorized to be transported by vessel may be carried on board a vessel in a transport vehicle or freight container subject to the following conditions (see additional requirements concerning the transport of Class 1 (explosive) materials in §176.168 through §176.172 of this subchapter: **Volume I: Parts 4 and 7.**

(1) The material must be in proper condition for transportation according to the requirements of this subchapter. **Volume I: Section 5.1.1.2**

(2) All packages in the transport vehicle or freight container must be secured to prevent movement in any direction. Vertical

restraint is not required if the shape of the packages, loading pattern, and horizontal restraint preclude vertical movement of the load within the freight container or transport vehicle. **Volume I:Section 7.5.2; Supplement: IMO/ILO/UNECE Guidelines for Packing of Cargo Transport Units; Section 4 Additional advice on the packing and securing of dangerous goods**

(3) Bulkheads made of dunnage which extend to the level of the cargo must be provided unless the packages are stowed flush with the sides or ends. **Supplement: IMO/ILO/UNECE Guidelines for Packing of Cargo Transport Units; Section 4 Additional advice on the packing and securing of dangerous goods**

(4) Dunnage must be secured to the floor when the cargo consists of dense materials or heavy packages. **Supplement: IMO/ILO/UNECE Guidelines for Packing of Cargo Transport Units; Section 3.2.2 Ladings, such as those transported in full size drums, are subject to this requirement.**

(5) Each package marked in accordance with 172.312(a)(2) of this subchapter must be stowed as marked. **Supplement: IMO/ILO/UNECE Guidelines for Packing of Cargo Transport Units; Sections 3.2.11 and 4.3.6 Package Orientation within freight container.**

(6) Any slack spaces between packages must be filled with dunnage. **Supplement: IMO/ILO/UNECE Guidelines for Packing of Cargo Transport Units; Section 3.2.3** No voids. Place any required labels and markings in such a way as to make visual inspection easier for inspectors. It may save time and expense.

(7) The weight in a container must be distributed throughout as evenly as possible and the maximum permissible weight must not be exceeded. **Supplement: IMO/ILO/UNECE Guidelines for Packing of Cargo Transport Units; Section 3.2.5 Even load; Distributed.**

(8) Adjacent levels of bagged and baled cargo must be stowed in alternate directions so that each tier binds the tier above and below it.

(10) The lading must be contained entirely within the freight container or vehicle body without overhang or projection except that oversized machinery such as tractors or vehicles with batteries attached may overhang or project outside the intermodal container provided all of that portion of the lading that consists of hazardous materials is contained entirely within the freight container. No open bed container or vehicle is permitted to carry hazardous materials unless it is equipped with a means of properly securing the lading. **Supplement: IMO/ILO/UNECE Guidelines for Packing of Cargo Transport Units; Section 3.1.9 Hazardous materials must be within freight container or vehicle body. Open bed containers must be equipped with restraint capability.**

(b) A transport vehicle containing hazardous materials may be carried only on board a trailer ship, ferry vessel or car float.

§176.83 Segregation. (d) **Segregation in transport units:** Two hazardous materials for which any segregation is required may not be stowed in the same transport unit. **Volume I: Chapter 7.2.2 Segregation required for incompatible hazardous materials.**

MARITIME SEGREGATION REQUIREMENTS

Maritime segregation requirements are considerably more stringent than their surface transportation counterparts in many respects. Therefore, if an intermodal shipment includes a maritime leg, shippers should ensure the appropriate maritime segregation requirements are met. In most respects, the segregation requirements contained in the Federal Regulations are consistent with those found in the IMDG Code.

Federal Regulations. Maritime segregation requirements are found in 49 CFR Part 176, Subpart D-General Segregation Requirements with additional requirements for explosives segregation found in sections 176.140 through 176.146. Of particular relevance to this guide is 49 CFR 176.83 (d), which prohibits the stowage of incompatible hazardous materials within the same cargo transport unit. Consequently, any hazardous materials which must be stowed "away from", "separated from", "separated by a complete bulkhead from", "separated longitudinally by an intervening complete compartment or hold from" as summarized in 49 CFR Table 176.83(b), and other applicable segregation or stowage requirements identified in the Hazardous Materials Table in 49 CFR 172.101 may not be stored in the same cargo transport unit.

IMDG Code. Chapter 7.2 of Volume I of the IMDG Code contains the principal segregation provisions. Additional provisions are contained in 7.1.1.12 (with reference to 3.4.3)for shipments of limited quantities materials and in 2.1.2of Class 1-Explosives. Paragraph 7.2.2.2.1 of the IMDG Code corresponds to 49 CFR 176.83 (d) and generally prohibits the stowage of incompatible hazardous materials within the same cargo transport unit. Although paragraph 7.2.2.3 allows hazardous materials that should be segregated "away from" each other to be carried in the same cargo transport unit with the approval of the Competent Authority, the United States Competent Authority has never authorized this approach. One other item of possible difference between 49 CFR and the IMDG Code is the treatment of dangerous goods that are packaged as limited quantities. While in both rules, relief is granted from the prohibition of stowage of incompatible materials within the same cargo transport unit, there are some differences in the definitions for what constitutes a limited quantity.

THE SHIPPING ENVIRONMENT

The first step in load planning is to understand the forces to which the cargo will be subjected in transit. Each mode of transport presents a different shipping environment that must be accommodated in the load plan. A container carried on a chassis (highway), for example, will be subject to different forces than that carried on a rail flat car, and thus may require a different system of securing the load. Consequently, for intermodal cargo movements, all transportation environments to be encountered should be considered and cargo secured for the most severe transportation mode to be encountered. An intermodal shipment may combine all three transportation modes, as follows:

- Shipper loads a container which is then transported by highway to a rail head;
- Container is transferred to rail car and transported by rail (COFC) to a seaport;
- Container is transferred to freight vessel (containership or RORO) and transported across the ocean to the port of destination;
- Container is transferred to surface transportation mode(s) and received by the consignee and unloaded.

FORCES AFFECTING CARGOES IN SURFACE AND MARITIME TRANSPORTATION

GENERAL

While each method of transportation presents its stresses and hazards to cargo in transport, some cross modal boundaries. During the design of a load plan, the types and degrees of stress most likely to be encountered should be considered. Some of the publications that discuss transportation forces and provide blocking and bracing guidelines are provided in the Bibliography of this guide. Additionally, a representative intermodal standard is provided as Table I.1 below:

***Source: American Bureau of Shipping, Rules for the Certification of Cargo Containers

Note: The ABS standard is representative of several similar standards. However, some differences in acceleration values exist among the standards. e.g., IMO/ILO/UN/ECE's "Guidelines for the Packing of Cargo Transport Units" use a 4G longitudinal acceleration value for rail. Acceleration values are expressed as multiples of the standard acceleration (1G) due to gravity of 32 feet per second^2 (9.8 meters per second^2). As an example of the effect of acceleration on a cargo load, consider a cargo weighing 4000 pounds experiencing a 2G acceleration. The resulting force would be 4000 pounds x 2G = 8,000 pounds.

Table 1.1, American Bureau of Shipping (ABS) Intermodal Acceleration Standard [1]

Mode	Longitudinal Acceleration	Lateral Acceleration	Vertical Acceleration	
			Down	Up
Rail	2.0G	0.3G	1.7G	1.7G
Highway	0.7G	0.2G	1.7G	0.5G
Maritime	0.4G	0.6G	1.8G	1.8G
Terminal Handling	None	None	2.0G	None

***

RAIL

While there are some differences in the shipping environments of Trailer on Flat Car (TOFC) and Container on Flat Car (COFC) rail shipments, they are considered to be the same for the purposes of this guide. Rail transportation subjects the cargo primarily to longitudinal shocks. Trailers or containers may be carried in backwards or reverse direction. Therefore, impact can come from either direction - to the nose or the doors of the container - and load planning must prepare for impact from both directions. Rail loads characteristically experience stresses from the following:

- **Coupler slack** can lead to individual cars accelerating or decelerating at rates different from the whole train. This causes longitudinal forces on the load.
- **Coupling impact or shock** causes longitudinal forces on the load.
- **Suspension system and track dynamic vibration**, which can produce frequencies as high as 5 cycles/sec with 'G' forces up to 1.25.
- **Sway or side to side motion** from curves or uneven track causes lateral forces on the load.

HIGHWAY

The characteristic forces on lading during highway transport are due to the following:

Primary hazards. Major hazards include:

- **Vertical shocks** from surface irregularities from rough roads, bridge crossings, etc.
- **Vibrations**, particularly vertical, from road conditions, speed, and vehicle/cargo characteristics.

Secondary hazards. Less significant hazards include:

- **Longitudinal shocks** from impacts against loading docks, coupling impacts, braking, and accelerations.
- **Lateral shocks and sway** from running over curbs or other abrupt surface irregularity encountered by one side of the trailer

CARGO HANDLING AT THE PORT INTERFACE

The port interface is the waterfront facility where the maritime and surface transportation modes converge. Characteristic forces are dependent upon the method of freight handling required for the vessel type:

Roll on/Roll Off vessels (ROROs) generally impose less severe container movements than that for container ships during loading and off loading. Instead of being handled by cranes, trailers and rail cars roll directly onto specially fitted ships and consequently experience the forces of the surface modes of transportation while being loaded or unloaded.

Container ships require specially designed handling equipment at waterfront facilities, such as yard haulers and container cranes, resulting in cargoes experiencing the following forces:

- **Vertical shocks** from lifting and landing containers at the facility and the container ship.
- **Vibrations**, particularly vertical, from road conditions, speed, and vehicle/ cargo characteristics.

Longitudinal shocks from braking, and accelerations by container handling equipment.

VESSEL MOTIONS AT SEA

Shipments are typically subject to a number of independent forces from ship movement. A ship at sea may move in all of the following six directions at once due to wave action (see Figure I.1, Forces Affecting Maritime Shipments, below):

- **Roll** (motion about the vessel's longitudinal axis).
- **Pitch** (motion about the vessel's transverse axis).
- **Heave** (vertical bodily motion of the vessel).
- **Yaw** (motion about the vessel's vertical axis).
- **Surge** (longitudinal, fore and aft, bodily motion).
- **Sway** (lateral, side to side, bodily motion).

Furthermore, there are two common combination movements:

- **Slamming** (a combination of heaving, surging, and swaying).
- **Pounding** (a combination of heaving and pitching).

In addition, loads can be affected by:

- **Wave** impact (shocks to the vessel from heavy seas).
- **Water** entry (faulty container).
- **Condensation** (from lading or container).

Through movements such as those described above, cargo may be subjected to vertical, athwartship, and fore/aft shifting within the freight container. Because a freight container may be stowed on a ship with its longitudinal axis in the athwartship direction as well as in the more common longitudinal configuration, the possible effects on a container and its lading from ship movement are many. Further, their repetitiveness tends to break down cushioning and bracing. Tight loading and adequate bracing is imperative to prevent damage.

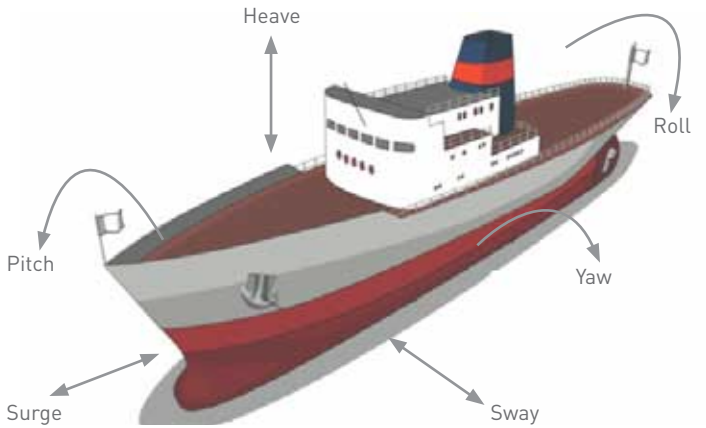


FIGURE 1.1 Forces Affecting Maritime Shipments
A ship at sea may move in six different directions simultaneously.

MATERIALS

CONTENTS

SECTION 2

DUNNAGE

USE THE CURRENT ASTM STANDARD D996

Basic Function of Dunnage

- Abrasion Protection
- Void Filling
- Package Protection (such as crushing, denting, or internal damage)
- Load Separation

Commonly used material for each function are:

ABRASION PROTECTION

- Wood/Nails used in the construction decking or risers to protect drum rolling hoops and heads from abrasion
- Plywood
- Kraft paper
- Wood overlay with Kraft paper

Criteria for Wood and Nails

Condition

Select all blocking and bracing material from sound lumber free from cross grain or dry rot. Do not use lumber with knots, knotholes and check for splits which affect its strength or interfere with proper nailing.

International shipments require compliance with ISPM 15.

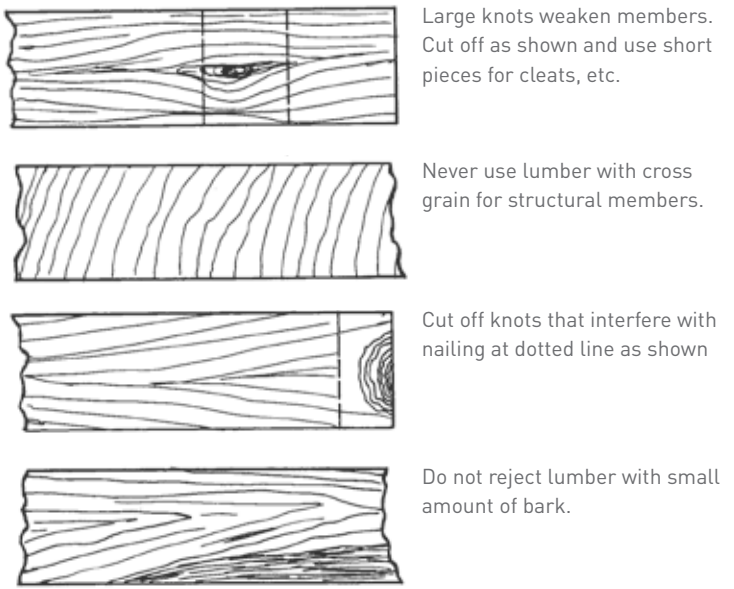


FIGURE 2.1 Criteria for Wood

Use properly seasoned lumber, free of pests, for all blocking and bracing. Do not use green lumber as it does not have the strength or stiffness qualities of dry lumber. Under certain conditions green lumber will give off quantities of moisture which can have harmful effects on some commodities.

TABLE 2.A
Species of Wood Most Commonly Used for Blocking and Bracing

Group I Soft Woods	Specific Gravity	Group 2 and 3 Medium Woods	Specific Gravity	Group 4 Hard Woods	Specific Gravity
Cottonwood	0.37	Douglas-Fir	0.51	Ash	0.64
Fir (Balsam)	0.41	Hemlock	0.44	Beech	0.67
Fir (White)	0.42	Maple (Hard Black)	0.62	Elm	0.66
Pine (Lodgepole)	0.43	Larch	0.59	Hickory	0.80
Pine (Ponderosa)	0.42	Pine (So. Yellow)	0.59	Maple (Hard Sugar)	0.68
Pine (White East)	0.37	Pine (Norway)	0.47	Oak (White)	0.71
Pine (White West)	0.42	Cedar (Port Oxford)	0.44	Oak (Red)	0.66
Spruce (White)	0.45	Sweet Gum	0.53		
Poplar (Yellow)	0.43				

TABLE 2.B
Standard Thickness for Yard Lumber

Nominal Thickness Rough Lumber	Actual Thickness S4S*
2" x 4"	1 ½" x 3 ½"
2" x 6"	1 ½"x 5 ½"
2" x 8"	1 ½" x 7 ½"
4" x 4"	3 ½" x 3 ½"
4" x 6"	3 ½" x 5 ½"
4" x 8"	3 ½" x 7 ¼"

*Surfaced four sides

When selecting the size of lumber, give consideration to the weight, size and nature of the commodity to be secured.

TABLE 2.C
Wood Groups

Group II and III Woods Medium	Group I Woods Soft
Size 2" x 3"	Size 2" x 4"
Size 2" x 4"	Size 2" x 6"
Size 2" x 6"	Size 2" x 8"
Size 3" x 4"	Size 3" x 6"
Size 4" x 4"	Size 4" x 6"
Size 4" x 6"	Size 4" x 8"
Size 6" x 6"	Size 6" x 8"
Size 6" x 8"	Size 6" x 10"

Storage

Lumber should be properly stored to protect it from the elements. This will prevent decay from affecting its strength.

Criteria for Nails

Type

Table D shows the sizes of common nails, power driven nails, staples, and spikes which may be used in the construction of blocking and bracing.

TABLE 2.D
Common Nails, Power Driven Nails, Power Driven Staples and Spikes

	Common Nails		Power Driven Nails		Power Driven Staples		Spikes	
Size Penny Weight	**Length** in Inches	**Wire** Diameter Inches	**Length** in Inches	**Wire** Diameter Inches	**Length** in Inches	**Wire** Diameter Inches	**Length** in Inches	**Wire** Diameter Inches
6d	2	.113	--	--	--	--	--	--
8d	2 ½	.131	2 3/8	.113	2½, 2	.080	--	--
10d	3	.148	3	.120	¾	.080	3	.192
12d	3 ¼	.148	3 ¼	.131	3, 3 ¼	--	3 ¼	.192
16d	3 ½	.162	3 ½	.131	--	.080	3 ½	.207
20d	4	.192	4	.145	3 ½	.080	4	.225
30d	4 ½	.207	4 ¾	.165	3 ½	--	4 ½	.244
40d	5	.225	5 1/8	.165	--	--	5	.263
50d	5 ½	.244	--	--	--	--	5 ½	.283
60d	6	.263	--	--	--	--	6	.283
5/16	--	--	--	--	--	--	7	.312
3/8	--	--		--	--	--	8	.375

Size

Consult Tables 2.E & 2.F to determine proper size for nails. It is important to use proper size nails to achieve sufficient holding power. Nails one size smaller than those used for medium or soft wood may be used for extremely hardwood (Group 4 of table 2.A).

Table 2.E
Sizes of Nails and Spikes for Various Thicknesses of Material

Thickness of Material (Rough Lumber) Holding Head of Nail or Spike	Thickness of Material (Rough Lumber) Holding Point of Nail						
1"	1 ¼"	2"	3"	4"	5"	6"	
1"	6d *8d	6d *8d	10d *12d	16d --	16d --	16d --	16d --
2"	10d *12d	10d 12d	16d --	20d 30d	40d 50d	40d 60d	40d 60d
3"	16d 20d	20d *30d	30d 40d	40d 60d	60d 7" spike	7" spike --	8" spike --
4"	40d *50d	40d 50d	50d 60d	60d 7" spike	7" spike 8" spike	8" spike 9" spike	9" spike --
5"	50d 60d	60d --	60d 7" spike	7" spike 8" spike	8" spike 9" spike	9" spike --	10" spike --
6"	7" spike --	7" spike --	7" spike 8" spike	8" spike 9" spike	9" spike 10" spike	10" spike --	10" spike --

d – Penny *Nails Clinched

Table II.F
Withdrawal Power of Common & Threaded Nails
Allowable Loads In Pounds Per Inch of Penetration

	Size of Nails			
Specific Gravity	8d	12d	16d	20d
0.75	87	---	---	127
0.68	69	78	85	101
0.67	66	75	82	97
0.66	64	72	79	94
0.62	55	62	68	80
0.51	34	38	42	49
0.47	27	31	34	40
0.45	25	28	30	36
0.44	23	26	29	34
0.43	22	25	27	32
0.42	21	23	25	30
0.41	21	22	24	29
0.37	15	17	19	22

Number

The number of nails will vary with the size and weight of the load. Use a sufficient number of nails as the strength of the blocking and bracing increases directly with the number and size of nails.

Position

Drive nails into side grain of lumber. In this position they have 50 percent more holding power. It is preferable to drive nails in position where they will see lateral resistance as shown in Fig. 2.2 and Fig. 2.3.

Figure 2.2

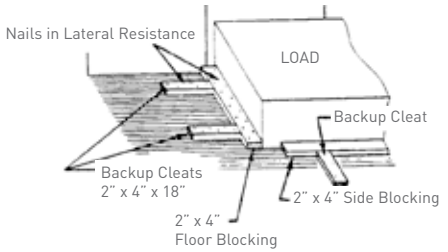


Figure 2.3

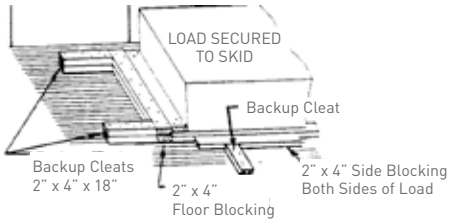


FIGURE 2.2 & 2.3

Pre-drill

Lumber may be pre-drilled with holes slightly smaller than the diameter of the shank of the nail. This will facilitate driving, prevent splitting and increase the holding power of the nail.

TABLE 2.G
Lateral resistance of Nails (in pounds)
When Nailed Through 2" Thick Floor Blocking and Into Trailer Floor

1 ¼" Trailer Floor – Hardwoods (Group IV)				
Size of Common Nail (d)				
8	10	12	16	20
344	733	916	956	1043

Load applied is at a 90° angle to the shank or direction of driving of nail point in the securing wood.

Note: For types of lumber see Table 2.A.

Automatic Type Nails

It is permissible to use smaller nails than those specified in Table 2.E when using an Automatic Type nail. However, the number of nails used must be increased by one-third (1/3) and only the following size substitution may be made:

Common Nails		Power Driven Nails
10d	or	8d or 10d
20d	or	16d or 20d

Separator

When stacking commodities in multiple layers, use a separator to provide an even base for the upper layers. The separator material selected should provide adequate support for the weight of the lading. Generally ½" plywood sheets or other suitable material may be used as a separator. In cases where units consist of bags or bales, place fiberboard to protect between separator material and tops of lower units.

Slip Sheets

Heavy-duty rough finish Kraft paper or other suitable material is useful as transportation equipment liner and to protect printed surfaces.

Corner Protection

Corner posts are used to square up the load and as corner protectors on unitized loads. Corner posts also provide space to protect packages from abrasion. Corner posts may be constructed from plywood, hardboard, multi-wall-corrugated fiberboard or other suitable material.

VOID FILLING

These structures are used to fill crosswise or lengthwise space in a trailer/container, not occupied by the lading. Void fillers are used to minimize the movement of lading during transportation. Void fillers should be of sufficient height to protect the tallest stack of cargo.

