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Standard Practices for Securement of Cargo in Intermodal and Unimodal Surface Transport[1]

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1. Scope

1.1 These practices are intended to serve as a guide to shippers, carriers, and consignees for load planning, loading, blocking, and bracing of intermodal and unimodal cargo in surface transport. The practices are referenced to a bibliography of information concerning the above. Hazardous materials, bulk cargo, non-containerized break bulk in ocean carriage, and transport of cargo by air are not included in these practices at this time.

1.2 These practices shall apply to cargo in surface transport on flat bed, open top, box car, truck, van, and intermodal containers.

1.3 The practices are intended to form a framework for the safe and effective loading and unloading of cargo in intermodal and unimodal surface transport. They are not intended to provide comprehensive detail relating to specific types of cargo, but will reference to source materials wherein such detail may be found.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D996 Terminology of Packaging and Distribution Environments

D4675 Guide for Selection and Use of Flat Strapping Materials

2.2 *Association of American Railroads Standards:*

Pamphlet No. 41 Dictionary of Standard Terms[3]

Manual of Standards and Recommended Practices, Section I[3]

Circular No. 43 Rules Governing the Loading, Blocking and Bracing of Freight in Closed Trailers and Containers for TOFC/COFC Service[3]

Intermodal Loading Guide for Products in Closed Trailers and Containers[3]

3. Terminology

3.1 *Definitions*—General definitions for the packaging and distributions environments are found in Terminology D996.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *blocking*—restraining the movement of lading via securement to or at the floor using wood, metal, or other materials.

3.2.2 *bracing*—restraining the movement of lading via the securement above the floor using wood, metal, or other materials.

3.2.3 *break bulk*—both a verb and a descriptive noun. As a verb, means to unload and distribute a portion or all of the contents of a container or vehicle. As a noun, meaning 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).

3.2.4 *bulk cargo*—freight not in packages.

3.2.5 *cargo*—lading; the product or products being moved forward.

3.2.6 *carrier*—any common carrier, contract carrier, private carrier, or other transportation company.

3.2.7 *consignee*—the company or person to whom articles are shipped (also receiver).

3.2.8 *container*—see *intermodal container* as differing from *shipping container.*

3.2.9 *distribution cycle*—the series of transportation and warehousing events which occur during the movement of cargo

[1] These practices are under the jurisdiction of ASTM Committee D10 on Packaging and are the direct responsibility of Subcommittee D10.25 on Palletizing and Unitizing of Loads.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from Railinc,7001 Weston Pkwy., Ste, 200, Cary, NC 27513. https://www.aarpublications.com/

from point to point; includes points of shipment, loading, discharge, deconsolidation, storage, delivery, and consignment.

3.2.10 *dunnage*—temporary material used in blocking, flooring or lining, 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. (See *loading* in Terminology D996.)

3.2.11 *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, ocean, rail, and truck (see *unimodal*).

3.2.12 *intermodal container*—a reusable container manufactured to standard dimensions intended to unitize cargo or freight for shipping by one or more modes of transportation without the need for intermediate handling of the contents. (See *container* in Terminology D996.)

NOTE 1—Throughout these practices, "container" should be understood as "intermodal container."

3.2.13 *lading*—freight which constitutes a load.

3.2.14 *lateral*—crosswise, or across the container. Lateral movement of lading describes a horizontal, side-to-side movement of lading in the transport vehicle.

3.2.15 *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.

3.2.16 *longitudinal*—lengthwise, or forward and back. Longitudinal movement of lading describes a horizontal, end-to-end movement of lading in the transport vehicle.

3.2.17 *packaging material*—see Terminology D996.

3.2.18 *rolling stock*—a generic term used to describe railcars.

3.2.19 *securement*—methods used to secure lading within a container or vehicle.

3.2.20 *shipper*—the originator of a shipment (also consignor).

3.2.21 *unimodal*—the movement of a particular load of cargo via only one type of transport, that is, ocean, rail, or truck.

3.2.22 *vehicle*—as opposed to an intermodal container, refers to a truck trailer or van, also, may be utilized in intermodal transport, such as TOFC (trailer on flat car) or COFC (Container on Flat Car).

