ICHCA
INTERNATIONAL

STOW IT RIGHT!

A guide to stowing of freight in freight containers

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Warning

This document provides a guide to planning the loading of cargo so that its shipment will be satisfactory to the shipper, carrier and consignee. It will also help in the prevention of damage to containers and their cargoes when travelling by road, rail, and particularly by ship. For detailed advice it is necessary to read this in conjunction with relevant national and international legislation and guidance.

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1. | Preface

The purpose of this document is to facilitate the proper loading, transport and discharge of freight containers. The information in this document will serve as a guide to planning the loading of cargo so that its shipment will be satisfactory to the shipper, carrier and consignee. It will also help in the prevention of damage to containers and their cargoes when travelling by road, rail, and particularly by ship.

The information in this document is of a general nature, as the many different commodities, types, sizes, shapes and modes of transport on which the cargo may be carried preclude publishing detailed recommendations. For detailed advice it is necessary to read this in conjunction with relevant national and international legislation and guidance. The guidance in this publication is recommendatory.

The IMO/ILO/UNECE Guidelines for Packing of Cargo Transport Units (CTUs) and the other publications listed at the end of this booklet should be consulted when planning and executing CTU operations. These contain guidance that is, in some cases, less onerous than that contained in this document. As an example, the IMO Guidelines state “In no case should more than 60% of the load be concentrated in less than half of the length of a container measured from one end.” whereas this publication recommends, for rail carriage of a laden container, that the weight of the load be evenly distributed from side to side and from end to end of the container and to a uniform height of loading (insofar as loading permits). This is that because of the additional problems that can arise due to vibration. Shippers should evaluate specific movements and take special precautions in the packaging, handling, stowing and securing of their cargo within containers.

Shippers are also advised that the internal dimensions of containers are not always the same. The external dimensions - minimum door opening width and height, and allowable maximum gross weight, are standardised but items such as payload (how much cargo can be loaded) and interior width may vary. If required, specific data on the container to be used can be obtained from the organisation supplying the container.

The aim of this document is to promote the proper loading of containers. However, it is recognised that sometimes, even when the best practices are followed, cargo can shift inside a container whilst that container is in transit. It is recommended that a safety strap be fitted between the inner-most locking bars of the container doors prior to the doors being unlocked. This will help to prevent the doors from springing open and causing injury to persons standing in front of them if the cargo has shifted and is applying pressure to the inside of the doors.

2. | Choosing the container

There are many types of containers available to cover virtually any shipping need. To achieve the most efficient use of a container during loading and unloading and as protection for the cargo during transit, care should be taken in selecting a suitable container. If the container is not ideally suited to the cargo, or if the cargo is stowed inappropriately in the container, major

delays (days or weeks) in delivery can occur. Four major considerations should be taken into account when choosing containers.

- Loading and unloading facilities
- Cargo environment
- Physical characteristics of the cargo
- Possible turn-out of the cargo by enforcement agencies

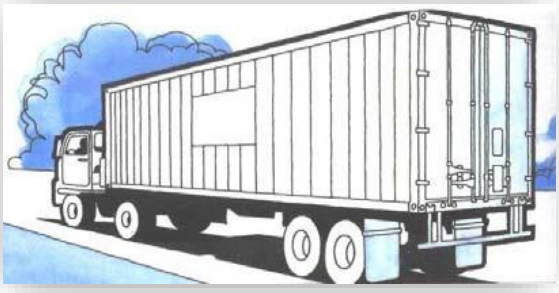
The physical characteristics of dry cargo, or restrictions at the loading/unloading facility, may require the use of special containers such as open-top or side loading flatbeds. Liquid bulk tanks and dry bulk units are specially designed for a variety of bulk commodities. If a temperature controlled environment is required, a refrigerated container should be used. Insulated/ventilated containers are also available for specific commodities.

Shippers should assess their total need and request the specific type of container to satisfy their cargo requirements.

Prior to loading, shippers should verify that the container:

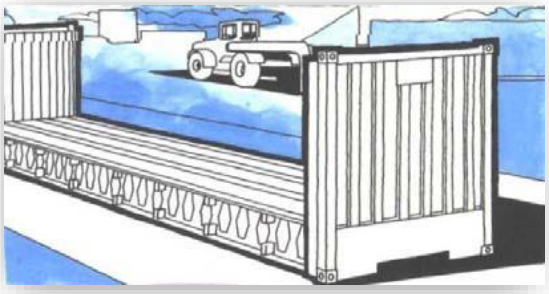
- has been properly ventilated and does not contain an atmosphere that is deficient in oxygen or contains hazardous vapours
- has a valid CSC (Container Safety Convention) plate
- is clean and dry inside without any protruding nails or other abnormalities in the floor or elsewhere that might cause damage to the cargo
- does not have anchor or lashing points at the floor edges that protrude into the cargo space and could potentially damage cargo
- has no placards, marks or signs on its exterior relating to previous cargoes
- is, or will be, properly placarded, marked and signed for the cargo being loaded and
- is in good visual condition