Dunnage Bags

Dunnage bags are usually made of paper, plastic or rubber that are inflated to secure cargo. Filled dunnage bags must not touch floor, as chafing can lead to rupture. Dunnage bags are used to fill voids in a crosswise or lengthwise direction to restrain loads.

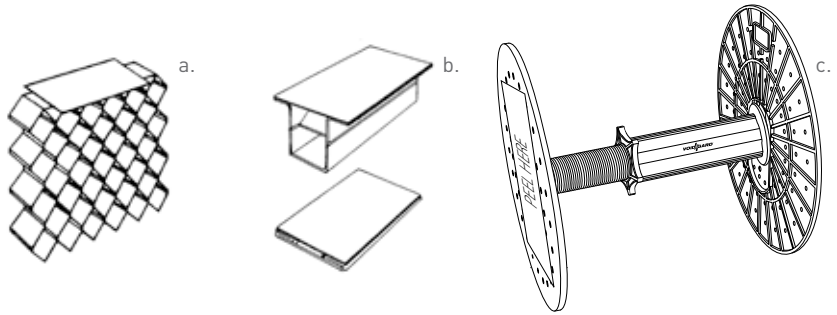
Bulkheads

Bulkheads are custom built wood structures used generally to fill voids in a drum load. They are also useful to separate a section of drums in a mixed load. Bulkheads can be faced with plywood to provide a smooth face separator for sections of other type packages.

Fiberboard Fillers

Corrugated or solid fillers come in various shapes and sizes. These types are usually used to prevent side to side motion of the lading. See examples of void fillers below.

FIGURE 2.4 Dunnage Bags
Dunnage Bags are NOT B.O.E. or
AAR approved for Dangerous Goods Applications



a. Honeycomb style
b. Collapsible
c. Void Gard

FIGURE 2.5

RESTRAINT SYSTEM COMPONENTS

Restraint systems usually consist of three components:

- the restraint itself (belt, strap, or bulkhead);
- a means of anchoring the restraint to the transport unit; and
- a means of tightening (for belts or straps)

STRAPPING AND WEBBING

Heavy-duty steel strapping has long been the primary choice of unitizing cargos; however, plastic strapping or webbing has seen an increase in use. Strap protectors, such as corner guards or metal plates, should be used to provide a suitable radius to protect straps at all points on lading having sharp edges and/or sharp corners. Be sure tensioning and sealing equipment is used properly. Check the tools periodically to ensure proper operating conditions.

Steel Strapping

Many sizes and strengths of steel strapping are available. In determining which strap is to be used, the shipper must be aware of the weight of each section of the load to be strapped. As a general rule, more straps of lower strength should be used to restrain a load, as opposed to fewer straps of higher strength.

The combined joint strength of the number of straps for rigid braced loads in each longitudinal impact direction must equal the weight of the lading being secured, except as provided in approved loading methods.

Use the proper combination of steel straps, seals, sealing tools, notches or crimps to provide the minimum joint strength for sizes listed in Table 2.H. Figure 2.6 provides examples of notches or crimps.

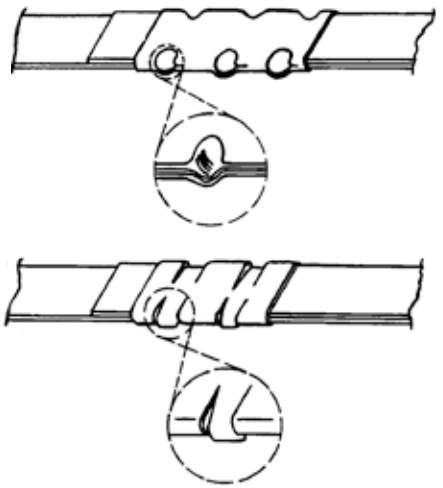


FIGURE 2.6 Examples of Notches

TABLE 2.H

Width & Thickness (in.)	Width & Thickness (mm)	Minimum Breaking Strength (lbs.)	Minimum Joint Strength (lbs.)	Minimum No. of Pairs of Notches on Joint	Minimum No. of Pairs of Crimps on Joint					
					Surface Finish					
Securement Bands		--	--	Surface Finish All Types	Uncoated-Dry		Coated-Not Waxed		Waxed	
1 ¼ x .031	32 x .75	4750	3565	2	3					
1 ¼ x .035	--	4750	3565	2	3					
1 ¼ x .044	--	6750	5065	4	4					
1 ¼ x .050	--	6750	5065	4	4					
--	--	--	--	--	Std.	Grit	Std.	Grit	Std.	Grit
2 x .044	--	10600	7950	4	4	4	4	4	6	4
2 x .050	--	10600	7950	4	4	4	4	4	6	4
2 x .065	--	13800	10350		4	4	4	4	6	4

Plastic Strapping

The unique feature of plastic strapping is its ability to stretch under load, then return to its previous tension. Plastic strapping is usually non-woven, taking the form of flat extrusions or adhering strands. The most common width is ½" and it is widely available in nylon, polyester, rayon and polypropylene. This makes it superior to steel strapping for compressible packages. In these loads, plastic strapping can retain tension, whereas steel straps may go slack (Note: there may be a loss of tension due to stretching as shown in Figure 2.7). These properties are illustrated in Figure 2.8 and Table 2.J.

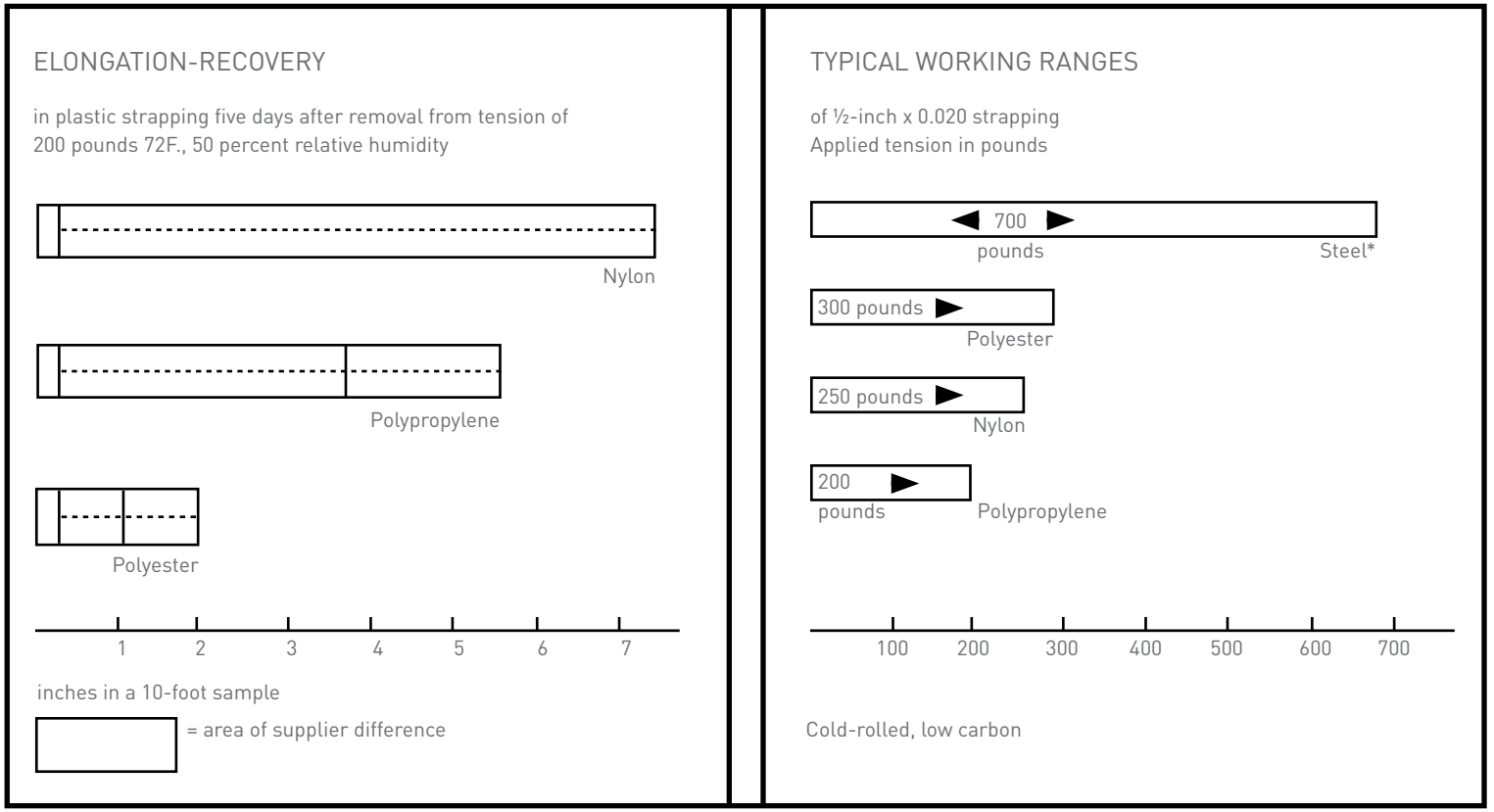


FIGURE 2.7 & 2.8 Plastic Strapping Properties

TABLE 2.J
STRAPPING PROPERTIES

Strapping	Break Strength* (Pounds)	Working Range (per cent)	Elongation Recovery inches	Retained Tension**
Steel***	1,170	0.1	0.1	700/665
Polyester	600	2.5	2	300/224
Nylon	630	7.0	9	250/175
Polypropylene	500	5.0	5.4	200/50

*For 1.2 x 0.020-inch samples
***Initially tension at maximum of working range after 24 hours
***Low carbon cord-rolled steel

Webbing

Webbing is woven to meet various high strength needs; it is available in various materials and weaves. Some typical polyester specifications may be found in Table 2.K. Nylon webbing has similar values but with 3-4 times higher elongation. Polypropylene in those sizes has about 2/3 the strength of polyester with even higher elongation. For this reason polyester is generally recommended for restraint systems. Joint strength of properly made attachment is normally at least 95% of tensile.

Remember that webbing stretches and may loosen. Webbing must be supported at the gate to prevent falling away from load face.

As this is generally a customized or patented application, it works well. However, in general usage as a system to serve all cargoes, a shipper should beware. Persons using web securing should be trained. All webbing used for this purpose must be rated and carry certification. Most belting systems are color coded for safe working limit. Extreme caution must be taken in regards to chaffing or its use on sharp or uneven surfaces or the webbing will rapidly wear or tear. Also some synthetic fibers will degrade in strong ultraviolet sunlight.

The webbing and fasteners must be carefully checked prior to use to assure they are in good order. And finally, should the system be exposed to extreme heat it will fail far more quickly than steel wire.

TABLE 2.K
SOME TYPICAL SPECIFICATIONS IN POLYESTER

WIDTH		BREAKING STRENGTH	
in.	mm.	lbs.	kgs.
1	25	3500	1550
1	25	5000	2250
1 ½	37	7500	3400
1 ¾	45	6500	3000
1 ¾	45	13600	6150
1 ¾	45	15000	6800

This method of bracing is used only in trailers equipped with belt rails attached to the side walls, logistics posts, or in systems using temporary anchoring devices applied to floors that are capable of securing the weight desired. The number, size and strength required under these methods is dependent upon the weight and dimensions of the commodity loaded. The anchored load provides rigid bracing of the lading by the use of steel straps secured to the trailer side walls with load anchors or floor with approved anchor plates.

Apply load anchors per manufacturers' instructions using correct anchors with appropriate belt rails or logistics posts (see Figure 2.9). Install load anchors a minimum of 18" behind face of load and stagger so no more than two are secured in vertical alignment (see Figure 2.9). Use gates constructed as illustrated in Figures 2.10 and 2.11 with these load anchors. The restraining capacity of two 1 ¼" x .031" steel straps, which are correctly sealed and anchored on each side wall and correctly tensioned and sealed across the face of the lading, is 7,100 lbs.

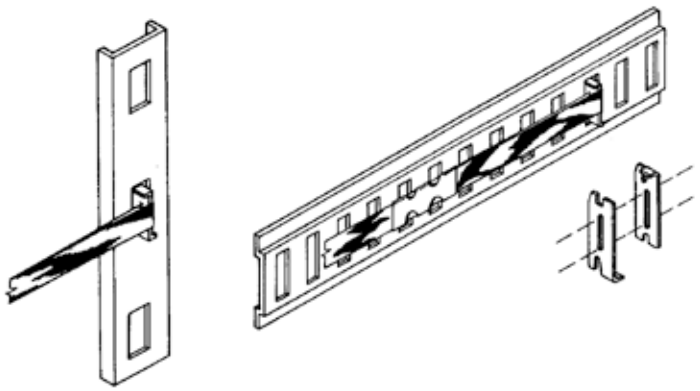


FIGURE 2.9 Load-Restraining Systems
Load Anchors

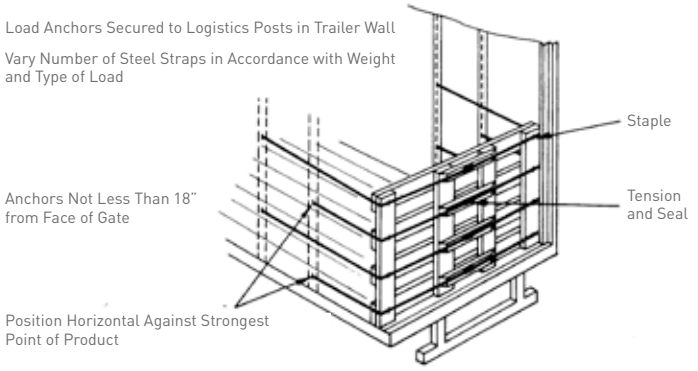
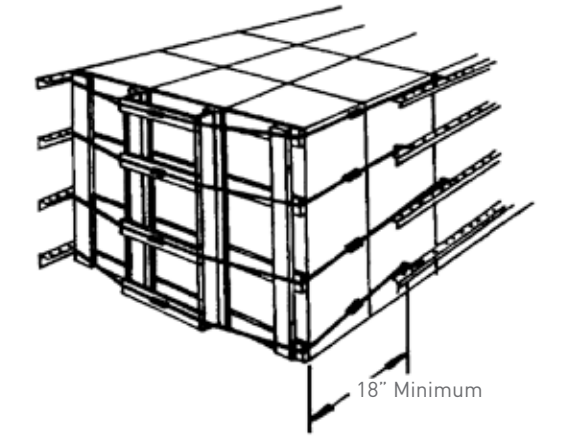
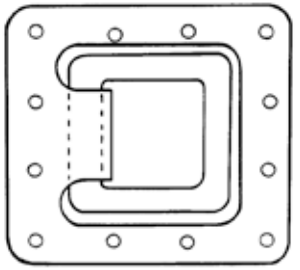


FIGURE 2.10 Construction of Gates

When two or more steel straps are used, tension the straps simultaneously to bring the load back uniformly in position and seal the straps (see Figure 2.11). 'D' Ring strengths are specified in ISO 1496 Annex F. Bottom rail D rings have 500 Kg maximum capacity and upper D rings have a 1000 Kg maximum capacity. It is very important not to exceed this weight bearing capacity when using D rings as anchor points for your securing systems. One must also take into account G forces when calculating ultimate load.



Container 'D' Ring



Retrofit 'D' Ring

FIGURE 2.11 (above) **& 2.12** Seal the Straps & 'D' Rings

“T” Gates and Beams

“T” Gates - rigid bulkhead designed to fit doorpost slots or vertical brace slots of transport equipment. Not suitable where doorposts 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.

Interior Load Bars

Load Bars are usually made of steel or aluminum. Standard duty bars are designed for economy and ease of use. Heavy-duty bars are designed for maximum restraint. Bars are available in various sizes and some may be equipped with rubber shoes to prevent the bar from slipping.

Rubber Mats

Rubber restraint mats provide a quick and easy method of restraining paper rolls and dense products. Mats eliminate nail damage to floors and have the added benefit of reducing loading and unloading time. Mats are generally reusable, improve safety in loading and are available in pads or perforated rolls.

Ty-Gard

Bonded Fabric load securement is constructed of spun-bonded polyester and polyester yarn with a tensile strength of 600 pounds per inch of width. A 16” wide strip has a load retention value of 9000 pounds. A pressure sensitive adhesive system is used to adhere the laminated webbing to virtually any type side wall.

Other Securement systems

Title 49 Code of Federal Regulations Part 393 describe regulations regarding the use of tie down assembly for U.S. highway transportation. Although the rules apply to cargo securement in motor vehicles, there are intermodal implications when containerized freight is being transported. Specific rules for tie downs are found in 49CFR section 393.102 of the Federal Motor Carrier Safety regulations.

PRELOADING PREPARATION

CONTENTS

SECTION 3

PRODUCT AND PACKAGING CONSIDERATIONS

PACKAGES

An important component of good load planning is the preparation of the packages prior to loading. This includes not only the packaging of the materials to be shipped, but the consolidation of those packages into larger units as well. Although packaging is beyond the scope of this Guide, it is worth noting that strict compliance with all applicable regulations governing the packaging of hazardous materials can greatly reduce the number and severity of incidents involving accidental release of those hazardous materials.

Some of the most serious and critical concerns involve the physical characteristics of a product. Each must be considered on its own merits when determining the packaging to be used, and how the packages will be stowed in the trailer or intermodal freight container. The compatibility of each product with the other products included in the same shipment, as well as any restrictions placed upon the coloading of different hazardous materials with other hazardous materials, must also be carefully considered.

As this Guide has mentioned earlier, the loaded intermodal freight container can encounter many hazards during transport over land or aboard ship. If these dangers are not anticipated and dealt with while the shipment is being prepared, damage to the cargo, vehicle or intermodal freight container, terminal area, other intermodal containers or vehicles, and even the vessel may result.

It is important to verify that the packaging selected for use is approved for the material to be shipped, and that all of the required markings and labels have been applied to each package. A thorough inspection of the cargo before and during loading into the vehicle or intermodal freight container is a must.

Even if it has been determined that all packages comply with the applicable regulations, problems can arise if the shipper is not aware of precautions that may be needed for the particular types of packages being offered for shipment. These precautions may be based on a multitude of factors, including package integrity, amount of outage or ullage within the package, density of product (including the tendency of certain dry products to settle or "bulk down"), and unitization by palletizing – all of which are factors to be considered when planning a load.

PACKAGES – SPECIAL CONSIDERATIONS

Package Integrity – It is important to consider the sturdiness of the packages when planning the load. Not all packages are built to withstand the same forces and therefore may require different bracing and securement methods. Compressed gas cylinders, closed-head, and heavy gauge drums, for example, are generally sturdier than combination packages containing glass, plastics or earthenware inner receptacles.

Lading and Fill – Nearly all packagings are designed and tested to contain a certain volume or weight of material. Packages that are overfilled or underfilled can lead to severe problems. Some common problems related to this are discussed below.

- **Steel Drums** – Changes in temperature during transport can cause changes in pressure and density of liquid products in steel drums. If the drums are overfilled leaving insufficient outage or ullage bulging of the drums and/or leakage could occur.
- **Fiber Drums** – A fiber drum designed to carry 200 Kg (440 Lbs.) of a product with a normal volumetric fill can fail with contents of only 100 Kg (220 Lbs.) of a low-density dry product which settles during transport, since this leaves a large empty space above the product. This condition greatly reduces available internal support against side impact, which, if it occurs, can distort the drum and cause the lid to come off. This condition reduces the vertical stacking strength of the underfilled drums.
- **Plastic Drums** - Plastic drums rely on properly sealed closures and a full package to maintain their full stacking strength. Partially filled drums are more susceptible to fail under compression. The filling temperature of the product may affect the performance of the drum.
- **Plastic Packages** – Plastic packages tend to deform under load concentration. Any package of this type should be transported on full-surface pallets or skids, or should be floor-loaded. Uneven loading can cause partial collapse and/or toppling of the load. When such packages are stacked pallet design should support the load.
- **Bags** - Bags tend to settle and compact unevenly, leading to unstable unitized loads and/or uneven heights of the unitized load. Compacting and evening the bags prior to transport can help counteract this tendency.
- **Fiberboard Boxes** – When the outer packaging is constructed of corrugated fiberboard, it is important to remember that the strength of the fiberboard will vary with humidity and other factors such as temperature and time. The stacking strength available from the inner receptacles and other packaging materials (such as

partitions and pads) should be considered in the unitized load configuration.

- **Flexible Intermediate Bulk Container (FIBC)** - The securement of stacked loads requires special consideration to minimize or eliminate the possibility of shifting or toppling during transport.

FIGURE 3.1 Flexible IBC

- **Rigid IBC**- There are several designs and materials-of-construction for rigid IBCs (RIBC). The most common types usually consist of a combination of a polyethylene "bottle-in-a-box", "bottle-in-a-cage", or "bottle-in-a-can". Other types may be constructed entirely of wood, rigid plastics, all metal, all metal with an inner liner, etc. While RIBCs can be easily stacked and secured, extra care must be taken if they are to be stacked in the vehicle or intermodal freight container. Stacking of RIBCs should be avoided.

FIGURE 3.2 Rigid IBC

- **Gas Containers** – These containers, referred to in U.S. DOT Hazardous Materials Regulations as "Multi-unit Tank Car Tanks", are used for gases such as Chlorine, Sulfur Dioxide and Refrigerant Gases. The tanks are cylindrical in shape, transported in a horizontal position and, as filled for shipment, can each weigh in the vicinity of 1590 Kg (3500 Lbs.). Since they are shipped in a horizontal position, they must , be separately secured to prevent rolling within the vehicle or intermodal freight container, using floor-secured chocks or specially designed cradles, and must not be stowed more than one high. Also, since their lateral dimension does not extend to the full width of the vehicle or container, securement against lateral movement must also be considered.

UNITIZING

In many cases, packages can be unitized for convenience , and to provide a measure of protection. The most common method—palletizing—is usually an economical method of unitizing, and offers advantages to the shipper, including:

Reduced Package Damage – Because a large number of small packages can be handled mechanically, the risk of damage during material handling is greatly reduced.

Improved Security - With unitized loads, the opportunity for pilfering and theft is reduced, and evidence of tampering is more easily detected.

Greater Handling Efficiency – Use of unitized loads speeds the loading and unloading of the vehicle or intermodal freight container, and lends itself to greater efficiency in securement.

Key Types and Features:

Strapped Loads – This method is suitable for many types of packages, particularly those which are irregularly shaped (such as compressed gas cylinders). This method can be relatively expensive compared to other methods, and may, if packages are compressible, loosen and become unstable. While steel strapping is still widely used, plastic strapping is becoming the preferred choice of many shippers today. (For a discussion of Steel Strapping, see Section 2, Strapping and Webbing). Note that due to environmental and safety considerations, some customers and end users may insist on particular types of strapping.