4. Significance and Use

4.1 Numerous sources provide detailed information as to the loading, blocking, bracing, and unloading of specific types of cargo in unimodal and intermodal transport. Some of these sources are proprietary, others are massive and complex in scope, and none are consistently promulgated to shippers, carriers, and consignees. Many of the losses experienced by cargo in transport are due to the failure to practice proper basic cargo handling and loading techniques. These practices are intended to outline those techniques in simple, clear, generic, and easy to promulgate formats, including posters, slides, videotapes, and pamphlets, and are further intended to serve as the basis upon which a comprehensive cargo handling methodology may be built.

4.2 Users of these practices should avail themselves of the detailed resource information available. The practices as defined are not sufficient to form a complete cargo handling protocol.

5. Shipping Environment

5.1 *General*—Each method of transportation presents its own stresses and hazards to cargo in transport. During the design of a load plan, the types and degrees of stress most likely to be encountered should be considered. The following sections provide a general outline which indicates which stresses are most prevalent during each type of transport.

5.1.1 *Highway Transportation Hazards*—Vertical shocks caused by rough roads, bridge crossings, and other surface irregularities, are the primary hazard of this transport mode. Longitudinal shocks, caused by impacts against loading docks, coupling impacts, braking, and accelerations are the secondary hazard of this transport mode. Lateral and complex shocks occur when one side of the vehicle encounters a curb or other abrupt surface irregularity. Turning and cornering impose centrifugal forces and lateral shocks. Pavement joints and the natural harmonics of vehicle suspension may create dangerous vibrations. Generally, the most severe shocks in highway transport are vertical. Vibration input, particularly vertical, can be significant and sometimes greater than with other modes of transport. Road conditions, speed, and vehicle and cargo characteristics affect vibration input.

5.1.2 *Rail Transport Hazards*—Rail transportation subjects the cargo primarily to longitudinal shocks. These shocks occur routinely when railcars are coupled, and as slack in railcar couplings is taken up during braking and acceleration. Trailers or containers may be carried in backwards or in reverse direction. Vertical and lateral shocks are produced in much the same manner as highway transport. Physical characteristics of the railcar suspension system and track structure produce vibration, bounce, pitch, yaw, and roll. (Trailer on flat car (TOFC) will produce various combinations.)

5.1.3 *Ocean Transport Hazards*—Ocean transport subjects the cargo to lateral forces from vessel rolling. Rolls to 40° may be experienced in severe seas. A container on board a vessel may travel 70 ft with each complete roll, as often as 7 to 10 times per minute. The sway, pitch, surge, yaw, and heave of the vessel at sea also produce multi-directional forces. Vertical shocks are produced when the container is rapidly lowered and stacked, during vessel loading. It is important to remember that goods in ocean transport are subject to repeated stresses. Small voids tend to become large voids due to repetition.

5.1.4 *Terminal Handling*—The most severe shocks encountered in terminal handling of intermodal containers are generally vertical and occur during placement and movement during handling.

6. Intermodal Containerized Shipments

6.1 Containerized carriage of international cargo usually includes highway, railroad, and ocean transportation modes.

The container may be handled by many varied types of equipment, such as fork lifts, side loaders, straddle carriers and cranes. Each mode subjects the cargo to different, often severe, dynamic forces. A fundamental understanding of these forces is necessary to properly package and stow the cargo. The design criteria established by the International Organization for Standardization (IPSO) are based on load factors which indicate the most likely stresses to be applied to intermodal containers at their corner fittings (see 6.2.3). While these factors do not translate exactly to stresses on cargo within the containers, they do provide good indicators as to the degree and directions of stress most likely to be encountered and can be helpful in load planning.

6.2 *Design Characteristics of Intermodal Containers:*

6.2.1 Intermodal containers are manufactured to meet design criteria of the IPSO and classification societies such as the American Bureau of Shipping (A.B.S.). Some containers, which operate only in rail and highway modes, are manufactured to similar specifications of the Association of American Railroads (A.A.R.) Manual of Standards and Recommended Practices, Section I.

