Code of Practice for Packing of Cargo Transport Units (CTUs)

(CTU Code)

Annexes

2013 Draft version

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Annex 1. Consequences of improper packing procedures

1 Consequences of badly packed and secured cargo

1.1 Cargo which has not been properly packed and sufficiently secured in a cargo transport unit may move inside the unit when it is exposed to acceleration, e.g. by hard braking of a vehicle on the road or by heavy ship motions at sea. Moving cargo resulting from improper securing may cause accidents, damage to the cargo, to other cargo or to the cargo transport unit. In particular heavy cargo items may develop inertia forces under such traffic accelerations, which may let them break through the CTU boundaries, menacing persons, environment or property of third parties.

Figure 1.1 Lack of longitudinal securing

Figure 1.2 Inadequate side wall strength

1.2 Figure 1.1 shows an example where hard braking and a lack of longitudinal securing has resulted in the cargo breaking through the container doors. Figure 1.2 shows a second example where the cargo has been secured against a vehicle side with inadequate strength.

1.3 Cargo breaking out of CTUs is of particular danger on board RO/RO vessels, where shifting cargo and CTUs may affect safe operations on the vehicle deck or the stability of the ship (See Figure 1.3 and Figure 1.4).

Figure 1.3 Cargo breaking out of a trailer

Figure 1.4 Shifted cargo on a RO/RO deck

Figure 1.5 Heavily listing vessel after cargo has shifted

1.4 Cargo having broken out of a trailer has caused other trailers to shift and the vessel to get a heavy list (see Figure 1.5)

1.5 Damage to the cargo is always an economic loss. Additionally, in case of dangerous goods, any damage to a receptacle may impair its containment capability and cause spillage of the contents (see Figure 1.6), thus endangering persons and affecting the safety of the transport vehicle or ship.

Figure 1.6 Unsecured packages

Figure 1.7 Loose packages on rail wagon

1.6 Spilled cargo may also endanger the environment. Cargo from road or rail transport may cause contamination of the soil and/or water, and marine pollution when released at sea.

Figure 1.8 Spilled liquid dangerous goods

Figure 1.9 Broken IBCs

2 Consequences of insufficient control of humidity

2.1 Some CTUs like containers present a closed box with a specific micro climate. During a long distance transport the humidity contained in the goods and in the packing material including timber used for blocking and protection may condensate on the inner boundaries of the container or on the cargo or even within the cargo. If sensible goods are packed carelessly into such a closed CTU, mainly box containers for sea transport, metal parts, if not properly protected, may corrode, clean surfaces may be stained and organic materials may suffer from mould or rot or other degradation.

Figure 1.10 Mould damage

Figure 1.11 Condensation damage

2.2 In particular hygroscopic cargoes have variable water content. In ambient air of high relative humidity, they absorb water vapour, while in ambient air of low relative humidity, they release water vapour. If packed into a container in a climate of high relative humidity they would bring a considerable amount of water into the container, providing for an internal high relative humidity.

This water may be released from the goods during temperature changes and may condensate with the above mentioned consequences. If this threat has not been averted by pre-drying the cargo to a so-called "container-dry" state, the high water content may result in mould, rot and biochemical changes. For some products, these phenomena are also associated with self-heating, which may go as far as spontaneous combustion, for example with oil seeds, oil seed expellers and fish meal.

2.3 More information on preventing condensation can be found in Annex 5 *Condensation Damage*.

3 Consequences of the use of unsuitable CTUs

3.1 A CTU should be suitable for the particular cargo to be packed:

- climatically sensitive cargoes may require ventilated containers or a CTU with controlled atmosphere (reefer or heated container)
- heavy packages or packages with small footprints may require CTUs capable of carrying concentrated loads
- dry bulk powders and granules may require CTUs with stronger end walls

to avoid structural failure, overloading, serious damages or cargo losses.

2 CTUs showing structural deficiencies may fail under normal transport conditions, e.g. the bottom of a damaged container may collapse when the container is lifted, the front wall of a damaged road vehicle may give way upon hard braking or goods in a container with leaking roof may suffer from entering water. This makes a thorough pre-check of each CTU indispensable before packing may commence.

Figure 1.12 Ice from leak in door gasket

Figure 1.13 Overstressed floor

4 Consequences of overloading of CTUs

4.1 A CTU overloaded by excess mass presents a serious threat to the safety of work of the various persons along the chain of transport, who are in charge of handling, lifting or transporting the CTU. This applies to all modes of transport on road, rail and sea.

4.2 There many hazards associate with an overloaded CTU:

4.2.1 When loading or unloading the CTU on or off a ship, vehicle or rail-car and handling the CTU by mobile lifting equipment in a terminal area may result in a failure of the lifting equipment.

4.2.2 While attempting to lift an overloaded CTU from a ship, vehicle or rail-car, the lifting equipment may have inadequate lifting capacity and the lift fails (see Figure 1.14) or is aborted. An unacceptable delay will occur while a replacement device with greater capacity is sourced.

Figure 1.14 Tipped container handler (© abc.net.au)

4.2.3 Where cranes and lifting equipment are equipped with weight limit controls such failures may not occur, however, as these controls are designed to protect the crane from overstressing, they may not detect that the CTU is overloaded. As a consequence the overloaded CTU will enter transport chain and may cause an accident where the CTU turns over or falls from the transport equipment.

4.3 A CTU that is not overloaded, i.e. the gross mass of the CTU is less than the maximum permissible mass of the CTU, may be packed with cargo so that the gross mass exceeds the permissible gross mass of the vehicle. This hazard may be aggravated by the road vehicle's driver being unaware of the excess mass, and as a consequence may not adjust his driving habits accordingly. A similar hazard may arise from the specific conditions in intermodal road / rail transport, as rail wagon design does not provide for a sufficient overweight safety margin.

4.4 In view of the above, all efforts should be taken to prevent exceeding the maximum gross mass of the CTU or the capacity of the transport medium. However, if a unit is found to be overloaded or overweight, it should be removed from service until it has been repacked to its maximum gross mass.

4.5 Where there are no facilities for lifting and / or repacking an overloaded or overweight CTU, the CTU operator should arrange transport under the supervision of transport authorities back to the originator where re-packing can occur.

5 Consequences of improper documentation and miss-declaration

5.1 Missing or incomplete documentation may hamper the proper planning or executing the packing of a CTU. It may also interfere with the further transport and generate delays and thereby economic losses. This applies also to the correct and timely communication of non-technical information like the identification number or the seal number.

5.2 Missing information to the carrier identifying extraordinary cargo properties, such as out of gauge packages (over height, over width or over length), overweight or offset of centre of gravity, may cause damage to the cargo due to inadequate handling methods that could not be adjusted to meet the unusual properties of the packed CTU.

5.3 Missing or incorrect information on dangerous goods may lead to improper stowage of the CTU on the transport vehicle, in particular a ship. In case of an incident such as spillage or fire, missing dangerous goods information will impede emergency response actions.

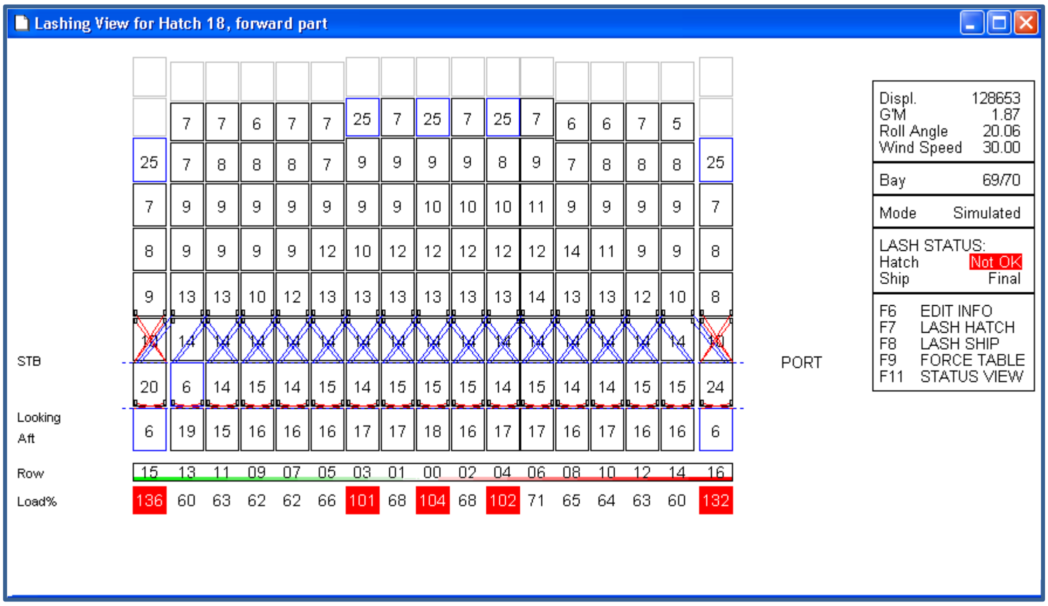


Figure 1.15 Container ship bay plan example

5.4 Figure 1.15 shows and example of a container ship's bay plan where containers have been incorrectly stowed. In row 01 there are 8 containers with a total stack mass of 96 tonnes. The load is shown as 68%. The next stack (00) has a miss-declared container placed on the top stack. Instead of the 7 tonnes (stack mass 98 tonnes) the transport documents declare, its actual mass is 25 tonnes (stack mass 116 tonnes). The stack load increases to 104% with a resulting risk of the stack failing when the ship rolls.

5.5 Row 15 and 16 show a greater risk with the load at 132% and 136% respectively. Any of the stacks in the rows where the load is greater than 100%. When the ship rolls these stacks will move transversely far greater than the adjacent stacks and as a result the whole bay may fail.

Figure 1.16 Stack failure

5.6 Incorrect gross mass declared for a CTU could result in overloading of a road vehicle or a rail car, especially if two or more units are loaded on one vehicle or one rail car. In case of sea transport, improper mass declaration of a container may result in an improper stowage position on board the ship and thereby in a fatal overstressing of the securing equipment for a stack of containers.

Annex 2. Information and documentation flow

1 Information flow

1.1 To ensure that the cargo is transported from originator to destination safety and securely, it is essential that those involved in CTU movements fully comply with the proper flow of information.

1.2 This includes the responsibility of the packer to identify all packages packed into a CTU and to include them in all appropriate documentation (see Part 2 *Documents related to transport*).

1.3 Additionally it will include a responsibility for a declaration to be made on the actual mass of cargo carried within the CTU and any hazards that may be present for all or some of the journey.

1.4 Parties involved with transport are responsible for ensuring that documentation and information is provided in adequate time and using terms that are internationally accepted.

1.5 The functions of the supply chain are discussed in Chapter 4 and can be summarised in the following graphical representation:

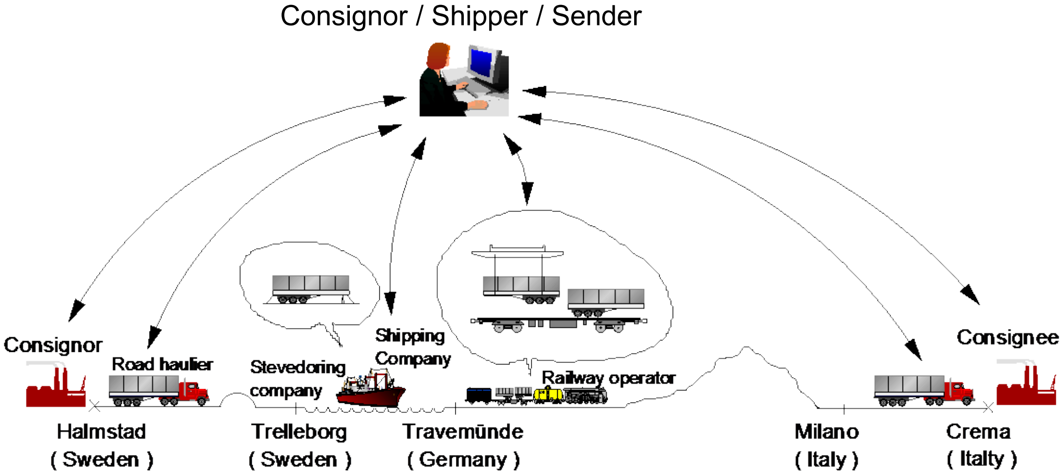


Figure 2.1 Typical flow of information

1.6 Within the terms of this Code of Practice the principle contacts are between the shipper and the carrier. Others parties such as the terminal or haulier, though actively involved are responsible either of these parties.

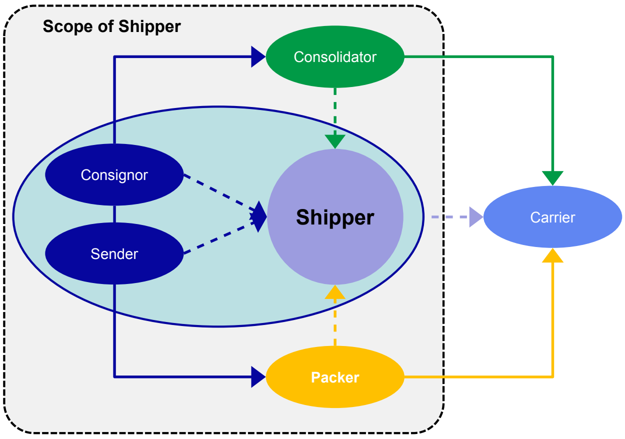


Figure 2.2 Relationship of functions

1.7 Figure 2.2 shows the relationship of functions at the start of the supply chain. A sender and consignor may be considered as the same function and under certain circumstances may be also referred to as the shipper. However the shipper may act as the processor of information receiving information about the cargo and the packing details from the consignor / sender and packer / consolidator respectively.

1.7.1 The shipper may also be the packer / consolidator receiving goods from the consignor and packing them into the CTU before despatching it to the carrier.

1.7.2 Finally the shipper may be the consignor, producing the goods, packing it into the CTU and then contracting the carrier to move the CTU to its destination.

1.7.3 There is a final combination, where the shipper combines the consignor, the packer and the carrier, however for the purposes of this Code of Practice, this combination will not be considered.

1.8 The shipper will arrange the transport of the goods, and depending on the nature of the contract between the shipper, the carriers and the consignee. In some contracts there is an agree location, terminal or destination where the shipper fulfils their responsibilities. Thereafter responsibility is transferred to the consignee or another shipper.

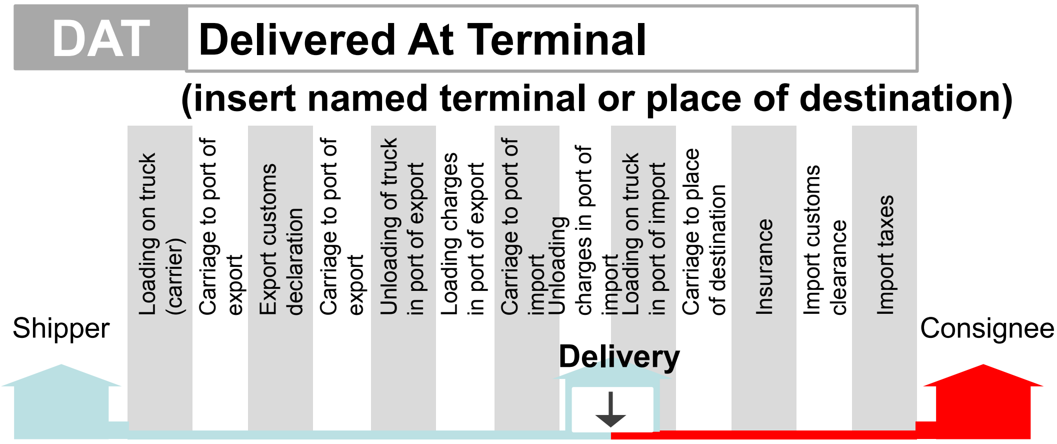


Figure 2.3 Typical contract term

1.8.1 Figure 2.3 shows a typical INCOTERM published by the International Chamber of Commerce. Under this contract the shipper is responsible for all aspects of transport up until the CTU is unloaded at the port of import.

1.8.2 Thereafter the consignee, or their agent who will undertake the function of a shipper, will arrange onward transport of the CTU and continue the chain of information for the shipment.

2 Documents related to transport

2.1 The CMR note (Road transport)

The CMR note is the consignment note through which the CMR Convention is applied to international road haulage when at least one of the countries is a Contracting country to the Convention. There are only a very few specific exemptions. Existence of the CMR note confirms that the carrier (i.e. the transportation company) has received the goods and that a contract of carriage exists between the consignor/trader and the carrier. If CMR applies to a contract it provides all parties to the contract with the complete regime for the determination of their rights, obligations, liabilities and remedies, in respect of claims for loss, damage or delay to the goods. Unlike a bill of lading, a CMR is not a document of title or a declaration, although some States regard it as such. It does not necessarily give its holder and/or the carrier rights of ownership or possession of the goods, which will be decided by the courts on a case-by-case basis.

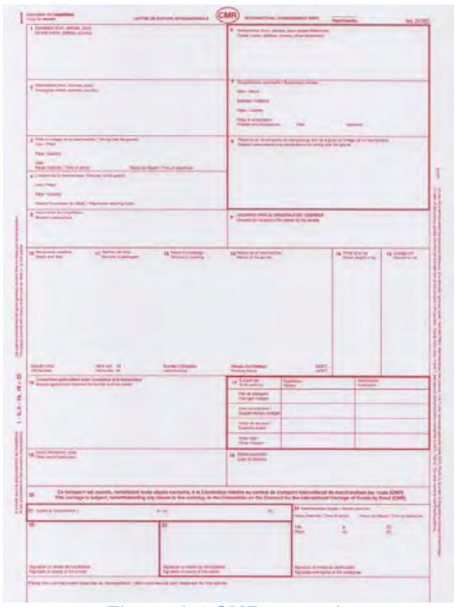


Figure 2.4 CMR example

2.2 Forwarders certificate of receipt (FCR) (all modes of transportation)

2.2.1 The Forwarders Certificate of Receipt was introduced for the use by international freight forwarders. The FCR document enables the freight forwarder to provide the consignor with a special document as an official acknowledgement that he has assumed responsibility of the goods.

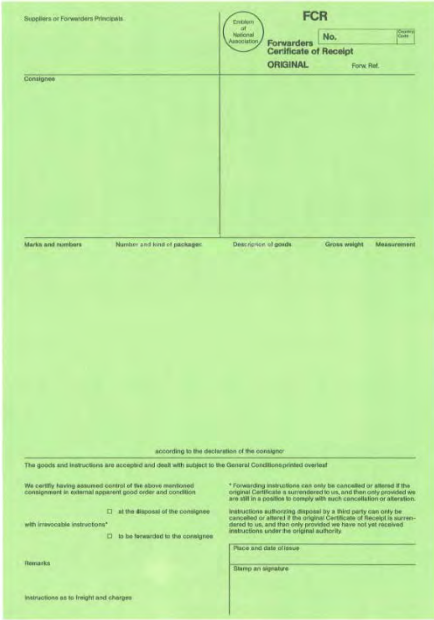


Figure 2.5 : Example FCR

2.2.2 By completing the FCR the freight forwarder certifies that he is in possession of a specific consignment with irrevocable instructions for despatch to the consignee shown in the document or for keeping it at his disposal. These instructions may only be cancelled if the original FCR document is handed over to the issuing freight forwarder and only if he is in a position to comply with such cancellation or alteration.

2.2.3 The FCR will primarily be used when the supplier sells the goods ex works and needs to prove that he has complied with his obligations to the buyer by presenting a FCR. In the case of a Letter of Credit the seller will under such conditions be able to present a FCR issued by a forwarder in order to obtain payment of the sales price placed at his disposal by the buyer under the terms of the Letter of Credit. The seller can no longer dispose of goods handed over to the forwarder once the FCR document has been handed over to the buyer.

2.2.4 The FCR is not negotiable. As the delivery of the consignment to the consignee does not depend on the handing over of this document, only one original is issued. Should further copies be required, forms specially overprinted with the words "Copy not negotiable" should be used.

2.2.5 Another similar document, the Forwarders' Certificate of Transport (FCT), is negotiable. This means that the forwarder accepts responsibility to deliver to a destination you specify - not to an unchangeable destination as with the FCR.

2 CIM consignment note (Rail transport)

2.1.1 This document confirms that the rail carrier has received the goods and that a contract of carriage exists between trader and carrier.

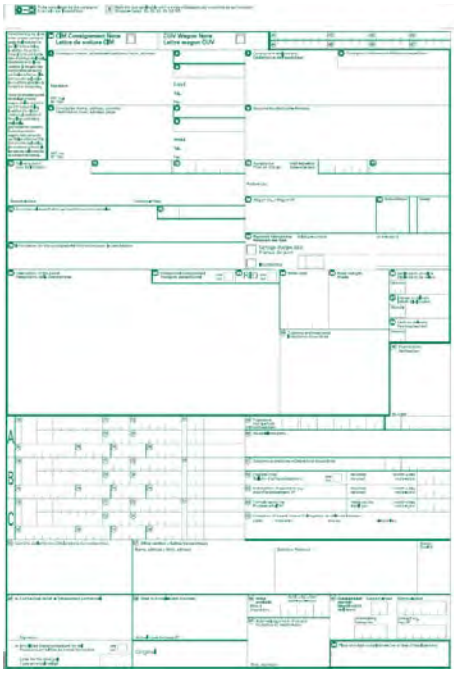


Figure 2.6 CIM example

2.1.2 Unlike a bill of lading, a CIM note isn't a document of title. It doesn't give its holder rights of ownership or possession of the goods.

2.1.3 Key details to be provided in the note include:

- a description of the goods;
- the number of packages and their weight; and
- the names and addresses of the sender and recipient.

2.1.4 The consignor is responsible for the accuracy of CIM notes, and is liable for any loss or damage suffered by the carrier due to inaccurate information. Notes are used to calculate compensation if goods are lost or damaged.

2.2 Export Cargo Shipping Instruction (ECSI) (Sea transport)

This is the document is used to provide the shipping company with details of your goods and set out your instructions for the shipment. It follows up on the initial booking, when space will have been confirmed on particular sailings. The process is often concluded by telephone.

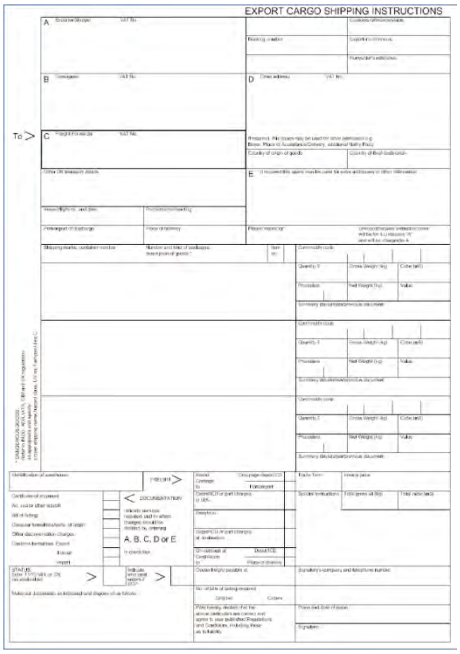

EXPORT CARGO SHIPPING INSTRUCTIONS

Figure 2.7 : ECSI example

2.3 Standard Shipping Note (Sea transport)

If the goods are non-hazardous, a Standard Shipping Note is required. This gives the port of loading the information it needs to handle your goods correctly. It's also used by the shipping company to check the actual information about the goods once they have been loaded into the container with the predicted information supplied beforehand.


STANDARD SHIPPING NOTE FOR NON-DANGEROUS GOODS ONLY

Figure 2.8 SSN example

2.4 Dangerous Goods Note (Sea transport)

2.4.1 If however, the goods are considered to be dangerous as per the IMDG Code, a Dangerous Goods Note (DGN) will also be required.

2.4.2 At the bottom of the DGN is a section “Container / vehicle packing certificate”. This section must be completed by a representative of the organisation that completes the packing of the dangerous goods, who may not be the shipper or consignor.


DANGEROUS GOODS NOTE

Figure 2.9 DGN example

2.5 Bill of lading (Sea transport)

2.5.1 This is issued by the carrier and serves three purposes:

- it shows that the carrier has received the goods;
- it provides evidence of a contract of carriage; and
- it serves as a document of title to the goods.

2.5.2 There are a number of different types of Bill of Lading some of which may be transmitted electronically.

Figure 2.10 BoL example

2.6 Multimodal bill of lading

2.6.1 Increasingly, international trade journeys are intermodal, with freight forwarders playing a crucial coordinating role. Much multimodal transports are handled with such a document.

2.6.2 The FIATA Multimodal Transport Bill of Lading (FBL) is a carrier-type transport document for the use by freight forwarders acting as multimodal transport operators (MTO).

2.6.3 A freight forwarder acting as Multimodal Transport Operator (MTO) or marine carrier issuing a FBL is responsible for the performance of transport. The freight forwarder does not only assume responsibility for delivery of the goods at destination, but also for all carriers and third parties engaged by him for the performance of the whole transport.

2.7 Sea waybill (Sea transport)

This fulfils the same practical functions as the bill of lading, but does not confer title to the goods and is therefore quicker and easier to use. It's often used where there's a well-established trading relationship between buyer and seller or in transactions where ownership doesn't change hands, e.g. between divisions of a single company.

Figure 2.11 SWB example

Annex 3. Safe transport of containers at sea

1 Introduction

This Annex is an extract of the International Chamber of Shipping (ICS) and World Shipping Council (WSC) publication "*Safe Transport of Containers at Sea*"[1]. Although much of the information in that document is outside of the scope of the Code of Practice, it provides those involved with the packing and handling of container type CTUs with a better understanding of the requirements for safe transport of containers on maritime transport and is recommended reading.

2 Marine terminal operations (MTOs)

2.1 Overview

2.1.1 This Annex addresses actions that should be undertaken by marine terminal operators when accepting containers, and the correct procedures to be followed when loading and unloading containers on board ships. This guidance follows the sequence of actions normally expected of a container terminal during its operations, and takes into consideration existing practical constraints concerning terminal productivity and overall safety and security, as well as local methods and practices, which may vary from port to port and from terminal to terminal.

2.1.2 It should be stressed that at all times and in all operations, the safety and security of the terminal, the shoreside and shipboard personnel, and ships calling at the port must always take precedence over terminal productivity.

2.2 Shipper's booking

Prior to berth assignment and the development of a cargo loading plan, terminal operators should receive full container details from the carrier, including, but not limited to:

- Gross mass of laden container (gross cargo mass plus container tare mass);
- Full hazard details of DG;
- Exact dimensions, nature and extent of over size with respect to OOG cargo;
- Temperature setting in degrees centigrade (°C) or degrees Fahrenheit (°F) with respect to reefer containers;
- Any special requirements, e.g. under deck stow, deck stow, cool stow, away from sources of heat, import priority container etc., and any other parameter that will affect the stacking in the yard and planning on board the ship;
- Digital photographs of the cargo packing and securing arrangements.

2.3 Berth assignment

2.3.1 Terminal operators should pre-assign berths on the basis of the following criteria:

- Proximity to the export yard and, to a lesser extent as appropriate, to the import yard as well. Berths should preferably be pre-assigned at least 3 days in advance of the ship's arrival;
- Number of gantry cranes available at the berth to match with what is needed for optimal crane deployment;
- Adequate outreach capacity of gantry cranes;
- Adequate water depth, for which early advice of the estimated arrival draft is important and which may present problems for ships with a short steaming time (e.g. less than 24 hours) from the previous port.

2.3.2 The export yard should be pre-determined before commencement of receiving export containers, normally 3 days before the ship's arrival, although some containers may start arriving at the terminal as much as 7 days prior to the ship's arrival.

[1] Safe Transport of Containers by Sea. Guidelines for best practice. Marisec Publications, 2008. Available from publications@marisec.org

2.4 Cargo cut off

Adequate cargo delivery cut-off is necessary to ensure proper segregation of containers at export container yards, in order to facilitate stowage planning and crane sequencing. Adequate time should also be provided to facilitate drafting of the stowage plan.

2.5 Safety and security checks prior to entry

2.5.1 It is important for the terminal to ensure that containers accepted into the terminal are safe for operations and do not present a threat to the safety and security of the terminal, or ships and personnel within its environs. It is particularly important to ensure that "paperless" systems do not result in any dilution of the need to verify documentation.

2.5.2 The terminal should undertake the following actions at the first entry gate of the export yard, or while the container is in the terminal and before it goes onto a ship:

- Match the carrier's documentation against that of the haulier in order to prevent fraudulent shipments;
- Check the integrity of the container and its seal in order to preclude stowaways and the smuggling of contraband or threats to security. Whenever a broken or missing seal is found, it should be reported to the shipper and the authorities, and replaced with a new seal. The new seal number should be recorded;
- Check the container number against documentation;
- Check the presence of placards and markings on DG containers and verify them against documentation;
- Verify the container mass against documentation by use of a weighbridge or mass gauge/load indicator on yard equipment or, alternatively, verify that weighing has occurred before entry and that such weighing was compliant with accepted best practice;
- Ensure, during the lifting of the container by any terminal equipment, that an evaluation is made by the operator to check that the mass of the cargo is reasonably evenly distributed. If it is determined to exceed the "60% within half the length rule", the terminal must take steps to rectify the problem;
- Sideline any container that appears to be structurally unsound and/or unsafe for a more detailed examination;
- Check the lashing of non-enclosed containers;
- Confirm the dimensions of OOG cargo and update booking data accordingly;
- Notify the container operator if OOG cargo is found to be improperly or inadequately secured to the container;
- Check reefer temperatures against setting and, in cases where the allowable variance is exceeded, follow up with the container operator. A reasonable temperature variance should be set to trigger follow up action with container operators, and this should vary depending on the cargo type, i.e. chilled or frozen. If this is not possible at the gate due to a low battery, then the check should be made when the box is plugged into the terminal's power supply;
- Check reefer plugs and wires for defects prior to plugging into the terminal's reefer system.

2.6 Export yard

The placing of containers in the export yard should be pre-planned, and outbound containers segregated according to size, type and mass categories (Empty, L, M, H and XH) in order to facilitate smooth loading.

2.7 Stowage instruction

2.7.1 Terminal planners should liaise directly with the stowage co-ordinator in order to develop the stowage instruction. The instruction must be as specific as possible indicating, inter alia, the following:

- Stowage locations by bay, row and tier;
- Segregation by port marks and mass categories;
- Exact stowage locations and segregation of DG containers, reefers and OOG cargo.

2.7.2 Should changes to the plan be necessary, then the terminal planner should liaise with the stowage co-ordinator.

2.7.3 No major changes to the stowage layout should be carried out without acceptance from the stowage co-ordinator.

2.8 Crane sequencing

2.8.1 Cargo operations will normally commence with discharge and end with loading, although not all the cranes will complete discharge and start loading at the same time due to varying discharge/load throughputs allotted to each crane.

2.8.2 For maximum productivity, cranes should be sequenced so that they are spread out and can move in the same direction, i.e. from forward to aft or aft to forward, in order to avoid clashing. Furthermore, crane sequencing information should include details on bays and compartments (on deck, under deck, port section, starboard section, centre, etc.).

2.8.3 In order to avoid clashing and thus crane idling, it is important that no two cranes should ever come closer than within an appropriate clearance, i.e. from centre to centre of the cranes.

2.8.4 It is important to ensure that sufficient time is allowed to manage relay containers, as tight connection times can disrupt terminal planning and crane sequencing.

2.9 Ship / shore communication

Direct radio communication capability between the terminal (planners, foremen, watchmen, etc.) and the ship's duty officers must be established.

2.10 Arrival condition

2.10.1 Terminal planners must take into consideration the ship's arrival condition in order to develop the discharge/load sequencing.

2.10.2 In order to preclude incidents of the ship touching bottom as a result of having been assigned a berth with inadequate water depth, the ship must be required to submit accurate draft information for arrival to facilitate berth assignment. Attention must also be paid to air draft, both with regard to bridges over the access waterway but also the cranage at the berth.

2.11 Implementing the loading plan

Cargo operations should preferably not commence prior to checking the ship's departure condition and obtaining confirmation that it is ready to sail, based upon the loading plan given by the terminal planner to the ship on its arrival. The implications of any departure from the loading plan should be fully addressed through discussion between the ship's officers, the terminal planner and the shipping line's stowage co-ordinator.

2.12 Discharging

2.12.1 Discharge of containers must be sequenced to ensure that bending moments are not exceeded.

2.12.2 If a container is lifted and it is observed to be leaking or in an offensive condition, it should be returned to its cell and the crew should be informed of the condition of the container.

2.13 Loading

2.13.1 Loading must be sequenced in such a way as to ensure that bending moments are not exceeded, and one sided stow should be avoided to preclude excessive torsional moments.

2.13.2 Any deviation from the loading plan must be agreed and accepted by the ship's master.

2.13.3 During loading and discharging, it must be ensured that the ship's list does not exceed more than a few degrees. It will usually not be possible to continue cargo operations safely if the list exceeds 5 degrees.

2.13.4 If a container is lifted and it is observed to be leaking or in an offensive condition, it should be returned to the dock and the dock should be informed of the condition of the container. The terminal should never load a leaking or offensive container onto the ship.

2.14 Container lashing

The responsible ship's officer and the lashing supervisor should check that all containers are adequately lashed in accordance with the lashing plan upon completion of operations by the lashing gang.

2.15 Prior to departure

2.15.1 On completion of loading, the terminal should submit the final stowage bay plan to the ship, advising as to any changes made. On the basis of this, finalised departure conditions should be developed by the ship and submitted to the terminal.

2.15.2 The ship's officers should ensure that the following has been performed to their satisfaction:

- The terminal has stowed and segregated DG, 00G and reefer containers in accordance with the stowage instruction;
- Lashings for each and every container on deck have been securely tightened and are secured.

2.16 Transhipment containers

2.16.1 Transhipment containers pose significant challenges for terminal operators. Although beyond the same degree of control, transhipment containers must still be supervised in the interests of the safety and security of the terminal itself and of the wider transport chain.

2.16.2 The safety and security checks outlined in Section 7.5 should also apply to transhipment containers, with special attention given to the verification of total container mass against documentation, and the even distribution of mass.

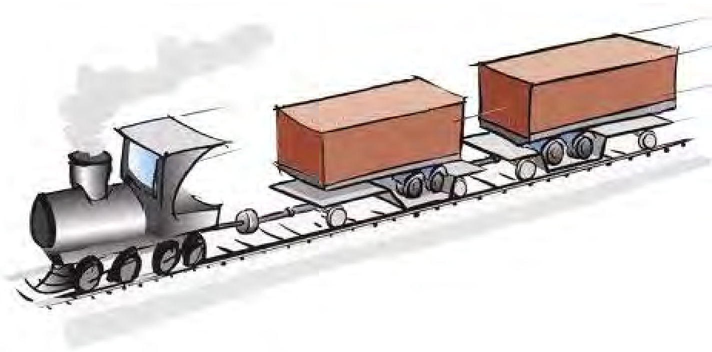
2.16.3 Tight connections for the movement of transhipment containers between line haul and feeder ships have to be managed such that terminal planning and crane sequencing will not be severely disrupted.

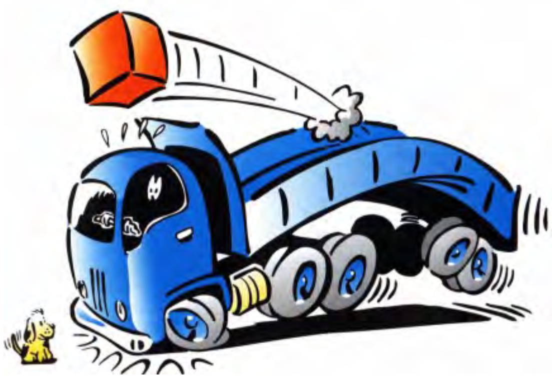
CTU Code

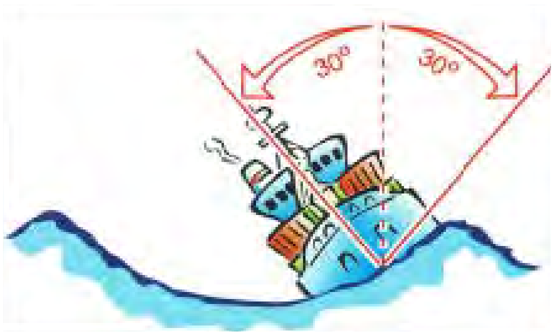
(Annex 4)

QUICK LASHING GUIDE

Cargo securing on CTUs for transports on Road, Combined Rail and in Sea Area A, B & C







CONTENT

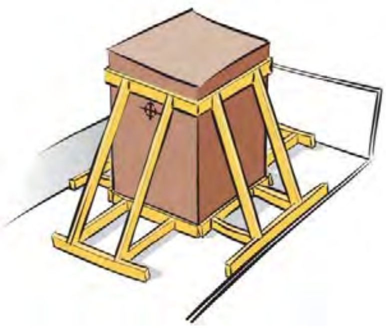
CARGO SECURING METHODS

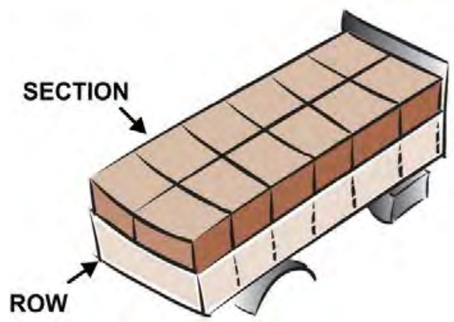
Goods shall be prevented from sliding and tipping in forward, backward and sideways directions by locking, blocking, lashing or a combination of these methods.

Blocking and Bracing

Blocking means that the cargo is stowed against fixed blocking structures and fixtures on the CTU. Clumps, wedges, dunnage, stanchions, inflatable dunnage bags and other devices which are supported directly or indirectly by fixed blocking structures are also considered as blocking.

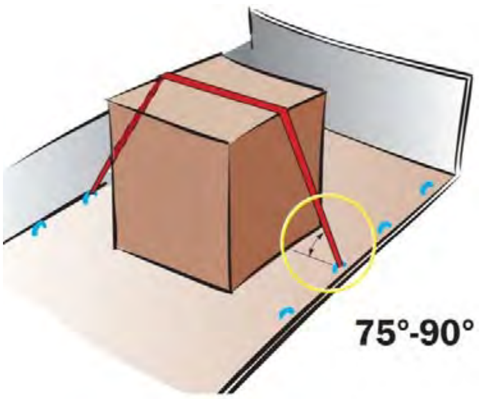
Blocking is primarily a method to prevent the cargo from sliding, but if the blocking reaches high enough, it also prevents tipping. Blocking is the primary method for cargo securing and should be used as far as possible.





The sum of void spaces in any direction should not exceed 15 cm. However, between dense rigid cargo items, such as steel, concrete or stone, the void spaces should be further minimized, as far as possible.

Top-over lashing

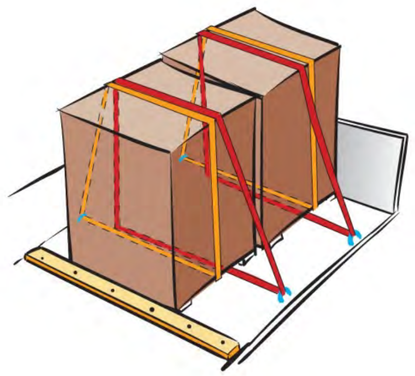


When using the tables for top-over lashing the angle between the lashing and the platform bed is of great importance. The tables are valid for an angle between 75°-90°. If the angle is between 30°- 75° twice the number of lashings are needed (alternatively the table values are halved). If the angle is less than 30°, another cargo securing method should be used.

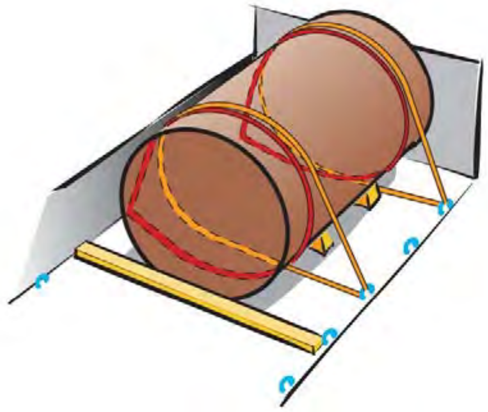
Top-over lashings preventing tipping forward **and** backward has to be placed symmetrically on the cargo.

Half loop lashing

A pair of half loop lashings prevents cargo from sliding and tipping sideways. Minimum one pair of half loop lashings per section should be used.

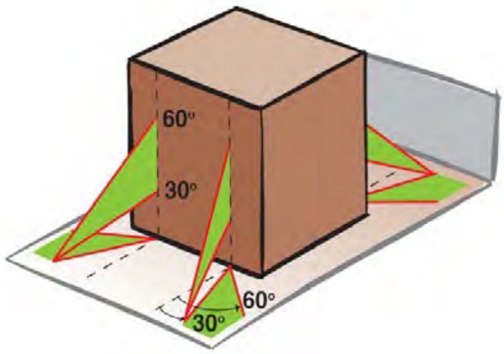


For tipping half the MSL value is to be used for design purposes.



When long cargo units are secured with half loop lashings, at least two pairs should be used to prevent the cargo from twisting.

Straight lashing

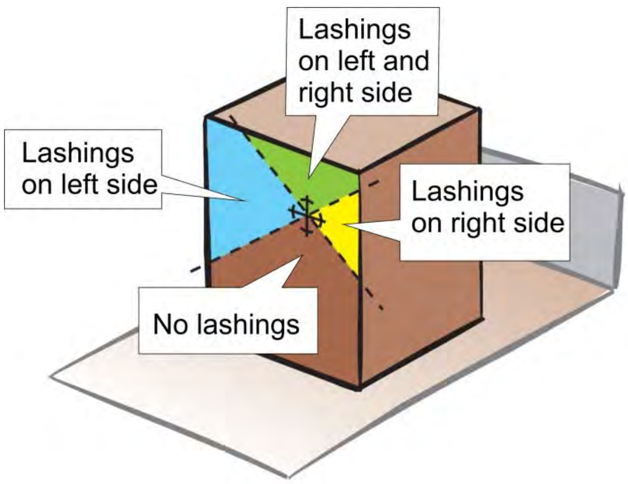


The allowable areas for fixing the lashings on the cargo unit are bounded by straight lines (one for each side), drawn through the centre of gravity in an angle of 45°.

The tables are valid for an angle of 30 - 60° between the lashing and the platform bed.

Sideways and lengthways the lashing angle should also lie between 30 - 60°.

If the cargo unit is blocked forward and backward and the lashings are placed with an angle of 90° towards the longitudinal axle, the cargo mass in the tables may be doubled.



When the lashings are fixed above the centre of gravity, the unit may also have to be blocked in the bottom to prevent sliding.

Spring lashing

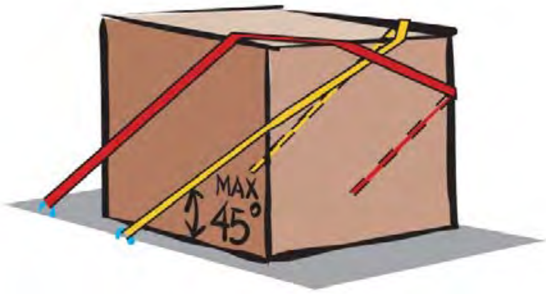
A spring lashing is used to prevent cargo from sliding and tipping forward or backward.

The angle between the lashing and the platform bed should be maximum 45°.

There are a number of ways to apply spring lashings, as illustrated below.

A.

B.



C.

Observe:

- Alternative A is not fully effective for tipping avoidance.
- Alternative C has two parts per side and thus secures twice the cargo mass given in the lashing tables.

If the spring lashing doesn't act on the top of the cargo the mass prevented from tipping is decreased. E.g. if the spring lashing acts at half the cargo height, it secures half the cargo mass given in the tipping tables.

For cargo units with the centre of gravity above their half height, the table values for tipping should be halved.

To prevent tipping, the spring lashing needs to be dimensioned for the mass of the outer section only.

BASIC CARGO SECURING REQUIREMENTS

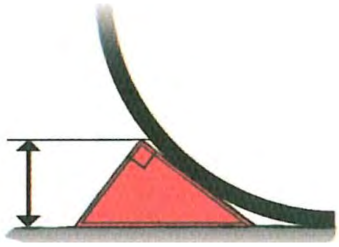
Non-rigid goods

If the goods are not rigid in form (bags, bales etc.) more lashings than prescribed in this quick lashing guide may be needed.

Rolling units

If rolling units aren't blocked, chocks with a height of at least 1/3 of the radius, shall be used.

If the unit is secured by lashings ensuring that the unit cannot roll over the chocks, the chock height need not to be greater than 20 cm.



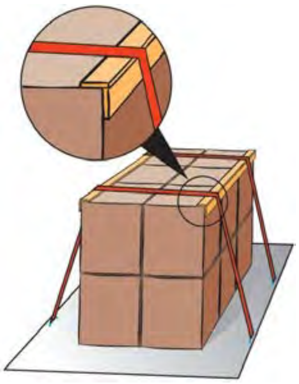
Bottom blocking

Bottom blocking preventing cargo from sliding must have a height of at least 5 cm, if the cargo isn't prevented from climbing over the blocking by suitable lashings.

Supporting edge beam

In some cases fewer lashings are needed than the number of sections that are to be secured. Since each unit has to be secured, the lashing effect may in these cases be spread out by supporting edge beams. For each end section one lashing shall be used as well as at least one lashing per every other section.

These edge beams can be manufactured profiles or deals (minimum 25x100 mm) nailed together.

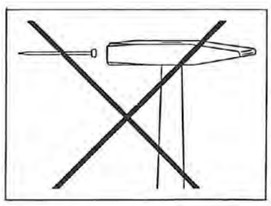


Blocking against the doors

When the door end of a CTU is designed to provide a defined wall resistance (e.g. the doors of a general cargo container) the doors may be considered as a strong cargo space boundary and used for cargo securing, provided the cargo is stowed to avoid impact loads to the door end and to prevent the cargo from falling out when the doors are opened.

Nailing

Nailing to the floor should not be done unless agreed with the CTU supplier.



SLIDING - FRICTION

Different material contacts have different friction factors. The table below shows recommended values for the friction factor (92.5% of the static friction). The values are valid provided that both contact surfaces are "swept clean" and free from any impurities. In case of direct lashings, where the cargo may move a little before the elongation of the lashings provides the desired restraint force, the dynamic friction applies, which is to be taken as 75 % of the friction factor. This effect is included in the lashing tables.

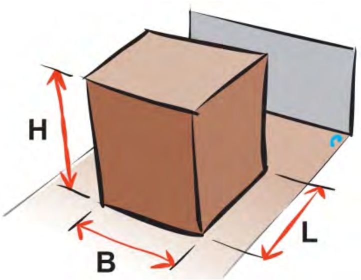
Material combination in contact surface	Friction factor μ	
	Dry	Wet
SAWN TIMBER/WOODEN PALLET		
Sawn timber/wooden pallet - plywood/plyfa/wood	0.45	0.45
Sawn timber/wooden pallet - grooved aluminium	0.40	0.40
Sawn timber/wooden pallet - stainless steel sheet	0.30	0.30
Sawn timber/wooden pallet - shrink film	0.30	-
PLANED WOOD		
Planed wood - plywood/plyfa/wood	0.30	0.30
Planed wood - grooved aluminium	0.25	0.25
Planed wood - smooth steel sheet	0.30	0.30
PLASTIC PALLETS		
Plastic pallet - plywood/plyfa/wood	0.20	0.20
Plastic pallet - grooved aluminium	0.15	0.15
Plastic pallet - smooth steel sheet	0.15	0.15
CARDBOARD (UNTREATED)		
Cardboard - cardboard	0.50	-
Cardboard - wooden pallet	0.50	-
BIG BAG		
Big bag - wooden pallet	0.40	-
STEEL AND SHEET METAL		
Flat steel - sawn timber	0.50	-
Unpainted metal with rough surface - sawn timber	0.50	-
Painted metal with rough surface - sawn timber	0.50	-
Unpainted metal with rough surface - unpainted rough metal	0.40	-
Painted metal with rough surface - painted rough metal	0.30	-
Unpainted metal with smooth surface - unpainted smooth metal	0.20	-
Painted metal with smooth surface - painted smooth metal	0.20	-

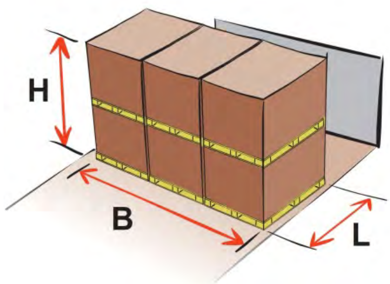
Material combination in contact surface	Friction factor μ	
	Dry	Wet
STEEL CRATES		
Steel crate - plywood/plyfa/wood	0.45	0.45
Steel crate - grooved aluminium	0.30	0.30
Steel crate - smooth steel	0.20	0.20
CONCRETE		
Concrete with rough surface - sawn timber	0.70	0.70
Concrete with smooth surface - sawn timber	0.55	0.55
ANTI-SLIP MATERIAL		
Rubber against other materials when contact surfaces are clean	0.60	0.60

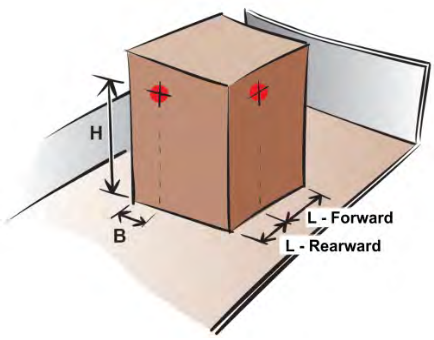
It has to be ensured, that the used friction factors are applicable to the actual transport. When a combination of contact surfaces is missing in the table above and when the surfaces are not swept clean the friction factor 0.30 or the value in the table if it is lower shall be used. If the surface contacts are not free from frost, ice and snow a friction factor μ = 0.20 shall be used. For oily and greasy surfaces or when slip sheets have been used a friction factor μ = 0.10 shall be used[1].

TIPPING - DIMENSIONS

The definition of **H**, **B** and **L** as shown to the right are to be used in the tables for tipping for cargo units with the centre of gravity close to its geometrical centre.







The definition of **H**, **B** and **L** as shown to the left are to be used in the tables for tipping for cargo units with the centre of gravity away from its geometrical centre.

For defining required number of lashings to prevent tipping, H/B and H/L is calculated. The obtained values are to be rounded up to the nearest higher value shown in the tables.

[1] For sea transport please also see CSS Code annex 13 subsection 7.2.

CARGO SECURING EQUIPMENT

Labelling

Cargo securing equipment may be labelled with one or more of the following quantities:

- **MBL** = Minimum Break Load
- **MSL** = Maximum Securing Load
- **LC** = Lashing Capacity according to EN 12195 (used for road transport)
- **S_{TF}** = Standard Tension Force = Pre-tension

The unit **daN,** where *1 daN = 1 kg*, is sometimes used to indicate the LC and S_{TF} for cargo securing equipment. MBL and MSL are usually stated in **kg** or **tons**.

Maximum Securing Load, MSL

- During sea transport the cargo securing arrangements are designed with respect to the **MSL** in the equipment.
- If labelling of MSL is missing MSL is primarily taken as LC when dimensioning according to the tables in this Quick Lashing Guide.
- Alternatively the MSL for different types of equipment is calculated from the minimum break load, **MBL**, according to the table below:

Equipment	MSL
Web lashing, re-usable	50% of MBL
Web lashing, single use	75 % *) of MBL
Chain lashing (class 8), speed lash, turnbuckle	50% of MBL
Wire, new	80% of MBL
Wire, used	30% of MBL
Steel strapping	70% of MBL
Tag washer	50% of MBL
Air bag	50% of MBL

*) Maximum 9 % elongation at MSL

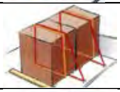
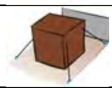
If labelling of the pre-tension force is missing **10% of MBL**, although not more than 1,000 kg, may be used as pre-tension when dimensioning according to the tables in this Quick Lashing Guide.

Lashing eyes

The lashing eyes should have at least the same strength in MSL as the lashings. For a half loop lashing the lashing eye should have at least the strength of 1.4 × MSL of the lashing if both ends of the lashing are fixed to the same eye.

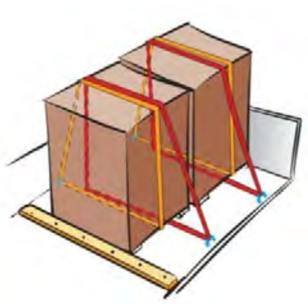
CONVERSION FACTORS FOR OTHER TYPES OF LASHING EQUIPMENT

For lashing equipment with MSL and pre-tension other than those shown in tables in this quick lashing guide, the table values shall be multiplied by a conversion factor corresponding to the actual lashing method and type of equipment, see the table below. All values used should be taken in **daN**, where *1* ***daN*** *≈ 1* ***kg***.

Lashing method		Webbing	Chain	Steel strapping	Wire
Top-over lashing		Pre-tension*/400	Pre-tension*/1,000	Pre-tension*/240	Pre-tension*/1,000
Half loop lashing		MSL*/2,000	MSL*/5,000	MSL*/1,700	MSL*/9,100
Spring lashing					
Straight lashing					

* Pre-tension and MSL are the values for the lashing equipment intended to be used

Example: A cargo unit shall be transported in Sea Area C. How many tons are prevented from sliding sideways by a pair of half loop web lashings with MSL 4 ton, if the friction factor is 0.3?



The quick lashing guide shows that a pair of half loop **web lashings** with MSL 2,000 daN prevents 4.3 ton of cargo from sliding sideways in Sea Area C, when the friction factor is 0.3.

MSL for the current web lashing is 4 ton ≈ 4,000 daN.

According to the table above, the conversion factor for half loop lashings is; MSL/2,000 = 4,000/2,000 = 2. The cargo mass prevented from sliding according to the lashing table shall be multiplied by the conversion factor and each pair of half loop web lashings thus prevents 2 × 4.3 = 8.6 ton of cargo from sliding sideways. This means that the cargo mass prevented from sliding by a pair of half loop lashings can be doubled when the MSL value for the lashing is doubled as long as the lashing eyes are strong enough.

REQUIRED NUMBER OF LASHINGS

The lashing tables in this quick lashing guide show the cargo mass in ton (1000 kg) prevented from sliding or tipping per lashing. The values in the tables are rounded to two significant figures.

The required number of lashings to prevent sliding and tipping is calculated by the help of the tables on the following pages according to the following procedure:

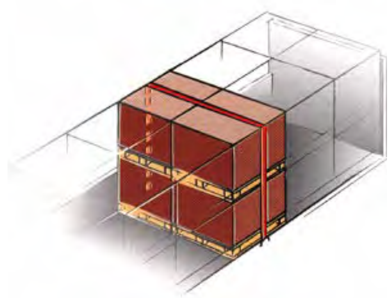
1. Calculate the required number of lashings to prevent sliding
2. Calculate the required number of lashings to prevent tipping
3. The largest number of the above is selected

Even if there is neither sliding nor tipping risk, it is recommended to always use at least one top-over lashing per every 4 ton of cargo or similar arrangement to avoid wandering for non-blocked cargo due to vibrations.

CARGO STOWED IN MORE THAN ONE LAYER

Method 1 (simple)

1. Determine the number of lashings to prevent sliding using the mass of the entire section and the lowest friction of any of the layers.
2. Determine the number of lashings to prevent tipping.
3. The largest number of lashings in step 1 and 2 is to be used.



Method 2 (advanced)

1. Determine the number of lashings to prevent sliding using
2. the mass of the entire section and the friction for the bottom layer.
3. Determine the number of lashings to prevent sliding using the mass of the section’s upper layer and the friction between the layers.
4. Determine the number of lashings for the entire section which is required to prevent tipping.
5. The largest number of lashings in step 1 to 3 is to be used.

CTU Code

QUICK LASHING GUIDE A

Cargo securing on CTUs for transports on Road, Combined Rail and in Sea Area A

Accelerations to be expected expressed in parts of the gravity acceleration (1g = 9.81 m/s^2).

Transport mode/ Sea area	Sideways		Forward		Backward	
	S	V	F	V	B	V
Road	0.5	1.0	0.8	1.0	0.5	1.0
Combined Rail	0.5	1.0	0.5	1.0	0.5	1.0
Sea Area A	0.5	1.0	0.3	0.5	0.3	0.5

V = Vertical acceleration in combination with longitudinal or transverse acceleration

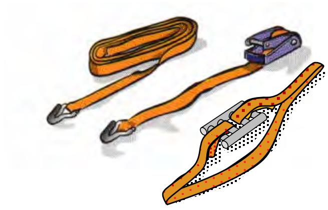
Goods; not rigid in form

If the goods aren’t rigid in form, more lashings than stipulated in this quick lashing guide could be required.

- All dimensions referred to as ton are equal to metric ton of 1000 kg.
- Sideways, forward and backward refers to a fore-and-aft stowed CTU.

WEBBING

Top-over lashings

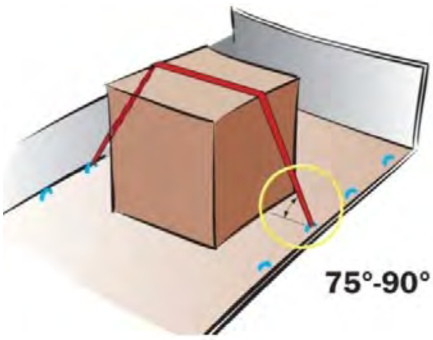


The tables are valid for **webbing** with an MSL of 2,000 daN - (2,000 kg = 2 ton) and a pre-tension of minimum 400 daN - (400 kg).

The values in the tables are proportional to the pre-tension in the lashings.

The masses in the tables are valid for one top-over lashing.

TOP-OVER LASHING

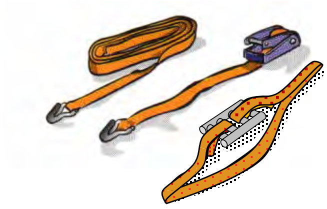


Cargo mass in ton prevented from sliding *per top-over lashing*			
μ	**SIDEWAYS**	**FORWARD**	**BACKWARD**
0.00	0.00	0.00	0.00
0.05	0.08	0.05	0.08
0.10	0.18	0.10	0.18
0.15	0.30	0.16	0.30
0.20	0.47	0.24	0.47
0.25	0.71	0.32	0.71
0.30	1.1	0.43	1.1
0.35	1.7	0.55	1.7
0.40	2.8	0.71	2.8
0.45	6.4	0.91	4.3
0.50	no slide	1.2	7.1
0.55	no slide	1.6	16
0.60	no slide	2.1	no slide
0.65	no slide	3.1	no slide
0.70	no slide	5.0	no slide

Cargo mass in ton prevented from tipping per top-over lashing								
SIDEWAYS							**FORWARD**	**BACKWARD**
H/B	**1 row**	**2 rows**	**3 rows**	**4 rows**	**5 rows**	**H/L**	**per section**	**per section**
0.6	no tip	no tip	no tip	6.3	2.9	0.6	no tip	no tip
0.8	no tip	no tip	5.4	2.1	1.4	0.8	no tip	no tip
1.0	no tip	no tip	2.2	1.3	0.96	1.0	no tip	no tip
1.2	no tip	4.5	1.3	0.90	0.72	1.2	no tip	no tip
1.4	no tip	2.2	0.98	0.70	0.58	1.4	5.9	no tip
1.6	no tip	1.5	0.77	0.57	0.48	1.6	2.5	no tip
1.8	no tip	1.1	0.63	0.48	0.41	1.8	1.6	18
2.0	no tip	0.89	0.54	0.42	0.36	2.0	1.2	7.1
2.2	7.1	0.74	0.47	0.37	0.32	2.2	0.93	4.4
2.4	3.5	0.64	0.41	0.33	0.29	2.4	0.77	3.2
2.6	2.4	0.56	0.37	0.30	0.26	2.6	0.66	2.4
2.8	1.8	0.50	0.34	0.27	0.24	2.8	0.57	1.8
3.0	1.4	0.45	0.31	0.25	0.22	3.0	0.51	1.4

WEBBING

Half-loop lashings

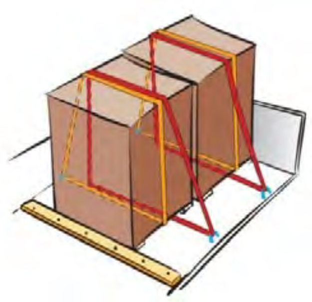


The tables are valid for **webbing** with an MSL of 2,000 daN - (2,000 kg = 2 ton) and a pre-tension of minimum 400 daN - (400 kg).

The masses in the tables below are valid for one pair of half loop lashings.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

HALF LOOP LASHING SLIDING

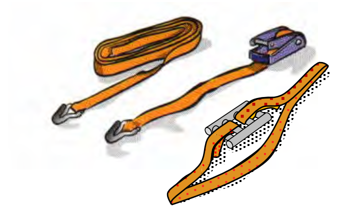


Cargo mass in ton prevented from sliding *per pair of half loop lashing*	
µ	**SIDEWAYS**
0.00	4.1
0.05	4.6
0.10	5.2
0.15	5.9
0.20	6.7
0.25	7.7
0.30	9.1
0.35	11
0.40	13
0.45	17
0.50	no slide
0.55	no slide
0.60	no slide
0.65	no slide
0.70	no slide

Cargo mass in ton prevented from tipping *per pair of half loop lashing*					
SIDEWAYS					
H/B	**1 row**	**2 rows**	**3 rows**	**4 rows**	**5 rows**
0.6	no tip	no tip	no tip	18	8.2
0.8	no tip	no tip	15	5.9	4.1
1.0	no tip	no tip	6.1	3.6	2.7
1.2	no tip	13	3.8	2.5	2.0
1.4	no tip	6.4	2.8	2.0	1.6
1.6	no tip	4.2	2.2	1.6	1.4
1.8	no tip	3.2	1.8	1.4	1.2
2.0	no tip	2.5	1.5	1.2	1.0
2.2	20	2.1	1.3	1.0	0.91
2.4	10	1.8	1.2	0.94	0.82
2.6	6.8	1.6	1.1	0.85	0.74
2.8	5.1	1.4	0.96	0.78	0.68
3.0	4.1	1.3	0.87	0.71	0.63

WEBBING

Straight lashings

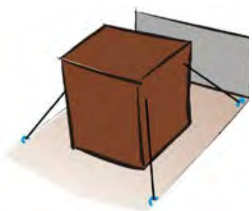


The tables are valid for **webbing** with an MSL of 2,000 daN - (2,000 kg = 2 ton) and a pre-tension of minimum 400 daN - (400 kg).

All masses are valid for one straight lashing.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

STRAIGHT LASHING SLIDING

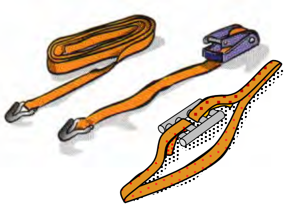


Cargo mass in ton prevented from sliding *per straight lashing*			
μ	**SIDEWAYS per side**	**FORWARD**	**BACKWARD**
0.00	1.0	0.64	1.0
0.05	1.2	0.76	1.2
0.10	1.5	0.89	1.5
0.15	1.8	1.0	1.8
0.20	2.2	1.2	2.2
0.25	2.7	1.4	2.7
0.30	3.3	1.6	3.3
0.35	4.1	1.8	4.1
0.40	5.2	2.1	5.2
0.45	6.8	2.4	6.8
0.50	no slide	2.8	10
0.55	no slide	3.2	13
0.60	no slide	3.7	no slide
0.65	no slide	4.4	no slide
0.70	no slide	5.2	no slide

Cargo mass in ton prevented from tipping *per* straight lashing				
H/B	**SIDEWAYS per side**	**H/L**	**FORWARD**	**BACKWARD**
0.6	no tip	**0.6**	no tip	no tip
0.8	no tip	**0.8**	no tip	no tip
1.0	no tip	**1.0**	no tip	no tip
1.2	no tip	**1.2**	no tip	no tip
1.4	no tip	**1.4**	10	no tip
1.6	no tip	**1.6**	4.7	no tip
1.8	no tip	**1.8**	3.2	36
2.0	no tip	**2.0**	2.5	15
2.2	16	**2.2**	2.1	10
2.4	8.7	**2.4**	1.9	7.9
2.6	6.1	**2.6**	1.7	6.1
2.8	4.8	**2.8**	1.6	4.8
3.0	4.1	**3.0**	1.5	4.1

WEBBING

Spring lashings



The tables are valid for **webbing** with an MSL of 2,000 daN - (2,000 kg = 2 ton) and a pre-tension of minimum 400 daN - (400 kg).

The masses in the tables are valid for one spring lashing.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

SPRING LASHING

Cargo mass in ton prevented from sliding *per* spring lashing		
μ	**FORWARD**	**BACKWARD**
0.00	3.6	5.8
0.05	3.9	6.5
0.10	4.3	7.3
0.15	4.7	8.3
0.20	5.1	9.5
0.25	5.6	11
0.30	6.1	13
0.35	6.8	15
0.40	7.5	19
0.45	8.3	24
0.50	9.3	35
0.55	11	43
0.60	12	no slide
0.65	14	no slide
0.70	16	no slide

Cargo mass in ton prevented from tipping *per* spring lashing		
H/L	**FORWARD**	**REARWARD**
0.6	no tip	no tip
0.8	no tip	no tip
1.0	no tip	no tip
1.2	no tip	no tip
1.4	67	no tip
1.6	33	no tip
1.8	24	259
2.0	19	115
2.2	17	79
2.4	15	63
2.6	14	50
2.8	13	40
3.0	12	35

TAG WASHERS AND NAILS

TAG WASHER
Approximate cargo mass in ton prevented from sliding by one tag washer for wood on wood in combination with top-over lashing only

μ**	SIDEWAYS						
	∅ 48	∅ 62	∅ 75	∅ 95	30×57	48×65	130×130
MBL (ton)	0.5	0.7	0.9	1.2	0.5	0.7	1.5
0.10	0.31	0.44	0.56	0.75	0.31	0.44	0.94
0.20	0.42	0.58	0.75	1.00	0.42	0.58	1.3
0.30	0.63	0.88	1.1	1.5	0.63	0.88	1.9
	FORWARD						
0.10	0.18	0.25	0.32	0.43	0.18	0.25	0.54
0.20	0.21	0.29	0.38	0.50	0.21	0.29	0.63
0.30	0.25	0.35	0.45	0.60	0.25	0.35	0.75
	BACKWARD						
0.10	0.31	0.44	0.56	0.75	0.31	0.44	0.94
0.20	0.42	0.58	0.75	1.00	0.42	0.58	1.3
0.30	0.63	0.88	1.1	1.5	0.63	0.88	1.9

** Between tag washer and platform bed/cargo.

4" – NAIL
Approximate cargo mass in ton prevented from sliding by one nail

μ***	SIDEWAYS per side		FORWARD		BACKWARD	
	blank	galvanised	blank	galvanised	blank	galvanised
MBL (ton)	0.22	0.32	0.22	0.32	0.22	0.32
0.00	0.22	0.32	0.14	0.20	0.22	0.32
0.05	0.24	0.36	0.15	0.21	0.24	0.36
0.10	0.28	0.40	0.16	0.23	0.28	0.40
0.15	0.31	0.46	0.17	0.25	0.31	0.46
0.20	0.37	0.53	0.18	0.27	0.37	0.53
0.25	0.44	0.64	0.20	0.29	0.44	0.64
0.30	0.55	0.80	0.22	0.32	0.55	0.80
0.35	0.73	1.1	0.24	0.36	0.73	1.1
0.40	1.1	1.6	0.28	0.40	1.1	1.6
0.45	2.2	3.2	0.31	0.46	1.5	2.1
0.50	no slide	no slide	0.37	0.53	2.2	3.2
0.55	no slide	no slide	0.44	0.64	4.4	6.4
0.60	no slide	no slide	0.55	0.80	no slide	no slide
0.65	no slide	no slide	0.73	1.1	no slide	no slide
0.70	no slide	no slide	1.1	1.6	no slide	no slide

*** *Between cargo and platform bed.*

CTU Code

QUICK LASHING GUIDE B

Cargo securing on CTUs for transports on Road, Combined Rail and in Sea Area B

Accelerations to be expected expressed in parts of the gravity acceleration (1g = 9.81 m/s2).

Transport mode/ Sea area	Sideways		Forward		Backward	
	S	V	F	V	B	V
Road	0.5	1.0	0.8	1.0	0.5	1.0
Combined Rail	0.5	1.0	0.5	1.0	0.5	1.0
Sea Area B	0.7	1.0	0.3	0.3	0.3	0.3

V = Vertical acceleration in combination with longitudinal or transverse acceleration

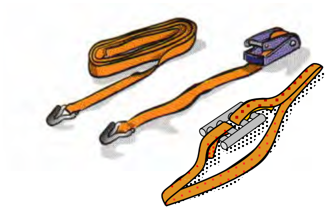
Goods; not rigid in form

If the goods aren't rigid in form, more lashings than stipulated in this quick lashing guide could be required.

- All dimensions referred to as ton are equal to metric tonne of 1000 kg.
- Sideways, forward and backward refers to a fore-and-aft stowed CTU.

WEBBING

Top-over lashings

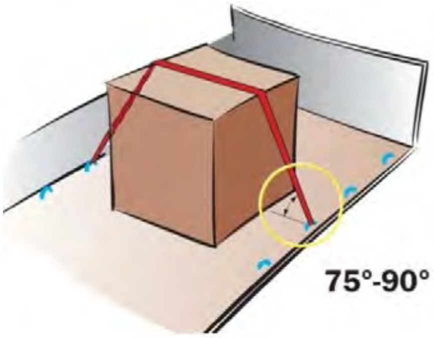


The tables are valid for **webbing** with an MSL of 2,000 daN - (2,000 kg = 2 ton) and a pre-tension of minimum 400 daN - (400 kg).

The values in the tables are proportional to the pre-tension in the lashings.

The masses in the tables are valid for one top-over lashing.

TOP-OVER LASHING

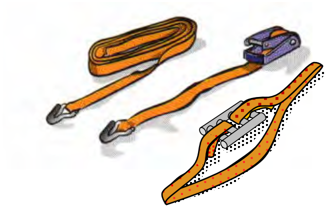


Cargo mass in ton prevented from sliding *per* top-over lashing			
μ	SIDEWAYS	FORWARD	BACKWARD
0.00	0.00	0.00	0.00
0.05	0.05	0.05	0.08
0.10	0.12	0.10	0.18
0.15	0.19	0.16	0.30
0.20	0.28	0.24	0.47
0.25	0.39	0.32	0.71
0.30	0.53	0.43	1.0
0.35	0.71	0.55	1.3
0.40	0.95	0.71	1.6
0.45	1.3	0.91	1.9
0.50	1.8	1.2	2.4
0.55	2.6	1.6	2.9
0.60	4.3	2.1	3.5
0.65	9.2	3.1	4.4
0.70	no slide	5.0	5.5

Cargo mass in ton prevented from tipping *per* top-over lashing								
SIDEWAYS							FORWARD	BACKWARD
H/B	1 row	2 rows	3 rows	4 rows	5 rows	H/L	per section	per section
0.6	no tip	no tip	4.1	1.9	1.3	**0.6**	no tip	no tip
0.8	no tip	7.4	1.6	1.0	0.80	**0.8**	no tip	no tip
1.0	no tip	2.2	0.98	0.70	0.58	**1.0**	no tip	no tip
1.2	no tip	1.3	0.71	0.53	0.45	**1.2**	12	12
1.4	no tip	0.93	0.55	0.43	0.37	**1.4**	5.9	5.9
1.6	5.9	0.72	0.46	0.36	0.31	**1.6**	2.5	3.9
1.8	2.7	0.59	0.39	0.31	0.27	**1.8**	1.6	3.0
2.0	1.8	0.50	0.34	0.27	0.24	**2.0**	1.2	2.4
2.2	1.3	0.43	0.30	0.24	0.22	**2.2**	0.93	2.0
2.4	1.0	0.38	0.27	0.22	0.19	**2.4**	0.77	1.7
2.6	0.86	0.34	0.24	0.20	0.18	**2.6**	0.66	1.5
2.8	0.74	0.31	0.22	0.18	0.16	**2.8**	0.57	1.3
3.0	0.64	0.28	0.20	0.17	0.15	**3.0**	0.51	1.2

WEBBING

Half-loop lashings

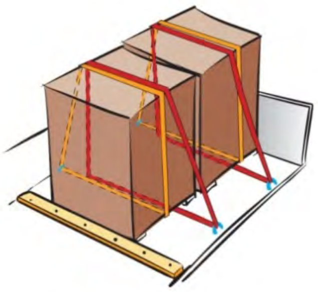


The tables are valid for **webbing** with an MSL of 2,000 daN - (2,000 kg = 2 ton) and a pre-tension of minimum 400 daN - (400 kg).

