UK P&I CLUB

Carefully to Carry

SEPTEMBER 2006

Containers in non-cellular ships

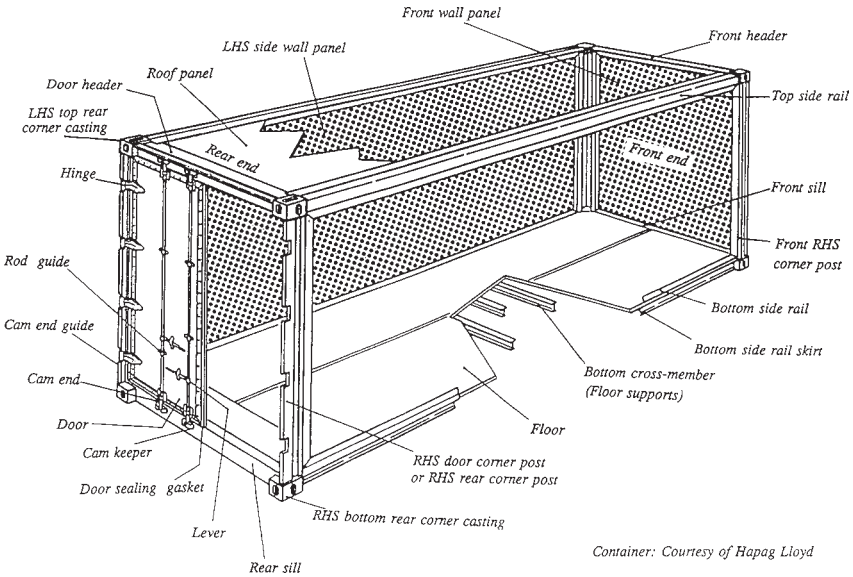
What is an ISO container?

The letters ISO stand for the International Standards Organization, which in general terms defines a container as an article of transport equipment:

- Of a permanent character and accordingly strong enough to be suitable for repeated use.
- Specially designed to facilitate the carriage of goods by one or more modes of transport without intermediate reloading.
- Fitted with devices permitting its ready handling, particularly its transfer from one mode of transport to another.
- So designed as to be easy to fill and empty.
- Constructed to dimensions and to quality criteria set out by the ISO.

The classic and standard ISO container is the 20ft unit, traditionally a fully-enclosed and rigid rectangular box 20ft in length and of 8ft x 8ft end cross-section, fitted with a pair of hinged doors at the rear end provided with hardware to close, lock and secure its contents. Within the shipping industry, this is known as a TEU (a twenty-foot equivalent unit).

In recent years there has been a demand for containers of 8ft 6ins in height. A demand which has made this higher unit standard in some trades. Unit



Container: Courtesy of Hapag Lloyd

"The carrier shall properly and carefully load, handle, stow, carry, keep, care for and discharge the goods carried."

Hague Rules, Articles iii, Rule 2

Carefully to Carry Advisory Committee

This report was produced by the Carefully to Carry Committee – the UK P&I Club's advisory committee on cargo matters. The aim of the Carefully to Carry Committee is to reduce claims through contemporaneous advice to the Club's Members through the most efficient means available.

The committee was established in 1961 and has produced many articles on cargoes that cause claims and other cargo related issues such as hold washing, cargo securing, and ventilation.

The quality of advice given has established Carefully to Carry as a key source of guidance for shipowners and ships' officers. In addition, the articles have frequently been the source of expertise in negotiations over the settlement of claims and have also been relied on in court hearings.

In 2002 all articles were revised and published in book form as well as on disk. All articles are also available to Members on the Club website. Visit the Carefully to Carry section in the Loss Prevention area of the Club website www.ukpandi.com for more information, or contact the Loss Prevention Department.