Plastic Strapping – This type of strapping can be woven or non-woven, taking the form of flat extrusions or adhering strands. Strapping comes in a variety of widths and is widely available in nylon, polyester, rayon and polypropylene. It is most common use is in unitizing packages on a pallet or skid. Some materials have the limited ability to stretch under load. Properties and sizes of

plastic strapping should be considered when deciding upon the most appropriate method.

CAUTION: The shipper may use lumber, plywood or another type of full-surface cap to assist in providing stacking protection. Loads that are subject to compression may also be supported with vertical framing, such as corner posts which provides the necessary additional stacking strength. When fiberboard packages are unitized, they should be interlocked to provide stability and strength to the unit.

Stretch or Shrink Film Wrap – This method is an excellent medium-cost system for many packages. It helps keep packages clean, and can provide some atmospheric protection. It is, however, not desirable where unsupported gaps exist between packages in the unit. Both wrap types require special application equipment. Shippers should note that if regulatory markings and labels on the packages cannot be seen through the wrap, it will be necessary to mark and label the outside of the unit.

Stabilized or Bonded Block – Non-skid, low tensile adhesive is used to "tack" /stick bags or boxes to form a tight, strong load. This method is low-cost and effective; however, the adhesive may cause tears in the outer surfaces of fiberboard packages and multi-wall paper bags.

Corrugated Fiberboard Sleeves – These provide relatively low-cost unitization along with some cosmetic protection of packages and, subject to the caution regarding susceptibility to humidity, some stacking strength. Shippers must ensure compliance with regulations applicable to marking and labeling of the outer sleeve if this is the chosen method for unitizing the packages.

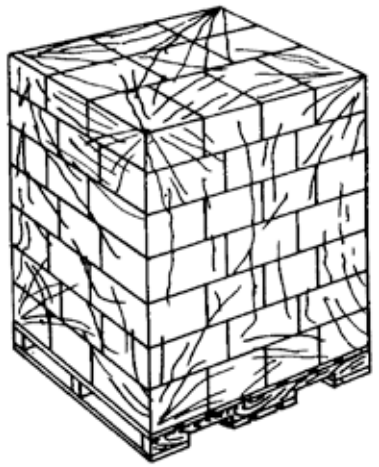
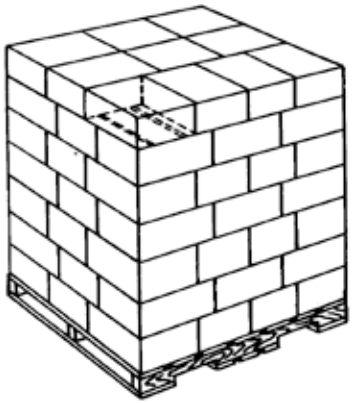


FIGURE 3.3 Pallet Load Utilizing one of the Stretch Wrap or Shrink-Wrap Films

a.



b.

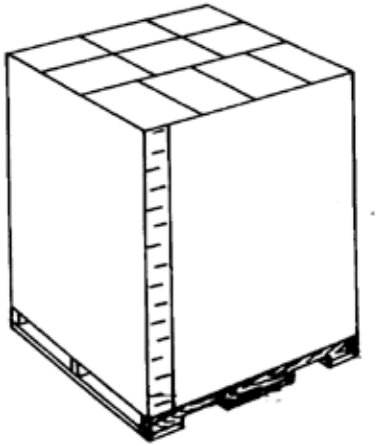


FIGURE 3.4 & 3.5

a. Spot Gluing of Containers. Double Dash Represents Glue Lines
b. Corrugated Fiberboard Sleeves.

Precautions Concerning Use – There are three factors which must be first considered in using pallets. The first relates to requirements imposed by certain national governments, while the other two relate to pallet dimensions:

First, in choosing to use wooden pallets, the shipper should be aware that the agricultural authorities of most countries require compliance with the ISPM15 standard for solid wood packaging materials. This requires that the wood used for pallets and other packaging is first treated to ensure the ISPM15 requirements are met. Wooden pallets and any other wood used for load securement should meet the ISPM15 requirements. when exported from the U.S.

Second, the shipper must consider the interior dimensions of the vehicle when selecting a pallet size. The following recommended sizes are considered compatible with dimensions of most freight containers and over-the-road highway trailers. Note that the first dimension given is the stringer length of two-way pallets. The pallet designation is that which is recognized for Chemical Industry Pallets (CP). Also, see Appendix D for Chemical Industry Shipping Pallet Guidelines as recommended by the Chemical Packaging Committee.

CP6 – 1200 x 1000 mm (48 x 40 inches)
CP7 – 1300 x 1100 mm (52 x 44 inches)
CP9 – 1140 x 1140 mm (45 x 45 inches)

Third, the lading must fit, to the greatest extent possible, the dimensions of the pallet. If an optimum fit is not possible, the lading must fit entirely within the dimensions of the pallet. Should underhang or overhang exist, it should be minimized. Underhang should be filled with appropriate void filling material to prevent lading shift.

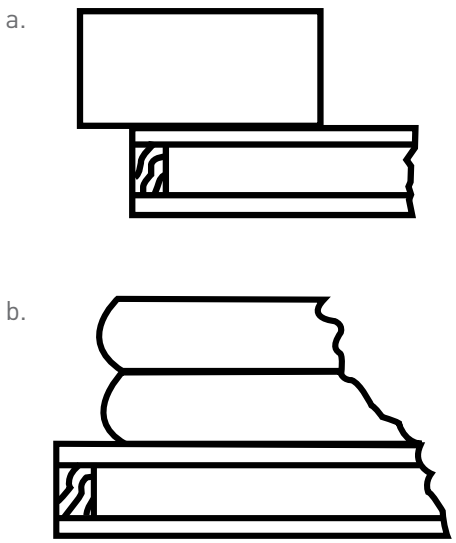


FIGURE 3.6 a. overhang
b. underhang

ORDERING THE INTERMODAL FREIGHT CONTAINER

While the objective of this Guide is to aid shippers in successfully and safely shipping cargo from origin to destination, it is recognized that absolute prevention of loss or damage to the cargo is not possible; however, proper selection and use of the vehicle or intermodal freight container will go a long way toward achieving this goal.

INTERMODAL FREIGHT CONTAINER SELECTION

Before a intermodal freight container is ordered, the shipper should have a thorough understanding of the types and sizes of intermodal freight containers that are available, along with the product characteristics and packaging of the products that are to be loaded into the intermodal freight containers.

As a general rule, most cargo can be stowed, subject to co-lading limitations in the applicable regulations, in general-purpose or dry-cargo containers. These containers will vary as to overall dimensions, and even those with the same external dimensions may vary, from one to another, in their internal dimensions. Appendix C of this Guide contains detailed specifications for intermodal freight containers.

General Purpose Intermodal Freight Containers - These are most commonly available in 20- or 40- foot lengths with 8-foot external widths and heights. Other, less commonly available sizes, may be 24, 25, 27 and 45 feet in length.

Insulated Intermodal Freight Containers – Insulated intermodal freight containers are used for cargo that cannot be subjected to rapid changes in temperature. They should be selected for use when extreme changes in ambient temperatures are anticipated. Because these intermodal freight containers are insulated, interior dimensions and cubic capacities are less than those of general-purpose containers.

Refrigerated ("Reefer") Intermodal Freight Containers – Cargo that must remain frozen or under refrigeration is transported in a intermodal freight container which is fitted with standard refrigeration units powered by electricity, liquid-gas or diesel fuel. The interior volume of these intermodal freight containers is less than those of insulated containers, since space is taken by the refrigeration units in addition to the necessary insulation.

PRODUCT AND SHIPPING CONSIDERATIONS

Before a vehicle or intermodal freight container is ordered, it is crucial that anything that could cause delay in shipment and delivery of the cargo must be examined and eliminated or minimized.

FIGURE 3.7 20/40 Foot General Purpose Intermodal Freight Containers

a.

b.

FIGURE 3.8 a. 20 Foot Porthole Type
b. Refrigerated Intermodal Freight Container (Temperature Controlled)

The factors that should be examined include:

- Do the Terms of Sale affect the selection of the carrier? Does the ocean carrier have limited intermodal freight container service?
- Does the Letter of Credit stipulate the ports of exit and entry? If so, does this limit the types and sizes of available intermodal freight containers?
- Can the destination port accommodate the size intermodal freight container selected? Does the customer have the capability to unload the intermodal freight container?
- Total weight of cargo, including all dunnage and securement equipment and devices, must not exceed the limits of the vehicle or freight container and must not exceed any of the highway weight limitations. NOTE: The person filling the container must certify the total gross weight of intermodal vehicles or containers (including cargo, pallets, dunnage, securement devices or equipment, and even ice, if used as a refrigeration medium), for all intermodal shipments.
- Cargo dimensions and stackability may require vehicle or intermodal freight container door openings of a particular size.

- If cargo dimensions or weight limitations prevent the full order from being shipped in one vehicle or intermodal freight container, shippers should seek means to adjust the quantity of cargo to be shipped.
- Consideration should be given to maximizing the cube for intermodal freight containers.
- Certain goods must not be loaded into the same vehicle or intermodal freight container with other goods which are liable to contaminate or be contaminated by those goods, unless appropriate precautions can be taken (as, for instance, by separation) to prevent any contamination. Goods, particularly hazardous materials, must not be loaded into the same intermodal freight container with other goods if the possibility exists that mixing can cause the production of excessive heat, fire, or formation of flammable or toxic gases. Restrictions imposed by regulations as to co-loading, stowage and segregation must be strictly adhered to, by shippers as well as transporters.
- A determination must be made as to whether there are special needs for each product to be loaded – including ventilation, need for insulation or refrigeration, and the like.
- The transportation modes that are to be used throughout the entire route should be known before loading.
- Consult the carrier for any specific commodity restrictions.

It must be emphasized that all aspects of the movement of goods must be carefully planned and coordinated with all parties involved in the supply chain.

INSPECTION OF THE INTERMODAL FREIGHT CONTAINER

On receipt of the intermodal freight container or vehicle, it is vitally important that the shipper conduct an inspection of both the interior and exterior, and confirm a valid inspection decal, sticker, stamp, or other is affixed on or near the CSC (International Convention for Safe Containers) Safety Approval Plate, or that the container is marked with the required Approved Continuous Examination Program (49 CFR Part 452.7). This will ensure that the goods are not subjected to risk due to defects that could damage them or cause loss of product. Section V of this Guide addresses this subject in greater detail.

CONCLUSION

While it is the responsibility of the supplier of the intermodal freight container or vehicle to furnish those which are clean, dry, free of residue of previous ladings, odor and mechanical defects, and are structurally sound, it is the responsibility of the shipper to inspect each vehicle or intermodal freight container to assure that it is in fact suitable to safely carry the intended lading to destination. If a vehicle or intermodal freight container is found to be unsuitable for loading, it should be rejected, and returned to the carrier or lessor for replacement.

LOADING

CONTENTS

SECTION 4

Table of Contents - Continued

LOADING

With knowledge of shipping environments, materials, unitizing loads and the bracing methods just described, the reader is ready to load cargo into a transport unit. This section will serve as a general guide to loading, showing the reader what to look for in the preloading inspection of transport equipment, how to create and use a load plan, and how to use dunnage. Additionally, solutions to special loading patterns such as dense loads, less-than truckload (LTL), and double deck sections are described. Finally, preferred loading patterns for some typical loads are illustrated.

Remember, **GOOD LOAD PLANNING IS IMPORTANT**. Experience has shown that proper preplanned load patterns and restraint systems not only reduce damage and loss, but are much more efficient to install. **IMPLEMENTATION OF A GOOD LOAD PLAN** will minimize load shifting in transit.

PRE-TRIP INSPECTION OF EQUIPMENT

The first question to ask yourself: "Is this the correct container/vehicle for the product to be loaded?"

49 CFR 176.27 and IMDG 5.4.2 requires the container and the container/vehicle unit should be inspected inside and outside before it is loaded. If the equipment appears severely damaged, it should not be loaded and the carrier/operator should be contacted with a view to obtaining a replacement. The following checklist may be used as a guide to inspecting the container/vehicle before loading.

PRE-TRIP ORDERING/INSPECTION CHECKLIST

Ordering Container/Vehicle

- Determine size and type of container/vehicle needed.
- Advise supplier of container/vehicle the nature of the goods to be shipped.
- Advise supplier of special requirements (e.g. temperature controls, etc.)

Inspection-Exterior

- Did we receive the correct container/vehicle for this shipment?
- Is there obvious damage to main framework:
- Corner Posts and Doors?
- Corner Fittings?
- Do doors and locks operate properly and can receive a security device - gaskets and seals in good condition?
- Is there a Safety Approval Plate (SAP) (49 CFR 451.21 Subpart C - Appendix C – Container Safety Approval Plate).
- Have old hazardous material placards been removed?

- Check vehicle lights, brakes, tires, etc. for proper operation.

Inspection-Interior

- Is light visible from inside closed unit? Check floors, walls, and ceiling for holes and other visible signs of leakage.
- Is floor solid and clear of all bolts, nails, or material, which could damage packages and/or cause injury to personnel? Are cargo tie-downs (D - Rings) and door posts in good condition?
- For wall mount restraint systems - check for wall/panel cleanliness and soundness.
- Are the side-wall panels securely fastened to the wall and free of protruding objects?
- Is unit free from residue or odor from previous lading?

REJECT UNITS WHICH DO NOT MEET THESE CRITERIA OR MAKE THE NECESSARY CORRECTIONS.

PLANNING THE LOAD – GENERAL GUIDELINE

CONTAINER OR TRAILER LOADING DO'S AND DON'TS

DO

1. Keep within the load limits of the unit and meet both Federal and Local weight restriction limits. Never overload. See the Bridge Formula.
2. Distribute the weight evenly on floor of container or over the axles of the vehicle. Special weight distribution requirements must be considered for dense cargo.
3. Load hazardous materials in accord with applicable regulation: See the Segregation Chart "Regulation" section. If export, check International Maritime Organization (IMO) segregation chart. It may be different.
4. Load ALL cargo tightly to prevent shifting which could damage cargo or container/vehicle.
5. Observe special handling instructions - such as "This side up"; "Do not drop"; or "Fragile".
6. Separate cargo with sharp corners/protrusions using dividers, slip sheets, and cushioning materials, as necessary.

7. Load lighter cargo on top of heavier cargo and load dry goods cargo over liquid cargo wherever possible.
8. Beware of environmental (ie. condensation/pressure) problems that may develop due to changes in temperature/humidity/altitude.
9. If an export shipment is to be made where wood is used to secure the load, check the agriculture requirements of the destination country for possible restrictions (ISPM 15). www.ippc.int
10. Arrange the load with blocking and bracing such that labels and markings are visible to inspectors.
11. Use approved cargo securement methods based on the lading, mode of transportation, and trailer/container utilized.

DO NOT

1. Do not load damaged/leaking cargo or cargo with external contamination (including water).
2. Do not load without a plan.
3. Do not ship without proper labels and/or placards.
4. Do not ship until doors are properly closed / sealed.
5. Do not load more than 60% of load weight in half length of equipment.

Do not ship without utilizing approved cargo securement methods.

PLANNING THE LOAD - (DETAILED)

Example - This discussion follows the actual load plan from the next page.

The project: The Shipping Department has just received a Bill of Lading to move 78 drums of a flammable liquid weighing 500 pounds each (gross). The Traffic Department has routed the load by Container On Flatcar (COFC) to a port. A 20-foot container on chassis (on 5 axles) will be used over the road to the rail loading facility. The state of origin has an allowable axle limit of 34,000 pounds, and permits a total gross of 80,000 lbs. (Tractor, chassis, container & packages).

Check Equipment Tare:	Tractor	16,000 lbs.
	Chassis	6,000 lbs.
	Container	6,000 lbs.
		28,000 lbs.

Note that loads to 52,000 pounds can be carried (80,000 - 28,000). Checking state regulations - axle weight limit is 34,000 pounds. Since this load is 39,000 pounds (78 drums x 500 lbs.) and tare is 28,000 pounds for a total of 67,000 pounds on 5 axles, axle weight limit is not a problem.

Select Method - We decided to use Method D - 'T' Gates for a Double Layer Drum Load in a 20' Container. This is acceptable for all modes. Three modes will be used in this shipping ... road, rail, and ocean. Six "T" bar units, 3 for each layer, will be used (39,000/6,700 = 5.82). **Load Plan** - We lay out on a sketch the load plan and determine materials required. **Specify Package Protection (dunnage and restraint)** - Plywood; ½" between layers or AAR approved equivalents ½" for load facing, lumber – 2x6" for "T" bars and 2x4" for spacer bars.

Recheck General Guidelines (Section IV) - Note: All Do's and Don'ts are met.

THIS IS THE PLAN BY WHICH THE LOAD IS TO BE MADE. IT IS IMPORTANT TO TAKE THE TIME TO DO THIS WORK CAREFULLY. IN MOST LOCATIONS MANY LOADS WILL BE REPETITIVE AND IF THE PLAN IS DONE CAREFULLY IT CAN BE REUSED.

LOAD PLANNING FORM

Note: This form is set up for an 80,000 lb. gross 20 ft. intermodal container. Make suitable adjustments for other equipment.

Step 1: Check tares to assure the load is legal.

Tractor:	16,000
Trailer or Chassis Tare:	6,000
Container:	6,000
Total:	28,000

Good for up to 52,000 lbs. Allowable Weight is 80,000 – (Tare) 28,000

Step 2: Select restraint system: **METHOD 4 "T" GATES (Section IV, Method 4B**

Anchor type: Door post slots or vertical brace slots.

Step 3: Lay out load approximately to scale. Follow the Rules.

T" gate assembly requires 7-3/4 inches

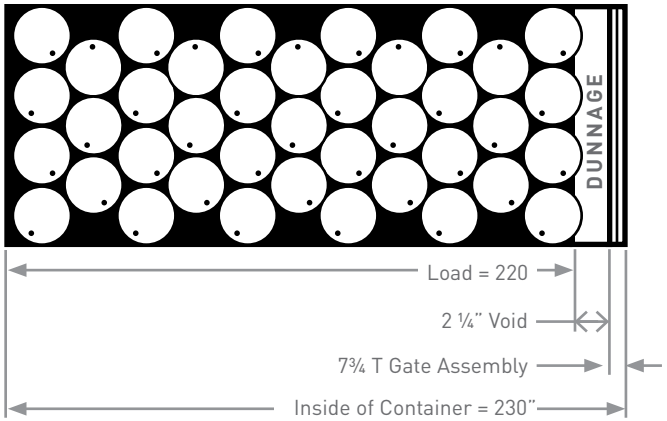


FIGURE 4.1 20 FT Intermodal Container
Top View

In this load 2-1/4 inch void should be filled with appropriate dunnage.

Step 4: Specify lading protection. Bulkhead, protectors, cushioning at gate.

"T" bars & dunnage. Appropriate dunnage for this load may be "cut to size" 2X4" boards placed between plywood and "T" gates to fill void. Detail of other material requirements is found in method description.

Step 5: Recheck key loading rules. All General Guidelines are met

SPECIAL CAUTIONS

While the example just given is relatively simple, many loads are more complex. Some additional cautions are:

- Where goods of regular shape and size are concerned, a tight load from wall-to-wall should be sought. However, in many instances some void spaces occur. If the spaces are too large, then the load should be completed by using filler dunnage, i.e., honeycomb, folded corrugated board, air bags or other suitable means.
- Cargo weight should be evenly distributed over the floor of the container or the axles of the vehicle. Where the cargo items of varying weight are to be loaded onto a container, or where the container will not be full (either because of insufficient cargo or because the maximum weight allowed will be reached before the container is full) then the load should be arranged and secured so that the approximate center of the weight of the cargo is close to the mid-point of the container. In no case should more than 60 percent of the load be in less than half of the length of the container.
- If an export shipment is to be made, be certain that all wood in the container complies with agriculture regulations - some countries have wood treatment requirements.
- In a mixed load with more than one barrier, with a fragile freight section such as glass case goods, always put the more fragile freight in the door section (the last bay loaded).
- In a load made up with a single barrier the more fragile packages should be in the center of the load.
- Less Than Truckload (LTL) Shipments should be given special consideration. By regulation, the load must be secure before leaving your site. Remember that all packages should be secured from falling or shifting in transit. Load locks, air bags, plywood, 2 x 4's or 2x 6's, fillers, etc. should be used for this purpose.

USING DUNNAGE

The important thing to remember is that voids should be filled to prevent packages from shifting or falling.

DO'S AND DON'TS

DO

- Use strong dunnage such as bulkheads across the container (to fill longitudinal voids) for rail movement - minimum load capability - 1,500 lb./sq.ft.
- Size it to fit the section of load to be protected. Width and height as near as possible to face of packaging or unit load.
- Use vertical separator sheets such as corrugated, fiber kraft laminated veneer or plywood to segregate sections of load.
- Use AAR approved or equivalent divider sheets as decking when load sections are layered - e.g., boxes over drums, drums over drums, other cargo over rigid intermediate bulk containers, etc.

DO NOT

- Reuse damaged filler - crushed honeycomb or broken pallets, etc. They will cause damage.
- Use cushioning or fillers as a bulkhead.

REMEMBER - CUSHIONING AND FILLERS ARE NOT BULKHEADS. BULKHEADS ARE STRONG, RIGID SEPARATORS DESIGNED AS PART OF A GATE OR BARRIER OR SOMETIMES AS A STRONG VOID FILLER.

SPECIAL CONSIDERATIONS

RISERS

Risers may be used to elevate alternate rows of cylindrical packages to minimize chafing and damage. Risers are used with open head drums having locking ring closure. The elevation of alternate rows will minimize the contact of the locking ring closure. **Caution:** Transverse risers are acceptable for rail movement but should not be nailed in place.