The masses in the tables below are valid for one pair of half loop lashings.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

HALF LOOP LASHING SLIDING

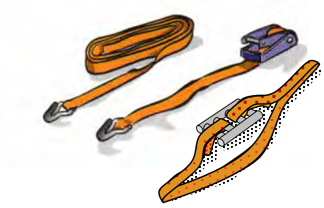


Cargo mass in ton prevented from sliding *per* pair of half loop lashing	
µ	**SIDEWAYS**
0.00	2.9
0.05	3.2
0.10	3.5
0.15	3.9
0.20	4.3
0.25	4.7
0.30	5.3
0.35	5.9
0.40	6.6
0.45	7.5
0.50	8.6
0.55	10
0.60	12
0.65	14
0.70	no slide

Cargo mass in ton prevented from tipping *per* pair of half loop lashing					
SIDEWAYS					
H/B	**1 row**	**2 rows**	**3 rows**	**4 rows**	**5 rows**
0.6	no tip	no tip	12	5.2	3.7
0.8	no tip	21	4.5	2.9	2.3
1.0	no tip	6.4	2.8	2.0	1.6
1.2	no tip	3.7	2.0	1.5	1.3
1.4	no tip	2.7	1.6	1.2	1.0
1.6	17	2.1	1.3	1.0	0.89
1.8	7.8	1.7	1.1	0.88	0.77
2.0	5.1	1.4	0.96	0.78	0.68
2.2	3.8	1.2	0.84	0.69	0.61
2.4	3.0	1.1	0.76	0.62	0.55
2.6	2.5	0.97	0.69	0.57	0.50
2.8	2.1	0.87	0.63	0.52	0.46
3.0	1.9	0.80	0.58	0.48	0.43

WEBBING

Straight lashings

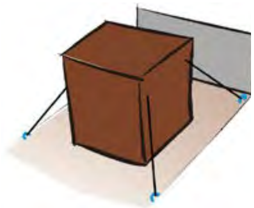


The tables are valid for **webbing** with an MSL of 2,000 daN - (2,000 kg = 2 ton) and a pre-tension of minimum 400 daN - (400 kg).

All masses are valid for one straight lashing.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

STRAIGHT LASHING SLIDING

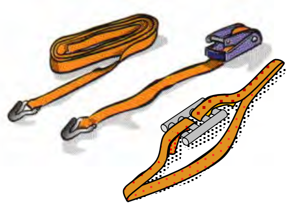


Cargo mass in ton prevented from sliding *per* straight lashing			
µ	**SIDEWAYS per side**	**FORWARD**	**BACKWARD**
0.00	0.73	0.64	1.0
0.05	0.87	0.76	1.2
0.10	1.0	0.89	1.5
0.15	1.2	1.0	1.8
0.20	1.4	1.2	2.2
0.25	1.6	1.4	2.7
0.30	1.9	1.6	3.3
0.35	2.2	1.8	4.1
0.40	2.6	2.1	4.9
0.45	3.0	2.4	5.6
0.50	3.6	2.8	6.2
0.55	4.3	3.2	7.0
0.60	5.2	3.7	7.9
0.65	6.4	4.4	8.9
0.70	no slide	5.2	10.0

Cargo mass in ton prevented from tipping *per* straight lashing				
H/B	**SIDEWAYS per side**	**H/L**	**FORWARD**	**BACKWARD**
0.6	no tip	**0.6**	no tip	no tip
0.8	no tip	**0.8**	no tip	no tip
1.0	no tip	**1.0**	no tip	no tip
1.2	no tip	**1.2**	19	19
1.4	no tip	**1.4**	10	10
1.6	11	**1.6**	4.7	7.4
1.8	5.5	**1.8**	3.2	5.9
2.0	3.8	**2.0**	2.5	5.1
2.2	3.0	**2.2**	2.1	4.5
2.4	2.5	**2.4**	1.9	4.1
2.6	2.2	**2.6**	1.7	3.8
2.8	2.0	**2.8**	1.6	3.6
3.0	1.9	**3.0**	1.5	3.4

WEBBING

Spring lashings



The tables are valid for **webbing** with an MSL of 2,000 daN - (2,000 kg = 2 ton) and a pre-tension of minimum 400 daN - (400 kg).

The masses in the tables are valid for one spring lashing.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

SPRING LASHING

Cargo mass in ton prevented from sliding *per* spring lashing		
μ	**FORWARD**	**BACKWARD**
0.00	3.6	5.8
0.05	3.9	6.5
0.10	4.3	7.3
0.15	4.7	8.3
0.20	5.1	9.5
0.25	5.6	11
0.30	6.1	13
0.35	6.8	15
0.40	7.5	18
0.45	8.3	19
0.50	9.3	21
0.55	11	23
0.60	12	25
0.65	14	28
0.70	16	31

Cargo mass in ton prevented from tipping *per* spring lashing		
H/L	**FORWARD**	**REARWARD**
0.6	no tip	no tip
0.8	no tip	no tip
1.0	no tip	no tip
1.2	115	115
1.4	67	67
1.6	33	51
1.8	24	43
2.0	19	38
2.2	17	35
2.4	15	33
2.6	14	31
2.8	13	30
3.0	12	29

CHAINS

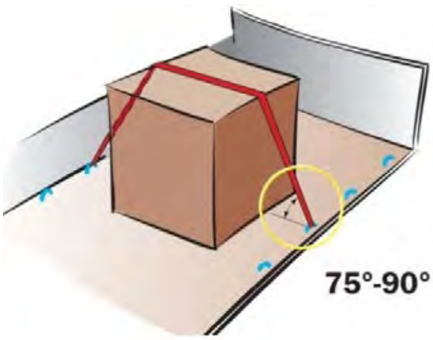
Top-over lashings

The tables are valid for **chain (∅ 9 mm, class 8)** with an MSL of 5,000 daN - (5,000 kg = 5 ton) and a pre-tension of minimum 1000 daN - (1000 kg = 1 ton).

The values in the tables are proportional to the pre-tension in the lashings.

The masses in the tables are valid for one top-over lashing.

TOP-OVER LASHING



Cargo mass in ton prevented from sliding *per* top-over lashing			
μ	**SIDEWAYS**	**FORWARD**	**BACKWARD**
0.00	0.00	0.00	0.00
0.05	0.14	0.12	0.20
0.10	0.30	0.25	0.44
0.15	0.48	0.41	0.76
0.20	0.71	0.59	1.2
0.25	0.98	0.81	1.8
0.30	1.3	1.1	2.5
0.35	1.8	1.4	3.2
0.40	2.4	1.8	3.9
0.45	3.2	2.3	4.8
0.50	4.4	3.0	5.9
0.55	6.5	3.9	7.2
0.60	11	5.3	8.9
0.65	23	7.7	11
0.70	no slide	12	14

Cargo mass in ton prevented from tipping *per* top-over lashing								
SIDEWAYS							**FORWARD**	**BACKWARD**
H/B	**1 row**	**2 rows**	**3 rows**	**4 rows**	**5 rows**	**H/L**	**per section**	**per section**
0.6	no tip	no tip	10	4.6	3.3	**0.6**	no tip	no tip
0.8	no tip	19	4.0	2.5	2.0	**0.8**	no tip	no tip
1.0	no tip	5.6	2.4	1.7	1.4	**1.0**	no tip	no tip
1.2	no tip	3.3	1.8	1.3	1.1	**1.2**	30	30
1.4	no tip	2.3	1.4	1.1	0.92	**1.4**	15	15
1.6	15	1.8	1.1	0.90	0.78	**1.6**	6.3	9.8
1.8	6.8	1.5	0.97	0.78	0.68	**1.8**	4.0	7.4
2.0	4.4	1.2	0.84	0.68	0.60	**2.0**	3.0	5.9
2.2	3.3	1.1	0.74	0.61	0.54	**2.2**	2.3	4.9
2.4	2.6	0.95	0.67	0.55	0.49	**2.4**	1.9	4.2
2.6	2.2	0.85	0.60	0.50	0.45	**2.6**	1.6	3.7
2.8	1.8	0.76	0.55	0.46	0.41	**2.8**	1.4	3.3
3.0	1.6	0.70	0.51	0.43	0.38	**3.0**	1.3	3.0

CHAINS

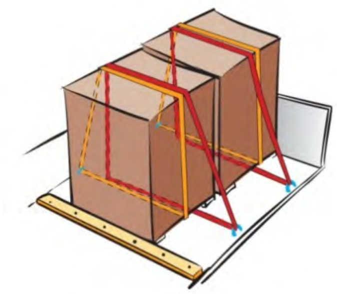
Half-loop lashings

The tables are valid for **chain (∅ 9 mm, class 8)** with an MSL of 5,000 daN - (5,000 kg = 5 ton) and a pre-tension of minimum 1,000 daN - (1,000 kg = 1 ton).

The masses in the tables below are valid for one pair of half loop lashings.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

HALF LOOP LASHING SLIDING

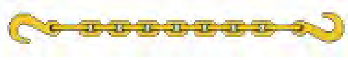


Cargo mass in ton prevented from sliding *per* pair of half loop lashing	
μ	**SIDEWAYS**
0.00	7.3
0.05	8.0
0.10	8.8
0.15	9.7
0.20	11
0.25	12
0.30	13
0.35	15
0.40	17
0.45	19
0.50	22
0.55	25
0.60	30
0.65	36
0.70	no slide

Cargo mass in ton prevented from tipping *per* pair of half loop lashing					
SIDEWAYS					
H/B	**1 row**	**2 rows**	**3 rows**	**4 rows**	**5 rows**
0.6	no tip	no tip	29	13	9.3
0.8	no tip	53	11	7.2	5.7
1.0	no tip	16	7.0	5.0	4.1
1.2	no tip	9.4	5.0	3.8	3.2
1.4	no tip	6.6	3.9	3.1	2.6
1.6	42	5.1	3.2	2.6	2.2
1.8	20	4.2	2.8	2.2	1.9
2.0	13	3.5	2.4	1.9	1.7
2.2	9.4	3.1	2.1	1.7	1.5
2.4	7.5	2.7	1.9	1.6	1.4
2.6	6.2	2.4	1.7	1.4	1.3
2.8	5.3	2.2	1.6	1.3	1.2
3.0	4.6	2.0	1.4	1.2	1.1

CHAINS

Straight lashings

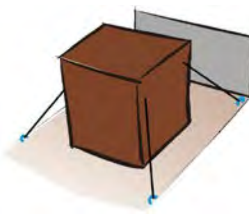


The tables are valid for **chain (∅ 9 mm, class 8)** with an MSL of 5000 daN - (5000 kg = 5 ton) and a pre-tension of minimum 1000 daN - (1000 kg = 1 ton).

All masses are valid for one straight lashing.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

STRAIGHT LASHING
SLIDING



Cargo mass in ton prevented from sliding *per* straight lashing			
μ	**SIDEWAYS per side**	**FORWARD**	**BACKWARD**
0.00	1.8	1.6	2.5
0.05	2.2	1.9	3.1
0.10	2.6	2.2	3.8
0.15	3.0	2.6	4.6
0.20	3.5	3.0	5.5
0.25	4.1	3.4	6.7
0.30	4.8	3.9	8.2
0.35	5.6	4.5	10
0.40	6.5	5.2	12
0.45	7.6	6.0	14
0.50	9.0	6.9	16
0.55	11	8.0	18
0.60	13	9.3	20
0.65	16	11	22
0.70	no slide	13	25

Cargo mass in ton prevented from tipping *per* straight lashing				
H/B	**SIDEWAYS per side**	**H/L**	**FORWARD**	**BACKWARD**
0.6	no tip	**0.6**	no tip	no tip
0.8	no tip	**0.8**	no tip	no tip
1.0	no tip	**1.0**	no tip	no tip
1.2	no tip	**1.2**	47	47
1.4	no tip	**1.4**	25	25
1.6	28	**1.6**	12	18
1.8	14	**1.8**	8.1	15
2.0	9.6	**2.0**	6.4	13
2.2	7.6	**2.2**	5.4	11
2.4	6.4	**2.4**	4.7	10
2.6	5.6	**2.6**	4.2	9.6
2.8	5.0	**2.8**	3.9	9.0
3.0	4.6	**3.0**	3.6	8.5

CHAINS

Spring lashings

The tables are valid for chain (∅ 9 mm, class 8) with an MSL of 5,000 daN - (5,000 kg = 5 ton) and a pre-tension of minimum 1,000 daN - (1,000 kg = 1 ton).

The masses in the tables are valid for one spring lashing.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

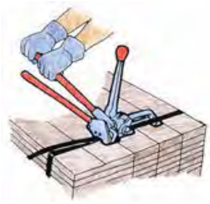
SPRING LASHING

Cargo mass in ton prevented from sliding *per* spring lashing		
μ	**FORWARD**	**BACKWARD**
0.00	9.0	14
0.05	9.8	16
0.10	11	18
0.15	12	21
0.20	13	24
0.25	14	27
0.30	15	32
0.35	17	38
0.40	19	45
0.45	21	49
0.50	23	53
0.55	26	58
0.60	30	63
0.65	34	70
0.70	40	77

Cargo mass in ton prevented from tipping *per* spring lashing		
H/L	**FORWARD**	**REARWARD**
0.6	no tip	no tip
0.8	no tip	no tip
1.0	no tip	no tip
1.2	288	288
1.4	168	168
1.6	82	128
1.8	59	108
2.0	48	96
2.2	42	88
2.4	38	82
2.6	35	78
2.8	33	75
3.0	31	72

STEEL STRAPPING

Top-over lashings

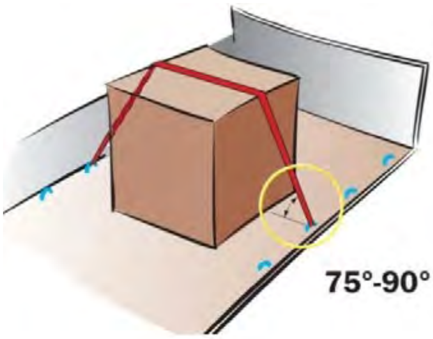


The tables are valid for **steel strapping (32 × 0.8 mm)** with an MSL of 1,700 daN - (1,700 kg = 1.7 ton) and a pre-tension of minimum 240 daN - (240 kg).

The values in the tables are proportional to the pre-tension in the lashings.

The masses in the tables are valid for one top-over lashing.

TOP-OVER LASHING

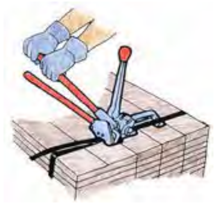


Cargo mass in ton prevented from sliding *per* top-over lashing			
μ	**SIDEWAYS**	**FORWARD**	**BACKWARD**
0.00	0.00	0.00	0.00
0.05	0.03	0.03	0.05
0.10	0.07	0.06	0.11
0.15	0.12	0.10	0.18
0.20	0.17	0.14	0.28
0.25	0.24	0.19	0.43
0.30	0.32	0.26	0.61
0.35	0.43	0.33	0.76
0.40	0.57	0.43	0.95
0.45	0.77	0.55	1.2
0.50	1.1	0.71	1.4
0.55	1.6	0.94	1.7
0.60	2.6	1.3	2.1
0.65	5.5	1.8	2.6
0.70	no slide	3.0	3.3

Cargo mass in ton prevented from tipping *per* top-over lashing								
SIDEWAYS							**FORWARD**	**BACKWARD**
H/B	**1 row**	**2 rows**	**3 rows**	**4 rows**	**5 rows**	**H/L**	**per section**	**per section**
0.6	no tip	no tip	2.5	1.1	0.79	**0.6**	no tip	no tip
0.8	no tip	4.5	0.95	0.61	0.48	**0.8**	no tip	no tip
1.0	no tip	1.3	0.59	0.42	0.35	**1.0**	no tip	no tip
1.2	no tip	0.79	0.42	0.32	0.27	**1.2**	7.1	7.1
1.4	no tip	0.56	0.33	0.26	0.22	**1.4**	3.5	3.5
1.6	3.5	0.43	0.27	0.22	0.19	**1.6**	1.5	2.4
1.8	1.6	0.35	0.23	0.19	0.16	**1.8**	0.97	1.8
2.0	1.1	0.30	0.20	0.16	0.14	**2.0**	0.71	1.4
2.2	0.79	0.26	0.18	0.15	0.13	**2.2**	0.56	1.2
2.4	0.63	0.23	0.16	0.13	0.12	**2.4**	0.46	1.0
2.6	0.52	0.20	0.14	0.12	0.11	**2.6**	0.39	0.89
2.8	0.44	0.18	0.13	0.11	0.10	**2.8**	0.34	0.79
3.0	0.39	0.17	0.12	0.10	0.09	**3.0**	0.30	0.71

STEEL STRAPPING

Half-loop lashings

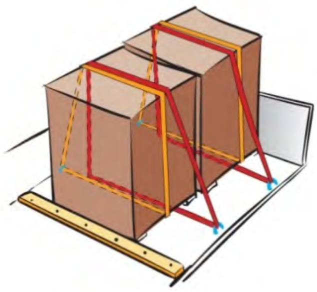


The tables are valid for **steel strapping** (**32 × 0.8 mm)** with an MSL of 1,700 daN - (1,700 kg = 1.7 ton) and a pre-tension of minimum 240 daN - (240 kg).

The masses in the tables below are valid for one pair of half loop lashings.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

HALF LOOP LASHING SLIDING



Cargo mass in ton prevented from sliding *per* pair of half loop lashing	
μ	**SIDEWAYS**
0.00	2.5
0.05	2.7
0.10	3.0
0.15	3.3
0.20	3.6
0.25	4.0
0.30	4.5
0.35	5.0
0.40	5.6
0.45	6.4
0.50	7.3
0.55	8.5
0.60	10
0.65	12
0.70	no slide

Cargo mass in ton prevented from tipping *per* pair of half loop lashing					
SIDEWAYS					
H/B	**1 row**	**2 rows**	**3 rows**	**4 rows**	**5 rows**
0.6	no tip	no tip	10.0	4.5	3.2
0.8	no tip	18	3.8	2.4	1.9
1.0	no tip	5.4	2.4	1.7	1.4
1.2	no tip	3.2	1.7	1.3	1.1
1.4	no tip	2.3	1.3	1.0	0.89
1.6	14	1.7	1.1	0.87	0.75
1.8	6.7	1.4	0.94	0.75	0.65
2.0	4.3	1.2	0.81	0.66	0.58
2.2	3.2	1.0	0.72	0.59	0.52
2.4	2.5	0.92	0.64	0.53	0.47
2.6	2.1	0.82	0.58	0.48	0.43
2.8	1.8	0.74	0.53	0.44	0.39
3.0	1.6	0.68	0.49	0.41	0.36

STEEL STRAPPING

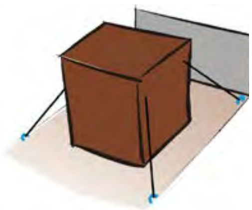
Straight lashings

The tables are valid for **steel strapping (32 × 0.8 mm)** with an MSL of 1,700 daN - (1,700 kg = 1.7 ton) and a pre-tension of minimum 240 daN - (240 kg).

All masses are valid for one straight lashing.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

STRAIGHT LASHING SLIDING

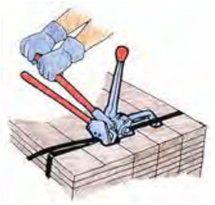


Cargo mass in ton prevented from sliding *per* straight lashing			
μ	**SIDEWAYS per side**	**FORWARD**	**BACKWARD**
0.00	0.62	0.54	0.87
0.05	0.74	0.64	1.1
0.10	0.87	0.75	1.3
0.15	1.0	0.88	1.6
0.20	1.2	1.0	1.9
0.25	1.4	1.2	2.3
0.30	1.6	1.3	2.8
0.35	1.9	1.5	3.5
0.40	2.2	1.8	4.2
0.45	2.6	2.0	4.7
0.50	3.1	2.3	5.3
0.55	3.7	2.7	6.0
0.60	4.4	3.2	6.7
0.65	5.5	3.7	7.6
0.70	no slide	4.4	8.5

Cargo mass in ton prevented from tipping *per* straight lashing				
H/B	**SIDEWAYS per side**	**H/L**	**FORWARD**	**BACKWARD**
0.6	no tip	**0.6**	no tip	no tip
0.8	no tip	**0.8**	no tip	no tip
1.0	no tip	**1.0**	no tip	no tip
1.2	no tip	**1.2**	16	16
1.4	no tip	**1.4**	8.7	8.7
1.6	9.4	**1.6**	4.0	6.3
1.8	4.7	**1.8**	2.8	5.1
2.0	3.2	**2.0**	2.2	4.3
2.2	2.6	**2.2**	1.8	3.9
2.4	2.2	**2.4**	1.6	3.5
2.6	1.9	**2.6**	1.4	3.2
2.8	1.7	**2.8**	1.3	3.0
3.0	1.6	**3.0**	1.2	2.9

STEEL STRAPPING

Spring lashings



The tables are valid for **steel strapping** (**32 × 0.8 mm)** with an MSL of 1,700 daN - (1,700 kg = 1.7 ton) and a pre-tension of minimum 240 daN - (240 kg).

The masses in the tables are valid for one spring lashing.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

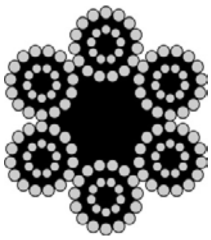
SPRING LASHING

Cargo mass in ton prevented from sliding *per* spring lashing		
μ	**FORWARD**	**BACKWARD**
0.00	3.1	4.9
0.05	3.3	5.5
0.10	3.6	6.2
0.15	4.0	7.0
0.20	4.3	8.1
0.25	4.8	9.3
0.30	5.2	11
0.35	5.8	13
0.40	6.4	15
0.45	7.1	16
0.50	7.9	18
0.55	8.9	20
0.60	10	22
0.65	12	24
0.70	14	26

Cargo mass in ton prevented from tipping *per* spring lashing		
H/L	**FORWARD**	**REARWARD**
0.6	no tip	no tip
0.8	no tip	no tip
1.0	no tip	no tip
1.2	98	98
1.4	57	57
1.6	28	44
1.8	20	37
2.0	16	33
2.2	14	30
2.4	13	28
2.6	12	27
2.8	11	25
3.0	11	25

WIRE

Top-over lashings

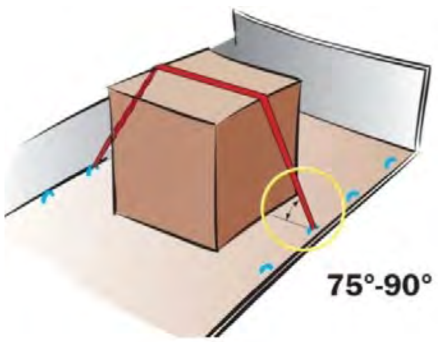


The tables are valid for **steel wire rope (∅ 16 mm/144 wires)** with an MSL of 9100 daN - (9,100 kg = 9.1 ton) and a pre-tension of minimum 1,000 daN - (1000 kg = 1 ton).

The values in the tables are proportional to the pre-tension in the lashings.

The masses in the tables are valid for one top-over lashing.

TOP-OVER LASHING

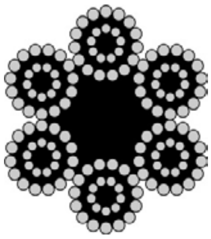


Cargo mass in ton prevented from sliding *per* top-over lashing			
μ	**SIDEWAYS**	**FORWARD**	**BACKWARD**
0.00	0.00	0.00	0.00
0.05	0.14	0.12	0.20
0.10	0.30	0.25	0.44
0.15	0.48	0.41	0.76
0.20	0.71	0.59	1.2
0.25	0.98	0.81	1.8
0.30	1.3	1.1	2.5
0.35	1.8	1.4	3.2
0.40	2.4	1.8	3.9
0.45	3.2	2.3	4.8
0.50	4.4	3.0	5.9
0.55	6.5	3.9	7.2
0.60	11	5.3	8.9
0.65	23	7.7	11
0.70	no slide	12	14

Cargo mass in ton prevented from tipping *per* top-over lashing								
SIDEWAYS							**FORWARD**	**BACKWARD**
H/B	**1 row**	**2 rows**	**3 rows**	**4 rows**	**5 rows**	**H/L**	**per section**	**per section**
0.6	no tip	no tip	10	4.6	3.3	**0.6**	no tip	no tip
0.8	no tip	19	4.0	2.5	2.0	**0.8**	no tip	no tip
1.0	no tip	5.6	2.4	1.7	1.4	**1.0**	no tip	no tip
1.2	no tip	3.3	1.8	1.3	1.1	**1.2**	30	30
1.4	no tip	2.3	1.4	1.1	0.92	**1.4**	15	15
1.6	15	1.8	1.1	0.90	0.78	**1.6**	6.3	9.8
1.8	6.8	1.5	0.97	0.78	0.68	**1.8**	4.0	7.4
2.0	4.4	1.2	0.84	0.68	0.60	**2.0**	3.0	5.9
2.2	3.3	1.1	0.74	0.61	0.54	**2.2**	2.3	4.9
2.4	2.6	0.95	0.67	0.55	0.49	**2.4**	1.9	4.2
2.6	2.2	0.85	0.60	0.50	0.45	**2.6**	1.6	3.7
2.8	1.8	0.76	0.55	0.46	0.41	**2.8**	1.4	3.3
3.0	1.6	0.70	0.51	0.43	0.38	**3.0**	1.3	3.0

WIRE

Half-loop lashings

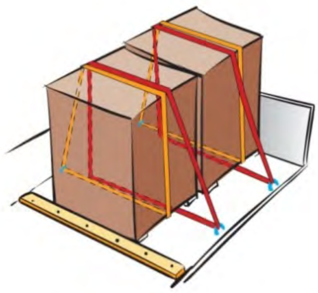


The tables are valid for **steel wire rope (∅ 16 mm/144 wires)** with an MSL of 9,100 daN - (9,100 kg = 9.1 ton) and a pre-tension of minimum 1,000 daN - (1,000 kg = 1 ton).

The masses in the tables below are valid for one pair of half loop lashings.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

HALF LOOP LASHING SLIDING

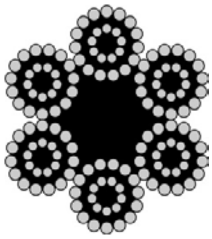


Cargo mass in ton prevented from sliding *per* pair of half loop lashing	
μ	**SIDEWAYS**
0.00	13
0.05	15
0.10	16
0.15	18
0.20	19
0.25	21
0.30	24
0.35	27
0.40	30
0.45	34
0.50	39
0.55	46
0.60	54
0.65	65
0.70	no slide

Cargo mass in ton prevented from tipping *per* pair of half loop lashing					
SIDEWAYS					
H/B	**1 row**	**2 rows**	**3 rows**	**4 rows**	**5 rows**
0.6	no tip	no tip	54	24	17
0.8	no tip	97	20	13	10
1.0	no tip	29	13	9.0	7.4
1.2	no tip	17	9.2	6.9	5.8
1.4	no tip	12	7.2	5.6	4.8
1.6	77	9.4	5.9	4.7	4.0
1.8	36	7.6	5.0	4.0	3.5
2.0	23	6.4	4.3	3.5	3.1
2.2	17	5.6	3.8	3.1	2.8
2.4	14	4.9	3.4	2.8	2.5
2.6	11	4.4	3.1	2.6	2.3
2.8	9.7	4.0	2.9	2.4	2.1
3.0	8.4	3.6	2.6	2.2	2.0

WIRE

Straight lashings

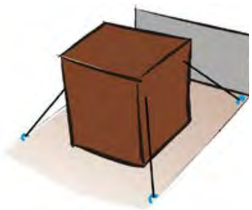


The tables are valid for **steel wire rope (∅ 16 mm/144 wires)** with an MSL of 9,100 daN - (9,100 kg = 9.1 ton) and a pre-tension of minimum 1,000 daN - (1,000 kg = 1 ton).

All masses are valid for one straight lashing.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

STRAIGHT LASHING SLIDING

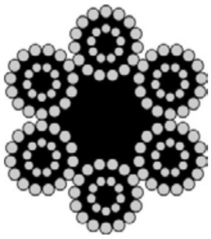


Cargo mass in ton prevented from sliding *per* straight lashing			
μ	**SIDEWAYS per side**	**FORWARD**	**BACKWARD**
0.00	3.3	2.9	4.6
0.05	4.0	3.4	5.7
0.10	4.7	4.0	6.9
0.15	5.5	4.7	8.3
0.20	6.4	5.4	10
0.25	7.5	6.2	12
0.30	8.7	7.2	15
0.35	10	8.2	19
0.40	12	9.5	23
0.45	14	11	25
0.50	16	13	28
0.55	20	15	32
0.60	24	17	36
0.65	29	20	41
0.70	no slide	23	45

Cargo mass in ton prevented from tipping *per* straight lashing				
H/B	**SIDEWAYS per side**	**H/L**	**FORWARD**	**BACKWARD**
0.6	no tip	**0.6**	no tip	no tip
0.8	no tip	**0.8**	no tip	no tip
1.0	no tip	**1.0**	no tip	no tip
1.2	no tip	**1.2**	85	85
1.4	no tip	**1.4**	46	46
1.6	50	**1.6**	22	33
1.8	25	**1.8**	15	27
2.0	17	**2.0**	12	23
2.2	14	**2.2**	9.8	21
2.4	12	**2.4**	8.6	19
2.6	10	**2.6**	7.7	17
2.8	9.2	**2.8**	7.1	16
3.0	8.4	**3.0**	6.6	15

WIRE

Spring lashings

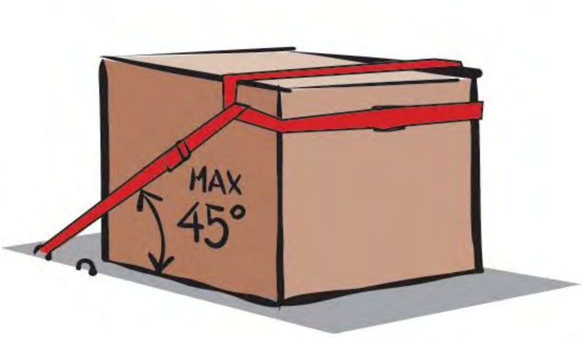


The tables are valid for **steel wire rope (∅ 16 mm/144 wires)** with an MSL of 9,100 daN - (9,100 kg = 9.1 ton) and a pre-tension of minimum 1,000 daN - (1,000 kg = 1 ton).

The masses in the tables are valid for one spring lashing.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

SPRING LASHING



Cargo mass in ton prevented from sliding *per* spring lashing		
μ	**FORWARD**	**BACKWARD**
0.00	16	26
0.05	18	29
0.10	19	33
0.15	21	38
0.20	23	43
0.25	25	50
0.30	28	58
0.35	31	70
0.40	34	81
0.45	38	88
0.50	42	96
0.55	48	105
0.60	54	115
0.65	62	127
0.70	73	140

Cargo mass in ton prevented from tipping *per* spring lashing		
H/L	**FORWARD**	**REARWARD**
0.6	no tip	no tip
0.8	no tip	no tip
1.0	no tip	no tip
1.2	525	525
1.4	306	306
1.6	150	233
1.8	107	197
2.0	87	175
2.2	76	160
2.4	68	150
2.6	63	142
2.8	59	136
3.0	56	131

TAG WASHERS AND NAILS

TAG WASHER
Approximate cargo mass in ton prevented from sliding by one tag washer for wood on wood in combination with top-over lashing only

μ**	SIDEWAYS						
	∅ 48	∅ 62	∅ 75	∅ 95	30×57	48×65	130×130
MBL (ton)	0.5	0.7	0.9	1.2	0.5	0.7	1.5
0.10	0.21	0.29	0.38	0.50	0.21	0.29	0.63
0.20	0.25	0.35	0.45	0.60	0.25	0.35	0.75
0.30	0.31	0.44	0.56	0.75	0.31	0.44	0.94
	FORWARD						
0.10	0.18	0.25	0.32	0.43	0.18	0.25	0.54
0.20	0.21	0.29	0.38	0.50	0.21	0.29	0.63
0.30	0.25	0.35	0.45	0.60	0.25	0.35	0.75
	BACKWARD						
0.10	0.31	0.44	0.56	0.75	0.31	0.44	0.94
0.20	0.42	0.58	0.75	1.00	0.42	0.58	1.3
0.30	0.60	0.83	1.1	1.4	0.60	0.83	1.8

** Between tag washer and platform bed/cargo.

4" – NAIL
Approximate cargo mass in ton prevented from sliding by one nail

μ***	SIDEWAYS per side		FORWARD		BACKWARD	
	blank	galvanised	blank	galvanised	blank	galvanised
MBL (ton)	0.22	0.32	0.22	0.32	0.22	0.32
0.00	0.16	0.23	0.14	0.20	0.22	0.32
0.05	0.17	0.25	0.15	0.21	0.24	0.36
0.10	0.18	0.27	0.16	0.23	0.28	0.40
0.15	0.20	0.29	0.17	0.25	0.31	0.46
0.20	0.22	0.32	0.18	0.27	0.37	0.53
0.25	0.24	0.36	0.20	0.29	0.44	0.64
0.30	0.28	0.40	0.22	0.32	0.52	0.76
0.35	0.31	0.46	0.24	0.36	0.56	0.82
0.40	0.37	0.53	0.28	0.40	0.61	0.89
0.45	0.44	0.64	0.31	0.46	0.67	0.97
0.50	0.55	0.80	0.37	0.53	0.73	1.1
0.55	0.73	1.1	0.44	0.64	0.81	1.2
0.60	1.1	1.6	0.55	0.80	0.92	1.3
0.65	2.2	3.2	0.73	1.1	1.0	1.5
0.70	no slide	no slide	1.1	1.6	1.2	1.8

*** Between cargo and platform bed.

Packing Code

QUICK LASHING GUIDE C

Cargo securing on CTUs for transports on Road, Combined Rail and in Sea Area C

Accelerations to be expected expressed in parts of the gravity acceleration (1g = 9.81 m/s2).

Transport mode/ Sea area	Sideways		Forward		Backward	
	S	V	F	V	B	V
Road	0.5	1.0	0.8	1.0	0.5	1.0
Combined Rail	0.5	1.0	0.5	1.0	0.5	1.0
Sea Area C	0.8	1.0	0.4	0.2	0.4	0.2

V = Vertical acceleration in combination with longitudinal or transverse acceleration

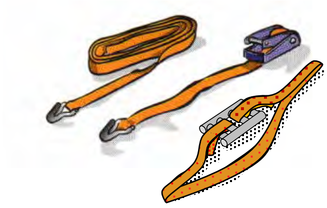
Goods; not rigid in form

If the goods aren't rigid in form, more lashings than stipulated in this quick lashing guide could be required.

- All dimensions referred to as ton are equal to metric ton of 1000 kg.
- Sideways, forward and backward refers to a fore-and-aft stowed CTU.

WEBBING

Top-over lashings

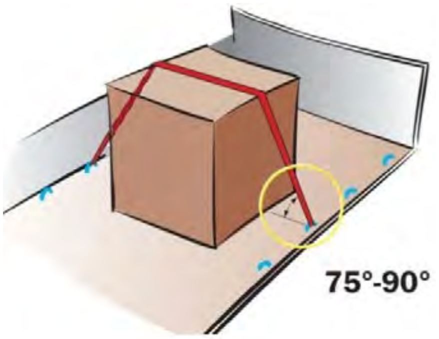


The tables are valid for **webbing** with an MSL of 2,000 daN - (2,000 kg = 2 ton) and a pre-tension of minimum 400 daN - (400 kg).

The values in the tables are proportional to the lashings' pre-tension.

The masses in the tables are valid for one top-over lashing.

TOP-OVER LASHING

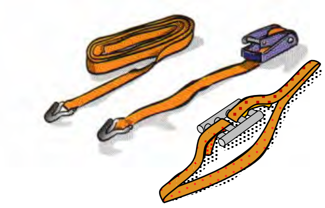


Cargo mass in ton prevented from sliding *per* top-over lashing			
μ	**SIDEWAYS**	**FORWARD**	**BACKWARD**
0.00	0.00	0.00	0.00
0.05	0.05	0.05	0.08
0.10	0.10	0.10	0.18
0.15	0.16	0.16	0.29
0.20	0.24	0.24	0.39
0.25	0.32	0.32	0.51
0.30	0.43	0.43	0.63
0.35	0.55	0.55	0.75
0.40	0.71	0.71	0.89
0.45	0.91	0.91	1.0
0.50	1.2	1.2	1.2
0.55	1.6	1.3	1.3
0.60	2.1	1.5	1.5
0.65	3.1	1.7	1.7
0.70	5.0	1.9	1.9

Cargo mass in ton prevented from tipping *per* top-over lashing								
SIDEWAYS							**FORWARD**	**BACKWARD**
H/B	**1 row**	**2 rows**	**3 rows**	**4 rows**	**5 rows**	**H/L**	**per section**	**per section**
0.6	no tip	no tip	2.4	1.4	1.0	0.6	18	18
0.8	no tip	3.2	1.2	0.81	0.66	0.8	5.9	5.9
1.0	no tip	1.5	0.77	0.57	0.48	1.0	3.5	3.5
1.2	no tip	0.97	0.57	0.44	0.38	1.2	2.5	2.5
1.4	5.9	0.72	0.46	0.36	0.31	1.4	2.0	2.0
1.6	2.5	0.57	0.38	0.31	0.27	1.6	1.6	1.6
1.8	1.6	0.47	0.32	0.26	0.23	1.8	1.4	1.4
2.0	1.2	0.41	0.28	0.23	0.21	2.0	1.2	1.2
2.2	0.93	0.35	0.25	0.21	0.18	2.2	0.93	1.0
2.4	0.77	0.31	0.23	0.19	0.17	2.4	0.77	0.93
2.6	0.66	0.28	0.21	0.17	0.15	2.6	0.66	0.84
2.8	0.57	0.26	0.19	0.16	0.14	2.8	0.57	0.77
3.0	0.51	0.23	0.17	0.15	0.13	3.0	0.51	0.71

WEBBING

Half-loop lashings

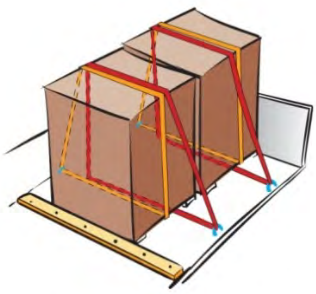


The tables are valid for **webbing** with an MSL of 2,000 daN - (2,000 kg = 2 ton) and a pre-tension of minimum 400 daN - (400 kg).

The masses in the tables below are valid for one pair of half loop lashings.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

HALF LOOP LASHING SLIDING

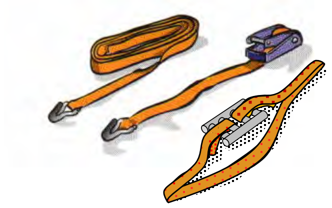


Cargo mass in ton prevented from sliding *per* pair of half loop lashing	
μ	**SIDEWAYS**
0.00	2.5
0.05	2.8
0.10	3.0
0.15	3.3
0.20	3.6
0.25	4.0
0.30	4.3
0.35	4.8
0.40	5.3
0.45	5.9
0.50	6.6
0.55	7.4
0.60	8.4
0.65	9.7
0.70	11

Cargo mass in ton prevented from tipping *per* pair of half loop lashing					
SIDEWAYS					
H/B	**1 row**	**2 rows**	**3 rows**	**4 rows**	**5 rows**
0.6	no tip	no tip	7.0	3.9	2.9
0.8	no tip	9.1	3.3	2.3	1.9
1.0	no tip	4.2	2.2	1.6	1.4
1.2	no tip	2.8	1.6	1.3	1.1
1.4	17	2.1	1.3	1.0	0.89
1.6	7.3	1.6	1.1	0.87	0.76
1.8	4.6	1.4	0.92	0.75	0.66
2.0	3.4	1.2	0.80	0.66	0.58
2.2	2.7	1.0	0.71	0.59	0.52
2.4	2.2	0.90	0.64	0.53	0.47
2.6	1.9	0.81	0.58	0.49	0.43
2.8	1.6	0.73	0.53	0.45	0.40
3.0	1.5	0.67	0.49	0.41	0.37

Straight lashings

WEBBING

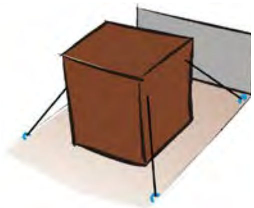


The tables are valid for **webbing** with an MSL of 2,000 daN - (2,000 kg = 2 ton) and a pre-tension of minimum 400 daN - (400 kg).

All masses are valid for one straight lashing.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

STRAIGHT LASHING SLIDING

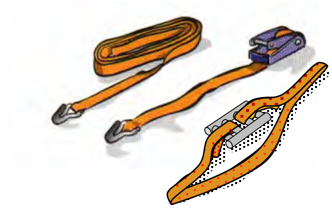


Cargo mass in ton prevented from sliding *per* straight lashing			
μ	**SIDEWAYS per side**	**FORWARD**	**BACKWARD**
0.00	0.64	0.64	1.0
0.05	0.76	0.76	1.2
0.10	0.89	0.89	1.5
0.15	1.0	1.0	1.8
0.20	1.2	1.2	2.1
0.25	1.4	1.4	2.3
0.30	1.6	1.6	2.6
0.35	1.8	1.8	2.8
0.40	2.1	2.1	3.1
0.45	2.4	2.4	3.3
0.50	2.8	2.8	3.6
0.55	3.2	3.2	3.9
0.60	3.7	3.7	4.2
0.65	4.4	4.4	4.5
0.70	5.2	4.8	4.8

Cargo mass in ton prevented from tipping *per* straight lashing				
H/B	**SIDEWAYS per side**	**H/L**	**FORWARD**	**BACKWARD**
0.6	no tip	**0.6**	20	20
0.8	no tip	**0.8**	7.6	7.6
1.0	no tip	**1.0**	5.1	5.1
1.2	no tip	**1.2**	4.0	4.0
1.4	10	**1.4**	3.4	3.4
1.6	4.7	**1.6**	3.0	3.0
1.8	3.2	**1.8**	2.7	2.7
2.0	2.5	**2.0**	2.5	2.5
2.2	2.1	**2.2**	2.1	2.4
2.4	1.9	**2.4**	1.9	2.3
2.6	1.7	**2.6**	1.7	2.2
2.8	1.6	**2.8**	1.6	2.1
3.0	1.5	**3.0**	1.5	2.0

WEBBING

Spring lashings

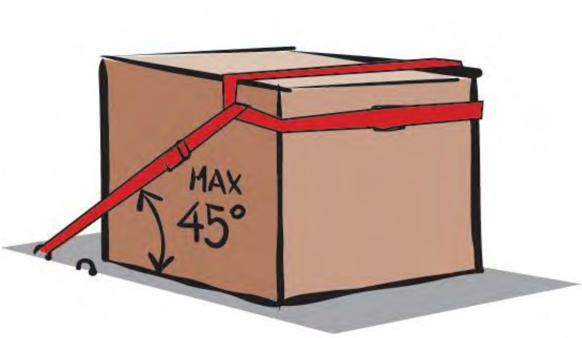


The tables are valid for **webbing** with an MSL of 2,000 daN - (2,000 kg = 2 ton) and a pre-tension of minimum 400 daN - (400 kg).

The masses in the tables are valid for one spring lashing.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

SPRING LASHING



Cargo mass in ton prevented from sliding *per* spring lashing		
μ	**FORWARD**	**BACKWARD**
0.00	3.6	5.8
0.05	3.9	6.5
0.10	4.3	7.3
0.15	4.7	8.3
0.20	5.1	9.0
0.25	5.6	9.4
0.30	6.1	9.9
0.35	6.8	10
0.40	7.5	11
0.45	8.3	12
0.50	9.3	12
0.55	11	13
0.60	12	13
0.65	14	14
0.70	15	15

Cargo mass in ton prevented from tipping *per* spring lashing		
H/L	**FORWARD**	**REARWARD**
0.6	86	86
0.8	38	38
1.0	29	29
1.2	25	25
1.4	22	22
1.6	21	21
1.8	20	20
2.0	19	19
2.2	17	19
2.4	15	18
2.6	14	18
2.8	13	18
3.0	12	17

CHAINS

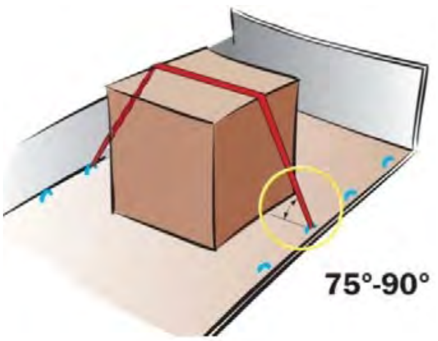
Top-over lashings

The tables are valid for **chain (∅ 9 mm, class 8)** with an MSL of 5,000 daN - (5,000 kg = 5 ton) and a pre-tension of minimum 1,000 daN - (1,000 kg = 1 ton).

The values in the tables are proportional to the pre-tension in the lashings.

The masses in the tables are valid for one top-over lashing.

TOP-OVER LASHING



Cargo mass in ton prevented from sliding *per* top-over lashing			
μ	SIDEWAYS	FORWARD	BACKWARD
0.00	0.00	0.00	0.00
0.05	0.12	0.12	0.20
0.10	0.25	0.25	0.44
0.15	0.41	0.41	0.72
0.20	0.59	0.59	0.98
0.25	0.81	0.81	1.3
0.30	1.1	1.1	1.6
0.35	1.4	1.4	1.9
0.40	1.8	1.8	2.2
0.45	2.3	2.3	2.6
0.50	3.0	3.0	3.0
0.55	3.9	3.4	3.4
0.60	5.3	3.8	3.8
0.65	7.7	4.3	4.3
0.70	12	4.8	4.8

Cargo mass in ton prevented from tipping *per* top-over lashing								
SIDEWAYS							**FORWARD**	**BACKWARD**
H/B	**1 row**	**2 rows**	**3 rows**	**4 rows**	**5 rows**	**H/L**	**per section**	**per section**
0.6	no tip	no tip	6.1	3.4	2.6	**0.6**	44	44
0.8	no tip	8.0	2.9	2.0	1.6	**0.8**	15	15
1.0	no tip	3.7	1.9	1.4	1.2	**1.0**	8.9	8.9
1.2	no tip	2.4	1.4	1.1	0.95	**1.2**	6.3	6.3
1.4	15	1.8	1.1	0.90	0.78	**1.4**	4.9	4.9
1.6	6.3	1.4	0.95	0.76	0.67	**1.6**	4.0	4.0
1.8	4.0	1.2	0.81	0.66	0.58	**1.8**	3.4	3.4
2.0	3.0	1.0	0.71	0.58	0.52	**2.0**	3.0	3.0
2.2	2.3	0.89	0.63	0.52	0.46	**2.2**	2.3	2.6
2.4	1.9	0.79	0.57	0.47	0.42	**2.4**	1.9	2.3
2.6	1.6	0.71	0.51	0.43	0.38	**2.6**	1.6	2.1
2.8	1.4	0.64	0.47	0.40	0.35	**2.8**	1.4	1.9
3.0	1.3	0.59	0.43	0.37	0.33	**3.0**	1.3	1.8

CHAINS

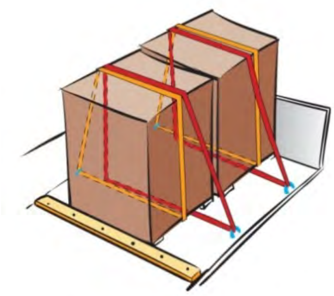
Half-loop lashings

The tables are valid for chain (∅ 9 mm, class 8) with an MSL of 5,000 daN - (5,000 kg = 5 ton) and a pre-tension of minimum 1,000 daN - (1,000 kg = 1 ton).

The masses in the tables below are valid for one pair of half loop lashings.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

HALF LOOP LASHING SLIDING



Cargo mass in ton prevented from sliding *per* pair of half loop lashing	
µ	**SIDEWAYS**
0.00	6.4
0.05	6.9
0.10	7.6
0.15	8.2
0.20	9.0
0.25	9.9
0.30	11
0.35	12
0.40	13
0.45	15
0.50	16
0.55	19
0.60	21
0.65	24
0.70	28

Cargo mass in ton prevented from tipping *per* pair of half loop lashing					
SIDEWAYS					
H/B	**1 row**	**2 rows**	**3 rows**	**4 rows**	**5 rows**
0.6	no tip	no tip	17	9.7	7.3
0.8	no tip	23	8.3	5.7	4.6
1.0	no tip	11	5.5	4.1	3.4
1.2	no tip	6.9	4.1	3.1	2.7
1.4	42	5.1	3.2	2.6	2.2
1.6	18	4.1	2.7	2.2	1.9
1.8	12	3.4	2.3	1.9	1.6
2.0	8.5	2.9	2.0	1.7	1.5
2.2	6.7	2.5	1.8	1.5	1.3
2.4	5.5	2.2	1.6	1.3	1.2
2.6	4.7	2.0	1.5	1.2	1.1
2.8	4.1	1.8	1.3	1.1	1.00
3.0	3.6	1.7	1.2	1.0	0.93

CHAINS

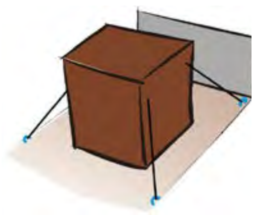
Straight lashings

The tables are valid for **chain (∅ 9 mm, class 8)** with an MSL of 5,000 daN - (5,000 kg = 5 ton) and a pre-tension of minimum 1,000 daN - (1,000 kg = 1 ton).

All masses are valid for one straight lashing.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

STRAIGHT LASHING SLIDING

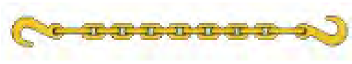


Cargo mass in ton prevented from sliding *per* straight lashing			
μ	**SIDEWAYS per side**	**FORWARD**	**BACKWARD**
0.00	1.6	1.6	2.5
0.05	1.9	1.9	3.1
0.10	2.2	2.2	3.8
0.15	2.6	2.6	4.6
0.20	3.0	3.0	5.2
0.25	3.4	3.4	5.8
0.30	3.9	3.9	6.4
0.35	4.5	4.5	7.0
0.40	5.2	5.2	7.6
0.45	6.0	6.0	8.3
0.50	6.9	6.9	9.0
0.55	8.0	8.0	9.7
0.60	9.3	9.3	11
0.65	11	11	11
0.70	13	12	12

Cargo mass in ton prevented from tipping *per* straight lashing				
H/B	**SIDEWAYS per side**	**H/L**	**FORWARD**	**BACKWARD**
0.6	no tip	**0.6**	51	51
0.8	no tip	**0.8**	19	19
1.0	no tip	**1.0**	13	13
1.2	no tip	**1.2**	10	10
1.4	25	**1.4**	8.5	8.5
1.6	12	**1.6**	7.5	7.5
1.8	8.1	**1.8**	6.9	6.9
2.0	6.4	**2.0**	6.4	6.4
2.2	5.4	**2.2**	5.4	6.0
2.4	4.7	**2.4**	4.7	5.7
2.6	4.2	**2.6**	4.2	5.5
2.8	3.9	**2.8**	3.9	5.3
3.0	3.6	**3.0**	3.6	5.1

CHAINS

Spring lashings



The tables are valid for **chain (∅ 9 mm, class 8)** with an MSL of 5,000 daN - (5,000 kg = 5 ton) and a pre-tension of minimum 1000 daN - (1,000 kg = 1 ton).

The masses in the tables are valid for one spring lashing.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

SPRING LASHING

Cargo mass in ton prevented from sliding *per* spring lashing		
μ	**FORWARD**	**BACKWARD**
0.00	9.0	14
0.05	9.8	16
0.10	11	18
0.15	12	21
0.20	13	22
0.25	14	24
0.30	15	25
0.35	17	26
0.40	19	28
0.45	21	29
0.50	23	30
0.55	26	32
0.60	30	34
0.65	34	35
0.70	37	37

Cargo mass in ton prevented from tipping *per* spring lashing		
H/L	**FORWARD**	**REARWARD**
0.6	216	216
0.8	96	96
1.0	72	72
1.2	62	62
1.4	56	56
1.6	52	52
1.8	50	50
2.0	48	48
2.2	42	47
2.4	38	46
2.6	35	45
2.8	33	44
3.0	31	43

STEEL STRAPPING

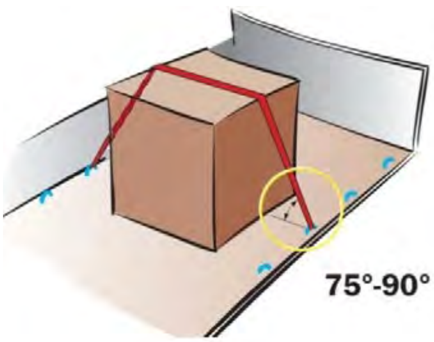
Top-over lashings

The tables are valid for **steel strapping** (**32 × 0.8 mm)** with an MSL of 1700 daN - (1,700 kg = 1.7 ton) and a pre-tension of minimum 240 daN - (240 kg).

The values in the tables are proportional to the pre-tension in the lashings.

The masses in the tables are valid for one top-over lashing.

TOP-OVER LASHING

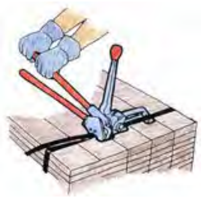


Cargo mass in ton prevented from sliding *per* top-over lashing			
μ	**SIDEWAYS**	**FORWARD**	**BACKWARD**
0.00	0.00	0.00	0.00
0.05	0.03	0.03	0.05
0.10	0.06	0.06	0.11
0.15	0.10	0.10	0.17
0.20	0.14	0.14	0.24
0.25	0.19	0.19	0.30
0.30	0.26	0.26	0.38
0.35	0.33	0.33	0.45
0.40	0.43	0.43	0.53
0.45	0.55	0.55	0.62
0.50	0.71	0.71	0.71
0.55	0.94	0.81	0.81
0.60	1.3	0.91	0.91
0.65	1.8	1.0	1.0
0.70	3.0	1.1	1.1

Cargo mass in ton prevented from tipping *per* top-over lashing								
SIDEWAYS							**FORWARD**	**BACKWARD**
H/B	**1 row**	**2 rows**	**3 rows**	**4 rows**	**5 rows**	**H/L**	**per section**	**per section**
0.6	no tip	no tip	1.5	0.82	0.62	**0.6**	11	11
0.8	no tip	1.9	0.70	0.48	0.39	**0.8**	3.5	3.5
1.0	no tip	0.89	0.46	0.34	0.29	**1.0**	2.1	2.1
1.2	no tip	0.58	0.34	0.27	0.23	**1.2**	1.5	1.5
1.4	3.5	0.43	0.27	0.22	0.19	**1.4**	1.2	1.2
1.6	1.5	0.34	0.23	0.18	0.16	**1.6**	0.97	0.97
1.8	0.97	0.28	0.19	0.16	0.14	**1.8**	0.82	0.82
2.0	0.71	0.24	0.17	0.14	0.12	**2.0**	0.71	0.71
2.2	0.56	0.21	0.15	0.13	0.11	**2.2**	0.56	0.63
2.4	0.46	0.19	0.14	0.11	0.10	**2.4**	0.46	0.56
2.6	0.39	0.17	0.12	0.10	0.09	**2.6**	0.39	0.51
2.8	0.34	0.15	0.11	0.09	0.08	**2.8**	0.34	0.46
3.0	0.30	0.14	0.10	0.09	0.08	**3.0**	0.30	0.43

STEEL STRAPPING

Half-loop lashings

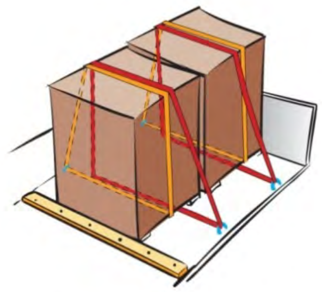


The tables are valid for steel strapping (32 × 0.8 mm) with an MSL of 1,700 daN - (1,700 kg = 1.7 ton) and a pre-tension of minimum 240 daN - (240 kg).

The masses in the tables below are valid for one pair of half loop lashings.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

HALF LOOP LASHING SLIDING

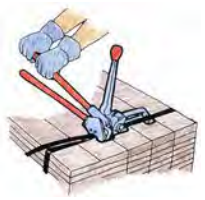


Cargo mass in ton prevented from sliding *per* pair of half loop lashing	
μ	SIDEWAYS
0.00	2.2
0.05	2.4
0.10	2.6
0.15	2.8
0.20	3.1
0.25	3.4
0.30	3.7
0.35	4.1
0.40	4.5
0.45	5.0
0.50	5.6
0.55	6.3
0.60	7.2
0.65	8.2
0.70	9.6

Cargo mass in ton prevented from tipping *per* pair of half loop lashing					
SIDEWAYS					
H/B	1 row	2 rows	3 rows	4 rows	5 rows
0.6	no tip	no tip	5.9	3.3	2.5
0.8	no tip	7.7	2.8	1.9	1.6
1.0	no tip	3.6	1.9	1.4	1.2
1.2	no tip	2.4	1.4	1.1	0.91
1.4	14	1.7	1.1	0.87	0.75
1.6	6.2	1.4	0.92	0.74	0.64
1.8	3.9	1.2	0.78	0.64	0.56
2.0	2.9	0.98	0.68	0.56	0.50
2.2	2.3	0.86	0.61	0.50	0.44
2.4	1.9	0.76	0.55	0.45	0.40
2.6	1.6	0.69	0.50	0.41	0.37
2.8	1.4	0.62	0.45	0.38	0.34
3.0	1.2	0.57	0.42	0.35	0.32

STEEL STRAPPING

Straight lashings

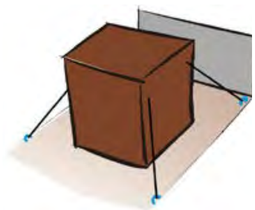


The tables are valid for **steel strapping (32 × 0.8 mm)** with an MSL of 1,700 daN - (1,700 kg = 1.7 ton) and a pre-tension of minimum 240 daN - (240 kg).

All masses are valid for one straight lashing.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

STRAIGHT LASHING SLIDING

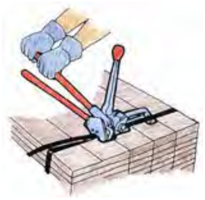


Cargo mass in ton prevented from sliding *per* straight lashing			
μ	**SIDEWAYS per side**	**FORWARD**	**BACKWARD**
0.00	0.54	0.54	0.87
0.05	0.64	0.64	1.1
0.10	0.75	0.75	1.3
0.15	0.88	0.88	1.6
0.20	1.0	1.0	1.8
0.25	1.2	1.2	2.0
0.30	1.3	1.3	2.2
0.35	1.5	1.5	2.4
0.40	1.8	1.8	2.6
0.45	2.0	2.0	2.8
0.50	2.3	2.3	3.1
0.55	2.7	2.7	3.3
0.60	3.2	3.2	3.6
0.65	3.7	3.7	3.9
0.70	4.4	4.1	4.1

Cargo mass in ton prevented from tipping *per* straight lashing				
H/B	**SIDEWAYS per side**	**H/L**	**FORWARD**	**BACKWARD**
0.6	no tip	**0.6**	17	17
0.8	no tip	**0.8**	6.5	6.5
1.0	no tip	**1.0**	4.3	4.3
1.2	no tip	**1.2**	3.4	3.4
1.4	8.7	**1.4**	2.9	2.9
1.6	4.0	**1.6**	2.6	2.6
1.8	2.8	**1.8**	2.3	2.3
2.0	2.2	**2.0**	2.2	2.2
2.2	1.8	**2.2**	1.8	2.0
2.4	1.6	**2.4**	1.6	1.9
2.6	1.4	**2.6**	1.4	1.9
2.8	1.3	**2.8**	1.3	1.8
3.0	1.2	**3.0**	1.2	1.7

STEEL STRAPPING

Spring lashings



The tables are valid for **steel strapping** (**32 × 0.8 mm)** with an MSL of 1,700 daN - (1,700 kg = 1.7 ton) and a pre-tension of minimum 240 daN - (240 kg).

The masses in the tables are valid for one spring lashing.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

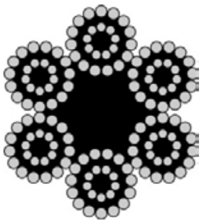
SPRING LASHING

Cargo mass in ton prevented from sliding *per* spring lashing		
μ	**FORWARD**	**BACKWARD**
0.00	3.1	4.9
0.05	3.3	5.5
0.10	3.6	6.2
0.15	4.0	7.0
0.20	4.3	7.6
0.25	4.8	8.0
0.30	5.2	8.5
0.35	5.8	8.9
0.40	6.4	9.4
0.45	7.1	9.9
0.50	7.9	10
0.55	8.9	11
0.60	10	11
0.65	12	12
0.70	13	13

Cargo mass in ton prevented from tipping *per* spring lashing		
H/L	**FORWARD**	**REARWARD**
0.6	74	74
0.8	33	33
1.0	25	25
1.2	21	21
1.4	19	19
1.6	18	18
1.8	17	17
2.0	16	16
2.2	14	16
2.4	13	15
2.6	12	15
2.8	11	15
3.0	11	15

WIRE

Top-over lashings

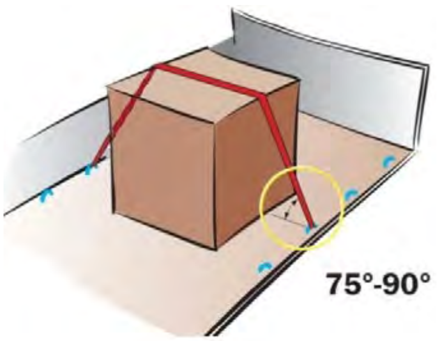


The tables are valid for **steel wire rope (∅ 16 mm/144 wires)** with an MSL of 9,100 daN - (9,100 kg = 9.1 ton) and a pre-tension of minimum 1,000 daN - (1,000 kg = 1 ton).

The values in the tables are proportional to the pre-tension in the lashings.

The masses in the tables are valid for one top-over lashing.

TOP-OVER LASHING

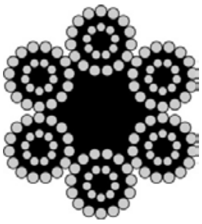


Cargo mass in ton prevented from sliding *per* top-over lashing			
μ	**SIDEWAYS**	**FORWARD**	**BACKWARD**
0.00	0.00	0.00	0.00
0.05	0.12	0.12	0.20
0.10	0.25	0.25	0.44
0.15	0.41	0.41	0.72
0.20	0.59	0.59	0.98
0.25	0.81	0.81	1.3
0.30	1.1	1.1	1.6
0.35	1.4	1.4	1.9
0.40	1.8	1.8	2.2
0.45	2.3	2.3	2.6
0.50	3.0	3.0	3.0
0.55	3.9	3.4	3.4
0.60	5.3	3.8	3.8
0.65	7.7	4.3	4.3
0.70	12	4.8	4.8

Cargo mass in ton prevented from tipping *per* top-over lashing								
SIDEWAYS							**FORWARD**	**BACKWARD**
H/B	**1 row**	**2 rows**	**3 rows**	**4 rows**	**5 rows**	**H/L**	**per section**	**per section**
0.6	no tip	no tip	6.1	3.4	2.6	**0.6**	44	44
0.8	no tip	8.0	2.9	2.0	1.6	**0.8**	15	15
1.0	no tip	3.7	1.9	1.4	1.2	**1.0**	8.9	8.9
1.2	no tip	2.4	1.4	1.1	0.95	**1.2**	6.3	6.3
1.4	15	1.8	1.1	0.90	0.78	**1.4**	4.9	4.9
1.6	6.3	1.4	0.95	0.76	0.67	**1.6**	4.0	4.0
1.8	4.0	1.2	0.81	0.66	0.58	**1.8**	3.4	3.4
2.0	3.0	1.0	0.71	0.58	0.52	**2.0**	3.0	3.0
2.2	2.3	0.89	0.63	0.52	0.46	**2.2**	2.3	2.6
2.4	1.9	0.79	0.57	0.47	0.42	**2.4**	1.9	2.3
2.6	1.6	0.71	0.51	0.43	0.38	**2.6**	1.6	2.1
2.8	1.4	0.64	0.47	0.40	0.35	**2.8**	1.4	1.9
3.0	1.3	0.59	0.43	0.37	0.33	**3.0**	1.3	1.8

WIRE

Half-loop lashings

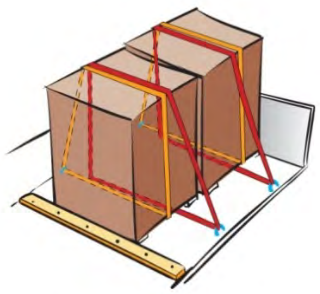


The tables are valid for **steel wire rope (∅ 16 mm/144 wires)** with an MSL of 9,100 daN - (9,100 kg = 9.1 ton) and a pre-tension of minimum 1,000 daN - (1,000 kg = 1 ton).

The masses in the tables below are valid for one pair of half loop lashings.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

HALF LOOP LASHING SLIDING

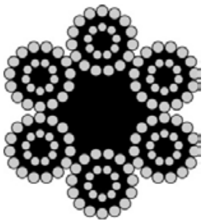


Cargo mass in ton prevented from sliding *per* pair of half loop lashing	
μ	**SIDEWAYS**
0.00	12
0.05	13
0.10	14
0.15	15
0.20	16
0.25	18
0.30	20
0.35	22
0.40	24
0.45	27
0.50	30
0.55	34
0.60	38
0.65	44
0.70	51

Cargo mass in ton prevented from tipping *per* pair of half loop lashing					
SIDEWAYS					
H/B	**1 row**	**2 rows**	**3 rows**	**4 rows**	**5 rows**
0.6	no tip	no tip	32	18	13
0.8	no tip	41	15	10	8.4
1.0	no tip	19	9.9	7.4	6.2
1.2	no tip	13	7.4	5.7	4.9
1.4	77	9.4	5.9	4.7	4.0
1.6	33	7.4	4.9	3.9	3.4
1.8	21	6.2	4.2	3.4	3.0
2.0	15	5.3	3.7	3.0	2.7
2.2	12	4.6	3.3	2.7	2.4
2.4	10	4.1	2.9	2.4	2.2
2.6	8.6	3.7	2.7	2.2	2.0
2.8	7.5	3.3	2.4	2.0	1.8
3.0	6.6	3.1	2.2	1.9	1.7

WIRE

Straight lashings

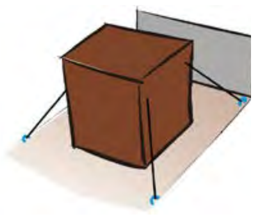


The tables are valid for **steel wire rope (∅ 16 mm/144 wires)** with an MSL of 9,100 daN - (9,100 kg = 9.1 ton) and a pre-tension of minimum 1,000 daN - (1,000 kg = 1 ton).

All masses are valid for one straight lashing.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

STRAIGHT LASHING SLIDING

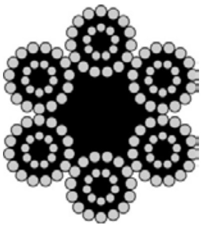


Cargo mass in ton prevented from sliding *per* straight lashing			
μ	SIDEWAYS per side	FORWARD	BACKWARD
0.00	2.9	2.9	4.6
0.05	3.4	3.4	5.7
0.10	4.0	4.0	6.9
0.15	4.7	4.7	8.3
0.20	5.4	5.4	9.5
0.25	6.2	6.2	11
0.30	7.2	7.2	12
0.35	8.2	8.2	13
0.40	9.5	9.5	14
0.45	11	11	15
0.50	13	13	16
0.55	15	15	18
0.60	17	17	19
0.65	20	20	21
0.70	23	22	22

Cargo mass in ton prevented from tipping *per* straight lashing				
H/B	SIDEWAYS per side	H/L	FORWARD	BACKWARD
0.6	no tip	**0.6**	93	93
0.8	no tip	**0.8**	35	35
1.0	no tip	**1.0**	23	23
1.2	no tip	**1.2**	18	18
1.4	46	**1.4**	15	15
1.6	22	**1.6**	14	14
1.8	15	**1.8**	12	12
2.0	12	**2.0**	12	12
2.2	9.8	**2.2**	9.8	11
2.4	8.6	**2.4**	8.6	10
2.6	7.7	**2.6**	7.7	9.9
2.8	7.1	**2.8**	7.1	9.6
3.0	6.6	**3.0**	6.6	9.3

WIRE

Spring lashings



The tables are valid for **steel wire rope (∅ 16 mm/144 wires)** with an MSL of 9,100 daN - (9,100 kg = 9.1 ton) and a pre-tension of minimum 1,000 daN - (1,000 kg = 1 ton).

The masses in the tables are valid for one spring lashing.

The values in the tables are proportional to the maximum securing load (MSL) in the lashings.

SPRING LASHING

Cargo mass in ton prevented from sliding *per* spring lashing		
μ	**FORWARD**	**BACKWARD**
0.00	16	26
0.05	18	29
0.10	19	33
0.15	21	38
0.20	23	41
0.25	25	43
0.30	28	45
0.35	31	48
0.40	34	50
0.45	38	53
0.50	42	56
0.55	48	58
0.60	54	61
0.65	62	65
0.70	68	68

Cargo mass in ton prevented from tipping *per* spring lashing		
H/L	**FORWARD**	**REARWARD**
0.6	394	394
0.8	175	175
1.0	131	131
1.2	112	112
1.4	102	102
1.6	95	95
1.8	91	91
2.0	87	87
2.2	76	85
2.4	68	83
2.6	63	81
2.8	59	80
3.0	56	79

TAG WASHERS AND NAILS

TAG WASHER
Approximate cargo mass in ton prevented from sliding by one tag washer for wood on wood in combination with top-over lashing only

μ**	SIDEWAYS						
	∅ 48	∅ 62	∅ 75	∅ 95	30×57	48×65	130×130
MBL (ton)	0.5	0.7	0.9	1.2	0.5	0.7	1.5
0.10	0.18	0.25	0.32	0.43	0.18	0.25	0.54
0.20	0.21	0.29	0.38	0.50	0.21	0.29	0.63
0.30	0.25	0.35	0.45	0.60	0.25	0.35	0.75
	FORWARD						
0.10	0.18	0.25	0.32	0.43	0.18	0.25	0.54
0.20	0.21	0.29	0.38	0.50	0.21	0.29	0.63
0.30	0.25	0.35	0.45	0.60	0.25	0.35	0.75
	BACKWARD						
0.10	0.31	0.44	0.56	0.75	0.31	0.44	0.94
0.20	0.35	0.49	0.63	0.83	0.35	0.49	1.0
0.30	0.37	0.51	0.66	0.88	0.37	0.51	1.1

** Between tag washer and platform bed/cargo.

4" – NAIL
Approximate cargo mass in ton prevented from sliding by one nail

μ***	SIDEWAYS per side		FORWARD		BACKWARD	
	blank	galvanised	blank	galvanised	blank	galvanised
MBL (ton)	0.22	0.32	0.22	0.32	0.22	0.32
0.00	0.14	0.20	0.14	0.20	0.22	0.32
0.05	0.15	0.21	0.15	0.21	0.24	0.36
0.10	0.16	0.23	0.16	0.23	0.28	0.40
0.15	0.17	0.25	0.17	0.25	0.30	0.43
0.20	0.18	0.27	0.18	0.27	0.31	0.44
0.25	0.20	0.29	0.20	0.29	0.31	0.46
0.30	0.22	0.32	0.22	0.32	0.32	0.47
0.35	0.24	0.36	0.24	0.36	0.33	0.48
0.40	0.28	0.40	0.28	0.40	0.34	0.50
0.45	0.31	0.46	0.31	0.46	0.35	0.52
0.50	0.37	0.53	0.37	0.53	0.37	0.53
0.55	0.44	0.64	0.38	0.55	0.38	0.55
0.60	0.55	0.80	0.39	0.57	0.39	0.57
0.65	0.73	1.1	0.41	0.59	0.41	0.59
0.70	1.1	1.6	0.42	0.62	0.42	0.62

*** Between cargo and platform bed.

Annex 5. CONDENSATION DAMAGE

1. Introduction

Condensation damage is a collective term for damage to cargo in a CTU from internal humidity especially in box containers on long voyages. This damage may materialise in form of corrosion, mildew, rot, fermentation, break-down of cardboard packaging, leakage, staining, chemical reaction including self-heating, gassing and auto-ignition. The source of this humidity is generally the cargo itself and to some extent timber bracings, pallets, porous packaging and moisture introduced by packing the CTU during rain or snow. It is therefore of utmost importance to control the moisture content of cargo to be packed and of any dunnage used, taking into consideration the foreseeable climatic impacts of the intended transport.

2. Definitions

For the assessment of the proper state of "container-fitness" of the cargo to be packed and for the understanding of typical processes of condensation damage the most relevant technical terms and definitions are given below:

Absolute humidity of air	Actual amount of water vapour in the air, measured in g/m^3 or g/kg
Condensation	Conversion of water vapour into a liquid state. Condensation usually starts when air is cooled down to its dew point in contact with cold surfaces
Corrosion threshold	A relative humidity of 40% or more will lead to an increasing risk of corrosion of ferrous metals
Crypto climate in the container	State of relative humidity of the air in a closed container, which depends on the water content of the cargo or materials in the container and on the ambient temperature
Daily temperature variation in the container	Rise and fall of temperature in accordance with the times of day and often exaggerated by radiation or other weather influences
Dew point of air:	Temperature below the actual temperature at which a given relative humidity would reach 100%. Example: The dew point of air at a temperature of 30°C and 57% relative humidity (= 17.3 g/m^3 absolute humidity) would be 20°C, because at this temperature the 17.3 g/m^3 represent the saturation humidity or 100% relative humidity
Hygroscopicity of cargo	Property of certain cargoes or materials to absorb water vapour (adsorption) or emit water vapour (desorption) depending on the relative humidity of the ambient air
Mould growth threshold	A relative humidity of 75% or more will lead to an increasing risk of mould growth on substances of organic origin like foodstuff, textiles, leather, wood, ore substances of non-organic origin such as pottery.
Relative humidity of air	Actual absolute humidity expressed as percentage of the saturation humidity at a given temperature. Example: An absolute humidity of 17.3 g/m^3 in an air of 30°C represents a relative humidity of $100 \cdot 17.3 / 30.3 = 57\%$.
Saturation humidity of air	Maximum possible humidity content in the air depending on the air temperature (2.4 g/m^3 at -10°C; 4.8 g/m^3 at 0°C; 9.4 g/m^3 at 10°C; 17.3 g/m^3 at 20°C; 30.3 g/m^3 at 30°C; see Figure 5.1 below)
Sorption equilibrium	State of equilibrium of adsorption and desorption at a given relative humidity of the ambient air and the associated water content of the cargo or material
Sorption isotherm	An empirical graph showing the relation of water content of a cargo or material to the relative humidity of the ambient air. Usually the adsorption process is used to characterising the above relation. Sorption isotherms are specific for the various cargoes or materials (see Figure 5.2 below).