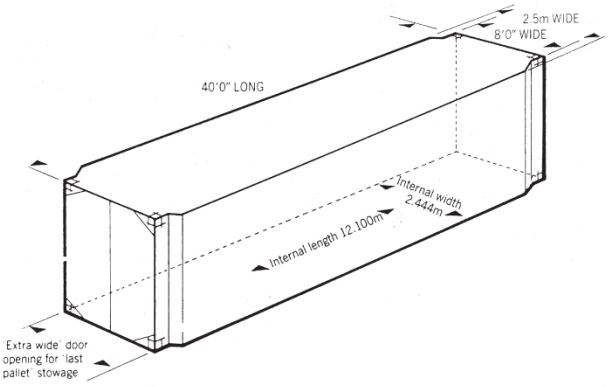
heights of 9ft 6ins are also not uncommon. Both have created problems for stowing and securing containers in adjacent stacks of mixed heights.

The longitudinal extension of the basic container is the 30ft and 40ft rectangular box. Some shipping lines use containers of 35ft and 45ft length. Another variation is the CUC Cellular Unit specially designed to carry two rows of 2.1m x 1m Europallets without wasted space. All these dimensions are external.

ISO conforming containers, usually with a timber floor, may be constructed of various materials:

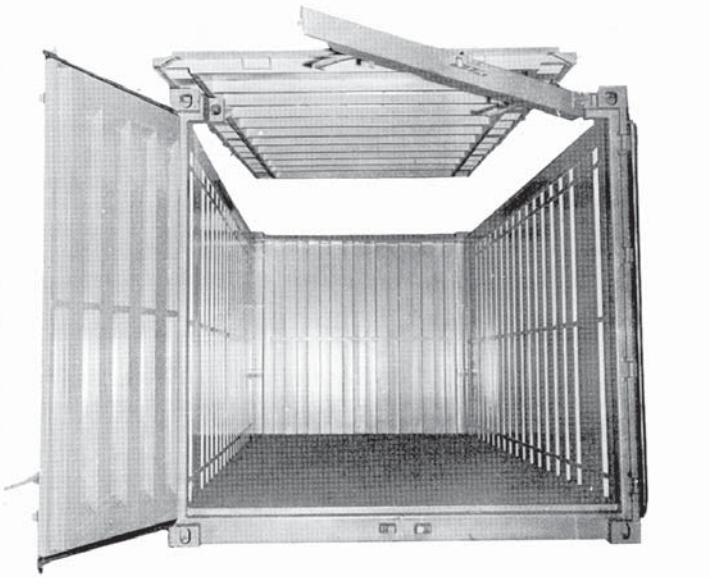
- Entirely of steel sides, ends, roof and floor constructed of flat panels or corrugated sheets.
- Various aluminium alloys in similar flats or profiles.
- Marine plywood of various thickness.
- Glass-reinforced plastic (GRP) .
- Two or more materials.

The corner posts, corner castings, bottom rails, under-bearers and sills are of steel and should meet the dimensional tolerance and strength specifications as established by the ISO, and additionally as surveyed and approved by several of the ship classification societies.



From the basic TEU a multiplicity of variations has evolved, i.e., the open-top container, the tilt-sided container, the flat rack, the various types of reefer units, and bulk-liquid tanks of various shapes fitted with ISO structural frames. There are also variations in length and height. Reference to *Jane's Freight Containers and Containerisation International Yearbook* provides detailed insight into the range of units available.

A normal 20ft unit has a tare weight of between 2 and 2.5 tonnes, a cargo weight (payload) capacity of between 17.5 tonnes and 18.5 tonnes, with a maximum gross weight of about 22 tonnes. A 40ft unit has a tare weight of between 3.5 tonnes and 4 tonnes, a cargo weight (payload) capacity of about 26 to 27 tonnes,



20ft all-steel opening roof container

20ft x 8ft tank container. May contain highly corrosive and/or toxic liquids. Courtesy Jane's Freight Containers

with a maximum gross weight of 30 to 32 tonnes. Special 20ft units for the carriage of steel coils, manufactured to much more stringent specifications, are able to carry cargoes of up to 27 tonnes weight. It is important that the relevant recommended gross weights are not exceeded.