FIGURE 1: Typical container types



Typical ISO general purpose container

Typical ISO “reefer” container



Typical ISO “flat rack” container

Typical ISO open top container

Typical ISO tank container

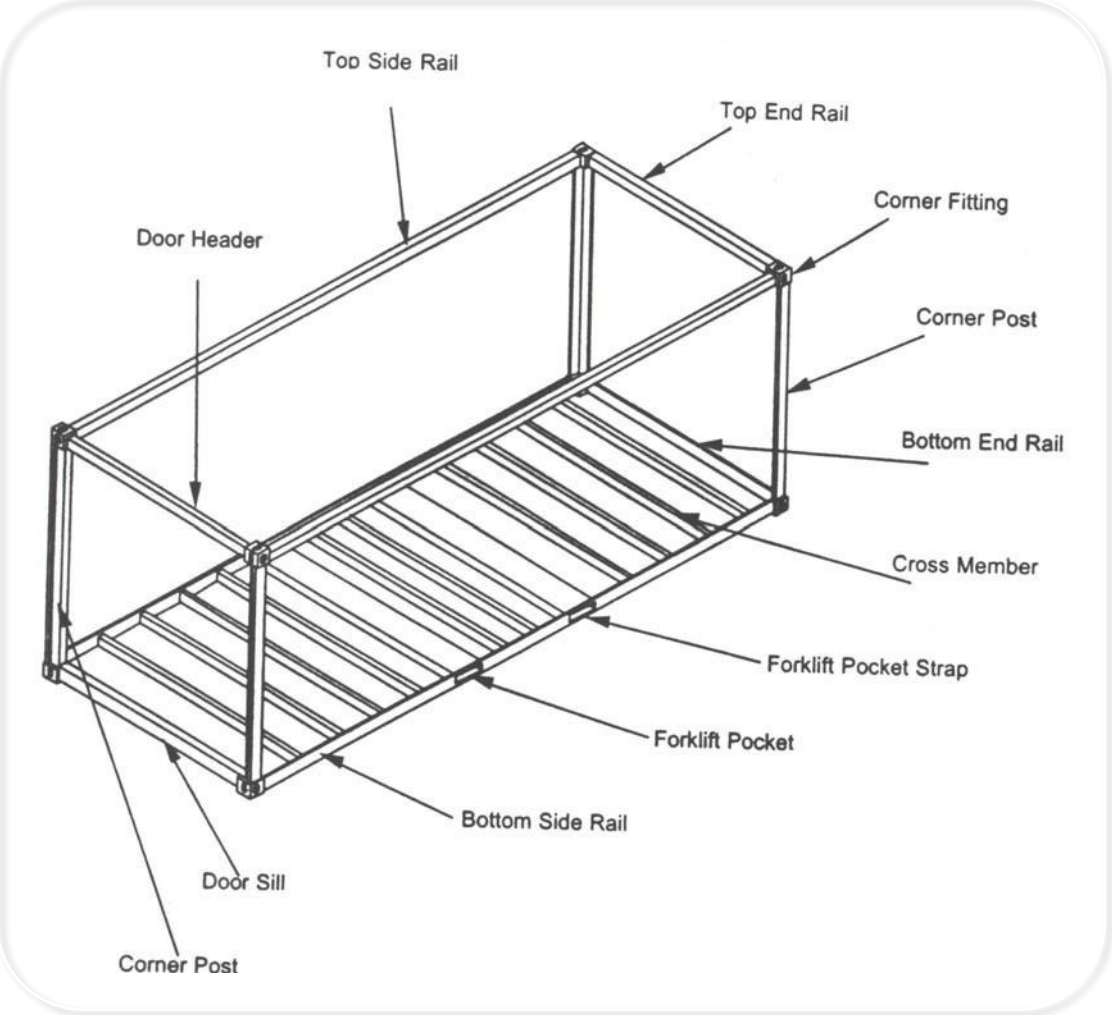
Typical ISO side-loading container

More detailed information on the types of containers that are available and their structural strengths can be found in the relevant ISO standards (see References). This type of information is frequently available from the company supplying the containers to be loaded. Regardless of the container type chosen, that container should not be used unless it has a Convention for Safe Containers (CSC) approval plate, The plate should be marked with the type approval of the container and either stamped with the date of the last examination of the container (first 5 years or subsequent 30 month intervals) or have a current ACEP (Approved Continuous Approval Program) decal on it.

3. | Container construction

All parts of the container contribute to its structural integrity. Corner posts are the strongest part of the container. The corner posts and corner fittings (castings) are used for lifting the container and also to support the stacking of containers above it. The corner posts should be used for blocking and bracing because of their strength.

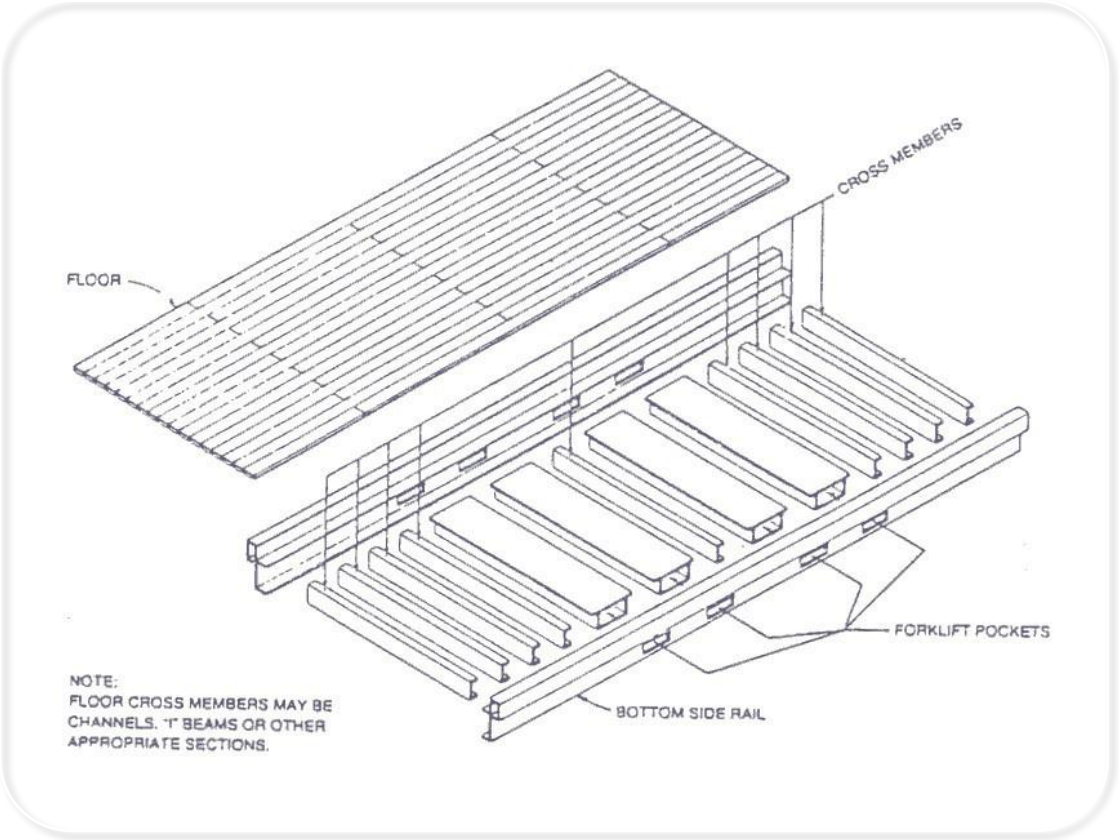
FIGURE 2: Main container structural members



Most containers are constructed of steel and have wooden floors. The floor is supported by cross-members that are attached to the right and left bottom rails (see Figure 3). The composite floor used in general purpose containers will typically allow loading 11,340 kg (25,000 lb) in any 3050 mm (10 foot) length of the floor, or 1,134 kg (2,500 lb) per cross-member. The cargo should be evenly distributed so that these limits are not exceeded. It should be ensured that the maximum allowable payload of the container is not exceeded.