RUBBER MATS

Rubber Mats have been approved and tested for rail shipments (ref. Association of American Railroads "Intermodal Loading Guide for Products in Closed Trailers and Containers"). Method E-7 "Closed Head Steel Drums In a 3-4-3 Pattern on Rubber Matting with Steel or Polyester Cord Strap describes this method. **This rubber matting method should be considered for over the road vehicles as well.**

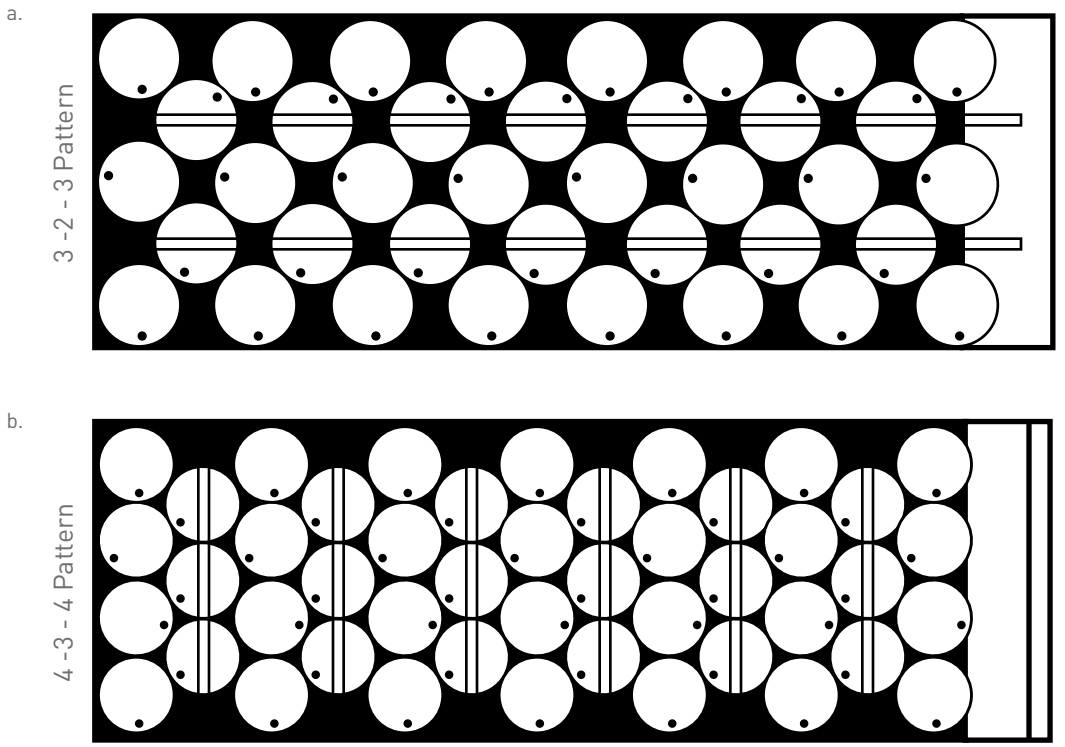


FIGURE 4.2 & 4.3

a. Open head drums longitudinal risers
b. Open head drums lateral risers

FIGURE 4.4 Partial Deck-Lightweight Load Ty-Gard2000®
Check load plan for weight distribution

PARTIAL SECOND LAYER LOADS

A partial second layer is often necessary to obtain maximum load in the container/vehicle.

There are several solutions to this problem.

Guideline

- Apply Ty-Gard as shown in Method C.
- Load cargo tightly to nose and alternate bottom/second layer cargo with divider sheets as decking.
- Add dunnage/filler as required.
- Secure Ty-Gard.
- Recheck load plans for compliance with axle weight restrictions.
- Partial Second Deck - Heavy cargo such as drums (to meet axle weight restrictions)

PROCEDURE:

First secure last row of partial second tier and then secure last row of lower deck.

Apply horizontal divider sheets/decking when Section A-B is loaded and then load second layer of cargo. Be sure to utilize appropriate separator material between tiers of cargo.

DENSE LOAD

To meet axle weight restrictions which prevent loading to the nose of the transport equipment.

NOTE: Method C is shown

a.

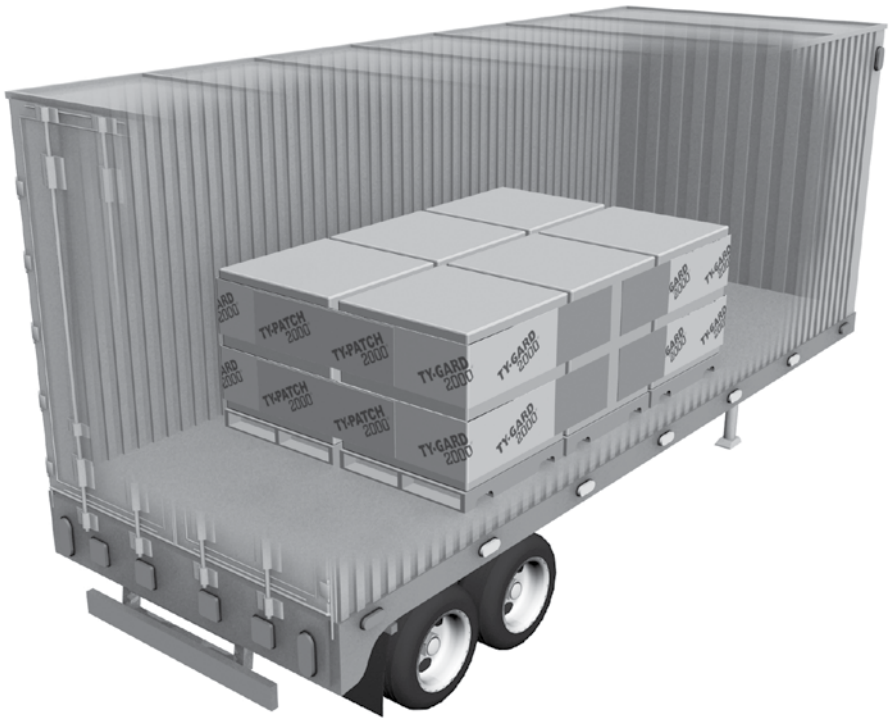


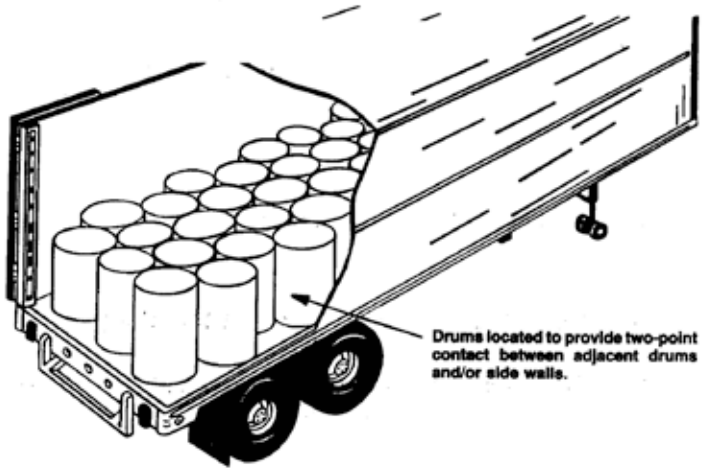
FIGURE 4.5 Method C

EXAMPLES OF PREFERRED LOADING PATTERNS

Cylindrical packages such as steel, plastic, or fiber drums

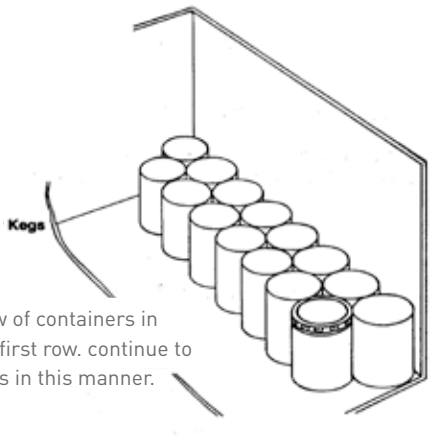
METHOD OF LOADING CYLINDRICAL PACKAGES

a.



b.

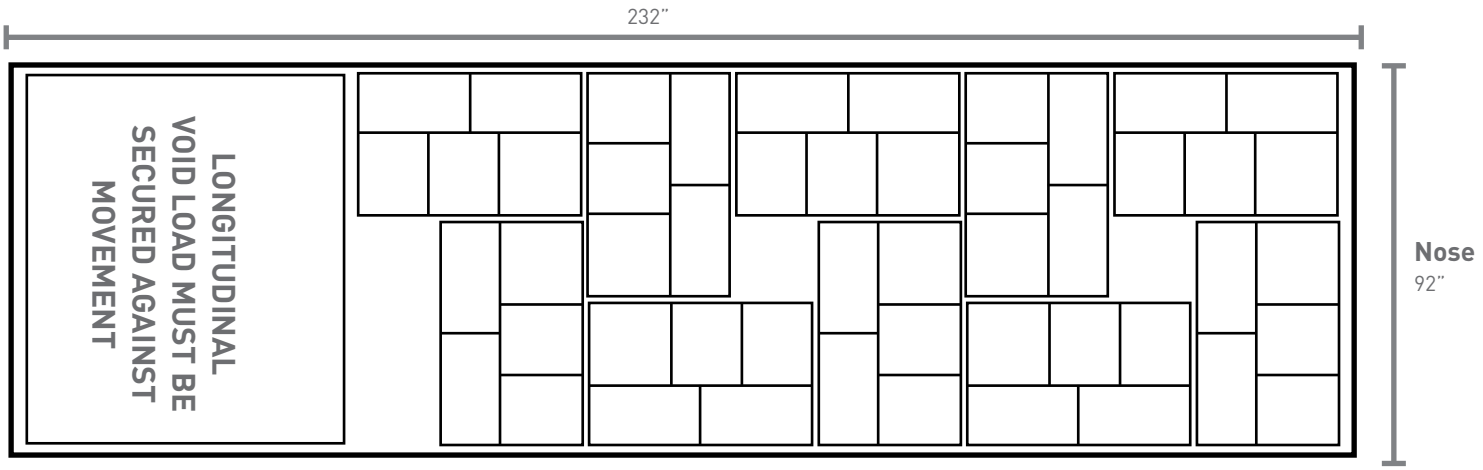
Drums located to provide two-point contact between adjacent drums and/or side walls.

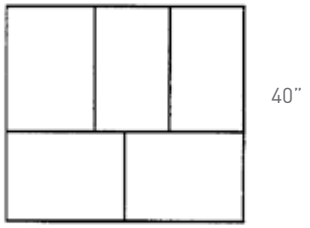


Recess second row of containers in valleys created by first row. continue to load alternate rows in this manner.

FIGURE 4.6 & 4.7

a. Drums in a 4-3-4 pattern
b. Pail or kegs in offset pattern

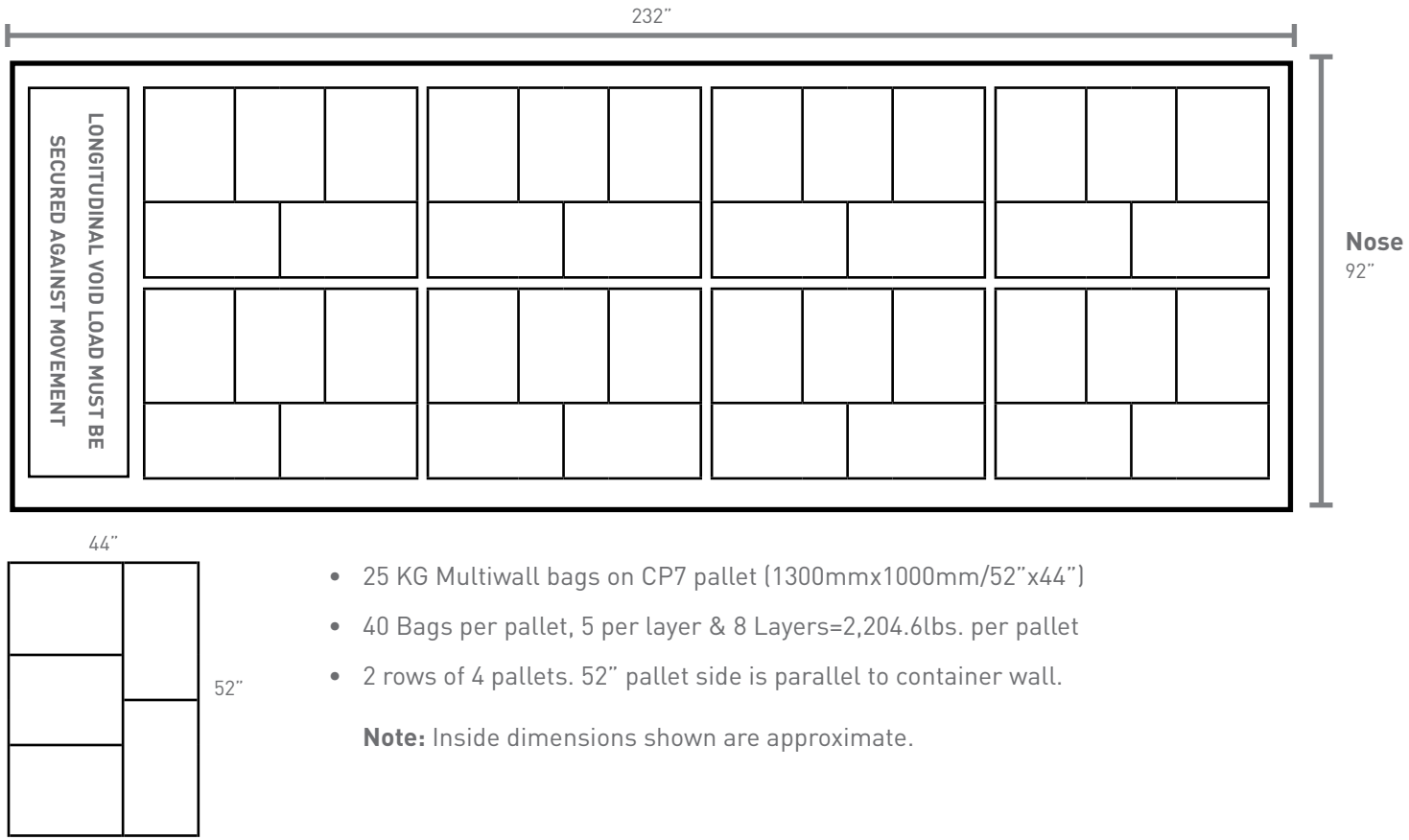




- 20 KG Multiwall bags on CP6 pallet (1200mmx1000mm/48"x40")
- 50 Bags per skid, 5 per layer & 10 Layers=2,204.6lbs. per pallet
- 2 rows of 5 pallets, pallets are pinwheeled.

Note: Inside dimensions shown are approximate.

FIGURE 4.8 20 KG Palletized Bags in 20 foot Intermodal Container



- 25 KG Multiwall bags on CP7 pallet (1300mmx1000mm/52"x44")
- 40 Bags per pallet, 5 per layer & 8 Layers=2,204.6lbs. per pallet
- 2 rows of 4 pallets. 52" pallet side is parallel to container wall.

Note: Inside dimensions shown are approximate.

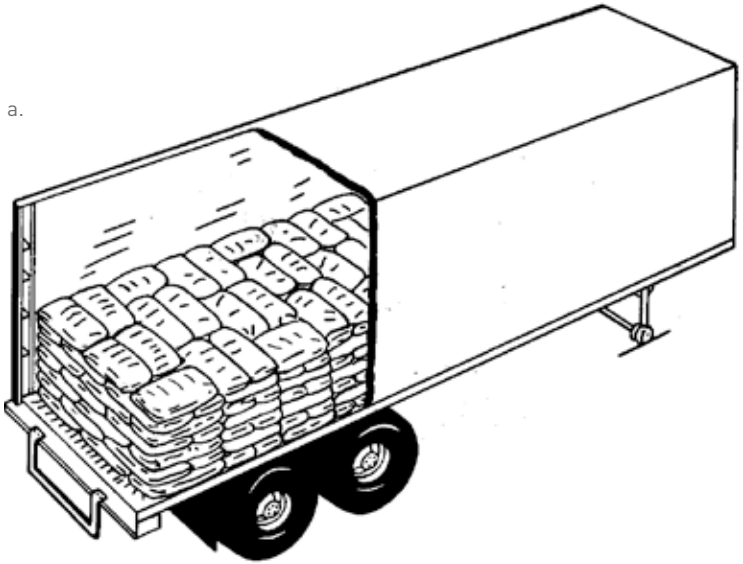
FIGURE 4.9 25 KG Palletized Bags in 20 foot Intermodal Container

Loose Loaded Bags

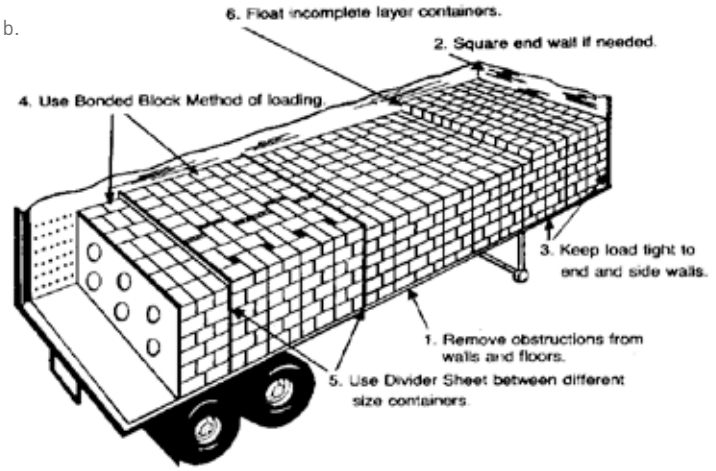
Trailer should be lined with a heavy duty liner paper to protect bags from abrasion. Layers of each unit should have bags lengthwise and crosswise in manner illustrated.

Location of lengthwise bag staggered by layers to bind bags in lower layers.

a.



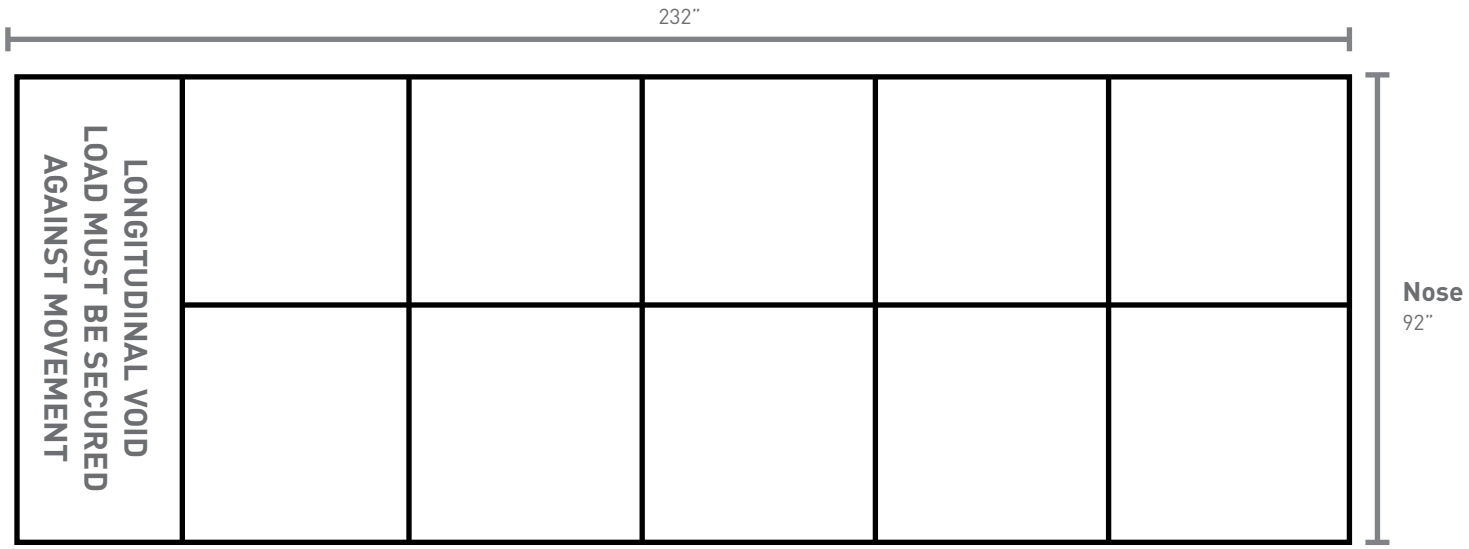
b.



Apply securement to restrain load from damaging doors and/or lading falling out during transit or when doors are opened at destination. Height and nature of lading and type of trailer will determine restraining method used. See Section 5.

FIGURE 4.10 & 4.11

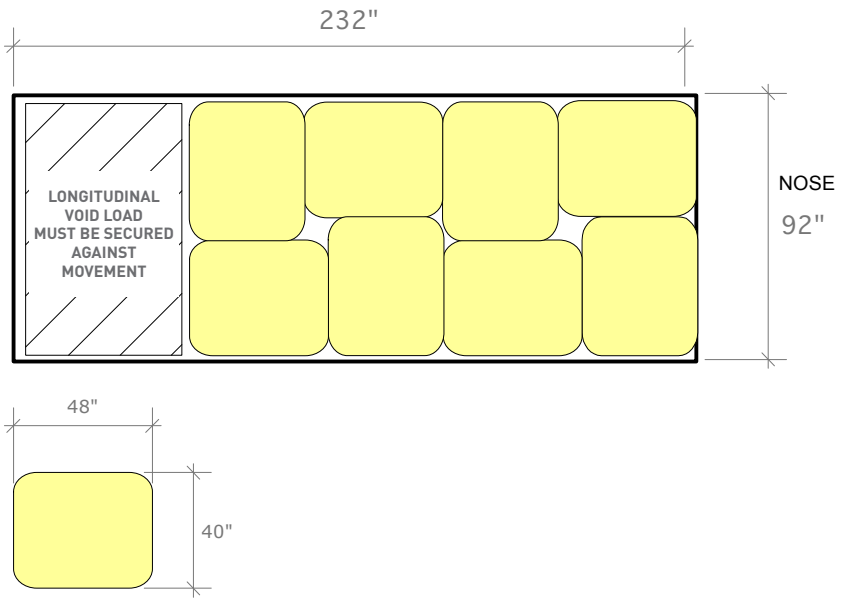
a. Figure 4.10
b. Figure 4.11
Loading Fiberboard Containers



- 500 KG FIBC stacked on CP9 pallet (1140mmx1140mm/45"square)
- FIBCS may be individually palletized or double-stacked on a single pallet
- 2 Rows of 5 pallets

Note: Inside dimensions shown are approximate.
Flexible Intermediate Bulk Containers should be protected from sharp objects. The sides of container should be free of protruding objects that may damage or puncture FIBCs.