The *International Convention for Safe Containers* (CSC) 1996, lays down structural requirements for containers and requires countries who ratify it to establish effective procedures for testing, inspection, approval and maintenance. The Convention also requires that a safety approval plate be affixed to every approved container. Amongst other things, this plate should record the maximum operating gross weight, the allowable stacking weight and the transverse racking test load value.

All persons concerned with the packing and carriage of containers should also be conversant with the contents of the IMO/ILO/UN ECE *Guidelines for Packing of Cargo Transport Units* (CTUs) 1997, which now supersedes the earlier IMO/ILO *Guidelines for Packing Cargo in Freight Containers or Vehicles*.

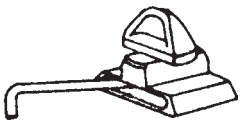
Securing containers

Despite the length of time that ISO containers have been in use, there is still little uniformity in the method and systems adopted for securing containers to the ship's structure and to each other. The wide range of equipment and fittings manufactured throughout the world for securing containers tends to give rise to diverging views as to what constitutes a safe and secure lashing system. One essential is that the securing gear used is of the correct strength. This can be readily established. A number of international companies produce and market container securing equipment and maintain their own specialist consultancy services, which provide advice on how to stow and lash containers safely in a particular ship.

Where shipowners have sought the advice of experienced manufacturers/specialist consultants about lashing and securing arrangements, the plans produced are generally effective and when fully and conscientiously implemented result in a very low incidence of loss and damage.

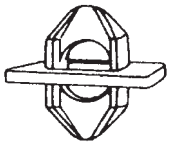
The wide variety of container securing fittings on the market is matched by an equally wide range of technical terms used for the components involved. It would be of great assistance to shore-based personnel if ships' officers and surveyors, when referring to container securing devices, used only those words and terms appearing in the handbook of the manufacturer concerned, together with a photocopy (or photograph) of the type of component involved. Manufacturers of securing equipment are usually willing to provide, on application, catalogues of components with detailed line drawings and pictures and the appropriate handbooks should be kept onboard the ships. It should also be borne in mind that, as from 1 January 1998, all vessels (other than dedicated bulk carriers, tankers, and certain exempted vessels) are required to have a cargo securing manual onboard, approved by the national administration or by a duly appointed certifying authority.

The following are line drawings of some of the many components available in different container securing systems, reproduced by kind permission of International Lashing Systems and Coubro & Scrutton Ltd, Securing Division, to whom the Association extends its due acknowledgments and thanks

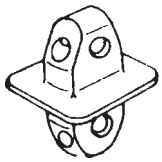


1. Flat based, shoe fitting twistlock, used in connection with slide shoes fitting. Sometimes known as a dovetail twistlock

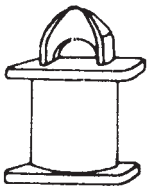
2. A single, sliding lockable base cone for use with keyhole foundations



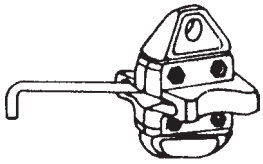
3. A single, non-lockable, inter-layer stacker, sometimes known as an intermediate stacking cone. When the horizontal plate is extended to accept two such fittings the item is known as a double inter-layer stacker or double intermediate stacking cone. They may be for transversal or longtitudinal applications



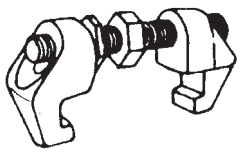
4. A single, lockable inter-layer stacker, or lockable intermediate cone, used with right-handed locking bars or blocking pins



5. A 6" spacer with single stacking cone, sometimes supplied with two opposing cones. Used to bring the tops of unequal size adjacent containers in stack to the same horizontal line so that screw-bridge fittings may be attached to corner castings (see 7.)



