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

This standard is issued under the fixed designation D5728; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 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).

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[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/

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 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.