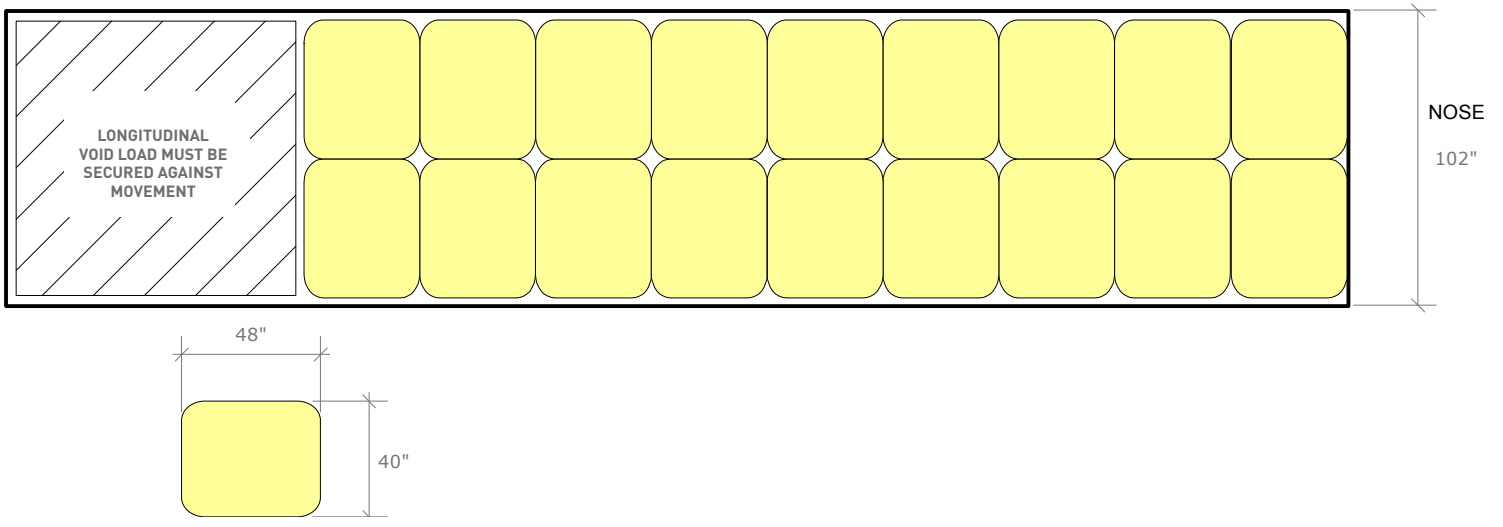
FIGURE 4.12 500 KG Intermediate Bulk Containers (FIBC) in 20 foot Intermodal Containers



- 275 Gallon RIBC (48"x40")
- 2,204.6 LB. NET, 194 LB. TARE
- 2 Rows of 4 RIBCS, RIBCS are double Stacked.

Note: Inside dimensions shown are approximate.

FIGURE 4.13 275 Gal. Rigid Intermediate Bulk Containers (RIBC) in 20 foot Intermodal Container



- 275 Gallon RIBC (48" X 40")
- 2,204.6 LB. NET, 194 LB. TARE, 2,398.6 LB. GROSS
- 2 ROWS OF 9 RIBCS

Note: Inside dimensions shown are approximate.

FIGURE 4.14 275 Gal. Rigid Intermediate Bulk Containers (RIBC) in 40 foot Over-the-Road Trailer

SECURING SYSTEMS

CONTENTS

SECTION 5

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	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.

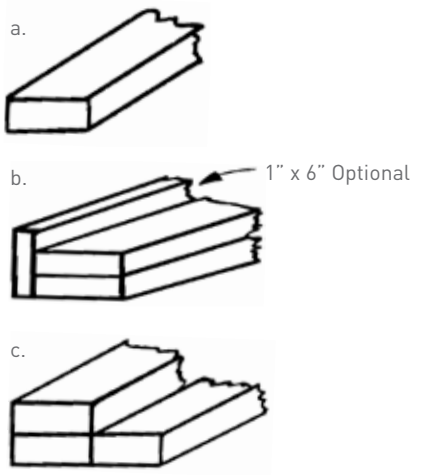


FIGURE 5.2

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

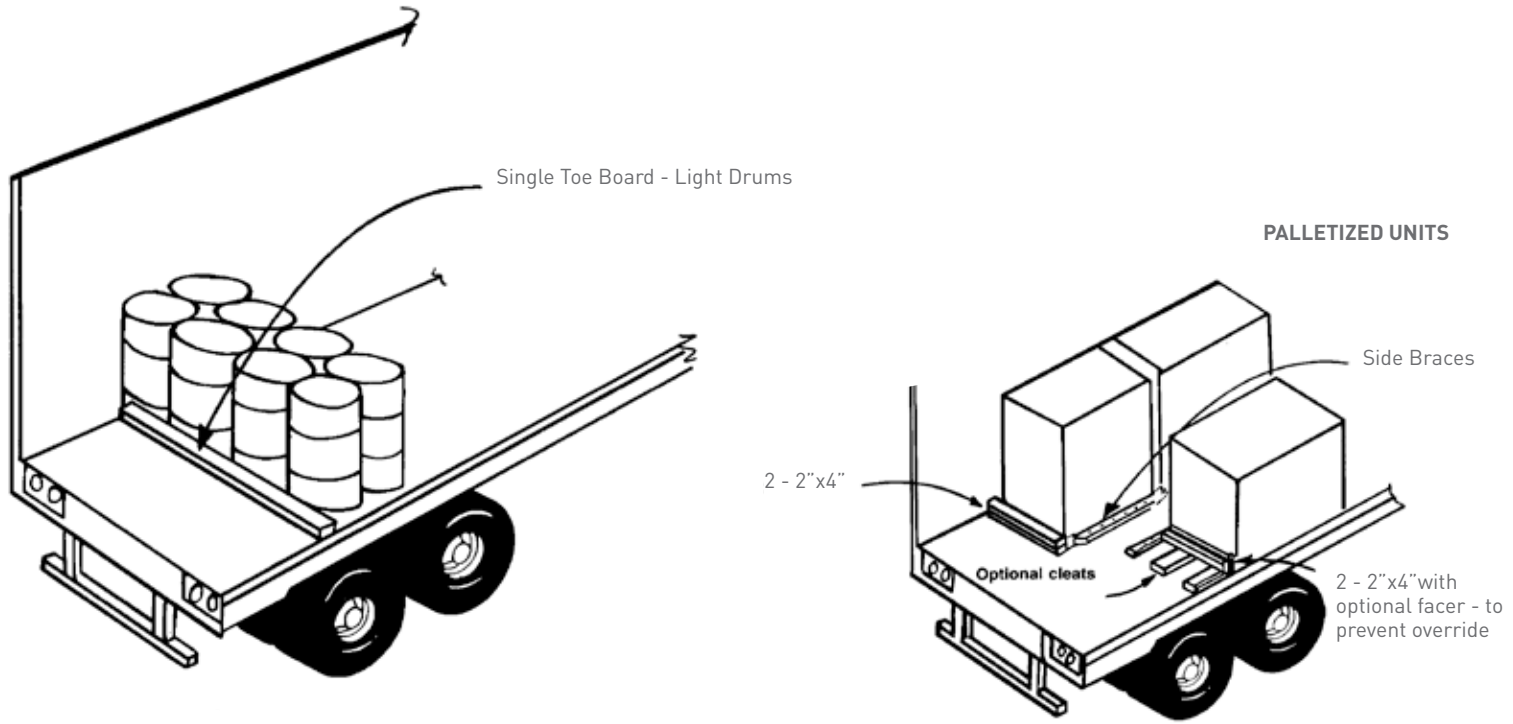


FIGURE 5.3 Typical Uses of Toe Boards

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. 1-¼" x .031" Heavy Duty

Seals of recommended type by Manufacturer

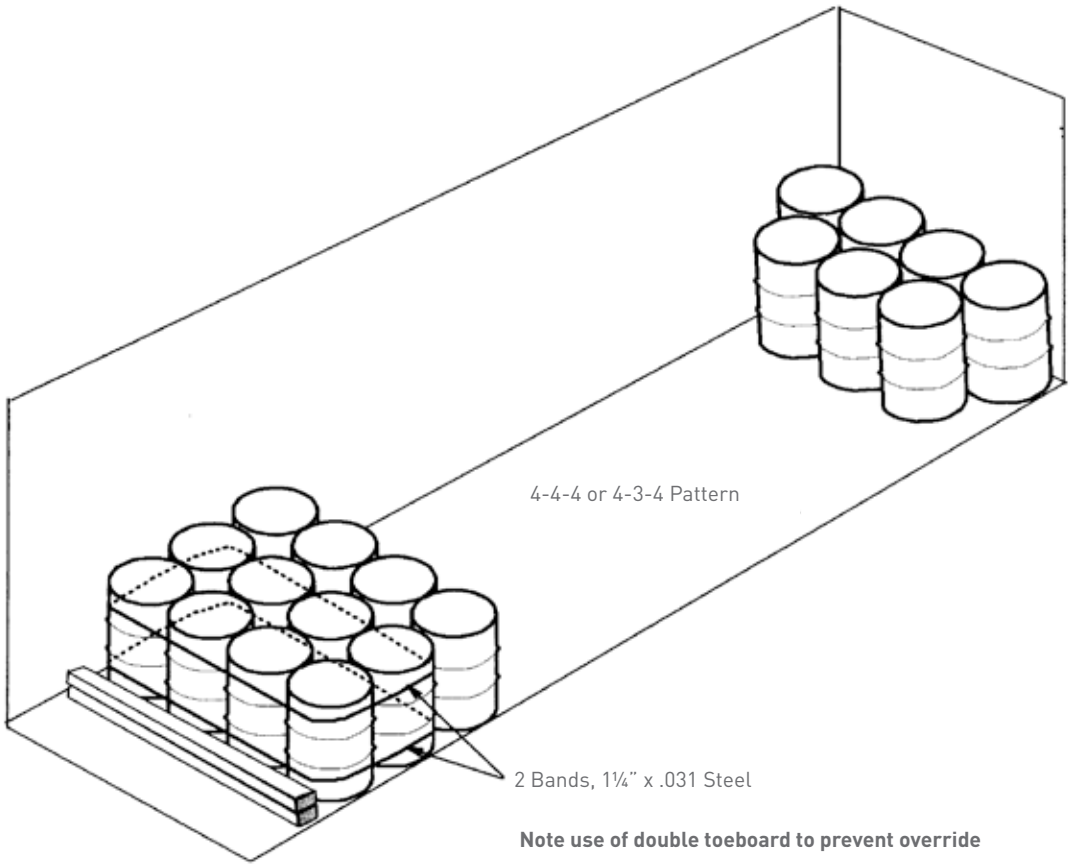

4-4-4 or 4-3-4 Pattern
2 Bands, 1¼" x .031 Steel
Note use of double toeboard to prevent override

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.

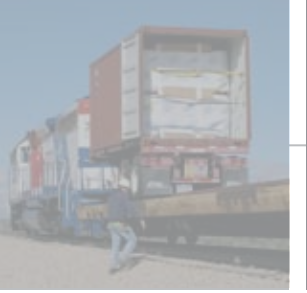
Area of Application

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

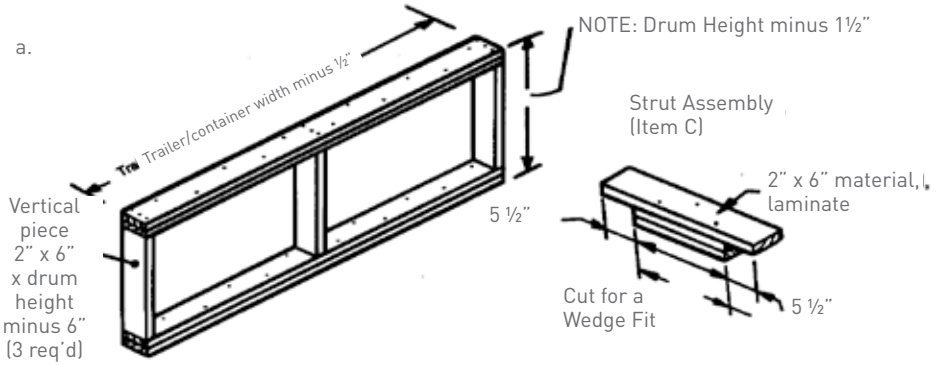
CAUTION: Trailer/container must have brace slot corner posts, or door posts which extend a minimum of 2 ½". Follow load plan carefully except for center section.

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.

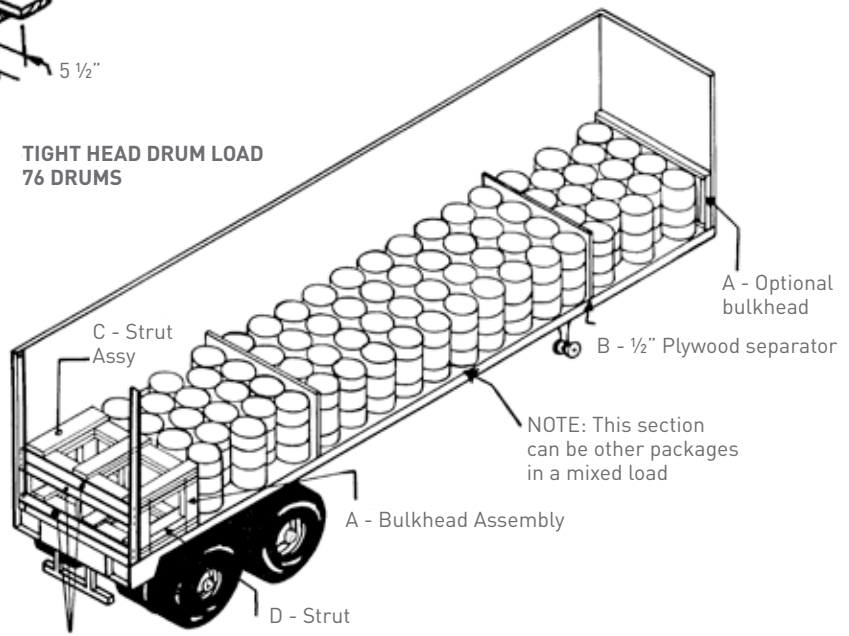


a.



Horizontal piece, 2" x 6" x trailer/container width minus ½" (doubled) (2 req'd). Nail first piece to vertical pieces w/3-10d nails at each joint and laminate w/1-10d nail every 6"

b.



E- 2 x 6 Brace Boards

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.

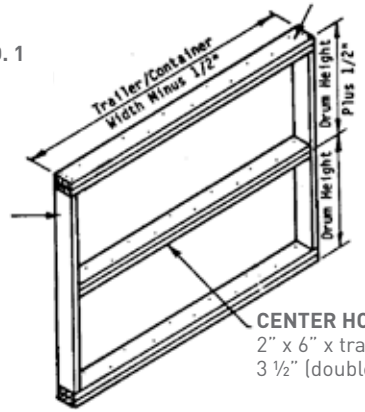
Note: A system using 'T' Gates for drums as an alternate to this system and is shown under Method D(2).

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 ½" (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 ½" (2 req'd). Nail to each center horizontal piece.

CENTER HORIZONTAL PIECE
2" x 6" x trailer/container width minus 3 ½" (doubled) (1 req'd) laminate.

b.

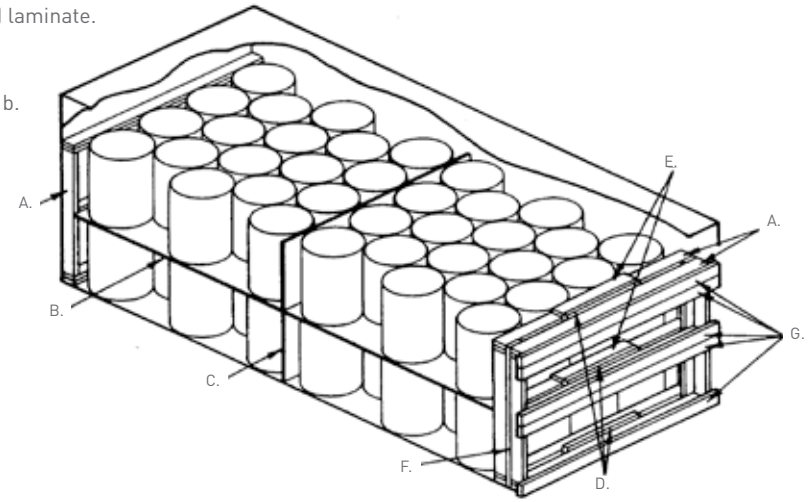


FIGURE5
5.6 & 5.7

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.

FIGURE 5.11 COFC Load of 55 Gallon Drums Using Three Tygard Barriers

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

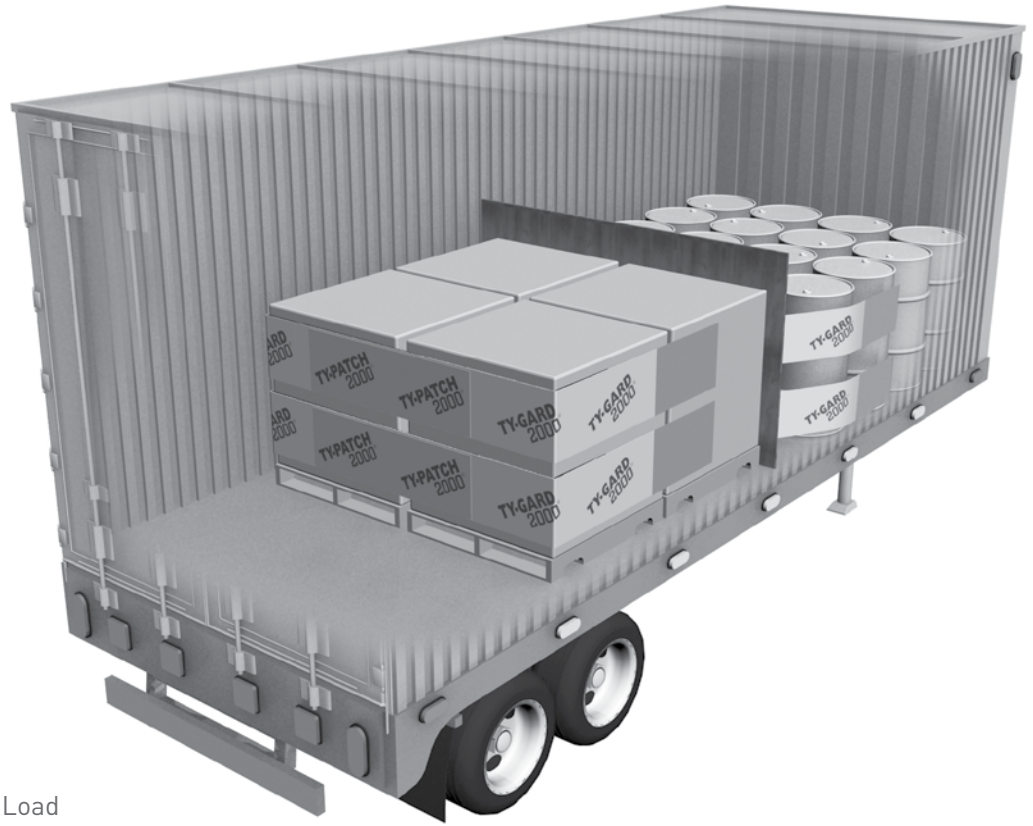


FIGURE 5.13

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

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.

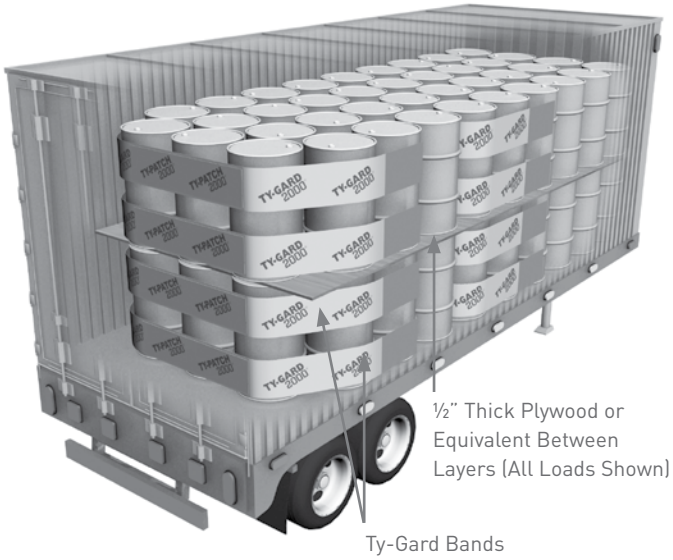


FIGURE 5.17 Sketch 1 - 78 Drum Load, 4-4 Pattern
78 Tight Head 55 Gallon Steel or Plastic Drums in Two Layers Secured by Ty-Gard in a 20' ISO Container

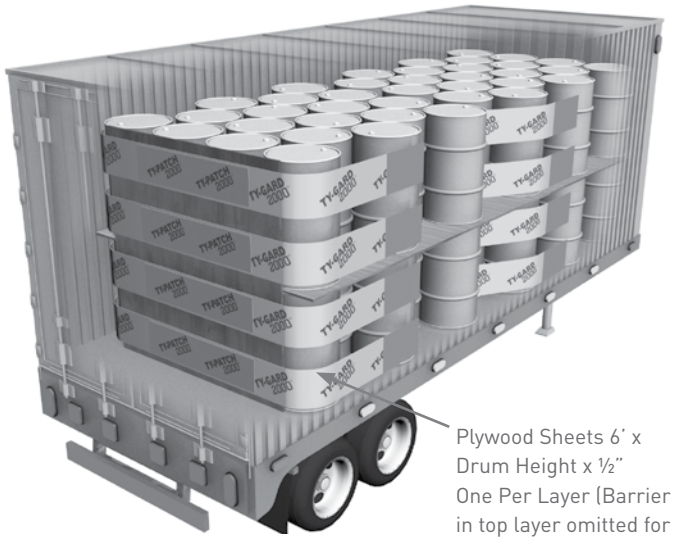


FIGURE 5.18 Sketch 2 - 78 Drum Load, 4-3-4 Pattern

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 (½" plywood or equivalent material) are used between the bottom and top layers.