6. A handle-operated turn-foot twistlock, or inter-layer twistlock, to secure a base corner casting to a deck fitting and/or to secure the top corner casting of the container to the bottom corner casting of the next container above



7. A screw-bridge fitting, sometimes referred to as a bridge fitting or a tension clamp or compression clamp, or container bridge. Used to connect the upper corner castings of a top layer of containers in stack

Inter-layer stackers, twistlocks, turnbuckles, lashing rods, chains, deck connections, etc., are all subject to deterioration or physical damage of one kind or another and should always be inspected before use. Operational structural failure of twistlock inter-layer stackers may well result from them being weakened by rough handling at discharge ports, e.g., by stevedores throwing down the twistlocks from third tier levels, for instance. Such rough handling could also cause defects in other components, which may then fail under operational stress. One solution is the provision of suitable bags or boxes, which can be used to collect components before lowering them to deck level to be retained in dedicated storage areas.

A combination of circumstances may result in the securing equipment of a container stack being subjected to the maximum design stress. In that event, if the recommended measures are not followed, loss of or damage to containers, cargo, or ship could well occur.

For example if:

- Upper height tension clamps (bridge fittings, screw-bridge fittings) are omitted in a system which requires their use.

- 'Handy-wire' is used in place of tension clamps.
- Damaged fittings are used.
- Marine personnel experiment by omitting parts of, or altering, the designed securing system.
- Containers are mixed with breakbulk general cargo without careful planning and adequate securing.
- Containers are distributed vertically without taking into account their respective and relative weights.
- Officers new to a ship assume, without checking, that the same securing system used on their previous ship can be used.
- Ships' officers are not given sufficient time to check that all approved securing measures have been carried out.
- Ships' officers are not given the information and time necessary to calculate the vessel's stability condition, including fluid GM and GZ curves for the port of destination, or to check sheer stress and bending moments.

The United Kingdom Department of Trade Merchant Shipping Notice no. 624, October 1971 (now superseded but containing sound guidelines) states, *inter alia*:

"3. Except where there is provision enabling twistlock, or other similar device, to be inserted in the bottom corner fittings of the container and into suitably designed recesses in the hatchcovers of fabricated deck stools of appropriate strength, containers carried on deck should be stowed one high only. In such cases, the containers should preferably be stowed fore and aft, prevented from sliding athwartships and securely lashed against tipping. Containers should be stowed on deck two or more high only on those ships that have securing arrangements specially provided. At no time should the deck loaded containers overstress the hatchcover or the hatchway structure; in cases of doubt details of stress limitations should be obtained from the classification society."

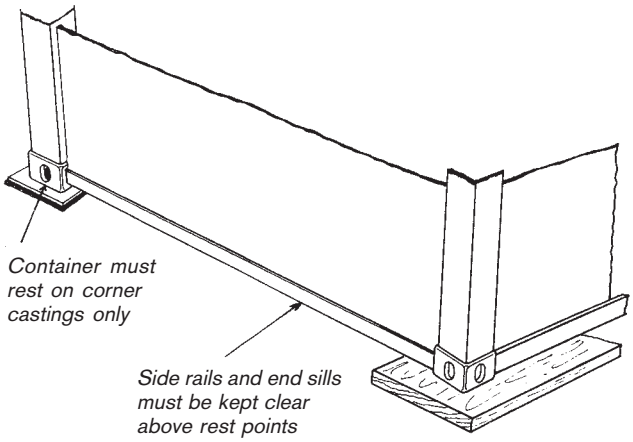
While it is recognised that containers are carried more than one high in non-purpose built ships, experience has shown that the foregoing advice is sound commonsense and good seamanship and that adequate provision must be made for positive corner-casting securing at base tier level, whether stowed on the weather-deck, the hatchcovers, the tween decks or hold tank-tops. If fittings are being welded to hatchcovers, decks or tank top plating, full consideration must be given to the downward-acting forces which the ship's structure will be required to withstand when fully laden containers are in position.

Bear in mind that a single stack of two 20ft x 20 tonne units will exert a downloading of 40 tonnes, such that the point-loading beneath each corner casting will be about 345 tonnes/m^2.