Water content of cargo	Latent water and water vapour in a hygroscopic cargo or associated material, usually stated as percentage of the wet mass of cargo (e.g. 20 t cocoa-beans with 8% water content will contain 1.6 t water).

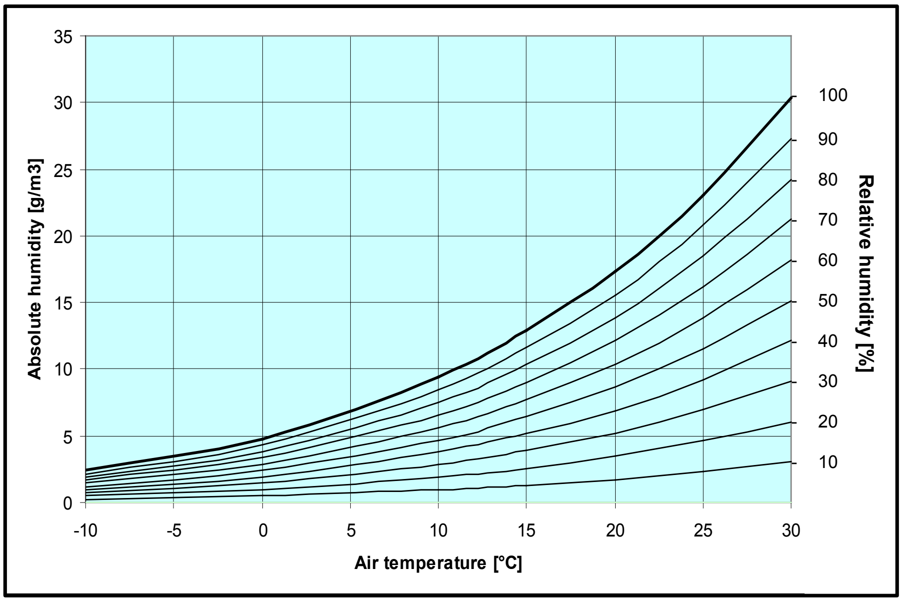


Figure 5.1 Absolute and relative humidity

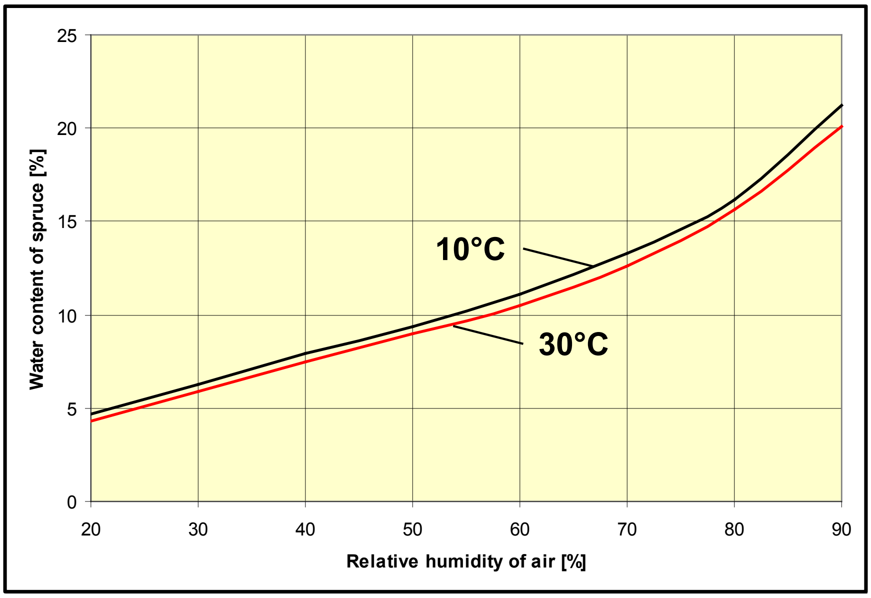


Figure 5.2 Sorption isotherms of Sitka spruce

3. Mechanisms of condensation

3.1 Closed CTUs, in particular box containers, packed with a cargo that contains water vapour, will quickly develop an internal crypto climate with a distinguished relative humidity in the air surrounding the cargo. The level of this relative humidity is a function of the water content of the cargo and the associated materials of packaging and dunnage, following the specific sorption isotherms of the cargo and associated materials. A relative humidity of less than 100% will prevent condensation, less than 75% will prevent mould growth and less than 40% will prevent corrosion. However, this protective illusion is only valid as long as the CTU is not subjected to changing temperatures.

3.2 Daily temperature variations to CTUs are common in longer transport routes, in particular in sea transport, where they also depend largely on the stowage position of the CTU in the ship. Stowage on top of the deck stow may cause daily temperature variations of more than 25 °C, while positions in the cargo hold may show marginal variations only.

3.3 Rising temperatures in a CTU in the morning hours will cause the established relative humidity of the air to drop below the sorption equilibrium. This in turn initiates the process of desorption of water vapour from the cargo and associated materials, thus raising the absolute humidity in the internal air, in particular in the upper regions of the CTU with the highest temperature. There is no risk of condensation during this phase.

3.4 In the late afternoon the temperature in the CTU begins to decline with a pronounced drop in the upper regions. In the boundary layer of the roof, the air reaches quickly the dew point at 100% relative humidity with immediate onset of condensation, forming big hanging drops of water. This is the formidable container sweat which will fall down onto the cargo and cause local wetting with all possible consequences of damage. Similarly, condensate on the container walls will run down and may wet the cargo or dunnage from below.

3.5 The condensed water retards the overall increase of the relative humidity in the air and thereby decelerates the absorption of water vapour back into the cargo and associated materials. If this temperature variation process is repeated a number of times, the amount of liquid water set free by desorption may be considerable, although some of it will evaporate during the hot phases of the process.

3.6 A quite similar mechanism of condensation may take place if a container with a warm and hygroscopic cargo, e.g. coffee in bags, is unloaded from the ship but left unopened for some days in a cold climate. The cargo will be soaked by condensation from the inner roof of the container.

3.7 Notwithstanding the above described risk of container sweat due to the daily temperature variation, an entirely different type of condensation may take place if cargo is transported in a closed CTU from a cold into a warm climate. If the CTU is unpacked in a humid atmosphere immediately after unloading from the vessel, the still cold cargo may prompt condensation of water vapour from the ambient air. This is the so-called cargo sweat, which is particularly fatal on metal products and machinery, because corrosion starts immediately.

4. Loss prevention measures

4.1 Corrosion damage: Ferrous metal products, including machinery, technical instruments and tinned food should be protected from corrosion either by a suitable coating or by measures which keep the relative humidity of the ambient air in the CTU reliably below the corrosion threshold of 40%.

4.2 The moisture content of dry dunnage, pallets and packing material can be estimated with 12% to 15%. The sorption isotherms for those materials show that with this moisture content the relative humidity of the air inside the CTU will inevitably establish itself at about 60% to 75% after closing the doors. Therefore additional measures like active drying the dunnage and packing material or the use of desiccants (drying agents in pouches) should be taken, in combination with a sealed plastic wrapping.

4.3 Fibreboard packaging and dunnage when used in association with dangerous goods should undergo water resistance test using the Cobb method as specified in ISO 535.[1]

4.4 Mould, rot and staining: Cargoes of organic origin, including raw foodstuff, textiles, leather, wood and wood products, or substances of non-organic origin such as pottery, should be packed into a CTU in "container-dry" condition. Although the mould growth threshold has been established at 75% relative humidity, the condition "container-dry" defines a moisture content of a specific cargo that maintains a sorption equilibrium with about 60% relative humidity of the air in the CTU. This provides a safety margin against daily temperature variations and the associated variations of relative humidity. Additionally, very sensitive cargo should be covered by non-woven fabric (fleece) which protects the cargo top against falling drops of sweat water. The introduction of desiccants into a CTU containing hygroscopic cargo, that is not "container-dry", will generally fail due to the lack of sufficient absorption capacity of the drying agent.

4.5 Collapse of packing: This is a side effect of moisture adsorption of usual non-waterproof cardboard. With increasing humidity from 40% to 95% the cardboard loses up to 75% of its stableness. The consequences are the collapse of stacked cartons, destruction and spill of contents. Measures to be taken are in principle identical to those for avoiding mould and rot, or the use of "wet strength" cardboard packaging.

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1 EN 20535:1994, ISO 535:1991 Paper and board. Determination of water absorptiveness. Cobb method

4.6 Unpacking:

4.6.1 Goods loaded in a cold climate on arrival in a warm climate with higher absolute humidity should be delayed until the goods have warmed up sufficiently for avoiding cargo sweat. This may take a waiting time of one or more days unless the goods are protected by vapour tight plastic sheeting and a sufficient stock of desiccants. The sheeting should be left in place until the cargo has completely acclimatised.

4.6.2 Hygroscopic goods loaded in a warm climate on arrival in a cold climate with low absolute humidity should be unpacked out immediately after unloading from the vessel, in order to avoid cargo damage from container sweat. There may be a risk of internal cargo sweat when the cargo is cooled down too quickly in contact with the open air, but experience has shown that the process of drying outruns the growth of mould, if the packages are sufficiently ventilated after unpacking.

Annex 6. **CTU types**

This Annex provides detailed information on the types of CTU available with the aim of providing packers and shippers with the best possible independent advice

1 ISO Containers

1.1 Containers – General

1.1.1 A container[1] (freight container) is an article of transport equipment which is:

- 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 pack and unpack;
- having an internal volume of at least 1 m^3 (35,3ft^3)

1.1.2 A container is further defined by the international convention for safe containers[2]:

- designed to be secured and / or readily handled, having corner fittings for these purposes
- of a size such that the area enclosed by the four outer bottom corners is either:
  - at least 14 m^2 (150ft^2) or
  - at least 7 m^2 (75ft^2) if it is fitted with top corner fittings.

1.1.3 ISO container dimensions

ISO Freight container internal dimensions

Freight container description	Freight container designation	Length, *L*			Width, *W*			Height, *H*			Volume, *V*	
		mm	ft	in	mm	ft	in	mm	ft	in	m^3	ft^3
45ft long x 9ft 6in high	1EEE	13,522	44	4 ⅜	2,330	7	7 ¾	2,655	8	9 ½	83.6	3,068
45ft long x 8ft 6in high	1EE							2,350	7	9 ½	74.0	2,719
40ft long x 9ft 6in high	1AAA	11,998	39	4 ⅜	2,330	7	7 ¾	2,655	8	9 ½	74.2	3,043
40ft long x 8ft 6in high	1AA							2,350	7	9 ½	65.7	2,697
40ft long x 8ft high	1A							2,197	7	2 ½	61.4	2,495
40ft long half height	1AX							1,054	3	6 ½	29.5	1,236
30ft long x 9ft 6in high	1BBB	8,931	29	3 ⅝	2,330	7	7 ¾	2,655	8	9 ½	55.2	2,007
30ft long x 8ft 6in high	1BB							2,350	7	9 ½	48.9	1,779
30ft long x 8ft high	1B							2,197	7	2 ½	45.7	1,646
30ft long half height	1BX							1,054	3	6 ½	21.9	809
20ft long x 9ft 6in high	1AAA	5,867	19	3	2,330	7	7 ¾	2,655	8	9 ½	36.3	1,220
20ft long x 8ft 6in high	1AA							2,350	7	9 ½	32.1	1,081
20ft long x 8ft high	1A							2,197	7	2 ½	30.0	1,000
20ft long half height	1AX							1,054	3	6 ½	14.4	491
10ft long x 8ft high	1A	2,802	9	2 $^5/_{16}$	2,330	7	7 ¾	2,197	7	2 ½	14.3	235
10ft long half height	1AX							1,054	3	6 ½	6.9	115

Figure 6.1 ISO container sizes

1.1.4 In addition to the standard lengths there are regional / domestic variations which include 48ft, 53ft and longer.

1.1.5 The standard width is 8ft (2.438mm), with regional variations of 8ft 6in (USA) and 2.5m (Europe).

1.1.6 The ISO standard heights are half height (4ft 3in / 1,295mm), 8ft (2,438mm), 8ft 6in (2,591mm) and 9ft 6in (2,896mm).

- There are very few 8ft high containers left in circulation

[1] ISO 830:1999 Freight containers - vocabulary

[2] The international convention for safe containers (CSC), 1972 as amended, IMO.

- Practically all the 20ft long containers are 8ft 6in high
- Practically all of the 45ft long containers are 9ft 6in high
- Regional heights of 9ft, 10ft and 3m can be found for specific cargoes.

1.1.7 Fork-lift pockets

- May be provided on 20ft and 10ft containers
- Are not generally fitted on 30ft and longer containers.
- On 20ft are generally fitted with for pockets with centres of 2,050mm ±50mm and may be used for lifting full containers. Some 20ft containers may have a second set at 900 mm centres which are used for emptying lifting. However this design feature is now almost extinct.

1.2 General cargo containers for general purpose (ISO 1496 part 1)

Containers built to this international standard includes:

- Dry freight (box) container
- Dry freight with bulk capabilities
- Ventilated container
- Open top container
- Open side container
- Named container

1.2.1 Dry freight containers

1.2.1.1 A general purpose container (also known as a GP or dry van) is a container which is totally enclosed and weather-proof. It generally will have a corten steel frame with a rigid roof, rigid side walls, rigid end walls at least one of which is equipped with doors, and a floor. It is intended to be suitable for the transport of cargo in the greatest possible variety.

1.2.1.2 It is not intended for the carriage of a particular category of cargo, such as cargo requiring temperature control, a liquid or gas cargo, dry solids in bulk, cars or livestock or for use in air mode transport.


Figure 6.2 : 20' GP


Figure 6.3: 40' GP

Figure 6.4: 45' GP

1.2.1.3 The GP container is by far the largest container type in the intermodal fleet comprising about 90% of the ISO series I (maritime) fleet. The 20ft x 8ft 6in GP container is the largest single container type forming just under half of the GP fleet and about 40% of all container types and sizes.

1.2.1.4 Dimensions and volume

- There are very few 20ft long x 9ft 6in high GP containers
- There are very few 30ft long GP containers, this length can be considered as obsolete and not available.
- There are very few 45ft long GP container that are not 9ft 6in high. GP containers with lower heights can be considered as unavailable.

.1 Minimum internal dimensions and volume

ISO Freight container internal dimensions												
Freight container description	Freight container designation	Length, *L*			Width, *W*			Height, *H*			Volume, *V*	
		mm	ft	in	mm	ft	in	mm	ft	in	m^3	ft^3
45ft long x 9ft 6in high	1EEE	13,522	44	4 ⅜	2,330	7	7 ¾	2,655.0	8	9 ½	83.6	3,068
45ft long x 8ft 6in high	1EE							2,350.0	7	9 ½	74.0	2,719
40ft long x 9ft 6in high	1AAA	11,998	39	4 ⅜	2,330	7	7 ¾	2,655.0	8	9 ½	74.2	3,043
40ft long x 8ft 6in high	1AA							2,350.0	7	9 ½	65.7	2,697
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30ft long x 9ft 6in high	1BBB	8,931	29	3 ⅝	2,330	7	7 ¾	2,655.0	8	9 ½	55.2	2,007
30ft long x 8ft 6in high	1BB							2,350.0	7	9 ½	48.9	1,779
30ft long x 8ft high	1B							2,197.0	7	2 ½	45.7	1,646
30ft long half height	1BX							1,054.0	3	6 ½	21.9	809
20ft long x 9ft 6in high	1AAA	5,867	19	3	2,330	7	7 ¾	2,655.0	8	9 ½	36.3	1,220
20ft long x 8ft 6in high	1AA							2,350.0	7	9 ½	32.1	1,081
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20ft long half height	1AX							1,054.0	3	6 ½	14.4	491
10ft long x 8ft high	1A	2,802	9	$2\,^{5}/_{16}$	2,330	7	7 ¾	2,197.0	7	2 ½	14.3	235
10ft long half height	1AX							1,054.0	3	6 ½	6.9	115

Figure 6.5 Table of internal dimensions

.2 Minimum door openings

- 9ft 6in high – 2,566 mm high x 2,286 mm wide.
- 8ft 6 in high – 2,261 mm high x 2,286 mm wide
- 8ft high – 2,134 x 2,286 mm wide

.3 Rating and load distribution

- 20ft long GP containers generally have a maximum gross mass greater than 30,000kg. The ISO standard was 30,480 kg, but this has been increased to 32,500 kg.
- 40ft and 45ft GP containers generally have a maximum gross mass of 32,500kg or 34,000kg
- Loads should be distributed across the flooring (see table below and Annex 14 Part 3):

Length	Mass (tonnes) per linear m			Mass (kg) per m^2)		
	30480	32500	34000	30480	32500	34000
45ft	2.25	2.40	2.51	967	1,032	1,079
40ft	2.54	2.71	2.83	1,090	1,163	1,216
20ft	5.20	5.54	5.80	2,230	2,377	2,487

Figure 6.6 Guide for load distribution

1.2.1.5 Strengths and ratings

.1 Wall strengths

- side walls - 0.6P evenly distributed over the entire side wall
- front and rear walls – 0.4P evenly distributed over the entire wall.

Walls are tested to withstand the above load so that there is no or limited plastic (permanent) deformation. Walls that are tested and found to have a greater plastic deformation will be down rated and this will be marked on the CSC safety approval plate. Line 7 and / or 8 will be marked with end wall and side wall strength respectively, if it is lesser or greater than the standard load.

.2 Floor strength

- The floor is tested using a vehicle equipped with tyres, with an axle load of 7 260 kg (i.e. 3 630 kg on each of two wheels). It shall be so arranged that all points of contact between each wheel and a flat continuous surface lie within a rectangular envelope measuring 185 mm (in a direction parallel to the axle of the wheel) by 100 mm and that each wheel makes physical contact over an area within this envelope of not more than 142 cm^2 . The wheel width shall be nominally 180 mm and the wheel centres shall be nominally 760 mm. The test vehicle shall be manoeuvred over the entire floor area of the container. The width of the test load is limited to the overall width of the wheels. The test shall be made with the container resting on four level supports under its four bottom corner fittings, with its base structure free to deflect.

- Annex II of the International Convention for Safe Containers requires that containers are subjected to point loads tests identical to the ISO test except with the test load limited to 5,460 kg.

The actual capacity of the floor will depend on the size and type of wheel used by the fork truck, wider and larger diameter wheels may permit larger axle loads.

.3 Cargo securing systems

- Anchor points are securing devices located in the base structure of the container.
- Lashing points are securing devices located in any part of the container other than their base structure.
- They are either fixed, hinged or sliding eyes, rings or bars.

	Number of lashings per side			
	40ft	30ft	20ft	10ft
Anchor points	8	6	5	4
Lashing points	Not specified			

Figure 6.7 Table of lashings in ISO container

- Each anchor point shall be designed and installed to provide a minimum rated load of 1 000kg applied in any direction. Many containers have anchor points with a rating of 2,000kg.
- Each lashing point shall be designed and installed to provide a minimum rated load of 500kg applied in any direction.

1.2.1.6 Typical cargoes

.1 The 20ft long GP container provides the most flexible of all the container types and sizes as it is capable of carrying denser materials and is often used to carry granite, slate and marble blocks.

.2 The GP container is used for such cargoes as dairy and other “clean” products which require the interior to be “as new” without corrosion and flaking paint. At the other end of the spectrum, the GP container may be used for corrosive materials, such as wet salted hides. It is important that consignors advise the container supplier of the cargo prior to its delivery so that the correct standard of container can be delivered.

.3 Packages can be loaded by hand and stacked across the container, lifted in using a counterbalance or pallet truck, or slid in on skids or slip sheets. When loading using a counterbalance truck, it is important that the axles load does not exceed that maximum permitted and that the cargo is distributed evenly.


Figure 6.8 Hand stacking


Figure 6.9 Using fork truck


Figure 6.10 Unit load packing

.4 GP containers are also used to transport cars and small vans either driven and secured to the floor, or secured to specialist racking that can be fitted and removed from the container without any modifications.


Figure 6.11 Individual cars


Figure 6.12 Car racks


Figure 6.13 Solid bulk


Figure 6.14 Bulk liquid

.5 The GP container is also becoming a major transporter of bulk powders, granules and liquids, within dry liner bags or flexitanks.

1.2.1.7 Variations

.1 There are few variations to the basic GP container, some 40ft GP containers are built with a door at each end. The example shown in Figure 6.15 shows the doors above the gooseneck tunnel and fork pockets for handling when empty.


Figure 6.15 40ft 8ft 6in high double ended container


Figure 6.16 With doors open

.2 Another variant to the general purpose container is the pallet-wide container. These units have end frames that comply with the requirements of the series 1 ISO freight container, but can accommodate two 1,200 mm wide pallets across the width of the container. This is achieved through a two designs where the side walls are thinner and moved outside of the ISO envelope.

- Pallet-wide containers may not be fitted with anchor points and only have a limited number of lashing points.

1.2.2 Dry freight with bulk capabilities (see also 1.5.4)

1.2.2.1 These are dry freight fitted with loading hatches in the roof and / or discharge hatches in the end walls.

1.2.2.2 They have the same physical and strength characteristics of the dry freight container.

1.2.2.3 The lashing points along the roof may be fitted with hooks that may only be used to support the bulk liner bag.

1.2.3 Closed vented or ventilated containers:

1.2.3.1 A closed vented or ventilated container is a closed type of container similar to a general purpose container but designed to allow air exchange between its interior and the outside atmosphere. It will be totally enclosed and weatherproof, having a rigid roof, rigid side walls, rigid end walls and a floor, at least one of its end walls equipped with doors and that has devices for ventilation, either natural or mechanical (forced)

Figure 6.17 20ft passive ventilated container

Figure 6.18 Ventilated container inner grill

1.2.3.2 Vented containers are containers that have passive vents at the upper part of their cargo space. While most containers built now are fitted with two or more vents fitted in the front or side walls, ventilated containers are containers which have a ventilating system designed to accelerate and increase the natural convection of the atmosphere within the container as uniformly as possible, either by non-mechanical vents at both the upper and lower parts of their cargo space, or by internal or external mechanical means.

1.2.3.3 This is a very specialised piece of equipment and was quite popular in the 1990's with in excess of 5,000 in service.

1.2.3.4 Dimensions and volume

All ventilated containers are 20ft long and 8ft 6in high.

1.2.3.5 Minimum internal dimensions and volume

Similar to the 20ft GP Container

1.2.3.6 Minimum door openings

Similar to the 8ft 6in high GP containers

1.2.3.7 Rating and load distribution

The latest production of ventilated containers was built with a maximum gross mass of 30,480kg.

1.2.3.8 Strengths and ratings

Similar to the GP container.

1.2.3.9 Typical cargoes

Ventilated containers were developed to carry green coffee beans and other agricultural products. Produce such as melons, oranges, potatoes, sweet potatoes, yams and onions are sometimes carried in ventilated containers.

1.2.3.10 Variations

Most ventilated containers have ventilation grills built into the top and bottom side rails and the front top rail and bottom sill. To further improve the movement of air though the container an electrical fan can be mounted in the door end and connected up to shore and ships' supply. After the cargo has been delivered the fan can be removed and the fan hatch closed so that the container can be used as a GP container. These units are referred to as Fantainers.

1.2.4 Open top containers:

1.2.4.1 An open top container is similar to a general purpose container in all respects except that it has no permanent rigid roof. It may have a flexible and moveable or removable cover, e.g. of canvas, plastic or reinforced plastic material often referred to as a Tarpaulin, “tarp” or “Tilt”. The cover is normally supported on movable or removable roof bows. In some cases the removable roof is fabricated from steel that can be fitted to of lift from the top of the open top container. Containers thus built have been known as ‘solid top’ containers.

Figure 6.19 20ft open (soft) top container

Figure 6.20 20ft open hard top container

1.2.4.2 The open top container is designed to operate with the tarpaulin or hard top fitted or not fitted, therefore to withstand the loads exerted onto the side walls the top side rails are substantially larger than those of a GP container. For the traditional open top container, the top side rail also has to accommodate receptacles for the roof bows and loops for attaching the tarpaulin. It is essential that the tarpaulin is the correct design and the eyelets on the tarpaulin match the eyes on the top side rail, front and back rails and around the corner fittings to ensure the best weathertightness and to permit the TIR wire to be threaded through all of them to maximise security.

1.2.4.3 The open top container was designed for two categories of cargo, those that are too heavy or difficult to load by conventional methods through the doors, or that are too tall for a standard GP container. The hard top, open top container caters for the former but due to the rigid roof, transporting tall cargoes may present problems with moving the roof to the destination.

1.2.4.4 The other feature of the open top container is the ability to pack tall items into the container through the doors, as the header (transverse top rail above the doors) are generally movable or removable (known as swinging headers). The swinging header either forms a trough into which the tarpaulin is attached or it folds over the front face of the header to prevent water runoff from entering the container. The header is held in place by hinges at each end adjacent to the corner fittings, and each hinge has a removable pin that so that the header can be swung out of the way. However it is advisable to remove both pins and lift the header down using a fork truck rather than leaving the header unsupported at one end.

Figure 6.21 20ft open top with tilt removed and rear header open

1.2.4.5 Open tops are generally 20ft or 40ft long and 8ft 6in high. There are few 9ft 6in high to cater for some cargoes and which will enable standard tarpaulins or hard tops to be used.

1.2.4.6 Dimensions and volume

With the exception of the .removable tarpaulin, roof, the dimensions are generally in line with the GP container.

1.2.4.7 Minimum internal dimensions and volume

Similar to the GP Container

1.2.4.8 Minimum door openings

Similar to the 8ft 6in high GP containers

1.2.4.9 Rating and load distribution

As GP container.

1.2.4.10 Strengths and ratings

Similar to the GP container.

1.2.4.11 Typical cargoes

Open top containers carry a variety of tall and heavy, generally project type cargo. Regular cargoes include glass sheets mounted on special A frames often lifted in through the roof and covered using an over height tarpaulin, large diameter tyres .for mine vehicles and scrap steel.

Figure 6.22 20ft open top with scrap steel

Figure 6.23 20ft open top with extra large tyres

1.2.4.12 Variations

There are few variations from the standard tarpaulin covered open top container. Many designs have been developed to ease the fitting and removal of the tarpaulin roof and roof bows. These include sliding tarpaulins which concertina towards the front of the container and captive roof bows that lift out on one side and hand from a bar on the other, thus reducing the risk of loss when an over height cargo is carried.

Figure 6.24 20ft coil carrier

Figure 6.25 40ft ingot and bar carrier

Hard top open top containers have been adapted to carry large steel coils or long bars.[3] These specialist open top containers may have higher maximum gross mass values.

1.2.5 Open side containers:

1.2.5.1 The open side container was introduced into the maritime fleet as a GP container variation and as an alternative to the standard curtain sided trailer used in road transport. Original designs had a curtain on one or both sides, a rigid roof and rear doors. Without side walls the base structure had to be self-supporting, therefore required to be more substantial than the GP floor to achieve the same floor strength and load carrying capabilities. In this form the open side container took on some of the characteristics of the platform based container with complete superstructure.[4] As a consequence of the self-supporting floor the tare generally increased.

1.2.5.2 To improve security some manufacturers offer solid doors in place of the curtains offering doors to one or both sides, with no rear doors, with doors at the rear of the container and with door at the front of the container, offering one, two, three and four side access.

1.2.5.3 The open side container is a specialist item of transport equipment, although the 45ft long and 2,5m wide pallet-wide curtain side variation is becoming more popular in Europe. However the full length side door 20ft long unit is also becoming popular also as a regional variation in other parts of the world.

Figure 6.26 45ft curtain sided swap body

Figure 6.27 20ft side door container

1.2.5.4 Dimensions

As GP container.

1.2.5.5 Minimum internal dimensions and volume

Similar to the GP Container although the internal height is reduced to approximately 2.4m.

1.2.5.6 Minimum door openings

Reduced height to match the reduction of internal height.

1.2.5.7 Rating and load distribution

Maximum gross mass is generally 34,000kg for newer 45ft long units. 20ft units will be 30,480kg or higher.

1.2.5.8 Strengths and ratings

.1 Wall strengths

- side walls – Refer to CSC safety approval plate. Open side containers with tarpaulin sides may have little (0.3P) or no strength, however some are fitted with removable gates or rigid side doors which may achieve full side wall strength (0.6P).
- front and rear walls – 0.4P evenly distributed over the entire wall.

.2 Floor strength

- as GP container.

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[3] Langh Ships

[4] platform based container with a permanent fixed longitudinal load carrying structure between ends at the top.

.3 Cargo securing systems

- Anchor points may be recessed onto the floor but may be rated lower than standard GP containers. Please check with CTU operator.

1.2.5.9 Typical cargoes

Open side containers are designed to carry packages that can be loaded using a fork truck, typically pallets and long packages.

1.2.5.10 Variations

Variations are available for specific trades, such as an open side container with a built in half height deck.

Other variations include internal full length or partial length central walls to provide support to the base structure and assist with pallet placement.

Figure 6.28 20ft open side with mezzanine deck

1.2.6 Named cargo containers:

1.2.6.1 Named cargo types of containers are containers built in general accordance with ISO standards either solely or principally for the carriage of named cargo such as cars or livestock.

Figure 6.29 Double height car carrier

Figure 6.30 Single height car carrier

Figure 6.31 Livestock carrier

Figure 6.32 Genset container

1.2.6.2 One particular container type is the Power Pack, which can be used to supply 3 phase electricity to reefer container when carried by rail, to supplement or provide power on board power during sea transport or to supplement or provide power in terminals.

1.2.6.3 A power pack would typically consist of a diesel generator set (250kW-700kW) with up to 64 sockets. They can include built in fuel tanks for the generator or use a 20ft tank container carried in an adjacent slot.

1.2.6.4 Externally it will be the same as a 20ft GP container

1.3 Thermal containers (ISO 1496 part 2)

1.3.1 A thermal container is a container that has insulating walls, doors, floor and roof. Over the years the thermal container has evolved from a simple insulated container with no device for cooling and/or heating through refrigerated an insulated container cooled using expendable refrigerants such as ice, 'dry ice' (solid carbon dioxide), or liquefied gasses but again with no external power or fuel supply.

1.3.2 A variation of this design is the porthole container, which are refrigerated by cold air from an external source introduced through a porthole. This design is being phased out.

1.3.3 The most common variant of the thermal container is the integrated refrigerated container, often referred to as the "Reefer". The internal temperature is controlled by a refrigerating appliance such as a mechanical compressor unit or an absorption unit. The Reefer consists of a container body with insulated walls, sides and roof plus insulated doors at the rear. The front of the container body is left open for mounting the refrigeration machinery.

Figure 6.33 20ft refrigerated container

Figure 6.34 40ft refrigerated container

1.3.4 Refrigeration machinery is generally powered by 3-phase electricity supplied by a trailing lead that can be connected to sockets on board ship or in the terminal. Where there is insufficient power capacity freestanding "power packs" can be used. Power packs can also be used to supply power to a number of Reefers being carried by rail. When the Reefer is to be carried by road, unless the journey is relatively short, most cargo owners will require the reefer to be running and for this nose mounted or trailer mounted generator set are available.

1.3.5 There are some refrigerated containers fitted with integrated power packs, fitted with a diesel generator negating the need for a standalone generator. However the volume of diesel that these containers can carry is limited and need to be monitored regularly. These are very specialist pieces of equipment and used on close loop trades, and are not generally available.

1.3.6 Where reefers are used to transport chilled or frozen cargo by road, some owners have integral refrigerated containers with the machinery including a diesel generator.

1.3.7 The refrigeration machinery works by passing air through the container from top to bottom. In general, the "warm" air is drawn off from the inside of the container, cooled in the refrigeration unit and then blown back in the container as cold air along the "T" floor grating.

1.3.8 To ensure adequate circulation of the cold air, the floor is provided with an "T" section gratings. Pallets form an additional space between container floor and cargo, so also forming a satisfactory air flow channel.

1.3.9 The last form of thermal containers are those that to operate within areas with low or very low ambient temperatures, often servicing areas of extreme cold such as Alaska. The design of which can be based on a thermal as described above except with a heating device, or by the use of a general purpose container fitted with internal insulation and heating filaments.

1.3.10 The mix of reefer units has changed over the last few years, new purchases of 20ft and 40ft long 8ft 6in high reefer containers has not matched the number of sales of old units, therefore the fleet size is shrinking. On the other hand the 40ft 9ft 6in high reefer has been growing with 150,000 added to the fleet in the last three years.

1.3.11 Dimensions and volume

Externally the same as 20ft, 40ft and 45ft GP containers.

1.3.12 Typical internal dimensions

ISO Refrigerated container internal dimensions												
Freight container description	Freight container designation	Length, *L*			Width, *W*			Height, *H*			Volume, *V*	
		mm	ft	in	mm	ft	in	mm	ft	in	m^3	ft^3
45ft long x 9ft 6in high	1EEE	13,115	43	¼	2,294	7	6 ½	2,554	8	4 ½	81.5	2,878
40ft long x 9ft 6in high	1AAA	11,590	38		2,294	7	6 ½	2,554	8	4 ½	67.9	2,398
40ft long x 8ft 6in high	1AA							2,350	7	9 ½	62.5	2,697
20ft long x 9ft 6in high	1AAA	5,468	17	11	2,294	7	6 ½	2,554	8	4 ½	32.0	1,003
20ft long x 8ft 6in high	1AA							2,350	7	9 ½	29.5	1,081

Figure 6.35 ISO reefer container dimensions

The dimensions shown above are typical for a steel reefer unit, however packers are advised to contact the CTU operator for exact internal dimensions,

1.3.13 Door openings

- Each thermal container shall be provided with a door opening at least at one end.
- All door openings and end openings shall be as large as possible.
- The usable width shall correspond with the appropriate minimum internal dimension given in Figure 6.35.
- The usable height shall be as close as practicable to the appropriate minimum internal dimension given in Figure 6.35.

1.3.14 Table 3.Rating and load distribution

The latest production of 20ft reefers has a maximum gross mass of 30,480kg and 40ft and 45ft long a maximum gross mass of 34,000kg

1.3.14.1 Strengths and ratings

.1 Wall strengths

- side walls - 0.6P evenly distributed over the entire side wall
- front and rear walls – 0.4P evenly distributed over the entire wall.

Walls are tested to withstand the above load so that there is no or limited plastic (permanent) deformation. Walls that are tested and found to have a greater plastic deformation will be down rated and this will be marked on the CSC safety approval plate. Line 7 and / or 8 will be marked with end wall and side wall strength respectively, if it is lesser or greater than the standard load.

.2 Floor strength

- The floor is tested using a vehicle equipped with tyres, with an axle load of 5,460kg (i.e. 2,730kg on each of two wheels). It shall be so arranged that all points of contact between each wheel and a flat continuous surface lie within a rectangular envelope measuring 185mm (in a direction parallel to the axle of the wheel) by 100mm and that each wheel makes physical contact over an area within this envelope of not more than $142cm^2$. The wheel width shall be nominally 180mm and the wheel centres shall be nominally 760mm. The test vehicle shall be manoeuvred over the entire floor area of the container. The width of the test load is limited to the overall width of the wheels. The test shall be made with the container resting on four level supports under its four bottom corner fittings, with its base structure free to deflect.

The strength of the floor will depend on the size and type of wheel used by the fork truck, wider and larger diameter wheels may permit larger axle loads.

Mechanical handling equipment with narrow wheels may damage the “T” section flooring, and wherever possible the width of the wheels should be greater than twice the distance between centre lines of “T” sections.

.3 Cargo securing systems

- There is no requirement for either anchor or lashing points within the standard and very few thermal containers will be fitted with them.

1.3.15 Typical cargoes

Reefer containers were developed to transport perishable cargoes. A "perishable" may be described as something that is easily injured or destroyed. Without careful treatment, the time taken to deteriorate to a condition which will either reduce the value or render it unsaleable (shelf life) may become unacceptably short.

Careful consideration of the factors affecting the "shelf life" of perishables should be made and applied during their transportation.

Perishables include frozen produce, meats, seafood, dairy products, fruit and vegetables, horticultural products such as flowering bulbs and fresh flowers plus chemical compounds and photographic materials.

1.3.16 Variations

Reefer can be fitted with a number of refrigeration units from different suppliers and those can also provide controlled atmosphere provisions.

Structurally, special designs have been produced for rail based equipment, 48, 53 and 58ft long and over wide units (2.6m).

1.4 Tank containers for liquids, gases and pressurised dry bulk (ISO 1496 part 3):

1.4.1 A tank container comprises two basic elements, the tank (barrel) or tanks and the framework and complies with the requirements of ISO 1496-3.[5]

1.4.2 In the freight container industry, the term “tank” or “tank container” usually refers to a 20ft tank container consisting of a stainless steel pressure vessel supported and protected within a steel frame.

1.4.3 However the tank container industry has developed a number of containment designs that carry all sorts of bulk liquids, powders, granules and liquefied gases, however it is important to differentiate bulk liquid and pressurised dry bulk tank containers from non-pressured dry bulk containers that may look very similar to a tank container.

1.4.4 The majority of the maritime tank container fleet is 20ft long and 8ft 6in high. The split between the major tank designs is not known although the most current production is generally Collar tanks. All the tank designs fulfil the requirements of the ISO standards.

1.4.5 Designs

There are three main structural types of tank container used in the international transport of bulk liquids and liquefied gases - beam, frame and collar. All designs have been manufactured since the 1970s.

All designs can be top lifted, must be stackable and the pressure vessel / barrel as well as all valves and other service equipment must remain within the ISO envelope, i.e. no part can protrude past the outer faces of the corner fittings.

1.4.5.1 Frame Tanks

This design consists of two end frames separated by two main beams at low level forming a support frame. Since there is more material in the support frame than with other designs the tare is relatively high. Often the lower beams are “castellated” a method of lightening the main beams by cutting holes to reduce the tare and therefore to increase the payload. Top rails are often light weight, play little part in the overall structural strength and often there to support the walkway. Top rails in these cases are not usually attached to the pressure vessel. In some designs these rails can be attached using mechanical fasteners (nuts and bolts) but are more often welded in place.

The pressure vessel is supported from the main beams generally on saddle supports which are in the form of bolted clamps or welded interface supports.

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5 ISO 1406-3, Series 1 freight containers – Specification and testing – Part 3: Tank containers for liquids, gases and pressurised dry bulk.

Figure 6.36 20,000l frame tank

Figure 6.37 25,000 l frame tank

The two pictures above show a 20,000 litre (Figure 6.36) and a 25,000 litre design (Figure 6.37). Both are insulated.

1.4.5.2 Beam Tanks

A beam tank is supported by a series of bearers attached to the end frames which interface with the pressure vessel at various locations on the periphery of the barrel. The interface consists of plates that are welded to the pressure vessel and the bearers to ensure load sharing and a “barrier” between carbon steel and stainless steel components.

The example shown in Figure 6.38 is a typical beam tank with no top or bottom side rails. The tank is attached using four beams that connect at the four corner fittings of each end frame. The walkway is supported using brackets attached to the pressure vessel.

Figure 6.38 Beam tank no top rail

Figure 6.39 Beam tank with top rail

Figure 6.39 shows a different design where the attachment of the pressure vessel is made using fabricated brackets attached to the corner posts and the end frame corner braces. Top side rails are fitted to the top corner fittings.

The tank container is also un-insulated.

Both examples show low volume pressure vessels 17,500 lt.

Figure 6.40 Four 10ft ISO beam tanks

Figure 6.40 shows four 10ft ISO International beam tanks, being carried as two 20ft units. In this example two 10ft units are connected using approved horizontal interbox connectors and the design tested in that configuration. They can then be loaded, handled and stowed in the same way as any 20ft ISO tank container.

1.4.5.3 Collar Tanks

The collar tank is probably the simplest of all the tank designs with a minimum of differing materials in contact with the pressure vessel. Attachment of the pressure vessel to the end frames is by means of a stainless steel collar which is welded to the pressure vessel end dome at the edge (out-set) or to the crown of the domed ends of the pressure vessel (in-set). The collar connects with the side posts, top and bottom rails and the diagonal braces via interface flanges.

The collar is continuous at the front / non discharge end. At the rear of the tank container some collar tank designs have a break in the collar where the discharge valve is located.

Figure 6.41 25,000 l collar tank

Figure 6.41 shows an insulated 25,000 litre collar tank. Once insulated it is virtually impossible to distinguish between the inset and outset collar design.

1.4.6 Dimensions and volume

Practically all maritime tank containers are 20ft long and 8ft 6in high although there are 30ft and 40ft versions.

1.4.7 Minimum internal dimensions and volume

Volume vary from 9,000 litres to 27,000

1.4.8 Minimum door openings

No doors fitted

1.4.9 Rating and load distribution

Maximum gross mass for tank containers varies but is generally 34,000 kg.

1.4.10 Typical cargoes

Tank containers can carry practically all liquids from orange juice to whisky, and non-regulated to dangerous good.

1.4.11 Variations

Tank containers can be supplied un-insulated or insulated, with steam heating, with electrical heating, with refrigerant plants attached, with cooling tubes.

Additionally the tank can be partitioned into a two or more discrete compartments or divided with baffle / surge plates

1.5 Non pressurised containers for dry bulk (ISO 1496 part 4)

1.5.1 Within this type of container, there are a number of variations available. The definition of a non-pressurised dry bulk container is:

"Container for the transport of dry solids, capable of withstanding the loads resulting from filling, transport motions and discharging of non-packaged dry bulk solids, having filling and discharge apertures and fittings and complying with ISO 1496 part 4[6]."

Figure 6.42 30ft dry bulk box container

1.5.2 Within that standard two sub types are described:

"Box type – dry bulk non-pressurised container for tipping discharge having a parallelepiped[7] cargo space and a door opening at least at one end, which therefore may be used as a general purpose freight container."

"Hopper type – dry bulk non-pressurised container for horizontal discharge having no door opening, which therefore may not be used as a general purpose freight container."

1.5.3 These are specialised items of equipment and are generally located near companies that are actively involved with the transport of bulk materials. In Europe there are a number of specialist companies who provide complete logistics services for bulk dry materials.

1.5.4 Box type

1.5.4.1 Box type bulk containers have the outwards appearance of the GP container with loading and or discharge hatches.

1.5.4.2 Loading hatches are generally round, 600mm in diameter varying in number from one centrally up to six along the centre line.

1.5.4.3 Discharge hatches come in a number of forms:

.1 Full width "letterbox" type either in the front wall or in the rear as part of the door structure or "cat flap" type hatches fitted into the rear doors.

.2 In some box type dry bulk containers with full width discharge hatches in the rear (door) end, the hatch can be incorporated into the left hand door, as shown in Figure 6.42, or as shown in Figure 6.44, access is gained to the interior by a smaller right hand door only. Box type bulk containers with this design feature are not available for use as a general purpose container when not being employed as a bulk container.

Figure 6.43 Letterbox type hatch in container front wall

Figure 6.44 letterbox type hatch in fixed rear end

Figure 6.45 Cat flap type hatch in rear doors

1.5.4.4 New type code designations are being introduced for all categories of dry bulk containers.

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6 ISO 1496-4:1991, Series 1 freight containers – specification and testing – Part 4: Non pressurised containers for dry bulk.

7 A parallelepiped is a three-dimensional figure formed by six parallelograms. (The term rhomboid is also sometimes used with this meaning.

1.5.4.5 Dimensions and volume

The majority of bulk containers in Europe are 30ft long and often 2.5m wide and therefore should be considered as a swap body, however they have the appearance of an ISO container and are often confused with them.

In other parts of the world the majority of bulk containers are 20ft long although 40ft and 45ft containers have been built for transporting dry bulk materials and cellular friendly .pallet-wide containers are also built to this standard to increase the internal volume.

1.5.4.6 Minimum internal dimensions and volume

- Similar to the GP Container
- Cellular friendly – 2,400mm internal width.

1.5.4.7 Minimum door openings

For those units with doors, they are broadly similar to 8ft 6in and 9ft 6in high GP containers

1.5.4.8 Rating and load distribution

Dry bulk containers are often built to meet the particular transport requirements of a customer or product. Maximum gross mass can be as high as 38 tonnes which require specialist road vehicles and handling equipment, but generally the maximum gross mass is higher than for a similar sized GP container.

30ft dry bulk containers in use in Europe may also be manufactured with reduced stacking capabilities, therefore are not suitable for stacking more than one fully laden container above it.

1.5.4.9 Strength and rating

.1 Wall strengths

- side walls - 0.6P evenly distributed over the entire side wall
- front and rear walls: 40ft and 30ft - 0.4P evenly distributed over the entire wall.
  20ft and 10ft - 0.6P evenly distributed over the entire wall.

.2 Floor strength

- The floor is tested using a vehicle equipped with tyres, with an axle load of 5,460kg (i.e. 2,730kg on each of two wheels). It shall be so arranged that all points of contact between each wheel and a flat continuous surface lie within a rectangular envelope measuring 185mm (in a direction parallel to the axle of the wheel) by 100mm and that each wheel makes physical contact over an area within this envelope of not more than $142cm^2$. The wheel width shall be nominally 180mm and the wheel centres shall be nominally 760mm. The test vehicle shall be manoeuvred over the entire floor area of the container. The width of the test load is limited to the overall width of the wheels. The test shall be made with the container resting on four level supports under its four bottom corner fittings, with its base structure free to deflect.

.3 Cargo securing systems

- There is no requirement for either anchor or lashing points within the standard
- Containers without two opening doors or pallet-wide may not have anchor points and only be fitted with liner support hooks.

1.5.4.10 Typical cargoes

These containers are suitable for all types of dry powder, granules and aggregate generally which are free flowing.

1.5.4.11 Variations

Dry bulk containers for aggregate are generally built with larger loading and/or discharge hatches. They may also be built without a solid top, so blending the dry bulk container with the open top container.

1.5.5 Hopper Type

1.5.5.1 Hopper type dry bulk containers are very specialist items of equipment and are generally built to meet the specific requirements of the cargo to be carried. An example of such a specialist item is shown in Figure 6.46 is a 30ft five compartment silo container with each compartment capable of handling about 6 m^3 of product. When designing silo containers a number of characteristics need to be considered. Firstly the length; 30ft is associated with European transport and is ideally suited to medium density powders and granules. For higher density cargoes and for north / south deep sea trades the 20ft units would be appropriate. For low density cargoes the new internationally approved length of 45ft is becoming popular. The material, shape and volume of the hopper and discharge will be dictated by the dry cargo being carried and its flowability. Lastly the loading and discharge capabilities will need to be designed to interface with the facilities at origin and destination.

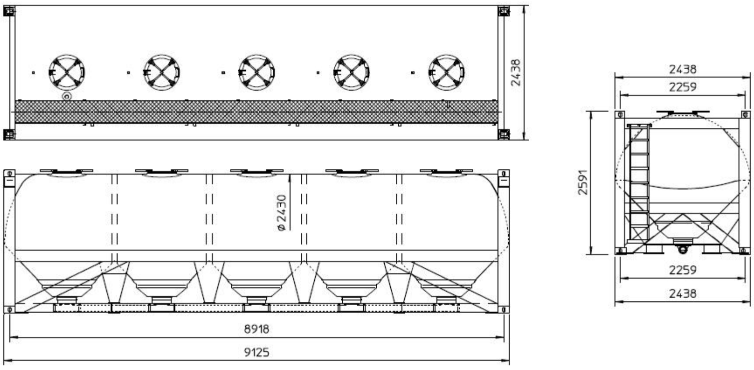


Figure 6.46 30ft hopper type dry bulk container

1.5.5.2 In the example shown in Figure 6.46 loading is achieved through the top loading hatches and the separate compartments ensure that the container can be evenly loaded and the cargo kept stable from longitudinal movement. Unloading can be either vertical discharge where the container is positioned above receiving hoppers set below the road surface / rail bed or from the rear by horizontal discharge to the rear mounted discharge pipe via an internal conveyor / screw. This type of container would not be tipped.

1.5.5.3 If the cargo is to be discharged vertically by gravity into ground level receiver hoppers then the freight container can either be lifted onto the discharge area or must be mounted on a special trailer / chassis that permits such discharge.

1.6 Platform and platform based containers (ISO 1496 part 5)

1.6.1 Platform based containers are specific-purpose containers that have no side walls, but has a base structure. The simplest version is the platform container which has no superstructure whatsoever but is the same length, width, strength requirement and handling and securing features as required for interchange of its size within the ISO series of containers. There are approximately 16,300 platform containers in the maritime fleet.

Figure 6.47 20ft platforms

Figure 6.48 40ft fixed post flatrack

1.6.2 Since the platform container has no vertical superstructure, it is impossible to load one or more packages on it and then stack another container above it. To do this a platform based container with incomplete superstructure with vertical ends is required. The end structure can consist of posts, posts with transverse rails or complete end walls. The original designs for these were fitted with fixed end walls and were called flatracks.

1.6.3 The next design innovation was to build a platform based container with folding ends which could act as a platform when the end walls / posts were folded down or as a flatrack with the end walls erected.

Figure 6.49 20ft with portal end frame

Figure 6.50 40ft folding flatrack

Figure 6.51 40ft folding super rack

1.6.4 Folding flatracks are now the major project transport equipment with about 151,000 containers in service in the maritime fleet. They can be readily sourced in most locations, although there are areas where concentrations are greater to meet local on-going demand.

1.6.5 Dimensions and volume

Platforms and fixed end flatracks are available in 20ft and 40ft lengths whereas folding flatracks are available in these two lengths plus a very limited number of 45ft long containers.

Folded flatracks can be stacked using the integral interconnectors for empty transport, forming an 8ft 6in high pile. 20ft folded flatracks are stacked in groups of 7 and 40ft in stacks of 4.

Figure 6.52 Stack of 40ft folding end flatracks

1.6.6 Minimum internal dimensions and volume

Flatracks with end walls erected will have internal volume similar to the GP container, although the size of the corner posts will restrict the width at the ends. However most flatracks are built with end walls that create an 8ft 6in high container so that the distance between the deck and the top of the posts are approximately 1,953mm (6ft 5in).

Owners, recognising that the more packages that they can fit “inside” the height of the flatrack walls, have started to build some flatracks with higher end walls thus forming a 9ft 6in high container.

A progression from that is the flatrack with extendable posts that takes the overall height to 13ft 6in high.

1.6.7 Minimum door openings

No doors fitted

1.6.8 Rating and load distribution

Flatrack maximum gross mass values have increased over the past years, rising from 30,480kg to 45,000kg and most 40ft flatracks are now built to this rating. This means that payloads of approximately 40 tonnes evenly distributed over the deck and supported by the side rails can be lifted and transported by suitable modes. Many flatrack owners will provide information on concentrated loads that can be carried centrally.

1.6.9 Strength and rating

.1 Wall strengths

- side walls – There is no test for side walls
- front and rear walls: Where there is a solid end wall, it must be tested for 0.4P evenly distributed over the entire wall.

.2 Floor strength

- The floor is tested using a vehicle equipped with tyres, with an axle load of 5,460kg (i.e. 2,730kg on each of two wheels). It shall be so arranged that all points of contact between each wheel and a flat continuous surface lie within a rectangular envelope measuring 185mm (in a direction parallel to the axle of the wheel) by 100mm and that each wheel makes physical contact over an area within this envelope of not more than 142cm^2 . The wheel width shall be nominally 180 mm and the wheel centres shall be nominally 760mm. The test vehicle shall be manoeuvred over the entire floor area of the container. The width of the test load is limited to the overall width of the wheels. The test shall be made with the container resting on four level supports under its four bottom corner fittings, with its base structure free to deflect.

.3 Cargo securing systems

- Anchor points are securing devices located in the base structure of the container.
- Lashing points are securing devices located in any part of the container other than their base structure.

	Number of lashings per side		
	40ft	30ft	20ft
Anchor points	8	6	5
Lashing points	Not specified		

Figure 6.53Table for lashings on a flatrack

- Each unit shall be fitted with cargo-securing devices complying with the following requirements:
  - The anchor points shall be designed and installed along the perimeter of the container base structure in such a way as to provide a total minimum securing capability at least equivalent to:
    - 0.6P transversally
    - 0.4P longitudinal (for those containers having no end walls or end walls that are not capable of withstanding the full end wall test.
  - Such securing capability can be reached either:
    - by a combination of a minimum number of anchor points rated to an appropriate load; or
    - a combination of a higher number of anchor points having a lower individual rated load.
- Each anchor point shall be designed and installed to provide a minimum rated load of 3 000 kg applied in any direction.
- Each lashing point shall be designed and installed to provide a minimum rated load of 1,000 kg applied in any direction.

1.6.10 Typical cargoes

The platform container and flatrack are used to transport out of gauge packages and items that need special handling. One of the most readily identifiable cargoes carried are road, farm and construction vehicles carried on flatracks or platforms because they are often over-height or width.

1.6.11 Variations

There are a number of variations available from specialist flatrack suppliers, pipe carriers, coil carriers and car manufacturers to name but three. However these are generally held for specific trades and are few in number.

Figure 6.54 45ft car carrying folding flatrack

Figure 6.55 Bin carrier

Figure 6.56 Covered steel coil carrier

Figure 6.57 Open steel coil carrier

2 European Swap Body

2.1 General

2.1.1 An item of transport equipment having a mechanical strength designed only for rail and road vehicle transport by land or by ferry, and therefore not needing to fulfil the same requirements as series 1 ISO containers; having a width and/or a length exceeding those of series 1 ISO containers of equivalent basic size, for better utilisation of the dimensions specified for road traffic;

2.1.2 Swap bodies are generally 2.5m or 2.55m wide although thermal swap bodies can be up to 2.6m wide.

2.1.3 Swap bodies generally fall into three length categories:

Class A: 12.19 (40ft), 12.5, 13.6 or 13.712m (45 ft) long

Class B: 30ft long

Class C: 7.15, 7.45 or 7.8m long. The most commonly used length in this class is 7.45m

2.1.4 Swap bodies are fixed and secured to the vehicles with the same devices as those of series 1 ISO containers: for this reason, such devices are fixed as specified in ISO 668 and ISO 1161, but owing to the size difference. are not always located at the swap body corners.

2.1.5 Most swap bodies were originally designed for road and rail transport without the need for stacking and lifting achieved using grapple arms or lowering the swap body onto their own legs (Class C). Class A and B outwardly have the appearance of the ISO container and all sizes are now produced with the ability to top lift and to have limited stacking capability.

2.1.6 Stacking

2.1.6.1 All classes of swap body may be stacked if the design permits it and has been subjected to appropriate tests. Such swap bodies will be fitted top fittings. The external faces will be 2.438m (8ft) when measured across the unit and 2.259m between aperture centres.

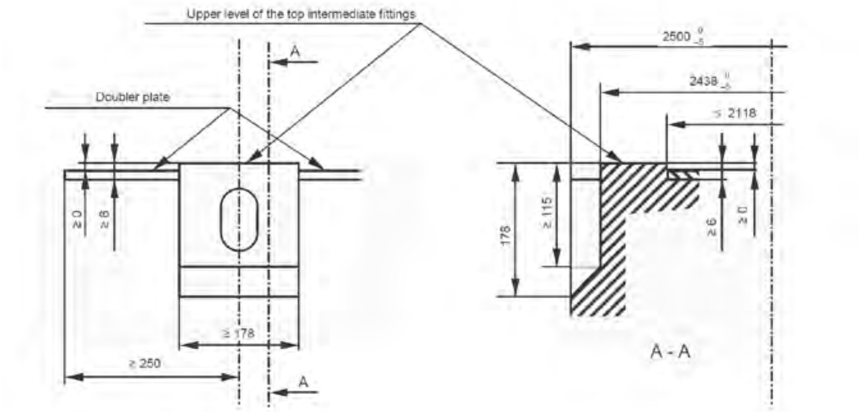


Figure 6.58Swap body top fitting detail

Figure 6.59 7.45 Class C stackable swap body with set-back top fittings

2.1.6.2 The placing of the top corner fittings is such that the container can be handled using standard ISO container handling equipment.

2.1.6.3 The stacking capability is generally well below that of the ISO container. Before stacking the container the handler must check the stacking strength shown on the Safety Approval Plate (if fitted) or marks on the container to indicate its stacking capability, for example “2 high stacking only”.

2.1.6.4 The top fittings will be placed as follows:

- Class A swap bodies will have top fittings at the central 40ft positions and at the corners,
- Class B will have corner fittings only
- Class C box type swap bodies will have corner fittings only. Swap tanks will have the top fittings directly above the lower (at 20ft positions).

2.2 Dimensions and rating

2.2.1 Swap bodies of Class A (EN 452 and CEN / TS 14993)

Designation	Length (mm)	Length (ft)	Height	Width	Rating (kg)
A 1219	12,192	40ft	2,670[1]	2,500[2]	34,000
A 1250	12,500	41ft			
A 1360	13,600	44ft 7in			
A 1371[3]	13,13,716	45ft	2900[4]	2550	32,000 to 34,000

Figure 6.60Swap body Class A rating

1 The body height of 2,670 mm assures transport without hindrance on the main railway lines of Europe.

2 A maximum width of 2,600 mm is permitted for certain thermal bodies according to Council Directive 88/218/EEC. The body width of 2,500mm assures transport without hindrance throughout Europe.

[3] Swap bodies for combined transport – stackable swap bodies type A 1371 Technical specification

[4] Maximum height

2.2.2 Swap bodies – non stackable swap bodies of Class C

Designation	Length (mm)	Length (ft)	Height	Width	Rating (kg)
C 745	7,450	24ft 5in	2,750	2,550	16,000
C 782	7,820	25ft 8in			

Figure 6.61 Swap body Class C rating

2.3 Securing of cargo on road vehicles – lashing points on commercial vehicles for goods transport.(EN 12640)

2.3.1 Lashing points shall be designed so that they transmit the forces they receive into the structural elements of the vehicle. They shall be fixed in the loading platform and in the vertical front end wall. In their position of rest they shall not project above the horizontal level of the loading platform nor beyond the vertical surface of the front end wall into the loading space.

NOTE: The recesses in the loading platform required to accommodate the lashing points should be as small as possible.

2.3.2 Lashing points shall be designed to accommodate lashing forces applied from any direction within the conical area determined as follows:

- angle of inclination ß from 0° to 60°;
- angle of rotation (α) from 0° to 180° for lashing points with a transverse distance from the side wall and the lashing points ≤ 50 mm;
- angle of rotation (α) from 0° to 360° for lashing points within a transverse distance from the side wall and the lashing points ≥ 50 mm but ≤ 250 mm.

2.3.3 Number and layout of the lashing points

2.3.3.1 Lashing points on the floor

The number of lashing points shall be determined by the highest result of the following:

- length of the loading platform;
- maximum distance between lashing points;
- permissible tensile load

2.3.3.2 Length of the loading platform

- For vehicles with an effective cargo loading length greater than 2 200 mm there shall be at least 6 lashing points, at least 3 on each side.

2.3.3.3 Maximum distance between lashing points

.1 The lashing points are to be arranged in such a way that:

- with the exception of the area above the rear axle, the distance between two adjacent lashing points on one side shall be not more than 1,200mm. In the area above the rear axle the distance between two adjacent lashing points shall be as close to 1,200mm as practicable but in any case shall not be more than 1,500mm;
- the distance from front or rear end wall shall not be greater than 500mm;
- the distance from the side walls of the loading area should be as small as possible and in any case shall not be greater than 250mm.

Loading length (mm)	Number of pairs
7,450	7
7,820	7
9,150 (30ft)	8
12,190	11
12,500	11
13,600	12
13,719	12

Figure 6.62 Number of lashings based on length

.2 For vehicles with a maximum authorised total mass greater than 12 tonnes, the number of lashing points n shall be calculated by use of the formula:

$$n = \frac{1.5 \times P}{20}$$

Where p is the inertial force in KN resulting from the maximum payload

Payload (kg)	Number of lashing points
16,000	12
32,500	24
34,000	25

Figure 6.63 Number of lashing based on maximum net mass

2.3.3.4 Permissible tensile load

Permissible tensile load for lashing points – 20kN

2.3.4 Strengths

2.3.4.1 End walls

For all designs – 0.4P

2.3.4.2 Side walls

Designation	Type	Loading
A 1371	Box	0.6P
	Box	0.3P
	Open sided	0.3P
Other A Class and C Class	Curtain sided	0.24P to 800 mm and 0.06P to remaining upper part (sides may not be used for cargo securing / retaining)
	Drop sided	0.24P on the rigid part and 0.06P to the remaining upper part

Figure 6.64 Swap body side wall strength by type

2.3.4.3 Floor strength

Designation	Loading
A 1371	As ISO floor test with test load of 5,460 kg
Other A Class and C Class	As ISO floor test with test load of 4,400 kg

Figure 6.65 Swap body floor strength by Class

2.4 Swap body types

2.4.1 Box type swap body:

The standard box type swap body will have a rigid roof, side walls and end walls, and a floor and with at least one of its end walls or side walls equipped with doors. There are a number of variations to the basic design that can include units fitted with roller shutter rear door, hinged or roller shutter side doors to one or both sides and Garment carriers which is a box type swap body with single or multiple vertical or horizontal tracks for holding transverse garment rails.

Figure 6.66 Class C Swap body

2.4.2 Open side swap body:

2.4.2.1 The open side swap body falls into a number of different variations all designed to provide a similar access to standard trailer bodies. All designs will be an enclosed structure with rigid roof and end walls and a floor. The end walls may be fitted with doors.

.1 Curtain side unit: swap body with movable or removable canvas or plastic material side walls normally supported on movable or removable roof bows.

.2 Drop side swap bodies: swap bodies with folding or removable partial height side walls and movable or removable canvas or plastic material side walls above normally supported on movable or removable roof bows.

.3 Tautliner: swap body with flexible, movable side walls (e.g. made of canvas or plastic material normally supported on movable webbing).

.4 Gated tautliner – swap body fitted with a swinging gate at either end to provide top lift or stacking capability at the 20 or 40ft positions. A flexible, movable side wall may be fitted between the gates or over the full length of the swap body.

Figure 6.67 Class C side door swap body

.5 Full length side door: swap body with full length concertina doors to one or both sides

2.4.3 Thermal swap body:

A thermal swap body is a swap body that has insulating walls, doors, floor and roof. Thermal swap bodies may be: insulated - with no device for cooling and/or heating, refrigerated - using expendable refrigerants such as ice, 'dry ice' (solid carbon dioxide), or liquefied gasses, and with no external power or fuel supply, Like the ISO container there are variants to this basic design such as the mechanically refrigerated swap reefer.

2.4.4 Tank Swap Bodies (Swap Tanks)

2.4.4.1 The options for the design of the swap tanks are far less sophisticated than for ISO tanks. However the most important difference relates to their handling and stacking capabilities. All swap tanks have bottom fittings at the ISO 20ft or 40ft locations. Generally the bottom fittings are wider than their ISO counterparts, this is so that the bottom aperture is in the correct ISO position / width while the outer face of the bottom fitting extends to the full width if the unit (2.5 / 2.55m).

2.4.4.2 Approximately 85% of all swap tanks can be stacked and top lifted. However the majority of filling and emptying facilities for tanks however will leave the tank on its transport equipment thus negating the need for the stacking / lifting capability.

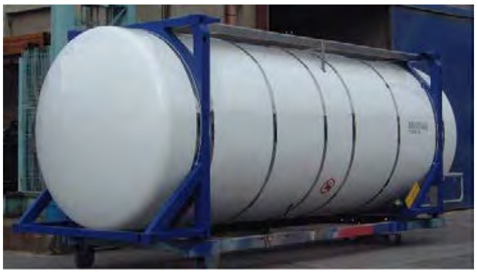


Figure 6.68 Swap tank showing exposed ends

Figure 6.69 30ft stackable swap tank for powder

2.4.4.3 The swap tank should never be lifted from the side when loaded.

2.4.4.4 There are swap tanks which are not stackable or capable for lifting using traditional spreaders. The design of these earlier models was similar to the frame tank with the pressure vessel being supported from the bottom side beams. Some non stackable swap tanks are still built today to meet the particular needs of the industry, particularly intra-European.

Figure 6.70 Non stackable swap tank

2.4.4.5 A swap tank is a swap body that includes two basic elements, the tank or tanks, and the framework. Unlike the ISO tank container the tank barrel is not always fully enclosed by the frame work which may present a risk of damage another container or object falls onto the exposed tank barrel.

2.4.5 Swap Bulker:

A swap bulker is a swap body that consists of a cargo carrying structure for the carriage of dry solids in bulk without packaging. It may be fitted with one or more round or rectangular loading hatches in the roof and “cat flap” or “letter box” discharge hatches in the rear and/or front ends. Identical in most ways to the ISO bulk container except that it may have reduced stacking capability. Often 30ft long.

3 Regional or domestic containers

Domestic containers are those containers that:

- have a mechanical strength designed only for rail and road vehicle transport by land or by ferry, and therefore not needing to fulfil the same requirements as series 1 ISO containers and;
- can be of any width and/or length to suit national legislation for better utilisation of the dimensions specified for road traffic. In general they will be 2.5 or 2.6m or 8ft 6in wide.
- may have castings at least at each corner and suitable for top lifting;

- may have corner castings that are the same width as the width of the container when measured across the unit to the external faces of the castings.
- may be stacked.
- Domestic containers may be general cargo containers or specific cargo containers.

4 Roll trailers

4.1 Roll trailers are exclusively used for the transport of goods in RO/RO ships and are loaded or unloaded and moved in port areas only. They present a rigid platform with strong securing points at the sides, and occasionally brackets for the attachment of cargo stanchions. The trailer rests on one or two sets of low solid rubber tyres at about one third of the length and on a solid socket at the other end. This end contains a recess for attaching a heavy adapter, the so-called gooseneck. This adapter has the king-pin for coupling the trailer to the fifth wheel of an articulated truck.

4.2 The packing of a roll trailer with cargo or cargo units must be planned and conducted under the conception that the cargo must be secured entirely by lashings (see Annex 14 sub-section 4.3.2). However, roll trailers are available equipped with standardised locking devices for the securing of ISO containers and swap bodies.

5 Road vehicles

5.1 Introduction

5.1.1 Vehicles with a closed superstructure are the primary choice for cargo that is sensitive against rain, snow, dust, sunlight, theft and other consequences of easy access. Such closed superstructure may consist of a solid van body or a canvas covered framework of roof stanchions and longitudinal battens, occasionally reinforced by side and stern boards of moderate height. In nearly all cases these vehicles have a strong front wall integrated into the closed superstructure. Closed superstructures of road vehicles may be provided with arrangements for applying approved seals.

5.2 Road vehicle types

5.2.1 Flatbed - used for almost any kind of cargo, but goods need to be protected from the elements and theft.

5.2.2 Drop side – like a flatbed but with fold down partial height side and rear panels.

Figure 6.71 Flat back truck

Figure 6.72 Drop side truck

Figure 6.73 Tilt trailer

Figure 6.74 Curtain side trailer

5.2.3 Tilt - like a flatbed, but with a removable PVC canopy.

5.2.4 Curtain-sider - the mainstay of road haulage, this has a rigid roof and rear doors. The sides are PVC curtains that can be drawn back for easy loading.

5.2.5 Open top – similar to the box but with a removable canvas or netting top cover generally used for bulk cargoes Canvas covered vehicles may be packed or unpacked through the rear doors as well as from the side(s). The side operation is accomplished by forklift trucks operating at the ground level. The option of loading or unloading via the top is limited to vehicles where the canvas structure can be shifted to one or both ends of the vehicle.

5.2.6 Box - a secure option for valuable goods. Solid van superstructures generally have two door wings at the end and will be packed or unpacked by forklift trucks, suitable for moving packages inside a CTU.

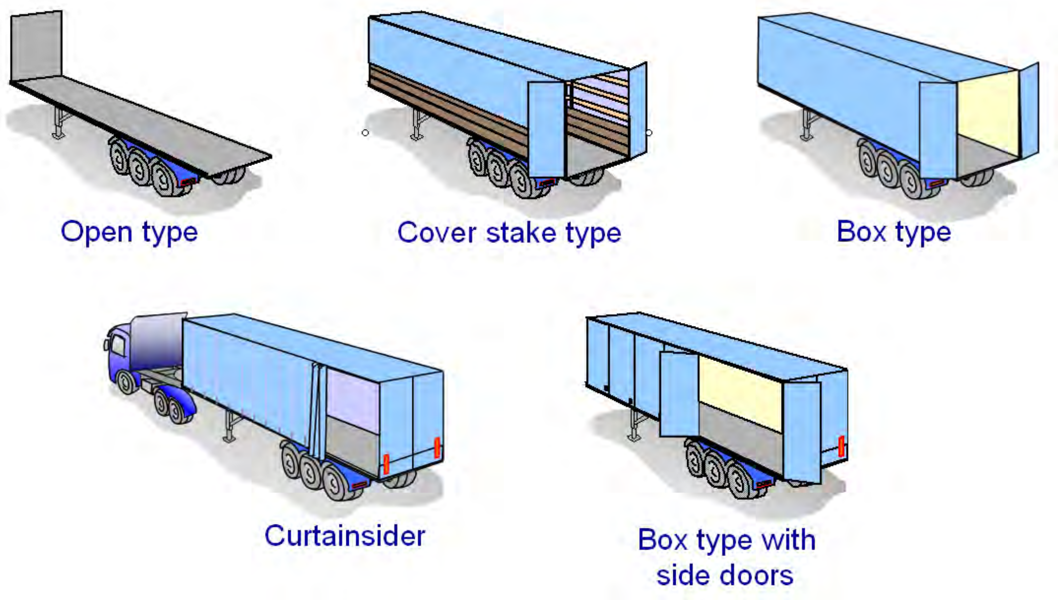


Figure 6.75 Different types of trailer

Figure 6.76 Open top trailer

Figure 6.77 Box trailer

Figure 6.78 Road train

Figure 6.79 Low loader

Figure 6.80 Van

5.2.7 Road train - a rigid vehicle at the front, which pulls a trailer behind it.

5.2.8 Low-loaders - often used for transporting heavy machinery and other outsize goods. Set low to the ground for easy loading.

5.2.9 Vans are frequently used to transport smaller cargoes shorter distances.

5.2.10 Semi-trailers suitable for combined road/rail transport may be equipped with standardised recesses for being lifted by suitable cranes, stackers or forklift trucks. This makes a lifting transfer from road to rail or vice versa feasible.

5.3 In addition to the road specific vehicles that are shown above, there are also road vehicles that carry other CTUs:

5.3.1 Container carriers – flatbed, extendable or skeletal trailers designed to carry one or two 20ft long, or one 30ft and longer containers.

Figure 6.81 Container trailer

Figure 6.82 European swap body train

5.3.2 Swap-body system - built to accommodate European swap-body units. Allows containers to be swiftly transferred during intermodal transport.

5.4 Road vehicle capacity and dimensions

5.4.1 Road vehicles are allocated a specific maximum payload. For road trucks and full trailers the maximum payload is a constant value for a given vehicle and should be documented in the registration papers. However, the maximum allowed gross mass of a semi-trailer may vary to some extent with the carrying capacity of the employed articulated truck as well as in which country it is operating. The total gross combination mass, documented with the articulated truck, must never be exceeded.

5.4.2 The actual permissible payload of any road vehicle depends distinctly on the longitudinal position of the centre of gravity of the cargo carried. In general, the actual payload must be reduced if the centre of gravity of the cargo is conspicuously off the centre of the loading area. The reduction should be determined from the vehicle specific load distribution diagram. Applicable national regulations on this matter must be observed. In particular ISO box containers transported on semi-trailers with the doors at the rear of the vehicle quite often tend to have their centre of gravity forward of the central position. This may lead to an overloading of the articulated truck if the container is loaded toward its full payload.

5.4.3 The boundaries of the loading platform of road vehicles may be designed and made available in a strength that would be sufficient – together with adequate friction – to retain the cargo under the specified external loads of the intended mode of transport. Such advanced boundaries may be specified by national or regional industry standards. However, a large number of road vehicles are equipped with boundaries of less resistivity in longitudinal and transverse direction, so that any loaded cargo must be additionally secured by lashings and/or friction increasing material. The rating of the confinement capacity of such weak boundaries may be improved if the resistance capacity is marked and certified for the distinguished boundary elements of the vehicle.

5.4.4 Road vehicles are generally equipped with securing points along both sides of the loading platform. These points may consist of flush arranged clamps, securing rails or insertable brackets and should be designed for attaching the hooks of web lashings and chains. The lashing capacity of securing points varies with the maximum gross mass of the vehicle. The majority of vehicles is fitted with points of a lashing capacity (LC) or maximum securing load (MSL) of 20 kN. Another type of variable securing devices are pluck-in posts, which may be inserted into pockets at certain locations for providing intermediate barriers to the cargo. The rating of the lashing capacity of the securing points may be improved if their capacity is marked and certified.