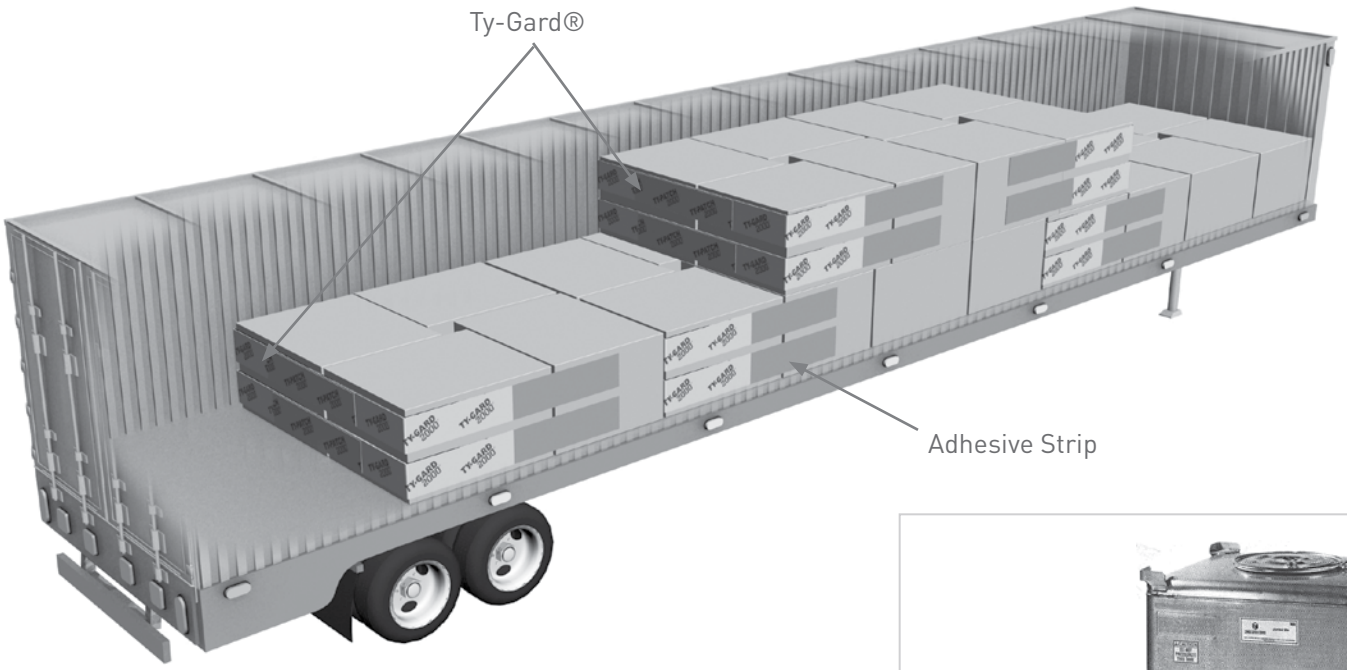


FIGURE 5.19

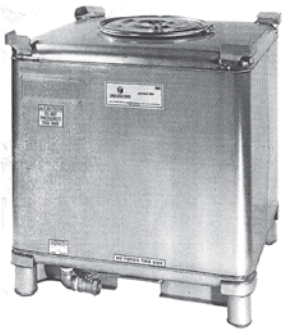


FIGURE 5.20

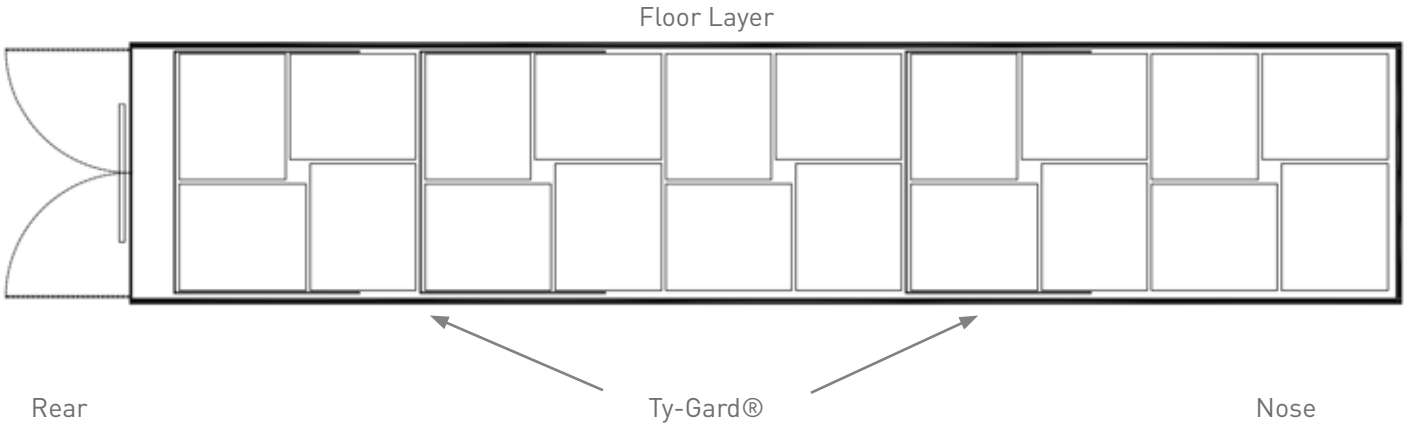


FIGURE 5.21

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

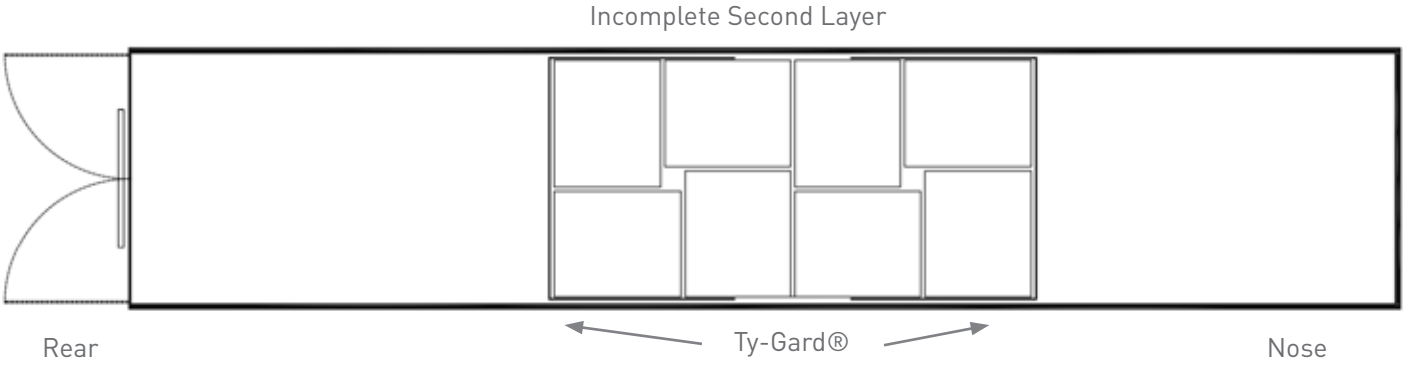


FIGURE 5.22

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.

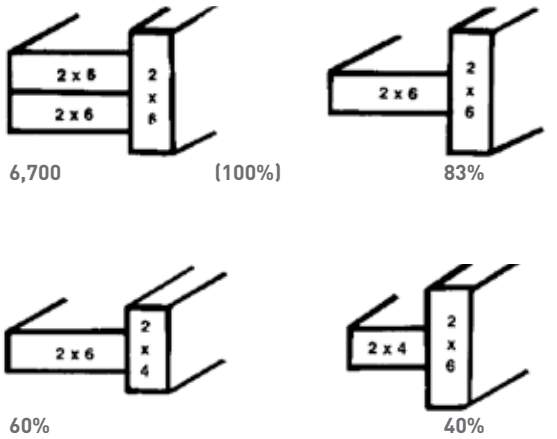
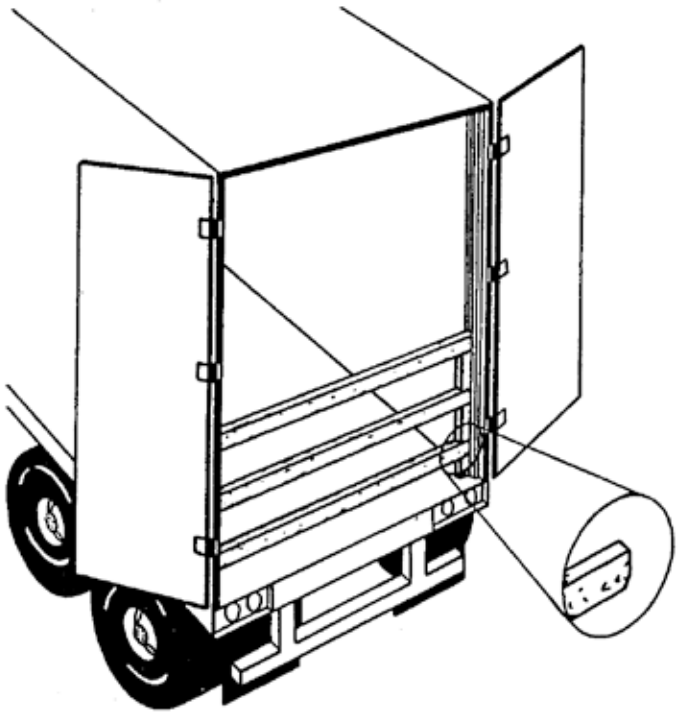
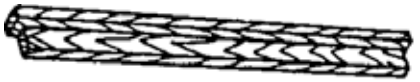


FIGURE 5.23 Nail Every 8"



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

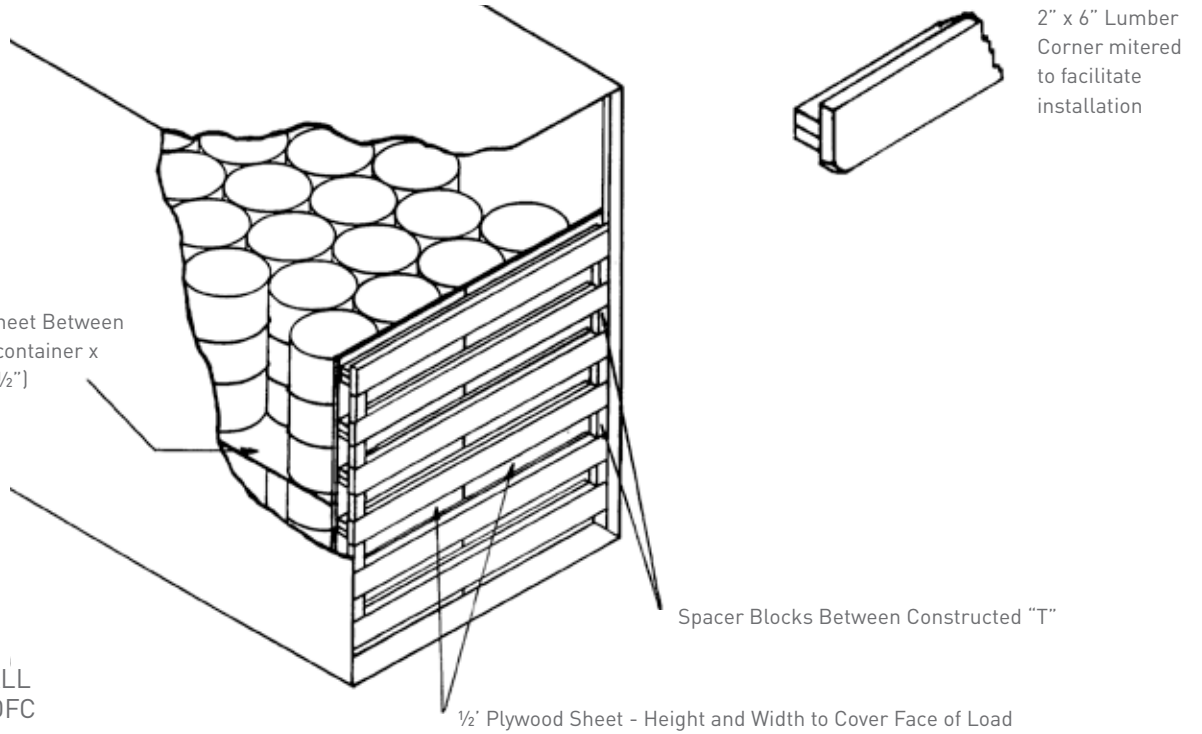
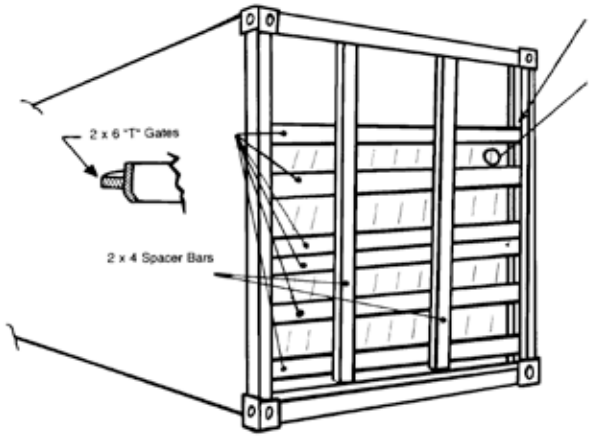


FIGURE 5.25 MODES - ALL
For Rail COFC



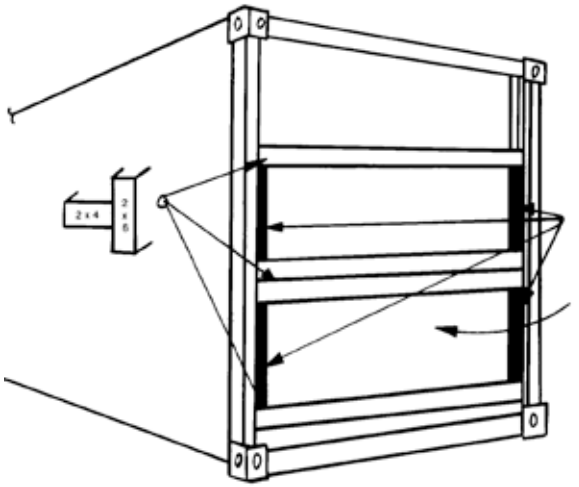
Fit 'T' gates to doorpost slots

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)

FIGURE 5.26 MODES - ALL
For Rail COFC



Spacers

Fill voids to load with spacer bulkheads or pallets

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.

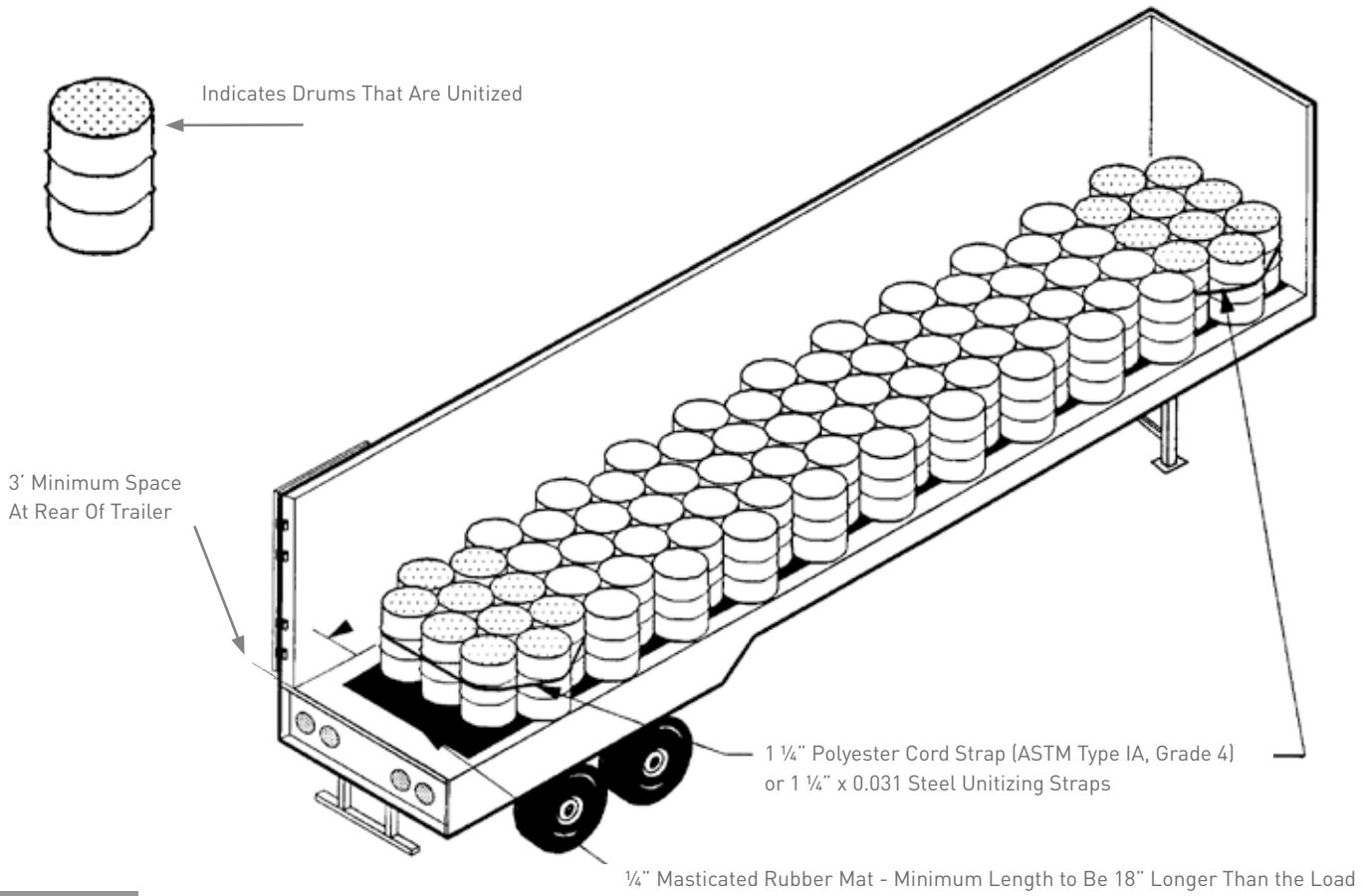

Indicates Drums That Are Unitized
3' Minimum Space
At Rear Of Trailer
1 ¼" Polyester Cord Strap (ASTM Type IA, Grade 4)
or 1 ¼" x 0.031 Steel Unitizing Straps
¼" Masticated Rubber Mat - Minimum Length to Be 18" Longer Than the Load

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 piont 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 lessor 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.

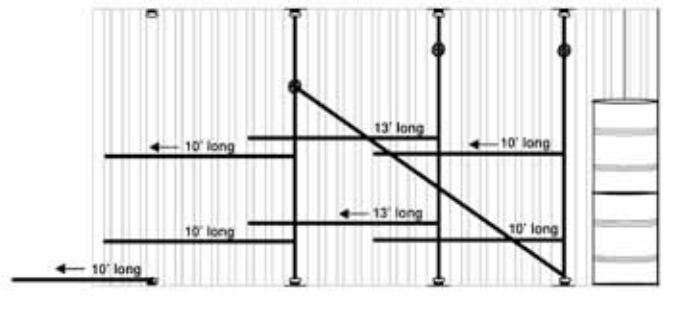
- Temporarily hold the ends of these lengths with tape or magnets to the corner of the container.
- Repeat for the other side of the container.

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.

a.



b.

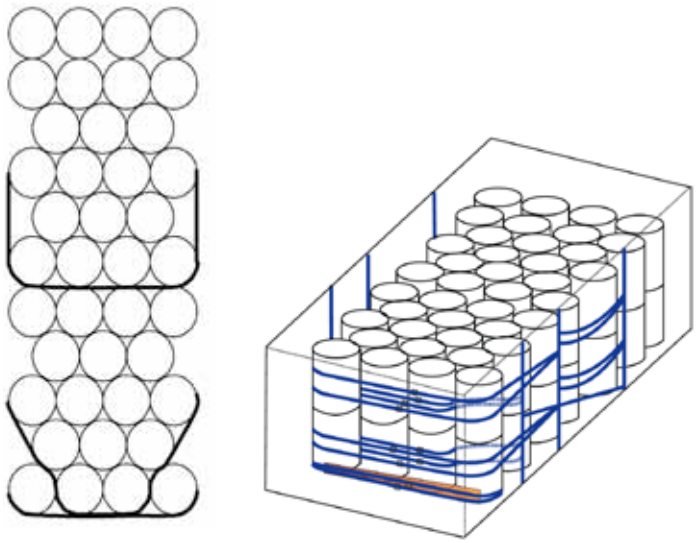


FIGURE 5.29

a. Typical Horizontal and Vertical Lengths of Strapping
b. Strapping System (22 straps, 14 buckles and one 2x4 Cut with Ends Cut at 45° Angle) Each Strap Requires Pnematic Tensioning Per Instructions.

APPENDICES

APPENDIX A

DEPARTMENT OF TRANSPORTATION CONTACTS

The following telephone numbers are current as of May 2010. However, they are subject to change. In that event, please contact the Department of Transportation Telephone Operator at (202) 266- 4000 for assistance.

Federal Railroad Administration
Hazardous Materials Division
RRS-12 Mail Stop 25
1200 New Jersey Avenue, SE
Washington, DC 20590
Phone (202) 493-6244
Fax (202) 493-6478
World Wide Web Address: www.fra.dot.gov

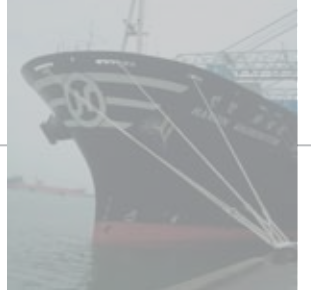
Federal Motor Carrier Safety Administration
United States Department of Transportation
1200 New Jersey Avenue SE
Washington, DC 20590
Phone 1 (800) 832-5660
Fax (202) 366- 7908
World Wide Web Address: www.fmcsa.dot.gov

U.S. Department of Transportation
Pipeline and Hazardous Materials Safety Administration
East Building, 2nd Floor
1200 New Jersey Ave., SE
Washington, DC 20590
Phone (202) 366-4433
Fax (202) 366-3666
Hazardous Materials Information (Toll Free): 1 (800) 467-4922
World Wide Web Address: www.phmsa.dot.gov

United States Coast Guard
Commandant, U. S. Coast Guard
2100 Second Street SW
Washington, D.C. 20593-0001
Assistant Commandant for Marine Safety and Environmental Protection
Office of Operating and Environmental Standards
Hazardous Materials Standards Division (CG-5223)
Phone (202) 372-1401
World Wide Web Address: www.uscg.mil

OR

Office of Compliance
Ports and Facilities Compliance Division (G-MOC-3)
Phone: (202) 267-6700
World Wide Web Address: www.compliance.gov/



APPENDIX B

SUMMARY OF PROCEDURES FOR OBTAINING APPROVAL OF NEW LOADING AND BRACING METHODS OR MATERIALS

FOR RAIL: Association of American Railroads (AAR) procedure for approval of railroad interchange.