Containers are designed and constructed to stand on the four bottom corner castings alone. The bottom side rails, the front and rear sills and the under-floor cross bearers should remain free of bottom contact at all times.

NEVER stow ISO containers on their bottom rails or skirts. ALWAYS stow ISO containers on their corner castings only

When stowed like this skirts and bottom rails collapse and general slackness develops in the stow



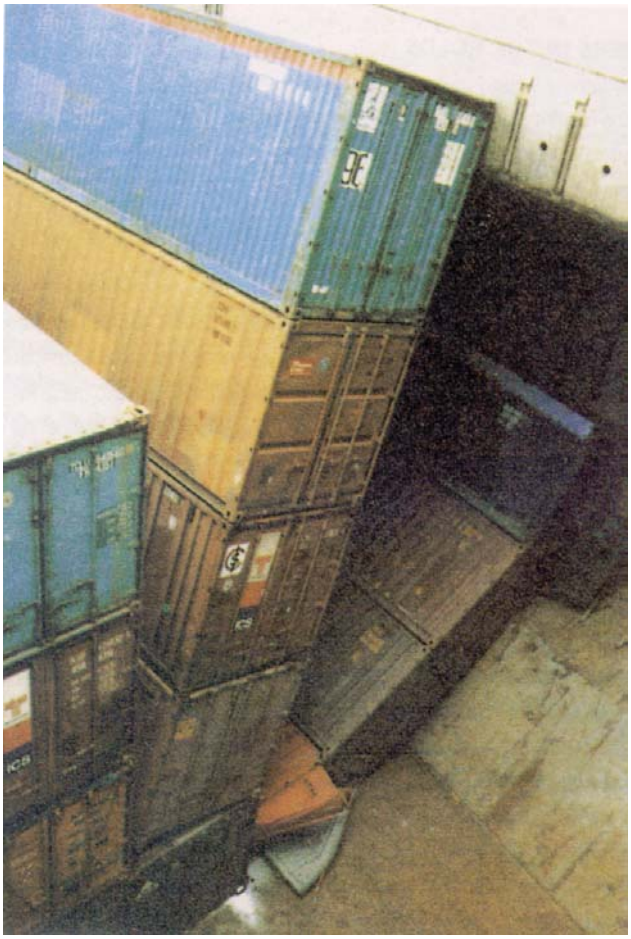
Between the upper corner castings of one container and the bottom corner castings of the next adjacent container, inter-layer stackers (frequently referred to as 'cones' or 'intermediate stacking fittings') must be fitted. The pattern and causes of container damages aboard ships indicate that lockable inter-layer stackers or twistlocks should be used between all container tiers and, where possible, double form stackers or twistlocks should be used to bridge-lock the units one to another, transversely and/or longitudinally. It is appreciated that in some lashing systems, lockable inter-layer stackers or twistlocks are not obligatory except to attach the first tier of containers to the hatchcover or deck. Where this is the case it is important to ensure that the full lashing requirements of the particular system are complied with.

Where containers of 8ft end section only are being used, the adjacent corners will be on the same level. Containers of 4ft, 4ft 3ins, 8ft 6ins and 9ft 6ins height are frequently intermingled and thus a six inch step or more can occur between adjacent heights in the same transverse stack. In systems where tension clamps/ bridge-fittings are required between corner castings at the upper level, the uneven step should be compensated for by using spacer-fittings beneath a container to bring the upper surface of the stack completely level or, by using variable-height clamps. Handy-wire is not an acceptable alternative, as it cannot be made either taut or rigid.

Where two 20ft units are placed in what would normally be a 40ft container position, it is difficult, or even impossible, to apply wires, chains or bar lashings to the adjacent corners. Their absence is not fully compensated for by using double inter-layer stackers or similar components, because the container stack as a whole, and particularly those units in the bottom tier, may be subjected to excessive racking stresses should the ship start rolling heavily in heavy seas. Some compensation can be applied by the use of antirack bands (two tensioned metal straps fitted diagonally across the corners of the ends of the base tier containers) but a permanent alternative full lashing system properly planned for the particular ship is to be preferred.