The thickness of the floor should be considered when nailing timber or other materials to it for the purpose of blocking and bracing. Nails should not exceed the thickness of the blocking plus 25 mm (1”). Nails which exceed this length may strike a floor cross-member and cause damage.

FIGURE 3: Container base structure



The uniformly distributed load of 1,134 kg (2,500 lbs) per cross-member includes a substantial safety factor to allow for accelerations to which a container may be subjected in normal service. It can be used as a general rule subject always to the need to ensure the maximum allowable payload of the container is not exceeded.

Typically general (dry cargo) containers and open top containers have door openings of at least 2286 mm (90”) and an inside width of at least 2330 mm (92”).

The protrusions of the corner posts that create the door opening provide an excellent means to block and brace because of their strength. Blocking and bracing across the front of the container also provides a good way to construct a barrier. When loading heavily concentrated cargo, such as large coils, reels or machinery, the base area of the cargo resting on the container floor, should be spread over at least three cross- members. This can be accomplished by securing large timbers lengthwise on the floor to support the load; the more cross-members supporting the load the better. Heavy loads on skids should always be loaded so the skids run lengthwise (front to rear) in the container. Most containers are constructed with 305 mm (12”) centres between cross-members; however, some containers have 457 mm (18”) between cross-member centres. The difference in construction can be identified by viewing the underside of the container and measuring the distances between cross-members, if necessary.

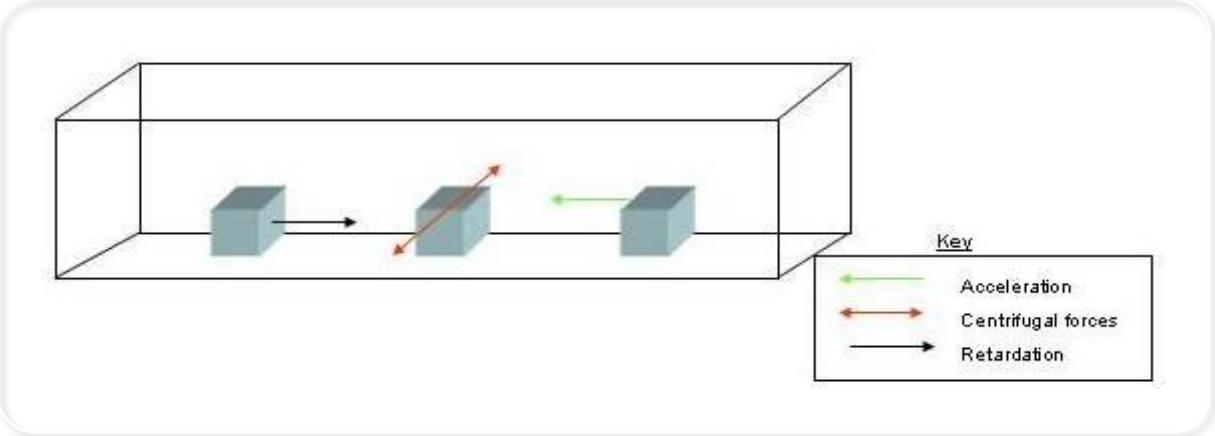
4. | Forces to which containers may be subjected in transit

4.1. Road transport

Containers are sometimes moved by truck during transport. This may be over the public road, in a depot or at a port.

During transport by road, cargo may be subjected to various forces, namely, acceleration, deceleration (retardation), and centrifugal forces created during turning (Figure 4). These forces can result in the cargo shifting within the container.

FIGURE 4: Typical highway forces



Therefore, it is necessary for the shipper to ensure that cargo is properly packaged for containerisation and also that it is properly blocked and braced within the container.

4.2. Rail transport

Containers are often moved by rail to and from various inland points. These containers may be subjected to severe forces such as acceleration, deceleration (retardation), vibration and centrifugal forces which may result in the shifting of cargo (Figure 5).

FIGURE 5: Shifted cargo

The blocking and bracing procedures used for rail movements are similar to those used for road movements. The cargo should be restrained from moving fore and aft and side to side (Figure 6).

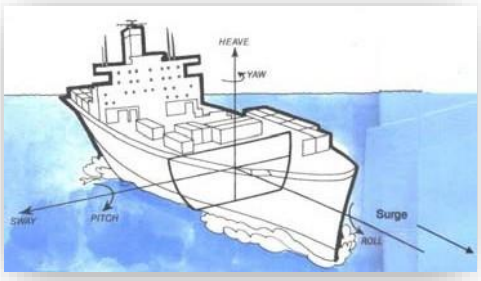
FIGURE 6: Use of inflatable dunnage to restrain vertical movement and use of the corner post to prevent longitudinal movement

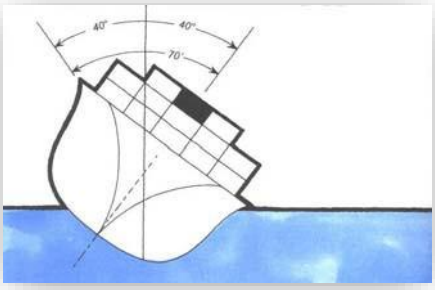
When blocking and bracing a load, the corner posts can be used as fore and aft restraints. When containers are supported by their four corner posts whilst being carried on rail wagons, additional problems may arise due to vibration. Therefore, it is necessary to distribute the weight of the load from side to side and from end to end of the container and to a uniform height.

4.3. Sea transport

Sea transport may induce entirely different forces (Figure 7) to those experienced during rail or road transport. When loading a container for sea transport, six basic ship motions should be taken into consideration. A ship may move in a single motion or combination of all six motions.

FIGURE 7: Ship motions





Normally these forces are not excessive. However, there are times when storm conditions increase these forces placing strain on the container and its contents. It is generally accepted that the forces experienced under storm conditions can be considerably higher than those experienced during land transport. Typically vertical and longitudinal acceleration forces of up to 2g and transverse forces of up to 0.8g are taken as design criteria in many national and international standards. It is necessary to take these possible forces into consideration when stowing containers.

It is vitally important for sea transportation that the total weight (the gross weight or gross mass) of the loaded container be accurately declared. Under declaring the gross mass can be particularly destructive on a ship; unfortunately a stack of containers collapsing, containers being lost over the side of the ship at sea and even the capsizing of the entire ship, all because of under declared gross mass, are not that uncommon.

5. | Packaging

Containerisation has not eliminated the need for adequate interior and exterior packaging of cargo. Packaging for containerised shipments requires careful consideration. The packaging should be sufficiently strong to accommodate stacking within a container and the vertical and horizontal pressures sustained during transit by road, rail or ship.