5.4.5 The maximum individual truck length is 12m, articulated truck and trailer length is 16.5m and road trains are allowed up to 18.75m. The maximum width for all is 2.55m. If a vehicle has an overall height of 3m or above, a notice is required must be displayed in the cab showing its full height.

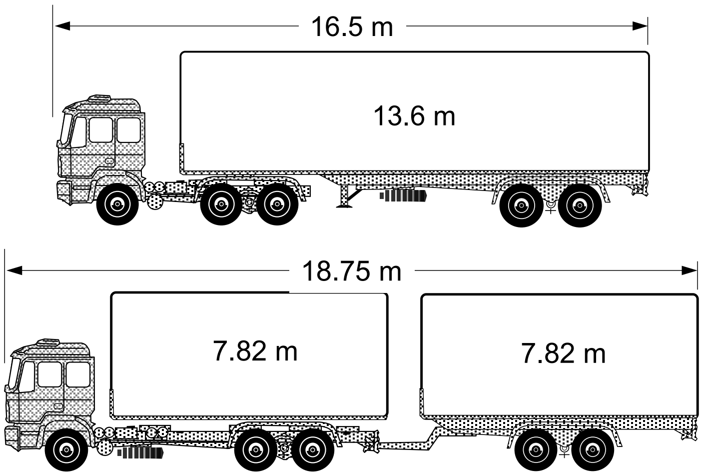
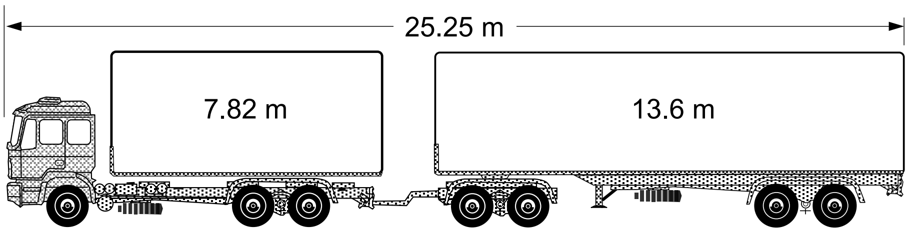


Figure 6.83 Standard European vehicle length

5.4.6 Other countries set different overall lengths and maximum vehicle masses.

5.4.7 Within Europe trials are currently being undertaken to examine longer and heavier trucks, up to 25m in the length and 60 tonnes overall gross mass. These sizes may be permitted within regions or areas within Europe.



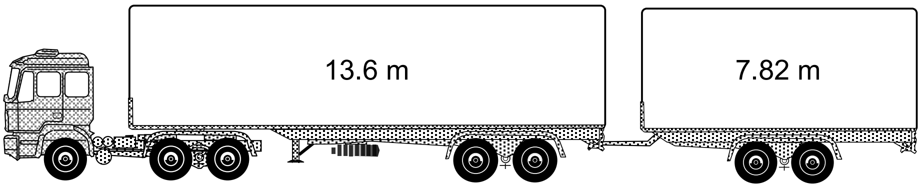


Figure 6.84 European maga trucks

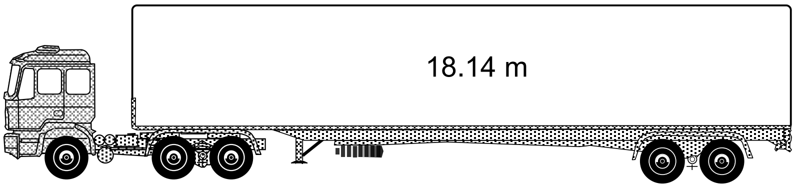


Figure 6.85 Maximum trailer length in the US

5.4.8 Within the US National Highway network, the gross vehicle mass is generally limited to 80,000lb with an maximum overall length varying from 48ft (14.63m) to 59ft 6in (18.14m) depending on the state. However longer combinations vehicles* are permitted on specific road routes (corridors)

6 Railway wagons

6.1 General

6.1.1 In intermodal transport, railway wagons are used for two different purposes: First, they may be used as carrier unit to transport other CTUs such as containers, swap bodies or semi-trailers. Second, they may be used as a CTU themselves which is packed or loaded with cargo and run by rail or by sea on a railway ferry.

6.1.2 The first mentioned purpose is exclusively served by open wagons, which are specifically fitted with locking devices for securing ISO containers, inland containers and swap bodies or have dedicated bedding devices for accommodating road vehicles, in particular semi-trailers. The second mentioned purpose is served by multifunctional closed or open wagons, or wagons which have special equipment for certain cargoes, e.g. coil hutches, pipe stakes or strong lashing points.

6.1.3 On board ferries the shunting twin hooks are normally used for securing the wagon to the ships deck. These twin hooks have a limited strength and some wagons are equipped with additional stronger ferry eyes. These external lashing points should never be used for securing cargo to the wagon. Wagons which are capable for changing their wheel sets over from standard gauge to broad gauge or vice versa, are identified by the first two figures of the wagon number code.

6.1.4 The maximum payload and concentrated loading marks are shown in section Annex 8 Part 6.

6.1.5 Closed railway wagons are designed for the compact stowage of cargo. The securing of cargo should be accomplished by tight packing or blocking to the boundaries of the wagon. However, wagons equipped with sliding doors should be packed in a way that doors remain operable.

6.1.6 When a railway ferry is operating between railway systems of different gauges, wagons which are capable for changing their wheel sets over from standard gauge to broad gauge or vice versa are employed. Such wagons are identified by the first two figures of the wagon number code.

6.2 Intermodal Trains

6.2.1 Intermodal trains come in two forms, unaccompanied and accompanied CTUs.

6.2.2 **Unaccompanied CTUs** (trailers, containers and swap bodies as illustrated in Figure 6.86) are lifted on and off rail wagons at terminals using top lift reach stackers or overhead gantries.

Figure 6.86 Unaccompanied intermodal train

Figure 6.87 Trailer loading using grapple arms

Figure 6.88 Container loading using reach stacker

6.2.2.1 The recent trend in container handling equipment being used has been directed towards adjustable spreaders utilising the top lift capabilities of the container and swap body (shown Figure 6.88).

6.2.2.2 The introduction of the rolling motorway (RoMo) and trailer on flat car (ToFC) has reinvigorated the used of the grappler arm (shown Figure 6.87) originally designed for the swap body.

6.2.3 **Accompanied CTUs** are generally rigid or tractor and trailer units which are driven onto the train wagon. These trains are often point to point services.

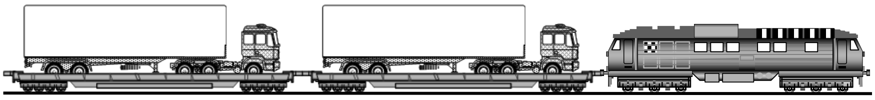


Figure 6.89 Accompanied intermodal train

Figure 6.90 Loading road vehicles

6.2.3.1 Accompanied CTU trains will normally have a coach included in the train for the drivers who are accompanying the CTUs.

6.3 Wagon Types

6.3.1 The wagons in Europe are divided in thirteen main classes:

6.3.1.1 Open wagons

- Class "E" – Normal open wagon
- Class "K" – 2 axle flat wagon
- Class "L" – 2 axle special flat wagon
- Class "O" – 2 axle flat wagon with sideboards
- Class "R" – 4 axle flat wagon

Figure 6.91 Normal open wagon

Figure 6.92 2 axle flat wagon

6.3.1.2 Closed wagons

- Class "G" – Closed wagon
- Class "H" – Special closed wagon

Figure 6.93 Closed wagon

Figure 6.94 Special closed wagon

6.3.1.3 Special wagons

- Class "F" – Special open wagon
- Class "I" – Isolated/Refrigerator wagon
- Class "S" – 4+ axle special flat wagon
- Class "T" – Wagon with opening roof
- Class "U" – Special wagon
- Class "Z" – Tank wagon

Figure 6.95 Special open wagon

Figure 6.96 Special flat wagon

6.3.1.4 Payload limits are often about 25 to 30 ton for two axle wagons or 50 ton and above for multi axle wagons.

6.3.1.5 The strength requirements according to UIC are described in this chapter for “Covered wagons with fixed or movable roofs and sides conforming to UIC 571-1 and 571-3 and class T wagons” and “High-sided open wagons conforming to UIC 571-1 and 571-2”. “Wagons with a fully opening roof complying with UIC 571-3 and wagons with folding roofs” are not described.

6.3.2 The wagons in North America are divided in nine main classes:

- Class "X" - Box Car Types
- Class "R" - Refrigerator Car Types

- Class "V" - Ventilator Car types
- Class "S" - Stock Car types
- Class "H" - Hopper Car Types
- Class "F" - Flat Car types
- Class "L" - Special Car types
- Class "T" - Tank Car types
- Class "G" - Gondola Car types

Figure 6.97 Box car

Figure 6.98 Flat car

Figure 6.99 Hopper type car

Figure 6.100 Gondola car

6.3.2.1 In each class the wagons are subdivided depending on payload. The three most common payloads are 50 ton, 70 ton and 100 ton.

6.4 Wagon strength guide

This chapter describes the strength of the Box car types and some of the Flat car types. The recommended practices for design and construction also have rules for Hopper Cars and Gondola cars but it is only the Box car types and Flat car types that are used for general cargo.

6.4.1 European Railways

6.4.1.1 Covered wagons

.1 Sides with body pillars must be able to withstand a transverse force of 8kN (800kg) acting at a height of one metre above the wagon floor on a pair of opposite body pillars. A residual deformation of maximum 2mm is acceptable.

.2 Sides with metal construction must be able to withstand a transverse force of 10kN (1,000kg) acting at a height of one metre above the wagon floor on the body side at a point located below the end loading hole (or ventilation hole) and in the centre-line of this hole. A residual deformation of maximum 3mm is acceptable. A 100×100 mm hardwood rod shall be used when applying the force.

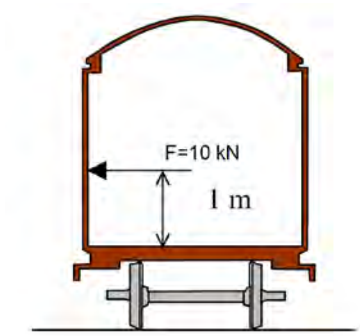


Figure 6.101 Side wall strength test

6.4.1.2 High-sided open wagons

Sides must be able to withstand a transverse force of 100kN (10 t) acting at a height of one and a half metre above the wagon floor applied to the four centre pillars. A residual deformation of maximum 1mm is acceptable.

6.4.2 American Railways

6.4.2.1 For box car side walls there are not mentioned any maximum force demands in the AAR regulations. There are however a maximum force demand when designing adjustable or fixed side wall fillers in Box cars. Box cars equipped with adjustable side wall fillers at diagonally opposite sides of car, for filling void space crosswise of car, may be used provided such space do not exceed 38cm. Box cars equipped with full side wall fillers at both sides in both ends of car, for filling void space crosswise of car, may be used provided such space do not exceed 15 cm from each side of car. The wall fillers shall be designed to withstand a lateral force equivalent to 25% of the weight of cargo, (= 0.25 g). The force shall be uniformly distributed over the entire face of the wall filler.

6.4.2.2 Lateral pressure of granular, lump or pulverized bulk material shall be considered in the design of wagons in which such pressure may be active. If the weight of the cargo is 4.8ton per metre of length the lateral force from the cargo in a typical closed top 70-ton Box car is 10ton per meter of length. The lateral force is to be distributed vertically so that it is a maximum at the floor line decreasing uniformly to zero at the top surface of the cargo.

Annex 7. Intermodal road / rail / sea load distribution

1 Introduction

1.1 Construction of load distribution diagrams requires to fulfil not only the technical characteristics of maritime containers, wagons and vehicles but also various requirements defines by legislative measures, guidelines and standards. The Annex focuses on the 40ft general purpose container as an example of the load distribution diagram generation.

1.2 Cargo centre of gravity is important to know when packing containers. The standard ISO 830 in sec. 8.1.3 defines eccentricity of centre of gravity as follows: “longitudinal and/or lateral horizontal differences between the centre of gravity of any container (empty or loaded, with or without fittings and appliances) and the geometric centre of the diagonals of the centres of the four bottom corner fittings”.

1.3 The container payload - P is defined according to the 5.3.3 of ISO 830 as “maximum permitted mass of payload, including such cargo securement arrangements and/or dunnage as are not associated with the container in its normal operating condition.“ It can be calculated by subtracting the tare mass from the maximum permissible gross mass of the container.

2 Load distribution diagrams

2.1 Load distribution diagram for 40ft container

2.1.1 The container payload, tare and gross mass as well as the load distribution guide “60:40” are necessary to construct container load distribution diagram. The diagram limits the position of cargo centre of gravity (CoG) of certain mass to not exceed container gross mass, payload and to meet load distribution requirements. 40ft container with a gross mass of 30,480 kg, tare of 4000 kg and payload of 26,480 kg is used as an example. Maximum container mass on corner fittings respecting load distribution rule 60:40 is calculated as follows:

$$R_{2\max} = 0.45 \cdot P \cdot \frac{l_2}{L} + \frac{T}{2} = 0.45 \cdot 26480 \cdot \frac{11985}{12030} + \frac{4000}{2} = 13871.43kg$$

$$R_{1\max} = 0.55 \cdot P \cdot \frac{l_2}{L} + \frac{T}{2} = 0.55 \cdot 26480 \cdot \frac{11985}{12030} + \frac{4000}{2} = 16509.52kg$$

R_{1max} = maximum gross mass on front wall end corner fitting

R_{2max} = maximum gross mass on rear (door) end corner fitting

T = tare mass

P = Payload

L = length of cargo deck

2.1.2 Therefore maximum load on either the front or rear corner fittings is 16,5 tonnes. Maximum mass of the cargo packed in a container should not to exceed maximum corner fitting mass is showed in Figure 7.1 (blue curve). The second rule is that the position of the centre of gravity shall be from 0,45 L to 0,55 L

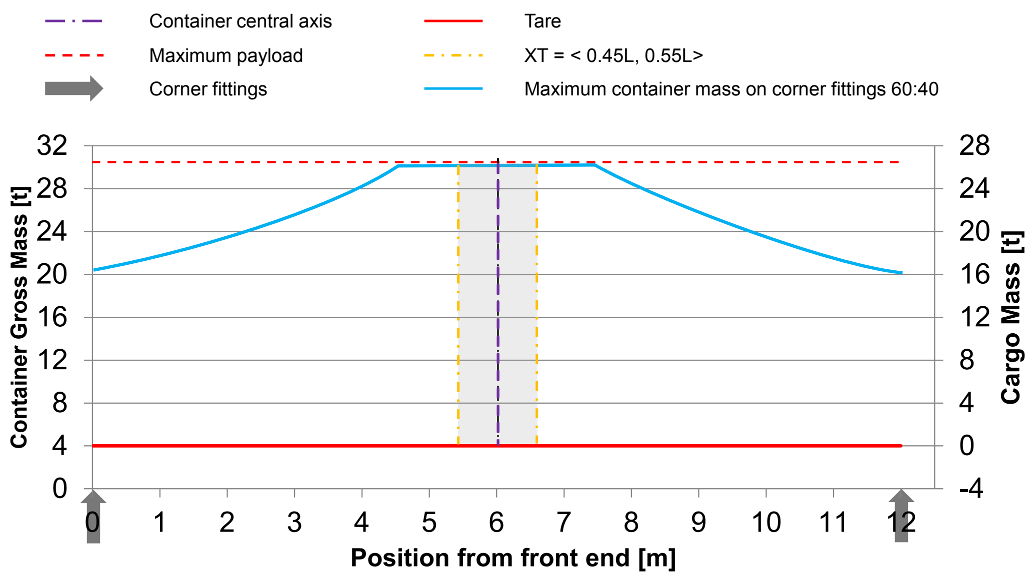


Figure 7.1 Load distribution diagram for 40ft container

2.1.3 The result in Figure 7.1 shows that these boundaries are smaller (within the maximum container payload) than maximum corner fittings mass therefore the centre of gravity of any cargo shall be located in a grey area.

2.2 Load distribution diagram of two-axle container wagon

2.2.1 This two-axle wagon is suitable example because it is possible to load 40’ container only and wagon payload is lower than container gross mass.

2.2.2 Load distribution diagram of two axle container wagon is influenced by following parameters:

- wagon tare,
- wagon gross mass for different route category (A, B, C, D), train speed (S, SS) and selected rail operators,
- wagon payload for different route category (A, B, C, D), train speed (S, SS) and selected rail operators,
- maximum authorised axle mass per route category (A, B, C, D),
- maximum uneven axle load 2:1 according to UIC Loading guidelines, (12)
- axle tare mass,
- wagon wheel base,
- distance from the end of the loading platform to neighbouring axle,
- length of the loading platform,
- position of wagon container locks.

Number of axles	2
Axle wheelbase	8.000 m
Cargo deck length	12.780 m
Container location distance	11.985 m
Wagon tare	10.80 t
Axle tare	5.40 t
Wagon payload	
A	21.30 t
B	25.30 t
C	29.20 t
Wagon gross mass	
A	32.10 t
B	36.10 t
C	40.00 t
Maximum axle mass	
A	16.00 t
B	18.00 t
C	20.00 t

Figure 7.2 Sample rail wagon data

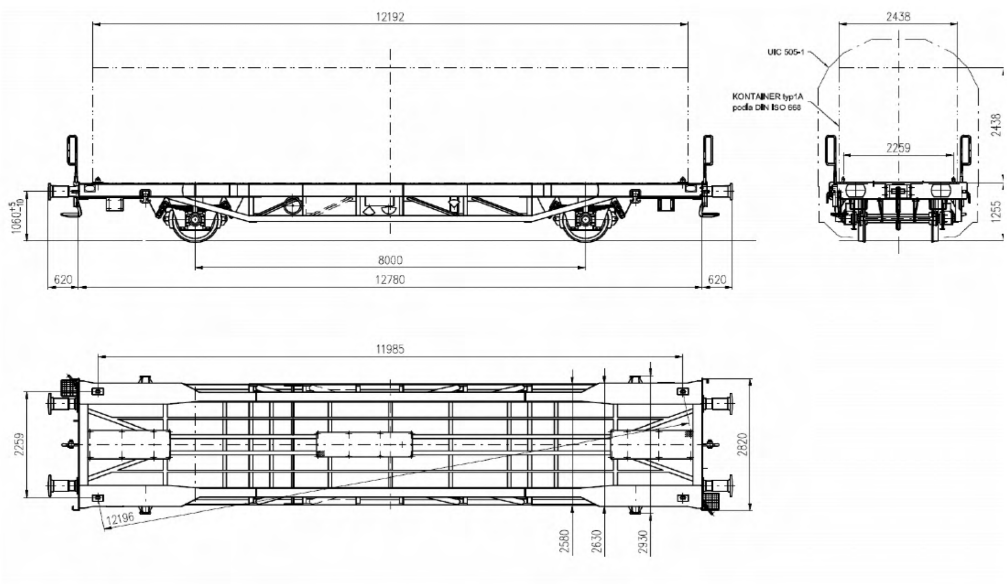


Figure 7.3 Sample container wagon

2.2.3 Load distribution diagram for the sample rail wagon are defined as:

- maximum axle masse (R_{1max}, r_{2max}) per route category (A, B and C curves for R_{1max} and $R_{2\ max}$)
- maximum payload for route category
- $R_1 : R_2 < 2 : 1$ and $R_2 : R_1 < 2 : 1$ curves

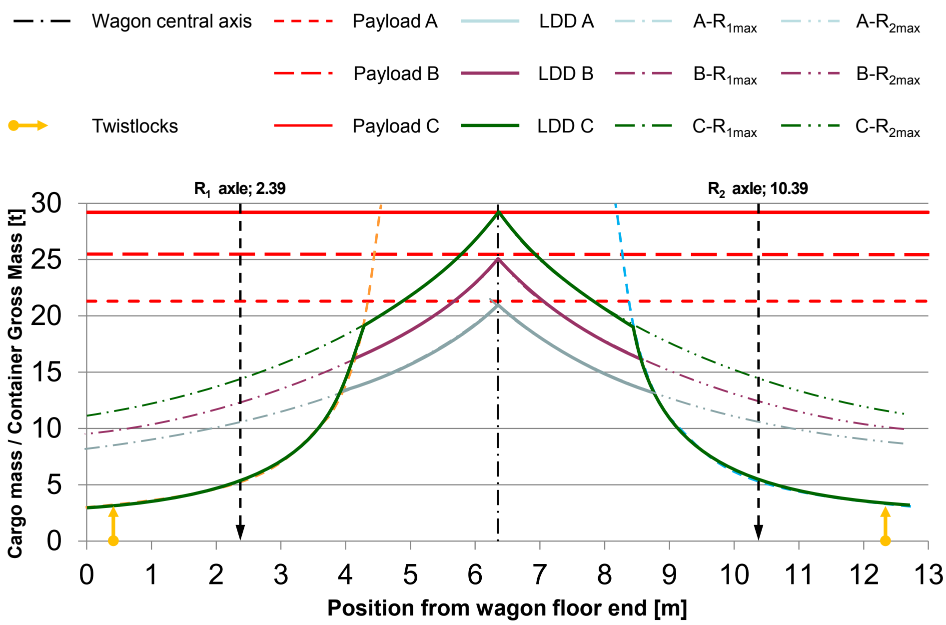


Figure 7.4 Load distribution diagrams (LDD) for container wagon for different route categories

2.2.4 Load distribution diagrams of a typical container wagon show area where cargo centre of gravity for different cargo mass must be located. This area is bounded by maximum axle mass per different route category and by maximum uneven axle load 2:1. The axle curves meet in one point which presents disadvantage because if we want to load the cargo with the highest possible mass its centre of gravity must be right in the middle of the wagon. For example if CoG of load of 29,2 t is 6,7m (6,39 is middle axis) from wagon floor end this creates axle mass R_1 = 18.9 t and R_2 = 21.1 t which is higher than 20 tonnes permitted per route category C.

2.3 Load distribution diagram of semi-trailer container trailer

2.3.1 Technical characteristics of typical gooseneck 45ft extendable trailer are used in this section. Load distribution diagram of semi-trailer is influenced by following parameters:

- container trailer tare (5,6 t),
- maximum king-pin load technical suitable for three-axle tractor (15 tonnes) and king-pin load influenced by two-axle tractor (9,8 t – two-axle tractor tare of 8,2 t supposed) – B curves in figure below,
- maximum gross combination mass (40 t , 44 t or semi-trailer gross mass 39 t) – C axis,
- king-pin and triple axle tare (1.6 t / 4 t supposed),
- maximum triple axle load (3 x 9 t) – D curve,
- length of loading platform (13,716 m),
- position of container twist-locks for 40’container,
- distance from maximum front container face to king-pin and from 40’ container front face to king-pin axis (1,716 m / 0,963 m),
- distance king-pin to first axle and between axles (7,85 m / 1,41 m / 1,31 m),
- minimum king-pin and triple axle load (25% / 25% of maximum semi-trailer mass is chosen) – E and A curves in figure below.

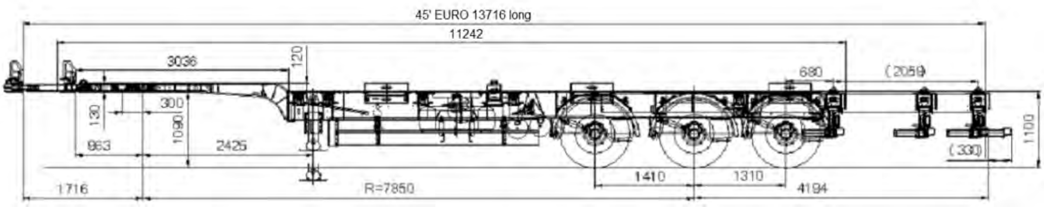


Figure 7.5 Typical three axle extendable 45ft container trailer

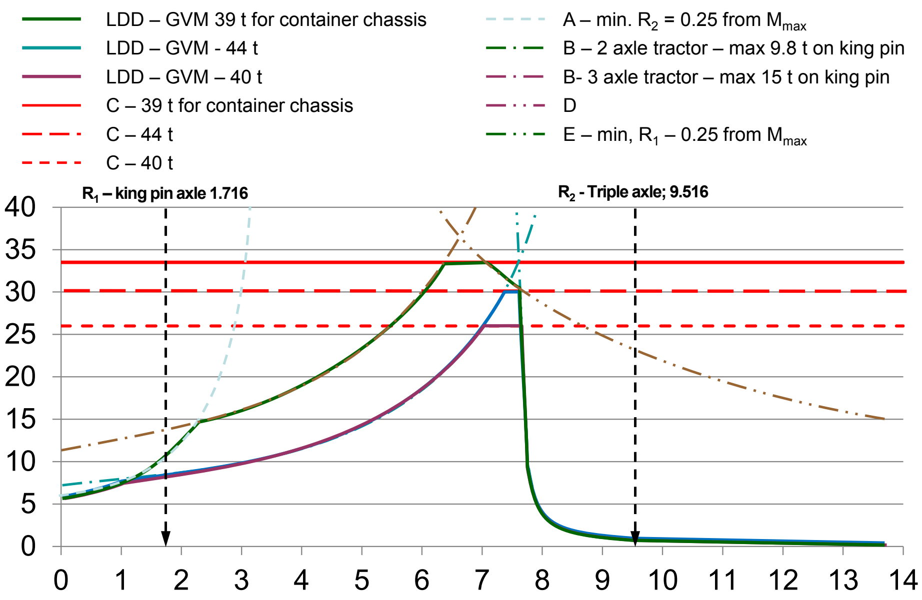


Figure 7.6 Three alternatives for load distribution diagram for container trailer

2.4 Three alternatives of load distribution diagrams of the example container trailer are showed in figure above. Permissible load on king-pin determines if it is necessary to use two-axle or three-axle tractor when is possible to use permissible technical load on king-pin of 15 t. Because of maximum allowed mass of 18 t for two axle tractor limits permissible load on king-pin to 9,8 t (8,2 t tractor tare supposed) when two axle tractor is used. Maximum gross combination masses and maximum semi-trailer gross mass are showed as C axis and limits the payload of container trailer.

3 Intermodal load distribution diagrams

3.1 Intermodal load distribution diagram of 40ft container carried on two-axle container wagon

3.1.1 Intermodal load distribution diagram of 40ft loaded on container wagon is possible to construct from container and wagon LDD's. Here we have to take into consideration also the container tare because this also presents the cargo for the wagon. In the diagram below we can see container GM on right vertical axis and cargo mass on left vertical axis so it is possible to simultaneously check loading of container as well as wagon with the container.

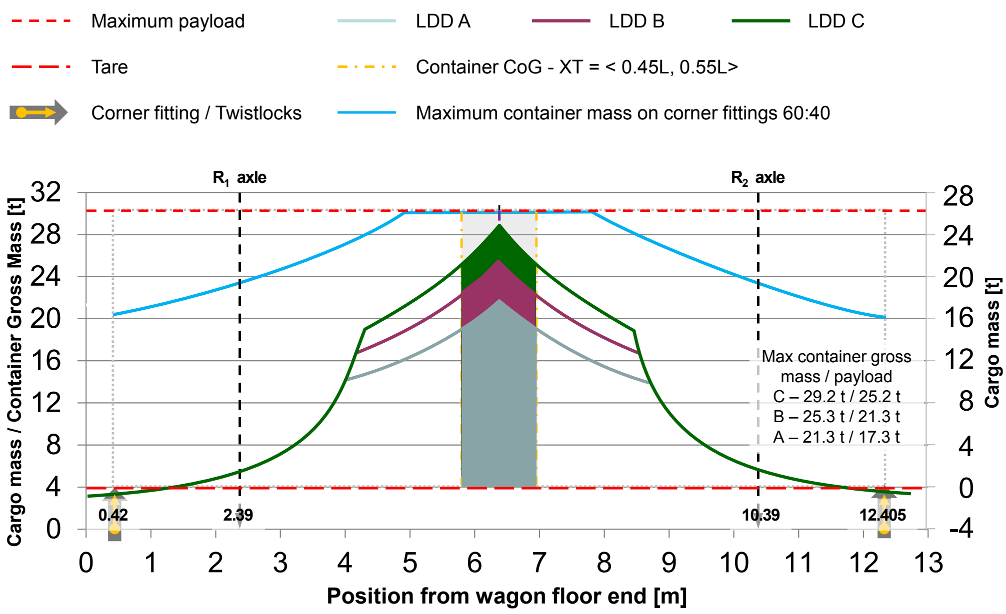


Figure 7.7 Load distribution diagram of 40ft container loaded onto a 2 axle wagon

3.1.2 When container and wagon LDD's are combined then three area of position of cargo centre of gravity for different mass are bounded by LDD curves for this type of wagon constructed for route categories A, B, C. Container LDD is displaced vertically by container tare mass.

3.2 Intermodal load distribution diagram of 40ft container carried on container chassis

3.2.1 Intermodal load distribution diagram of 40ft container loaded on container chassis is possible to construct from container and chassis LDD's. Here we have to take into consideration also the container tare weight because this also presents the cargo for container chassis. Again container gross mass is in right vertical axis and cargo mass on left vertical axis in the diagram below. Therefore it is possible to check loading of container as well as chassis with the container.

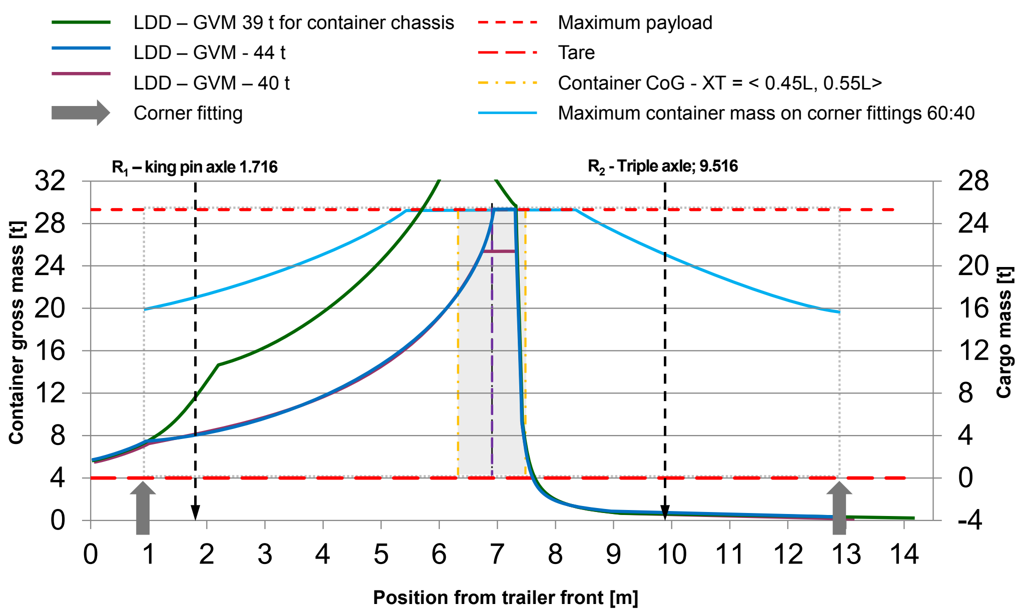


Figure 7.8 Load distribution diagram for 40ft container on container trailer

3.2.2 When container and chassis LDD's are combined then correct load distribution to maximum payload is possible only when three-axle tractor is used. When maximum king-pin load is limited by two-axle tractor than the centre of gravity should be eccentrically towards container doors and almost on the limits of container load distribution. With higher cargo mass the risk of incorrect unloading increases. When lighter two-axle tractor is used the loading situation looks more favourably for gross combination weight 40 t but for GCM 44 t there is not big difference. In case that the cargo centre of gravity is in first container half (close to front wall where loading with container doors towards back is supposed) than the tractor is overloaded (see Figure 7.8).

3.3 Intermodal load distribution diagram of 40ft container carried on two-axle container wagon and container chassis

3.3.1 Intermodal road-rail-sea load distribution diagram is constructed when LDD of container, container wagon and container chassis are combined. Here the limitations for loading on wagon and container chassis are again seen

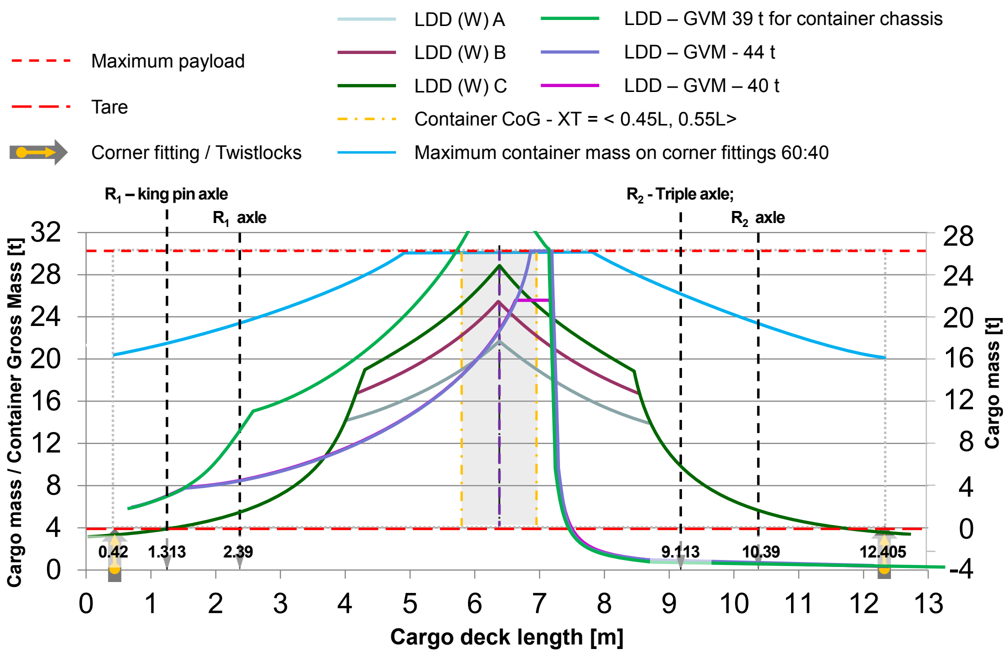


Figure 7.9 Load distribution diagram for 40ft container mounted on trailer and wagon

3.3.2 The figure above shows all LDD’s and we can clearly decide that maximum cargo mass in this case is 26.2 tonnes limited by container chassis and gross combination mass of 40 t. Maximum eccentricity of the cargo centre of gravity shall be maximum 3.6% which is limited by maximum axle load of railway wagon for route category C.

Annex 8. Approval Plates

1 Definitions

Reinforced vehicle body	vehicle body, having a reinforced structure, and complying with the minimum requirements of paragraph 5.3 of EN 12642 (performance code XL according to Table 1)
Solebar	Main beam of a rail wagon / car
Standard vehicle body	vehicle body complying with the minimum requirements of paragraph 5.2 of EN 12642[1] (performance code L according to Table 1) which, depending on cargo weight and friction, requires additional securing of cargo using lashing equipment

2 Safety Plates

2.1 Containers and, under certain conditions, also swap bodies and road trailers are required by applicable regulations to bear a safety approval plate.

2.2 Swap-bodies and road trailers destined for transport by rail within the European railway network require a marking as per EN 13044. This operational marking provides information for codification and for approval of the swap body or semi-trailer for rail transport.

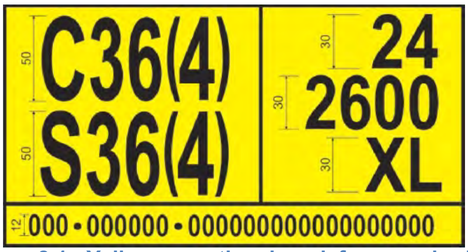


Figure 8.1 : Yellow operational mark for swap bodies

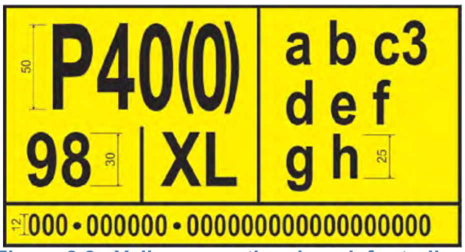


Figure 8.2 : Yellow operational mark for trailers

2.3 The data on the plates shown in Figure 8.1 and Figure 8.2 relate to dimensions of CTU and how they can fit onto rail wagons. The significant information relates to the characters “XL” shown on both plates. This indicates the strength of the swap bodies’ body, standard or reinforced with the marking referring to EN 12642.

Component	Standard structure code L	Reinforced structure code XL
Front wall	0.4P and maximum limit[a]	0.5P without maximum limit
Rear wall	0.25P and maximum limit[b]	0.3P without maximum limit
Side wall	Up to 0.3P	0.4P[c]
[a] 5,000 daN [b] 3,100 daN [c] Except for double-decker		

Figure 8.3 Static test conditions

2.4 The XL test requirements specifically apply to the following types of body structures:

- box type
- drop side with side and tail boards without cover
- drop side with side and tail boards with tarpaulin cover
- curtain-siders

[1] EN 12642:2006 Securing of cargo on road vehicles – body structure of commercial vehicles – minimum requirements

2.5 Under the International Convention for Safe Containers (CSC), containers are required to bear a safety approval plate permanently affixed to the rear of the container, usually the left hand door. On this plate, the most important information for the packer are:

- the date manufactured,
- the maximum gross mass and
- the allowable stacking mass.

The maximum gross mass shall never be exceeded.

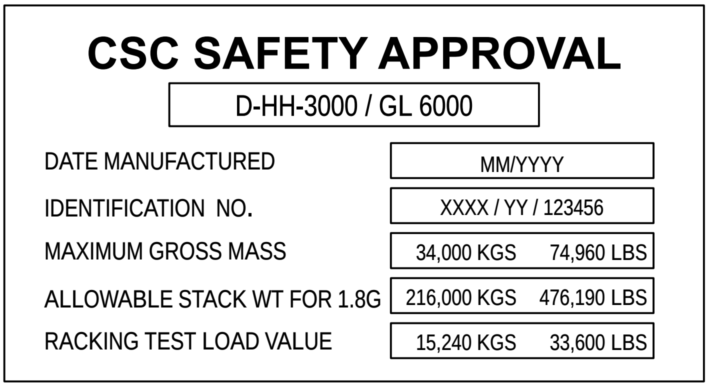


Figure 8.4 Diagram of CSC safety approval plate

2.6 The CSC convention requires containers to be thoroughly examined 5 years after manufacture and subsequently at least every 30 months. The date of the next periodic examination is stamped on the approval plate or affixed to it in form of a decal:

Figure 8.5 : CSC safety approval plate with next examination date

2.7 As alternative to such periodic inspections, the owner or operator of the container may execute an approved continuous examination programme where the container is frequently inspected at major interchanges. Containers operated under such programme should be marked on or near to the safety approval plate with a mark starting "ACEP" followed by numerals and letters indicating the approval number of this continuous examination programme.

Figure 8.6 : Safety approval plate with ACEP mark

2.8 If there is no ACEP mark and if the next examination date is already elapsed, or is before the expected arrival time of the container at its destination, the container should not be used in intermodal or international transport.

3 Maximum Gross Mass

3.1 Containers, like all CTUs, have a maximum gross operating mass or rating which is shown both on the CSC Safety Approval Plate (see Figure 8.4) and on the rear end of the container (see Figure 8.7).

Figure 8.7 Rear of container

3.2 The maximum gross mass (or weight as shown on some containers) shall not be exceeded and it is the shipper's responsibility to ensure this. Over-loading containers may result in:

- the container being stopped and the cargo repacked into two or more other containers;
- the container and / or cargo being damaged during handling or transport
- the handling or transporting equipment being damaged.

3.3 The two values shown on a container should be the same, however if they are different the value shown on the CSC Safety Plate should be used.

3.4 The tare mass shown in the figure relates to the empty mass of the container and should always be shown on the rear end of the container. This value will include any permanently attached equipment such as an integral refrigeration unit, but will not include items that are attached, such as a nose mounted generator (clip on unit).

3.5 The maximum payload (or net mass) may be shown on the rear of the container, however the correct method for calculating the maximum mass of cargo that the container can carry is:

$$\mathbf{P = R - (T_c + T_g + T_s)}$$

Where:

P	Maximum mass of cargo
R	Maximum gross mass of container
T_c	Tare mass of the container
T_g	Mass of additional attached items
T_s	Mass of the securing and bracing materials

4 Allowable Stacking Mass

4.1 The allowable stacking mass represents the maximum superimposed load that any container can be subjected to and is often referred to as the stacking capability or stack height (when converted to a number of containers).

4.2 ISO containers are built to the provisions of ISO 1496 which will require that the container is built to withstand a minimum superimposed load of 192,000kg. This value is the equivalent of eight superimposed containers with an average mass of 24,000kg.

4.3 Table 1 shows the stacking configuration for a selection of average superimposed container masses. Note the mass of the bottom container is not taken into account when calculating the superimposed average mass.

Average gross mass (kg) of containers	24,000	30,480	32,500	34,000	36,000
Stack height	8 over 1	6 over 1	5 over 1	5 over 1	5 over 1
Laden container stack					

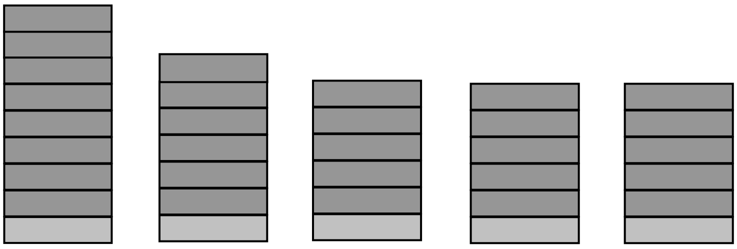


Figure 8.8 Superimposed stack heights

4.4 Containers having an allowable stacking mass of less than 192,000 kg are not unrestrictedly suitable for sea transport. This includes:

- containers built to a previous standard
- swap bodies
- containers designed to be used with one door removed / open

4.5 Swap containers and tanks have a different design and therefore a different stacking capability. The wider designed width of the swap bodies means that there is a step between the corner posts and the top corner fittings which are shown clearly on the swap tank as shown in Figure 8.9 and Figure 8.10.

Figure 8.9 Step back at the top fitting

Figure 8.10 Step back with secondary side lift aperture

4.6 Containers with a step of this nature will generally have a lower stacking capability. The container may be marked with a warning decal that indicates that there is a reduced stacking capability.

4.7 Containers that carry cargoes that give off large volumes of moisture can be transported with one door removed or open. Only those containers that have been tested and certified for this format may be used and should be shown on the CSC safety approval plate.

4.8 Containers with one door off / open will have reduced allowable stacking mass and racking as shown in Figure 8.11

Figure 8.11 CSC safety approval plate with one door off data

4.9 Where there is reduced allowable stacking mass, due to design or operation, the total gross mass of containers and swap bodies placed above must not exceed this value.

4.10 Containers which are designed with an allowable stacking mass less than 192,000kg then it should be marked in accordance with the current version of ISO 6346. This means that the fourth character of the ISO size type code will be a letter.

5 Tank data plates

5.1 All tank containers and swap tanks require essential manufacturing and test data to be recorded on a data plate. This will be generally found on the rear of the tank but can be found attached to one of the rear corner posts at the side.

5.2 The plate shown in Figure 8.12 is a typical tank data plate with the sections identified.

Owner's name and address

Manufacturers name, address and manufacturing serial number

Tank design details

Operation details

Pressures

Materials

Connections

Inspecting authority

Hydraulic test data

Timber content

CSC Safety approval plate

Customs plate

Figure 8.12 Typical tank data plate

5.3 The important sections are the CSC safety approval plate and the hydraulic test data. Every tank must be subjected to a pressure test every 30 months and a full hydraulic test every 5 years and the date of the test marked on the data plate.

6 Rail wagon marks

6.1 Static axle load and linear load

6.1.1 The axle load and axle spacing of the vehicles defines the vertical quasi-static load input to the track.

6.1.2 The load limits for wagons take into account their geometrical characteristics, weights per axle and weights per linear metre.

6.1.3 They shall be in accordance with the classification of lines or sections of lines, categories A, B1, B2, C2, C3, C4, D2, D3, D4 as defined in the table below.

Classification	Mass per axle (P)						
	A	B	C	D	E	F	G
Mass per unit length (*p*)	16.0 t	18.0 t	20 t	22.5 t	25.0 t	27.5 t	30.0 t
5.0 t / m	A	B1					
6.4 t / m		B2	C2	D2			
7.2 t / m			C3	D3			
8.0 t / m			C4	D4	E4		
8.8 t / m					E5		
10.0 t / m							

p = Mass per unit length, i.e. the wagon mass plus the mass of the load, divided by the wagon length in metres, measured over the buffers when non-compressed.

P = Mass per axle

6.1.4 Classification according to the maximum mass per axle P is expressed in capital letters (A, B, C, D, E, F, G); classification according to the maximum mass per unit length *p* is expressed in Arabic numerals (1, 2, 3, 4, 5, 6), except for Category A.

6.1.5 Rail vehicle load table

Shown on each side to the left

The maximum payload is generally not a fixed value for the distinguished wagon, but allocated case by case by means of the intended track category (categories A, B, C, D) and the speed category (S: ≤ 100 km/h; SS: ≥ 120 km/h). These payload figures imply a homogeneous load distribution over the entire loading area.

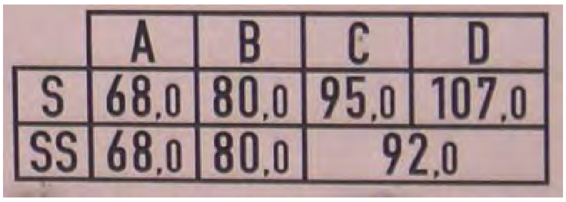


Figure 8.13 Allocation of payload to a rail car

6.1.6 Concentrated loads

Shown in the centre of each solebar[2]

In case of concentrated loads a reduction of the payload is required, which depends on the loaded length and the way of bedding the concentrated load. The applicable load figures are marked in each wagon. Also any longitudinal or transverse eccentricity of concentrated loads is limited by the individual axle load capacity or the wheel load capacity.

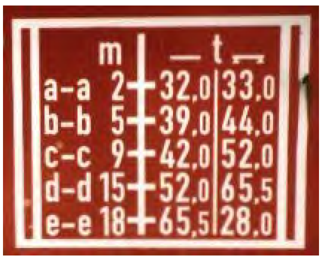
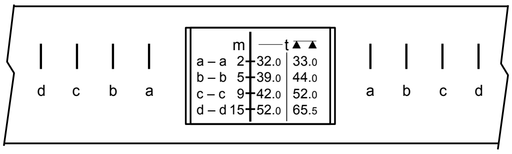


Figure 8.14 Reduction in payload due to concentrated load and bedding distance

2 Main side beam of a rail wagon



Column	Symbol	Description
1		Signs showing the length of the supporting surfaces of concentrated loads, or the distance between supports
2	m	Distance in metre between the signs showing the length
3	———	Maximum tonnage of concentrated loads
4	▲ ▲	Maximum tonnage of loads resting on two supports

Annex 9. Transport of perishable cargo

1 What are perishables?

1.1 A "perishable" may be described as something that is easily injured or destroyed. In the context of this annex perishables are usually, but not always, foodstuffs. Without careful treatment, the time taken to deteriorate to a condition which will either reduce the value or render it unsalable (shelf life) may become unacceptably short.

1.2 Careful consideration of the factors affecting the "shelf life" of perishables should be made and applied during their transportation.

1.3 Perishables include frozen produce, meats, seafood, dairy products, fruit and vegetables, horticultural products such as flowering bulbs and fresh flowers plus chemical compounds and photographic materials.

2 General issues

2.1 Shippers and consignees should be aware of the maturity indices for chilled horticultural produce. Whilst there are procedures for retarding the ripening process, it is not possible to reverse it.

2.2 There are various models, makes and ages of refrigerated containers in use. When exporting temperature and time sensitive commodities, exporters should liaise accordingly with the shipping company to ensure a container fit for purpose is supplied that is capable of operating to desired and mutually agreed requirements.

2.3 Maintaining proper conditions during shipment from the packing shed to the overseas market is an important factor in minimising quality loss.

2.4 Problems could occur in the carriage of containerised reefer cargo due to the lack of adequate and accurate carriage instructions issued by shippers. It is extremely important that rational procedural precautions are routinely adopted and instructions are always given in writing to all parties in the transport chain. Shippers must ensure that all documentation shows the Set Point temperature. It is recommended that the information contained in the electronic Pre-receival Advice should be made available to all parties in the transport chain.

2.5 The Shipper is in the best position to know the optimum temperature and container vent settings (or Fresh Air Exchange rates) for the carriage of his product and his reefer instructions should be followed unless they are obviously wrong or raise a natural uncertainty. Carriage instructions given to a shipping company must be complete, adequate and accurate to avoid the risk of damage to the cargo.

2.6 The successful delivery of horticultural produce from origin to destination in refrigerated containers is also dependent on the maintenance of suitable storage and packing conditions during transport.

2.7 The quality of the produce can be maintained only if each link in the chain continuously maintains the integrity of the chain. of the product.

3 Conditions which affect the commodity

3.1 General

3.1.1 There are several interrelated factors which affect each type of perishable product during its useful life, either under refrigeration or not. These are briefly dealt with in the ensuing sections.

3.1.2 The CTU owner may contribute to these conditions through equipment purchase and operation. The consignee may be indirectly concerned, through the choice of wrapping material, for the appearance of the product at the retail outlet.

3.1.3 Consignors must ensure that commodities leave their care in prime condition and, in the case of fruit and vegetables, that harvesting was carried out at the correct maturity. Fungicidal or similar treatments are often required for safe carriage over long distances. Occasionally the type of package which the producer or consignor consider to be economically acceptable may have a significant bearing on the condition through the effect on air circulation and cooling.

3.2 Temperature

3.2.1 General

3.2.1.1 Temperature is particularly important both for long and short journeys. The object of refrigeration is to prolong the storage life of a perishable food product by lowering the temperature so that metabolic deterioration and decay caused by microorganisms or enzymes are retarded.

3.2.1.2 For a commodity whose storage life is counted in weeks, transport within one or two degrees of the optimum carrying temperature may be satisfactory when the journey time is only a few days. When storage life is counted in days it is essential to transport at the optimum temperature for the particular product.

3.2.1.3 There are regulations in various countries concerning the transport of certain chilled and frozen produce which limit the maximum product temperature within the transport chain.

3.2.1.4 It must be stressed that the only temperature, which can be controlled is the 'Set Point'. The Set Point corresponds to air delivery temperature for chilled cargo. The term 'carriage temperature' therefore, cannot be used in carriage instructions.

3.2.2 Air Delivery Temperature

3.2.2.1 This is the temperature at which air leaves the cooler to be delivered to the interior of the vehicle or container by ducts or through a plenum chamber. The required air delivery temperature is sometimes given in instructions from consignors, generally with the intention of avoiding chilling or freezing injury of the commodity.

3.2.2.2 Air delivery temperature is usually controlled in containers when the refrigeration unit is set to control at temperatures above -4°C.

3.2.2.3 Many designs of refrigerated road vehicles do not have a means of controlling the delivery air temperature as a single thermometer, generally placed in the return air, is used by the temperature controller. Air entering the cargo space can thus be below the freezing point of the commodity in question.

3.3 Air Return Temperature

3.3.1 This is the temperature of the air leaving the interior of the CTU before entering the cooler.

3.3.2 Air return temperature is generally accepted as representing the average temperature of the commodity within the carriage space.

3.3.3 Many road vehicles use this temperature for controlling the operation of the refrigeration plant. In general, containers with their sophisticated control equipment use return air control only for frozen cargoes below -4°C.

3.4 Space Temperature

3.4.1 Few if any road vehicles monitor the temperature of the commodity, or the air space within the vehicle. In container transport, where in-transit sterilisation (cold treatment) may be required by regulations covering particular destinations, up to four sensors may be placed at locations within the commodity.

3.4.2 It is impossible to define a single position within a vehicle or container which is representative of the average commodity temperature. Even with comparatively well designed equipment the maximum commodity temperature is usually greater than the return air temperature.

3.5 Temperature Range

3.5.1 The temperature range defines the limits within which all temperatures in the cargo should fall. If a carrying temperature is suggested which is likely to cause the temperature of any part of the cargo to fall outside these limits, it should be a subject of careful enquiry and possible rejection of responsibility.

3.5.2 In many cases the lower limit will be the product freezing point. In the case of fresh fruit and vegetables the freezing point is an absolute limit, which if passed will almost certainly result in irreversible damage. For many tropical and sub-tropical fruit the lower storage temperature is that minimum below which chilling injury can occur and this temperature may be substantially higher than the freezing point.

3.5.3 The upper temperature limit is less rigidly defined except in cargoes of fruit that are being subjected to in-transit sterilisation where the upper limit must not be exceeded by any part of the cargo at any time within the stated quarantine period.

3.5.4 There are distinct differences between the range of air temperature as indicated by the delivery and return air thermometers, the range of air temperature within the vehicle and the range of the commodity temperature.

3.5.5 All three can be kept to a minimum and can be made to converge, by limiting the heat inflow from the outside of the vehicle or by increasing the refrigerated air flow or by a combination of both.

3.6 The general relationship between the various temperatures is illustrated below.

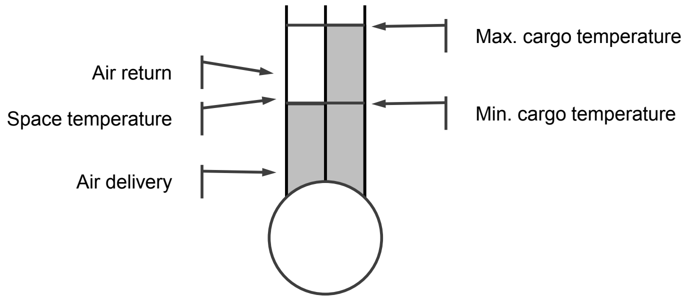


Figure 9.1 Relationship of cargo and air temperature

3.7 Relative Humidity

3.7.1 The relative humidity of the air around the produce is of particular importance both in long and short term storage.

3.7.2 Dry air may cause desiccation of the product which can affect the appearance and will certainly reduce the weight at the point of sale.

3.7.3 Very damp air, with high relative humidity, will encourage the growth of moulds and bacteria on chilled carcass meat and also lead to the development of various fungal disorders on many fruits and vegetables.

3.7.4 When chilled meat is transported, there are significant changes in relative humidity when the refrigeration unit is turned off for any reason.

3.7.5 Typically the relative humidity increases from 85% to nearly 100% and prolonged periods at these levels can have a significant effect on the microbiological spoilage.

3.7.6 Generally levels between 90% and 95% are recommended for fresh vegetables and up to 98% for root crops. For fresh fruit levels vary but are generally between 85% and 95% depending on the fruit and variety.

3.7.7 Relative humidity of the air around the produce is dependent on the water activity at the surface of the product, the rate of fresh air ventilation, the relative humidity of the fresh air and the temperature of the refrigerant coil relative to the dew point of the air in the cargo space. Thus any problems which arise may be related to any of several factors.

3.8 Weight Loss

3.8.1 This is one of the least understood effects of refrigerated or ventilated stowage. Produce loses weight by the transfer of water vapour to the surrounding air. If this air is very dry then the rate of transfer will be increased and hence the rate of weight loss.

3.8.2 When unwrapped produce is loaded warm into a refrigerated vehicle there is a loss of weight during cooling due to evaporation. In this situation the refrigeration plant may be operating at full rate, particularly if controlling the return air temperature. The evaporator coil will be at a much lower temperature than the dew point of the air passing over it, from which water will then condense drying the air which will cause further evaporation from the meat. For example, carcass quarter beef can lose 2% of its initial weight in cooling from 20°C to 6°C. Under these circumstances the cooling loss will be more significant than the transport loss.

3.8.3 Similar effects apply to fruit and vegetables particularly when loaded above the transport temperature and cooled in transit. Weight loss can be reduced by effective design of packaging, notably by the use of plastic films, but this can result in condensation on the inside of the film.

3.8.4 The design of refrigeration equipment, particularly the air cooler or evaporator coil, is important as is the need to ensure that the coil temperature does not fall to very low temperatures thus promoting rapid air drying.

3.9 Air Circulation and Distribution

3.9.1 The need for adequate air circulation and particularly for even distribution is paramount. Poor air distribution can adversely affect localised product temperatures and result in a wide spread of temperature through the load. This together with the effect on localised humidity and weight loss combine to reduce the quality and shelf life.

3.9.2 If warm produce is loaded then a good distribution of air is essential for even cooling and a satisfactory product temperature range in the vehicle or container. An adequate volume of air must be circulated to cool the produce quickly and to maintain the desired range of air temperature (this practice is not recommended except in special circumstances).

3.9.3 Distribution depends on equipment and packaging design but primarily on the way the cargo is stowed.

3.9.4 Equipment which can operate independently of stowage or packaging has been demonstrated but has not proved to be commercially acceptable.

4 Packing

4.1 General

Packing is one of the more important factors in all types of transport and is particularly affected by the packaging of the commodity, whether it be carton, pallet, net bag or hanging meat. The stow must be stable to avoid damage during handling and in transit yet it must permit air to circulate freely through and around the commodity.

4.2 Frozen Produce

4.2.1 Frozen produce should always be accepted for transportation when precooled to the correct carrying temperature. It is then only necessary for air to circulate around the periphery of the load and a block stow, i.e. one that has no deliberate spacing between any of the packages or pallets, is all that is required. It is of course necessary to ensure that air can circulate under, over and to each side and end of the stow.

4.2.2 The air space between the vehicle wall and the produce is often maintained by permanent spacers or battens which are built into the walls. There has been an increasing trend for side walls to be smooth and concern has been expressed about the possibility of elevated temperatures in these areas. Several trials with frozen produce in smooth sided containers have failed to demonstrate a significant problem as there is invariably space for air to flow as a result of slightly loose stowage. Problems would arise where boxes fit tightly across the space.

4.3 Chilled Produce

4.3.1 Chilled products such as fruit and vegetables are living organisms and produce heat as they respire (or breathe). The quantity of heat generated depends on the variety of fruit or vegetable and usually varies with the product temperature. To ensure that this heat is removed it is essential that a large proportion of the circulating air passes through, rather than around the stow, to give good contact with all parts of the load.

4.4 Cartons for Fruit

4.4.1 If the dimensions of the package are suitable, a block stow can be used with cartons stowed one on top of the other preferably "in register". Brick stows, whilst giving good stability, do not allow free passage of air between the cartons and may give rise to local hot spots. Ventilated cartons generally give better results than enclosed cartons and are used, for example, for bananas which have high respiration rates and are accepted for carriage within a few hours of cutting to be cooled in transit.

4.4.2 Deciduous fruit such as apples and pears, when precooled to storage temperatures, can be transported satisfactorily in closed cartons of either the tray pack or cell pack types.

4.4.3 Stone fruits are susceptible to problems arising from respiratory heat and without good air circulation have been found to rise in temperature, particularly when block stowed on pallets.

4.4.4 Where fruit is not properly precooled, spacing between packages will facilitate air distribution which can be achieved by the use of dunnage where this is found to be practicable. To achieve adequate cooling rates the whole of the floor area should be covered without leaving any large gaps between adjacent cartons, probably not greater than 10 mm, so that a uniform distribution of the air flow between the cartons will occur.

4.4.5 It should be recognised that most refrigerated vehicles and containers are designed to maintain produce at the carrying temperature, their use for cooling produce should only take place after careful consideration of all the factors involved. It is a recognised practice to cool bananas in containers but in-transit cooling is an accepted part of the banana delivery chain from cutting to point of sale.

4.4.6 For most products, a vehicle or container is unlikely to cool cargo from ambient levels of 20 to 25°C down to carrying temperatures close to 0°C in much less than 5 to 7 days.

4.4.7 Cooling rates are limited by the need to avoid over cooling the cargo and by the rate of heat transfer from the cargo in addition to any limitations in the refrigeration capacity of the equipment.

4.5 Vegetables

4.5.1 The heat of respiration of many vegetables is higher than for fruit and for journeys under refrigeration these commodities should be precooled to the carriage temperature.

4.5.2 Certain leafy vegetables, salad crops etc. are precooled by vacuum coolers or hydrocoolers, wrapped in polyethylene bags and then placed in cardboard cartons. At storage temperatures these commodities can be carried safely with a block stow, preferably with the cartons in register.

4.5.3 For commodities stowed in net bags, for example onions, potatoes, carrots and melons, whether carried under refrigeration or forced ventilation, it is advisable to break the stow with dunnage when the size of the commodity is particularly small. For example, onions for pickling present a much higher resistance to air flow than those used for other culinary purposes.

4.5.4 Carrots are a further example where product density under some circumstances can impede air flow. With commodities in nets or sacks, the bottom tier should be vertical with alternate layers stowed horizontally.

4.5.5 When commodities are carried without refrigeration it is essential to break the stow by using pallets turned on end, particularly in periods of hot weather. All fruit and vegetables produce heat which will, unless vented to the atmosphere, raise the product temperature.

4.6 Chilled Meat

4.6.1 Hanging meat carcasses should be arranged to allow adequate air circulation to all parts of the load. Care must be taken with stowage to minimise possible product damage. It is prudent to load meat to meat and bone to bone always placing bone against the side walls of the vehicle or container.

4.6.2 Effect of Stowage on Air and Temperature Distributions

4.6.3 In order to ensure good temperature distribution it is essential to have air uniformly distributed throughout the load. This can be brought about by having the cargo uniformly stowed over the floor of the vehicle or container. Poor stowage results in poor air distribution which gives rise to slow cooling when produce is not fully precooled. A large spread of temperature throughout the load may also result.

4.6.4 The major principles to adopt are:

4.6.4.1 Stow as uniformly as the product will allow. Do not leave large gaps between pallets or at the ends of the vehicle. Avoid alternating areas of very tight and loose stowage which may lead to local hot spots building up over a period of time.

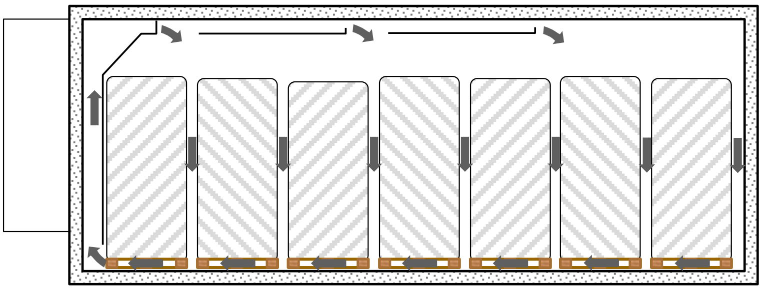


Figure 9.2 Ideal packing pattern for pallets

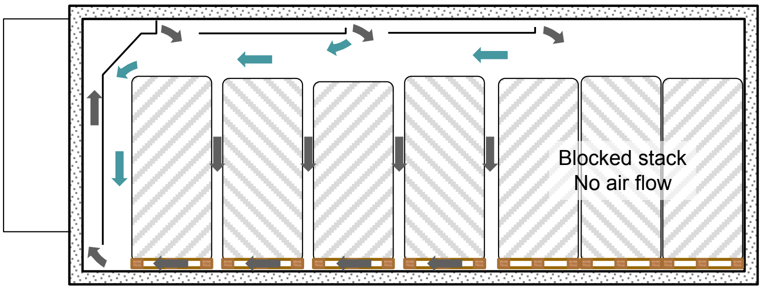


Figure 9.3 Irregular packing pattern

4.6.4.2 With break bulk stows, empty cartons or timber should be used to fill the gap between the end of the load and the doors. If the cargo is on pallets the floor should be covered wherever there are blank spaces.

4.6.4.3 Always leave an air gap between the top of the load and the roof of the vehicle. This is usually 10 cm on long vehicles and 7.5 cm on 20ft. containers. Good air circulation is not possible if there is no gap. Some vehicles have canvas ducts to distribute air - these should not be distorted with too high a load.

4.6.5 With loose cartons it is possible to have a load uniformly spaced over the floor area when the dimensions of the cartons are compatible with the internal dimensions of the container or vehicle.

4.6.6 Vertical separations (dunnage) are useful with cartons, particularly with warm or respiring cargoes, but it is better to use ventilated cartons to allow a through flow of air. Some cargoes have a higher resistance to air flow than others and this will have an effect on both the volume of air circulated by the fan and as a consequence the temperature distribution.

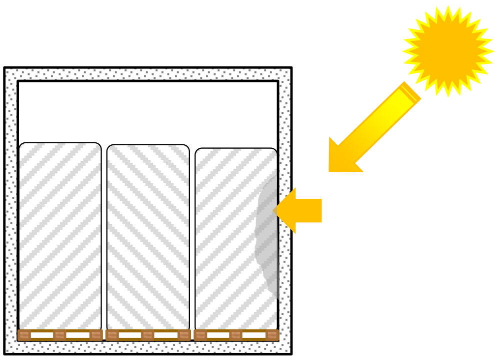


Figure 9.4 block stacked to side wall

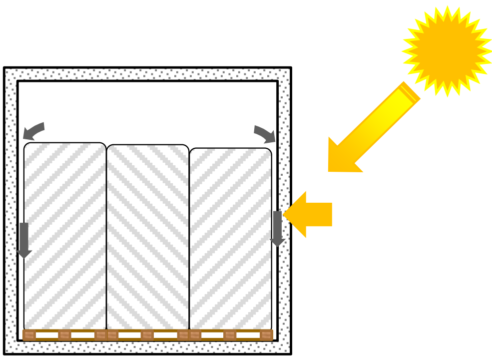


Figure 9.5 Blocked stacked with air passage

4.6.7 Direct sunlight on the exterior of a refrigerated may, over time, cause parts of the side wall to heat up locally and without the cooling effect of moving air over the inner face, penetrate into the cargo. This is caused by the cargo being stacked directly against the side wall of the CTU passing through areas of extreme (high) temperatures.

5 Packing

5.1 Temperature considerations

Temperature is considered to be measured and stated in Degrees Celsius [°C], while Fresh Air Exchange rates should be stated in cubic metres per hour (CMH) for the purpose of this Code. Any variance from this practice must be highlighted to all parties in the chain to ensure that there is no misunderstanding.

5.2 Carton design

5.2.1 Many perishable commodities are transported in some form of carton. The quality of the carton tends to depend on the value of the product and occasionally on the length of the journey. Practically all fibreboard has a poor wet strength so there is a limit to the height to which cartons of fruit can be stowed without the load gradually compressing. A good quality tray pack carton can be stowed about nine high for a period of six weeks without collapsing. The effect of carton collapse, apart from possible bruising of the contents, is to reduce the air gaps, making dunnage battens ineffective and lead to an increase in the pressure drop through the load with a reduction in the volume of air being circulated.

5.2.2 Designs of package which facilitate good cooling rates and the maintenance of small temperature gradients in the load usually have perforations to allow air to move freely through the cartons.

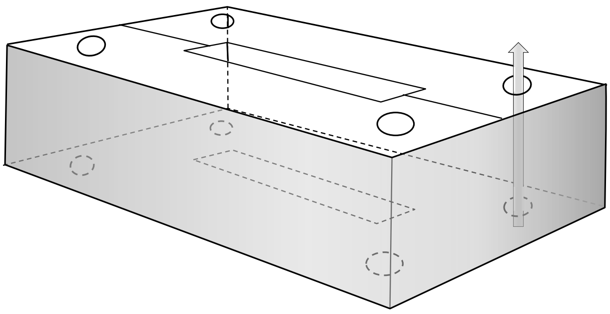


Figure 9.6 Ventilated carton

5.3 Packaging Design and Heat Transfer

5.3.1 Package design plays an important part in transferring heat from the product to the cooling air and the two examples given below typify two extremes.

5.3.2 Maximum cooling (and heating) rates are achieved with unwrapped fruit in ventilated cartons, e.g. citrus fruit (these are sometimes individually tissue wrapped). At the other extreme, wrapped pears in telescopic cartons with polyethylene liners have a very slow rate of cooling.

5.3.3 The rate of air circulation within the vehicle also has an effect on the heat transfer from the package. It is possible to obtain improvements in cooling of cartons up to a maximum rate of air circulation of 90 times the empty volume of the storage space per hour. Above this level returns are small as the increase in heat transfer coefficient between the surface and the air is offset by the insulating effect of the carton material.

5.3.4 Cooling rates decrease with lower air circulation rates and at very low rates, probably less than around 10 changes per hour, the air volume flowing past the individual packages may be insufficient to remove respiratory heat with a resulting rise in product temperature.

5.3.5 Some figures for cooling at different rates of air circulation are as follows:

Average ½ cooling times	60 air changes	90 air changes
Non ventilated cartons	69.1 hours	54.6 hours
Ventilated cartons	26.6 hours	24.5 hours

5.3.6

5.3.7 However when stacking ventilated cartons, it is important to ensure that ventilation holes do line up. If using an interlocked stack, the ventilations holes may not align when the carton is designed for vertical stacking. Where the air passage through the cartons is blocked there is a risk of the contents deteriorating.

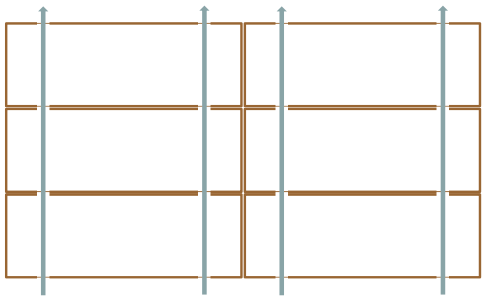


Figure 9.7 Free passage of air

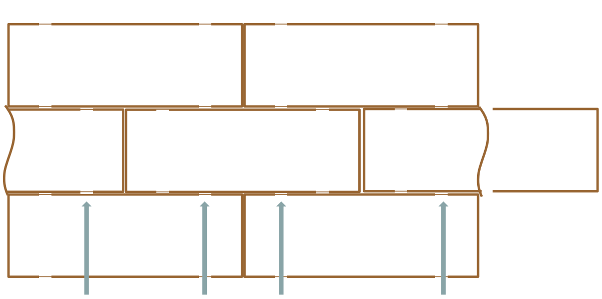


Figure 9.8 Blocked air passage

5.3.8 Generally speaking fruit and vegetables which have a high metabolic heat production rate should always be carried in packages which have a high rate of heat transfer to the surrounding air.

6 Ventilation

6.1 Many cargoes, particularly fruit and vegetables carried in the chilled condition, require some form of ventilation. This can be indicated by the measurement of the concentration of carbon dioxide in the cargo air. Outside marine operations little if anything is done to monitor this gas.

6.2 With CTUs, which are independent of a central monitoring system, it is usual to ventilate continuously even though the amount of ventilation may exceed requirements. Commodities that are known to be sensitive to the effects of ethylene are generally ventilated at a high rate.

6.3 Several manufacturers of transport refrigeration equipment are now fitting adjustable venting ports which allow the operator to set the vent to allow fresh air exchanges in accordance with the requirements of the commodity being carried and with reference to the ambient conditions in the operational area. For a typical 40ft CTU air exchange rates in the range 30-250 m^3/hr equivalent would be equivalent to 0.5-4.5 changes/hr.

Figure 9.9 Ventilation port

7 Atmospheres

7.1 The Effects on Quality and Storage

7.2 The gases which affect the storage life of fruit and vegetables are oxygen, carbon dioxide, and ethylene. Carbon dioxide is a product of the normal metabolism where oxygen is absorbed from the atmosphere and carbon dioxide is given back to the atmosphere.

7.3 Uncontrolled levels of carbon dioxide can be harmful to fruit and vegetables during transport and storage. It can normally be replaced by ventilating the storage space with fresh air. Approximately one air change of the empty space (CTU) per hour is sufficient to maintain carbon dioxide at tolerable levels for most fruit. Higher rates of ventilation may be specified for other reasons e.g. ethylene removal.

7.4 Low levels of oxygen, usually brought about by the use of liquid nitrogen as the refrigerant, may have an undesirable effect on product quality. Consequently liquid nitrogen should only be used with caution, as a total loss refrigerant for chilled produce.

7.5 All fruit and vegetables produce ethylene, at varying rates depending on commodity. Ethylene stimulates ripening and accelerates senescence to a varying degree in all fruit and vegetables but the effects are sufficiently severe to cause problems in only a proportion of commodities. It is also a by-product from internal combustion engines and may be present in the atmosphere where these are operated in local sheltered conditions. For example diesel or LPG powered fork lift trucks should never be used for packing CTUs with fruit, cut flowers or shrubs.

7.6 As with carbon dioxide the effects of ethylene can be reduced by ventilation with fresh air. Concentrations at or below one part per million the gas that can cause problems so measurement can provide difficult. The use of sophisticated and expensive equipment such as a gas chromatograph can only be carried out for test purposes rather than regular monitoring. Consignors of commodities known to be sensitive to ethylene should ensure that the packer is aware and that ventilation on the CTU is between two and three air changes, of the empty volume, per hour. For less sensitive commodities about one air change per hour is usually sufficient.

7.7 Various methods of absorbing ethylene from the atmosphere are available. These include:

- Potassium permanganate, sometimes used as a coating or with silica gel (absorbent pads).
- Activated charcoal filters.
- Brominated charcoal filters.
- Catalytic filters.
- Combination with ozone. Ozone generators are available but are probably better suited to use in large storage spaces.

7.8 In the transport field fresh air provides the most convenient and reliable method of maintaining low ethylene levels.