The AAR procedure for obtaining approval of new loading and securement systems for use in rail shipments consists of two separate test programs. Both tests must be successfully completed to receive AAR approval.

The first test is an impact test. This test consists of controlled impacts at 4, 6 and a minimum of 6* mph into a string of five empty rail cars having standard draft gears and a minimum combined weight of 250,000 lbs., followed by a reverse impact (at the opposite end of the test car from the first impacts) at a minimum of 6* mph. In the case of TOFC/COFC impact tests, the first three impacts are done toward the doorway end of the trailer/container with the doors open. The procedures for conducting the test are outlined in greater detail in the AAR General Information Bulletin No. 2, "Rules and Procedures for Testing New Loading and Bracing Methods or Materials."

If the new loading and securement system successfully completes the impact test, the second test program requires a series of test shipments. Sufficient cars or trailers/containers must be shipped using the proposed system to produce a minimum of twenty-five usable reports. The reports must be complete in detail to permit accurate evaluation of performance.

As an alternate to the foregoing 25 test shipments, the AAR may request that the system be tested under AAR Procedures for Simulation Testing of New Closed Car, Trailer or Container Loading and Bracing Methods or Materials. The procedures presently require simulation testing of one test load on the Vibration Test Unit at the AAR Transportation Test Center.

When the test has been completed, a report summarizing the test performance is prepared by the AAR for consideration by the appropriate AAR committees. Authority for approval rests with the AAR and/or the designated AAR committee.

* For the approval of methods used to load and brace explosives, the final forward impact and reverse impact must be a minimum of 8 mph.

The criteria for acceptance by railroads were as follows:

(a) There shall be no loss of contents from, serious damage to, or serious deformation of packages.

(1) Serious damage is defined as a package condition such that the package is leaking or cannot be safely forwarded, stacked, or stored in a warehouse.

(2) Serious deformation is defined as a package condition such that the package is damaged to such an extent there is reasonable probability of leak without further impact.

(b) There shall be no damage to transportation equipment that precludes reuse without repair.

(c) The blocking and bracing system shall not show appreciable loss of ability to restrain the lading.

By agreement with the AAR, load securement methods for use in rail shipments were evaluated using three basic load types. They were 55-gallon steel drums in a 4-3-4 load pattern and a 4-4 load pattern and mixed loads. An impact test on mixed loads was not required for any securement method successfully impact tested with a 4-4 drum pattern.

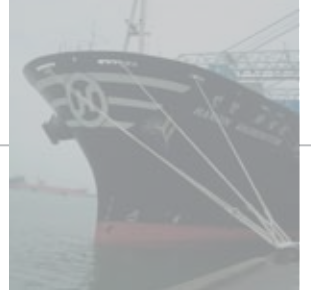
Methods approved for steel drums were also considered approved for poly drums unless there was some indication that a problem might exist with poly drums for a specific method.

FOR HIGHWAY: Federal Motor Carrier Safety Regulations 49 CFR 393.104

Protection against longitudinal movement - When a motor vehicle carries cargo that is not firmly braced against a front-end structure..., the cargo must be secured so that, when the vehicle decelerates at a rate of 20 feet per second the cargo will remain on the vehicle and will not penetrate the front end structure.

Protection against lateral movement - When a vehicle carries cargo that may shift sideways in transit, the cargo must either be securely blocked or braced against the sides, sideboards, or stakes of the vehicle or be secured by devices...

FOR MARITIME: Maritime securment requiremets adhere to 49 CFR 176.76. Additionally IMDG can be applied which are both performance based guidelines. The test shipments should be sufficient in number to test the system's performance under varying factors normally associated with containerized shipments in maritime transportation, especially environmental and physical conditions. Environmental conditions include differing temperature, humidity, sea state, ocean route, voyage duration, and other natural conditions that cargo securing systems



normally would experience. Physical conditions include differing container stowage locations relative to the vessel's center of gravity (i.e. longitudinal, transverse and vertical), methods of container securement to the vessel, etc. Successful shipments may be considered those that demonstrate:

- No loss of contents from or significant deformation of packages;
- No damage to transportation equipment, including container deformation, that precludes reuse without repair or inhibits container handling operations; and,
- No appreciable loss of restraining system's ability to restrain the lading.

APPENDIX C

TRANSPORT EQUIPMENT DATA

For specifics see The Official Intermodal Equipment Register

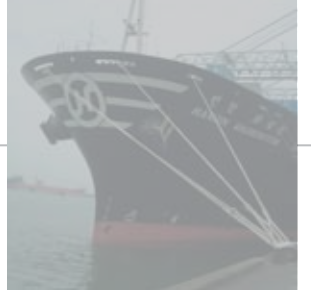
DRY CARGO GENERAL PURPOSE

INTERMODAL CONTAINERS

Exterior Dimensions (feet) W x H x L	Interior Dimensions (inches) W x H x L	Approx. Cube (cu. ft.)	Approx. Cargo Capacity (LBS.) *	Door Opening (inches) W x H	Tare Weight (LBS.)
8' x 8'6" x 40'	92" x 94" x 474"	2,380'	58,000	89" x 84"	8,700
8' x 8'6" x 20'	92" x 94" x 232"	1,172'	40,000	92" x 90"	4,400
8' x 8' x 6'8"	90" x 85" x 73-1/2"	329'	16,000-18,000	Various	
8' x 8' x 5'	90" x 85" x 54-1/8"	248'	12,000	Various	
8' x 8'6" x 24'	92" x 94" x 282"	1,415'	48,000	90" x 89"	4,100
8' x 9'6" x 45'	92" x 106" x 533"	3,008'	56,000	92" x 101"	10,800
8'6" x 9'6" x 48'	98" x 106" x 568"	3,434'	57,000	98" x 105"	9,700
8'6" x 9'6" x 53'	99" x 107" x 631"	3,830'	56,000	98" x 103"	10,200

*Cargo container manufacturer's rating only. Over the road capacity may be lower due to equipment choice and state regulations.

Figures are not exact. Weights shown are guidelines and highway limitations may reduce payloads to 50,000 pounds.
The high cube unit is suitable only for U.S. because road, rail, and bridge clearances allow overall height of 13'6".



VAN TRAILERS - COMMON SIZES AND WEIGHTS Includes - Container Chassis and Tractors for Estimating

Common Type	Exterior Dimensions L x W x H (feet)	Normal Interior W & H (inches)	Door Opening W x H (inches)	Approximate Tare (lbs.)
Highway - Van Trailer - ATA Type				
28'	28' x 8' x 13'6"	92" x 104"	92" x 102"	6,800
40'	40' x 8' x 13'6"	92" x 104"	92" x 102"	7,700
45'	45' x 8' x 13'6"	92" x 104"	92" x 102"	7,900
28'	28' x 8'6" x 13'6"	98" x 110"	98" x 108"	8,000
45'	45' x 8'6" x 13'6"	98" x 110"	98" x 108"	12,100
48'	48' x 8'6" x 13'6"	98" x 110"	98" x 108"	12,500
53'	53' x 8'6" x 13'6"	98" x 110"	98" x 108"	13,200
TOFC - Trailer AAR Type				
28'	28' x 8'6" x 13'6"	98" x 106"	98" x 108"	9,220
40'	40' x 8' x 13'6"	93" x 106"	92" x 103"	13,100
45'	45' x 8' x 13'6"	92" x 104"	92" x 102"	13,200
45'	45' x 8'6" x 13'6"	98" x 106"	98" x 104"	13,800
48'	48' x 8'6" x 13'6"	98" x 110"	98" x 110"	14,700
Container Chassis	20'	-	-	6,300
Tandem Axle	40'	-	-	7,000
Container Chassis	20'	-	-	9,000
Triaxle - Goose neck	40'	-	-	
Tractor - 2 Axle	-	-	-	12,000
3 Axle	-	-	-	15,000 - 16,000

CAUTION: There are many variations due to different types and state requirements. For greater detail see the manufacturer's data plate on the unit or applicable TTMA Recommended Practice Bulletins.

Notes: Design strength to withstand "G" factors as follows:

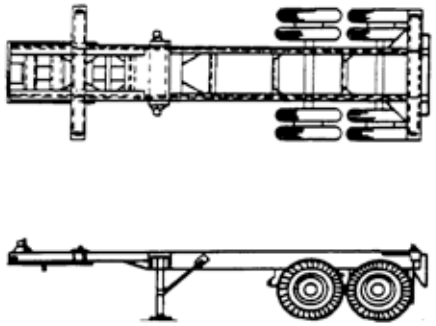
	Vertical	Lateral	Longitudinal
ATA Type	**1.0**	**0.4**	**3.5**
AAR Type	**1.7**	**0.3**	**3.5**

INTERSTATE DIMENSION AND WEIGHT LIMITATIONS

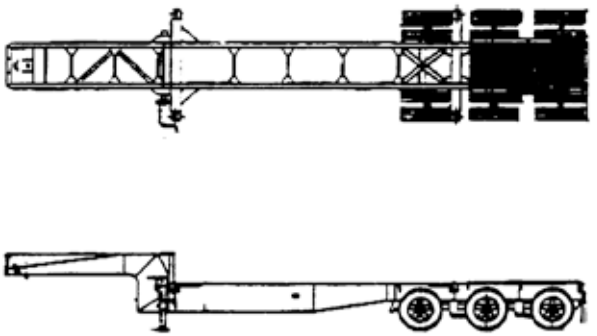
Dimension and weight limitations vary widely from state to state and are subject to many changes. For detailed current regulations consult the Truck Trailer Manufactures' Association (TTMA) or "Vehicle Size and Weight Manual", J.J. Keller & Associates.

In general:

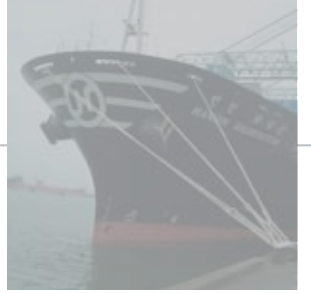
- Gross Loaded weight of tractor and trailer(s) is 80,000 lbs. Special permission is usually required for over 80,000 lbs.
- For Interstate and designated highways, most states do not impose an overall length restriction. However, several restrictions may apply to state and supplemental highways.



TANDEM AXLE CONTAINER CHASSIS



TRIAXLE CONTAINER CHASSIS



- 102" width is permitted on national highway network; however, many state/highways are limited to 96"

INTERSTATE SYSTEM LIMITS

Determining Maximum Weight

Bridge Formula

Federal law establishes the following maximum weight limits which states must allow on their portion of the Interstate System: single axle 20,000 lbs.; tandem axle 34,000 lbs., gross weight 80,000 lbs. (weights include, all enforcement tolerances). The maximum gross weight of a vehicle or combination is determined by the formula:

$$W=500\left[\frac{LN}{N-1}+12N+36\right]$$

W = Overall gross weight on any group of two or more consecutive axles to the nearest 500 lbs.

L = Distance in feet between the extremes of any group of two or more consecutive axles.

N = Number of axles in the group under consideration.

Exception: Two consecutive sets of tandem axles my carry a gross load of 34,000 lbs. each, provided the overall distance between the first and last axles of such consecutive sets of axles is 36 feet or more.

Basics in Understanding U.S. Size & Weight Limits for Over the Road Transportation

Definitions

Axles: Steel Shaft connecting the differential with the wheels.

Axle Load: Weight existing on a motor vehicle's axle; an axle weight limit on a highway refers to the maximum weight allowed on the truck's heaviest axle.

Axle Ratings: Rear axles on a truck generally carry three ratings: (1) carrying capacity rated at the ground (gaw rating); (2) total weight the axle is capable of carrying/pulling in service, gross combined weight (gcw rating): (3) the maximum horsepower limit the axle is capable of carrying in normal service (engine size rating.)

Tandem: Slang term for a tractor with two rear axles, both of which may be powered.

Tandem Axles: Pair of single axles mounted in suspension system, usually offer through drive with power equally divided between axles by interaxle differential mounted on front axle that transmits power to rear axle through a connecting shaft.

True Suspension Length: The least number of axles that may move a 20ft. General Commodity Ocean Container is three. The tire radius on U.S. designed equipment is approximately two feet. The average length of a tractor with a steering axle and a single non-steering axle is 19 feet. Separately, the length of the container and the tractor is 39 feet; however, the total length of the tractor when attached to a single non-steering axle, 20 foot chassis is 35 feet since the four feet of the non-steering axle on the tractor is under twenty foot chassis. Weight calculations must be measured by the gravity placed at the center of each axle. Since the tire radius is 2 feet, the length between the center of the two furthest axles on the unit must be considered to determine the length that the weight is truly suspended. Therefore, the true suspension length of the unit is calculated as follows:

35 feet – length from nose of the tractor to the far end of the chassis.
-2 feet – less length from the nose of the tractor to the center of the steering axle.
-2 feet – less length from the end of the chassis to the center of the furthest non-steering axle.

31 feet – TRUE SUSPENDED LENGTH

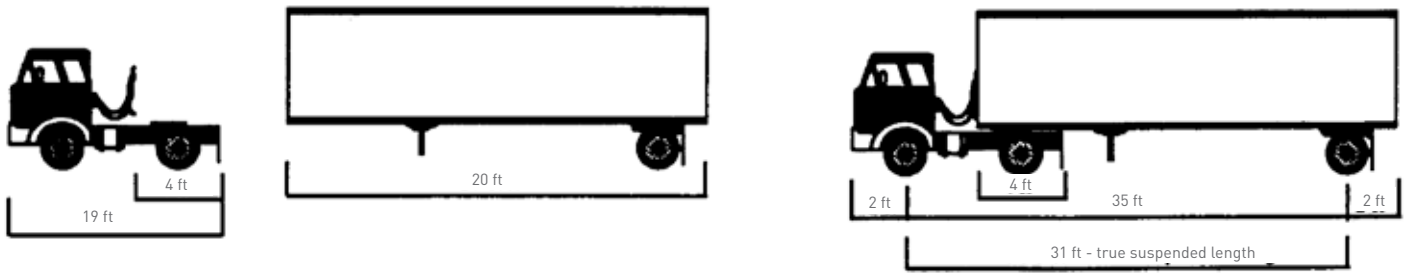
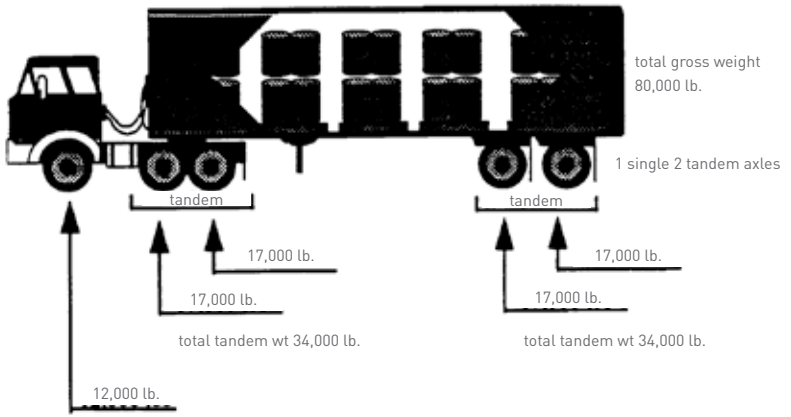


FIGURE 6.1

HOW TO KNOW IF YOU ARE WITHIN THE MAXIMUM WEIGHT REQUIREMENTS

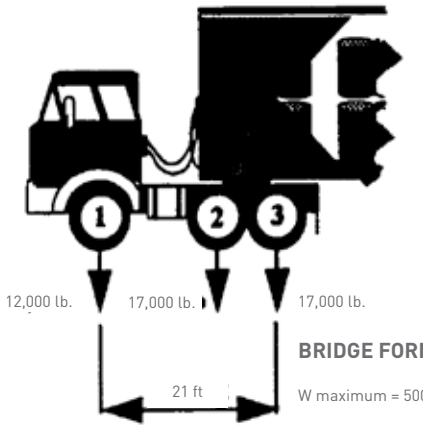


First: Check to see if total gross weight requirement is satisfied (maximum 80,000 lb. gross weight)

Second: Check to see if single and tandem gross weight requirements are satisfied (20,000 lb. maximum weight on single axle) and (34,000 lb. maxiumum weight on tandem axle)

Third: If both the first and second are within the permissible weight requirements, then the bridge formula must be applied. So far in our example, it meets the requirements.

FIGURE 6.2



BRIDGE FORMULA

$$W \text{ maximum} = 500 \left[\frac{LN}{N-1} + 12N + 36 \right] \text{ to the nearest 500 lbs}$$

W= (actual weight)
N=axels
L=feet between axles

FIRST CHECK

W (ACTUAL) = 12,000 + 17,000 + 17,000 = 46,000 lbs
N = 3 axels
L = 21feet

$$500 \times \left[\frac{21x3=63}{3-1 \quad =2} = 31.5+12N+36 \right]$$

$$500 \times \left[31.5+(12x3)+36=103.5 \right]$$

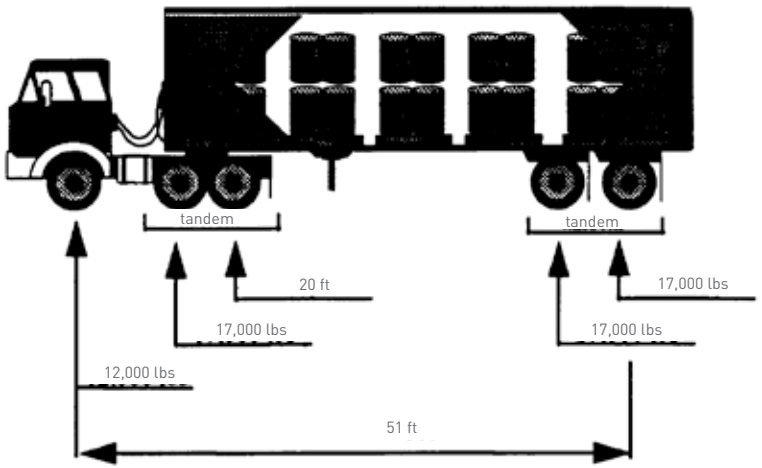
500 x 103.5=51,750 [to nearest 500lb=51,500]

OR

Obtain by looking at bridge table B (see attached) - 21feet by 3 axels at 46,000 lbs actual weight, we are okay in this example

FIGURE 6.3

Bridge Formula
First Bridge Formula Combination Check

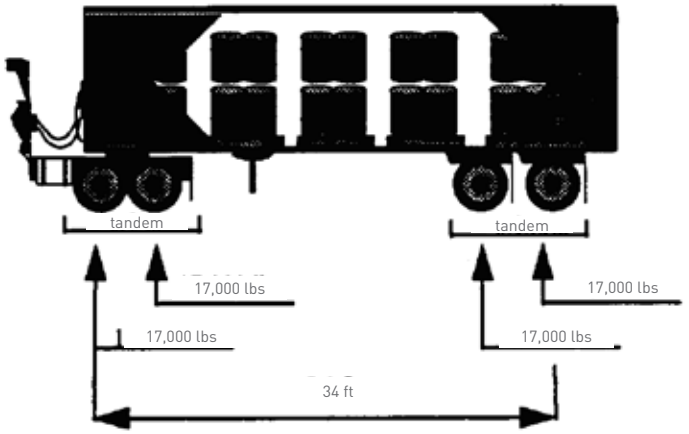


Actual weight = 12,000 + 17,000 + 17,000 + 17,000 + 17,000 = 80,000 lbs

Weight Maximum from Table B = L of 51 ft and N of 5 = 80,000 lbs

Since our actual weight of 80,000 does not go over the Maximum weight allowable this axle spacing is satisfactory.

FIGURE 6.4 Second Bridge Formula Combination Check
Checking axles 1 thru 5



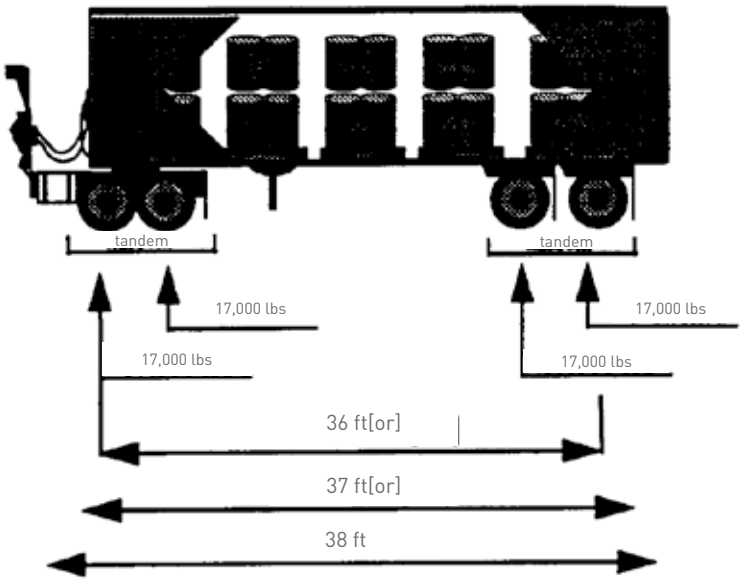
Actual weight = 17,000 + 17,000 + 17,000 + 17,000 = 68,000 lbs

Weight Maximum from Table B = L of 34 ft and N of 4 = 64,500 lbs

Since our actual weight of 68,000, this is a TILT or violation in that the actual weight exceeds the maximum allowed weight given for the axle spacing.

To correct, some load must be removed from the container or the axle spacing of 34 feet needs to be increased.

FIGURE 6.5 Last Bridge Formula Combination Check
Checking axles 2 thru 5



Actual weight = 17,000 + 17,000 +17,000 + 17,000 = **68,000 lbs**

Weight Maximum from Table B = L of **36 ft** and N of 4 = **66,000 lbs**
Weight Maximum from Table B = L of **37 ft** and N of 4 = **66,500 lbs**
Weight Maximum from Table B = L of **38 ft** and N of 4 = **66,500 lbs**

Normally, the above in all three cases would be over weight. However, the exception permits the following:

Two consecutive sets of tandem axles may carry a maximum gross load of 34,000lbs providing the overall distance between the first and last axles of each consecutive set of tandem axles is 36 feet or more.