All packaging, whether it is cases, drums, crates, etc should have the ability to adequately withstand all the forces of normal containerised transport while effectively containing the cargo. The strength and required service life of both interior and exterior packaging depends on the product, the trade route, and the different modes of transport used between the point of origin and destination. If container movement is not door-to-door, standard export packing may be necessary.

5.1. Special packaging

It is important that the merchandise does not move within the carton, box, or other receptacle in which it is packed. To immobilise the contents, it is necessary to provide adequate cushioning within the packaging and/or block and brace the contents.

Heavy machinery and items that are not uniform in shape or dimension should be crated, boxed, or palletised to permit ease of handling and compact stowage.

Each carton or box should be able to withstand the weight and pressure of cargo stacked up to eight feet high.

In addition, boxes, cartons, and crates should be able to survive lateral pressures exerted by adjacent cargo of up to 70% of the vertical stacking weight. This will help to prevent crushing of contents caused by the forces encountered during transport.

6. | Blocking and bracing

Knowing the construction of the container, as outlined in the section entitled “container construction” will help the shipper to prepare inexpensive blocking and bracing. The use of the corner posts to prevent cargo from shifting fore and aft is highly recommended. If a shipment is moved by rail there should always be adequate bracing in the front and rear of the container utilising the corner posts as restraints.

Cargo should be blocked and braced to the outer extremities of the floor in order to prevent lateral movement. The walls and doors of the container should **not** be used to support blocking and bracing.

The additional strength needed to prevent cargo from shifting and damaging the doors of the container and/or the cargo itself can be obtained by blocking and bracing against the top end rail (rear header). This (typically) steel header connects the two rear corner posts.

When blocking and bracing cargo, properly seasoned timber should be selected. Such timber should be sound and free from cross-grain, dry rot, knots, knotholes, or splits which might affect its strength or interfere with proper nailing.

When securing chocking and blocking to a container timber floor, adequate size nails in sufficient number to provide penetration of the blocking lumber should be used with a maximum penetration of 25mm (1 inch) into the container floor. Nails should be driven straight and “toenailing” (driving nails obliquely) should be avoided. Drilling holes in the container floor, walls or roof is not permitted for the purpose of securing cargo.

Many containers are equipped with securing points built into the floor of the container (at the side and end walls). These are normally rated for a force loading of at least 1 kN (2,205 lbf ft) applied in any direction. Securing points located elsewhere in a container typically have a minimum rated load of 0.5 kN (1,102 lbf ft) applied in any direction. On some containers these securing points extend into the cargo area. In such cases, care must be taken to ensure the cargo is protected from contact with these points.

7. | Commodity movement

7.1. Cased goods

Perhaps the easiest type of cargo to load is cased goods with cases or cartons of equal size. Because of this, basic loading considerations are often overlooked.

The load should be pre-planned and a loading pattern established. The stowage of regular size boxes (including fibreboard) is best achieved by using the bonded block method (Figure 8) whereby the weight is evenly distributed throughout the entire length of the container. If possible, the load should be tight and square from front to back and from wall to wall.

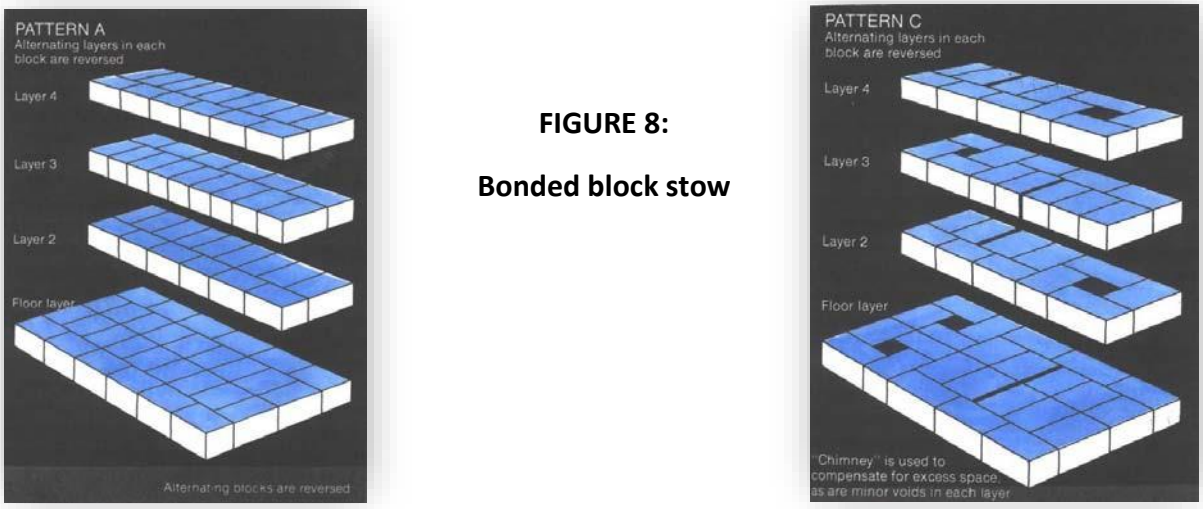
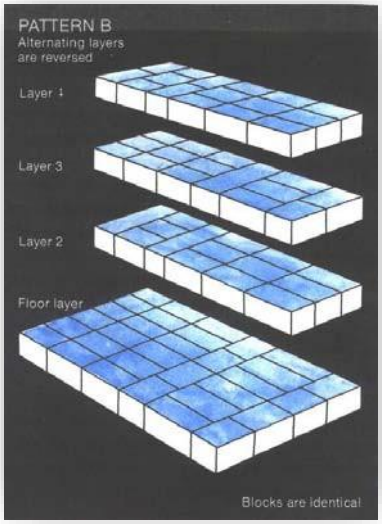


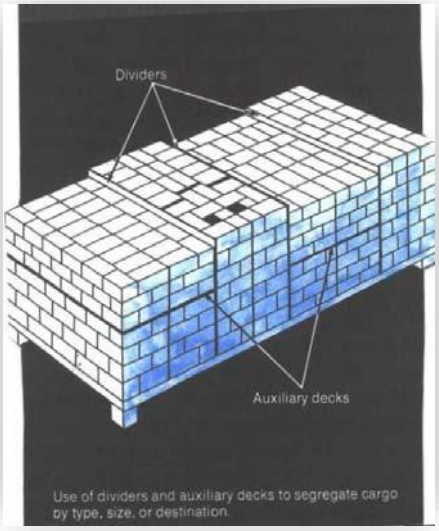
FIGURE 8:

Bonded block stow

When loading, the cases should be either turned or staggered to produce a lacing effect for more stability and less shifting (Figure 9).