6.2.2 Containers are designed to carry a specified weight spread evenly over the entire surface of the floor. Design also contemplates concentrated loads, up to 12 000 lb, imposed by the load wheels of forklifts and similar equipment during loading operations.

6.2.3 Intermodal containers are handled and secured by their corner fittings. Containers are designed to withstand the forces of their maximum payload, multiplied by a design load factor. The following table sets forth IPSO Design Load Factors, used to establish the load acting through corner fittings:

Vertical (downward)	1.8
Longitudinal	2.0
Lateral	0.6

6.2.4 The end panels, doors, and side panels of general-purpose containers are capable of withstanding only a fraction of the payload and are intended primarily to provide a weathertight enclosure. The IPSO Design Load Factors are 0.6 and 0.4 for end walls (including doors) and side walls, respectively. Uniform distribution of the load over the entire panel surface is assumed.

6.2.5 General purpose dry containers, 20 and 40 ft, are the most common in intermodal service. Many specialized containers, including open-top and flat-rack types, are available for non-standard cargoes that may be oversized or require lashings which are not possible in general purpose containers.

6.3 *Load Planning and Cargo Securement:*

6.3.1 Improper stowage of cargo within the container often causes damage to the cargo and the container. Extreme cases have resulted in vehicle overturn, damage to other property, and personal injury. Proper stowage is the duty of the shipper or other party placing the cargo into the container. Liability for damages attributed to improper stowage may be imposed on the responsible party.

6.3.2 During rail carriage, containers may be oriented in either longitudinal direction for all or a portion of their journey. Normal transportation forces may shift unsecured load or cause the cargo to exert excessive pressure against the front panel, doors, or side panels. Therefore, it is imperative that containers moving in rail service be loaded in compliance with general rules published by Railinc in Circular No. 43. AAR Pamphlet No. 45, found in AAR Intermodal Guide, includes illustrations for various methods of blocking and bracing.

6.3.3 It is the shipper's duty to properly package, identify, and mark the cargo. Poorly packaged cartons, crates or other shipping units and cargo lacking handling instructions cannot be expected to survive the normal hazards of transportation, which may include transload from one container to another, during the distribution cycle. Generally, packages shall be capable of being stacked up to 8 ft (2.43 m) in height and to withstand lateral pressures up to 70 % of their weight. Machinery and other heavy items should be crated or boxed, but provided with skids to permit proper handling and stowage.

6.3.4 Planning the load shall include adherence to limitations of container capacity and floor-weight concentrations. Highway weight-axle limitations, on both sides of ocean or rail transport, shall also be determined because some containers have total capacities that exceed local permissible limits.

6.3.5 Weights should be equally distributed to avoid concentrations at one side or one end. Heavy items should be placed at the bottom, with lighter items on top. Heavy items with relatively small base may require placement on dunnage members to distribute the weight over a larger area.

6.3.6 Void spaces must be blocked, braced, or otherwise filled. Blocking may be necessary to properly secure the cargo and distribute potential loads to the container structure. The method used depends largely on the type of cargo and how it is packaged. Numerous commercial products, including air bags, bulkheads, separators, cushioning materials, strapping, anti-skid mats, and other products available to fill void spaces are available.

6.3.7 Cargo securing devices or permanent fixtures for the attachment of lashings, are optional under IPSO standards for general purpose containers. If provided, they must meet minimum rated load capacity of 1000 kg, if located in the base structure, or 500 kg if located in any part of the container other than the base structure.

7. General Guidelines

7.1 It is important to recognize that these guidelines are generic, and will need to be adapted in accordance with intermodal container and cargo manufacturer's specifications (when appropriate and available), shipping environments to be encountered, and specific standards as promulgated by various shippers and carriers for particular types of lading.

NOTE 2—For example, shippers sending goods by truck might be able to place less emphasis on blocking and bracing at the doors of a van than when they ship via ocean or rail. Ocean transport rarely presents problems with vibration, while truck and rail both present environments in which vibration may be significant.

7.2 The practices shall be considered within the context of the environments to be encountered, the cargo to be carried, and specific types of dunnage and packaging to be utilized.

7.3 It is important that shippers, carriers, and consignees utilize the reference materials available to gain guidance for the proper loading of specific cargos whenever this is possible.