Most containers are designed to stack nine high when empty, but there is always a trade-off for height against weight when units carrying cargo are to be stacked, and it is rare for a sound container to suffer a structural collapse where height and weight criteria are properly balanced. Occasionally, however, container stows collapse when the weight of containers and their contents placed in the upper layers of a stack exceeds the permissible limit and produces unacceptable loads on the containers in the bottom tier, a situation which has given rise to catastrophic

Collapse of stow: Nine containers were damaged in this incident. Note the damaged container at the base of the stow



The same incident viewed from a different angle

collapse and losses even in purpose-built ships. Care should therefore be taken to ensure that the safe weight load of the individual container is not exceeded and that the gross and tare weights are accurately recorded and declared. Shipmasters should be alert to charterers insisting on stacks of full-weight units where this is both dangerous and contrary to any approved conditions for the particular ship.

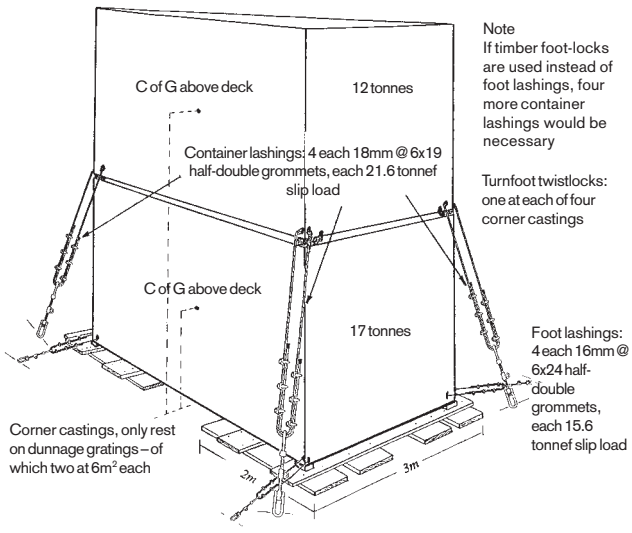
When circumstances require a mixture of general breakbulk cargo together with containers, whether above or below deck, great care must be taken with the

stowage. Damage resulting from cargo shifting continues to occur in these situations and appears to result from an unrealistic reliance upon the containers acting as 'restraining walls' instead of the cargo being secured in accordance with normal sound stowage practices. Great care should also be taken when loading general cargo on top of containers.

Simplicity of design does not always produce efficient systems. Nevertheless, the simplifying of container securing systems by avoiding a variety of fittings is a trend to be encouraged. The safety of the entire operation is likely to be enhanced if one or two proven types of fitting are always properly used.

Reliable statistics for the incidence of collapses in container stows during ocean voyages are not available, but the reported reasons for container stowage collapse appear to be basically ones of scale. That is to say, that the omissions, makeshifts and mistakes are mostly associated with relatively large container stowages and quick turnrounds. The trend for the future is a continuing rise in the frequency of the carriage of containers in non-purpose built ships; with port turnround times being reduced still further by more sophisticated terminal handling techniques. Everyone engaged in construction, testing, inspection repairing, packing, handling, stowage and securing of containers should appreciate the potential danger if there is one 'weak link' in the system. It requires the co-operation and watchfulness of all concerned to assist the ship's master in fulfilling his duty to ensure the safety of the ship and its cargo before proceeding to sea.

Don't overload the stack. A container constructed to accept, say, eight empty units above it (a total weight of 20 tonnes) is unlikely to withstand the superincumbent weight of 160 tonnes – even when static; and, when subjected to vertical acceleration/ deceleration stresses at sea, collapse and/or loss are almost certain to occur.



A safe and secure method of stowing and lashing a container twin-stack

Where applicable, shipmasters, owners and charterers should be conversant with the *International Code* for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes *On Board Ships* (the INF Code) – IMO 2000 Edition, of which paragraph 6.1 says, *inter alia*:

"In designing permanent devices, due consideration shall be given to the orientation of the packages and the following ship acceleration levels shall be taken into account: 1.5g longitudinally; 1.5g transversely; 1.0g vertically up; 2.0g vertically down."