FIGURE 9: Lacing packages





It may be necessary to place sheets of cardboard over the area where the door plate meets the wood flooring of the container in order to avoid creasing of the cartons, should shifting occur.

If the load does not fully occupy the entire length of the container, the rear section of the load may be stepped down to prevent shifting if movement is by road and/or sea. For rail movement, the cargo should be squared and a bulkhead constructed at the rear of the load. Blocking and bracing is still required when the load is “stepped down”.

FIGURE 10: Stepping down the load

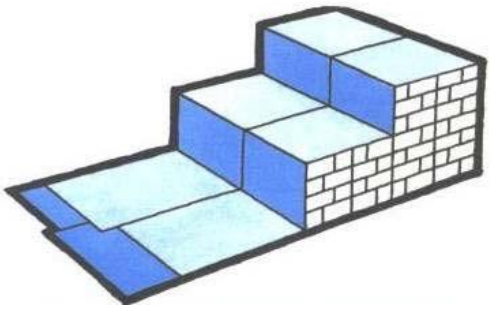
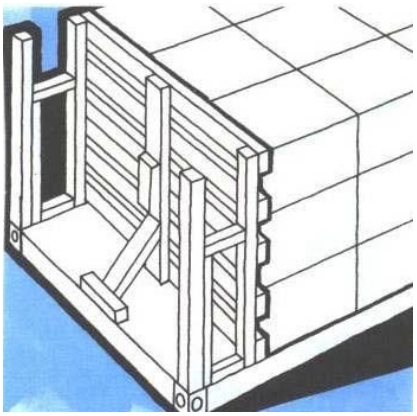


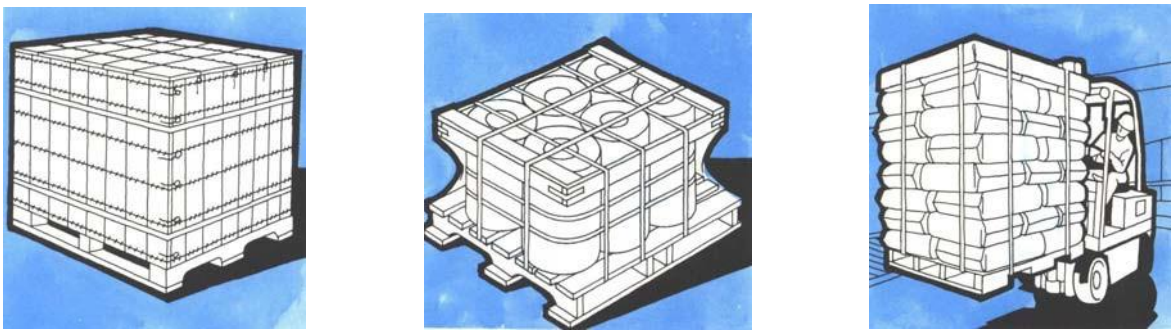
FIGURE 11: Constructing a “bulkhead”



Unitised cases are generally the best type of cargo for loading, unloading, stability in transit, and warehousing. The unit can be placed on a pallet, skid or slip sheet. As with a manually stacked load, the cases should be laced in each unit to reduce shifting.

Banding is one of the best methods of securing an entire unit load. If this is not practical, then the top tier should be banded, taped or glued (Figure 12).

FIGURE 12: Banding



Regardless of which type of pallet is used, spaces between the pallets and sidewalls should be filled by blocking and bracing or adequate dunnage in order to prevent lateral movement of the cargo. (Figure13).

FIGURE 13: Filling void spaces

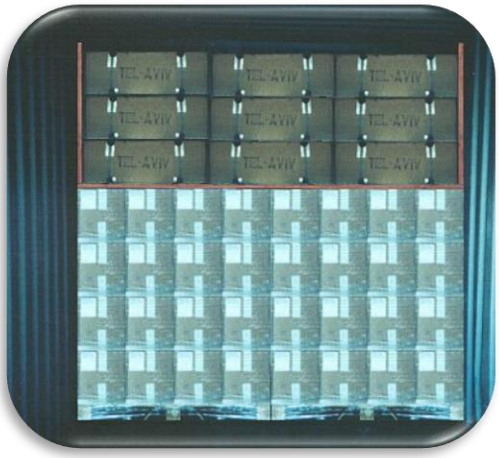
If it is necessary, because of the load factor or bearing weight, to double stack pallets then the maximum height for each stack of cargo should not exceed 223.5 cm (88”).

During loading, pallets should be tight against each other. Any space behind the last pallets should be chocked to prevent the units from shifting in transit.

Shrink wrap packing can provide great savings and convenience to the shipper. The shrink film conforms to the contour of the cargo and, if also carried out over the cargo in all directions and under the pallet can anchor the cargo to the pallet. A “shrink force” is applied at all points with equal pressure around the pallet giving the total load a high strength. This method creates a clear exterior package which aids in the immediate identification of the load in warehouses and other transit points. Since tears in the shrink wrap will not propagate, single

packages can be removed from the pallet without destroying its entire stability, so that the rest of the pallet remains reasonably intact. (Figure14).

FIGURE 14: Use of shrink wrapping



Shrink wrapping may also protect goods from environmental damage. Since the product is protected from the elements, warehousing and transport problems may be alleviated and “off season” shipments can be made.

When loading different sized cased goods, the guidelines that should be followed are the same as for equal size cased goods. The load should be tight and extra effort should be taken to ensure that the goods are secured in all directions to prevent movement. Different sized cased goods may also be unitised by using corrugated sleeves/caps or straps to secure the cases or cartons as a single unit (Figure 15).

FIGURE 15: Loading of different sized cased goods

Stowing of different sized cartons can be made easier using inflatable dunnage. Inflatable dunnage is typically relatively easy to position in a container and its balloon type of construction is designed to absorb sudden impacts by deformation, thereby protecting the cargo from shock impacts. This type of dunnage is available in either disposable or reusable form and can be used with almost any type of cargo (Figure 16). When inflatable dunnage is

used between the cargo and the container doors care should be taken since this may cause a pressure loading on the doors that will cause them to spring open when unlatched possibly injuring unwary workers. A warning label to alert workers to this potential danger is recommended whenever inflatable dunnage is used in this way.