8 Controlled atmosphere (C.A.) and modified atmosphere (M.A.)

8.1 The principles of atmosphere control have been known for many years and have been applied successfully to long term storage, in cold stores, of apples and pears. The techniques are now being applied to transport and packaging, not as a replacement, but as an enhancement of good temperature control.

8.2 Controlled or Modified Atmospheres do not eliminate the need for good Temperature Control. Modified or controlled atmospheres with reduced oxygen content and increased carbon dioxide content, with appropriate temperature control, can retard deterioration and maintain the quality or increase the storage life of various fruit and vegetables.

8.3 The beneficial effects of controlled and modified atmospheres include:

- Retarding fruit ripening.
- Retarding leaf senescence (ageing).
- Control of fungal and bacterial spoilage and insects.
- Control of physiological disorders e.g. spotting in leaf crops and bitter pit in apples.
- Reduction of ethylene production
- Reduction of sensitivity to ethylene.

8.4 Modified Atmospheres in CTUs

A packed CTU is purged with a tailored gaseous nitrogen mix immediately before shipment and then sealed.

8.5 Controlled Atmospheres in CTUs

Controlled atmosphere CTUs for marine applications control the oxygen level either using liquid nitrogen or by use of a continuous nitrogen generator in which air is pumped through hollow fibres to produce a gas mixture of 98% nitrogen and 2% oxygen. For some applications the commodity produces carbon dioxide at a sufficient rate to maintain the required level which can then be limited by scrubbing. Higher levels for the carriage of meat require a supply from either a cylinder or from blocks of dry ice.

9 Precooling

9.1 Why is it necessary?

9.1.1 In the first place to maintain the quality of produce. Prompt cooling of fruit and vegetables, immediately after harvesting, will lengthen the potential storage life.

9.1.2 Secondly and more importantly, a CTU is not designed to cool produce as they are designed only to maintain the product at the transport temperature. CTUs, in general, do not have sufficient capacity to cool produce quickly to maintain its condition, whereas cold stores, cooling tunnels and pressure cooling systems are designed for this task.

9.1.3 Fruit and vegetables are living organisms, consuming oxygen from the atmosphere and giving off carbon dioxide and water vapour and heat. This heat of respiration can add a significant load to the cooling system. The higher the temperature of the produce the greater the heat of respiration.

9.1.4 The level of heat of respiration can have a very significant effect on the time taken to cool the product to the transport temperature.

9.1.5 Tight stows of cartons on pallets are prone to slow cooling if the product is loaded warm and an illustration is given in Figure XXIX.10.

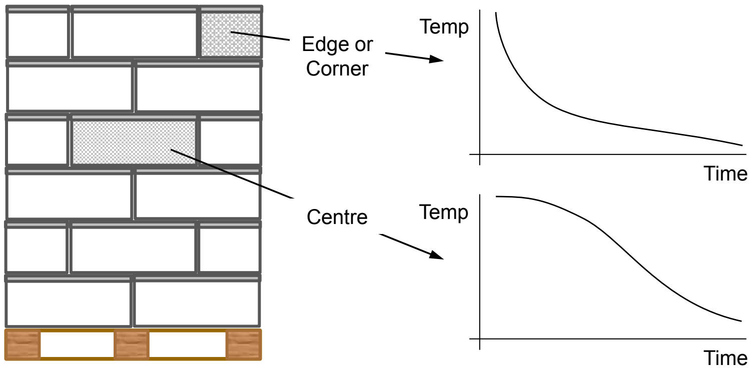


Figure 9.10 Cooling on a pallet

9.2 Vacuum damage

9.2.1 The consequence of cooling air is that the volume decreases in proportion to its temperature. Therefore a CTU opened and left with the doors open so that the inside temperature is the same as ambient can cause problems when pre-cooling. If the ambient temperature is high and the internal temperature is permitted to rise towards that temperature, then the doors are closed and the machinery activated with a low set point the volume of air inside will substantially decrease.

9.2.2 Refrigerated CTUs are designed with low air leakage so that the cold air cannot escape and air drawn in by the ventilation port can be properly controlled. The consequence of which is that when the doors and ventilation port are closed there can be very little air movement between the exterior and the interior. In such circumstances cooling the internal air will result in the internal pressure of the cargo space dropping. This can result in a vacuum that prevent the doors from being opened and in severe cases can result in the CTU imploding.

9.2.3 It is essential therefore that the ventilation port is opened when pre-cooling and set once the interior has been cooled to the required temperature. Thereafter packers should endeavour to keep the internal temperature as low as possible

10 Equipment

10.1 Types of CTU

10.1.1 Descriptions of refrigerated CTUs can be found in Annex 6 section 1.3.

10.1.2 For land transport, the refrigerated semi-trailer is the most popular form of vehicle although for local deliveries and short haul operations rigid vehicles are also used. The external dimensions of European semi-trailers can be as large as 13.6m x 2.6m x 2.7m high although in other countries they may be larger.

10.1.3 For marine use the most common types of container is the 40ft high cube integral refrigerated container, which has an inbuilt refrigeration unit similar to the refrigerated semi-trailer. The smaller 20ft version is available but only constitutes only 7% of the world's refrigerated fleet.

10.1.4 As with all types of transport equipment, there are mass restrictions which may limit the volume of the more dense produce which can be carried. This is more often found with frozen cargo.

10.2 How does a Mechanically Refrigerated Vehicle work?

The refrigeration unit fans cause temperature controlled air to circulate around the inside of the vehicle floor, walls, doors and roof to remove heat which is conducted from the outside. Some of the air should also flow through and between the cargo, particularly when carrying fruit and vegetables, where heat of respiration may be a significant proportion of the heat load. The various components of the heat load of a refrigerated CTU are given in Figure 9.11.

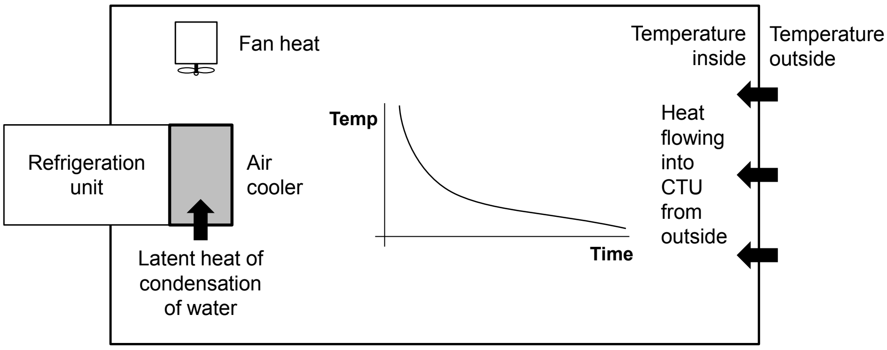


Figure 9.11 Heat load of a refrigerated CTU

10.3 Top Air Delivery Systems

Top air delivery is used predominately on refrigerated semi-trailers. Air is ducted from the refrigeration unit to the end of the vehicle or passes through and around the load returning via the floor or space under pallets. For chilled cargoes horizontal channels are required between rows of cartons to allow good return airflow through the load, whereas block stows are recommended for hard frozen cargoes that have been fully precooled. Some trailers are fitted with a false bulkhead wall with metal grill or holes in the lower part for return air passage. The cargo may be stacked to abut this bulkhead. Where return air bulkheads are not used it is a common practice to set wooden pallets on end between the front wall and the front of the load thus creating a return air channel.

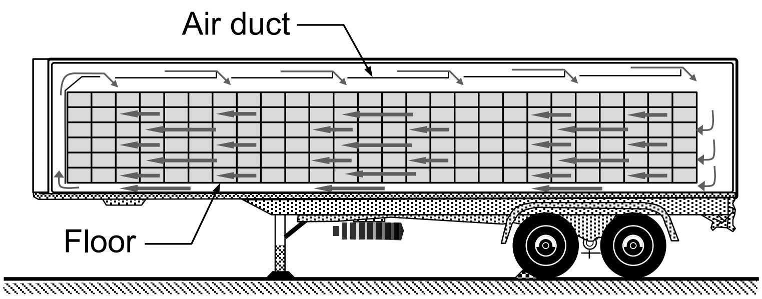


Figure 9.12 Top air delivery reefer

10.4 Bottom Air Delivery Systems

10.4.1 Bottom air delivery is generally used in marine containers. Air is blown through the evaporator into a plenum chamber, which distributes the flow evenly across the width of the floor. Depending on the stowage pattern the air passes along the floor to be circulated up through and around the stow returning via the roof space. With respiring cargoes, the most even temperature distribution is attained if the load completely covers the floor and the packaging or dunnage has been designed to allow a high proportion of the air to circulate through the load as well as around it. Where precooled frozen cargoes are concerned, a block stow is acceptable as only the heat from the container fabric has to be removed.

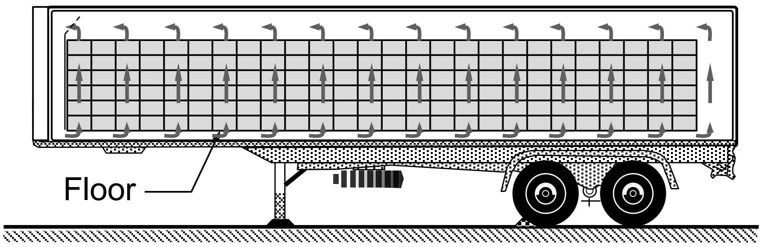


Figure 9.13 Bottom air delivery reefer

10.4.2 The heat, gained by the air as it circulates around the vehicle, is removed in the evaporator section. The air also picks up moisture from the produce and also from air from the refreshing vents when in use in ambient conditions with high humidity. This is deposited on the evaporator as water or ice, depending on the coil temperature. When ice is formed the air flow through the evaporator becomes restricted and defrosting becomes necessary when the flow falls to 75% of the frost free rate.

10.4.3 The rate of air circulation within the vehicle is equivalent to 60 to 90 air changes per hour of the empty volume. Some container operators are increasing the rate to 120 for chilled cargoes. Under maximum U.K. summer temperatures of 30°C and 0°C set point the range of air temperatures would be about 1.5°C at full speed and 2.5°C at half speed on 40ft semi-trailers. Tighter tolerances are achieved on marine containers where a 1°C spread would not generally be exceeded.

10.5 Floor Designs

10.5.1 There are generally four alternatives available, a T section floor, a castellated section floor, a perforated floor or the pallet.

10.5.2 T Section Floors - cause minimum obstruction to air flow, but can be damaged by fork lift trucks and are difficult to keep clean.

10.5.3 Castellated Floors - some obstruction to flow of air and increased pressure drop, very strong and easy to clean.

10.5.4 Perforated Floors - used traditionally in refrigerated ships and have been modified for use in containers. Give less obstruction to air flow and better distribution in the container than castellated. Difficult to clean unless removable.

10.5.5 Pallets - may be used with flat floors which are easily cleaned.

10.5.6 Road vehicles generally use flat checker plate or G.R.P. floors and marine containers are fitted with T section floors.

11 Capacity of the Refrigeration Unit

11.1.1 Most vehicle refrigeration units are fitted with a compressor which will maintain an internal temperature of -20°C in ambient temperatures of up to 40°C. When running in the chill mode at maximum speed the cooling capacity is approximately double that at low temperature. Reducing the compressor speed to 50% will reduce the cooling capacity by 35 to 40% but the net capacity may still exceed the refrigeration load.

11.1.2 All marine containers are capable of maintaining at least -18°C internal temperature in ambient temperatures of up to 40°C. Requirements for trade in desert regions have led to the development of units that will hold -25°C in 50°C ambient. Cooling capacities on marine containers and other units are reduced by various methods to give precise temperature control and heating is available for higher temperature products during carriage in cold ambient conditions.

11.2 Temperature Control

11.2.1 This is a function of refrigeration plant capacity and the load demand on the refrigeration unit. Systems vary from simple ON/OFF which is used on many road vehicles at all temperatures and for frozen control on marine containers, to sophisticated capacity regulation using electronic control of chill temperatures on marine containers.

11.2.2 Road Vehicle Control.

11.2.2.1 The typical road vehicle temperature control for a unit on diesel drive would be:

- Return Air > (Set Point + 2°C) High Speed Cool
- Return Air < (Set Point + 1°C) Low Speed Cool
- Return Air > (Set Point - 1°C) Low Speed Heat
- Return Air < (Set Point - 2°C) High Speed Heat

In practice these tolerances may vary or be subject to PID control.

11.2.2.2 On many diesel driven units, the compressor, condenser fan and evaporator fan are connected to a common drive train, consequently the evaporator fan speed is reduced when the compressor goes on to low speed and the reduced air flow allows the temperature gradient across the load to increase.

11.2.2.3 Typical air temperature variations under on/off control and two speed control are as follows:

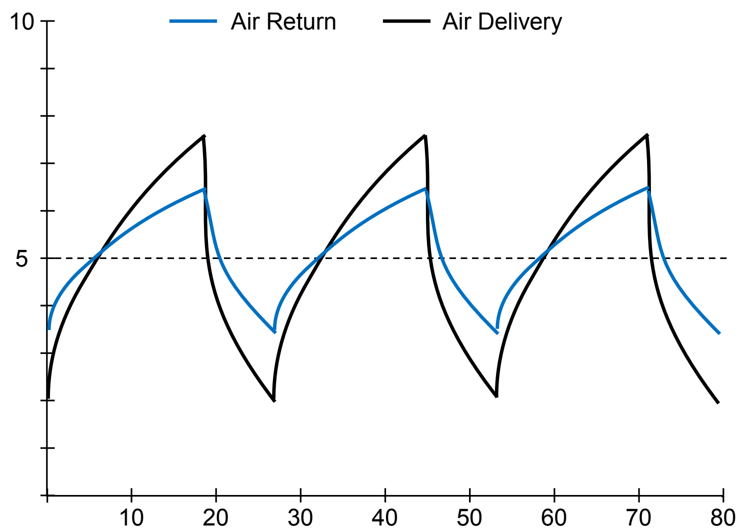


Figure 9.14 Variations of air temperature under thermostatic control

11.2.2.4 Control cycles of this type are known to cause chilling and freezing injury with sensitive fruit and vegetables. The main problem is the practice of controlling the return air temperature combined with relatively wide control swings.

11.2.2.5 Where parts of a load are several degrees above set point the thermostat may cause the compressor to run on full cool and thus freeze other parts of the load near to the air delivery location. This problem can be eliminated by controlling the delivery air temperature.

11.2.2.6 The variation between delivery and return air temperatures will tend to increase when the fan runs at low speed.

11.2.3 Continuous Temperature Control

11.2.3.1 The marine container industry has made significant improvements in temperature control which are of particular importance for the carriage of chilled produce over long distances involving total time spans of 6 to 8 weeks.

11.2.3.2 Temperatures are controlled to within +/-0.25°C of set point whilst the differential between supply and return air temperatures is minimised by high continuous rates of air circulation.

11.2.3.3 Precise control has been achieved by running the compressor continuously and reducing the cooling capacity to exactly balance the heat load at the required carriage temperature. The cooling capacity can be reduced in a variety of ways including the following:¬

11.2.3.4 Discharge gas bypass - hot gas from the compressor discharge is redirected to the evaporator. The flow rate is controlled either by a diverting valve or a combination of solenoid valves. This system has the advantage of precise temperature control over a very wide range of carriage temperatures, regardless of the ambient temperature, with stepless change between heating and cooling. However the system is not energy efficient and uses more power to hold a load at say +5°C in an ambient of +5°C than to hold the same load at -20°C using on/off control.

11.2.3.5 Reduction of Refrigerant Flow - the volume of gas pumped by the compressor may be reduced by either unloading compressor cylinders (by lifting valves), by increasing the cylinder head space volume or by throttling the flow with a valve placed in the suction line. These systems reduce power draw and work well in fairly high ambient temperatures but may give too much cooling power in low ambient temperatures leading to compressor cycling.

12 Factors affecting the relative humidity of air in the refrigerated space

12.1 The level of humidity in the air circulating in a temperature controlled CTU largely depends on the following:

- Surface area of the cooler.
- Minimum temperature of the cooler.
- Rate of moisture transfer between the air and the commodity.
- Fresh air ventilation rate.
- Relative humidity of the fresh air.

12.2 Container refrigeration units that offer some degree of humidity control as an option are now available. The relative humidity may be controlled in the range 50% to 95%, with the refrigeration unit operating in the chill temperature range.

12.3 The circulation of dry air causes water loss from the product with consequent weight and quality loss. Modern packaging, particularly films, has reduced the rate of moisture transfer from the commodity to the circulating air. Vacuum packaging is used for the transport of fresh and chilled meats.

12.4 Films are increasingly being used for most fruit and vegetables, often with perforations to limit moisture build up and avoid condensation within the package.

12.5 Some films are specifically designed to maintain a specific atmosphere mix within the package. The technique has been applied commercially and is dealt with in the section on Controlled and Modified Atmospheres.

13 Ventilated transport

13.1 Ventilated containers and trailers were developed for the carriage of respiring cargoes that do not require refrigeration and goods that may suffer condensation damage when carried in dry freight units. Ventilation removes the products of respiration and allows the product and container interior temperatures to closely follow the ambient temperature thus minimising condensation which will occur where the product is several degrees colder than the ambient air.

13.2 Vents are either incorporated in specially designed roof and bottom girders or are wire mesh panels cut into the side walls.

13.3 Passive vented containers and vehicles rely on convection within the body and pressure difference between the inside and outside.

13.4 Forced ventilated containers are fitted with an exhaust fan mounted either in a door or on the front bulkhead. Fresh air exchange rates of between 30 to 40 volumes per hour are attained.

13.5 Passive systems are used for the carriage of coffee and cocoa beans, chemicals and canned produce where even temperatures are necessary to limit condensation. Onions and other respiring products are normally carried in fan ventilated containers.

14 Commodities

14.1 Chilled Produce

14.1.1 Compatibility of Cargoes in Store

14.1.1.1 The mixing of several commodities in a single load, a common cold store often appears to be economically advantageous where a common carrying temperature is to be used.

14.1.1.2 To a long distance shipper a mixed load may mean two or more fruits or vegetables, to a meat shipper mixed carcasses and boxes of cuts or cryovac packs and to a grocer or ship's chandler a mixture of meats, dairy products, fruit, vegetables and non food products.

14.1.1.3 It is essential not to mix any commodity in a mixed load that will impair the quality of any other product within the load. With this aim in view the following factors must be studied to discern the compatibility of products:

- carriage temperature.
- transit time.
- packaging and stowage patterns. -ethylene production rate. -sensitivity to ethylene.
- emission of objectionable odours.
- sensitivity to odours of other product. e.g. odours given off by apples, citrus fruits, onions, pineapples and fish are absorbed by dairy products, eggs, meats and nuts.

14.1.1.4 Film packaging of products can reduce the risk of taint but too much reliance should not be placed on the method.

14.1.1.5 The problems of ethylene have been mentioned in the section on atmospheres and solutions suggested. There are obvious combinations where it is inadvisable to mix cargoes: as a general rule, bananas, avocado pears and kiwi fruit are among those fruit which should not be stored with other fruit which produce ethylene.

14.1.2 Fruit

14.1.2.1 Transport temperatures for fruit fall into two groups. Fruit which is essentially tolerant of low temperatures is carried at temperatures in the range -0.5 to 0°C. The aim is to carry at or as near to the freezing point of the particular fruit as possible, taking into account control temperature variations to avoid freezing any of the cargo.

14.1.2.2 More sensitive fruits are carried at higher temperatures which are a compromise between the harmful effects of low temperature, which may result in chilling injury and the benefit from low temperatures of slow ripening and retarded development of rots. Chilling injury is the physiological damage which results from exposure of fruit and vegetables to temperatures below a critical level for each variety and causes most problems with fruit and vegetables from tropical and sub-tropical areas.

14.1.3 Vegetables

14.1.3.1 Most temperate vegetables are tolerant of low temperatures and are carried close to 0°C, but as most tend to have a higher freezing point than fruit the delivery air temperature should not go below 0°C.

14.1.3.2 A higher range of temperatures are specified for certain vegetables which would otherwise suffer from chilling injury (see section on fruit). These include aubergines, cucumbers, marrows and most tropical vegetables.

14.1.3.3 Transport temperatures are given for some vegetables, in Table 7, which may be carried using fresh air ventilation without refrigeration. The method used would depend on the distances involved, ambient conditions and required shelf life. Two good examples are onions and potatoes.

14.1.4 Meat and Dairy Products

14.1.4.1 Chilled foods must be carried at temperatures between about -1.5°C and +5°C. For some products an upper maximum temperature of not more than 2°C may be specified, e.g. for chilled beef an upper limit of 0°C is recommended.

14.1.4.2 Difficulties may arise when transporting chilled meat with a specified return air temperature of between -1 and 0°C in high ambient temperatures. To maintain this level the delivery air temperature may have to fall to below the temperature at which the meat starts to freeze. For short journeys the problem should not arise as carriage temperatures of +1°C are usual.

14.1.4.3 High levels of carbon dioxide may be used for the carriage of chilled meat when the transport time is about 28 days and some figures are given below:

- Beef 10%-20% CO2 RH 90% +/-5%
- Horse meat 20% CO2 RH 90% +/-5%
- Lamb 25%-30% CO2 RH 90% +/-5%

14.1.4.4 Most beef and lamb for transport over long distances is either vacuum packaged or sometimes modified atmosphere packaging is employed. A gas mixture of 50/50 carbon dioxide and nitrogen is sometimes used, although as few films are impermeable to most gases the mixture will change after sealing.

14.1.4.5 Vacuum packaging, which is difficult to apply to whole carcasses, is generally used for individual cuts of meat. Similar packaging containing a high carbon dioxide content rather than a vacuum is sometimes used for lamb carcasses.

14.2 Frozen Produce

14.2.1 There are several important levels of temperature in the carriage of frozen produce:

14.2.1.1 Final thaw temperature around -1.5°C which should never be encountered during transportation and storage.

14.2.1.2 Softening temperature at about -4.5°C. Surface temperatures may occasionally reach this whilst loading carcass meat. Surfaces of outer packages or carcasses in containers or vehicles moving without refrigeration may also reach this figure.

14.2.1.3 The lower limit for mould development is -8.5°C. Considerable time is needed for moulds to grow at these temperatures.

14.2.1.4 An additional constraint may be limits set in legislation by either the exporting or receiving country.

14.2.2 Frozen foods continue to deteriorate, very slowly, and the lower the temperature the lower the rate of deterioration and consequent increase in shelf life. Deterioration appears as a loss of quality rather than any dramatic change and is the result of chemical activity such as oxidation and physical changes resulting from evaporation and the growth of ice crystals. The rate of change is also influenced by the exposed surface area of the cargo in relation to its weight and by the presence and nature of any packaging which can limit weight loss. For the small unit such as frozen fish, fruits and vegetables, packaging is essential.

14.2.3 Frozen Meat

14.2.3.1 Deep frozen meat, includes beef, veal, pork, lamb, venison and game. Meat is marketed and transported in several forms:

- Frozen carcasses and primal cuts (sides, legs etc.)
- Frozen retail cuts
- Frozen mince including hamburgers

14.2.3.2 ATP maximum internal temperature is currently -10°C but this is currently under review and may eventually be reduced to -18°C. The corresponding EEC figure is -12°C.

14.2.4 Frozen Poultry and Rabbit

14.2.4.1 Frozen poultry can be domestic fowls, turkeys, ducks, geese and guinea fowl.

14.2.4.2 Whole chickens are usually packed in plastic bags, whilst whole turkeys and ducks are vacuum or shrink packed.

14.2.4.3 ATP maximum internal temperature is currently -12°C.

14.2.5 Frozen Fish

14.2.5.1 Frozen fish has a shorter storage life than frozen meat being more susceptible to oxidation and the production of off-flavours and odours. Good packaging using films with low water vapour and oxygen permeability increases the shelf life. As an alternative fish can be protected by glazing with a sacrificial layer of ice on the surface which reduces oxidation and dehydration.

14.2.5.2 Frozen fish, particularly fatty fish would ideally be carried at -29°C or colder, ATP and EEC specify -18°C or colder with -15°C being allowed for short periods.

14.2.6 Butter

ATP regulations require butter to be carried at -14°C or colder, with -11 °C being allowed for short periods.

14.2.7 Dried Produce

Milk powder and similar products, having been dried during manufacture, tend to absorb water and taint odours. These are best stored in sealed insulated equipment and ventilation to admit moist air should be avoided.

14.2.8 Coffee and Cocoa Beans

See ventilated containers.

14.2.9 Chemicals

14.2.9.1 Many chemicals, films, industrial and biological non-food products are shipped in refrigerated or ventilated containers and vehicles. Specific instructions as regards handling, packaging, stowage and temperature for each product must be strictly observed.

14.2.9.2 Products that require low carrying temperatures should be precooled. Refrigerated containers are designed to maintain product temperatures; they have insufficient refrigeration capacity to cool products.

14.2.9.3 Great care must be taken in handling chemical and blood products to avoid leakage of potentially hazardous or odorous substances.

14.2.9.4 It is prudent to avoid using the same containers for certain hazardous cargoes and subsequently for foodstuffs.

15 Condensation

15.1 Condensation on to the cargo, cargo sweat, and the container interior can be caused by:

15.1.1 Air leakage into a container with a sufficiently cold interior or load, to provide a condensing surface for the humid ambient air. i.e. some of the cargo or the interior of the vehicle or container is at a temperature less than the dew point temperature of the interior air. The container air dew point is probably increased by fresh air from a leak.

15.1.2 Where a large temperature gradient exists across the load there may be evaporation from the warm section of the load and condensation on the colder areas (moisture migration).

15.1.3 Rapid changes in external temperatures.

15.2 Consider a cargo of canned fruit in an uninsulated vehicle at a daytime temperature of 20°C and a product temperature also of 20°C. The dew point of the container air is 16°C.

15.3 At night the external temperature falls to 14°C and so does the interior surface of the container roof, onto which water condenses until the dew point of the air falls to 14°C.

15.4 The water droplets drip on to the product to cause discoloration and label distortion on unprotected cans.

15.5 When the load has originated in a cold area and then passes rapidly into a warm zone the cans will not warm as quickly as the external temperature and water droplets will condense onto the load.

15.6 Many condensation problems can be avoided by ensuring packaging materials are dry at loading. Film wraps can also be of benefit.

15.7 For many products the use of vented or ventilated containers has proved to be a solution to condensation problems (see section 15. Ventilated Systems).

16 Miscellaneous

16.1 Taint

16.1.1 Care is usually taken to avoid mixing incompatible cargoes and with packaging to protect produce from odour problems. Another factor which should be considered is the environmental effect which results from the materials used to construct the vehicle or container and the previous cargo.

16.1.2 Some sources of taint are:

- Materials, generally of petrochemical origin, used in the manufacture of plastics, paint and sealants.
- Previous cargoes which have persistent odours, e.g. citrus fruit, potatoes, various chemicals. Particular care must be taken when carrying chemicals in equipment that is used for foodstuffs.
- Vehicle Cleansing to remove odours.
- Wash with detergent such as dichloros, rinse with clear water, then ventilate.
- With particularly severe or persistent odours steam cleaning may be necessary, again followed by ventilation.
- Some odours can be eliminated by alternate heating and ventilation.

16.2 Hygiene

16.2.1 It is important that the construction of the vehicle is such that crevices between panels or between walls and floor etc. are minimal and properly sealed with an approved mastic. Washing as outlined above should be carried out prior to carrying food, although fumigation may be necessary before loading such cargoes as chilled meat. A number of proprietary sprays are available for this purpose.

16.2.2 Fumigation with methyl bromide or ethylene dibromide is generally banned.

17 Dos and Don’ts

17.1 Maintenance

17.1.1 The following should be carried out on a regular basis:

- Refrigeration unit servicing.
- Check the calibration of the temperature control thermostat.
- Check the calibration of the thermometer and temperature recorder (when fitted).
- Body inspection and repair including attention to door seals which should be well maintained to prevent air leakage with the ingress of dust, moisture and undesirable

odours. All internal and external damage to panels should be promptly repaired to curtail the deterioration of the insulation due to penetration by moisture.

17.1.2 Normal deterioration of insulation is around 5% per year and the fuel bill will increase by this amount each year.

17.2 Before packing

17.2.1 Ensure that the refrigeration unit is set correctly, for the load, and is functioning properly and controlling the temperature at the required level.

17.2.2 Defrosting, particularly termination should be verified as loads may be spoiled by a unit running on continuous defrost without the knowledge of the driver.

17.2.3 A pre-trip service inspection procedure is strongly recommended for all transport refrigeration equipment.

17.2.4 The vehicle should be clean and free from odour particularly before loading meat, meat products, fish and dairy products.

17.3 Packing

17.3.1 Precool the container or vehicle to the product temperature before loading. Precooling prevents the warming of the product from heat in the walls, floor and roof.

17.3.2 Do not run the refrigeration unit during loading, it is a waste of fuel. Load as quickly as possible. If loading is interrupted, close the doors and run the refrigeration unit.

17.3.3 Check the temperature of the product with a thermometer of an accuracy conforming to EEC directives (where applicable). Take several product temperatures at random and write them down on the loading sheet.

17.3.4 Take note of any defects: broken cartons or cases or other mechanical damage to the product. Any peculiar odours or moulds on product or packages should be noted.

17.3.5 Stow the commodity uniformly in accordance with the shippers instructions remembering that air must flow between the packages when respiring products are carried. Always leave a space of not less than 10 cm (4") between the top of the load and the roof. With top air delivery using canvas ducts, avoid distorting the ducts. Do not stow cartons tight up against the side walls. If they do not fit across the width, stagger from one side to another, e.g. row 1 to left hand side and row 2 to right hand side.

17.3.6 When loading pallets try and leave a small space between each pallet. Do not leave large spaces in the centre of the stow.

17.3.7 With a part load, using bottom air delivery, cover the exposed floor with flattened cartons or paper to force air through the load instead of bypassing it.

17.3.8 When carrying a mixed load of fruit or vegetables always choose the higher commodity temperature not the lower one.

17.3.9 Do not accept cargoes to cool in transit without specific clearance from the consignor and consignee.

17.4 In transit

17.4.1 Try to run the refrigeration unit continuously unless restrictions apply as on a ferry or in a noise abatement area. Where switching off is unavoidable try to park in the shade.

17.4.2 Check the thermostat setting at the start and after any lengthy interruptions in the journey.

17.4.3 Keep an eye on the indicated temperature, alarm lamps and defrost operation.

17.5 Unpacking

17.5.1 Run the unit until the doors are about to be opened.

17.5.2 If there is any damaged cargo, make sure that the position of the goods is noted as this may help identify the cause of the damage.

17.5.3 Where applicable check temperatures of packages from various sections of the load in accordance with the EEC directive.

17.5.4 Do not accept a back load of anything which may contaminate the vehicle and cause tainting of future cargoes of foodstuffs.

Annex 10.SECURING OF RAILWAY WAGONS ON FERRIES

1. Introduction

This annex identifies research undertaken to identify under which conditions rail wagons may be transported in train ferries without running the risk of tipping. It shows the strength of the equipment, required to withstand the stresses induced by operation in certain conditions on the Baltic Sea. These conditions include the worst probabilistic case during a twenty-year period as well as the worst condition that can be expected during normal operations.

2. Securing arrangements on existing wagons

2.1 General

There are three different types of hooks / brackets that are found on the majority of rail wagons that permits fastening of cargo securing equipment. Older wagons are equipped with tow hooks, while newer models are fitted with tow hooks combined with holding-down brackets for securing purposes on train ferries. Representative National regulations state that when wagons are to be fitted with 8 brackets, four out of these may be pure holding-down brackets.

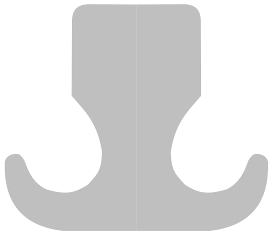


Figure 10.1 Tow Hook

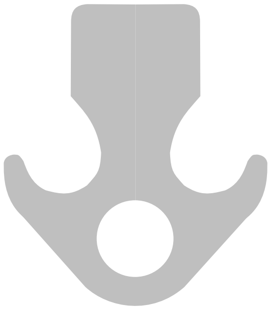


Figure 10.2 Tow hook with holding down bracket

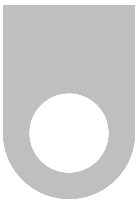


Figure 10.3 Holding down bracket

Figure 10.4 Rail wagon showing Tow hook with holding down bracket

2.2 Tow hook

2.2.1 The fitting of the tow hook to the wagon shall be able to withstand a force of 50 kN pulling in a direction within the spherical sector illustrated in the picture below.

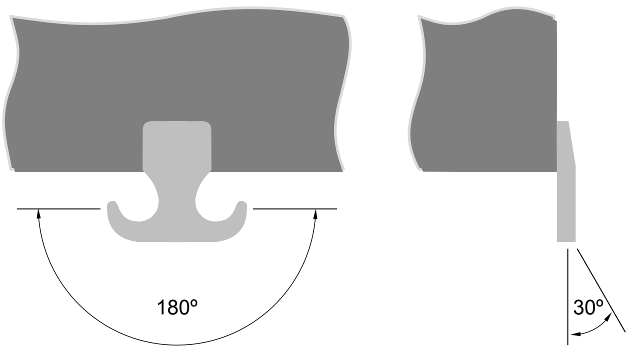


Figure 10.5 Tow hook force sector

2.2.2 The actual strength of the tow hook itself is however less. The older regulations stated that the tow hook was to be made of steel SS 1312 which is equivalent to the FE 360 in the new Swedish standard. Having a yield strength of 225 N/mm2, a hook of this steel standard allows for a maximum securing load (MSL) of 14 kN or 26 kN respectively, depending on which of the two options depictured in the figure below, that is chosen for fastening of the lashings.

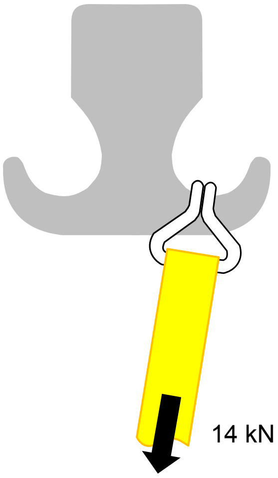


Figure 10.6 Direct fastening to a single hook

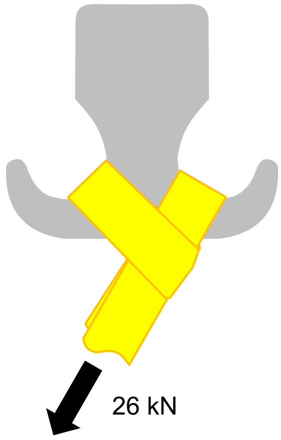


Figure 10.7 Fastening with a loop around the neck of the hook

2.3 Strength of holding-down bracket

2.3.1 The current regulations states that holding down brackets shall be dimensioned to allow for the following maximum securing load:

- 50 kN in the spherical sector from 0° horizontal to 45° downwards in the longitudinal direction and from 0° vertical to 30° outwards in the transversal direction.
- 80 kN in the spherical sector from 45° downwards in one of the wagons longitudinal directions to 45° in the other and from 0° vertical to 30° outwards in the transversal direction

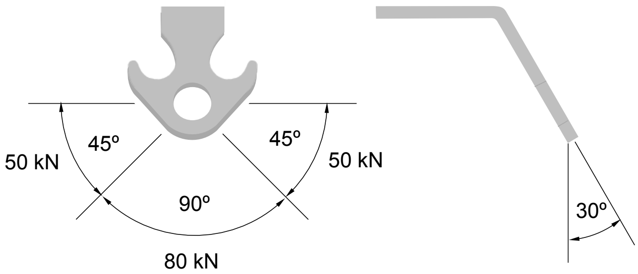


Figure 10.8 Hold down bracket force sectors

2.3.2 These two criteria apply for all types of holding down brackets, whether it's combined with a tow hook or it's a pure holding down bracket design.

2.4 Safety factor for calculated strength

2.4.1 IMO's Code of Safe Practice for Cargo Stowage and Securing states that when using balance calculation methods for assessing the strength of the securing devices, a safety factor is to be used to take account of the possibility of uneven distribution of forces or reduced capability due to the improper assembly of the devices or other reasons. This safety factor is used to derive the calculated strength (CS) from the maximum securing load (MSL):

$$CS = \frac{MSL}{\text{Safety Factor}}$$

2.4.2 In the calculation in this report forces has only been determined for two lashings concurrently and therefore uneven distribution between them has not been considered. The lashing angles used in the calculations are the greatest allowable ones and the centres of gravity are worst case estimations. Thus the safety factor has been omitted from the calculations of required strength of the lashings and tow hooks as well as the determination of permissible significant wave heights.

3. Wagon centre of gravity

3.1 The vertical centre of gravity for an empty rail wagon is estimated to 0.8m above the rail for wagon models with two axles and to 1.0m for those with four axles. The centre of gravity of rail wagons designed to carry containers is generally lower especially as the highest allowed centre of gravity of the cargo has been set to 2.8 m above the rail.

3.2 From *RIV Appendix II section 3.3* it can be derived that the maximum allowed distance from the transverse centre of gravity to the centreline of the wagon is approximately 0.10 m. Due to compression of the springs the cargos vertical centre of gravity is dislocated approximately another 0.10 m.

4. Allowable accelerations for wagons

4.1 Utilizing the centre of gravity and mass for the rail wagon that was calculated in the previous section in combination with the allowable lashing forces for the different types of towing arrangements and their geometry, it is now possible to derive a maximum allowable transversal acceleration for each wagon model at maximum load condition to avoid tipping.

4.2 The greater vertical angle the lashing equipment is applied at, the lesser is its contribution to prevent tipping. As stated in section 2.2 and 2.3 the vertical lashing angle, α, may vary between 0 and 30 degrees, and therefore α is set to 30°.

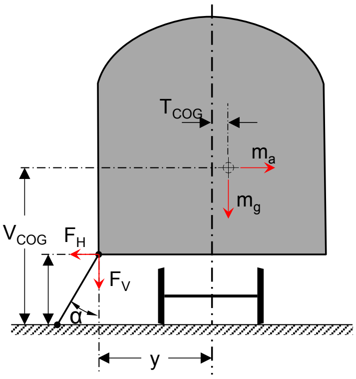


Figure 10.9 Securing rail wagons

4.3 The longitudinal lashing angle is set to 30°. Thus the allowable lashing force is set to 50 kN for the holding down brackets. In order to achieve a greater lashing capacity which is possible if the longitudinal lashing angle is larger than 45°, the distance between the lashing points in the vessel would have to be less than 1.5m.

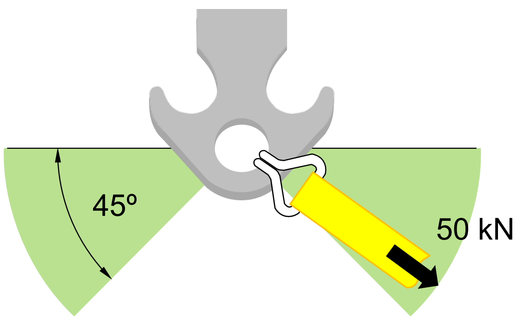


Figure 10.10 Lashing less than 45°

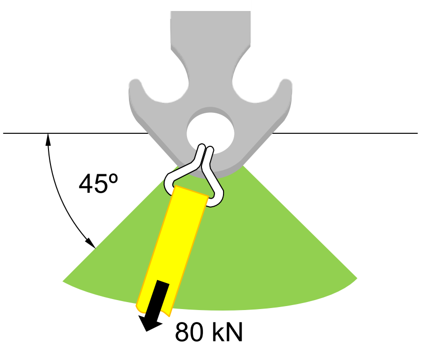


Figure 10.11 Lashing greater than 45°

Annex 11.CTU condition checks

1 General

A CTU should be thoroughly checked before it is packed with cargo. The following may be used as a guide to inspecting a unit before packing.

2 Exterior inspection

2.1 The structural strength of a CTU depends to a great extent on the integrity of its main framework comprising the corner posts, corner fittings, main longitudinal and the top and bottom end transverse members which form the end frame. If there is evidence that the CTU is weakened, it should not be used.

Figure 11.1 Container

Figure 11.2 Road vehicle

Figure 11.3 Closed trailer

Figure 11.4 Open trailer

2.2 The walls, floor and roof of a CTU should be in good condition, and not significantly distorted.

2.3 The doors of a CTU should work properly and be capable of being securely locked and sealed in the closed position, and properly secured in the open position. Door gaskets and weather strips should be in good condition.

2.4 A container on international voyages should be affixed with a current International Convention for Safe Containers (CSC)[1] Safety Approval Plate. A swap-body may be required to have a yellow code plate, fixed at its side wall (for details see UIC[2] leaflet 596), which proves that it has been codified in conformity with the safety rules of European railways. Such swap-bodies need not be affixed with a CSC plate, but many of them will have one in addition to the yellow code plate.

2.5 Irrelevant labels, placards, marks or signs should be removed or masked.

2.6 A vehicle should be provided with points for securing it aboard ships (refer to ISO 9367-1: Lashing and securing arrangements on road vehicles for sea transportation on Ro/Ro ships - General requirements - Part 1: Commercial vehicles and combinations of vehicles, semi-trailers excluded, and to ISO 9367-2: Lashing and securing arrangements on road vehicles for sea transportation on RO/RO ships - General requirements - Part 2: Semi-trailers).

2.7 When canvas covers are used, they should be checked as being in satisfactory condition and capable of being secured. Loops or eyes in such canvas which take the fastening ropes, as well as the ropes themselves, must be in good condition.

2.8 When loading swap-bodies, it should be borne in mind that in most cases, the bottom and floor of swap-bodies are the main areas of their structural strength.

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1 International Convention for Safe Containers (CSC), published by the International Maritime Organization (IMO).

2 International Union of Railways (UIC).

3 Interior inspection

3.1 A CTU should be weatherproof unless it is so constructed that this is obviously not feasible. Previous patches or repairs should be carefully checked for possible leakage. Potential points of leakage may be detected by observing if any light enters a closed unit. In carrying out this check, care should be taken to ensure that no person becomes locked inside a unit.

3.2 A CTU should be free from major damage, with no broken flooring or protrusions such as nails, bolts, special fittings, etc. which could cause injury to persons or damage to the cargo.

3.3 Cargo tie-down cleats or rings, where provided, should be in good condition and well anchored. If heavy items of cargo are to be secured in a CTU, the forwarder or shipping agent should be contacted for information about the cleat strength and appropriate action taken.

3.4 A CTU should be clean, dry and free of residue and persistent odours from previous cargo.

3.5 A folding CTU with movable or removable main components should be correctly assembled. Care should be taken to ensure that removable parts not in use are packed and secured inside the unit.

4 Road vehicles

4.1 Drivers are generally responsible for the condition of their road vehicle, however where trailers are left at the packer's facilities, checks should be made to ensure that it complies with national road regulations. These may include:

- brakes
- lights
- tyres
- conspicuity (see Appendix 1)

5 Containers

Containers, because of the handling methods employed, require additional checks and are covered below:

5.1 Damages which might affect the cargo in the CTU or impede effective transport, see Appendix 2

5.1.1 General:

- odour, infestation, debris
- vents blocked, not weathertight or missing

5.1.2 Floor:

- delamination of floor planks
- holes other than nail holes

5.1.3 Side panels, front panel, roof:

- dents into cube which reduce the internal width by more than 50 mm from inner corrugation or more than 70 mm from the floor to roof inner corrugation
- dents exceeding the outer face of corner castings more than 40 mm
- panels holed, torn or cut

5.1.4 Lashing rings:

- rings broken, cracked, missing or non-functional

5.1.5 Door:

- door holed, torn or broken
- missing or broken parts affecting door operation or weathertightness

5.1.6 Understructure:

- cross members bowed up by more than 50 mm or below line of corner castings

5.2 Damages which might impede safe transport of the CTU (structural deficiencies)

5.2.1 Top rail:

- local deformation to the rail in excess of 40mm
- separation or cracks or tears in the rail material in excess of 10mm in length.

5.2.2 Bottom rail:

- local deformation perpendicular to the rail in excess of 60mm
- separation cracks or tears in the rail's material:
  a) of flange in excess of 25mm in length or
  b) of web in any length

5.2.3 Header:

- local deformation to the header in excess of 50mm
- cracks or tears in excess of 10mm in length

5.2.4 Sill:

- local deformation to the sill in excess of 60mm
- cracks or tears in excess of 10mm in length

5.2.5 Corner posts:

- local deformation to the post in excess of 30mm
- cracks or tears in any length

5.2.6 Corner and intermediate fittings:

- missing corner fittings
- any through cracks or tears in the fitting
- any deformation of the fitting that precludes full engagement of the securing or lifting fittings
- any weld separation of adjoining components
- any reduction in the thickness of the plate containing the top aperture that makes it less than 26mm thick

5.2.7 Understructure:

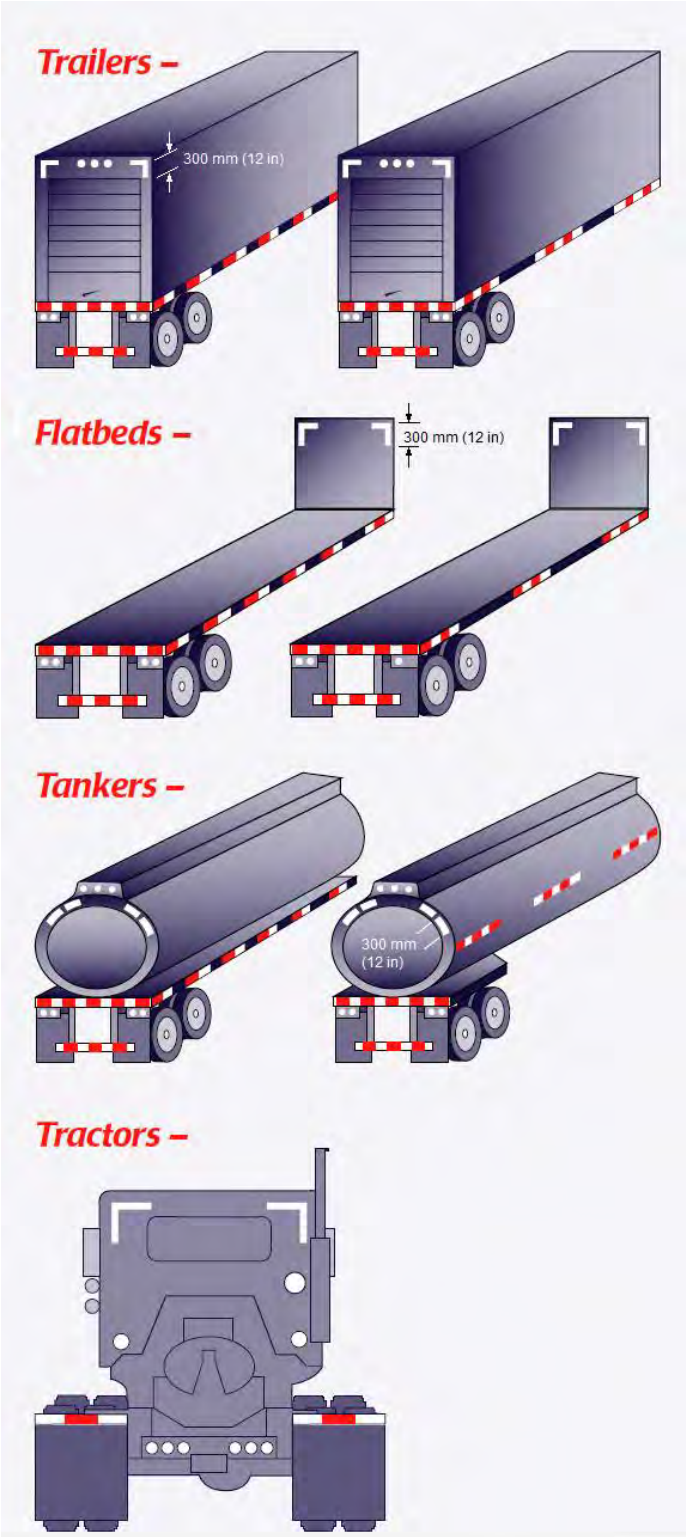
- one or more cross members are missing or detached.

5.2.8 Door:

- one or more locking rods are non-functional

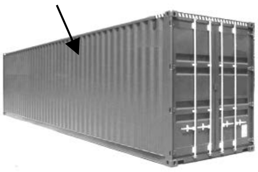
Appendix 1. Conspicuity requirements for road vehicles

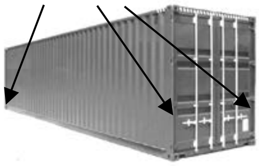
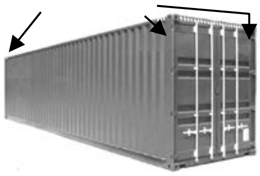
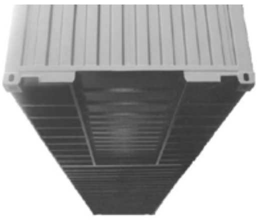
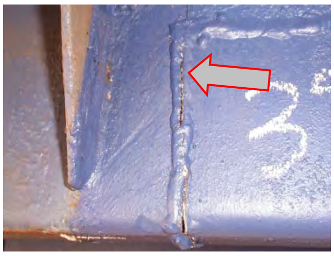
National regulations require the use of conspicuity materials (i.e., retro-reflective sheeting (or reflex reflectors)) on trailers and the rear of truck tractors. The rules are intended to reduce the incidence of motorists crashing into the sides or rear of trailers at night time and under other conditions of reduced visibility, and to reduce the incidence of motorists rear-ending truck tractors (being operated without trailers) under the same conditions.



Appendix 2. Container condition chart

The table below pictorially demonstrates some conditions where a container should not be used. If there is concern about the container's condition and suitability, please contact the CTU operator.

Item	Description
Top Rail 	  **Unserviceable** **Corroded and Unserviceable** Top side rails are generally made from 60mm square tube or a 60 x 15 mm flat bar. Punctures and deformations in the top or outer face of the square tube are generally not a cause for stopping a container. Deformation less than 60 mm to the flat bar will generally cause secondary damage to the side panels which does not constitute a safety risk.
 Bottom rails	   **Do Not Move** **Severe but Serviceable** **Bent but Serviceable** Bottom side rails provide the main strength of the container and damaged to this component can have severe consequences to the integrity of the container. However single deformations more than 50 mm (2”) and less than 100 mm (4”) should be inspected for other damage but may be allowed to proceed. If the side rails are bent downwards due to overloading, then the container may proceed to its destination so long as three of the corner fittings can be clamped down to the chassis.
Headers 	   **Unserviceable** **Unserviceable** **Corroded but serviceable** Tears and weld failure fittings to the top header (front or door end) near to the corner reduce the transverse racking strength of the container and therefore should not be stacked in a loaded state on board a ship.
 Sills	   **Unserviceable** **Do Not Move** **Unserviceable** The two unserviceable containers may be moved in a loaded state. The crack on the right hand picture is on the corner to the steel tube and can be difficult to see. If there are cracks adjacent to two or more corner fittings then the cargo should be re-stowed in a safe container before onward transportation.

<table>
<tr>
<td>Corner Posts
</td>
<td>
Unserviceable
Stacking loads are generally increasing and all of the load is transferred through the corner posts. Single large deformations are an obvious indication of a risk of failure. However a number of smaller deformations in the same post could increase the risk of failure and if there are three or more deformations in the same post, then the container should be examined prior to allowing the container to be stacked on board a ship.</td>
</tr>
<tr>
<td>Corner and intermediate fittings (Castings)
</td>
<td> 
Corroded but Serviceable Unserviceable
If two or more bottom corner fittings on a single container are found to be unserviceable, then the container should not be moved and the cargo re-stowed in a safe container.</td>
</tr>
<tr>
<td>
Understructure</td>
<td>  
Bent but serviceable Screw fixing still attached Bent but serviceable
All the examples shown above are serviceable although severely bent as the floor fixing screws are intact. Crossmembers that have become detached from one of the bottom side rails should be secured to prevent it from becoming totally detached and / or injuring people nearby.
 
Looks serviceable, but cracks in the repairs renders this container unserviceable
A line of insert repairs on adjacent cross members indicate that the floor has been overloaded and the crossmembers bent. The repairs have not been completed satisfactorily and the welds have developed cracks. If there are cracks on three or more adjacent then this container should not be lifted when loaded with a cargo.</td>
</tr>
</table>

<table>
<tr>
<td>Locking rod assemblies and Door Hardware</td>
<td>

Do Not Move

Do Not Move

Do Not Move
The door assemblies and hardware are important for retaining the cargo within the container and missing doors, broken hinges / hinge pins (centre picture) or lockrods that cannot be locked closed increase the risk of the doors “bursting” open and releasing the cargo. Containers where the doors are at risk should not be moved with cargo.
Note: in some instances the right hand door may be removed and the cargo retained by a suitable retaining temporary bulkhead for specific cargoes. Container with the door removed may be permitted to continue its journey if the Safety Approval Plate is marked that it has been tested in that state.
</td>
</tr>
<tr>
<td colspan="2">
The International Convention for Safe Containers (CSC), 1972, allows Control Officers to verify that the container carries a valid Safety Approval Plate as required by the Convention, unless there is significant evidence for believing that the condition of the container is such as to create an obvious risk to safety. Packers should be aware that containers may be stopped if Control Officers identify such deficiencies.
Many containers are covered by an Approved Continuous Examination Programme (ACEP) maintenance scheme and will have an ACEP reference number on or near the Safety Approval Plate. If there is no ACEP marking then the container should be covered by Periodic Examination Scheme. The Periodic Examination Scheme requires that the container is thoroughly examined every 30 months and a decal applied to show the Next Examination Date (NED). Failure to display either may contravene the requirements of the Convention but does not necessarily mean that the container is unsafe. Such containers should be examined and a NED applied prior to the container being moved internationally.
Where a container is considered to have a defect which could place a person in danger, then it should not be used for transport. Control Officers have the ability to permit the container to moved (e.g. to a place where it can be restored to a safe condition, or to its destination) if found to be in an unsafe condition, however this will not include international transport in where the container is packed.
It should be noted that:

this chart is not exhaustive for all types of containers or all possible deficiencies or combination of deficiencies
damage to a container may appear serious without creating an obvious risk to safety. Many damages such as holes may infringe customs requirements but may not be structurally significant; and
major damages may be the result of significant impact which could be caused by improper handling of the container or other containers, or significant movement of the cargo within the container. Therefore, special attention should be given to signs of recent impact damage.

</td>
</tr>
</table>

Annex 12.Receiving CTUs

1 Introduction

1.1 This annex covers a number of actions, activities and safety advice for persons involved in the reception and unpacking of a CTU.

1.2 When receiving a CTU, the consignee should:

1.2.1 confirm that the unit is as specified on the transport documentation, checking the CTU identification reference as shown in Figure 12.1. If the identification reference shown on the documentation is not the same as that on the CTU, do not accept it until confirmation is received from the shipper that the CTU is destined for you.

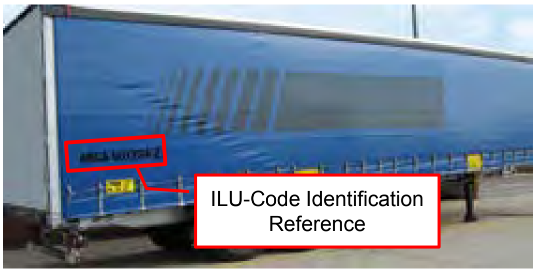


Figure 12.1 Three examples of CTU identification references

1.2.2 inspect the seal, if fitted. Inspecting a seal requires visual check for signs of tampering, comparison of the seal's identification number with the cargo documentation, and noting the inspection in the appropriate documentation. If the seal is missing, or shows signs of tampering, or shows a different identification number than the cargo documentation, then a number of actions are necessary:

1.2.3 The consignee should bring the discrepancy to the attention of the carrier and the shipper. The consignee should also note the discrepancy on the cargo documentation and notify Customs or law enforcement agencies, in accordance with national legislation. Where no such notification requirements exist, the consignee should refuse custody of the CTU pending communication with the carrier until such discrepancies can be resolved.

2 Positioning CTUs for packing

2.1 Wheeled operation

2.1.1 Road trailers and containers on chassis can be left at the packer's premises for a period of time without a tractor unit. When this happens, the correct positioning of the CTU is particularly important as a safe shifting of the CTU at a later stage might be difficult. After positioning, brakes should be applied and wheels should be chocked.

2.1.2 Trailers with end door openings and general purpose containers on chassis can be backed up to an enclosed loading bay or can be positioned elsewhere in the premises. For this type of operation a safe access to the CTU by means of suitable ramps is required.

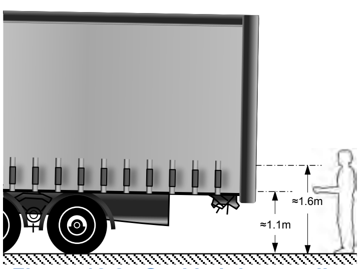


Figure 12.2 : Seal heights - trailer

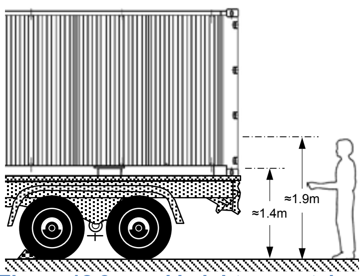


Figure 12.3 : seal heights - container

2.1.3 When a semi-trailer or a container on a chassis is to be packed, care should be taken to ensure that the trailer or chassis cannot tip while a lift truck is being used inside the CTU.

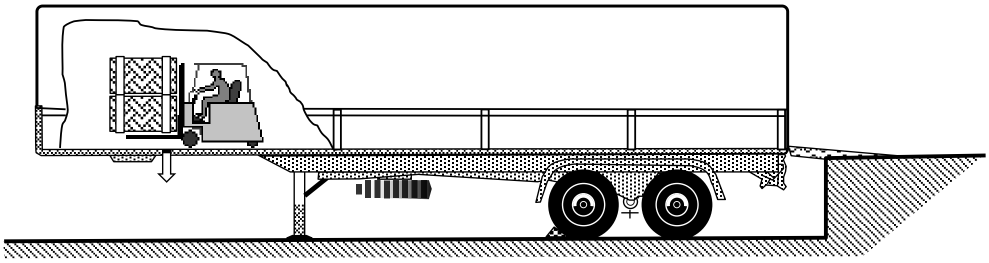


Figure 12.4 : Inadequate support of a trailer

If there is a risk for forward tipping the semi-trailer or chassis should be sufficiently supported by fixed or adjustable supports.

Figure 12.5 : Fixed support

Figure 12.6 : Adjustable support

2.2 Grounded operation

2.2.1 Containers may be unloaded from the delivery vehicle and be placed within secure areas for packing. The area should be level and have a firm ground. Proper lifting equipment is required.

2.2.2 When landing containers it should be ensured that the area is clear of any debris or undulations in the ground that may damage the under-structure (cross members or rails) of the container.

2.2.3 As container doors may not operate correctly when the ground is not level, the door end of the container should be examined. When one corner is raised off the ground, when the doors are out of line (see Figure 12.7) or when the anti racking plate is hard against one of the stops, the container doors should be levelled out by placing shims under one or other corner fitting, as appropriate.

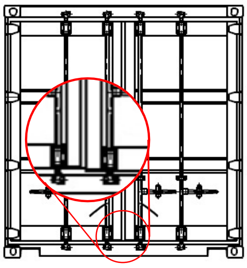


Figure 12.7 : Racked container

2.2.4 When a swap-body standing on its support legs is to be packed, particular care should be taken to ensure that the swap-body does not tip when a lift truck is used for packing. It should be checked that the support legs of the swap-body rest firmly on the ground and cannot shift, slump or move when forces are exerted to the swap-body during packing.

Figure XII.8 : Swap body landed on support legs

3 Removing seals

3.1 Stance

3.1.1 The height of the door handle and the seal varies depending on the type of CTU and the design of the door. Rigid vehicles and trailers are generally lower within a range 1.1 and 1.6m from the ground. Containers carried on a trailer will have the security cam fitted seal approximately 1.4m from the ground, but the handles and any seals attached to them at a height of approximately 1.9m

3.1.2 Seals attached to handles on containers doors (approximately 1.9m above the ground) will be about head height for the average person and attempting to cut through a bolt seal at that height is likely to result in a musculoskeletal injury.

3.1.3 The best posture for cutting seals is for the operator to stand upright with the angle at the elbow between 90° and 120° and the elbow in line or slightly forward of the body.

3.1.3.1 Avoid positions where the elbows are behind the body or above the shoulder.

3.1.3.2 When gripping the cutting tool, the wrist should be kept as straight as possible.

3.1.3.3 The best position of the cutting head will be approximately 0 to 15 cm above the height of the elbow. The height above ground level to the elbow for the average (western) man is 109 cm. This means that the best position for the seal will be between 109 and 124 cm (1.09 and 1.24m) above standing level.

3.1.4 Figure 12.9 shows a typical example of how many seals are actually cut. The operator has his back bent, the seal is well below the height of the elbow, the arms are almost straight and the left wrist is cocked, while the right appears to be straight.

Figure 12.9 Cutting the seal

3.1.5 The length of the bolt cutter levers are very long compared to the movement of the cutting blades, therefore the hands have to "squeeze" in a considerable distance.

3.1.6 Cutting resistance is high as the blades start to cut and reduces to grow again as the cut finishes. Therefore while the hands are wide apart the greatest inwards pressure is required.

3.2 Height adjustment

3.2.1 The normal height for the seals above ground level is between 1.09 and 1.24 m. This means that a normal person when cutting the lower seal position of a container mounted on a trailer and with an ideal stance would have their feet approximately 16 cm above ground level. For the higher seal position the foot position would be about 50 cm above the ground.

3.2.2 It is essential that the operator is able to gain a firm footing when cutting the seal. This may require the legs to be spread both laterally and longitudinally. The footing should be:

- non-slip
- level
- free from debris and loose items

There should also be no trip hazard or risk of the operator falling.

3.2.3 For cutting the seal at the lower position a single pallet with a plywood panel fixed to the top, or two pallets stacked with a plywood panel, all fixed together so that there is no risk of the items sliding independently would provide a suitable platform. However there is a risk of the operator accidentally falling from the platform during the cutting operation.

3.2.4 To access the highest seals, the use of a propriety platforms with a narrow work platform width may not allow the operator to stand comfortably and safely, the depth may not be sufficient. A second platform with a plywood panel fixed to both will allow sufficient area for the operator to stand and operate the bolt cutters safely (see Figure 12.10). Such platforms should also be fitted with fall protection by way of barriers.

Figure 12.10 Work platform

Figure 12.11 : Mobile work platform

Figure 12.12 : Mobile work device

Figure 12.13 : Mobile work station

3.2.5 Mobile work platforms similar to the one shown in Figure 12.11 may be rather more sophisticated than is required and a smaller version may be more appropriate. As an alternative a simpler device that can be fitted to the tines of a fork lift truck as shown in Figure 12.13.

3.2.6 The important feature of a mobile work platform is that they can be adjusted to exactly the correct height, has a platform of sufficient area and provides the operator with full fall protection.

3.2.7 A ladder can be used, but this is not a really suitable platform for cutting with large bolt cutters. For smaller cutters they may be used with care.

3.2.7.1 When carrying out a task using a ladder or a step ladder it is essential that three points of contact (hands and feet) are maintained at the working position. Since both hands are required to cut the seal using the bolt cutters, the third point of contact can be substituted by leaning the chest on the ladder or step ladder.

3.2.7.2 Working on a ladder or step ladder should not involve any side loading which necessitates twisting of the body, therefore it is improbable that a ladder can be positioned so as to comply with these requirements and provide sufficient room for the bolt cutters to be operated correctly.

3.2.7.3 Therefore if there is a choice only between a ladder and a step ladder the step ladder will probably provide the better work position.

3.2.8 The diagram Figure 12.14 shows the correct position for the operator with the bolt cutters held between the step ladder and the CTU.

3.2.9 In this position there is still a risk of the ladder falling sideways as the cutters are squeezed in, therefore the operator should be supported by a co-worker or the step ladder secured to prevent if falling or sliding.

3.2.10 A safer solution is to use wide mobile steps with a top platform should be sufficiently wide and deep to permit the operator to stand safely.

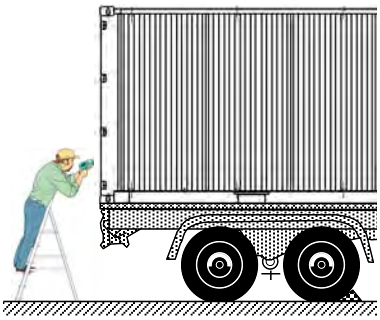


Figure 12.14 : Working on container doors

4 Preparing to open the doors

4.1 External Checks

4.1.1 Once the seal has been removed the CTU doors may be opened, however before doing so, a few more checks should be made.

4.1.1.1 Check the exterior for signs, marks or other labels that may indicate that the cargo may put those involved in unpacking the CTU at risk.

Figure 12.15 : Flexitank label

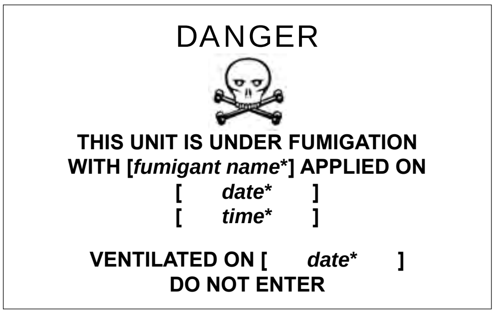


Figure 12.16 : Fumigation label

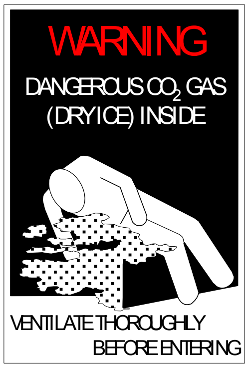


Figure 12.17: Dangerous atmosphere label

4.1.1.2 The labels shown above indicate that opening the doors must follow a particular process. Only the right hand door on a CTU carrying a flexitank should be opened (Figure 12.15). Cargo spaces that have been fumigated (Figure 12.16) or where there is CO_2 gas should be opened and ventilated before entering the CTU (Figure 12.17).

4.1.2 Dangerous Atmospheres

4.1.2.1 CTUs carrying dangerous goods also should be opened with care as there is a risk that the carrying packages have been damaged and the goods spilled.

4.1.2.2 Check the Material Safety Data Sheet (MSDS) especially the sections on inhalation and skin contact to identify the risks should the packaging be damaged. These risks should be considered when the doors are first opened.

4.1.2.3 While most shippers will endeavour to comply with dangerous goods regulations, there are many cases where, perhaps through a lack of knowledge, dangerous gases accumulate within the CTU.

4.1.2.4 Fumigants are highly toxic. Cargoes most likely to have been fumigated include foodstuffs, leather goods, handicrafts, textiles, timber or cane furniture, luxury vehicles and cargo in timber cases or on timber pallets from the Far East.

4.1.2.5 Containers transported under fumigation are required to be labelled and declared in accordance with the International Maritime Dangerous Goods Code. However, absence of marking cannot be taken to mean fumigants are not present. Containers marked as having been ventilated after fumigation may also contain fumigant that was absorbed by the cargo and released during transit.

4.1.2.6 However in practice not all containers that have been fumigated will have a warning label. Therefore a check of the doors or vents on the container side walls may assist. Tape applied to the door gaskets or the vents (see Figure 12.18) may be taped over indicating that there is a risk of a fumigant being used recently.

Figure 12.18 : Vent tapped over

4.1.2.7 In addition to the presence of fumigants, toxic gases associated with the cargo's manufacturing process have been found in dangerous levels, for example shoes may have high levels of toluene[1], benzene[2] and 1.2 dichloroethane[3].

4.1.2.8 In the short term, vapours irritate the eyes, the skin and respiratory tract. Inhalation of vapours can cause pulmonary oedema. The substance can have an effect on the central nervous system, the kidneys and the liver, causing functional deficiency.

4.1.3 If there are concerns that there are signs of a dangerous atmosphere, sampling the air inside the CTU before opening could be considered.

5 Measuring Gases

5.1 Surveys carried out in Europe from 2007 until 2012 found a number of undeclared gases carried in CTUs. Many of the gases are dangerous and would constitute a severe risk to those involved in unloading.

5.2 The person who controls the opening and entry of containers should always check the chemical properties and the threshold limit value (TLV) of the relevant chemical, referring to their own national standards and guidelines where they exist.

5.3 Unfortunately, one cannot rely on ones sense of smell as most of these gases will be well above their TLV by the time they can be detected. The only practical way is to take air samples. In the open this is very difficult. Initially, a device that identifies the gas is required before the concentration of the gas can be measured.

5.4 The simplest and easiest way to measure the internal atmosphere is to use a readily available detector tube device. Do not open the CTU but gas can be sampled by forcing a solid tube in through the door gaskets (see Figure 12.19).

Figure 12.19 : Sampling gas

5.5 There is no device available that can detect all hazardous gases, therefore one measurement will not provide sufficient information about the internal atmosphere and multiple tests will be required.

5.6 The risk of hazardous gases in CTUs is relevant to all parties in the supply chain. The causes of these gases can be attributed to internal business processes in manufacturing or by actions performed on behalf of third parties (service providers and logistics companies).

5.7 Action plans for testing and reacting to hazardous gases in CTUs may be drawn up by companies to protect their employees from the effects of these gases when opening and unpacking them. The companies producing the actions plans may not be the ultimate consignee of the goods, but may be responsible and authorisation for opening and unpacking the CTU earlier in the supply chain.

5.8 It should be remembered that hazardous gases may be introduced into the CTU by:

- deliberately adding gases to prevent deterioration of the goods by pests;
- emissions of substances used in the manufacture of products or dunnage;
- chemical or other processes in the cargo.

5.9 In addition, incidents may occur that permit the release of gases from declared or undeclared dangerous goods being carried.

[1] Toluene - Hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation. Slightly hazardous in case of skin contact (permeator).

[2] Benzene - Very hazardous in case of eye contact (irritant), of inhalation. Hazardous in case of skin contact (irritant, permeator), of ingestion. Inflammation of the eye is characterized by redness, watering, and itching.

[3] 1,2-dichloroethane is toxic and an irritant, whatever the means of absorption

6 Opening the doors

6.1 Unstable or poorly packed cargoes may be pressing against the doors which may be forced open when the door gear is released, or the cargo may fall out once the doors are opened.

6.2 The first action for steel doors is to “ring” them - that is to tap the flat surface of both doors. If the sound is dull and there is no resonance then it is likely that the cargo will be resting against the door. Extra care should be taken when opening the door.

6.3 If there is a risk that the cargo is resting against the doors or the CTU contains bulk materials, a safety chain can be fitted across the doors, from top to bottom corner fitting (see Figure 12.20). This technique can be also used on CTUs without corner fittings by applying a chain from an anchor point on each side or using a shorter chain attached to the locking bars. The length of the chain should be long enough to permit the doors to open but short enough so that the doors cannot open more 150 mm (6 in).

Figure 12.20 : Safety chain

6.4 If a diagonal chain cannot be fitted, then a loose strap across the inner lock rods may be used. If there is no facility for attaching the strap, or strap available the person opening the doors should always open the doors with caution.

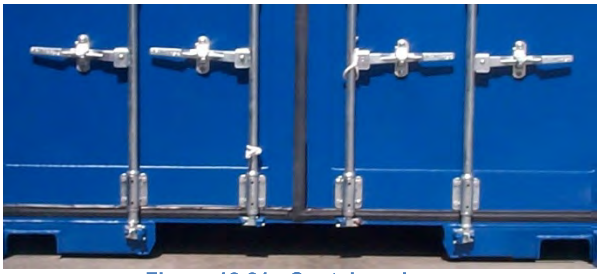


Figure 12.21 : Container doors

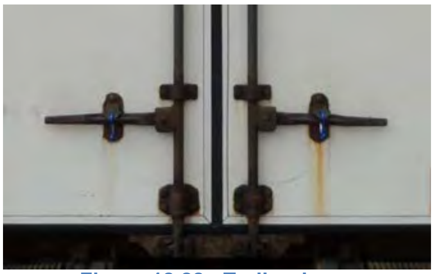


Figure 12.22 : Trailer doors

Figure 12.23 : Trailer doors

6.5 Handles for CTUs vary, some will have one locking bar, others two and the handle design may be a bar or a formed handle, as shown in Figure 12.21 to Figure 12.23.

Figure 12.24 : Handles on same side

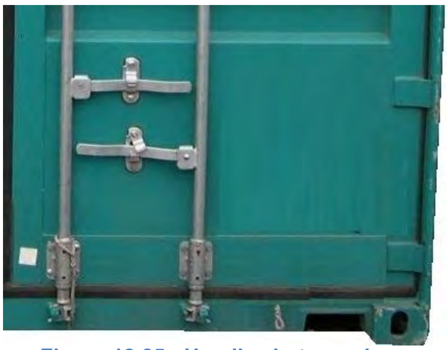


Figure 12.25 : Handles between bars

6.6 They may be in the format where the handle is on the same side of the locking rod (Figure 12.24) or between the rods (Figure 12.25).

6.7 Most CTU doors open easily by rotating the handles approximately 90° and then pulling on the handles of locking bars. The action of rotating the bars will mean that the cams push against their keepers and force the door open.

6.8 Figure 12.26 shows the operation of the cams on many containers. Rotating the lock rod (A) will cause the breaker surface of the cam to press against the keeper (B), thus forcing the door open (C).