Therefore, based on this exception, since the tandem axles do not carry a weight over 34,000 lbs. and the distance between the first and last axles of the consecutive sets of tandem axles are 36 ft or more, the above examples are permitted to ship based on the exception granted by Federal Law.

FIGURE 6.6

Exception to Bridge Formula & Table B
Two consecutive sets of tandem axles spaced 36 feet or more apart.

The Safety Approval Plate, conforming to the model reproduced below, shall take the form of a permanent, non corrosive, fireproof rectangular plate measuring not less than 200 mm x 100 mm. The words CSC SAFETY APPROVAL, of a minimum letter height of 8 mm, and all other words and numbers of a minimum height of 5 mm shall be stamped into, embossed on or indicated on the surface of the plate in any other permanent and legible way.

CSC SAFETY APPROVAL

1..... [GB-L/749/2/7/75]			
2 ..... DATE MANUFACTURED			
3 ..... IDENTIFICATION NO			
4..... MAXIMUM GROSS WEIGHT	kg	lb	
5 ..... ALLOWABLE STACKING WEIGHT for 1.8g	kg	lb	100mm
6 ..... RACKING TEST LOAD VALUE	kg	lb	
7.....			
8.....			
9.....			

200 mm

1. Country of approval and approval reference as given in the example on line 1. (The country of approval should be indicated by means of the distinguishing sign used to indicate country of registration of motor vehicles in international road traffic.)
2. Date (month and year) of manufacture.
3. Manufacturer's identification number of the container or, in the case of existing containers for which that number is unknown, the number allotted by the Administration.
4. Maximum operating gross weight (kg and lb).
5. Allowable stacking weight for 1.8g (kg and lb).
6. Transverse racking test load value (kg and lb).
7. End wall strength to be indicated on plate only if end walls are designed to withstand a load of less or greater than 0.4 times the maximum permissible payload, i.e. 0.4P.
8. Side wall strength to be indicated on plate only if the side walls are designed to withstand a load of less or greater than 0.6 times the maximum permissible payload, i.e. 0.6P.
9. First maintenance examination date (month and year) for new containers and subsequent maintenance examination dates (month and year) if plate is used for this purpose.

LOAD PLANNING FORM

NOTE: This form is set up for an 80,000 lb. Gross 40 ft. container or trailer. Make suitable adjustments for other equipment.

Step 1: Check tares to assure the load is legal

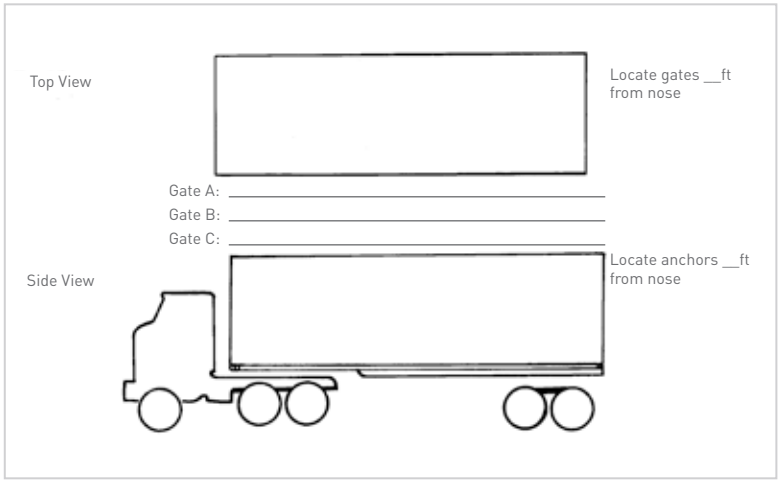
Tractor:_____
Trailer or Chassis Tare:_____
Allowable Weight is 80,000-(Tare) _____
Good for up to 52,000 lbs.
Container: _____
Total: _____

Step 2: Select restraint system:

METHOD: _____
__Toe Boards
__Unitizing
__Ty-Gard
__Web Strap
__T-Gates
__Matting

Anchor type: _____

Step 3: Lay out load approximately to scale. Follow the rules.



Step 4: Specify lading protection. Bulkhead, protectors, cushioning at Gate A.

_____

_____

_____

Step 5: Recheck key loading rules. All load rules are met.

APPENDIX D

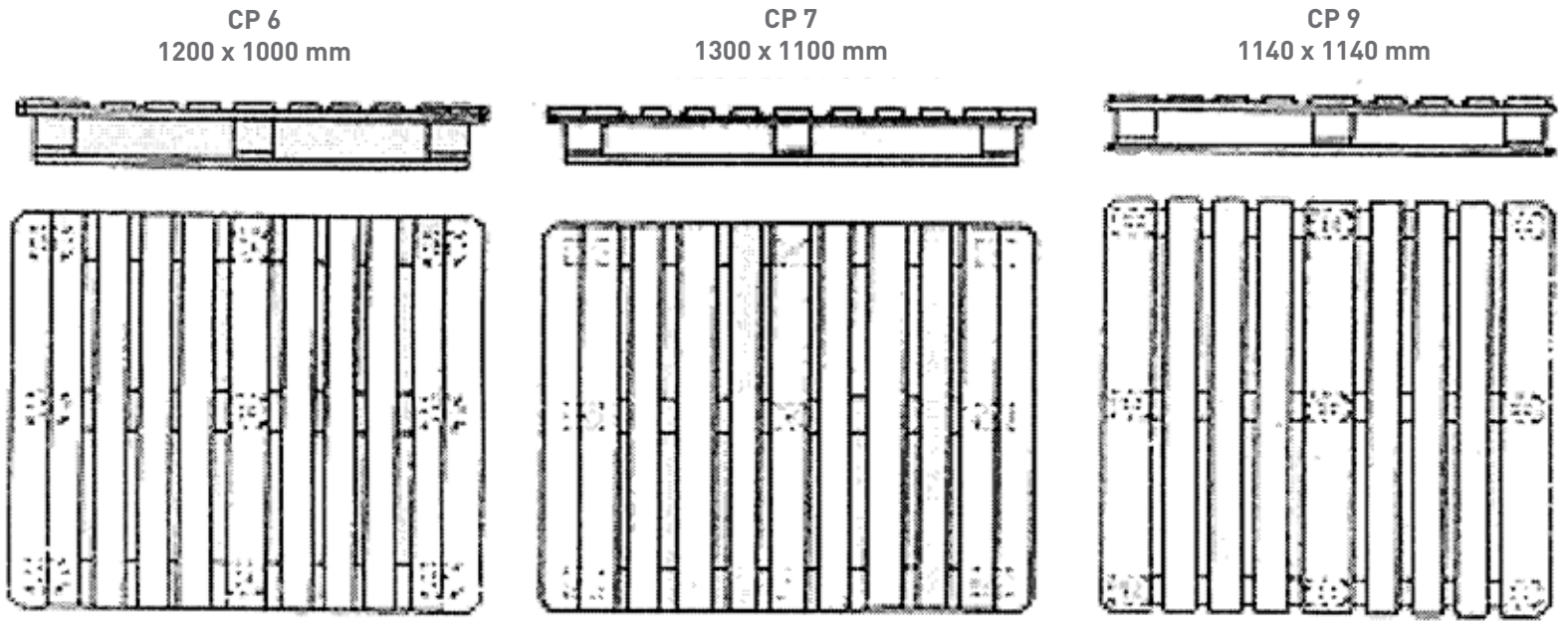
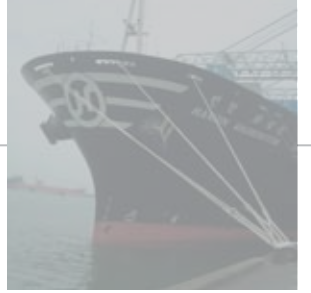


FIGURE 6.7 CP PALLETS

*Pallets Must meet ISPM-15 and IPPC international Guidelines



CPC PALLET STANDARDIZATION TASK GROUP

CHEMICAL INDUSTRY SHIPPING PALLET GUIDELINES

1. Recommended nominal base dimensions ± 3 mm (1/8") tolerance:
   1200 x 1000 mm 1300 x 1100 min 1140 x 1140 min
   NOTE: US equivalent nominal sizes
   48" x 40" 52" x 44" 45" x 45"
2. Maximum recommended platform height: 15 5 mm (6").
3. Square 'in each direction.
   NOTE :The difference in length of the two diagonals should not exceed 13 mm(1/2")
4. Four way, partial four way, or two-way entry.
5. Should be capable of accommodating pallet jacks.
   NOTE: For acceptable performance it isrecommended that pallet jack openings have a minimum width of 305 mm (12") and a minimum height of 95 mm(3 3/4") when under maximum load. The bottom surface should have 305 mm (12 ") square openings properly placed for pallet jack wheels. The center support should be a maximum of 155 mm (6") wide.
6. Top and bottom bearing surfaces should be designed to support the intended weight and package type; be flat, non skid and have no indentations or protrusions that could cause product damage.
   NOTE: For acceptable performance it is recommended that the top bearing surface have a minimum coverage of 62 percent and the bottom bearing surface have a minimum coverage of 45 percent.
7. Maximum recommended deflection of loaded pallet if racked: 12 mm (1 /2").
8. No protruding fasteners.
9. Should be made of recyclable materials.
10. Compatible in at least one direction with pallet conveyors, dispensers and automatic storage/retrieval systems.
11. Minimum recommended load capacity: One metric ton.
12. Should be capable of multiple stacking.
13. Should be capable of multiple trips.
14. Should be capable of safely moving product through its entire distribution system.

APPENDIX E

GLOSSARY

Definitions given are for the purposes of this guide only and may differ from those in other publications, federal regulations and international codes.

DEFINITIONS

BLOCKING Restraining the movement of lading via securement to or at the floor using wood, metal, or other materials.

BOX Common terminology describing intermodal container. Also, a rigid packaging completely enclosing the contents - wood, fiber or metal.

BRACING Restraining the movement of lading via the securement above the floor using wood, metal, or other materials.

BREAK BULK Both a verb and a descriptive noun. As a verb: to unload and distribute a portion of all of the contents of a container or vehicle. As a noun: a load in a container which is packaged individually and is sometimes not all of one type. Often used in reference to LCL (less than container load) or LTL (less than truckload).

BULKHEAD Strong wood or other material to secure or separate sections of cargo within transportation equipment.

BULL BOARDS Heavy boards designed to fit in channeled posts of transportation equipment as part of a restraint system.

BULL RINGS Securing devices mounted in the floor or wall of containers which provide anchor for the lashing and securing of freight.

CARGO Lading; the product or products being transported.

CARRIER A company or person engaged in the transportation of cargo, such as a common carrier, contract carrier, private carrier, or other transportation company.

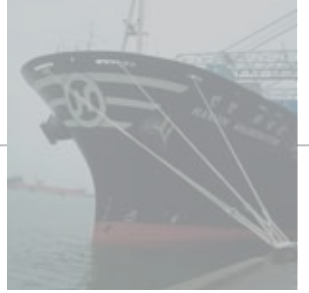
CHASSIS A trailer constructed to accommodate containers which are moved over-the-road.

COFC-(Container on Flat Car) Intermodal container on a railroad flat car.

CONSIGNEE The company or person to whom articles are shipped (also receiver).

CONTAINER See intermodal container.

CP PALLETS Chemical industry block pallets, manufactured and reconditioned according to standards and metric measurements as developed by European chemical manufacturers. Now available in the US and used by shippers for pallet loads going to European Union countries.



CONTAINERIZATION Stowage of general or specific cargos in a container for transport in the various modes.

CUSHIONING Protection from physical damage to the packages by material designed to absorb shock caused by external forces.

DANGEROUS GOODS Articles or substances which are capable of posing a significant risk to health, safety or to property when transported by ground, air and water and which are classified according to the regulations in Title 49 CFRor international standards such as the International Maritime Dangerous Goods Code. (See also Hazardous Materials)

DISTRIBUTION CYCLE The series of transportation and warehousing events which occur during the movement of cargo from point to point; includes points of shipment, loading, discharge, deconsolidation, storage, delivery, and consignment.

DIVIDERS Material or device used to separate sections of different packages in a load. Not a restraint system.

DRUM PROTECTORS Strong material used to spread bracing loads from restraint system components, to reduce damage to drum. May take form of 2 x 4 wood, fiber corner boards or fiber tube segments. Usually full height, they may also be used to support restraint straps.

DUNNAGE Material used in blocking, flooring, restraining, securing or lining, as racks, standards, strips, stakes or similar bracing, or supports not constituting a part of the carrying vehicle used to protect and make freight secure in, or on a carrying vehicle.

FILLER Material to eliminate or minimize voids in a load - may be corrugated, pneumatic or other; dunnage materials.

FILLER DECKING Wood (board or sheets), fiberwood (corrugated or solid) or composite wood/paper material used to separate layers.

G FORCE Acceleration of mass based on the standard acceleration (1G) due to gravity of 32 feet per sec.2 (9.8 meters per second2) e.g., For a cargo mass weighing 4000 pounds experiencing a 3G acceleration (3 times the gravitational acceleration) the G force exerted by the cargo mass is: 4000 pounds x 3G = 12,000 pounds.

GATE OR BARRIER The load restraint for a section of cargo. May be a bulkhead, blocking or other restraint system.

HAZARDOUS MATERIALS A substance or material determined by the U.S. 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 Title 49 Code of Federal Regulations. (See also Dangerous Goods).

ISPM - International standards for phytosanitary measures are prepared by the International Plant Protection Convention

INTERMEDIATE BULK CONTAINER (IBC) A rigid or flexible portable packaging, other than a cylinder or portable tank, which is designed for mechanical handling. IBC's manufactured in the United States may have a volumetric capacity of not more than 3000 liters (793 gallons) and not less than 450 liters (119 gallons), as specified in subparts N and O of Part 178 to Title 49 Code of Federal Regulations.

INTERMODAL A derivative of the word "modality", meaning "type of"; used to describe the movement of a particular load of cargo via more than one "type of" transport, that is, maritime, rail, and truck (see Unimodal).

INTERMODAL CONTAINER A reusable container manufactured to standard dimensions of 20' or 40' intended to unitize cargo or freight for shipping by one or more modes of transportation without the need for intermediate handling of the contents.

LADING Freight which constitutes a load.

LATERAL Direction relative to either the container or the transportation carrier. With respect to an intermodal container or truck trailer: refers to the crosswise or transverse direction (i.e. along the width). With respect to force or movement during transportation: refers to horizontal, side-to-side force or movement in a direction perpendicular to the direction of travel of a motor vehicle, rail car or vessel.

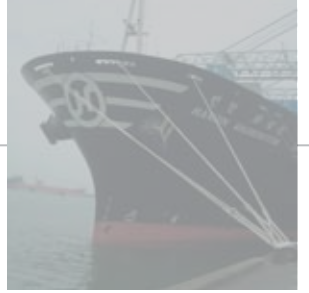
LOAD PLANNING A studied process whereby the goods to be shipped, the methods to be used in shipment, the stresses to be encountered, and the value of the goods are all considered in the design of a plan to minimize the potential for damage.

LONGITUDINAL Direction relative to either the container or the transportation carrier. With respect to an intermodal container or truck trailer: refers to the lengthwise direction (i.e. along the length). With respect to force or movement during transportation: refers to the direction of travel of a motor vehicle, rail car or vessel.

PACKAGE An "outside" packaging and its contents.

PACKAGING An assembly of one or more components necessary to assure compliance with the minimum packaging requirements of Title 49 Code of Federal Regulations and/or the international codes.

PACKAGING MATERIAL Each separate and distinct material which by itself or in combination with other materials, forms a package component.



RESTRAINT SYSTEM A method used in securing or controlling movement of the load in the transportation equipment to prevent damage to the load or the equipment.

RISER Materials (usually wood) applied beneath alternate stacks or rows of steel drums to decrease impact damage. May also be used to enable mechanical equipment entry.

ROLLING STOCK A generic term used to describe railcars.

ROLL ON - ROLL OF (RO-RO) Specific vessels are designed to load full trailers. Used primarily in locations with limited crane lift capacity such as ports in Puerto Rico and Alaska.

ROW A single line of shipping containers running lengthwise of the transit equipment and parallel to side wall. May be one or more high.

SECUREMENT Methods used to restrain the movement of lading within a container or vehicle during transportation.

SEPARATOR Any material placed between packages.

SHIPPER The originator of a shipment (also consignor).

STACK A single line of shipping containers running across the transit equipment. May be one or more high.

TRAILER-ON FLAT CAR (TOFC or pig) Trailers or chassi mounted containers transported on railway flat cars. Also known as piggy-back. Useage of TOFC is considerably less than COFC.

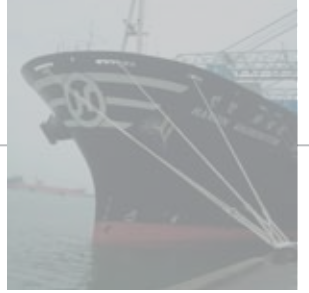
UNIMODAL The movement of a particular load of cargo via only one type of transport, that is, ocean, rail, or truck.

UNITIZED LOAD One or more packages retained on a pallet, slip sheet or other suitable base by gluing, interlocked stacking patterns, wrapping, strapping or other means for handling as a single unit.

APPENDIX E

ACRONYMS

AAR	Association of American Railroads
ABS	American Bureau of Shipping
ASTM	American Society of Testing and Materials
CFR	U. S. Code of Federal Regulations
COFC	Container on Flat Car
CPC	Chemical Packaging Committee (of the Institute of Packaging Professionals)
DOT	U.S. Department of Transportation
FHWA	Federal Highway Administration (of the U.S. DOT)
FIBC	Flexible Intermediate Bulk Container
FMCSR	Federal Motor Carrier Safety Regulations
FRA	Federal Railroad Administration (of the U.S. DOT)
IOPP	Institute of Packaging Professionals
IBC	Intermediate Bulk Container
ILO	International Labor Organization
IM	Intermodal
IMDG	International Maritime Dangerous Goods (as in IMDG code
ISPM-15	International Sanitary Plant Materials (International standards for phytosanitary measures)
IMO	International Maritime Organization
LTL	Less-Than-Truckload
NCB	National Cargo Bureau
NOM	Norma Oficial Mexicana
PHMSA	Pipline and Hazardous Materials Safety Administration (of the US DOT)
RIBC	Rigid Intermediate Bulk Container
RORO	Roll-on Roll-off
RTAC	Road and Transportation Association of Canada
SAP	Safety Approval Plate
SOLAS	International Convention for the Safety of Life at Sea
TDG	Transportation of Dangerous Goods
TOFC	Trailer on Flat Car
TTMA	Truck Trailer Manufacturers Association
UN	United Nations
USCG	United States Coast Guard
VOHMA	Vessel Operators Hazardous Materials Association



APPENDIX F

Suppliers of materials for loading, blocking and bracing can be easily found by an internet search using the appropriate key words.

INTERNET SEARCH KEY WORDS

Air Compressors

Angleboard

Beam End Sockets

Beverage Bulkheads

Bulk Containers

Bulk Containment (Grain) Doors

Bulkheads

Bulkheads(Pre assembled)

Car Liner Sheets

Cargo Restraining Devices

Core Plugs

Corner Protectors

Contour Buffer Pads

Cushion Contour Polyfoam Pads

D.I.D. Bags

Doorway Protection Strips

Edge Protectors (Coils and Rolls)

Friction Panels

Industrial Tapes

Load Bars

Load Cushioners

Masticated Rubber

Metal Blocking Devices

Non woven Strapping

Paperboard Products

Plastic Strapping

Rebonded Rubber Pads

Risers

Rubber Dunnage Bags

Rubber Mats

Shipping Separators Sheets

Shoring Beams

Slip Sheets

Steel Strapping

Strap Anchors

Strap Assemblies

Stretch Wrap Equipment and Film

Thermal Barriers

Trailer Liners

Top Caps

Ty-Gard2000®

Void Fillers

Winches

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Code of Federal Regulation, Title 49, Parts 100-199 and Parts 390-397, Superintendent of Documents, U.S. Government Printing Office, Mail Stop SSOP, Washington, D.C., 20402-9308.

Container Packing, Hapag-Lloyd AG, Cargo Service

Containers in Ocean Transport, National Cargo Bureau, Inc., 30 Vesey Street, New York, New York 10007

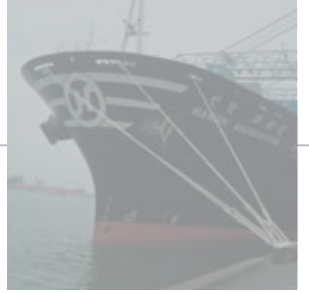
IMO/ILO/UN ECE Guidelines for Packing of Cargo Transport Units (CTUs), MSC/Circ.787 2May 1997, IMO, 4 Albert Embankment, London SEI 7SR, United Kingdom.

IMO Publications Catalogue, IMO, 4 Albert Embankment, London SEI 7SR, United Kingdom.

International Maritime Dangerous Goods Code, IMO, 4 Albert Embankment, London SEI 7SR, United Kingdom.

NOM, SECOFI, Direccion General de Normas (DGN), Puente de Tecamachalco Nr.6, Col. Lomas de Tecamachalco, Tecamachalco Estado de Mexico.

The Official Intermodal Equipment Register, Intermodal Publishing Company, Ltd., Agent R.P. DeMarco, Issuing Officer, 424 West 33rd Street, New York, New York 10001 (1/94)



Rules for the Certification of Cargo Containers, American Bureau of Shipping, ABS Plaza, 16855 Northchase Drive, Houston, TX 77060.

Shippers Guide for Proper Stowage of Intermodal Containers with Emphasis on Ocean Transport, National Cargo Bureau, Inc., 30 Vesey Street, New York, New York 10007.

Standard Practices for Securement of Cargo in Intermodal and Unimodal Surface, American Society of Testing and Materials (ASTM Standard D5728 -series), ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19248.

Stowage and Segregation Guide to IMDG Code, K.O. Storck Verlag, Publishers, Striepenweg 31, D-21147 Hamburg.

Transportation of Dangerous Goods, Director General, Transport Canada, Place de Ville, Ottawa, Ont. K1A 0N7

Truck Trailer Manufacturers Association - TTMA, 1020 Princess Street, Alexandria, VA 22314- Various Recommended Practices pamphlets.

Vehicle Sizes and Weights, J.J. Keller and Associates, 145 West Wisconsin Avenue, Neenah, WI 54956.