FIGURE 16: Use of inflatable dunnage

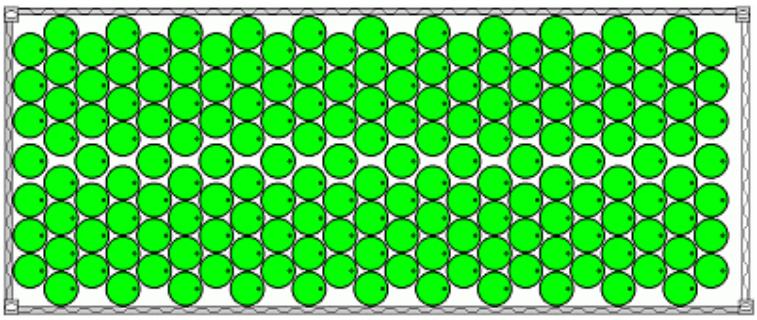
7.2. Drums

The diameter of the drum, type of construction, and height greatly affect the stowage plan of the container. Preplanning the loading pattern for the size of the container and the planned movement should be considered. Drums should not be stowed on the roll (on their side), as they are not designed to be stowed in this way.

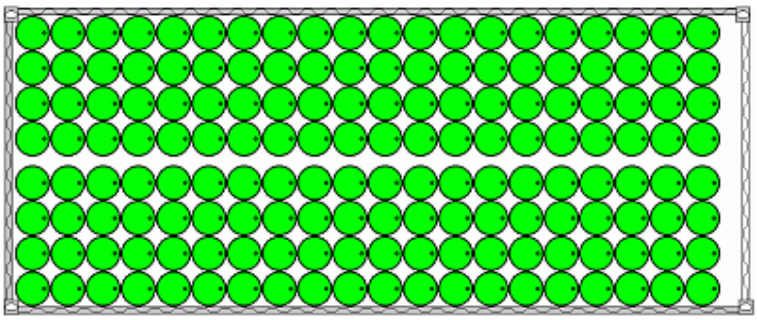
Rail movement of drums requires strong blocking and bracing to prevent fore and aft movement. Effective blocking and bracing may be achieved by (but is not limited to) the following method:

- A piece of timber (10cm x 5cm/4” x 2” nominal, appropriate dimensions to be evaluated by competent risk assessment) on its edge placed across the front of the container in front of the drums. This utilises the strength of the front corner posts to prevent forward motion.
- All drums in a tight or nested stowage with no void space between them.
- The last row of drums “squared off” and even. This is necessary in order to properly construct a strong barrier at floor level.
- A barrier to prevent rearward motion of the drums constructed. If timber is used for this barrier, the rear corner posts of the container should be its main support. If air dunnage or other commercial products are used, they should be securely fastened to prevent rearward motion and they should not be in direct contact with the container doors (Figure 17)

FIGURE 17: Different drum stowage patterns (plan view)



Offset stow



Soldier stow

When stowing drums in more than one tier, their weight should be taken into consideration in relation to:

- positioning within the container
- restriction of axle limitations for road transport
- maximum weight per cross-member (1,134 Kg or 2,500 lbs), and
- maximum allowable payload of the container.

Double decked drums in the nose or forward section of the container should have:

- A barrier placed in front of the double decked drums. The barrier should tie into the front corner posts of the container to prevent shifting and load transfer into the front wall of the container.
- A layer of suitable material of sufficient thickness (typically a minimum of 6 mm (0.25”) plywood or heavy cardboard, subject to risk assessment) placed between the top of the drums on the container floor and the bottom of the second tier of drums.
- The second tier of drums banded together in a tight nest. There should not be space on the sides of the drum. All drums should be flush with the walls of the container. Spaces to prevent side motion should be filled or blocking used to prevent lateral motion.

- Palletised double decked drums banded in a tight nest. The drums and pallets should be banded together as a unit.
- A barrier constructed to prevent shifting fore and aft. This barrier can be constructed in various ways utilising the floor drums as support and may be plywood, timber, pallets, or other suitable material.

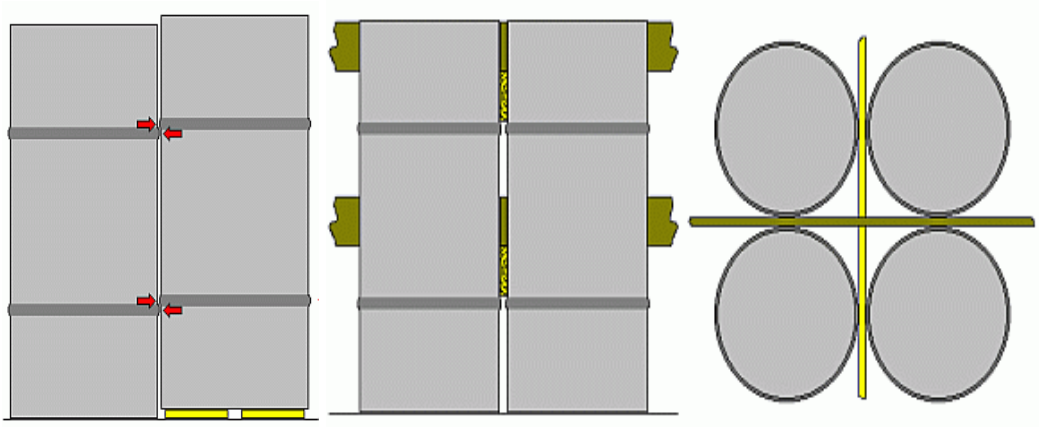
FIGURE 18: Double decked drums

Movement by rail transport creates harmonic oscillations (vibration) which can cause chaffing and rubbing of the drums in transit.

Metal drums with hoops and/or chimes should be protected by one of the following:

- placing dunnage, such as cardboard, between drums, or
- raising each alternate row of drums by putting longitudinal or horizontal timber on the floor. (Figure 19).

FIGURE 19: Protecting drums from vibration damage



7.3. High centre of gravity cargo

Certain heavy cargo, such as machinery, normally has a high centre of gravity. It is recommended that the following procedures should be carried out for this type of cargo. This cargo should be skidded with delicate parts crated. The machinery should be securely bolted to the skid. The drilling of holes in the container floor, walls, roof or doors to secure cargo is strictly prohibited. The skids should:

- be long enough to properly distribute the total weight over sufficient cross-members of the container
- ensure the total weight allowed per cross-member is no more than 1,134 kg (2,500 lbs)
- ensure the total load does not exceed the maximum allowable payload of the container. and
- be of a length and width that ensures the stability to top-heavy machinery.

The two main objectives for loading this type of cargo are:

- to keep it from tipping over (by bracing) and
- to keep it from shifting (by chocking).