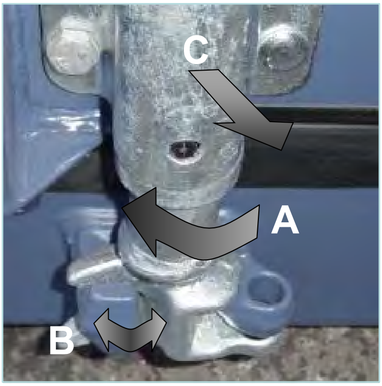


Figure 12.26 : Door cam operation

6.9 Once the lock rods have been fully rotated, adopt an upright stance and grasp the lock rods or the door at about shoulder height or just below and pull backwards using the whole body.

6.10 If the doors do not open easily:

6.10.1 check that the cams are clear of the keepers;

6.10.2 check that the CTU is level and the doors are not binding on the frame;

6.10.3 gain assistance to pull the doors open;

6.11 If one door will not open, and the other door may be opened (i.e. the CTU is not carrying a flexitank), then both doors could be opened at the same time which may make opening the doors easier.

6.12 As the door opens be prepared to step back quickly if:

6.12.1 the contents of the CTU start to fall out; or

6.12.2 the door appears to be pushing you, not you pulling the door.

6.13 If you need to step out of the way move away from the hinged side of the door.

6.14 Doors in the various types of CTU may open with different degrees of difficulty. The following contribute to this difficulty:

6.14.1 Corrosion to the door component and hinge pins

6.14.2 Damage to the door component, including door gear, or corner post resulting in the misalignment of the hinges.

6.14.3 Condition of the gaskets which does not seat properly on the door.

6.14.4 Racking of the CTU. Many CTUs rely on the doors to hold the rear end of the CTU square. If the CTU is placed on uneven ground the CTU may rack and the doors become mis-aligned (see Figure 12.27)

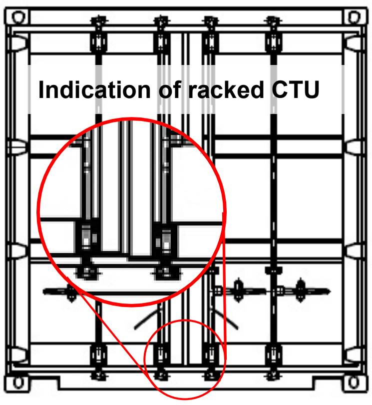


Figure 12.27 : Racked CTU

6.15 Once the doors are free to swing and there is no risk on injury caused by the cargo falling out, walk the doors through 270° and attach the retaining strap to the hook to prevent the door from swinging.

6.16 DO NOT ENTER THE CTU YET


Figure 12.28 : Door retaining strap

7 Ventilation

7.1 Introduction

7.1.1 Closed CTUs are enclosed spaces and care should be taken before entering. Even without toxic gases and other asphyxiates oxygen supply may be depleted which could make normal breathing difficult. Ventilating a CTU will allow fresh air to circulate into the CTU and around any cargo carried.

7.1.2 It is a risky activity and it is important that CTUs are ventilated responsibly. The person who opens and closes the doors must be aware of the possible risks involved and, if required, wear personal protective equipment (PPE). The selection of the appropriate PPE will depend on measurements taken to determine the concentration and toxicity of the gases within the CTU and may require a combination of breathing apparatus and skin protection.

7.2 Planning

7.2.1 When ventilating CTUs a number of factors will determine the action required:

7.2.1.1 The concentration of the gas. The greater the concentration the longer the CTU will require for ventilation.

7.2.1.2 The nature of the gas. Some gases are very light and volatile and will evaporate quickly. Others are less volatile and / or adhere to the cargo, such as methyl bromide and 1,2-dichloroethane. The time for ventilation will need to be decided upon accordingly. It may not be possible to completely remove traces of gases that adhere to the cargo and the CTU may only be declared clean and safe to enter after the cargo has been removed and the CTU washed.

7.2.1.3 Ambient temperature. Higher temperatures will generally permit faster evaporation thus reducing the time to declare the CTU safe to enter. At lower temperatures, some fumigants stop working and remain inert until the temperature again rises. This can mean that the correct volume of a fumigant for the journey initially applied in a hot packing location which then passes into a colder area may arrive at the destination with high levels of fumigant still remaining in the CTU.

7.2.1.4 The size of the CTU. A 12m long CTU has approximately twice the internal volume of a 6m unit, and if the doors are only at one end, the circulation of gas has to travel considerably further.

7.2.1.5 The loading method. A CTU that has been tightly packed and is especially full will be more difficult to ventilate than one with many gaps and “open air” around the packages.

7.2.1.6 The nature of the cargo. Cargo that absorbs gases, such as mattresses and clothes, requires more time for ventilation than hard surfaced products. Absorbent materials hermetically sealed within a plastic or similar cover will not require the same time to ventilate as an uncovered item.

7.2.1.7 Packing material used. Absorbent packing materials will require extra time for any gases to leach out. Such materials may require special disposal to meet local environmental regulations.

7.3 Ventilation of containers can happen in two ways, natural or forced ventilation.

7.3.1 Natural ventilation:

7.3.1.1 This can be done by simply opening the doors.

7.3.1.2 In some countries local regulations require an environmental permit for opening CTUs with high concentrations of dangerous gases. Once the application is received the Competent Authority determines under what conditions the company may ventilate on site. The granting of an environmental permit may take up to 6 months.

7.3.1.3 Estimate the necessary ventilation time in advance. CO, CO_2 or O_2 degassed quickly. At encountering these substances start with a minimum of 2 hours ventilation. For other substances this will be insufficient and it is suggested that the CTU is ventilated for at least 24 hours. Record start and end time.

7.3.2 Forced ventilation

7.3.2.1 To carry out forced ventilation or degassing there are several possibilities. A few examples:

- Powerful fans, one or more fans directing air into and / or out of the CTU will stimulated the circulation of gases within the CTU.
- A “degassing door” (Ventilation & Gas Recapture System). This door will completely seal off the CTU and is fitted with two sealable openings. When for example air is blown through the top opening and is extracted at the bottom the unwanted gas disappears with the air from the CTU. At the end of the hose where the air from the CTU comes out, a suitable filter can be placed so the gases don’t end up in the environment.

7.3.2.2 The advantage of forced ventilation is that it reduces the time necessary to remove high concentration of residual gas, partly because the climatic conditions can be optimised.

7.3.3 General Safety

7.3.3.1 Do not enter the CTU during ventilation.

7.3.3.2 Make sure that during ventilation warning signs or otherwise clearly indicate that the CTU should not be approached or entered. For methyl bromide, phosphine and sulfuryl fluoride, for example, a minimum distance of 20m all around the CTU should be set.

7.3.3.3 Toxic gas concentrations in the cargo space and the cargo itself should be measured and once they fall below the limit(s) the CTU may be released for entry. Carry out additional measurements if the doors are closed without the cargo being unpacked and the interior cleaned for a period of 12 or more hours.

7.3.3.4 The climatic conditions should also be monitored and action taken if:

- the outside temperature falls below 10°C. It is unlikely that ventilation will occur as gases will not evaporate at this temperature.
- there is no wind gases expelled from the CTU will not be diluted into the atmosphere and may linger at the CTU’s doors.

7.3.3.5 A specialist gas removal contractor should be used if:

- the concentration exceeds 6 times the limit
- if phosphine is detected. When opening a CTU or when unpacking or transferring cargo, highly toxic gas may be released as a result of residues of tablets not yet exhausted. In this case, the limit of the substance concerned may be exceeded.

7.3.3.6 Specialist gas removal contractors may move the CTU off site into closed and regulated area. The premises are inaccessible to unauthorised persons and the company guarantees that the cargo is monitored.

7.3.3.7 If in doubt, or for questions always contact a local company who specialises in the ventilation and de-gassing of CTUs.

7.3.4 Environment

7.3.4.1 Remember that toxic gases within the CTU will dissipate into the atmosphere. It should be remembered that the higher the gas concentration the greater the harm to the environment.

7.3.4.2 Consider the waste (residue) as hazardous waste. In practice this means that the waste should be offered to a certified collector to be processed or destroyed.

7.4 Ventilation first, then measure. This means that if the quantity and concentration of a toxic gas is known, then the CTU may be ventilated in accordance with the calculated time without the need for measuring the atmosphere until the ventilation time has expired. As always a test should be carried out before entering the CTU.

8 Returning the CTU

8.1 General

8.1.1 The internal and external cleanliness of CTUs is very important if unnecessary restrictions to their use and movement are to be avoided.

8.1.2 Under the terms of most bills of lading and other transport agreements, it is often the responsibility of the consignee to return the CTU in the same state that it was delivered. This means that the CTU should be:

8.1.2.1 clean. A clean CTU should have all cargo residues, packing, lashing and securing materials marks, signs and placards associated with packing the CTU or the cargo, and any other debris removed. (See Definitions)

8.1.2.2 returned in a timely manner. CTUs in the supply chain and associated road vehicles, if separate, are often schedules for immediate re-use or positioning. CTU suppliers may charge demurrage if the CTU is not returned as soon as practically possible after unpacking.

8.2 Cleanliness

8.2.1 CTUs will generally benefit from a thorough sweep, ensuring that debris and residue are removed from corners and recesses. Consignees are responsible for this as a minimum, but must also remove all signs of the cargo carried. Appropriate respirators and protective clothing should be provided for such work.

8.2.2 If additional cleaning is required the consignees should consider the following techniques:

8.2.2.1 washing – wash the interior of the CTU using a low pressure hose and a scrubbing brush (if required). To remove contamination a suitable additive or detergent can be used.

8.2.2.2 power washing – internal faces using a medium pressure washing device.

8.2.2.3 scraping – areas of contamination can be removed by light scrapping. Care should be taken not to damage the paint work, or flooring.

8.2.3 After a CTU with dangerous cargoes has been unpacked, particular care should be taken to ensure that no hazard remains. This may require special cleaning, particularly if spillage of a toxic substance has occurred or is suspected. When the CTU offers no further hazard, the dangerous goods placards, orange panels. "ENVIRONMENTALLY HAZARDOUS SUBSTANCE (AQUATIC ENVIRONMENT)[4] marks and any other marks or signs should be removed. A CTU that retains these exterior signs and marks should continue to be handled as though it still carried the dangerous goods.

8.2.4 Contamination of the CTU can be found in many different guises:

8.2.4.1 Damage to the interior paint work where the surface finish becomes cracked, flaky or softened by contact with a substance.

8.2.4.2 Stains and wet patches to any part of the container, especially the flooring, which can be transferred to a cloth by light wiping. Small dry stains that do not transfer to the cloth are considered as non-transferrable and may not be considered as contamination.

8.2.4.3 Visible forms of animals, insects or other invertebrates (alive or dead, in any lifecycle stage, including egg casings or rafts), or any organic material of animal origin (including blood, bones, hair, flesh, secretions, excretions); viable or non-viable plants or plant products (including fruit, seeds, leaves, twigs, roots, bark); or other organic material, including fungi; or soil, or water; where such products are not the manifested cargo within the container.

8.2.5 Dunnage, blocks, bags, braces. lashing materials, nails into the floor and tape used to cover vents and gaskets should all be removed.

8.3 Disposal

8.3.1 Local environmental regulations and legislation should be considered when disposing of waste removed from the CTU.

8.3.2 Cargo residues should be removed and disposed of in line with the consignee's procedures.

8.3.3 Wherever possible or practicable, dunnage bags and other materials should be recycled.[5]

8.3.4 Timber dunnage, blocks and braces should be checked for the appropriate IPPC mark, (see Annex 14 section 1.14). Other timber should be disposed of by incineration.

8.3.5 Liner bags and flexitanks are often removed by the supplier; however all will be contaminated and should be disposed of at an appropriate facility.

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[4] Known as Marine Pollutant in SOLAS.

[5] Do not re-use inflatable dunnage bags if they cannot be safely re-inflated.

8.3.6 Pests, animals and other invasive alien species should be disposed of as described in Annex 13 section 5.6.

8.4 Damages

8.4.1 The various types of CTU suffer differing degrees of damage en route. Rail wagons probably do not suffer much handling damage and are only likely to be damaged by poorly secured cargoes. Road vehicles, especially articulated trailers, do suffer from turning and reversing damage as the vehicle is manoeuvred. Containers and swap bodies will suffer from the same manoeuvring damage, but will also suffer from impact damage between other containers and swap bodies and handling equipment.

8.4.2 Drivers of road vehicles will generally report any manoeuvring damage but if the trailer or container has been collected from a terminal, will only be able to report on damages incurred in the delivery phase. Damages incurred earlier in the supply chain may go un-reported unless marked on an interchange document.

8.4.3 The consignee will generally be held responsible for any damage incurred, other than those that have been officially observed and endorsed by the CTU operator. For un-accompanied CTUs this endorsement must be shown on the interchange document. It is therefore important that any signs of damage, including recent damage, should be identified and reported on arrival.

Annex 13.Minimising the risk of re-contamination

1 Introduction

1.1 The delivery of a clean CTU to the packer is of little use if the container becomes re-contaminated during its movement within the supply chain. Appropriate measures should be taken to ensure re-contamination does not occur. This should include:

1.1.1 storing the container an appropriate distance away from pest habitats or resident pest populations (the distance will depend on the pest),

1.1.2 storing the clean container in areas free of risk from re-contamination by vegetation, soil, free standing water or unclean containers,

1.1.3 taking species' specific measures where quarantine pests are nominated by importing countries

1.1.4 fully paved/sealed storage and handling areas

1.1.5 safeguards should be applied in specific situations to prevent attracting pests such as when using artificial lights, or during seasonal pest emergence periods and occasional pest outbreaks

1.2 Where containers are moved to a storage area, packing area, port of loading, or are transiting through another country, prevention measures should be taken to avoid contamination.

2 Definitions

Clean	A clean CTU will be free from: a) any previous cargo residues; b) any securing materials used from previous consignments; c) any marks, placards or signs associated with previous consignments; d) any detritus (waste) that may have accumulated in the CTU; e) pests and other living or dead organisms, including any part, gametes, seeds eggs or propagules of such species that may survive and subsequently reproduce; soil; organic matter; f) all other items covered by contamination, infestation and invasive alien species.
Contamination:	Visible forms of animals, insects or other invertebrates (alive or dead, in any lifecycle stage, including egg casings or rafts), or any organic material of animal origin (including blood, bones, hair, flesh, secretions, excretions); viable or non-viable plants or plant products (including fruit, seeds, leaves, twigs, roots, bark); or other organic material, including fungi; or soil, or water; where such products are not the manifested cargo within the container..
Infestation	Presence in a package or CTU of a living pest that may cause harm to the recipient environment. Infestation includes pathogens, (virus, bacterium, prion or fungus) that may cause infection of plants and / or animals.
Invasive alien species	An alien (non-native) species whose introduction and/ or spread threatens biological diversity "Alien species" refers to a species, subspecies or lower taxon, introduced outside its natural past or present distribution; includes any part, gametes, seeds, eggs, or propgules of such species that might survive and subsequently reproduce. It includes pests and quarantine pests of non-native origin. Invasive alien species may be carried within and on a wide range of substrates, both organic and inorganic
Pest	Any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products.
Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially approved.
Re-contamination	The result of pests and other living organisms (including their nests, eggs, egg sacks, and body parts) being found in or on a clean CTU.

3 Safeguards

3.1 Artificial lighting

Container and other storage yards are often illuminated a number of high light pylons / towers. These are normally fitted with gas discharge lamps. Due to the height of the towers and the area that they illuminate the lights are generally “bright” and therefore can attract insect and other pests from some distance.

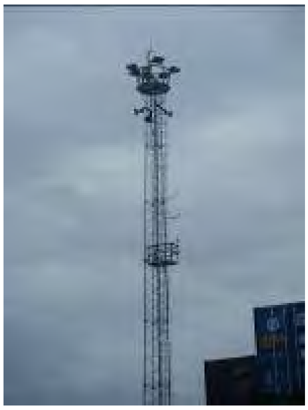


Figure 13.1 : Lighting tower

3.1.1 Lights That Attract

Lights that radiate ultraviolet and blue light attract more insects than other types of lights. Examples of these types of lights include black lights, metal halide and fluorescent. Lights that generate heat may attract insects.

3.1.2 Less Attractive to Bugs

Yellow incandescent, high-pressure sodium and regular incandescent light radiate less blue and ultraviolet light, thus reducing the attraction of insects to the area.

3.1.2.1 Low-Pressure Sodium Lights

Low-pressure sodium lights do not attract insects. They are efficient, and give off an orange-yellow light. The light gives off less light pollution at night, and is better for stargazers. The light will change the appearance of colours it illuminates, though, because of its orange-yellow glow.

3.1.2.2 LED Lighting

New versions of light-emitting diode, or LED, lighting are more efficient and attract fewer flying insects than other traditional lighting. LED lighting has a long lifespan, but can be more expensive for municipalities to install initially. LED lamps are more directional and give off less light pollution.

3.1.3 Considerations

Yard lights that do not give off ultraviolet radiation are considered less attractive to flying insects. Some bugs are attracted to the heat emitted from incandescent street lighting. Some bugs will be attracted to any light, which is called positively phototactic. Some insects, like moths, use light for navigation. Moths use the light from the moon, but when they encounter a brighter source, they move toward it.

3.2 Seasonal pest emergence

3.2.1 In any given landscape, there may be hundreds of species and cultivars of native and exotic trees, shrubs, and garden plants. Throughout the growing season, these plants may be attacked by a similarly diverse assortment of insects, including wood borers, leafminers, scale insects, plant bugs, and leaf-feeding caterpillars.

3.2.2 Timing is everything when managing landscape pests. To be effective, insecticides or biological controls must be applied when pests are present and at their most vulnerable life stage. For example, scale insects are best controlled after the eggs have hatched but before the crawlers have formed a protective cover. Controlling wood borers requires treating host trees with insecticides to intercept the newly hatched larvae before they have penetrated the bark. Leaf-feeding caterpillars such as bagworms and tent caterpillars are easiest to control when the larvae are small. Timing is especially important when using short-lived materials such as summer oils, soaps, and Bacillus thuringiensis (BT).

3.2.3 Frequent in-field inspection is the most reliable means to detect insect problems and time control efforts. Unfortunately, regular monitoring is too time-consuming for many landscape managers. Field workers may not know when or where to look for vulnerable life stages or may not recognize them when encountered. Pests such as the holly leafminer, honeylocust plant bug, and potato leafhopper feed in advance of any recognizable damage. Pheromone traps are available for monitoring certain insects (e.g., clearwing borers) but require time and expertise to use effectively.

3.3 Forecasting Using Plant Phenology

3.3.1 Phenology is the science dealing with the effects of climate on seasonal biological events, including plant flowering and insect emergence. Insects are cold-blooded, and like plants, their development will be earlier or later depending on spring temperatures. Since both plant and insect development are temperature-dependent, seasonal appearance of particular insect pests should follow a predictable sequence correlated with the flowering of particular landscape plants. In a three-year research project[1] , the seasonal development and emergence of 33 important insect pests were systematically monitored and tracked resulting in the creation of the timetable below. This information would help landscape managers and lay persons anticipate the appearance of important insect pests and effectively schedule control measures.

3.3.2 Using this science it is possible to develop a table which predicts the sequence and date of emergence of particular insects, pests or other species that could constitute a biotic threat if transported overseas. Seasonal emergence of each pest is correlated with the flowering of 34 familiar landscape plants.

3.4 Occasional pest outbreaks

3.4.1 Occasional invaders are insects and other arthropods that sporadically enter facilities and in particular CTUs, sometimes in large numbers.

3.4.2 By far the most common problem with occasional invaders is that they become an annoying nuisance. Some can bite, pinch, secrete foul odours, damage plants, stain indoor furnishings, and damage fabrics. Even after they are dead, the problem may continue. The bodies of dead insects can attract other pests that feed on them, and the bodies, shed skins, secretions and faeces of insects can cause allergic responses and trigger asthma.

3.4.3 Whether they're insects, mites or arthropods, occasional invaders typically live and reproduce outdoors. They invade structures when conditions indoors are better for them than outdoor conditions. It is important to know the conditions that prompt invasions of unwanted pests. Altering environmental conditions can make structures inhospitable for pests, and is an important component of integrated pest management.

3.4.4 How to stop occasional invaders

3.4.4.1 Exclusion is the first step to prevent all occasional invaders. Exclude them by ensuring that CTU doors are kept closed and that the seals are properly position. However, the vents found on many CTUs will permit insects to gain entry. It is therefore important to inspect CTUs interiors before use and / or movement.

3.4.4.2 Habitat modification is another important control method. A plant-free band of rock, gravel or other inorganic material extending away from the facility essentially puts a barrier between occasional invaders and the CTUs. Organic material, such as soil, leaves, mulch, bark, grass and ground covers, retain moisture which attracts pests and also provides food and shelter for them. Leaky pipes, faucets, misdirected downspouts and faulty grades can also provide moisture that attracts not just occasional invaders but many other pests including termites. The environment around a structure also can be manipulated by reducing outdoor lighting. Mercury vapour lights can be replaced with sodium vapour lights which are less attractive to insects. Low-wattage, yellow "bug light" bulbs can be used and shielded to reduce pest attraction. Indoors, windows and doors should be shaded so little or no light is visible from outside.

3.4.4.3 Various mechanical controls also can be employed. When pests enter in significant numbers, it is best to remove them with a vacuum cleaner. After vacuuming, seal them in bags and dispose of them promptly. Pests that cluster outdoors can sometimes be deterred, or at least discouraged, by spraying them with a water hose.

3.4.4.4 Traps are another useful mechanical control. Insect monitors, or sticky traps, can be purchased at local hardware stores, home and garden centres, from some pest control suppliers, or through the Internet. Sticky traps are simply cardboard with an adhesive that pests stick to when walking across them. When positioned indoors at likely entry points, on either side of doors, for instance, they can help monitor for pest intrusions. When numerous pests are caught on sticky traps in the garage, it may be time to apply additional methods before things get worse.

3.4.4.5 For pests attracted to lights, commercial light traps can be used, or makeshift light traps can be assembled for rooms where invaders congregate. Surround the lights with sticky traps.

[1] Timing Control Actions for Landscape Insect Pests Using Flowering Plants as Indicators, G.J. Mussey, D.A. Potter, and M.F. Potter: Department of Entomology, College of Agriculture, University of Kentucky.

3.4.5 Chemical control with pesticides also can be integrated into pest management plans, but consider using pesticides only after other methods fail. Baits, dusts and granular formulations, can be used in some situations (see discussions above). Total-release aerosols (known as “bombs” or “foggers”) are generally of little use in combating occasional invaders. These products may not penetrate deeply enough into cracks and voids to contact the pests hiding there. Pesticide application directly into nooks and crannies that harbour pests such as boxelder bugs and lady beetles is also often recommended, but treatment of wall and window frame voids, above false ceilings, etc., can be counterproductive. First, pests killed in these spots are often difficult to remove and are attractive to pests that feed on dead insects. Also, when exposed to accumulations of insects, some people develop allergic reactions to the insect fragments, shed skins and faeces. As an alternative to the direct treatment of voids, pests can be allowed to overwinter in them and emerge when temperatures warm up, at which time they can be killed and collected.

3.4.6 In most cases, the most effective and least hazardous pesticide applications for control of occasional invaders are outdoor applications. These involve residual pesticides applied in a band to the ground immediately around the foundation, the foundation wall, and sometimes around other potential points of entry including door and window frames, around vents, and where utility lines enter.

3.4.7 Microencapsulate, wettable powder, and suspended concentrate products work well for perimeter treatment because they don’t soak in to porous surfaces as much as other formulations and adhere more easily to pests. But the timing of perimeter treatments is critical to success. Applications at times when pests are not likely to enter the structure, after pests have already entered, or with ineffective products, can needlessly expose people, pets and other non-target organisms to pesticides while providing little or no control. The use of pesticides may be best left up to pest management professionals.

NOTE: When pesticides are used, it is the applicator’s legal responsibility to read and follow directions on the product label. Not following label directions, even if they conflict with information provided herein, may be a violation of local regulations.

4 Pests, Insects animals etc. that can cause re-contamination

4.1 Soil

4.1.1 Soil can contain spores, seed and eggs of one or more invasive alien species, and therefore should not be carried on or in the CTU internationally. Soil can be found at floor level in the internal corrugations of the side wall, in the internal angles of the corner posts and externally in the corner fitting apertures and body, fork pocket openings and on the upper surfaces of the cross rail bottom flanges.

Figure 13.2 : Mud in corner fitting

Figure 13.3 : Mud in fork pocket

4.1.2 Re-contamination of the CTU will generally result from positioning the CTU on mud, or a soft surface. Care should be taken to prevent the CTU from scraping across the ground surface.

4.1.3 Soil can also enter the CTU on the feet of persons, on the wheels of handling equipment and on the packages or goods themselves.

4.1.4 Soil should be swept out and bagged for incineration or washed out using a high pressure spray.

4.2 Plants/ plant parts/debris and seeds

4.2.1 Plants can grow on shipping containers if residual seed has been allowed to germinate with or without contaminating soil. Other plant matter found on shipping containers includes leaves and other plant parts. Leaves can harbour spores and bacteria that can harm crops at the destination.

Figure 13.4 : Previous cargo debris

4.2.1.1 Moths

Figure 13.5 : Asian gipsy moth

4.2.1.2 Snails and slugs

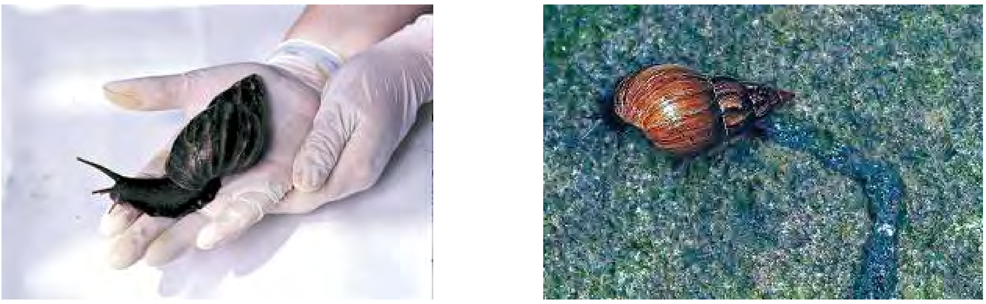


Figure 13.6 : Giant African snail

4.3 Ants

4.3.1 Some ant species are considered pests, and because of the adaptive nature of ant colonies, eliminating the entire colony is nearly impossible. Pest management is therefore a matter of controlling local populations, instead of eliminating an entire colony, and most attempts at control are temporary solutions.

Figure 13.7 : Pharaoh ant

Figure 13.8 : Carpenter ant nest

4.3.2 Ants classified as pests include the pavement ant, yellow crazy ant, sugar ants, the Pharaoh ant, carpenter ants, Argentine ant, odorous house ants, red imported fire ant and European fire ant. Populations are controlled using insecticide baits, either in granule or liquid formulations. Bait is gathered by the ants as food and brought back to the nest where the poison is inadvertently spread to other colony members through trophallaxis. Boric acid and borax are often used as insecticides that are relatively safe for humans. Bait may be broadcast over a large area to control species like the red fire ant that occupy large areas.

4.3.3 Individual ants should be swept out of CTUs if possible, but larger colonies or infestations, require the entire colony to be destroyed and removed for incineration.

4.4 Bees and wasps

Figure 13.9 : Sirex wasp

Figure 13.10 : Sirex wasp nest

4.5 Mould and Fungi

When containers are left in damp, dark conditions fungi and other airborne spores can lodge and grow on the residual soil left on surfaces of a shipping container.

4.6 Spiders

Figure 13.11: Wolf spider

Figure 13.12 : Spider eggs

4.7 Frass

4.7.1 Frass is the fine powdery material phytophagous (plant-eating) insects pass as waste after digesting plant parts. It causes plants to excrete chitinase due to high chitin levels, it is a natural bloom stimulant, and has high nutrient levels. Frass is known to have abundant amoeba, beneficial bacteria, and fungi content. Frass is a microbial inoculant, also known as a soil inoculant, which promotes plant health using beneficial microbes. It is a large nutrient contributor to the rainforest, and it can often be seen in leaf mines.

4.7.2 Frass can also refer to the excavated wood shavings that insect like the carpenter ants kick out of their galleries during the mining process. Carpenter ants do not eat wood, so they must discard the shavings as they tunnel.

Figure 13.13 : Wood frass from boring insect

4.7.3 Frass is a general sign of the presence of a wood boring or another inspect and therefore in need of cleaning. It is essential that affected plants or timber is removed and incinerated.

4.8 Animals (including frogs)

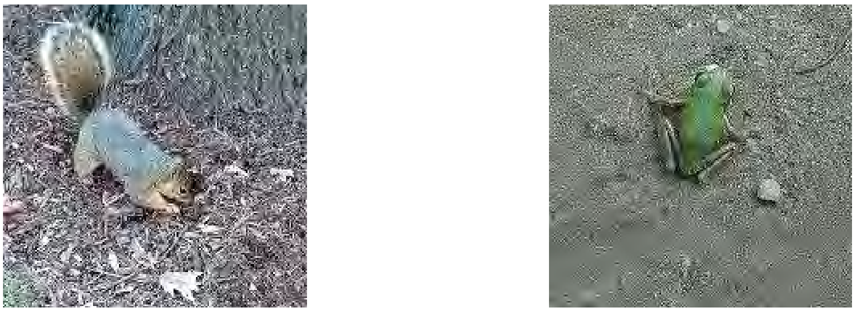


Figure 13.14 : Squirrels and frogs

5 Contaminant Treatment

5.1 The contaminant treatment method should be that most effective for the contamination present. Consideration should be given to containment and treatment of pests that have a potential for spread. In some cases the National Plant Protection Officer (NPPO) may request the specimen be collected for identification purposes.

5.2 If a CTU is found to have a minor re-contamination, cleaning can be effected using one of the following methods:

- sweeping out or vacuum cleaning the container and applying an absorbent powder if required.
- using low pressure water wash
- scraping

5.3 If a live animal or insect is found which can be swept or washed out then this should be done. Bodies of animals should be disposed of safely by bagging and incineration. If the animal is considered as too dangerous to remove, then close the CTU's doors and inform the CTU supplier.

5.4 Operators may have contracts with pest control organisations and these may be employed to remove serious re-contamination.

5.5 If any plants or animals shown in Appendix 1 are found within the CTU then the NPPO should be informed.

5.6 Examples of Contaminant Disposal methods

5.6.1 Bagging

Most operators within the supply chain can only resort to this option, where any pest or animal waste is placed within bag, sealed and then into a sealable containment bin for collection by a suitable pest control organisation. It is essential that there is no opportunity for the sealed bags to be attacked by other animals which could spread the pests contamination.

Figure 13.15 : Quarantine waste

5.6.2 Incineration

5.6.2.1 High temperature

High temperature incineration requires a temperature of 10,000°C and is unlikely that operators will have a facility to achieve this. Therefore any waste that should be incinerated using high temperature should be passed onto a suitable facility.

5.6.2.2 Low temperature

Incineration within a local incinerator for general waste may be suitable for timber and other non animal waste.

5.6.3 Deep burial

Deep burial requires quarantine waste to be buried below at least 2 m of non-quarantine waste. It is unlikely that this disposal method for supply chain operators.

Appendix 1 Species of Concern[2]

1. The following table illustrates some of the species of concern ('pests' and/or 'invasive alien species') that can be moved internationally within CTUs. Whether or not the species becomes harmful largely depends on the viability of the organism (and/or its reproductive units) upon arrival in a new location, as well as the environmental conditions in the recipient ecosystem.

2. Plants include the seeds and spores.

Plants			
Bluestem; Kleberg, Angleton, and yellow *Dichanthium annulatum; Dichanthium aristatum; Bothriochloa ischaemum var. songarica*		Bushkiller, Java, Javan grape *Cayratia japonica*	
Castorbean *Ricinus communi*		Chinaberry, pride of India, Indian lilac, umbrella tree *Melia azedarach*	
Chinese elm *Ulmus parvifolia*		Chinese wisteria *Wisteria sinensis*	
Cogongrass *Imperata cylindrica*		Elephant ear, coco yam, wild taro *Colocasia esculenta*	

[2] 100 of the World's Worst Invasive Alien Species, owe S., Browne M., Boudjelas S., De Poorter M. (2000) 100 of the World's Worst Invasive Alien Species A selection from the Global Invasive Species Database. Published by The Invasive Species Specialist Group (ISSG) a specialist group of the Species Survival Commission (SSC) of the World Conservation Union (IUCN), 12pp. First published as special lift-out in Aliens 12, December 2000. Updated and reprinted version: November 2004.

Golden bamboo
Phyllostachys aurea

Japanese climbing fern
Lygodium japonicum

Japanese honeysuckle
Lonicera japonica

Johnsongrass
Sorghum halepense

Lead tree, Leucaena, haole koa
Leucaena leucocephala

Macartney rose
Rosa bracteata

Motojo-bobo, childa, alien weed, bitter gingerleaf
Lycianthes asarifolia

Multiflora rose
Rosa multiflora

Old world climbing fern, small leaf climbing fern
Lygodium microphyllum

Privet, Chinese
Ligustrum sinense

Privet, Japanese
Ligustrum japonicum

Russian olive
Elaeagnus angustifolia

Silktree mimosa
Albizia julibrissin

Tree-of-heaven, Ailanthus, copal tree
Ailanthus altissima

Vaseygrass
Paspalum urvillei

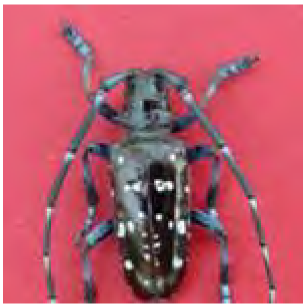
Animal / Insects

Argentine ant
Linepithema humile

Armored catfish, pleco
Hypostomus plecostomus, Pterygoplichthys anisitsi

Asian Gypsy Moth
Lymantria dispar

Asian long-horned beetle
Anoplophora glabripennis



Asian shore crab *Hemigrapsus sanguineus*			Asian tiger mosquito *Aedes albopictus*	
Australian spotted jellyfish *Phyllorhiza punctata*			Brown tree snake *Boiga irregularis*	
Brown/Mexilhao mussel, Green mussel *Perna perna, Perna viridis*			Cactus moth *Cactoblastis cactorum*	
Emerald ash borer *Agrilus planipennis*			European green crab, Mediterranean green crab *Carcinus maenas, C. aestuarii*	
Indo-Pacific swimming crab *Charybdis hellerii*			Lionfish *Pterois volitans*	

Monk parakeet
Myiopsitta monachus

Muscovy duck
Cairina moschata

New Zealand mud snail
Potamopyrgus antipodarum

Pacu, pirapatinga, red-bellied pacu
Colossoma sp., Piaractus sp.

Red-rim melania
Melanoides tuberculatus

Red-vented bulbul
Pycnonotus cafer

Sauerkraut grass, spaghetti Bryozoan
Zoobotryon verticillatum

Sirex Wasp
Sirex noctilio

Sirex wasp
larva and tunnel

South American cichlids *Cichla sp., Cichlasoma sp.*		Veined rapa whelk *Rapana venosa*	
White crust tunicate *Didemnum perlucidum*			

Annex 14. Packing and securing cargo into CTUs

1 Planning of packing

1.1 When applicable, planning of packing should be conducted as early as possible and before packing actually commences. Foremost, the fitness of the envisaged CTU should be verified (see Chapter 8). Deficiencies should be rectified before packing may start.

1.2 Planning should aim at producing either a tight stow, where all cargo packages are placed tightly within the boundaries of the side and front walls of the CTU, or a secured stow, where packages do not fill the entire space and must therefore be secured within the boundaries of the CTU by blocking and/or lashing.

1.3 The compatibility of all items of cargo and the nature, i.e., type and strength, of any packages or packaging involved should be taken into account. The possibility of cross-contamination by odour or dust, as well as physical or chemical compatibility, should be considered. Incompatible cargoes must be segregated.

1.4 In order to avoid cargo damage from moisture in closed CTUs during long voyages, care should be taken that other wet cargoes, moisture inherent cargoes or cargoes liable to leak are not packed together with cargoes susceptible to damage by moisture. Wet timber planks and bracings, pallets or packagings should not be used. In certain cases, damage to equipment and cargo by condensed water dripping from above may be prevented by the use of protective material such as polythene sheeting. However, such sheeting or wrapping may promote mildew and other water damage, if the overall moisture content within the CTU is too high. If drying agents shall be used, the necessary absorption capacity should be calculated. More information may be found in Annex 5 of this code.

1.5 Any special instructions on packages, or otherwise available, should be followed, e.g.:

- cargoes marked "this way up" should be packed accordingly;
- maximum stacking height marked should not be exceeded.

Note: See Appendix 1 for further details on packing marks.

1.6 Where packing results in stacks of packages, the strength of the individual packages must be capable of supporting those placed above them. Care should be taken that the stacking strength of packages is appropriate for the stack design. See Appendix 2 for information on the manufacture and testing of corrugated board.

1.7 Consideration should be given to potential problems, which may be created for those persons who unpack the CTU at its destination. The possibility of cargo falling out when the CTU is opened must definitely be avoided.

1.8 The mass of the planned cargo should not exceed the maximum payload of the CTU. In the case of containers, this ensures that the permitted maximum gross mass of the container, marked on the CSC Safety Approval Plate, will not be exceeded. For CTUs not marked with their maximum permissible gross mass or payload, these values should be identified before packing starts.

1.9 Notwithstanding the foregoing, any limitation of height or mass along the projected route that may be dictated by regulations or other circumstances, such as lifting, handling equipment, clearances and surface conditions, should be complied with. Such mass limits may be considerably lower than the permitted gross mass referred to above.

1.10 When a heavy package with a small "footprint" shall be shipped in a CTU, the concentrated load must be transferred to the structural transverse and longitudinal bottom girders of the CTU (see also section 3.1 of this Annex for details).

1.11 In longitudinal direction the centre of gravity of the packed cargo should be within allowed limits. In transverse direction the centre of gravity should be close to the half width of the CTU. In vertical direction the centre of gravity should be below half the height of the cargo space of the unit. If these conditions cannot be met, suitable measures should be taken to ensure the safe handling and transporting of the CTU, e.g. by external marking of the centre of gravity and/or by instructing forwarders/carriers. In case of CTUs, which shall be lifted by cranes or container bridges, the longitudinal centre of gravity should be close to a position at half the length of the CTU (see also Appendix 3.4).

1.12 If the planned cargo of an open-topped or open-sided CTU will project beyond the overall dimensions of the unit, suitable arrangements should be made with the carriers or forwarders for accommodating compliance with road or rail traffic regulations or advising on special stowage locations on a ship.

1.13 When deciding on packaging and cargo-securing material, it should be borne in mind that some countries enforce a garbage and litter avoidance policy. This may limit the use of certain materials and imply fees for the recovery of packaging at the reception point. In such cases, reusable packaging and securing material should be used. Increasingly, countries require timber dunnage, bracings and packaging materials to be free of bark.

1.14 If a CTU is destined for a country with wood treatment quarantine regulations, care should be taken that all wood in the unit, packaging and cargo complies with the International Standards for Phytosanitary Measures, No. 15 (ISPM 15)[1]. This standard covers packaging material made of natural wood such as pallets, dunnage, crating, packing blocks, drums, cases, load boards and skids. Approved measures of wood treatment are specified in Annex I of ISPM 15. Wood packaging material subjected to these approved measures should display the following specified mark:

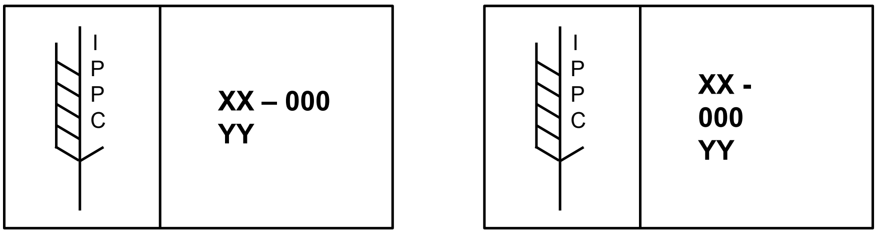


Figure 14.1 Phytosanitary mark

The marks indicating that wood packaging and dunnage material has been subjected to approved phytosanitary treatment in accordance with the symbols shown in Figure 13. will have the following components:

1.14.1 Country code

The country ode must be International Organisation for Standardisation (ISO) two letter code (shown in the figure as “XX”).

1.14.2 Producer / treatment provider code

The producer / treatment provider code is a unique code assigned by the national plant protection organization to the producer of the wood packaging material, who is responsible for ensuring that appropriate wood is used (shown in the figure as “000”).

1.14.3 Treatment code

The treatment code (shown as “YY” in the figure) shows the abbreviation for the approved measure used (HT for heat treatment, MB for fumigation with methyl bromide). In Europe the latters “DB” can be added where debarking has been done.

Note: Treatment must be carried out before the packaging and dunnage material is packed into the CTU. In-situe treatment is not permitted.

1.15 Damaged packages should not be packed into a CTU, unless precautions have been taken against harm from spillage or leakage (see also Chapter 10 for dangerous goods). The overall capability to resist handling and transportation stresses must be ensured.

1.16 The result of planning the packing of a CTU may be presented to the packers by means of an oral or written instruction or by a sketch or even scale drawing, depending on the complexity of the case. Appropriate supervision and/or inspection should ensure that the planned concept is properly implemented.

[1] Secretariat of the International Plant Protection Convention, Food and Agriculture Organization of the United Nations: Guidelines for Regulation Woods Packaging Material in International Trade.

2 Packing and securing materials

2.1 Dunnaging and separating material

2.1.1 Dunnaging materials should be used as appropriate for the protection of the cargo against water from condensed humidity, in particular by

- timber planks against water collecting at the bottom of the CTU,
- gunny cloth, paperboard or natural fibre mats against water dropping from the ceiling,
- timber planks or plywood against sweat water running down the sides of the CTU.

2.1.2 Timber planks or scantlings may also be used for creating gaps between parcels of cargo in order to facilitate natural ventilation, particularly in ventilated box containers. Moreover, the use of such dunnaging is indispensable, when packing reefer containers.

2.1.3 Timber planks, plywood sheets or pallets may be used to equalise loads within stacks of cargo parcels and to stabilise these stacks against dislocation or collapse. The same material may be used for separating packages, which may damage each other or even for installing a temporary floor in a CTU for eliminating inappropriate stack loads to the cargo.

Figure 14.2 Timber temporary floor

2.1.4 Cardboard or plastic sheathing may be used for protecting sensitive cargo from dirt, dust or moisture, in particular while packing is still in progress.

2.1.5 Dunnaging material, in particular sheets of plastic or paper and fibre nets may be used for separating unpackaged cargo items, which are designated for different consignees.

2.1.6 The restrictions on the use of dunnaging materials with regard to quarantine regulations, in particular wood or timber, should be kept in mind (see paragraphs 1.13 and 1.14).

2.2 Friction and friction increasing material

2.2.1 For handling and packing of cartons and pushing heavy units a low friction surface may be desirable. However, for minimising additional securing effort, a high friction between the cargo and the stowage ground of the CTU is of great advantage. Additionally, good friction between parcels or within the goods themselves, e.g. powder or granulate material in bags, will support a stable stow.

2.2.2 The magnitude of the vertical friction forces between a cargo item and the stowage ground depends on the mass of the item and a specific friction factor μ, which may be obtained from the Appendix 3 of this Annex.

Friction force $\mathbf{F_F = \mu \cdot C_z \cdot m \cdot g}$ [kN], with mass of cargo [t] and g = 9.81 [m/s^2].

2.2.2.1 The coefficients presented in Appendix 3 are applicable for static friction between different surface materials. These figures may be used for cargoes secured by blocking or by friction lashings.

2.2.2.2 For cargoes secured by direct securing, a dynamic friction coefficient should be used with 75% of the applicable static friction coefficient, because the necessary elongation of the lashings for attaining the desired restraint forces will go along with a little movement of the cargo.

2.2.2.3 The friction values given in Appendix 3 are valid for swept clean dry or wet surfaces free from frost, ice, snow, oil and grease. When a combination of contact surfaces is missing in the table in Appendix 3 or if it's coefficient of friction can't be verified in another way, the maximum μ-static to be used in calculations is 0.3. If the surface contacts are not free from frost, ice and snow a static friction coefficient μ = 0.2 shall be used. For oily and greasy surfaces or when slip sheets have been used a static friction coefficient μ = 0.1 shall be used. The coefficient of friction for a material contact can be verified by static inclination or dragging tests. With an inclination test the friction is obtained as tangents for the sliding angle and with a dragging or pulling test the friction is the relation between the horizontal force at sliding and the vertical force. A number of tests should be performed to establish the friction for a material contact (see Appendix 7).

2.2.3 The friction force cannot be increased by providing a greater contact area. As friction factors may be diminished, if the contact area is contaminated by sand, dust, traces of water, oil, grease, ice or snow, good cleaning of the stowage surface of a CTU before packing is important.

2.2.4 Friction increasing materials like rubber mats, sheets of structured plastics or special cardboard may provide considerably higher friction coefficients, which are declared and certified by the manufacturers. However, care should be taken in the practical use of these materials. Their certified friction coefficient may be limited to perfect cleanliness and evenness of the contact areas and to specified ambient conditions of temperature and humidity. The desired friction increasing effect will be obtained only if the weight of the cargo is fully transferred via the friction increasing material, this means only if there is no direct contact between the cargo and the stowage ground. Manufacturer's instructions on the use of the material should be observed.

2.3 Blocking and bracing material and arrangements

2.3.1 Blocking, bracing or shoring is a securing method, where e.g. timber beams and frames, empty pallets or dunnage bags are filled into gaps between cargo and solid boundaries of the CTU or into gaps between different packages. Forces are transferred in this method by compression with minimal deformation. Inclined bracing or shoring arrangements bear the risk of bursting open under load and should therefore be properly designed. In CTUs with strong sides, if possible, packages should be stowed tightly to the boundaries of the CTU on both sides, leaving the remaining gap in the middle. This reduces the forces to the bracing arrangement, because lateral g-forces from only one side will need to be transferred at a time.

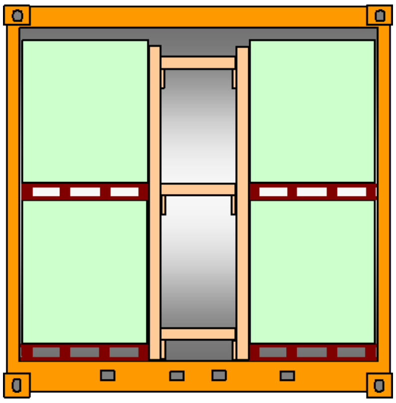


Figure 14.3 Centre gap with transverse bracing

2.3.2 Forces being transferred by bracing or shoring need to be dispersed at the points of contact by suitable cross-beams, unless a point of contact represents a strong structural member of the cargo or the CTU. Cross-beams of conifer timber should be given sufficient overlaps at the shore contact points. For the assessment of bedding and blocking arrangements, the nominal strength of timber should be taken from the table below:

	Compressive strength normal to the grain	**Compressive strength parallel to the grain**	**Bending strength**
Low quality	0.5 kN / cm²	2.0 kN / cm²	2.4 kN / cm²
Medium quality	0.5 kN / cm²	2.0 kN / cm²	3.0 kN / cm²

2.3.3 A bracing or shoring arrangement should be designed and completed in such a way that it remains intact and in place, also if compression is temporarily lost. This requires suitable uprights or benches supporting the actual shores, a proper joining of the elements by nails or cramps and the stabilising of the arrangement by diagonal braces as appropriate (see Figure 14.4 and Figure 14.5).

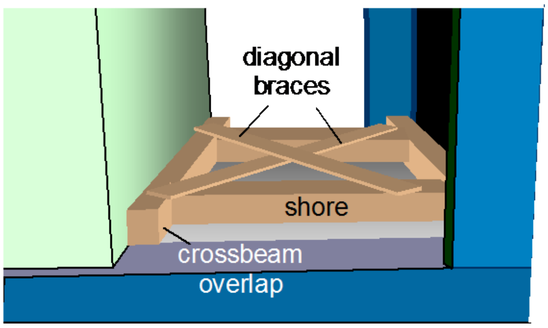


Figure 14.4 : Shoring arrangement showing cross beam overlap and diagonal braces

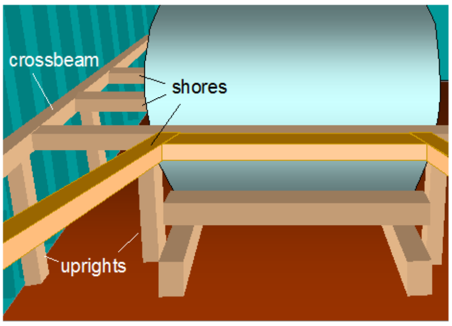


Figure 14.5 : Shoring arrangement with uprights and crossbeam

2.3.4 Transverse battens in a CTU, intended to restrain a block of packages in front of the door or at intermediate positions within the CTU, should be sufficiently dimensioned in their cross-section, in order to withstand the expected longitudinal forces from the cargo. The ends of such battens may be forced into solid corrugations of the side walls of the CTU. However, preference should be given to brace them against the frame structure, such as bottom or top rails or corner posts. Such battens act as beams, which are fixed at their ends and loaded homogeneously over their entire length of about 2.4 metres. Their bending strength is decisive for the force that can be resisted. The required number of such battens together with their dimensions may be identified by calculations, which is shown in Appendix 14.1.

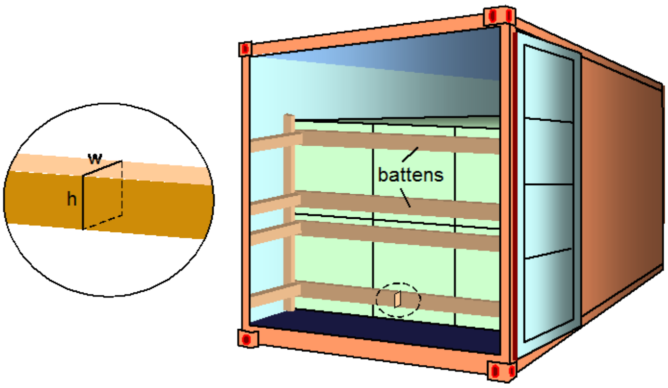


Figure 14.6 General layout of fence battens for door protection in a container

2.3.5 Blocking using timber battens that are attached using nails should be used for minor securing demands only. Depending on the size of the nails used, the shear strength of such a blocking arrangement may be estimated to take up a blocking force between 1 and 4 kN per nail. Nailed on wedges may be favourable for blocking round shapes like pipes. Care should be taken that wedges are cut in a way that the direction of grain supports the shear strength of the wedge. Any such timber battens or wedges should only be nailed to dunnage or timbers placed under the cargo. Wooden floors of closed CTUs are generally not suitable for nailing whereas the softwood flooring or platform and open CTUs is more acceptable. Nailing to any floor in CTUs should require the consent of the CTU operator. See Appendix 6 for more information about chock design.

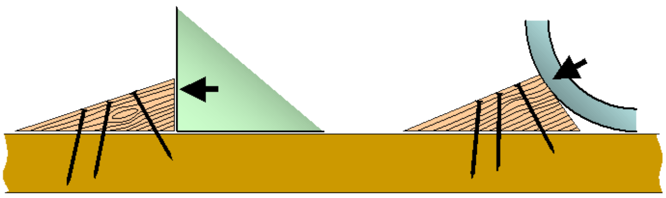


Figure 14.7 Properly cut and nailed wedges

2.3.6 Void spaces should be filled and may be favourably stuffed by empty pallets inserted vertically and tightened by additional timber battens as necessary. Material which may deform or shrink permanently, like rags of gunny cloth or solid foam, should not be used for this purpose. Small gaps between unit loads and similar cargo items, which cannot be avoided and which are necessary for the smooth packing and unpacking of the goods, are acceptable and need not to be filled. The sum of void spaces in any direction should not exceed 15 cm[2]. However, between dense and rigid cargo items, such as steel, concrete or stone, void spaces should be further minimized, as far as possible.

2.3.7 Gaps between cargo that is stowed on and firmly secured to pallets (by lashings or by shrink foil), need not to be filled, if the pallets are stowed tightly into a CTU and are not liable to tipping. Securing of cargo to pallets by shrink foil wrapping is only sufficient if the strength of the foil is appropriate for above purpose. It should be considered that in case of sea transport repetitive high loadings during bad weather may fatigue the strength of a shrink foil and thereby reduce the securing capacity.

Figure 14.8 Cargo firmly secured to pallets by textile lashings

2.3.8 If dunnage bags are used for filling gaps[3], the manufacturer's instructions on filling pressure and the maximum gap width should be accurately observed. Dunnage bags should not be used as a means of filling the space at the doorway, unless precautions are taken to ensure that they cannot cause the door to open violently when the doors are opened. If the surfaces in the gap are uneven with the risk of damage to the dunnage bags by chafing or piercing, suitable measures have to be taken for smoothing the surfaces appropriately. The blocking capacity of dunnage bags should be estimated by multiplying the nominal burst pressure with the contact area to one side of the blocking arrangement and with a safety factor of 0.75 for single use dunnage bags and 0.5 for re-usable dunnage bags (see Appendix 5.1 and Appendix 5.5).

Figure 14.9 :Gap filled with a central dunnage bag

Figure 14.10 : Irregular shaped packages blocked with dunnage bags

2.3.9 The restrictions on the use of blocking and bracing materials with regard to quarantine regulations, in particular for wood or timber, should be kept in mind (see paragraphs 1.13 and 1.14 of this Annex).

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2 Equivalent to the height of a pallet

3 Dunnage bags (inflated by air) may not be used on US railways.

2.4 Lashing materials

2.4.1 Lashings transfer tensile forces. The strength of a lashing may be declared by its breaking strength or breaking load (BL). The maximum securing load (MSL) is a specified proportion of the breaking strength and denotes the force that should not be exceeded in securing service. The term lashing capacity (LC), used in national and regional standards, corresponds to the MSL. Value for BL, MSL or LC are indicated in units of force, i.e. kilo-Newton (kN) or deka-Newton (daN).

2.4.2 The relation between MSL and the breaking strength is shown in the table below. The figures are consistent with Annex 13 of the IMO CSS-Code. Corresponding relations according to standards may differ slightly.

Material	MSL
shackles, rings, deck eyes, turnbuckles of mild steel	50 % of breaking strength
fibre ropes	33 % of breaking strength
web lashings	50 % of breaking strength
wire ropes (single use)	80 % of breaking strength
wire rope (re-useable)	30 % of breaking strength
steel band (single use)	70 % of breaking strength
chains	50 % of breaking strength
web lashing (single use)	75 % of breaking strength

2.4.3 The values of MSL quoted in the table above rely on the material passing over smooth or smoothed edges. Sharp edges and corners will substantially reduce these values. Wherever possible or practicable appropriate edge protectors should be used.

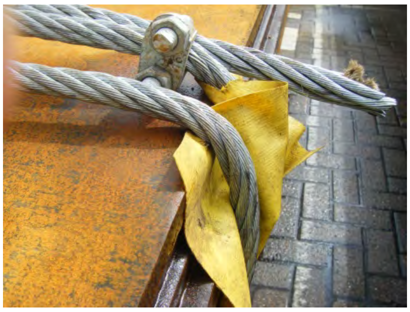

Figure 14.11 Poor edge protection

Figure 14.12 Steel edge protectors

2.4.4 Lashings transfer forces under a certain elastic elongation only. They act like a spring. If loaded more than the specific MSL, elongation may become permanent and the lashing will fall slack. New wire and fibre ropes or belts may show some permanent elongation until gaining the desired elasticity after repeated re-tensioning. Lashings should be given a pre-tension, in order to minimise cargo movement. However, the initial pre-tension should never exceed 50% of the MSL.

2.4.5 Fibre ropes of the materials manila, hemp, sisal or manila-sisal-mix and moreover synthetic fibre ropes may be used for lashing purposes. If their MSL is not supplied by the manufacturer or chandler, rules of thumb may be used for estimating the MSL with d = rope diameter in cm:

Natural fibre ropes: $MSL = 2 \cdot d^2$ [kN]

Polypropylene ropes: $MSL = 4 \cdot d^2$ [kN]

Polyester ropes: $MSL = 5 \cdot d^2$ [kN]

Polyamide ropes: $MSL = 7 \cdot d^2$ [kN]

Composite ropes made of synthetic fibre and integrated soft wire strings provide suitable stiffness for handling, knotting and tightening and less elongation under load. The strength of this rope is only marginally greater than that made of plain synthetic fibre.

2.4.6 There is no strength reduction to fibre ropes due to bends at round corners. Rope lashings should be attached as double, triple or fourfold strings and tensioned by means of wooden turn sticks. Knots should be of a professional type, e.g. bowline knot and double half hitch[4]. Fibre ropes are highly sensitive against chafing at sharp corners or obstructions.

2.4.7 Web lashings may be re-usable devices with integrated ratchet tensioner or one-way hardware, available with removable tensioning and lockable devices. The permitted securing load is generally labelled and certified as lashing capacity LC, which should be taken as MSL. There is no rule of thumb available for estimating the MSL due to different base materials and fabrication qualities. The fastening of web lashings by means of knots reduces their strength considerably and should therefore not be applied.

2.4.8 The elastic elongation of web lashings, when loaded to their specific MSL, is generally around 9% of the length and shall not exceed 13% according to European standards[5]. Web lashings should be protected against chafing at sharp corners, against mechanical wear and tear in general and against chemical agents like solvents, acids and others.

2.4.9 Wire rope used for lashing purposes in CTUs for sea-transport consists of steel wires with a nominal BL of around 1.6 kN/mm^2 and the favourite construction 6 x 19 + 1FC, i.e. 6 strands of 19 wires and 1 fibre core. If a certified figure of MSL is not available, the maximum securing load for one-way use may be estimated by MSL = 40 · d^2 kN. Other available lashing wire constructions with a greater number of fibre cores and less metallic cross-section have a considerably lesser strength related to the outer diameter. The elastic elongation of a lashing wire rope is about 1.6% when loaded to one-way MSL, but an initial permanent elongation must be expected after the first tensioning, if the wire rope is new.

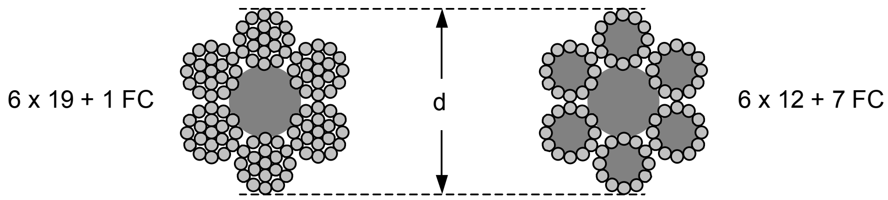

Figure 14.13 Typical lashing wire rope construction

2.4.10 Narrow rounded bends reduce the strength of wire ropes considerably. The residual strength of each part of the rope at the bend depends on the ratio of bend diameter to the rope diameter as shown in the table below.

ratio: bend diameter / rope diameter	1	2	3	4	5
residual strength with rope steady in the bend	65%	76%	85%	93%	100%

Bending a wire rope around sharp corners, like passing it through the edged hole of an eye-plate, reduces its strength even more. The residual MSL after a 180° turn through such an eye-plate is only about 25% of the MSL of the plain rope, if steady in the bend.

2.4.11 Wire rope lashings in sea-transport are usually assembled by means of wire rope clips. It is of utmost importance that these clips are of appropriate size and applied in correct number, direction and tightness. Recommended types of such wire rope lashing assemblies are shown in Figure 14.14. A typical improper assembly is shown in Figure 14.15.

4 Knots will reduce the strength of the rope.

5 EN 12195-2:2000

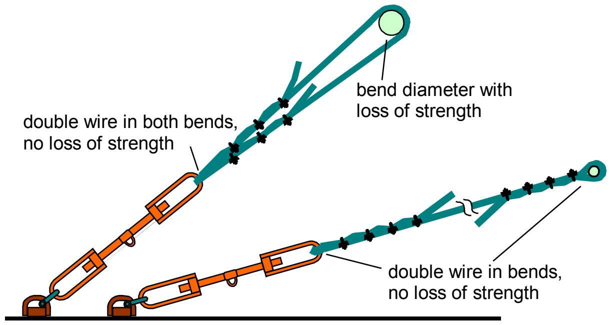

Figure 14.14 : Recommended assemblies for wire rope lashing

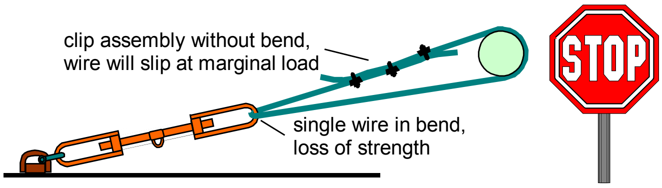

Figure 14.15 : Improper assembly for wire rope lashing

2.4.12 Tensioning and joining devices associated to wire rope lashings in sea-transport are generally not standardised. The MSL of turnbuckles and lashing shackles should be specified and documented by the manufacturer and at least match the MSL of the wire rope part of the lashing. If manufacturer information is not available, the MSL of turnbuckles and shackles made of ordinary mild steel may be estimated by $MSL = 10 \cdot d^2$ [kN] with d = diameter of thread of turnbuckle or shackle bolt in cm.

2.4.13 Wire rope lashings in road transport are specified as re-usable material of distinguished strength in terms of lashing capacity (LC), which should be taken as MSL. Connections elements like shackles, hooks, thimbles, tensioning devices or tension indicators are accordingly standardised by design and strength. The use of wire rope clips for forming soft eyes has not been envisaged. Assembled lashing devices are supplied with a label containing identification and strength data. When using such material, the manufacturer's instructions should be observed.

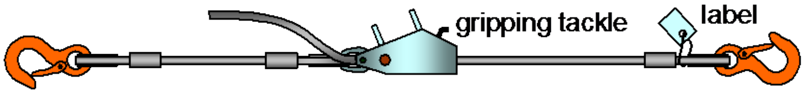

Figure 14.16 : Standard wire lashing used in road transport with gripping tackle

2.4.14 Lashing chains [used in sea-transport] are generally long link chains with an MSL = 100 kN and 8 grade steel. The MSL for other dimensions and steel qualities should be obtained from the manufacturer's specification. The elastic elongation of the above long link chains is about 1% when loaded to their MSL. Long link chains are sensitive against guiding them around bends of less than about 10 cm radius. The favourite tensioning device is a lever with a so-called climbing hook for re-tightening the lashing during service. Manufacturer's instructions and, when existing, national regulations on the use of the tensioning lever and re-tensioning under load should be strictly observed.

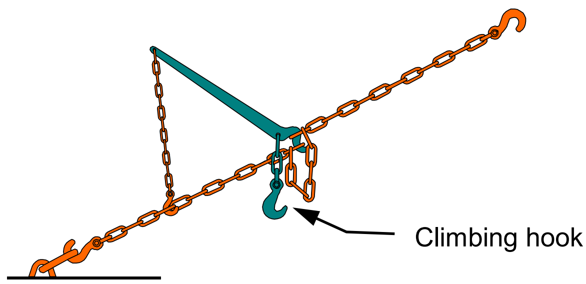

Figure 14.17 : Long link lashing chain with lever tensioner

2.4.15 Chain lashings used in road and rail transport according to European standards[6] are mainly short link chains. Long link chains are reserved for the transport of logs. Short link chains have an elastic elongation of about 1.5%, when loaded to their LC. The standard includes various systems of tensioners, specially adapted hooks, damping devices and devices to shorten a chain to the desired loaded length. Chain compound assemblies may be supplied with a label containing identification and strength data. Manufacturer's instructions on the use of the equipment should be strictly observed.

Figure 14.18 : Standard chain lashing with shortening hook

2.4.16 Steel band for securing purposes is generally made of high tension steel with a normal breaking strength of 0.8 to 1.0 kN/mm^2. Steel bands are most commonly used for compacting packages to form greater blocks of cargo. [In sea transport, such steel bands are also used to "tie down" packages to flatracks, platforms or roll-trailers.] The bands are tensioned and locked by special manual or pneumatic tools. Subsequent re-tensioning is not possible. The low flexibility of the band material with about 0.3% elongation, when loaded to its MSL, makes steel band sensitive for loosing pre-tension if cargo shrinks or settles down. Therefore, the suitability of steel band for cargo securing is limited and national restrictions on their use in road or rail transport should always be considered. The use of steel bands for lashing purposes should be avoided on open CTUs as a broken lashing could be of great danger if it hangs outside the CTU.

Figure 14.19 : Metal ingots compacted by steel banding (securing not completed)

2.4.17 Twisted soft wire should be used for minor securing demands only. The strength of soft wire lashings in terms of MSL is scarcely determinable and their elastic elongation and restoring force is poor.

2.4.18 Modular lashing systems with ready-made web lashings are available in particular for general cargo containers, to secure cargo against movement towards the door. The number of belts is to be calculated depending on the mass of the cargo, the lashing capacity of the belts, the lashing angle and the MSL of the lashing points in the container (see paragraph 7.2.4 of the Code).

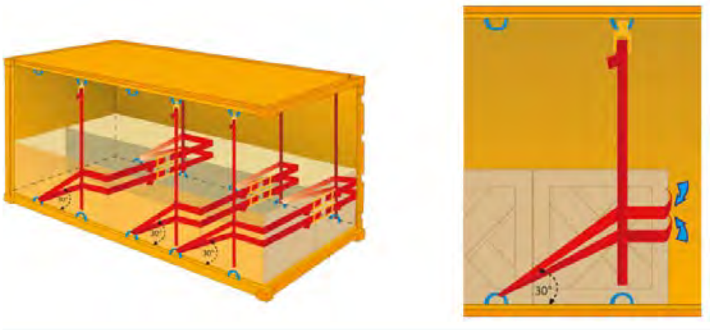

Figure 14.20 : Modular belt lashing system :

[6] EN 12195-3:2001

2.4.19 The belts are connected to the lashing points of the container with special fittings and are pre-tensioned by means of cam-buckles and a tensioning tool. More information may be obtained from the producers or suppliers of such modular systems.

3 Principles of packing

3.1 Load distribution

3.1.1 Containers, flatracks and platforms are designed according to ISO standards, amongst others, in such a way that the permissible payload P, if homogeneously distributed over the entire loading floor, can safely be transferred to the four corner posts under all conditions of carriage. This includes a safety margin for temporary weight increase due to vertical accelerations during a sea-passage. When the payload is not homogeneously distributed over the loading floor, the limitations for concentrated loads have to be considered. It may be necessary to transfer the mass to the corner posts and to support the cargo on strong timber or steel beams as appropriate.

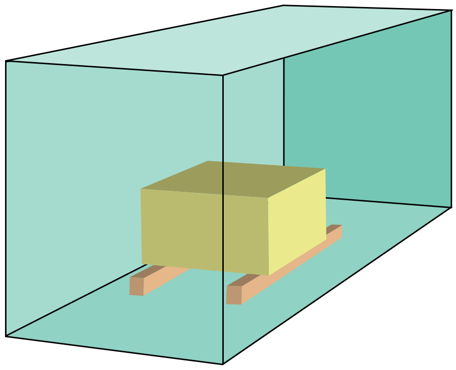

Figure 14.21 : Load transfer beams

3.1.2 The bending strength of the beams must be sufficient for the purpose of load transfer of concentrated loads. The arrangement, the required number and the strength of timber beams or steel beams may be identified by calculations shown in the Appendix 5.

3.1.3 Concentrated loads on platforms or flatracks should be similarly expanded by bedding on longitudinal beams or the load must be reduced against the maximum payload. The permissible load may be determined by calculations shown in the Appendix 5.

3.1.4 Where containers, including flatracks or platforms, shall be lifted and handled in an even state during transport, the cargo should be so arranged and secured in the container that its joint centre of gravity is close to the mid-length and mid-width of the container. In order to comply with restrictions like the observation of axle loads of road vehicles (see 3.1.7) and/or the avoidance of overloading the transverse bottom structure of the CTU, the eccentricity of the centre of gravity should not exceed ±5% in general[7]. Under particular circumstances an eccentricity of up to ±10% could be accepted, as advanced spreaders for handling ISO containers are capable of adjusting such eccentricity. The precise longitudinal position of the centre of gravity of a loaded CTU may be determined by calculation (see Appendix 5.4).

3.1.5 Roll trailers have structural properties similar to ISO platforms, but are less sensible against concentrated loads due to the usual wheel support at about 3/4 of their length from the gooseneck tunnel end. As they are generally handled without lifting, the longitudinal position of the cargo centre of gravity is not critical as well.

3.1.6 Swap bodies have structural properties similar to ISO box-containers, but in most cases less tare weight and less overall strength. They are normally not stackable. The loading instructions given under 3.1.2 and 3.1.5 should be applied to swap bodies as appropriate.

3.1.7 Road trucks and road trailers are in particular sensitive regarding the position of the centre of gravity of the cargo loaded in them, due to specified axle loads for maintaining steering and braking ability. Such vehicles may be equipped with specific diagrams, which show the permissible pay load as a function of the longitudinal position of its centre of gravity. Generally, the maximum pay load may be used only when the centre of gravity is positioned within narrow boundaries about half the length of the loading space.

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[7] As a rule of thumb this can be taken as 60% of the cargo's total mass in 50% of the CTU's length.

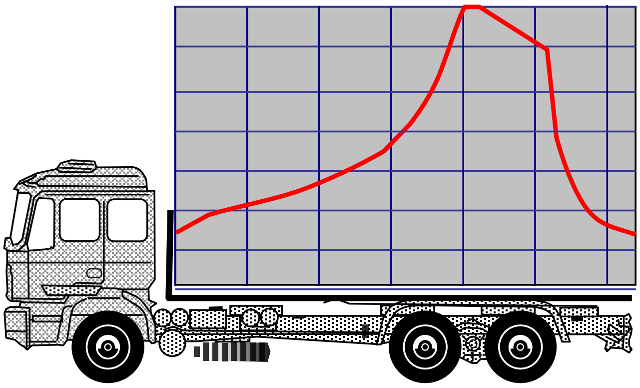


Figure 14.22 : Typical load distribution diagram for rigid truck

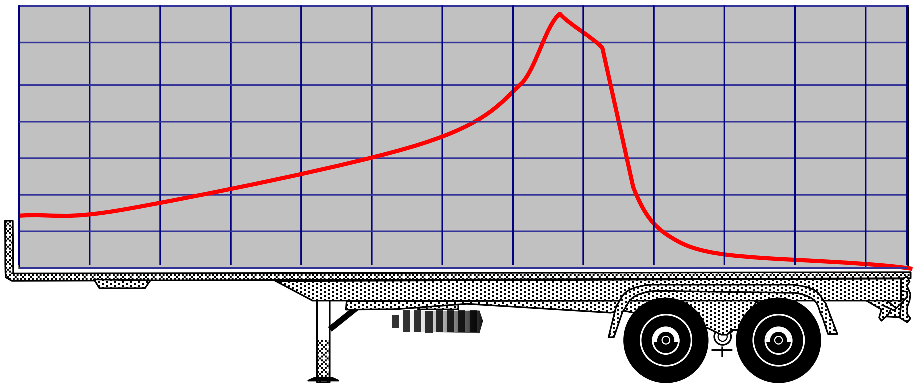


Figure 14.23 : Typical load distribution diagram for semi-trailer

3.1.8 Railway routes are classified into line categories, by which permissible axle loads and loads per metre length of cargo space are allocated to each railway wagon. The applicable figures must be observed in view on the intended route of the wagon. Tolerable concentrated loads are graded depending on their bedding length. The appropriate load figures are marked on the wagons. The transverse and longitudinal deviation of cargo centre of gravity from wagon centre-lines is limited by defined relations of transverse wheel loads and longitudinal axle/bogie loads. The proper loading of railway wagons should be supervised by specifically trained persons.

3.2 General stowage/packing techniques

3.2.1 Stowage and packing techniques should be suitable to the nature of the cargo with regard to weight, shape, structural strength and climatic conditions. This includes the proper use of dunnage material (see subsection 2.1), the selection of the appropriate method of mechanical handling and the proper stowage of vented packages. The concept of stowage should incorporate the feasibility of smooth unloading.

3.2.2 Any marking on parcels should be strictly observed. Cargoes marked "this way up" should not only be stowed upright but also kept upright during entire handling. Goods which may be subject to inspection by the carrier or by authorities, like dangerous goods or goods liable to customs duty, should if possible be stowed at the door end of the CTU.

3.2.3 When packing mixed cargoes, their mutual compatibility should be observed. Irrespective the regulations for the stowage of dangerous goods (see Chapter 10) the following general rules are applicable:

- Heavier cargoes should not be stowed on top of lighter cargoes. This will also provide for the centre of gravity of the CTU in a level not exceeding half the height of the CTU.
- Heavy units should not be stowed on top of fragile parcels.
- Sharp-edged pieces should not be stowed on top of units with weak surfaces.
- Liquid cargoes should not be stowed on solid cargoes.
- Dusty or dirty cargoes should not be placed near to clean and easily soiled cargoes like foodstuff in porous packing.

- Cargoes emitting moisture should not be stowed on or near to cargoes sensitive to moisture.
- Odorous cargoes should not be stowed in the vicinity of cargoes easily absorbing odour.
- Mutually incompatible cargoes should be loaded into the same CTU only, if their stow is appropriately separated and/or the goods are effectively protected by suitable sheathing material.