7.4 Check the container or vehicle before loading to ensure the following:

7.4.1 *Water Resistant*— No holes in the body, doors, or door seals, using the following inspection techniques:

7.4.1.1 Stand inside of the container, close both doors tightly, and examine for any light coming through cracks, holes, door gaskets, etc. Do not utilize this technique without another person outside of the container.

7.4.1.2 Close the container, run a hard stream of water over all exterior surfaces, open container, and look for leaks.

7.4.2 *Clean*—No residue from previous cargo, such as dirt, oil, or odor.

7.4.3 *Dry*—No standing water, condensation, or frost.

7.4.4 *Secure*—Locking rods and handles function properly.

7.4.5 *Safe for Cargo*— No nails or other protruding objects, which might damage cargo.

7.4.6 *Structurally Sound*—No bent, twisted, or broken frames, rails, headers, or locking bars.

7.5 Check the cargo before loading. Do not load cargo which is wet, but supposed to be dry, or has damaged packaging.

7.6 Do not load the following:

7.6.1 Dust-sensitive goods with dusty (powderous) goods which might sift,

7.6.2 Odor-sensitive goods with odor-emitting goods,

7.6.3 Moisture-sensitive goods with goods giving off moisture,

7.6.4 Goods with protruding parts, sharp edges, or corners with goods in easily-punctured packaging, or

7.6.5 Wet goods in contact with dry goods.

7.7 To avoid condensation, keep all unnecessary moisture out of the container or vehicle, as follows:

7.7.1 Ensure that the container or vehicle is dry before loading.

7.7.2 Ensure that the cargo is dry before loading.

7.7.3 Ensure that the dunnage and the blocking and bracing materials are dry before loading. Make every effort to avoid the use of green wood in pallets, blocking, and crating.

7.8 As a general rule, place heavier packages below lighter packages.

7.9 Balance the load, that is, do not put all of the heavier packages at one end or to one side.

7.10 Brace the load if it looks likely to fall over.

7.11 Block the load if it looks likely to shift during transport.

7.12 Doorways should not be expected to restrain heavy loads. As a general rule, doors should be protected against shifting loads.

7.13 Blocking and bracing should be constructed to use the design characteristics of the intermodal container or vehicle. For example, instead of only nailing to the floor, also brace against the side wall, but never nail into side walls.

7.14 Inflatable dunnage bags should be used in accordance with the manufacturer's specifications and carrier rules. Generally, however, the following may apply:

7.14.1 Inflatable bags should not be used to fill voids of more than 12 in. (0.3 m), unless specified by the manufacturer.

7.14.2 Place buffer material between inflatable dunnage and lading.

7.14.3 Secure dunnage bags in place with tape or strapping.

7.15 Strapping, wrapping, and netting should be used in accordance with manufacturer's specifications (see Guide D4675).

7.16 Dunnage should be secured in place so that it cannot fall over and create a risk to personnel during loading or unloading.

7.17 Lading should be placed in the container so that unloading is facilitated. In short, do not place goods in the container in such a way that they cannot be easily and safely unloaded. Use caution when opening any vehicle or container door for unloading.

7.18 Flat goods which may fracture, like stone or glass, should be shipped vertically or in an "A" frame. Such goods should not be shipped flat.

8. Keywords

8.1 blocking; bracing; cargo; intermodal; intermodal container; lading; loading; restraint; securement; shipping environments; unimodal

APPENDIX

(Nonmandatory Information)

X1. PARTIAL BIBLIOGRAPHY OF LITERATURE CURRENTLY AVAILABLE—LOADING AND LADING STANDARDS, GUIDELINES AND RECOMMENDATIONS, AND CARGO LOSS PREVENTION RESOURCES

X1.1 *Container Packing*, Hapag-Lloyd, West Germany, 1990—A generic 33-page brochure, including numerous photographs, general guidelines, weight limits, measurements of stresses occurring during transit (rail, truck, air, sea, handling), climatic stresses, methods of securement, load planning, advice on packing, pallets and fork lifting, types of containers.