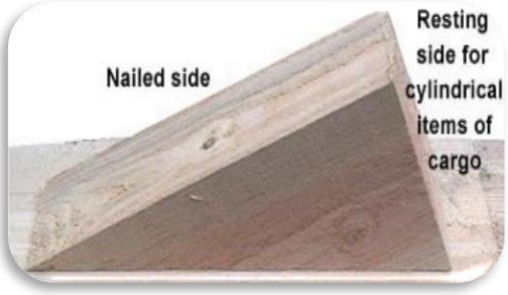
The optimum point of strength in the container for bracing is the floor where it meets the wall. The optimum point of strength for chocking is the corner posts.

If the shipment is being moved by rail, special consideration should be given to blocking and bracing in order to withstand the forces encountered during rail transport.

In order to ensure that the cargo and container arrive undamaged, the blocking and bracing system should utilise the strongest securing points within the container.

Proper nailing of blocks and chocks is critical, see Figure20 for some examples.

FIGURE 20: Use of wood wedges



Note grain ok for nailing

grain **not** ok for nailing

The nails have the task of pulling the boards and wedges close to the load in order to eliminate any damaging gaps

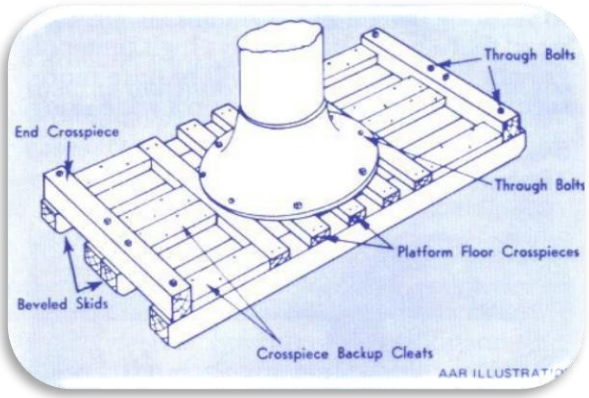
Tight chocks and braces minimise the movement of the cargo. Nails should be the thickness of the lumber plus 25mm (1”) in length when securing to the floor. Nails should be driven straight. Driving the nails at various angles through the wood blocks should be avoided.

7.4. High density/low profile cargo

High density/low profile cargo such a reels, coils, steel sheets, etc. require special blocking and bracing methods.

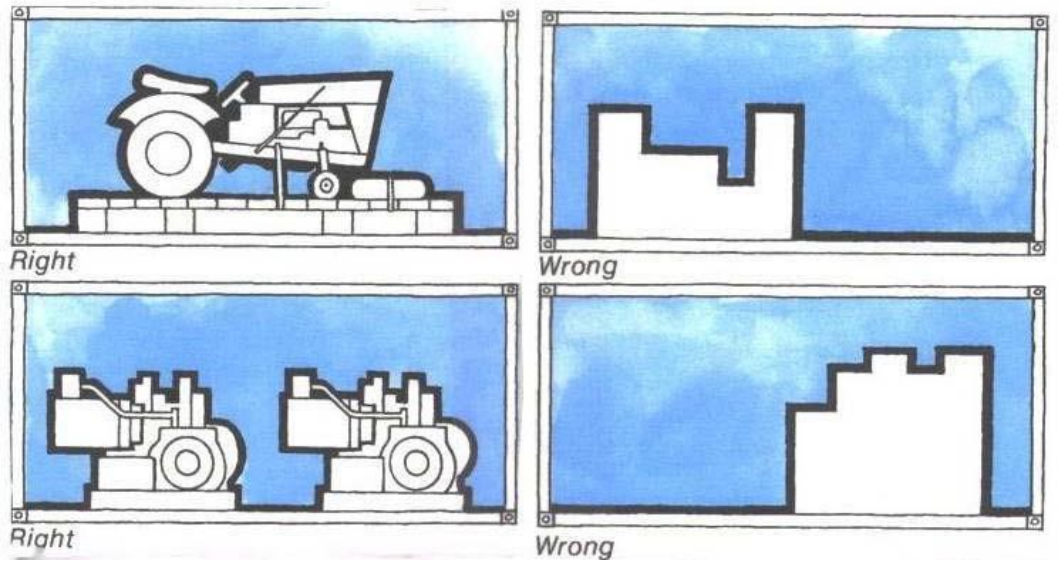
- Skids and main cradle supports should run fore and aft on the container floor and should never be placed wall to wall (side to side) on the floor of the container.
- Skids and main cradle support should be constructed to cover enough cross-members of the container to properly handle the total weight.
- The total weight per cross-member should not exceed 1,134 kg (2,500 lb).
- Skids and cargo should be prevented from shifting.

FIGURE 21: Spreading out the load (AAR)



Proper loading patterns for each specific piece of cargo should be established to ensure correct weight distribution throughout the container (Figure 22).

FIGURE 22: Proper and improper distribution of weight



Blocking and bracing should be determined for the mode of transport. If movement is by rail, blocking and bracing should be constructed to withstand lateral forces (side to side), as well as fore and aft motion.

Blocking and bracing should be high enough to prevent the cargo from jumping over it.

7.5. Mixed commodities

There are occasions when more than one commodity is loaded into a container. Along with the general loading guidelines listed in this guidance, it is recommended that:

- Heavy cargo should never be loaded on top of light cargo.
- Commodities giving off odours should never be loaded with a commodity which would be affected by odours.
- Dust producing goods should never be stowed adjacent to or on top of goods that can be damaged by dust permeation.
- Cargo that exudes moisture should not be stowed with cargo susceptible to liquid damage.
- Dunnage should be used between commodities with different types of packaging (cartons with crates, etc.) to prevent damage.
- Liquids should be stowed below dry goods
- Engine and gear box sumps should be drained. When this is not practicable, suitable drip trays should be positioned under this type of cargo.

Most mixed commodity loading is based on common sense. The main objective is never to stow commodities together where one might affect the successful transport of the other.

FIGURE 23: Stowage of mixed commodities

8. | Dangerous goods

The term dangerous goods specifically refers to those commodities that have been defined as such in the International Maritime Dangerous Goods (IMDG) Code - a substance or material or article capable of posing an unreasonable risk to health, safety and property when transported in commerce.

The stowage of different classes of dangerous goods within the same container is strictly regulated and is generally prohibited. The general segregation chart in the IMDG Code should be consulted when mixing classes of dangerous goods within the same container. There are four segregation terms that are used:

Away from (minimum of 3m separation);

Separated from;

Separated by a complete compartment or hold from; and

Separated longitudinally by an intervening complete compartment or hold from:

to indicate the degree of separation required between specific classes of dangerous goods. Only materials that do not have segregation requirements, or that require **Away from** segregation, can be stowed in the same freight container. Goods requiring **Away from** segregation may only be so stowed following written approval by a national competent authority. This approval should be obtained before the goods are loaded into the container.