3.2.4 Stacking of sensitive cartons of uniform size and shape should be precise in a way that the mass from above is transferred to the vertical boards of the cartons below. If necessary, e.g. due to lateral leeway of the stack in the CTU, intermediate sheets of fibreboard, plywood or pallets should be placed between layers of the stack. cartons of irregular shape and/or size should be stacked only with due consideration of their structural hardiness. Gaps and irregularities of level should be stuffed or equalised by means of dunnage.

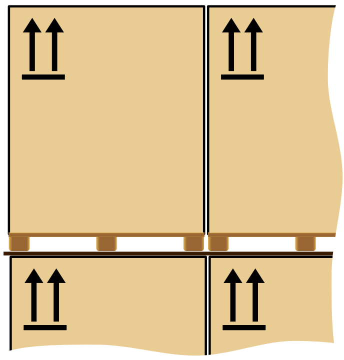


Figure 14.24 : With Intermediate board

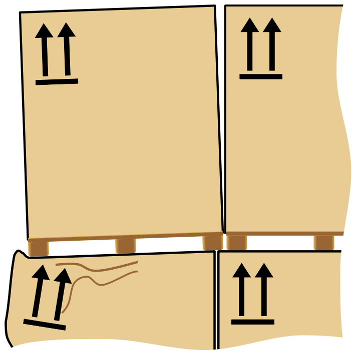


Figure 14.25 : Without intermediate board

3.2.5 Packages with a less defined shape like bags or bales may be stacked in an interlocking pattern, also called cross-tie, thereby creating a solid pile that may be secured by blocking or fencing. Round longish units like pipes may be stacked into the grooves of the layer below. However, care should be taken of the lateral forces produced by top layers in the grooves of the bottom layers, which may locally overload the side walls of the CTU if the friction between the pipes is low.

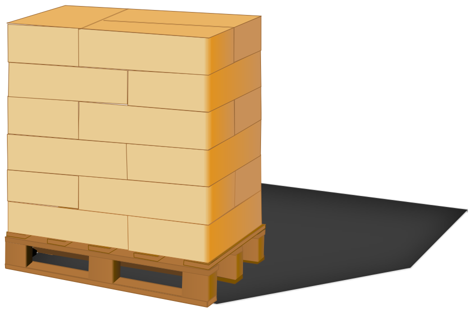


Figure 14.26 : Cross-tie stowage

3.2.6 Uniform parcels like drums or standardised pallets should be packed in a way that minimises lost space and provides a tight stow at the same time. Drums may be stowed either in regular lines, also called "soldier stowage", or into the vertical grooves, also called "offset stowage". With small drums the offset packing is more effective, while with greater drum diameters the advantage may be with the soldier stow. Pallet dimensions are widely standardised and adapted to the inner width and length of cargo spaces in road trucks, road trailers and swap bodies, but not throughout to the inner dimensions of ISO containers.

Figure 14.27 : Mixed stow, dry over wet goods

Figure 14.28 : Mixed stow, use of pallets

3.2.7 Near to completion of packing a CTU, care should be taken to build a firm face of the cargo so as to prevent a "fall out" when the CTU is opened. If there is any doubt about the stability of the face, further steps should be taken such as strapping top layers of cargo back to securing points or building a timber fence between the rear posts in a container (see paragraph 2.3.4). It should be borne in mind, that a container on a trailer usually inclines towards the doors aft and that cargo may move against the doors due to vibration induced shift or by jolts during transport.

3.3 Cargo handling

3.3.1 Relevant regulations on the use of personnel protection equipment (helmet, shoes, gloves and clothing) should be adhered to. Personnel should have been instructed on ergonomic aspects of manual lifting of weighty parcels. Weight limitations of parcels to be lifted and carried by persons should be observed.

3.3.2 FLTs, used for driving inside roofed CTUs, should have a short lifting mast and a low driver's overhead guard. If the lift truck operates inside a CTU care should be taken of the exhaust gases and equipment with electric power supply or similar should be used. The truck should be equipped with adequate lighting so that the operator can place packages accurately. FLTs operated by a combustion engine should comply with national combustion emission standards. FLTs with engines burning LPG-fuel should not be used in enclosed space, in order to prevent the accumulation of explosive gas mixtures from unexpected leaks.

3.3.3 Wherever there is a risk of explosion due to the vapours, fumes or dust given off by the cargo, all electrical equipment mounted on the trucks must be sealed to ensure that they are intrinsically safe for flammable and explosive atmospheres.

3.3.4 Driving FLTs into swap-bodies, semi-trailers or other supported CTUs should be done slowly, in particular with careful starting and braking, in order to avoid dangerous horizontal forces to the supports of the CTU.

3.3.5 If CTUs are to be loaded with FLTs from the side, significant lateral impact forces to the CTU must be avoided. Such lateral forces may occur when packages or overpacks are pushed across the loading area. If, during such operations, there is a risk of turning the CTU over packers may consider packing either from both sides to the centre line of the CTU or by using FLTs with higher capacity and long forks, which would permit accurate placement without pushing.

3.3.6 If persons need to access the roof of a CTU, e.g. for filling the CTU with a free-flowing bulk cargo, the load-bearing capability of the roof should be observed. Roofs of containers are designed for and tested with a load of 300 kg (660 lbs), which acts uniformly on an area of 600 x 300 mm (24 x 12 inches) in the weakest region of the roof (reference: CSC, Annex II). Practically, no more than two persons should work on a container roof simultaneously.

3.3.7 When loading or unloading heavy parcels with C-hooks through doors or from the sides of a CTU, care should be taken, that the transverse or longitudinal girders of the roof or side walls are struck neither by the hook nor the cargo. The move of unit should be controlled by appropriate means, e.g. guide ropes. Relevant regulations for the prevention of accidents should be observed.

4 Securing of cargo in CTUs

4.1 Aims and principles of securing

4.1.1 Arrangements or stacks of cargo items shall be packed in a way so as not to deform and to remain in place and upright with no tilting by their static friction and by their inherent stability, while packing or unpacking a CTU is in progress. This guarantees the safety of packers before additional securing devices are put in place or after such devices have been removed for unpacking.

4.1.2 During transport the CTU may be subjected to vertical, longitudinal and transverse accelerations, which cause forces to each cargo item, which are proportional to its mass. It should not be assumed, that because a package is heavy, it will not move during transport. The relevant accelerations are outlined in Chapter 5 of this Code in units of g, indicating the corresponding forces in units of weight of the distinguished cargo item. These forces may easily exceed the capability of static friction and tilting stability, so that cargo items may slide or tilt over. In addition, the CTU may be simultaneously subjected to temporary vertical accelerations, which cause a weight decrease, thereby reduce the friction and the inherent tilting stability, thus promoting sliding and tipping. Any securing of cargo must aim at the avoidance of such unwanted cargo behaviour. All parts of the cargo shall remain in place and shall not slide nor tip under the stipulated accelerations of the CTU during the intended route of transport.

4.1.3 Practical securing of cargo may be approached by three distinguished principles, which may be used individually or combined as appropriate:

- Direct securing is effected by the immediate transfer of forces from the cargo to the CTU by means of blocking, lashings, shores or locking devices. The securing capacity is proportional to the MSL of the securing devices.
- Friction securing is achieved by so-called tie-down or top-over lashings which, by their pre-tension, increase the apparent weight of the cargo and thereby the friction to the loading ground and also the tilting stability. The securing effect is proportional to the pre-tension of the lashings. Anti-slip material in the sliding surfaces considerably increases the effect of such lashings.
- Compacting cargo by bundling, strapping or wrapping is an auxiliary measure of securing that must always be combined with measures of direct securing or friction securing.

4.1.4 Lashings used for direct securing will inevitably elongate over time, thus permitting the package a degree of movement. To minimise this movement, (horizontal or lateral sliding, tipping or racking) ensure that:

- the lashing material has appropriate load-deformation characteristics (see subsection 2.4);
- the length of the lashing is kept as short as practicable; and
- the direction of the lashing is as close as possible to the direction of the intended restraining effect.

A good pre-tension in lashings will also contribute to minimising cargo motions, but the pre-tension should never exceed 50% of the MSL of the lashing. Direct securing by stiff pressure elements (shores or stanchions) or by locking devices (locking cones or twist-locks) will not imply significant cargo motion and should therefore be the preferred method of direct securing.

4.1.5 Lashings used for friction securing should be able to maintain the vital pre-tension for a longer period and should not fall slack from minor settling or shrinking of the cargo. Therefore synthetic fibre web lashings should be preferred to e.g. chains or steel band lashings. The pre-tension of tie-down lashings does in principle not fall under the limitation stated above for direct lashings, but will generally not be greater than 20% of the MSL of the lashing with manually operated tensioners. Care should be taken to establish this pre-tension on both sides of the lashing as far as is practical. For assessing a friction securing arrangement by calculation, the labelled standard pre-tension[8] should be used. If such marking is not available, a rule of thumb value of 10% of the breaking strength of the lashing, but not more than 10 kN, should be used for calculation.

4.1.6 Arrangements of direct securing devices should be homogeneous in a way that each device in the arrangement takes its share of the restraining forces appropriate to its strength. Unavoidable differences in load distribution within complex arrangements may be compensated by the application of a safety factor. Nevertheless, devices of diverging load-deformation properties

[8] Standard tension force S_{TF} according to EN-12195-2

should not be placed in parallel, unless used for the distinguishable purposes of sliding prevention and tipping prevention. If, for instance, timber blocking and direct web lashing is used in parallel against sliding, the stiffer timber blocking must be dimensioned so as to resist the expected load alone. This restriction does not apply to the combination of tie-down lashings and e.g. timber blocking.

4.1.7 Any cargo securing measures should be applied in a manner that does not affect, deform or impair the package or the CTU. Permanent securing equipment incorporated into a CTU should be used whenever possible or necessary.

4.1.8 During transport, in particular at suitable occasions of a multi-modal transport route, securing arrangements in CTUs should be checked and upgraded if necessary and as far as practicable. This includes re-tightening of lashings and wire rope clips and adjusting of blocking arrangements.

4.2 Tightly arranged cargoes

4.2.1 A vital prerequisite of cargo items for a tight stowage arrangement is their insensibility against mutual physical contact. Cargo parcels in form of cartons, boxes, cases, crates, barrels, drums, bundles, bales, bags, bottles, reels etc. or pallets containing the aforesaid items are usually packed into a CTU in a tight arrangement in order to utilise the cargo space, to beware cargo items from tumbling around and to enable measures of common securing against transverse and longitudinal movement during transport.

4.2.2 A tight stow of uniform or variable cargo items should be planned and arranged according to principles of good packing practice, in particular observing the advice given in subsection 3.2 above. If coherence between items or tilting stability of items is poor, additional measures of compacting may be necessary like hooping or strapping batches of cargo items with steel or plastic tape or plastic sheeting. Gaps between cargo items or between cargo and CTU boundaries should be filled as necessary (see paragraphs 2.3.6 to 2.3.8). Direct contact of cargo items with CTU boundaries may require an interlayer of protecting material (see subsection 2.1).

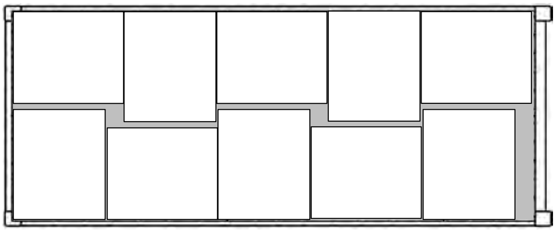


Figure 14.29 Packing 1,000 x 1,200mm unit loads into a 20ft container

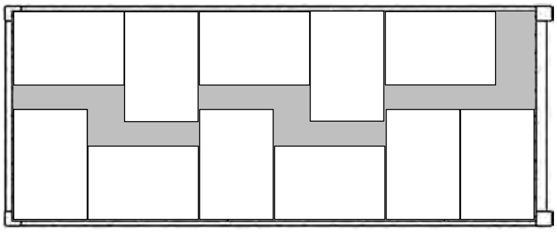


Figure 14.30 Packin 800 x 1,200mm unit loads into a 20ft container

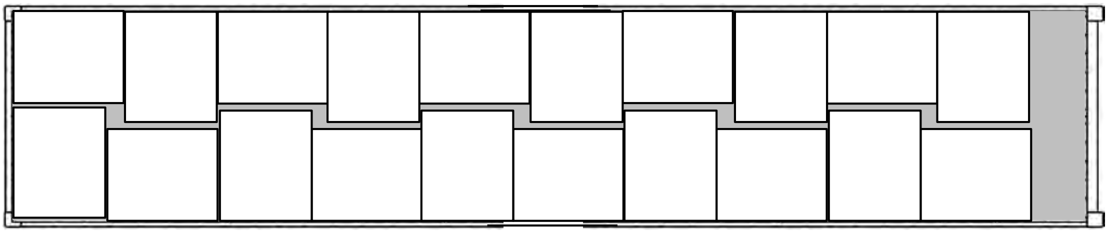


Figure 14.31 Packing 1,000 x 1,200mm unit loads into a 40ft container

4.2.3 CTUs with strong cargo space boundaries may inherently satisfy transverse and longitudinal securing requirements in many cases, depending on the type of CTU, the intended route of transport and appropriate friction among cargo items and between cargo and stowage ground.

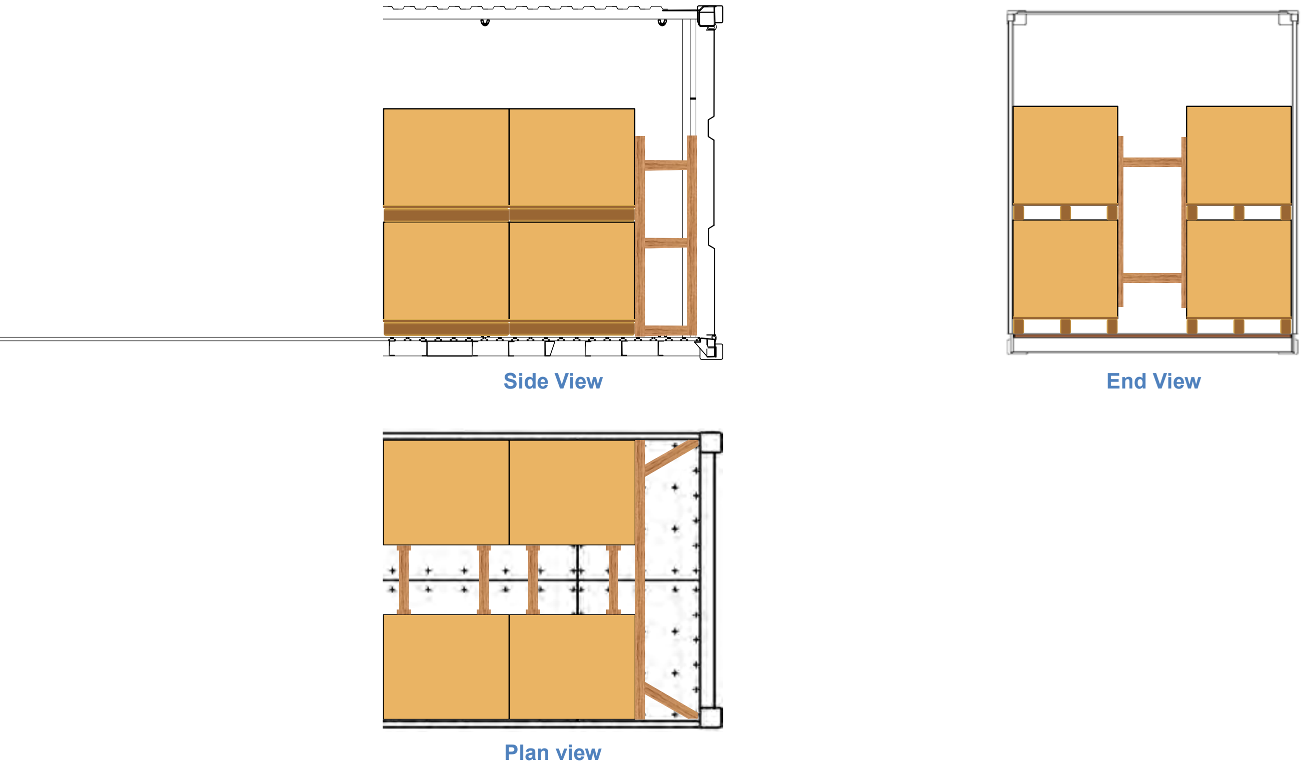


Figure 14.32 Blocking in a strong boundary CTU

4.2.4 The following balance demonstrates the confinement of tightly stowed cargo within strong cargo space boundaries:

$$a_{x,y} \cdot m \cdot g \;\le\; r_{x,y} \cdot P \cdot g + \mu \cdot a_z \cdot m \cdot g \text{ [kN]}$$

$a_{x,y}$ = horizontal acceleration coefficient in the relevant mode of transport (see Chapter 5),

m = mass of cargo loaded [t],

g = gravity acceleration 9.81 m/s^2,

$r_{x,y}$ = CTU wall resistance coefficient (see sub-section 7.2.5 in Code),

P = maximum payload of CTU (t)

μ = applicable friction coefficient between cargo and stowage ground (see Appendix 3),

a_z = vertical acceleration coefficient in the relevant mode of transport (see Chapter 5).

4.2.5 Critical situations may arise, e.g. with a fully loaded ISO box-container in road transport, where longitudinal securing must be able to withstand an acceleration of 0.8 g. The longitudinal wall resistance factor of 0.4 must be combined with a friction coefficient of at least 0.4 for satisfying the securing balance. If a balance cannot be satisfied, the mass of cargo must be reduced or the longitudinal forces must be transferred to the main structure of the container. The latter can be achieved by intermediate transverse fences of timber battens (see paragraph 2.3.4) or by other suitable means. Another option is the use of friction increasing material.

4.2.6 When the door end of a CTU is designed to provide a defined wall resistance (e.g. the doors of a general cargo container, (see sub-section 7.2.5 of the Code) the doors may be considered as a strong cargo space boundary, provided the cargo is stowed to avoid impact loads to the door end and to prevent the cargo from falling out when the doors are opened.

4.2.7 Where there is a risk that the forces on the door may exceed the designed limits of the CTU or where there is the need to stack packages at the centre of the CTU additional longitudinal blocking can be adopted.

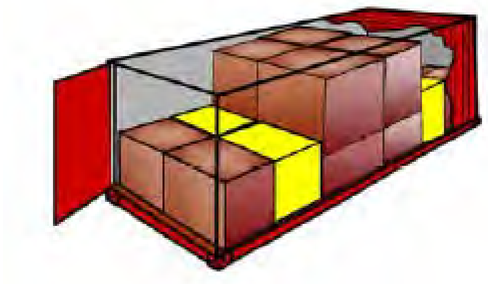


Figure 14.33 Threshold by height

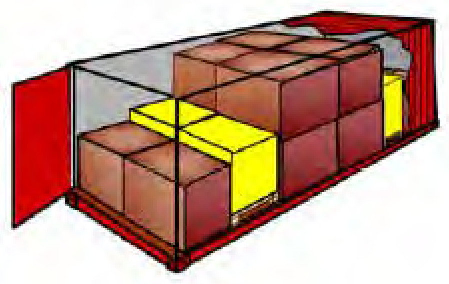


Figure 14.34 Threshold by elevation

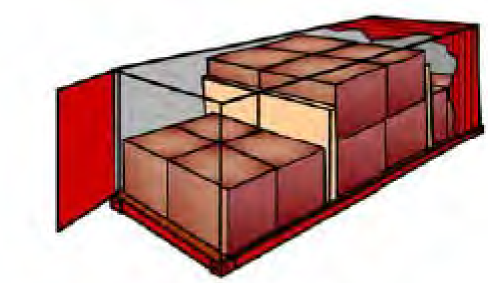


Figure 14.35 Threshold by board

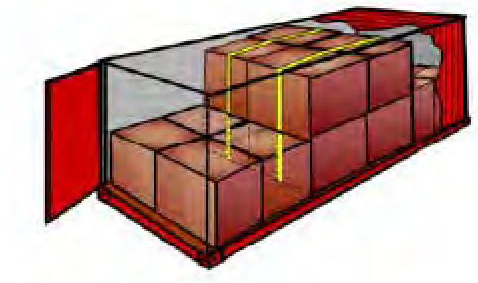


Figure 14.36 Round turn lashing

4.2.8 CTUs with **weak cargo space boundaries** like certain road vehicles and swap bodies will regularly require additional securing measures against sliding and tipping of a block of tightly stowed cargo. These measures should also contribute to compacting the block of cargo. The favourite method in this situation is friction-securing by so-called top-over lashings. For obtaining a reasonable securing effect from friction lashings, the friction coefficient between cargo and stowage ground should be sufficient and the inherent elasticity of the lashings should be able to maintain the pre-tension throughout the course of transport. The following balance demonstrates the confinement of tightly stowed cargo within weak cargo space boundaries and an additional securing force against sliding:

$$c_{x,y} \cdot m \cdot g \ \leq \ r_{x,y} \cdot P \cdot g + \mu \cdot c_z \cdot m \cdot g + F_{\text{sec}} + F_{dir}$$ [kN] (F_{sec} = additional securing force)

(F_{dir} = Direct lashing force)

If a wall resistance coefficient is not specified for the distinguished CTU, it should be set to zero. The additional securing (F_{sec}) may consist of blocking the base of the cargo against stronger footing of the otherwise weak cargo space boundary or bracing the block of cargo against stanchions of the cargo space boundary system. Such stanchions may be interconnected by pendants above the cargo for increasing their resistance potential. Alternatively, the additional securing force may be obtained by direct securing methods or top-over lashings. F_{sec} per top-over lashing is: $F_V \cdot \mu$, where F_V is the total vertical force from the pre-tension. For vertical lashings F_V is 1.8 times the pre-tension in the lashing.

4.2.9 On CTUs **without boundaries** the entire securing effect must be accomplished by securing measures like top-over lashings, friction increasing material and, if the CTU is a flatrack, by longitudinal blocking against the end-walls. The following balance demonstrates the securing of tightly stowed cargo on a CTU without cargo space boundaries:

$$c_{x,y} \cdot m \cdot g \ \leq \ \mu \cdot c_z \cdot m \cdot g + F_{\text{sec}}$$ [kN] (F_{sec} = additional securing force)

For F_{sec} see XXVIII.4.2.6. It should be noted that even in case of a friction coefficient that outnumbers the external acceleration coefficients, without cargo space boundaries a minimum number of top-over lashings is imperative for avoiding migration of the cargo due to shocks or vibration of the CTU during transport.

4.3 Individually secured packages

4.3.1 Packages of greater size, mass or shape or units with sensible exterior facing, which does not allow direct contact to other units or CTU boundaries, must be individually secured. The securing arrangement must be designed to prevent sliding and, where necessary, tipping, both in the longitudinal and transverse direction. Securing against tipping is necessary, if the following condition is true:

$$c_{x,y} \cdot d \geq c_z \cdot b \qquad \text{[kN]}$$

$c_{x,y}$ = horizontal acceleration coefficient in the relevant modes of transport (see Chapter 5),

d = vertical distance from centre of gravity of the unit to its tipping axis [m],

c_z = vertical acceleration coefficient in the relevant modes of transport (see Chapter 5).

b = horizontal distance from centre of gravity to tipping axis [m].

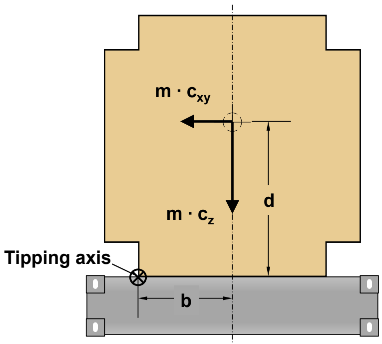


Figure 14.37 : Tipping criterion

4.3.2 Individually secured packages should preferably be secured by a direct securing method, i.e. by direct transfer of securing forces from the package to the CTU by means of lashings, shores or blocking.

4.3.2.1 A direct lashing will be between fixed fastening points on the package and the CTU and the effective strength of such a lashing is limited by the weakest element within the device, which includes fastening points on the package as well as fastening points on the CTU.

4.3.2.2 For sliding prevention by lashings the vertical lashing angle should preferably be in the range of 30° to 60°. For tipping prevention the lashings should be positioned in a way that provides effective levers related to the applicable tipping axis.

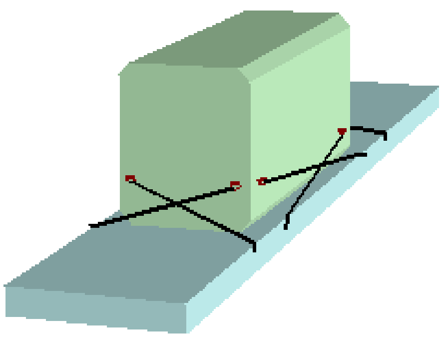


Figure 14.38 : Direct lashing against sliding

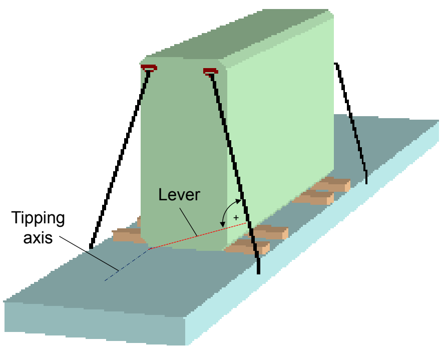


Figure 14.39 : Direct lashing against tipping

4.3.3 Packages without securing points should be either secured by shoring or blocking against solid structures of the CTU or by top-over, loop or spring lashings.

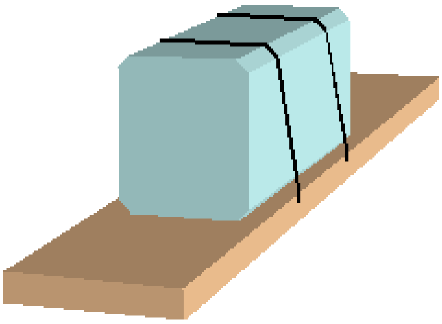


Figure 14.40 : Top over lashing

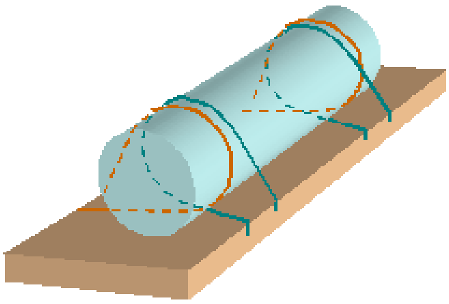


Figure 14.41 : Vertical half-loop lashing

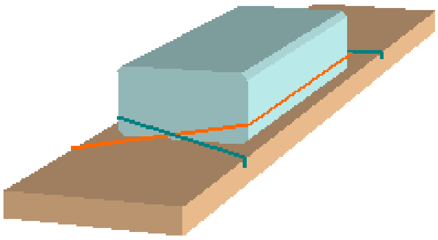


Figure 14.42 : Horizontal half-loop lashing

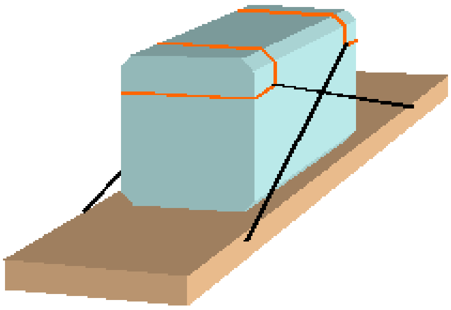


Figure 14.43 : Spring lashing

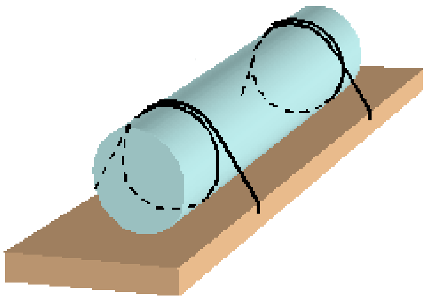


Figure 14.44 : Silly-loop lashing

4.3.3.1 Loop lashings with their ends fastened to either side (see Figure 14.44), also called "silly-loops", do not provide any direct securing effect and may permit the package to roll and therefore are not recommended

4.3.3.2 Corner fittings are available to provide alternative lashing to the spring lashing (Figure 14.43).

Figure 14.45 Corner Clip

Figure 14.46 Over width package with corner clip lashing

Figure 14.47 Package with corner clip from above

4.3.3.3 Any lashing method adopted will require that the lashing material stretches in order to develop a restraining force. As the material relaxes the tension in the lashing will slowly reduce, therefore it is important that the guidance given in 4.1.4 should be followed.

4.3.4 CTUs with **strong cargo space boundarie**s favour the method of blocking or shoring for securing a particular package. This method will minimise cargo mobility. Care should be taken that the restraining forces are transferred to the CTU boundaries in a way that excludes local overloading. Forces acting to CTU walls should be transferred by means of load spreading cross beams (see paragraphs 2.3.1 to 2.3.3). Very heavy packages, e.g. steel coils or blocks of marble, may require a combination of blocking and lashing, however with observation of the restrictions lined out in paragraph 4.1.6. Packages with sensible surface may rule out the blocking method and must be secured by lashings only.

Figure 14.48 : Transverse blocking of steel slab

4.3.5 Individual securing of packages in CTUs with **weak cargo space boundaries** and in CTUs **without boundaries** requires predominantly the method of lashing. Where applicable, blocking or shoring may be additionally applied, but if used in parallel with lashings, the restrictions lined out in paragraph 4.1.6 should be observed. Although the provision of good friction in the bedding of a package is recommended in any case, the use of top-over lashings for sliding prevention is discouraged unless the cargo has limited mass. Top-over lashings may be suitable for tipping prevention. In particular over-width packages, often shipped on flat bed CTUs, should not be secured solely by top-over lashings. The use of half loops and/or spring lashings is strongly recommended (see Figure 14.49 to Figure 14.51).

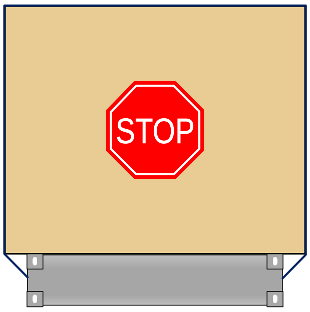


Figure 14.49 : Top-over lashing

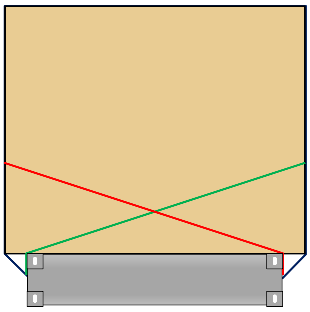


Figure 14.50 : Top-over and horizontal half-loop

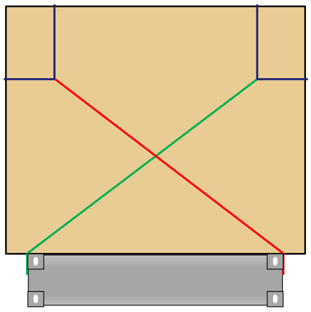


Figure 14.51 : Transverse spring lashing

4.3.6 Where horizontal half loops are used, a means must be provided to prevent the loops from sliding down the package.

4.3.7 Alternatively an over-width unit can be secured by half loops over the corners as shown in the figure below.

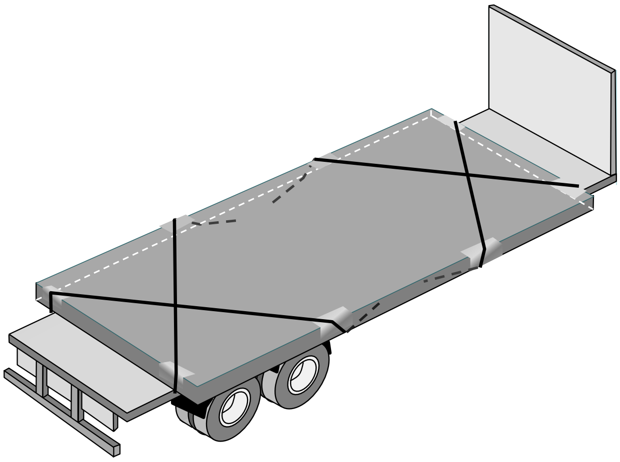


Figure 14.52 : Over-width package secured by diagonal half-loops

4.4 Evaluation of securing arrangements

4.4.1 Evaluation of securing arrangements means making up a balance of expected external forces and moments against the securing potential of the planned or implemented securing arrangement. Expected external forces should be determined by multiplying the applicable acceleration coefficient, given in Chapter 5 of this Code, with the weight of the package or block of packages in question.

$$F_{x,y} = m \cdot g \cdot c_{x,y} \quad \text{[kN]}$$

$F_{x,y}$ = expected external force [kN],

m = mass of cargo to be evaluated [t],

g = gravity acceleration 9.81m/s^2,

$c_{x,y}$ = horizontal acceleration coefficient in the relevant mode of transport (see Chapter 5).

Chapter 5 distinguishes three modes of transport, road, rail and sea. The sea transport mode is further subdivided into three categories of severity of ship motions, aligned to the significant wave height of distinguished sea areas. Therefore the selection of the applicable acceleration factor requires the full information on the intended mode and route of transport. Due consideration should be given to possible multi-modal transport, in order to identify the acceleration figures for the most demanding mode or leg of the transport route. These figures should be finally used for the evaluation of the securing arrangement.

4.4.2 The assessment of the securing potential includes the assumption of a friction coefficient, based on the combination of materials (Appendix 3) and the character of the securing arrangement (paragraph 2.2.2), and, if applicable, the determination of the inherent tilting stability of the cargo (paragraph 4.3.1). Any other securing devices used for blocking, shoring or lashing should be estimated by their strength in terms of MSL and relevant application parameters like securing angle and pre-tension. These figures are required for evaluating the securing arrangement.

4.4.3 In many cases the evaluation of a securing arrangement may be accomplished by means of a simple rule of thumb. However, such rules of thumb may be applicable for certain distinguished conditions of transport only, e.g. for sea transport, and may overshoot or fall short in other conditions. It is therefore advisable to phrase such rules of thumb for distinguished modes of transport and use them accordingly. Any phrasing of a rule of thumb should undergo a first-time check by means of an advanced assessment method.

4.4.4 Standardised assessment methods for the evaluation of securing arrangements may consist of appropriate pre-calculated tables, based on balance calculations, which give quick answers regarding the adequacy of a securing arrangement. Such methods may be directed to distinguished modes of transport, see Annex 5.

4.4.5 The evaluation of securing arrangements may be carried out by balancing forces and moments by an elementary calculation. However, the method used should be approved and suitable to the purpose. References:

- IMO CSS-Code, Annex 13, for sea transport,
- European Standard EN 12195-1:2010, for road transport,
- International Union of Railways (UIC), Agreement governing the exchange and use of wagons between Railway Undertakings (RIV 2000) Annex II, for rail transport.

4.4.6 The suitability of a specific securing arrangement may be evaluated and approved by a type-test. A simple form of such a type-test is the tilting test, which may be carried out by means of a dump truck or a platform and a crane. The test may be used to demonstrate resistance against any specified external acceleration. The corresponding test-angle depends on the existing friction coefficient for a sliding resistance test, or on the relation b/d for a tipping resistance test (see Appendix 4.1).

5 Packing bulk material

5.1 Non-regulated liquids in tank containers

5.1.1 Tank CTUs filled with liquids having a viscosity less than 2,680 mm^2/s at 20°C and to be transported by road, rail or sea should be filled to at least 80% of their volume for avoiding dangerous surging, but never more than 95% of their volume, unless specified otherwise. A filing ratio of maximum 20% is also accepted. A filling ratio of more than 20% and less than 80% is only permitted when the tank shell is subdivided, by partitions or surge plates, into sections of not more than 7500 l capacity.

5.1.2 The tank shell and all fittings, valves and gaskets should be compatible with the goods to be carried in that tank. In case of doubt, the owner or operator of the tank should be contacted. All valves should be correctly closed and checked for leak tightness.

5.1.3 For the transport of food stuff, the tank should comply with the following requirements:

- all parts of the tank which are in direct contact with the food stuff should be so conditioned that the overall food-grade property of the tank is guaranteed,
- the tank should be easily accessible and suitable for cleaning and disinfection,
- inspection of the interior should be possible,
- the exterior should be conspicuously marked with a marking “FOR FOOD STUFF ONLY” or with a similar wording.

5.2 Liquids in flexitanks

5.2.1 Flexitanks used for the transport of bulk liquids by road, rail or sea should carry a label that confirms the type approval by a recognised consultative body. The transportation of dangerous goods in flexitanks is prohibited.

5.2.2 During transport the contents of a flexitank will be subject to dynamic forces without significant retention from friction. These forces will act upon the boundaries of the CTU and may cause damage or complete failure. The design / construction of a flexitank should prevent the container from suffering bulging damage and comply with PAS 1008[9].

5.2.3 Therefore the payload of a CTU should be appropriately reduced, when it is used for carrying a loaded flexitank. The reduction depends on the type of CTU and on the mode of transport. When a flexitank is loaded into a general purpose ISO box container, the mass of the liquid in the flexitank should not exceed 24 tonnes or the volume should not exceed 24,000 litres whichever is the larger.

[9] PAS 1008, Specification for a flexitank used for the transportation of a liquid Under development BSi.

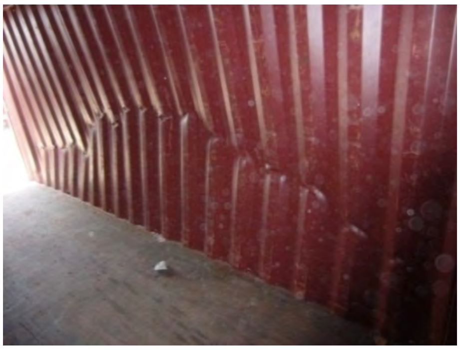


Figure 14.53 : Damaged CTU side wall

5.2.4 Road vehicles intended to carry loaded flexitanks should have boundaries of a certified strength that is sufficient to confine the weight of the cargo under the accepted load assumptions. The certification of fitness of the vehicle should explicitly address the bulk transport of liquid under the assumption of zero-friction. Nevertheless, the lining of the bottom of the loading area with friction increasing material and the application of over-the-top fibre belt lashings every two metres is recommended for stabilising the position and the strength of the flexitank.

5.2.5 Before being fitted with a flexitank, the CTU should be carefully inspected for structural integrity and fully functional locking bars for each door panel. The CTU should then be prepared by thorough cleaning, removing of all obstacles like protruding nails and by lining the bottom and walls with cardboard. In 40'-containers plywood should be used for lining of the side walls in order to avoid bulging damage. The door end of the CTU should be reinforced by battens, fitted into suitable recesses, and by a strong lining of cardboard or plywood. If the flexitank is equipped with a bottom connection tube, this lining should have an aperture matching with the position of the tube in way of the right hand door. The empty flexitank should be unfolded and laid out accurately to facilitate a smooth filling process.

Figure 14.54 : Container fitted with flexitank

5.2.6 For filling an empty flexitank the left hand door of the CTU should be firmly closed so that the inserted barrier is appropriately supported. The flexitank should be filled at a controlled rate. The use of spill protection devices like collecting bag or drip tray is recommended. After filling and sealing the tank the door of the CTU should be closed and a warning label should be attached on the left hand door panel. No part of the flexitank or retaining battens or bulkhead should touch either door when fully loaded.

Figure 14.55 : Flexitank warning label

5.2.7 For unloading a flexitank, the right hand door of the CTU should be opened carefully for getting access to the top or bottom connection tube of the flexitank. The left hand door must be kept closed until the flexitank is substantially empty. The use of spill protection devices like collecting bag or drip tray is recommended. The empty flexitank should be disposed according to applicable regulations.

5.3 Non-regulated solid bulk cargoes

5.3.1 Non-regulated solid bulk cargoes may be loaded into a CTU provided the boundaries of the cargo space are capable to withstand the static and dynamic forces of the bulk material under the foreseeable transport conditions (see Chapter 5).

5.3.2 The most common container in the world is the 20 ft general purpose dry freight container and it is these containers are most commonly used for carry dry bulk cargoes. However the design requirements of these containers are not always totally suitable for dry bulk cargoes, especially free flowing powders and granules. For instances extremely free flowing materials can damage the side and end walls due to stresses induced during intermodal transport where there is high sideway acceleration, such as turning a sharp corner on a road vehicle.

Figure 14.56 Bulging wall

5.3.3 Additionally the rear doors are the only means of access into the container and so need to be opened to load and remove the cargo. When transporting free flowing materials opening the rear doors may result in the cargo falling from the container with the associated injury to cargo handlers and loss of cargo. Therefore in order to transport powders and granules in general purpose containers false walls, known as bulkheads, need to be erected at the rear end to retain the cargo when one or both doors are opened.

5.3.4 ISO box containers are equipped with shoring slots in the door corner posts which are suitable to accommodate transverse steel bars of 60 mm square cross section. This arrangement is particularly designed to strengthen the container door end for taking a load of 0.6 P, as required for solid bulk cargoes. These bars should be properly inserted. The relevant transport capability of the CTU should be demonstrated by a case-related certificate issued by a recognised consultative body or by an independent cargo surveyor. This requirement applies in particular to multi-purpose ISO box containers and to similar closed CTUs on road vehicles, which are not explicitly designed to carry bulk cargoes.

5.3.5 It may be necessary to reinforce side and front walls of the CTU by plywood or chipboard facing in order to protect them from bulging or scratching.

Figure 14.57 : Lined 40' container

5.3.6 The CTU intended to carry a bulk cargo should be cleaned and prepared adequately as described under paragraph 5.2.5, in particular if a cargo-specific liner shall be used for accommodating bulk cargoes like grain, coffee beans or similar sensible materials.

Figure 14.58 : Container with bulk material liner

Figure 14.59 Container with bulk material liner and integral bars

5.3.7 Figure 14.59 shows an example of a bulk liner fitted to general purpose containers where the cargo is blown in through the central circular hole and then discharged through the flap at the bottom.

5.3.8 For all the CTU options apart from the box CTU, the best loading would be from an overhead silo feeding directly into the top loading hatches. For rear loading box type CTUs overhead silos can either feed a pump for blown loading or a conveyor feeder (see Figure 14.60 and Figure 14.61). Shippers can use alternative methods. Elevators such as shown in Figure 14.63 permit product to be loaded into a ground level hopper and then pumped up to feed into the rear or top hatch of any container.

Figure 14.60 Retractable nozzle

Figure 14.61 Retractable conveyor

Figure 14.62 Powder nozzle

Figure 14.63 Elevator

5.3.9 These loading methods do have restrictions, and it requires the loading operators to understand the “flowability” of the product being loaded so that it is evenly distributed across the entire container by gradually withdrawing the conveyor / blow pipe. Powders and grains which have a high angle of repose may settle unevenly and cause the ecentricity of the bulk material in the CTU which could result in handling difficulties.

5.3.10 Powders and granules when blown can be quite abrasive and during the loading operation care must be taken to ensure that the liner or the CTU is not damaged.

5.3.11 When using box type CTUs it should be recognised that it will have been used to transport a variety of cargoes, some of which may constitute a contaminate to the powder or granule to be carried. While shipping companies and owners will endeavour to ensure that CTUs are clean before delivery to a shipper, it is the shippers' responsibility to ensure that the CTU is fit for use before loading. Likewise after the shipment has been made, the consignee must clean the interior of the container to remove all traces of the cargo carried. Siftproof liners make the cleaning process easier, but they do not totally eliminate the need for pre and post laden cleaning.

5.3.12 Small and fine powders and grains if not contained within a liner may fall out through the doors during transport due to vibration. It is therefore recommended that all dry bulk cargoes are only carried within a suitable liner.

5.3.13 If crude or dirty material shall be transported, the CTU boundaries should be lined with plywood or chipboard for avoiding mechanical wastage of the CTU. In all cases an appropriate door protection should be installed consisting of battens fitted into suitable recesses and complemented by a strong plywood liner.

Figure 14.64 : Lined container loaded with scrap

5.3.14 Scrap and similar waste material to be carried in bulk in a CTU should be sufficiently dry to avoid leakage and subsequent contamination of the environment or other CTUs, if stacked ashore or transported in a vessel.

5.3.15 Depending on the internal friction and the angle of repose of the solid bulk cargo, the CTU may be inclined to a certain degree, to facilitate the loading or unloading operation. However, it should always be ensured that the walls of the CTU are not overstressed by the filling operation. It is not acceptable to turn a CTU by 90° to an upright position for filling, unless the CTU is especially approved for this method of handling.

5.3.16 Unloading containers is generally far easier than loading as gravity can greatly assist the process. All types of container apart from the vertical hopper type container can be tipped either on specialist tipping equipment or, as is becoming more popular, using tipping chassis / trailers.

5.3.17 Tipping trailers are available for all sizes of containers including 45 ft long. Figure 14.65 shows a fixed tipping device designed for 45 ft long containers. Fully laden (40 tonne) containers are lifted from the road transport on to the tipping frame. The frame has a wide base for stability during the lifting process.

Figure 14.65 Container tipping frame

5.3.18 When operating tipping trailers, especially the longer lengths, it is important that care is taken to ensure that the container is securely attached to the trailer and that the trailer is stabilised to prevent it from falling over.

5.3.19 The sketch in Figure 14.66 shows diagrammatic representations of the unloading process - in this case the cargo is pumped directly into a silo. An alternative to this would be the tipped trailer discharging directly into a ground level hopper.

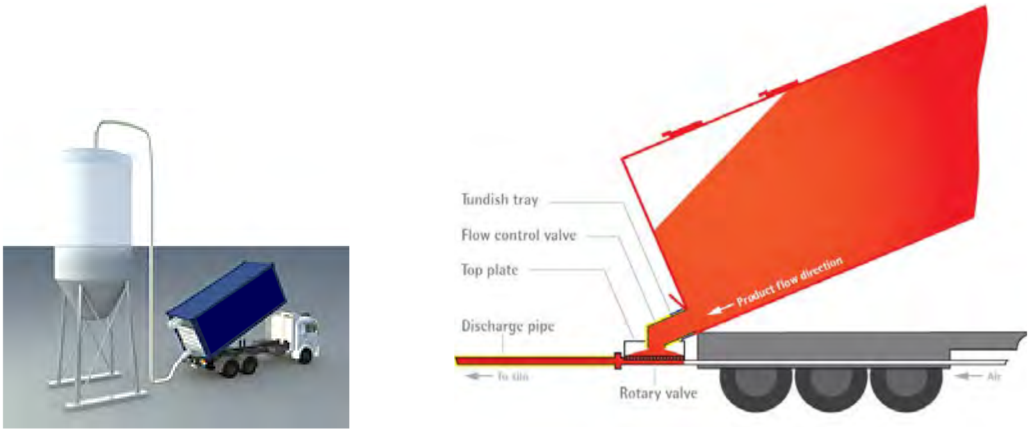


Figure 14.66 Discharge options

Appendix 1. Packaging marks

1 Introduction

1.1 Packages are often marked with handling instructions in the language of the country of origin. While this may safeguard the consignment to some extent, it is of little value for goods consigned to, or through, countries using different languages, and of no value at all if people handling the packages are illiterate.

1.2 Pictorial symbols offer the best possibility of conveying the consignor's intention and their adoption will, therefore, undoubtedly reduce loss and damage through incorrect handling.

1.3 The use of pictorial symbols does not provide any guarantee of satisfactory handling; proper protective packaging is therefore of primary importance.

1.4 The symbols shown in this annex are those most regularly exhibited and there others available in the international standard 7000.[10]

2 Symbols

1.5 Display of symbols

2.1.1 Symbols should preferably be stencilled directly on the package or may appear on a label. It is recommended that the symbols be painted, printed or otherwise reproduced as specified in this International Standard. They need not be framed by border lines.

2.1.2 The graphical design of each symbol shall have only one meaning; symbols are purposely designed so that they can also be stencilled without changing the graphics.

1.6 Colour of symbols

2.1.3 The colour used for symbols shall be black. If the colour of the package is such that the black symbol would not show clearly, a panel of a suitable contrasting colour, preferably white, shall be provided as a background.

2.1.4 Care shall be taken to avoid the use of colours which could result in confusion with the labelling of dangerous goods. The use of red, orange or yellow shall be avoided unless regional or national regulations require such use.

1.7 Size of symbols

For normal purposes the overall height of the symbols shall be 100 mm, 150 mm or 200 mm. The size or shape of the package may, however, necessitate use of larger or smaller sizes for the symbols.

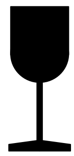
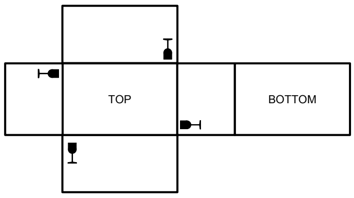
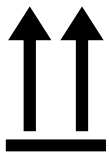
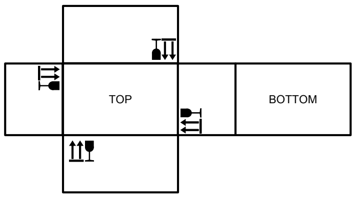
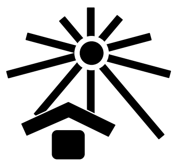
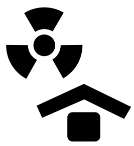
1.8 Positioning of symbols

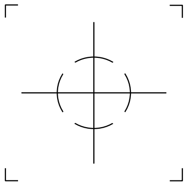
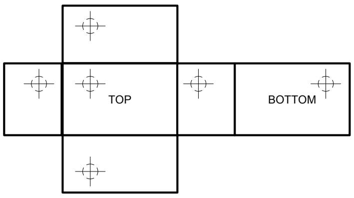
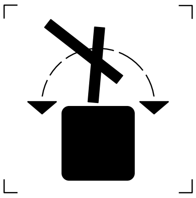
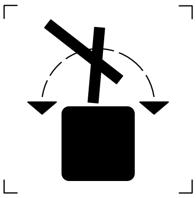
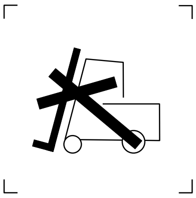
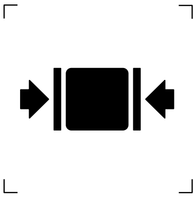
Particular attention shall be paid to the correct application of the symbols, as faulty application may lead to misinterpretation. Symbols No. 7 and No. 16 shall be applied in their correct respective positions and in appropriate respective places in order to convey the meaning clearly and fully.

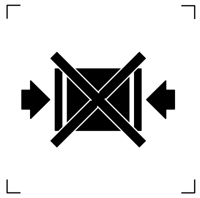
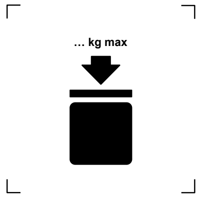
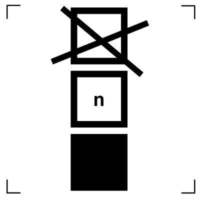
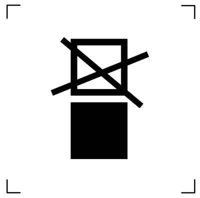
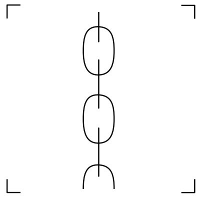
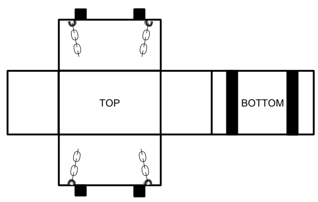
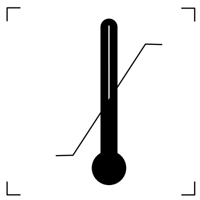
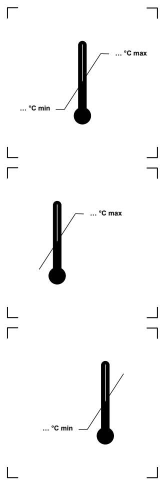
3 Handling instructions

Handling instructions shall be indicated on transport packages by using the corresponding symbols given in the following table.

[10] ISO 7000: 1989. Graphical symbols for use on equipment – Index and synopsis.

No.	Instruction / Information	Symbol	Meaning	Special Instructions
1	FRAGILE		Contents of the package are fragile therefore need to be handled with care.	Shown near the left-hand upper corner on all four upright sides of the package. 
2	USE NO HAND HOOKS		Hooks are prohibited for handling packages	
3	THIS WAY UP		Indicates correct orientation of the package	Shown as symbol No. 1. Where both symbols are required, symbol No. 3 shall appear nearer to the corner 
4	KEEP AWAY FROM SUNLIGHT		Package should not be exposed to sunlight.	
5	PROTECT FROM RADIOACTIVE SOURCES		Contents of the package may deteriorate or may be rendered totally unusable by penetrating radiation	
6	KEEP AWAY FROM RAIN		Package should be kept away from rain and dry	

No.	Instruction / Information	Symbol	Meaning	Special Instructions
7	CENTRE OF GRAVITY		Indicates the centre of gravity of the package	Where possible, "Centre of gravity" shall be placed on all six sides but at least on the four lateral sides relating to the actual location of the centre of gravity 
8	DO NOT ROLL		Package should not be rolled	
9	DO NOT USE HAND TRUCK HERE		Hand trucks should not be placed on this side when handling	
10	USE NO FORKS		Package should not be handled by fork lift trucks	
11	CLAMP AS INDICATED		Clamps should be placed on the sides indicated for handling	The symbol shall be positioned on two opposite faces of the package so that it is in the visual range of the clamp truck operator when approaching to carry out operation. The symbol shall not be marked on those faces of the package intended to be gripped by the clamps.

No.	Instruction / Information	Symbol	Meaning	Special Instructions
12	DO NOT CLAMP AS INDICATED		Package should not be handled by clamps on the sides indicated	
13	STACKING LIMITED BY MASS		Indicates the maximum stacking load permitted.	
14	STACKING LIMITED BY NUMBER		Maximum number of identical packages that may be stacked above, where “n” is the limiting number.	
15	DO NOT STACK		Stacking the package is not permitted and nothing should be placed on top.	
16	SLING HERE		Slings for lifting should be placed where indicated 	Shall be placed on at least two opposite faces of the package
17	TEMPERATURE LIMITS		Indicates the temperature limit within which the package should be stored and handled.	

Appendix 2. Carton performance

1 Introduction

1.9 Corrugated fibreboard can be evaluated by many material test methods including an edge crush test. There have been efforts to estimate the compression strength of a carton (usually empty, regular single-wall slotted containers, top-to-bottom) based on various board properties. Some have involved finite element analysis. One of the commonly referenced empirical estimations was published by McKee in 1963. This used the board edge crush test (ECT), the machine directions (MD) and cross direction (CD) flexural stiffness, the carton perimeter, and the carton depth. Simplifications have used a formula involving the board ECT, the board thickness, and the carton perimeter. Most estimation do not relate well to other carton orientations, carton styles, or to filled cartons.

2 Definitions

Basis Weight	A measure of the weight of cartonboard in a given area. The greater the basis weight the stronger the cartonboard. This is expressed either as grams per square meter (metric) or pounds per one thousand square feet (imperial).
Box compression strength (BCT)	The maximum load a given carton can stand for a moment.
Brightness	A measure of the light reflected from the clay surface of the cartonboard. The higher the brightness measurement, the more vibrant and precise the colour reproduction will be.
Bursting strength	A property of paper or paperboard used in packaging that measures its resistance to rupturing, defined as the hydrostatic pressure needed to burst a paperboard sample when it is applied uniformly across its side. Bursting strength is a function of various processes performed in the papermaking process.
Calliper	A measure of carton board thickness. It is expressed as microns (metric) or points (imperial)
Cross Direction (CD) Stiffness	A measure of the force required to bend the sheet in the cross direction orientation of the paper machine flow. When fed grain long during printing, a lower CD stiffness is advantageous. The sheets will contour around the cylinder, resulting in less scuffing and marking on the trailing edge of the sheet. In addition faster press speeds can be achieved. Expressed as milliNewton meters (metric) or Taber units (imperial).
Density	A measure of the basis weight per single calliper unit. During printing, higher density cartonboard will have improved colour-to-colour register as the sheet does not stretch when passing through press nip points. It may also permit the use of a more cost-effective lower calliper cartonboard
Machine Direction (MD) Stiffness	A measure of the force required to bend the sheet in the same orientation as the paper machine flow. MD stiffness is an important indicator of cartonboard strength as it provides increased cartonboard rigidity and fill line speeds for many manufacturers. It is expressed as milliNewton meters (metric) or Taber units (imperial).
MD/CD Ratio	A composite measure of cartonboard performance based on strength characteristics. The higher the ratio, the better the on press and fill line performance of the board
Plybond	A measure of the internal bond strength of the individual plies of cartonboard. A higher result indicates higher strength. High plybond strength will ensure that the cartonboard will not come apart during converting and will also help to ensure that the finished carton maintains its integrity throughout the supply chain. Expressed as kilograms per square centimetre (metric) or pounds per square inch (imperial).
Smoothness	A measure of the surface smoothness characteristics of the cartonboard expressed as micrometers. A lower result indicates a smoother sheet. A smoother sheet surface provides for enhanced colour laydown and improved press printing efficiency.
Stacking strength	The maximum load a carton can stand throughout the distribution cycle.

2 Manufacture of corrugated board

2.1 In the classical corrugator, the paper is softened with high-pressure steam. After the board is formed it is dried in the so-called dry-end. Here the newly formed corrugated board is heated from the bottom by hot plates. On the top, various pressures are applied by a load system on the belt.

2.2 The corrugated medium (middle) is often 0.026 pounds per square foot (0.13 kg/m²) basis weight in the U.S.; in the UK, a 90 grams per square metre (0.018 lbs/ft²) fluting paper is common. At the single-facer, it is heated, moistened, and formed into a fluted pattern on geared wheels. This is joined to a flat linerboard with a starch based adhesive to form single face board. At the double-backer, a second flat linerboard is adhered to the other side of the fluted medium to form single wall corrugated board. Linerboards are test liners (recycled paper) or kraft paperboard (of various grades). The liner may be bleached white, mottled white, coloured, or pre-printed.

2.3 Common flute sizes are "A", "B", "C", "E" and "F" or microflute. The letter designation relates to the order that the flutes were invented, not the relative sizes. Flute size refers to the number of flutes per linear foot, although the actual flute dimensions for different corrugator manufacturers may vary slightly. Measuring the number of flutes per linear foot is a more reliable method of identifying flute size than measuring board thickness, which can vary due to manufacturing conditions. The most common flute size in corrugated boxes is "C" flute.

Flute Designation	Flutes per linear foot	Flute thickness (in)	Flutes per linear meter	Flute thickness (mm)
A flute	33 +/– 3	3/16	108 +/– 10	4.8
B flute	47 +/– 3	1/8	154 +/– 10	3.2
C flute	39 +/– 3	5/32	128 +/– 10	4
E flute	90 +/– 4	1/16	295 +/– 13	1.6
F flute	128 +/– 4	3/16	420 +/– 13	0.8

Figure 14.67

2.4 Corrugated board can be specified by the construction (single face, single-wall, double-wall, etc.), flute size, burst strength, edge crush strength, flat crush, basis weights of components (pounds per thousand square feet, grams per square meter, etc.), surface treatments and coatings, etc.

2.5 The choice of corrugated medium, flute size, combining adhesive, and linerboards can be varied to engineer a corrugated board with specific properties to match a wide variety of potential uses. Double and triple-wall corrugated board is also produced for high stacking strength and puncture resistance.

3 Test methods

3.1 Carton strength

2.1.1 The strength of a corrugated carton starts with its material. A corrugated sheet consists of two major components - linerboard and medium. Linerboard is the flat paper that covers both sides of the sheet and the medium is the "fluted" or arched paper found between both liners. The flute, when anchored to the linerboards with a starched-based adhesive, resists bending and pressure from all directions. When placed vertically on its ends, the flutes form vertical columns, capable of supporting considerable amounts of weight.

2.1.2 Flutes come in five basic heights and shapes - the most common are "B-Flute"(used for die-cut cartons) and "C-Flute (used for Regular slotted cartons (RSCs). B-flute is compressed and appears thinner but as it is made with more paper it may provide stronger side wall protection from blows and punctures. C-flute is taller, with more air space, but offers enhanced stacking strength. For excellent graphic reproduction, consider E-flute.

2.1.3 The amount of virgin pulp fibres and the length of those fibres in a corrugated sheet substantially contribute to carton strength. For example, the difference between a 200# test carton and a 275# test carton is that the latter has more pulp fibres in its corrugated linerboard. The 200# test carton is rated to hold up to 65 lbs (29.5 kg). of carton and contents while the 275# carton can hold up to 95 lbs (43.1 kg). A 350# test carton is rated to hold up to 120 lbs (54.4 kg). of carton and contents.

2.1.4 The strength of the carton can be measured in two different ways

3.2 Mullen

2.1.5 A test performed to measure the bursting strength of paper or paperboard. In a Mullen test (also called a pop test), the paper sample is placed between two ring-like clamps in a device called a Mullen tester, and hydraulic pressure is used to inflate a rubber diaphragm, which expands against the sample stretching it. The measure of the total hydraulic pressure expanding the diaphragm at the time the sample ruptures (usually expressed in either pounds per square inch or kilopascals) is its bursting strength. Mullen tests are performed for each side of a paper or paperboard, and the bursting strength can be expressed as the average of both sides. Bursting strength expressed as a percentage is called the percent Mullen.

2.1.6 As far as Classification rules go, the mullen test is fairly easy to understand and easy to administer. However it is thought to correlate poorly with another important carton characteristic, stacking strength. In 1990 the trade associations for the corrugated industry sponsored proposals to revise their rules thus paving the way for an alternative rule for measuring carton strength, ECT.

3.3 Edge crust test (ECT)

2.1.7 The Edge Crush Test (ECT) measures the ability of combined board to sustain a top-to-bottom load. The strength is directly related to the compression strength of both the liners and medium. There are two gauges of strength. Box compression strength (BCT) is the maximum load a given carton can stand for a moment. Stacking strength is the maximum load a carton can stand throughout the distribution cycle. This means that the bottom carton must support the top load over a period of time in which it may be exposed to fluctuations in temperature and humidity as well as other factors that impact performance such as handling, pallet patterns, pallet deck board spacing, and overhang. All these factors weaken the stacking strength of the carton. Therefore the stacking strength of a carton is almost always much lower than its compression strength. The most commonly used carton style is the Regular Slotted Container (RSC). The McKee formula is a formula that can estimate the compression strength of a given carton. This is useful information when designing a package. By knowing the compression strength and carefully considering all the potential detractors encountered throughout the distribution cycle the designer may better determine the ECT test required to achieve the desired stacking strength.

2.1.8 McKee also created a simpler formula based on calliper of the combined board instead of bending stiffness

$$BCT = 5.87 \times ECT \times \sqrt{(\text{calliper of combined board} \times \text{carton perimeter})}$$

2.1.9 It provides accuracy close to the original equation and is easier to use, both in testing and mathematically. McKee's work was based on averages. Individual cartones will vary above and below the predicted value. The ability to predict the compression strength of a container is a considerable tool, but it is even more powerful to take a compression requirement, back out an ECT requirement and use it to determine appropriate board combinations. Solving for Ea, the simplified McKee formula is:

$$ECT = BCT / (5.87 \times \sqrt{(\text{calliper of combined board} \times \text{carton perimeter})}\}$$

3.4 Distribution environment and carton performance

2.1.10 The ability of a container to perform in distribution is significantly impacted by the conditions it encounters throughout the cycle. Some of these conditions are difficult for the packaging engineer to influence, including stacking time and relative humidity. Others are determined by handling and unitizing packages; for example, pallet patterns, pallet overhang, pallet deck board gaps and excessive handling. We can now estimate the impact of these conditions on container strength. If the original carton compression strength is known (determined in the lab using a dynamic compression tester), we can factor it by generally accepted multipliers to arrive at an estimated maximum safe stacking strength.

	Compression Loss	Multipliers	
Storage time under load	10 days-37 percent loss	.63	
	30 days-40 percent loss	.6	
	90 days-45 percent loss	.55	
	180 days-50 percent loss	.5	
Relative humidity, under load (cyclical RH variation further increases compressive loss)	50 percent-"--0 percent loss	1	
	60 percent-10 percent loss	.9	
	70 percent-20 percent loss	.8	
	80 percent-32 percent loss	.68	
	90 percent-52 percent loss	.48	
	100 percent-85 percent loss	.15	
Pallet Patterns		**Best Case**	**Worst case**
Columnar, aligned	Negligible loss	.9	.85
Columnar, misaligned	10-15 percentloss	.6	.4
Interlocked	40-60 percent loss	.8	.6
Pallet deckboard gap	10-25 percent loss	.9	.75
Excessive handling	10-40 percent loss	.9	.6

Appendix 3. Friction factors

Different material contacts have different friction factors. The table below shows recommended values for the friction factors. The values are valid provided that both contact surfaces are “swept clean” and free from any impurities. The values are valid for the static friction. In case of direct lashings, where the cargo has to move little before the elongation of the lashings provides the desired restraint force, the dynamic friction applies, which is to be taken as 70% of the static friction.

Material combination in contact surface	**Dry**	**Wet**
SAWN TIMBER/WOODEN PALLET		
Sawn timber/wooden pallet against plywood/wood	0.45	0.45
Sawn timber/wooden pallet against grooved aluminium	0.4	0.4
Sawn timber/wooden pallet against stainless steel sheet	0.3	0.3
Sawn timber/wooden pallet against shrink film	0.3	-
PLANED WOOD		
Planed wood against fabric base laminate/plywood	0.3	0.3
Planed wood against grooved aluminium	0.25	0.25
Planed wood against smooth steel	0.3	0.3
PLASTIC PALLETS		
Plastic pallet against plywood/wood	0.2	0.2
Plastic pallet against grooved aluminium	0.15	0.15
Plastic pallet against smooth steel sheet	0.15	0.15
CARDBOARD (UNTREATED)		
Cardboard against cardboard	0.5	-
Cardboard against wooden pallet	0.5	-
BIG BAG		
Big bag against wooden pallet	0.4	-
STEEL AND SHEET METAL		
Flat steel against sawn timber	0.5	-
Unpainted metal with rough surface against sawn timber	0.5	-
Painted metal with rough surface against sawn timber	0.5	-
Unpainted metal with rough surface against unpainted rough metal	0.4	-
Painted metal with rough surface against painted rough metal	0.3	-
Painted metal with smooth surface against painted smooth metal	0.2	-
Metal with smooth surface against metal with smooth surface	0.2	

Material combination in contact surface	**Dry**	**Wet**
STEEL CRATES		
Steel crate against plywood/plyfa/wood	0.45	0.45
Steel crate against grooved aluminium	0.3	0.3
Steel crate against smooth steel	0.2	0.2
CONCRETE		
Concrete with rough surface against sawn wood	0.7	0.7
Concrete with smooth surface against sawn wood	0.55	0.55
ANTI-SLIP MATERIAL		
Rubber against other materials when contact surfaces are clean	0.6	0.6]

It has to be ensured, that the used friction coefficients are applicable to the actual transport. When a combination of contact surfaces is missing in the table above or if its coefficient cannot be verified in another way, the maximum allowed μ static to be used is 0.3. If the surface contacts are not swept clean, free from frost, ice and snow a friction coefficient larger than μ = 0.2 shall not be used[11] . For oily and greasy surfaces or when slip sheets have been used, a static friction of μ = 0.1 applies.

[11] For sea transport see CSS Code Annex 13 subsection 7.2.

Appendix 4. Practical methods for the determination of the friction factor μ

To determine the friction factor μ two alternative methods are given. A practical approach to make an assumption on the applicable friction factor is the inclination test which can be carried out by any party involved in the packing of a CTU. The accurate method to determine the exact friction factor is the pulling test which however needs laboratory equipment.

1 Inclination test

The factor μ states, how lightly a cargo will slide if the cargo platform is tilted. A method to find μ is to incline a cargo platform carrying the cargo in question, and measure the angle (α) at which the cargo starts to slide. This gives the friction factor $\mu = 0.925 \cdot \tan \alpha$. Five tests have to be done under practical and realistic conditions, the largest and the lowest result shall be cancelled. The medium of the three counting results is the friction to be used.

2 Pulling test

2.1 The test rig consists of the following components:

- horizontal floor with a surface representing the cargo platform
- test device for tensile tests
- connecting device between the test equipment and the bottom of the package
- PC based evaluation system.

The tensile device shall meet ISO 7500-1.

2.2 The test conditions have to correspond with real ones; the contact surfaces have to be "swept clean" and free from impurities. Tests should be executed in an atmospheric condition 5 in accordance with ISO 2233:2001 at a temperature of + 20°C and 65% relative humidity.

2.3 The pulling speed should be 100mm / min, the sampling rate shall be at least 50 Hz.

2.4 A measurement of pulling force and way of displacement is made with the same test object in one arrangement with a respective glide path of 50 mm to 85 mm for each stroke. At least three individual strokes have to be carried out with an intermediate unloading of at least 30% of the pulling force per measurement.

2.5 A measurement series consists of three measurements for each of three strokes. The test piece and / or anti slip material has to be replaced for each measurement, so that any influence of material wear on the result of the measurement can be excluded.

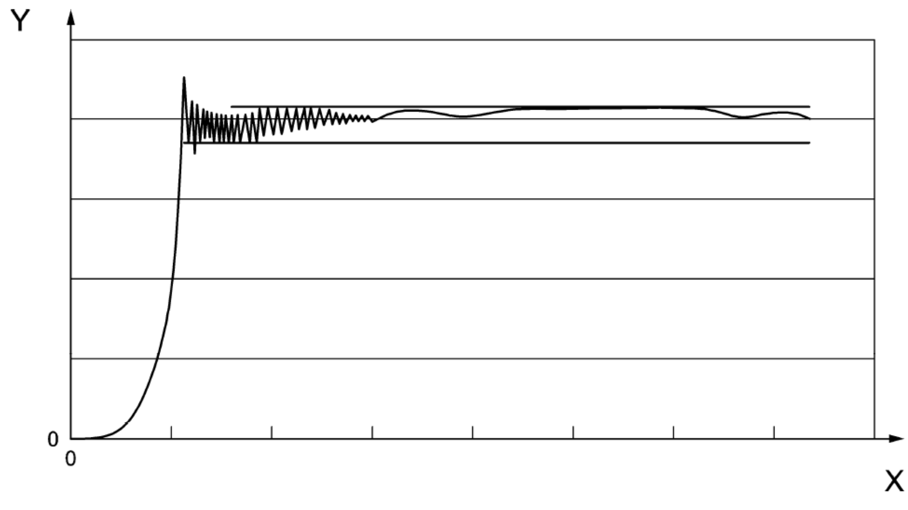


Figure 14.68

Key:

Y – Pulling force X - Direction of displacement

2.6 The friction factor μ has to be determined according to the equation mentioned below, taking into account the three medium values of each of the three measurements:

$$\mu = (\text{pulling force} \cdot 0.95) / (\text{weight} \cdot 0.925)$$

2.7 For a most realistic determination of frictional forces and coefficients of friction, multiple measurements series should be executed, each with different test samples for cargo area, anti-slip mat and load bearer or load."

Appendix 5. Specific packing and securing calculations

1 Resistivity of transverse battens

The attainable resistance forces F of an arrangement of battens may be determined by the formula:

$$F = n \cdot \frac{w^2 \cdot h}{28 \cdot L} \text{ [kN]}$$

n = number of battens

w = thickness of battens [cm]

h = height of battens [cm]

L = free length of battens [m]

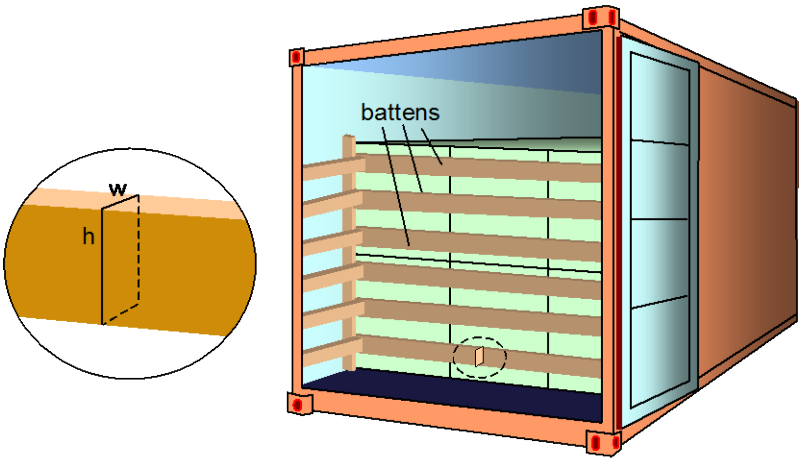


Figure 14.69 Transverse battens in an ISO container

Example:

A fence of six battens has been arranged. The battens have a free length L = 2.2 m and the cross-section w = 5 cm, h = 10 cm. The total attainable resistance force is:

$$F = n \cdot \frac{w^2 \cdot h}{28 \cdot L} = 6 \cdot \frac{5^2 \cdot 10}{28 \cdot 2.2} = 24 \text{ kN}$$

This force of 24 kN would be sufficient to restrain a cargo mass (m) of 7.5 t, subjected to accelerations in sea-area C with 0.4 g longitudinally (a_x) and 0.8 g vertically (a_z). The container is stowed longitudinally. With a friction coefficient between cargo and container floor of μ = 0.4 the following balance calculation shows:

$$a_x \cdot m \cdot g < \mu \cdot m \cdot (1\text{-}a_z) \cdot g + F \text{ [kN]}$$

$$0.4 \cdot 7.5 \cdot 9.81 < 0.4 \cdot 7.5 \cdot 0.2 \cdot 9.81 + 24 \text{ [kN]}$$

$$29 < 6 + 24 \text{ [kN]}$$

$$29 < 30 \text{ [kN]}$$

2 Bedding a concentrated load in a general purpose ISO box-container

2.1 Bedding arrangements for concentrated loads in general purpose ISO box containers should be designed in consultation with the supplier or operator of the container. If no specific advice is available the provisions described in this section should be applied.