This would seem to indicate that any lashing strength answers arrived at by using the 3-times rule would need to be doubled to satisfy the INF Code. Hopefully, guidance on this point will be provided by the IMO at the time any vessel applies for an international certificate of fitness for the carriage of INF cargo.

Containers in the holds of conventional ships and bulk carriers

While the securing of weather-deck stowages should follow the 3-times rule, the aggregate lashing strength of one to two times the static weight of the load has been found sufficient below decks, provided all foot-lock, vertical, and transverse interlocking arrangements are in place. The continuing incidence of catastrophic collapse of unsecured container stacks in non-purpose built holds and the financial losses arising there from provide ample evidence that such stacks will not stay in place on the basis of their total weight, alone.

Firm securing of the stacks to the ship's structure as a block is essential. If slackness develops during adverse weather conditions the containers will chafe and rack leading to overall distortion and possible collapse, especially if heavy units have been placed in upper tiers.

As indicated earlier herein, ISO containers are designed and constructed to be carried by stacking them one above the other in slots or cells below deck and on the weather-decks in purpose-built ships, or ships converted for such carriage. The design of bulk carriers appears to provide large, unobstructed spaces for the safe stowage of containers. They are however prone to the severe stresses arising in a heavy seaway in the same manner as other ships of similar size, and containers carried in block stowages below decks can create special problems if adequate securing measures are not adopted. It is not infrequent that an entire stow of containers collapses, with serious damage to the boxes and to the cargo within them.

Generally the cargo compartments of bulk carriers are

not of the right dimensions to enable the container stow to be a perfect fit. For instance, in those vessels fitted with sloping hopper side tanks there will be a large area of unusable space between a block of containers and the ship's sides. Adequate measures must be adopted to ensure that the containers, as a result of rolling stresses, will not move or collapse into these spaces.

Experience has indicated that to ensure the safe carriage of blocks of containers in a bulk carrier certain basic requirements must be fulfilled. Importantly, whenever possible the containers should be formed into one solid rigid block so that there will be no movement whatsoever. The bottom containers in the stacks should be secured to the ship's tank top plating by twistlocks or lockable locator cones and, in addition, twistlocks or lockable inter-layer stackers should be used between each container in the stack.

All the containers in a block may not be loaded or discharged at a single port, and in consequence there may be parts of a voyage when the block will be irregular rather than cuboid in shape. Do not neglect to fully resecure the stow. Omissions of this nature have been the prime cause of a number of casualties.
In the absence of these precautionary measures the stacking of containers two high or more will produce racking stresses, which tend to distort them laterally.

This problem will be aggravated during heavy weather when the weight of the containers in the upper part of the stow may cause the corner posts of the lower containers to buckle, with the inevitable result that the stow collapses. This is more likely to happen in the forward holds where the effects of pounding are more pronounced. Ideally, all ships converting to the carriage of containers in stacks two or more high should have the securing system and the strengthening requirements for the tank tops approved by the classification society.

In some systems the spaces between the containers and the sides of the holds are taken up with portable or hinged steel girder chocks which insert precisely into the corner castings of the various heights of containers. Alternatively, and in addition to the provision of any form of inter-layer stackers or twistlocks, solid bar or wire lashings may be required, tautened on turnbuckles hooked into securing points at the tanktop and at higher levels adjacent to the ship's shell plating.

There are some bulk carriers that have cargo spaces of suitable dimensions without upper or lower sloping wing tanks. Although alternative methods, when carefully implemented, have been used with success in such spaces, it is still recommended that the principles set out above be followed.

For further information please contact:
Loss Prevention Department, Thomas Miller P&I Ltd
Tel: +44 20 7204 2307. Fax +44 20 7283 6517
Email: lossprevention.ukclub@thomasmiller.com