In addition to the general class segregation and separation requirements, the shipper should be aware of chemical specific incompatibilities between individual dangerous goods that are specified in the IMDG Code. It is important to check the individual entries for each chemical

or article being shipped in order to be fully aware of and avoid any incompatible stows within a container.

There are numerous requirements relating to:

- the proper packaging of dangerous goods,
- documentation that must be prepared to fully describe the goods being shipped, and
- placards, marks or signs that must be on a container loaded with dangerous goods.

It is imperative that the shipper is aware of and meets all these requirements to ensure safety in transportation as the IMDG Code became mandatory on 1 January 2004. As an added precaution, and in order to facilitate emergency response, when dangerous and non-hazardous materials are loaded in the same container the dangerous goods should be loaded immediately inside the container doors.

9. | Fumigation

Significant hazards may remain in fumigated containers and bulk cargoes.

An increasing number of countries are enacting laws requiring the fumigation of all wooden packaging used in shipments to those countries. However, fumigation poses risks that are easily underestimated.

The UK P&I Club has advised its shipowner and operator members to ensure that adequate warnings are posted on containers under fumigation (as required by the IMDG Code) and that proper procedures are followed when entering such units. Even after a fumigated container has been ventilated and found free of fumigant gases, the levels of fumigant gasses can subsequently increase to dangerous levels if the unit is closed before unloading has been completed. Experience has shown that contact with residual fumigants can lead to severe injury, permanent disability or even death.

The Club issued its warning following a survey in Rotterdam, which found that 10 of the 303 containers chosen at random for inspection contained methyl bromide, formaldehyde or phosphine. Of the 10 units, only 4 displayed the required "Under Fumigation" warning label.

Containers that contain fumigated goods are considered to be class 9 dangerous goods by the IMDG Code, UN number 3359. The Code should be checked for any current placarding requirements and the correct wording of the warning sign that must be posted on the container doors.

Fumigants are typically used to protect foodstuffs from rodents, insects, mould and fungi. Of nine leading fumigants, the three most commonly used in containers are phosphine, sulphuryl fluoride and methyl bromide.

Phosphine is readily absorbed by inhalation and through the gastrointestinal tract. At low levels of inhalation, symptoms include headache, weakness, faintness and pains in the chest. At high levels, nausea, vomiting and pulmonary oedema can occur.

While the high toxicity of phosphine gas has long been recognised and is its primary hazard, its flammability risk is not widely appreciated. Its lower flammability limit is only 1.8 per cent by volume in air. If an air/phosphine mixture in which the phosphine concentration exceeds this limit is ignited in a confined space, it is highly probable that an explosion will occur.

Phosphine gas is generated from, for example, aluminium phosphide tablets when the aluminium phosphide reacts with moisture in the air. In addition to generating phosphine, this process also produces aluminium oxide as a residue and, occasionally, small quantities of diphosphine gas. Unlike phosphine, diphosphine is spontaneously combustible. Diphosphine is more likely to be generated if the aluminium phosphide tablets contain amounts of phosphorous in excess of that specified in an acceptable formulation.

Aluminium phosphide tablets are routinely used in fumigation and a very large number of shipments are fumigated annually without problems. Gassing incidents, due to inadequate ventilation of containers after they have been opened, have occurred in countries throughout the world. Fumigant explosions may occur when excess amounts of fumigants are used.

Contact with methyl bromide through inhalation and absorption through the skin can cause damage to the brain, nervous system, skin, lungs and possibly the kidneys.

More detail on fumigation is available in the ICHCA International Ltd Safety Briefing Pamphlet No 20 – Unseen Dangers in Freight Containers.

10. | Security

Containerisation has greatly reduced the amount of theft and pilferage in the shipping industry. To keep this theft rate low, certain security measures are necessary. The most important of these is the use of tamper-evident seals on the doors of containers. ISO PAS 17712 provides an excellent discussion on the different types of seals that may be used and establishes the performance requirements that seals should meet.

An accurate seal record should be maintained from point of origin to point of destination. Seal numbers should be recorded on appropriate documents and whenever it becomes necessary to break a seal, the reason for the use of a new seal should be annotated (i.e., customs inspection, etc.). Seal procedure will be ineffective without well-kept records, security of the seal supply, and documented responsibilities for both.

References

- BS 5073: 1982. Stowage of Goods in Freight Containers IMO/ILO/UNECE: Guidelines for Packing Cargo in Freight Containers ILO Portworker Development Programme video presentation.
- “If you think any fool can stuff a container - think again!” (TT Club / UK P&I Club) video ISO 668: Series 1 freight containers - Classification, dimensions and ratings.
- ISO 830: Freight containers - Vocabulary.
- ISO 3874: Series 1 freight containers - Handling and securing

- ISO 1496 – 1: Series 1 freight containers - Specification and testing – Part 1: General cargo containers for general purposes
- ISO 1496-2: Series 1 freight containers - Specification and testing - Part 2: Thermal containers.
- ISO 1496-3: Series 1 freight containers - Specification and testing - Part 3: Tank containers for liquids, gases and pressurized dry bulk.
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- ISO 1496-5: Series 1 freight containers - Specification and testing - Part 5: Platform and platform-based containers.
- IMO: IMDG (International Maritime Dangerous Goods) Code
- ICHCA International Ltd: International Safety Panel Briefing Pamphlet No 20 - "Unseen Dangers in Freight Containers"

About The Author

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Mr Bohlman joined Horizon Lines, LLC (then known as Sea-Land Service, Inc.) in 1975. In his current position as Director of Marine Services, he has primary responsibility for safety, security, environmental protection, Customs, ship-to-shore communications, crew management / labour relations and regulatory compliance. In addition, he has overall responsibility for HORIZON Lines' third party fleet management program under which 9 ships are being managed and operated for the US Navy's Military SeaLift Command and the US Maritime Administration.

Prior to joining Horizon Lines, Mr. Bohlman served with the U.S. Coast Guard as Chief Engineer on several Coast Guard cutters. As Chief of the Packaged Cargo Branch for the Coast Guard, he represented U. S. interests at IMO and the United Nations on fire protection, the safe transportation of dangerous goods and port security. He has lectured extensively at the World Maritime University and for the Organization of American States throughout Central America on port safety, fire prevention/response and port security. Mr. Bohlman is retired as a Captain in the U. S. Coast Guard Reserve.

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Additional information about Horizon Lines can be found at www.horizonlines.com.

International Cargo Handling Coordination Association

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