X1.2 *Intermodal Loading Guide for Products in Closed Trailers and Containers*, Damage Prevention and Freight Claim Committee of the Association of American Railroads, Railinc, Cary, NC —A generic reference containing three pamphlets: No. 45 which includes load planning, unitization, fillers, dividers and separators, and securement methods; AAR Circular 43–C, which includes the Rules Governing the

Loading, Blocking, and Bracing of Freight in Closed Trailers and Containers for TOFC/COFC Service; AAR Bureau of Explosives Pamphlet No. 6C on hazardous materials.

X1.3 *Closed Car Loading Methods*, Freight Claim and Damage Prevention Division of the Association of American Railroads, Washington, DC—Specific guidelines for particular types of freight in rail transit, including boxed, flat, barrelled, palleted, slip-sheeted, and other specific types of goods, and general guidelines for the loading of closed cars. Includes Pamphlet No. 41 on definitions.

X1.4 *Handling and Shipping Fresh Fruit and Vegetables by Rail* , General Information Bulletin #1, Damage Prevention Committee of the Association of American Railroads, Chicago, May 1976[3]—Specific information on load planning in refrigerated cars, along with guidelines for specific types of produce (temperatures and what can be mixed and what cannot). Also provides some general guidance on the loading of freezer cars.

X1.5 *Rubber Inflatable Dunnage*, published by ACME Products Division of Interlake Steel Corporation—How to use dunnage bags.

X1.6 *Proper Handling of Automobiles and Multi-Levels*—Chicago Northwestern System—A comprehensive and detailed publication on loss prevention and analysis regarding the transport of automobiles in multi-level cars in rail transport.

X1.7 *Recommended Practices for Motor Vehicle Loading/Unloading Operations and Securement* , Multi-Level Manual, Section II, Operations and Maintenance Department, Association of American Railroads, Washington, DC.[3]

X1.8 *Federal Motor Carrier Safety Regulations*, U.S. Department of Transportation, Sections 393.100-393-106.

X1.9 *General Rules Governing the Loading of Commodities on Open Top Cars*, Association of American Railroads, Washington, DC, 1989—A detailed guide with emphasis on securement, load distribution, loading guidelines for specific types of lading, the loading of commodities for COFC/TOFC transport.

X1.10 *An Assessment of the Common Carrier Shipping Environment*, USDA Forest Product Laboratory, 1979—Includes information on trucks, rail, aircraft, and ships; analysis of vibration data, handling data, shock, coupling, temperature, and humidity; compression, punctures, and abrasions.

X1.11 *Definition of Rail, Truck, and Ocean Shipping Environments*, Thomas E. Feltault, AAR (1992 ASTM, Subcommittee D10.24).

X1.12 *Design Characteristics of Intermodal Containers as They Apply to Loading, Blocking, and Bracing Requirements*, Paul R. Whittier, CMS-NAMS (1992 ASTM, Subcommittee D10.24).

X1.13 *International Maritime Organization (IMO) Code of Safe Practice for Cargo Stowage and Securing*, Nov. 6, 1991—General principals, securement systems, actions to be taken in heavy weather, securement on deck, securement of various types of specific cargo on board ship.

X1.14 *Damage Prevention and Freight Claim Section*, Association of American Railroads, Member Listing, published annually—A listing of damage prevention personnel from all American railroads.

X1.15 *Code of Safe Practice for Solid Bulk Cargoes*, as published by the Nation Cargo Bureau for the USCG via the Inter-Governmental Maritime Consultive Organization—Includes information on cargoes which may liquify and those possessing chemical hazards; specific properties of various cargoes carried in bulk.

X1.16 *TOFC Loading and Blocking Manual*, The Atchison, Topeka, and Santa Fe Railway Co.—Includes generic guidelines for TOFC traffic, COFC traffic, trailer and container component terms, narrative descriptions of intermodal environments.

X1.17 *Condensation Causes, Analysis, and Prevention*, Alan F. Spear, NAMS-CMS, Marine Surveyor, Davis and Company—Description of types and causes of condensation, preventative methods.

X1.18 *A Technical Summary of the Intermodal Environment Study*, John H. Blackman, AAR/Railinc (1990 ASTM, Subcommittee D10.24).