2.2 The centre of gravity of a concentrated load should be placed at half length of the container. If more than one concentrated load shall be packed into a container, the centres of gravity of the units should be placed at distances in terms of container length as shown in the table below:

Number of concentrated loads	Suitable longitudinal stowage position
2	1/4 3/4
3	1/7 1/2 6/7
4	1/8 3/8 5/8 7/8

2.3 [A concentrated load should be bedded on two longitudinal beams placed at a distance s without further contact of the package to the bottom of the container in between. The necessary length t_1 of those beams for satisfying transverse strength requirements should be determined by:

$$t_1 \geq 0.18 \cdot m \cdot (2.3 - s) \quad \text{[m]}$$

t_1 = length of longitudinal beams for satisfying transverse strength requirements [m]

m = mass of package [t]

s = distance (mid to mid) of longitudinal beams [m]

In the calculation above the distance s should not be entered with more than 1.6 m

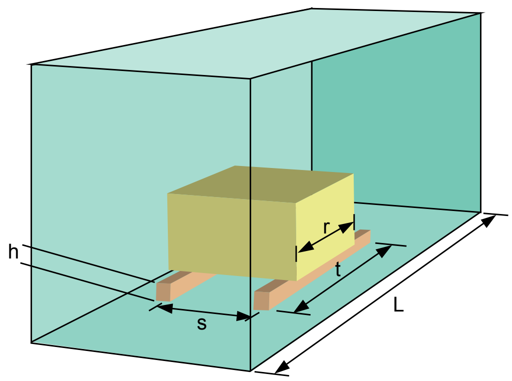


Figure 14.70 Bedding beams for concentrated loads in an ISO container

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2.4 For single concentrated loads of more than 50% of the payload of the container, additionally the necessary length t_2 of the beams for satisfying longitudinal strength requirements should be determined by:

$$t_2 \geq L \cdot \left(2 - \frac{P}{m}\right) \quad \text{[m]}$$

t_2 = length of longitudinal beams for satisfying transverse strength requirements [m]

m = mass of package [t]

L = length of container between mid of corner fittings [m]

P= payload of container [t]

The greater of the figures of t_1 and t_2 must be used for bedding.

2.5 The necessary section modulus W of **each** of the two beams should be determined by:

$$W = 60 \cdot m \cdot (t - r)\ [cm^3] \quad \text{for timber beams}$$
$$W = 4 \cdot m \cdot (t - r)\ [cm^3] \quad \text{for steel beams}$$

t = length of longitudinal beams, the greater of t_1 and t_2 [m]

m = mass of package [t]

r = bedding length of package [m]

In case that steel beams are used in a 20' container, the necessary length t_2 of the beams for satisfying longitudinal strength requirements may be determined the formula

$$t_2 = L \cdot \left(2 - \frac{1.3 \cdot P}{m}\right) \quad [m]$$

upon special agreement with the operator of the container.

2.6 When four beams instead of two beams are used, these should be arranged as straddled twin-beams with the distance s measured from mid to mid of each twin. The formulas for determination of the necessary section modulus are then applicable for each twin-beam.

2.7 When placing a single concentrated load of more than 50% of the payload into a 40' or 45' container, the required length of the beams may exceed reasonable limits of load transfer capability. In order to achieve the desired load spreading effect, preferably steel beams should be used with a height of web h not less than 0.05 · (t – r).

2.8 The section modulus of a single beam should be obtained from supplier's documents. The following tables may serve as a quick reference:

timber: nominal dimensions [cm]	10 x 10	12 x 12	15 x 15	20 x 20	25 x 25
section modulus [cm^3]	152	260	508	1236	2450

steel: (HEB): dimensions [cm]	12 x 12	14 x 14	16 x 16	18 x 18	20 x 20
section modulus [cm3]	144	216	311	426	570

Example:

m = 20 t; s = 1.2 m, r = 2.0 m, to be loaded into a 20' container with certified payload P = 28.3 t and a length L = 5.9 m.

$$t_1 \geq 0.18 \cdot 20 \cdot (2.3 - 1.2) = 3.96 \quad m$$
$$t_2 \geq 5.9 \cdot \left(2 - \frac{28.3}{20}\right) = 3.45 \quad m$$

Necessary beam dimensions for t = 4.0 m:

Timber: W = 60 · 20 · (4.0 – 2.0) = 2400 cm^3; timber beams of 25 x 25 cm will do.

Steel: W = 4 · 20 · (4.0 – 2.0) = 160 cm3; HEB steel beams of 14 x 14 cm will do.]

3 Permissible concentrated loads on flatracks

3.1 Bedding arrangements for concentrated loads on flatracks or platforms should be designed in consultation with the CTU operator of the flatrack or platform. **[**If no specific advice is available the provisions described in this section should be applied.

3.2 If the package is placed with its entire foot print over the length r on the flatrack or platform, the permissible load m is:

$$m = \frac{P \cdot L}{(2 \cdot L - r)} \quad \text{[t]}$$

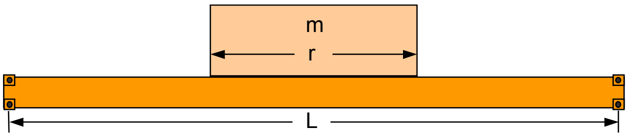


Figure 14.71 Concentrated load on an ISO platform container

3.3 If the package is rigid and stowed on transverse beddings that rest on the main girders of the flatrack or platform, the permissible load m is:

$$m = \frac{P \cdot L}{2 \cdot (L - r)} \quad \text{[t]}$$

Note: m must not exceed P in this formula

m = mass of package [t]

P= payload (maximum gross mass – tare mass) [t]

L= length of platform / flatrack container between mid-point of corner fittings [m]

r = length of package footprint or bridging distance [m]

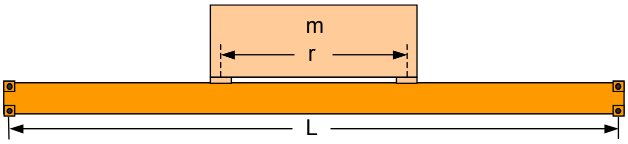


Figure 14.72 Concentrated load bridging the distance

Example:

A flatrack of the length L = 12 m and the payload of P = 40 t shall be packed with a package of the mass m = 26 t and the length r = 3.8 m. The permissible mass of a unit of that length would be:

$$m = \frac{P \cdot L}{2 \cdot (L - r)} = \frac{40 \cdot 12}{2 \cdot (12 - 3.4)} = 27.9 \text{ t}$$

This result shows that loading of 26 t is not permissible in this manner. If the same unit is placed on two transverse boards of a distance r = 3.4 m, the permissible mass of the package would be:

$$m = \frac{P \cdot L}{(2 \cdot L - r)} = \frac{40 \cdot 12}{(24 - 3.8)} = 23.8 \text{ t}$$

The package of 26 t may be packed in this way.

4 Longitudinal position of the centre of gravity of a CTU

4.1 The longitudinal position of the centre of gravity within the inner length of a loaded container is at the distance d from the front, obtained by the formula:

$$d = \frac{T \cdot 0.5 \cdot L + \sum(m_i \cdot d_i)}{T + \sum m_i}$$

d = distance of common centre of gravity from the front of stowage area [m]

T= tare mass of the CTU.) [t]

L= length of stowage area (inner length) [m]

m_n = mass of the individual packages or overpack [t]

d_n = distance of centre of gravity of mass m_n from front of stowage area [m]

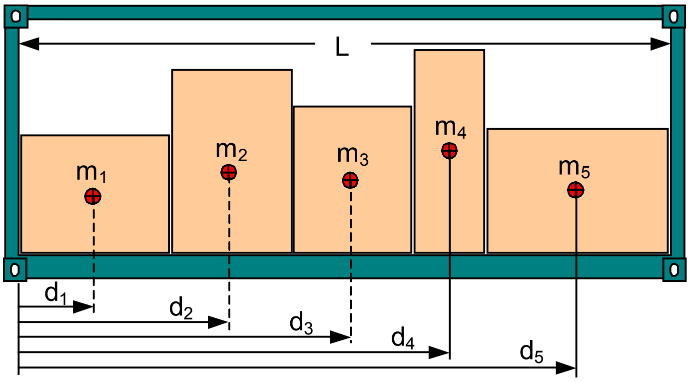


Figure 14.73 Determination of longitudinal centre of gravity

Example:

A 20' container with inner length L = 5.9 m and tare mass T = 2.3 t is loaded with five groups of cargo parcels as follows:

	m_i [t]	d_i [m]	$m_i \cdot d_i$ [t·m]
1	3.5	0.7	2.45
2	4.2	1.4	5.88
3	3.7	3.0	11.10
4	2.2	3.8	8.36
5	4.9	5.1	24.99
	Σm_i = 18.5		$\Sigma(m_i \cdot d_i)$ = 52.78

$$d = \frac{T \cdot 0.5 \cdot L + \sum(m_i \cdot d_i)}{T + \sum m_i} = \frac{2.3 \cdot 0.5 \cdot 5.9 + 52.78}{2.3 + 18.5} = \frac{59.565}{20.8} = 2.86 \text{ m}$$

5 Cargo securing with dunnage bags

5.1 Introduction

5.1.1 Accelerations in different directions during transport may cause movements of cargo, either sliding or tipping. Dunnage bags, or air bags, used as blocking device may be able to prevent these movements.

5.1.2 The size and strength of the dunnage bag are to be adjusted to the cargo weight so that the permissible lashing capacity of the dunnage bag, without risk of breaking it, is larger than the force the cargo needs to be supported with:

$$F_{DUNNAGE\ BAG} \geq F_{CARGO}$$

5.2 Force on dunnage bag from cargo (F_{CARGO})

5.2.1 The maximum force, with which rigid cargo may impact a dunnage bag, depends on the cargo's mass, size and friction against the surface and the dimensioning accelerations according to the formulas below:

Sliding:	**Tipping:**
$\mathbf{F_{CARGO} = m \cdot g \cdot (a_h - \mu_{static} \cdot 0.75 \cdot a_v)\ [kN]}$	$\mathbf{F_{CARGO} = m \cdot g \cdot (a_h - b_p/h_p \cdot a_v)\ [kN]}$

F_{CARGO} = force on the dunnage bag caused by the cargo [t]

m = mass of cargo [t]

a_h = Horizontal acceleration, expressed in g, that acts on the cargosideways or in forward or backward directions

a_v = Vertical acceleration that acts on the cargo, expressed in g

μ = Coefficient of friction for the contact area between the cargo and the surface or between different packages

b_p = Package width for tipping sideways, or alternatively the length of the cargo for tipping forward or backward

h_p = package height [m]

5.2.2 The load on the dunnage bag is determined of the movement (sliding or tipping) and the mode of transport that gives the largest force on the dunnage bag from the cargo.

5.2.3 It is only the cargo mass that actually impacts the dunnage bag that shall to be used in the above formulas. The movement forward, when breaking for example, the mass of the cargo behind the dunnage bag is to be used in the formulas.

5.2.4 If the dunnage bag instead is used to prevent movement sideways, the largest total mass of the cargo that either is on the right or left side of the dunnage bag is to be used, that is, either the mass m_1 or m_2, see Figure 4.6.

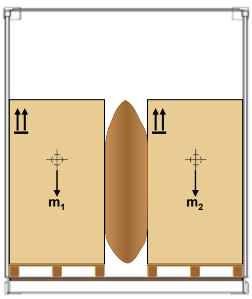


Figure 14.74 Equal height packages

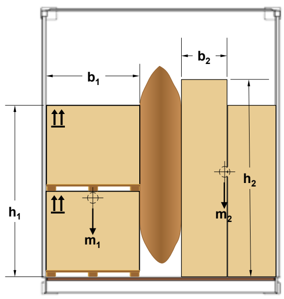


Figure 14.75 Unequal height packages

Figure

5.2.5 In order to have some safety margin in the calculations, the **lowest** friction coefficient should be used, either the one between the cargo in the bottom layer and the platform or between the layers of cargo.

5.2.6 If the package on each side of the dunnage bag has different forms, when tipping the relationship between the cargo width and height of the cargo stack that have the smallest value of b_p / h_p is chosen.

5.2.7 However, in both cases the total mass of the cargo that is on the same side of the dunnage bag is to be used, that is, either the mass m_1 or m_2 in Figure 4.7.

5.3 Permissible load on the dunnage bag (F_{DB})

5.3.1 The force that the dunnage bag is able to take up depends on the area of the dunnage bag which the cargo is resting against and the maximum allowable working pressure. The force of the dunnage bag is calculated from:

$$F_{DB} = A \cdot 10 \cdot g \cdot P_B \cdot SF \text{ [kN]}$$

F_{DB} =	force that the dunnage bag is able to take up without exceeding the maximum allowable pressure (kN)
P_B =	bursting pressure of the dunnage bag [bar]
A =	contact area between the dunnage bag and the cargo [m^2]
SF =	safety factor 0.75 for single use dunnage bags 0.5 for re-usable dunnage bags

5.4 Contact area (A)

5.4.1 The contact area between the dunnage bag and the cargo depends on the size of the bag before it is inflated and the gap that the bag is filling. This area may be approximated by the following formula:

$$\mathbf{A = (b_{DB} - \pi \cdot d/2) \cdot (h_{DB} - \pi \cdot d/2)}$$

b_{DB} =	width of dunnage bag [m]
h_{DB} =	height of dunnage bag [m]
A =	contact area between the dunnage bag and the cargo [m^2]
d =	gap between packages [m]
π =	3.14

5.5 Pressure in the dunnage bag

5.5.1 Upon application of the dunnage bag it is filled to a slight overpressure. If this pressure is too low there is a risk that the dunnage bag come loose if the ambient pressure is rising or if the air temperature drops. Inversely, if the filling pressure is too high there is a risk of the dunnage bag to burst or to damage the cargo if the ambient pressure decreases, or if the air temperature rises.

5.5.2 The bursting pressure (P_B) of a dunnage bag depends on the quality, size and the gap that the bag is filling. The pressure that the dunnage bag is experiencing as a result of forces acting from the cargo may never come close to bursting pressure as the bag is in danger of bursting and thus a safety factor according to above shall be used.]

or

3 [Permissible concentrated loads on flatracks

Bedding arrangements for concentrated loads on flatracks or platforms should be designed in consultation with the CTU operator of the flatrack or platform.

4 Bending strength of beams

4.1 If the cargo unit is flexible, so that it will rest over its entire length on the bedding beams, the required bending strength of beams should be determined by the formula:

$$n \cdot W = \frac{123 \cdot f_{dyn} \cdot m \cdot (t - r)}{\sigma_{perm}} \quad [\text{cm}^3]$$

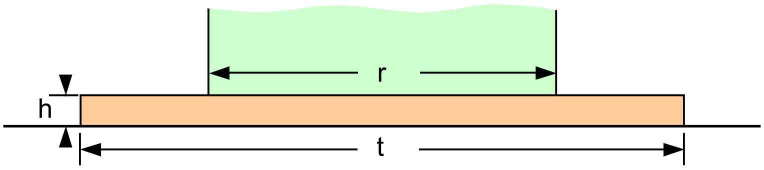


Figure 14.76 Beam for load spreading under a flexible package

4.2 If the package is rigid so that it will bridge a distance on the bedding beams, the required bending strength of beams should be determined by the formula:

$$n \cdot W = \frac{123 \cdot f_{dyn} \cdot m \cdot (t - r)^2}{\sigma_{perm} \cdot t} \quad [\text{cm}^3]$$

W = section modulus of one beam [cm3]

n = number of parallel beams

m = mass of package [t]

t = length of the beam [m]

r = loaded length of beam (footprint) or bridging distance [m]

σ_{perm}= permissible bending stress in beam [kN/cm^2]

f_{dyn} = vertical acceleration factor

- f_{dyn} = 1.0 for road and rail transport
- f_{dyn} = 1.5 for sea area A
- f_{dyn} = 1.7 for sea area B
- f_{dyn} = 1.8 for sea area C

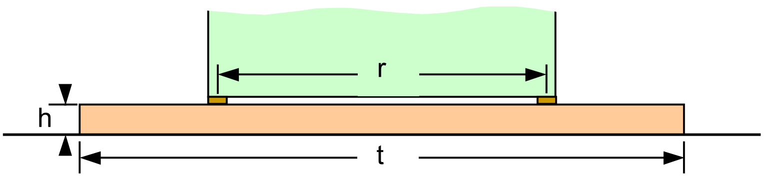


Figure 14.77 Beam for load spreading under rigid package

4.3 The permissible bending stress σ should be taken as 2.4 kN/cm2 for timber beams and 22 kN/cm2 for steel beams of HE-B profiles. The section modulus for a single beam should be obtained from supplier's documents. The following tables may serve as a quick reference:

timber: nominal dimensions [cm]	10 x 10	12 x 12	15 x 15	20 x 20	25 x 25
section modulus [cm^3]	152	260	508	1236	2450

steel: (HEB): dimensions [cm]	12 x 12	14 x 14	16 x 16	18 x 18	20 x 20
section modulus [cm3]	144	216	311	426	570

4.4 Normally two beams are used under each concentrated load, spread apart as far as possible. When four beams are used instead of two, these should be arranged as straddled twin-beams.

5 Longitudinal position of the centre of gravity of a CTU

5.1 The longitudinal position of the centre of gravity within the inner length of a loaded container is at the distance d from the front, obtained by the formula:

$$d = \frac{T \cdot 0.5 \cdot L + \sum(m_i \cdot d_i)}{T + \sum m_i}$$

d = distance of common centre of gravity from front of stowage area [m]

T= tare mass of the CTU.) [t]

L= length of stowage area (inner length) [m]]

m_n = mass of the individual packages or overpack [t]

d_n = distance of centre of gravity of mass m_n from front of stowage area [m]

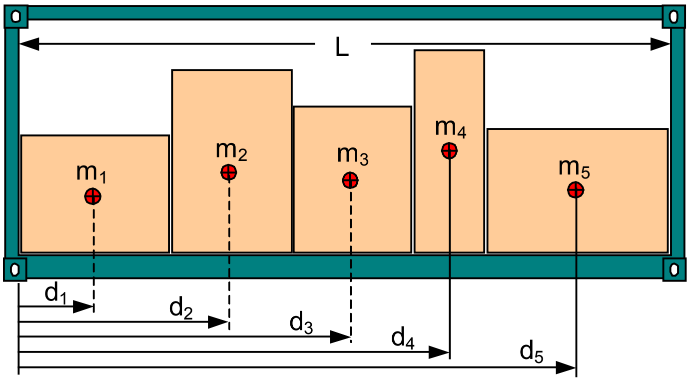


Figure 14.78 Determination of longitudinal centre of gravity

Example:

A 20' container with inner length L = 5.9 m and tare mass T = 2.3 t is loaded with five groups of cargo parcels as follows:

	m_i [t]	d_i [m]	$m_i \cdot d_i$ [t·m]
1	3.5	0.7	2.45
2	4.2	1.4	5.88
3	3.7	3.0	11.10
4	2.2	3.8	8.36
5	4.9	5.1	24.99
	Σm_i = 18.5	$\Sigma(m_i \cdot d_i)$ = 52.78	

$$d=\frac{T\cdot 0.5\cdot L+\sum(m_i\cdot d_i)}{T+\sum_i m_i}=\frac{2.3\cdot 0.5\cdot 5.9+52.78}{2.3+18.5}=\frac{59.565}{20.8}=2.86m$$

6 Cargo securing with dunnage bags

6.1 Introduction

6.1.1 Accelerations in different directions during transport may cause movements of cargo, either sliding or tipping. Dunnage bags, or air bags, used as blocking device may be able to prevent these movements.[12]

6.1.2 The size and strength of the dunnage bag are to be adjusted to the cargo weight so that the permissible lashing capacity of the dunnage bag, without risk of breaking it, is larger than the force the cargo needs to be supported with:

$$F_{DUNNAGE\ BAG} \geq F_{CARGO}$$

6.2 Force on dunnage bag from cargo (F_{CARGO})

6.2.1 The maximum force, with which rigid cargo may impact a dunnage bag, depends on the cargo's mass, size and friction against the surface and the dimensioning accelerations according to the formulas below:

Sliding:

$$F_{CARGO} = m \cdot g\cdot (a_h - \mu_{static} \cdot 0.75 \cdot a_v)\ [kN]$$

Tipping:

$$F_{CARGO} = m \cdot g\cdot (a_h - b_p/h_p \cdot a_v)\ [kN]$$

F_{CARGO} = force on the dunnage bag caused by the cargo [t]

m = mass of cargo [t]

a_h = Horizontal acceleration, expressed in g, that acts on the cargosideways or in forward or backward directions

a_v = Vertical acceleration that acts on the cargo, expressed in g

μ = Coefficient of friction for the contact area between the cargo and the surface or between different packages

b_p = Package width for tipping sideways, or alternatively the length of the cargo for tipping forward or backward

h_p = package height [m]

6.2.2 The load on the dunnage bag is determined of the movement (sliding or tipping) and the mode of transport that gives the largest force on the dunnage bag from the cargo.

6.2.3 It is only the cargo mass that actually impacts the dunnage bag that shall to be used in the above formulas. The movement forward, when breaking for example, the mass of the cargo behind the dunnage bag is to be used in the formulas.

6.2.4 If the dunnage bag instead is used to prevent movement sideways, the largest total mass of the cargo that either is on the right or left side of the dunnage bag is to be used, that is, either the mass m_1 or m_2, see Figure 5.6.

[12] Dunnage bags may not be used to secure cargo on US railways.

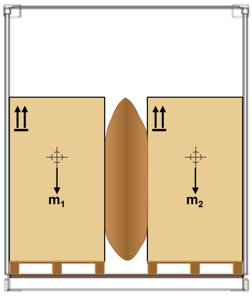


Figure 14.79 Equal height packages

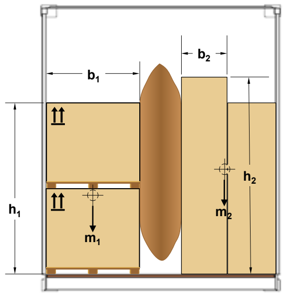


Figure 14.80 Unequal height packages

6.2.5 In order to have some safety margin in the calculations, the **lowest** friction coefficient should be used, either the one between the cargo in the bottom layer and the platform or between the layers of cargo.

6.2.6 If the package on each side of the dunnage bag has different forms, when tipping the relationship between the cargo width and height of the cargo stack that have the smallest value of b_p / h_p is chosen.

6.2.7 However, in both cases the total mass of the cargo that is on the same side of the dunnage bag is to be used, that is, either the mass m_1 or m_2 in Figure 5.7.

6.3 Permissible load on the dunnage bag (F_{DB})

6.3.1 The force that the dunnage bag is able to take up depends on the area of the dunnage bag which the cargo is resting against and the maximum allowable working pressure. The force of the dunnage bag is calculated from:

$$F_{DB} = A \cdot 10 \cdot g \cdot P_B \cdot SF \text{ [kN]}$$

F_{DB} =	force that the dunnage bag is able to take up without exceeding the maximum allowable pressure [kN]
P_B =	bursting pressure of the dunnage bag [bar]
A =	contact area between the dunnage bag and the cargo [m^2]
SF =	safety factor
	0.75 for single use dunnage bags
	0.5 for re-usable dunnage bags

6.4 Contact area (A)

6.4.1 The contact area between the dunnage bag and the cargo depends on the size of the bag before it is inflated and the gap that the bag is filling. This area may be approximated by the following formula:

$$\mathbf{A = (b_{DB} - \pi \cdot d/2) \cdot (h_{DB} - \pi \cdot d/2)}$$

b_{DB} =	width of dunnage bag [m]
h_{DB} =	height of dunnage bag [m]
A =	contact area between the dunnage bag and the cargo [m^2]
d =	gap between packages [m]
π =	3.14

6.5 Pressure in the dunnage bag

6.5.1 Upon application of the dunnage bag it is filled to a slight overpressure. If this pressure is too low there is a risk that the dunnage bag come loose if the ambient pressure is rising or if the air temperature drops. Inversely, if the filling pressure is too high there is a risk of the dunnage bag to burst or to damage the cargo if the ambient pressure decreases, or if the air temperature rises. It is therefore important that a properly calibrated pressure gauge is used when filling dunnage bags.

6.5.2 The bursting pressure (P_B) of a dunnage bag depends on the quality, size and the gap that the bag is filling. The pressure that the dunnage bag is experiencing as a result of forces acting from the cargo may never come close to bursting pressure as the bag is in danger of bursting and thus a safety factor according to above shall be used.]

Appendix 6. Chock design criteria

- Height varies with the size as shown in table A.2
- b. Length of the chock is 1.73 times the height
- c. For tyres and other narrow objects the width of the chock should be approximately 0.75 times the width of the object.
- d The chock angle between chock base and the drum engaging face shall be between 35 and 45 degrees.
- e. The drum engaging face could be recessed to increase the interface between the drum and the chock.

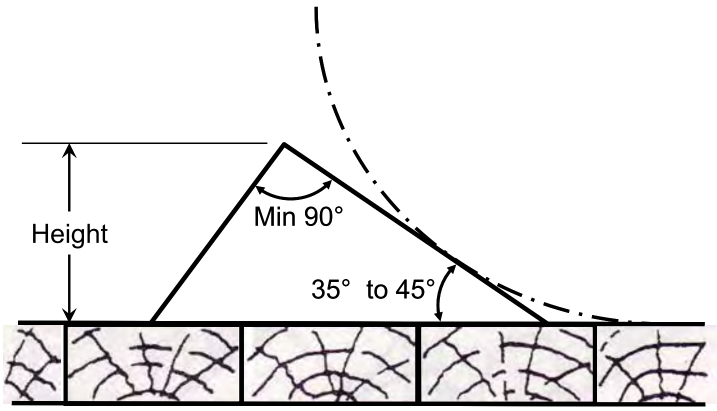


Figure 14.81 Chock design

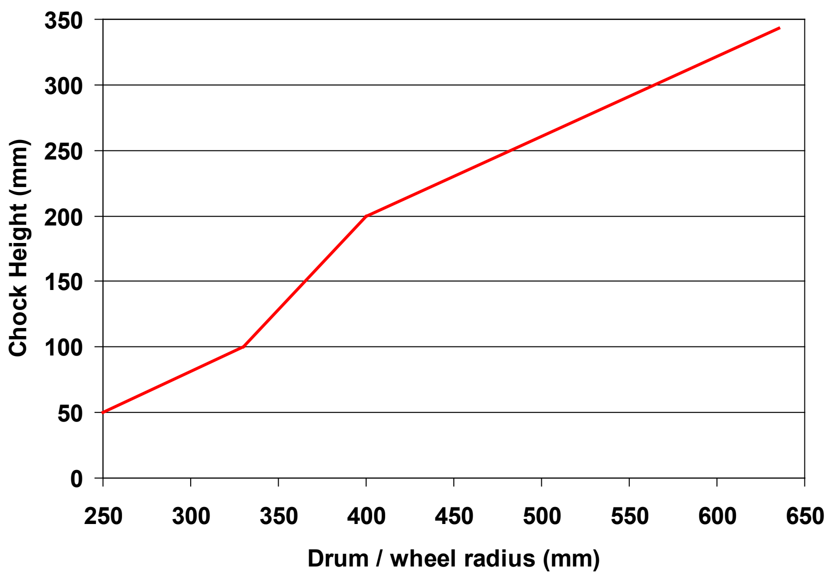


Figure 14.82 Chock height

Table A.2

Appendix 7. Practical inclination test for determination of the efficiency of cargo securing arrangements

1 The efficiency of a securing arrangement can be tested by a practical inclining test according to the following description.

2 The cargo (alternatively one section of the cargo) is placed on a lorry platform or similar and secured in the way intended to be tested.

3 To obtain the same loads in the securing arrangement in the inclining test as in calculations, the securing arrangement is to be tested by gradually increasing the inclination of the platform to an angle, α, according to the diagram below. The theories behind the calculation of the required inclination angle are shown in the enclosure to this annex.

4 The inclination angle to be used in the test is a function of the following parameters:

- The horizontal acceleration a_h for the intended direction (forward, sideways or backward) and the vertical acceleration a_v.
- To test the efficiency of the securing arrangement in the lateral direction, the greatest of the following test angles should be used:
  - the angle determined by the friction coefficient μ (for the sliding effect), or
  - the angle determined by the ratio of $\frac{B}{n \cdot H}$ (for the tilting effect).
- To test the efficiency of the securing arrangement in the longitudinal direction, the greatest of following test angles should be used:
  - the angle determined by the friction coefficient μ (for the sliding effect)
  - the angle determined by the ratio of $\frac{L}{H}$ (for the tilting effect).

5 The lowest coefficient of friction, between the cargo and the platform bed or between packages if over-stowed should be used. The definition of H, B, L and n is according to the sketches below.

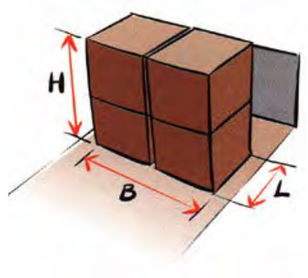


Figure 14.83

Package or section with the centre of gravity close to its geometrical centre (L/2, B/2, H/2). The number of loaded rows, n, in above section is 2.
L is always the length of one section also when several sections are placed behind each other.

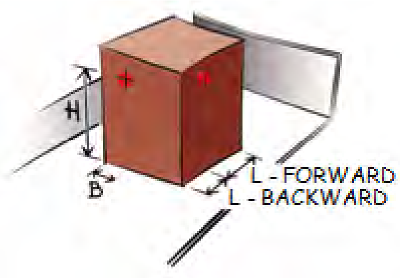


Figure 14.84

Package with the centre of gravity away from its geometrical centre.

The required test angle α as function of a_h (0,8 g, 0,7 g and 0,5g) as well as μ, $\frac{B}{n \cdot H}$ and $\frac{L}{H}$ when a_v is 1,0 g is taken from the diagram below.

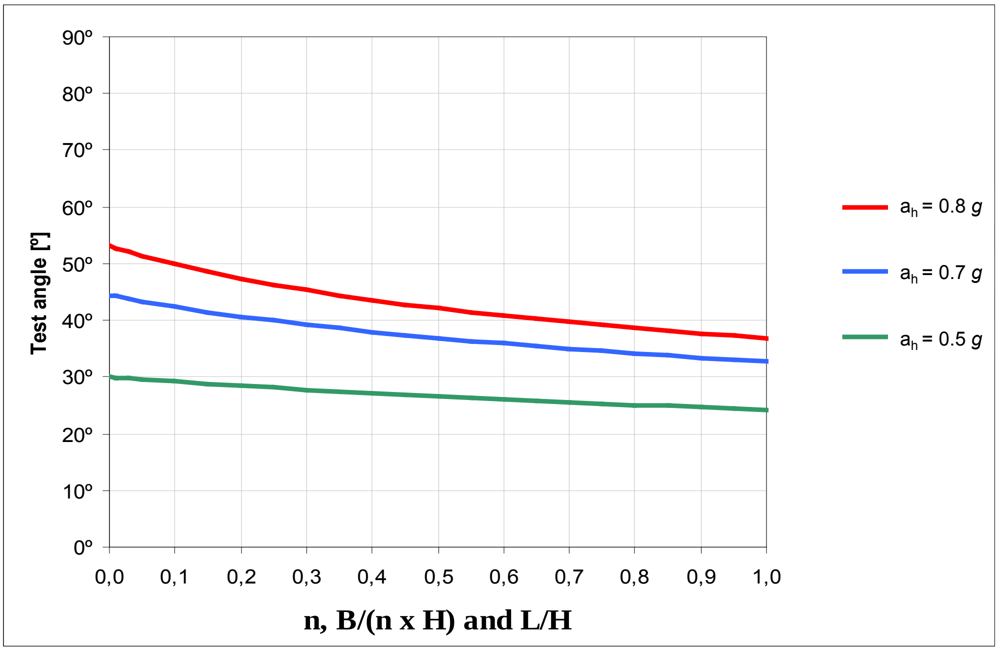


Figure 14.85

Example:

If μ and $\dfrac{B}{n \cdot H}$ is 0,3 at accelerations sideways at transport in sea area B (a_h = 0,7 g) the cargo securing arrangement shall manage to be inclined to approximately 39º, according to the diagram.

6 The securing arrangement is regarded as complying with the requirements if the cargo is kept in position with limited movements when inclined to the prescribed inclination α.

7 The test method will subject the securing arrangement to stresses and great care should be taken to prevent the cargo from falling off the platform during the test. If large masses are to be tested the entire platform should be prevented from tipping as well.

Figure 14.86

Figure 14.87

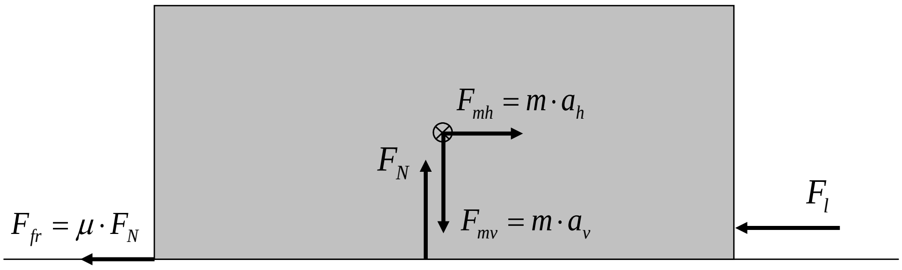
8 Figure 4.4 and Figure 4.5 shows tests to confirm the securing arrangements of a large package for acceleration forces forward and sideways.

Enclosure – Theoretical background

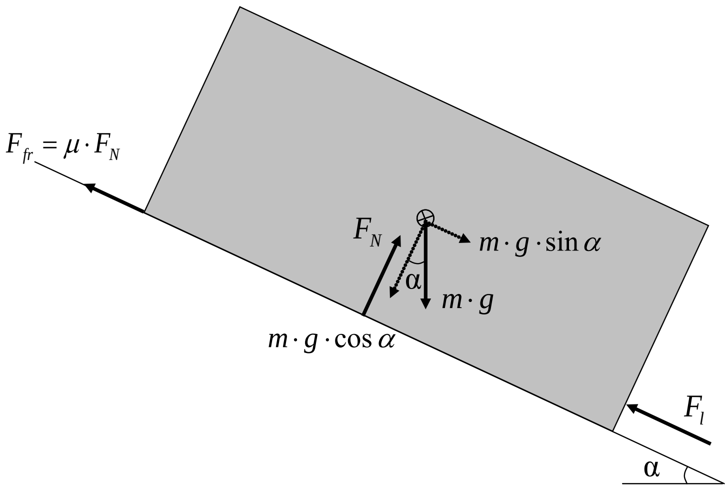
In this enclosure the equations are set up for the required static test angle to obtain the same forces in securing arrangements as in a real transport situation.

Case 1 – Horizontal lashing (type straight/cross lashing or blocking) – Sliding

Required static inclination angle as a function of μ, a_h and a_v to achieve the equivalent force F_l in a horizontal lashing as in a real transport situation.



$$\left.\begin{array}{l} \uparrow \;=\; \downarrow \quad F_N = m \cdot a_v \cdot g \\ \rightarrow \;=\; \leftarrow \quad m \cdot a_h \cdot g = F_l + \mu \cdot F_N \end{array}\right\} \quad F_l = m \cdot g \cdot (a_h - \mu \cdot a_v) \quad \text{(kN)} \qquad (1)$$



$$\left.\begin{array}{l} \uparrow \;=\; \downarrow \quad F_N = m \cdot g \cdot \cos\alpha \\ \rightarrow \;=\; \leftarrow \quad m \cdot g \cdot \sin\alpha = F_l + \mu \cdot F_N \end{array}\right\} \quad F_l = m \cdot g \cdot (\sin\alpha - \mu \cdot \cos\alpha) \quad \text{(kN)} \qquad (2)$$

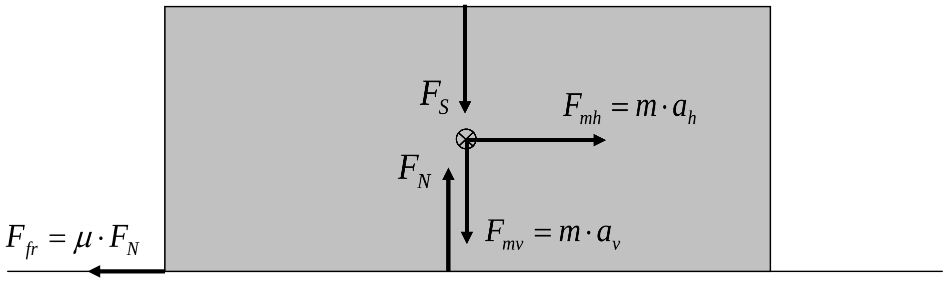
(1) = (2) =>

$$m \cdot g \cdot (a_h - \mu \cdot a_v) = m \cdot g \cdot (\sin\alpha - \mu \cdot \cos\alpha) \quad \Leftrightarrow \quad m \cdot g \cdot (\sin\alpha - \mu \cdot \cos\alpha) = m \cdot g \cdot (a_h - \mu \cdot a_v)$$

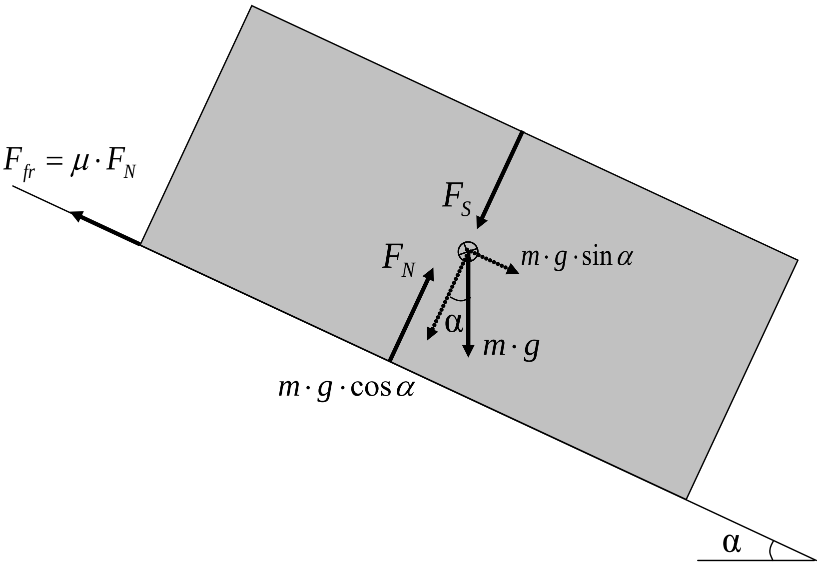
The solution of this equation with tables and diagrams of required inclination angle is shown in the section solution of equations below.

Case 2 – Vertical pressure (type top-over lashing) – Sliding

Required static inclination angle as a function of μ, a_h and a_v to achieve the equivalent force F_S in a vertical lashing as in a real transport situation.



$$\left.\begin{array}{lll} \uparrow = \downarrow & F_N = F_S + m \cdot a_v \cdot g \\ \rightarrow = \leftarrow & m \cdot a_h \cdot g = \mu \cdot F_N \end{array}\right\} \quad F_S = \frac{m \cdot g \cdot (a_h - \mu \cdot a_v)}{\mu} \quad \text{(kN)} \qquad (1)$$



$$\left.\begin{array}{lll} \uparrow = \downarrow & F_N = F_S + m \cdot g \cdot \cos\alpha \\ \rightarrow = \leftarrow & m \cdot g \cdot \sin\alpha = \mu \cdot F_N \end{array}\right\} \quad F_S = \frac{m \cdot g \cdot (\sin\alpha - \mu \cdot \cos\alpha)}{\mu} \quad \text{(kN)} \qquad (2)$$

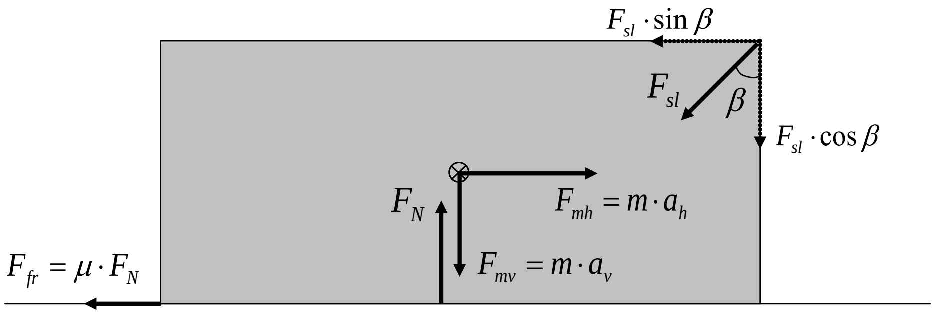
(1) = (2) =>

$$\frac{m \cdot g \cdot (a_h - \mu \cdot a_v)}{\mu} = \frac{m \cdot g \cdot (\sin\alpha - \mu \cdot \cos\alpha)}{\mu} \quad \Leftrightarrow \quad m \cdot g \cdot (\sin\alpha - \mu \cdot \cos\alpha) = m \cdot g \cdot (a_h - \mu \cdot a_v)$$

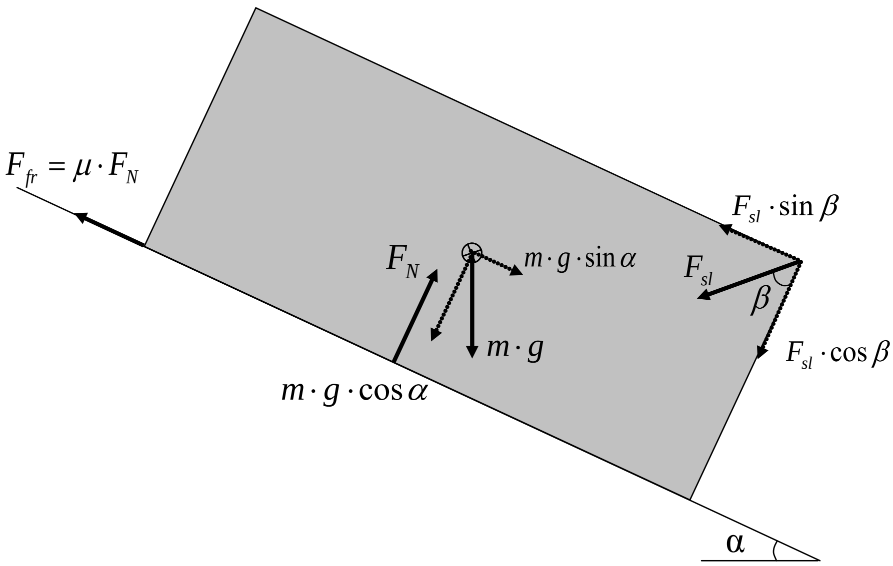
This is the same equation as in case 1.

Case 3 – Sloped lashing (type spring lashing and loop lashing) – Sliding

Required static inclination angle as a function of μ, a_h and a_v to achieve the equivalent force F_{sl} in a sloped lashing as in a real transport situation.



$$\left.\begin{array}{ll} \uparrow \;=\; \downarrow & F_N = F_{sl} \cdot \cos\beta + m \cdot a_v \cdot g \\ \rightarrow \;=\; \leftarrow & m \cdot a_h \cdot g = F_{sl} \cdot \sin\beta + \mu \cdot F_N \end{array}\right\} \quad F_{sl} = \frac{m \cdot g \cdot (a_h - \mu \cdot a_v)}{\sin\beta + \mu \cdot \cos\beta} \quad \text{(kN)} \qquad (1)$$



$$\left.\begin{array}{ll} \uparrow \;=\; \downarrow & F_N = F_{sl} \cdot \cos\beta + m \cdot g \cdot \cos\alpha \\ \rightarrow \;=\; \leftarrow & m \cdot g \cdot \sin\alpha = F_{sl} \cdot \sin\beta + \mu \cdot F_N \end{array}\right\} \quad F_{sl} = \frac{m \cdot g \cdot (\sin\alpha - \mu \cdot \cos\alpha)}{\sin\beta + \mu \cdot \cos\beta} \quad \text{(kN)} \quad (2)$$

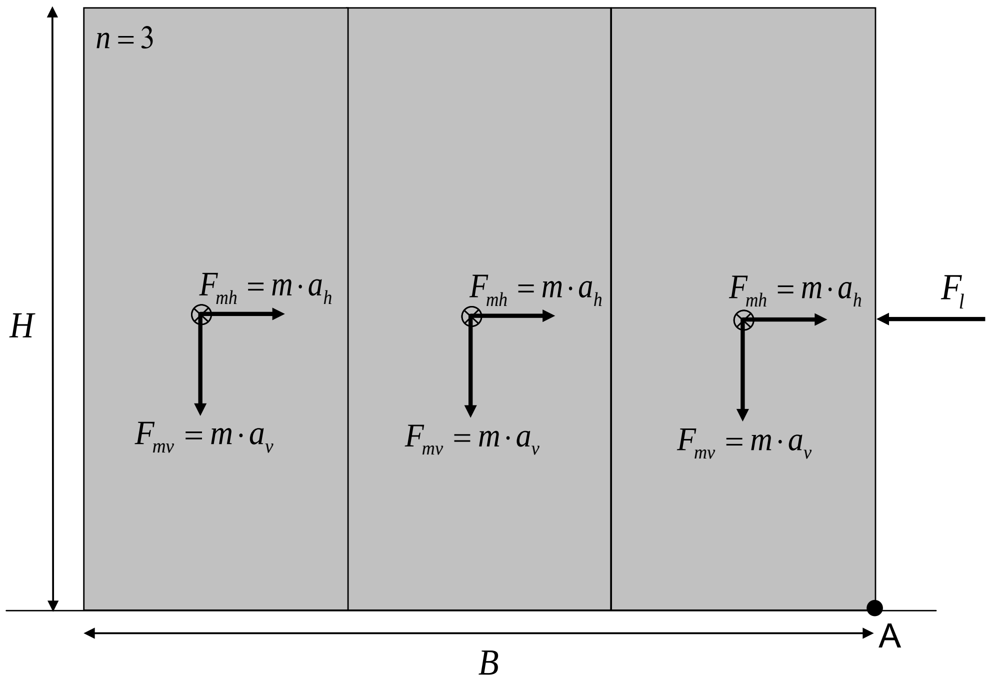
(1) = (2) =>

$$\frac{m \cdot g \cdot (a_h - \mu \cdot a_v)}{\sin\beta + \mu \cdot \cos\beta} = \frac{m \cdot g \cdot (\sin\alpha - \mu \cdot \cos\alpha)}{\sin\beta + \mu \cdot \cos\beta} \quad \Leftrightarrow \quad m \cdot g \cdot (\sin\alpha - \mu \cdot \cos\alpha) = m \cdot g \cdot (a_h - \mu \cdot a_v)$$

This is the same equation as in case 1 and 2.

Case 4 – Horizontal lashing (type straight/cross lashing) – Tipping sideways

Required static inclination angle as a function of a_h, a_v and $\frac{B}{n \cdot H}$ to achieve the equivalent force F_l in a horizontal lashing as in a real transport situation.

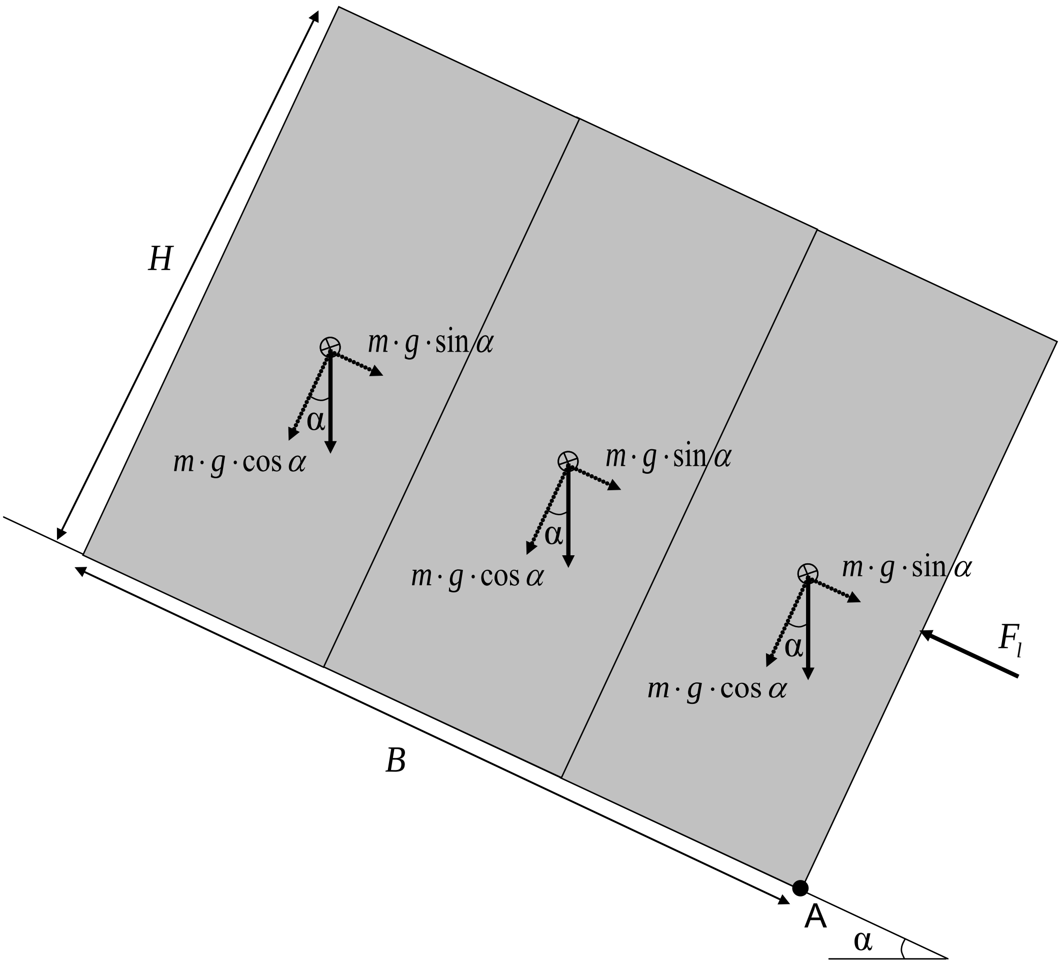


The centre of gravity is assumed to be in the geometrical centre.

↻A = ↺ A $$3 \cdot m \cdot a_h \cdot g \cdot \frac{H}{2} = F_l \cdot \frac{H}{2} + 3 \cdot m \cdot a_v \cdot g \cdot \frac{B}{2 \cdot n}$$

$$\Rightarrow \quad F_l = \frac{3 \cdot m \cdot a_h \cdot g \cdot \frac{H}{2} - 3 \cdot m \cdot a_v \cdot g \cdot \frac{B}{2 \cdot n}}{\frac{H}{2}} = \frac{3 \cdot m \cdot a_h \cdot g \cdot H - 3 \cdot m \cdot a_v \cdot g \cdot \frac{B}{n}}{H} =$$

$$= 3 \cdot m \cdot g \cdot (a_h - \frac{B}{n \cdot H} \cdot a_v) \text{ (kN)} \qquad (1)$$



↻A = ↺ A $\quad 3 \cdot m \cdot g \cdot \sin\alpha \cdot \frac{H}{2} = F_l \cdot \frac{H}{2} + 3 \cdot m \cdot g \cdot \cos\alpha \cdot \frac{B}{2 \cdot n}$

$$\Rightarrow \quad F_l = \frac{3 \cdot m \cdot g \cdot \sin\alpha \cdot H - 3 \cdot m \cdot g \cdot \cos\alpha \cdot \frac{B}{n}}{H} = 3 \cdot m \cdot g \cdot (\sin\alpha - \frac{B}{n \cdot H} \cdot \cos\alpha) \text{(kN)} \quad (2)$$

(1) = (2) =>

$$3 \cdot m \cdot g \cdot (a_h - \frac{B}{n \cdot H} \cdot a_v) = 3 \cdot m \cdot g \cdot (\sin\alpha - \frac{B}{n \cdot H} \cdot \cos\alpha)$$

$$\Leftrightarrow \quad m \cdot g \cdot (\sin\alpha - \frac{B}{n \cdot H} \cdot \cos\alpha) = m \cdot g \cdot (a_h - \frac{B}{n \cdot H} \cdot a_v)$$

This is the same equation as in case 1, 2 and 3, where μ has been exchanged by $\frac{B}{n \cdot H}$.

Solution of equations

Consequently, with γ as the value of μ, $\dfrac{B}{n \cdot H}$ and $\dfrac{L}{H}$ the following equation is obtained:

$$m \cdot g \cdot (\sin\alpha - \gamma \cdot \cos\alpha) = m \cdot g \cdot (a_h - \gamma \cdot a_v)$$

The solution to the above equation is:

$$\alpha = 2 \cdot \arctan\left(\frac{-1+\sqrt{1+\gamma^2-\gamma^2 \cdot a_v^2+2 \cdot \gamma \cdot a_v \cdot a_h - a_h^2}}{\gamma + \gamma \cdot a_v - a_h}\right), \qquad \gamma \neq \frac{a_h}{1+a_v}$$

$$\alpha = 2 \cdot \arctan\left(\frac{a_h}{1+a_v}\right), \qquad \gamma = \frac{a_h}{1+a_v}$$

where

γ a factor representing the values of μ, $\dfrac{B}{n \cdot H}$ and $\dfrac{L}{H}$

a_h the design horizontal acceleration in [g]

a_v the design vertical acceleration in [g]

g gravity acceleration 9,81 m/s^2

With a_v = 1,0 g, the solution to the equation will be:

$$\alpha = 2 \cdot \arctan\left(\frac{-1+\sqrt{1+2 \cdot \gamma \cdot a_h - a_h^2}}{2 \cdot \gamma - a_h}\right), \qquad \gamma \neq \frac{a_h}{2},$$

$$\alpha = 2 \cdot \arctan\left(\frac{a_h}{2}\right), \qquad \gamma = \frac{a_h}{2},$$

An alternative solution of the equation is to express γ as a function of α:

$$\gamma = \frac{a_h - \sin\alpha}{a_v - \cos\alpha}$$

In the table below the inclination α is calculated for different γ-factors at the horizontal accelerations a_h = 0,8 g, 0,7 g and 0,5 g and a_v = 1,0 g.

ah / γ - factor	0,8 *g*	0,7 *g*	0,5 *g*
	Required test angle α degrees		
0,00	53,1	44,4	30,0
0,05	51,4	43,3	29,6
0,10	49,9	42,4	29,2
0,15	48,5	41,5	28,8
0,20	47,3	40,7	28,4
0,25	46,3	39,9	28,1
0,30	45,3	39,2	27,7
0,35	44,4	38,6	27,4
0,40	43,6	38,0	27,1
0,45	42,8	37,4	26,8
0,50	42,1	36,9	26,6
0,55	41,5	36,4	26,3
0,60	40,8	35,9	26,0
0,65	40,2	35,4	25,8
0,70	39,7	35,0	25,6
0,75	39,2	34,6	25,3
0,80	38,7	34,2	25,1
0,85	38,2	33,8	24,9
0,90	37,7	33,4	24,7
0,95	37,3	33,1	24,5
1,00	36,9	32,8	24,3

Annex 15.Manual handling

1 Introduction

1.1 Manual handling relates to the moving of items either by lifting, lowering, carrying, pushing or pulling. But it's not just a case of 'pulling something' due to the weight of the item, although this can be a cause of injury. Injuries can be caused because of the amount of times a packer has to pick up or carry an item, the distance the packer carries it, the height the packer has to pick it up from or putting it down at (picking it up from the floor, putting it on a shelf above shoulder level) and any twisting, bending stretching or other awkward posture you may get in whilst doing a task.

1.2 Manual handling is one of the most common causes of injury at work and causes over a third of all workplace injuries which include work related Musculoskeletal Disorders (MSDs) such as upper and lower limb pain/disorders, joint and repetitive strain injuries of various.

1.3 Manual handling injuries can occur almost anywhere in the workplace and heavy manual labour, awkward postures and previous or existing injury can increase the risk. Work related manual handling injuries can have serious implications for both the employer and the person who has been injured. Employers may have to bear substantial costs, through lost production, sickness absence costs of retraining, wages/overtime to cover for the absent person and potentially compensation payments. The injured person may find that their ability to do their job is affected and there may be an impact on their lifestyle, leisure activities, ability to sleep and future job prospects.

1.4 It is essential that the risk to packers is properly managed. If possible all manual handling should be eliminated, however this is not always possible and where such handling is necessary, the risk of injury to the packer reduced by using mechanical handling devices (MHD).

1.5 The most recent survey of self-reported work-related illness estimated that in 2001/02, 1.1 million people in Great Britain suffered from musculoskeletal disorders (MSDs) caused or made worse by their current or past work. An estimated 12.3 million working days were lost due to these work-related MSDs. On average each sufferer took about 20 days off in that 12-month period.

1.6 Manual handling injuries can occur wherever people are at work, in terms of cargo transport units; it will be associated with packing and un-packing. Heavy manual labour, awkward postures and previous or existing injury are all risk factors implicated in the development of MSDs. Managers should:

- consider the risks from manual handling to the health and safety of their employees
- consult and involve the workforce. Packer know first-hand what the risks in the workplace are. So they can probably offer practical solutions to controlling them.
- Health and safety regulations will generally require employers to:
- avoid the need for hazardous manual handling, so far as is reasonably practicable;
- assess the risk of injury from any hazardous manual handling that can't be avoided; and
- reduce the risk of injury from hazardous manual handling, so far as is reasonably practicable.

1.7 Packers have duties too. They should:

- follow appropriate systems of work laid down for their safety;
- make proper use of equipment provided for their safety;
- co-operate with their employer on health and safety matters;
- inform the employer if they identify hazardous handling activities;
- take care to ensure that their activities do not put others at risk

2 Manual handling practice

When involved in manual handling the following practical tips should be considered:

2.1 Think before lifting/handling. Plan the lift. Can handling aids be used? Where is the load going to be placed? Will help be needed with the load? Remove obstructions such as discarded wrapping materials. For a long lift, consider resting the load midway on a table or bench to change grip.

2.2 Keep the load close to the waist.

2.3 Keep the load close to the body for as long as possible while lifting. Keep the heaviest side of the load next to the body. If a close approach to the load is not possible, try to slide it towards the body before attempting to lift it.

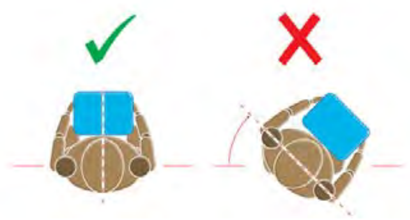
2.4 Adopt a stable position. The feet should be apart with one leg slightly forward to maintain balance (alongside the load, if it is on the ground). The worker should be prepared to move their feet during the lift to maintain their stability. Avoid tight clothing or unsuitable footwear, which may make this difficult.

2.5 Get a good hold. Where possible the load should be hugged as close as leg slightly forward to possible to the body. This may be better than gripping it tightly with hands only. maintain balance

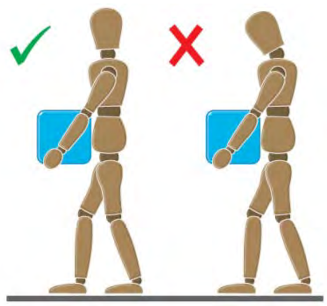
2.6 Start in a good posture. At the start of the lift, slight bending of the back, hips and knees is preferable to fully flexing the back (stooping) or fully flexing the hips and knees (squatting).

2.7 Don't flex the back any further while lifting. This can happen if the legs begin to straighten before starting to raise the load.

2.8 Avoid twisting the back or leaning sideways, especially while the back is bent. Shoulders should be kept level and facing in the same direction as the hips. Turning by moving the feet is better than twisting and lifting at the same time.



2.9 Keep the head up when handling. Look ahead, not down at the load, once it has been held securely.



2.10 Move smoothly. The load should not be jerked or snatched as this can make it harder to keep control and can increase the risk of injury.

2.11 Don't lift or handle more than can be easily managed. There is a difference between what people can lift and what they can safely lift.

2.12 Put down, then adjust. If precise positioning of the load is necessary, put it down first, then slide it into the desired position.

3 Mechanical handling

Many packages are placed within cargo transport units manually. However to assist the packers an number of mechanical handling devices (MHD) are used:

3.1 Sack truck – heavy and difficult to lift and grasp items can be moved into the CTU by means of a simple sack truck.

3.2 Conveyor – a belt or roller conveyor that can be extended into the length of a cargo transport units can be used to deliver packages to the packers where they are to be stacked. Generally used for light packages

3.3 Pallet truck – with the increase in pallets being used as the platform for a unitised package, a manual or motorised pallet truck can be used to move pallets into their position. Where the cargo transport unit cannot be easily connected by a ramp to the loading bay, a pallet truck can be used to reposition pallets delivered by a fork truck.

3.4 Electric or manual hoist – standard pallet trucks may not be able to carry two loaded pallets into the cargo transport unit so a hoist truck may be required.

3.5 Lift truck – as an alternative a fork truck can be used to position pallets within the CTU.

4 Mechanical handling techniques

Mechanical handling devices should comply with the following guidelines:

4.1 Care should be taken that there is sufficient height in the cargo transport unit for the hoist or lift truck when positioning upper pallets and a proper risk assessment carried out for the material handling equipment.

4.2 Ensure that the correct equipment is provided for the task and it is fit for purpose.

4.3 Lack of good handles can increase the amount of undue effort needed to move the load. MHDs should have handle heights that are between the shoulder and waist Handle height in relation to the different users can be a risk factor for their posture, they may find it uncomfortable and/or unable to apply a suitable grip.

4.4 If the equipment is without brakes it could be difficult to stop. If it has brakes but the brakes are poor/ineffective this could also make it difficult to stop.

4.5 When purchasing new trolleys etc., ensure they are of good quality with large diameter wheels made of suitable material and with castors, bearings etc. which will last with minimum maintenance

4.6 Ensure that the wheels suit the flooring and environment i.e. are the wheels on the device suited to the aluminium T floor in a refrigerated CTU.

5 Mechanical handling safety

5.1 Material handling devices should be maintained as part of a regular programme and a well promoted fault reporting system.

5.2 The use of mechanical handling devices described above presents the packer of CTUs with additional risks and handling issues.

5.3 Wheeled MHD such as the sack truck or the pallet truck have relatively small diameter wheels, often narrow in width presenting a very small footprint. The small footprint associated with a high mass will increase the risk of a floor failure. Such a failure can result in:

5.3.1 injuries to the packer as the device jerks or stops suddenly;

5.3.2 damage to the package if it should fall off the device;

5.3.3 damage to the device; and / or

5.3.4 damage to the CTU.

5.4 Mechanical handling devices can be powered, so that a motor or engine propels the device into and out of the CTU or non-powered. Such nom-powered device needs the packer to move them by either pulling or pushing while both empty and loaded.

5.5 When people push and pull, for example trollies, there may be risk of other musculoskeletal disorders which are discussed below.

5.6 The UK produced the following statistics on reported incidents related to pushing and pulling:

5.6.1 11% of manual handling - reported accidents investigated by HSE involved pushing and pulling.

5.6.2 The most frequently reported site of injury was the back (44%).

5.6.3 Followed by the upper limbs (shoulder, arms, wrist and hand) accounted for 28.6%.

5.6.4 12% more accidents involved pulling than pushing (where the activity could be identified within the reports).

5.6.5 35% of pushing and pulling accidents involved wheeled objects.

5.7 There are a number of risk factors associated with pushing and pulling of loads. To make it easy to remember, it can be broken down to **TILE**:

5.7.1 Task

- Steep slopes and rough surfaces can increase the amount of force required to push/pull a load.
- Packers should enlist help from another worker whenever necessary if they have to negotiate a slope or ramp, as pushing and pulling forces can be very high.
- For example, if a load of 400 kg is moved up a slope of 1 in 12 (about 5º), the required force is over 30 kg even in ideal conditions good wheels and a smooth slope.
- The risk also increases over longer distances and when the frequency of pushing/pulling does not provide sufficient rest/recovery time.
- Obstacles can create risks by the worker trying to avoid collision.
- Large amounts of effort to starting or stop the load moving or even to keep it moving.
- Position of the hands is comfortable for the worker. The hands are best positioned between the waist and shoulder height.
- To make it easier to push or pull, employees should keep their feet well away from the load and go no faster than walking speed. This will stop them becoming too tired too quickly

5.7.2 Individual

- Packers may have different characteristics and capabilities. For example, a tall worker may have to adopt an awkward posture to push a trolley with low handles, while a shorter worker may have difficulty seeing over the load.
- Individual concerns such as strains and sprains may temporarily reduce the amount of force a worker can safely handle.
- The task may require unusual capability, if this is so think about how and who should carry out the task.
- Specialised training or instruction maybe needed for lifting and carting equipment.

5.7.3 Load

- Consider the weight of the load and the weight of the equipment being used by the worker.
- Ensure the load is not excessive and that it is sufficiently stable for negotiating and slopes, corners or rough surfaces that may be encountered.
- As a rough guide the amount of force that needs to be applied to move a load over a flat, level surface using a well-maintained handling aid is at least 2% of the load weight.
- For example, if the load weight is 400 kg, then the force needed to move the load is 8 kg. The force needed will be larger, perhaps a lot larger, if conditions are not perfect (e.g. wheels not in the right position or a device that is poorly maintained).
- Moving an object over soft or uneven surfaces requires higher forces. On an uneven surface, the force needed to start the load moving could increase to 10% of the load weight, although this might be offset to some extent by using larger wheels. Soft ground may be even worse.
- The operator should try to push rather than pull when moving a load, provided they can see over it and control steering and stopping.
- Plan the route and ensure the worker can safely see over the load.

5.7.4 Environment

- Environmental factors such as temperature, lighting and air currents can increase the risk of pushing/pulling.
- Hot and humid environments can lead to the early onset of fatigue.
- Many CTUs are made of metal and when exposed to constant heat can become very warm inside. Packers working inside can quickly be overcome with heat exhaustion.
- Strong air movements can increase pushing forces and reduce the stability of the load.
- Very cold environments can also increase the risk.
- Environments where there is poor or bright lighting can affect the worker’s judgement.
- Cargo transport units generally do not have windows of translucent walls, so the interior can be dark. Often illumination of the interior is poor or provided by a bright light at the door end.
- Constant light change when packing (dark going in, bright coming out) can have adverse effect on the packer if carried out repeatedly.
- Floor surfaces that are clean and dry can help reduce the force needed to move a load.
- Constraints on posture may cause problems for the worker, which could affect the task and injure the worker.
- Constant and repetitive twisting, lifting and / or lowering as a packer places packages into a stack, perhaps from a conveyor can quickly result in back injuries.
- Confined spaces and narrow passages/doorways could provoke a tripping/trapping/abrasions injury.

6 Packaging information for manual handling

6.1 Consideration should be given to taking appropriate steps to provide general indications and, where it is reasonably practicable to do so, precise information on the mass of each package, and the heaviest side of any package whose centre of gravity is not positioned centrally.

6.1.1 Consignors should label a load if there is a risk of injury and it is reasonably practicable to do so.

6.1.2 Consignors do not have to provide this information if the effort involved in doing so would be much greater than any health and safety benefits that might result.

6.1.3 It is much better to reduce risky manual handling operations by providing lifting aids, splitting loads and telling people not to carry several items at once.

6.2 What information should be included

6.2.1 If it is reasonably practicable to give precise information the consignor should do so

6.2.2 Giving information that will help to prevent injury does not necessary require consignors to quote masses to anything more than the nearest kilogram or two.†

6.2.3 More detailed information would not help packers avoid risks. This also applies to indications of the heaviest side, unless the load is sufficiently out of balance to take handlers by surprise.

6.2.4 The purpose of providing information about weights is to quickly and reliably warn handlers when a load is heavy. So you need to put the information where it will be seen and is easy to understand.

Annex 16.Access to tank and bulk tops, working at height

1 Risk Assessment

Before accessing tank and bulk CTU tops, management of the packing and unpacking facilities and the transport companies should undertake a thorough risk assessment of the practices. Such assessments should cover:

1.1 Competence of operators

Operators are fit for duty and have passed successfully all the training necessary to fulfil the legislative requirements and site requirements, in particular regarding the handling of dangerous goods.

1.2 Site Instructions

Site access requirements are communicated to the hauliers and that safety procedures are communicated to the drivers upon arrival. Management must promote and maintain safety awareness, particularly during product handling. The management should ensure that loading / unloading operations are carried out under supervision.

1.3 Working at height

Provide safe conditions for working at heights as discussed in this Annex and comply with Part 3

1.4 Product Quality

The preferred option is product acceptance on the basis of a Certificate of Analysis. Taking samples from CTUs should be avoided. If the taking of samples is absolutely required, the management should ensure that samples are taken by qualified site personnel or by appointed surveyors with adequate safety precautions.

1.5 Emergency preparedness

Necessary site safety equipment is made available at the loading and unloading locations, e.g.: fire extinguisher(s), eye wash, safety shower, first aid equipment, emergency escape routes, emergency stop, decontamination equipment, and absorbent materials.

1.6 Near miss and incident reporting

There is a procedure to report all near misses, incidents, loading/discharge problems and unsafe situations or conditions, including follow-up. There should be a system in place to share information on important near-misses, incidents or unsafe situations with all parties involved.

2 CTU ladders

2.1 CTUs for bulk transport will often require access to the roof, to gain access to the interior of the CTU, to open and close the loading hatch or to sample the cargo. All of these units will have a built in feature to permit access, but these are provided for emergency access rather than regular use as they can restricted and in some cases incomplete rungs / steps.

Figure 16.1 : Full frame ladder

Figure 16.2 : Partial frame ladder

Figure 16.3 : Road tanker

2.2 Tank containers, swap tanks and road tankers will have a ladder built into the rear frame, some of which can be clearly discernible as a ladder, see Figure 16.3, while others may appear as a climbing frame see Figure 16.2.

2.3 Ideally, inbuilt ladders should be constructed with two styles and should have steps that are at least 300 mm with high friction surface and the steps uniformly spaced about 300 mm apart. The pictures above show good and less satisfactory versions.

2.4 The design of tank containers, swap tanks and road tankers permits the user to place their feet easily, however access to bulk CTUs is far less satisfactory. Often access is provided by a number of shaped bars attached to the rear doors as Figure 16.4. The example shows five shaped bars, the bottom and top steps quite narrow and the spacing varies from 480 mm to 640 mm. Operators attempting to climb onto and from the roof will find these steps difficult.

Figure 16.4 : Bulk container rungs

2.5 Where access is required to the top of the container, they will be marked with a warning decal as shown in Figure 16.5. The decal indicates a warning from all overhead hazards and power cables in particular. Operators when deciding whether to access the top of the container should make themselves aware of all potential hazards directly overhead and immediately adjacent to the container. This warning is particularly important for operations in rail transfer depots but may affect other handling operations.

Figure 16.5 : Overhead warning sign

2.6 Ladders built into the CTU should only be considered as a means of access to the top of the container in an emergency, as the process of climbing onto the top of the container entails a risk of slipping and falling. Operational access to tank container tops should be made using suitable mobile steps or from a gantry.

2.7 When a tank or dry bulk container is loaded onto a chassis the bottom of the ladder can be as much as 1,600 mm, and the top of the container as much as 4.3 m off the ground. Furthermore on some designs of chassis the container will be slightly inclined with the front end elevated which would mean that the ladder would be inclined backwards towards to the operator.

2.8 The steps / rungs are generally manufactured from steel or aluminium and can be slippery in the cold and wet. Operators can easily miss their step when climbing these ladders.

2.9 When transitioning from the ladder to the walkway on the container top, there are limited hand holds available for the operator to grip (see Figure 16.6) making the manoeuvre hazardous. An operator climbing onto the top of the tank container shown in Figure 16.7 will be presented with either the walkway securing bracket or the miss-stacking plate, neither of which are ideal handholds. Climbing off the top of the container can be more hazardous as the operator is attempting to locate rungs / steps which are not visible and in an awkward position.

Figure 16.6 : Container handhold

Figure 16.7 : Transitioning

3 Working at height safety

3.1 Typical health and safety regulations will state that every employer shall ensure that work is not carried out at height where it is reasonably practicable to carry out the work safely otherwise than at height. Where work is carried out at height, every employer shall take suitable and sufficient measures to prevent, so far as is reasonably practicable, any person falling a distance liable to cause personal injury.

3.2 The measures should include:

3.2.1 ensuring that the work is carried out:

- from an existing place of work; or
- (in the case of obtaining access or egress) using an existing means, which complies with guidelines with those regulations, where it is reasonably practicable to carry it out safely and under appropriate ergonomic conditions; and
- where it is not reasonably practicable for the work to be carried out in accordance with sub-paragraph 2.2.1, his providing sufficient work equipment for preventing, so far as is reasonably practicable, a fall occurring.

3.2.2 Where the measures taken do not eliminate the risk of a fall occurring, every employer should:

- so far as is reasonably practicable, provide sufficient work equipment to minimise:
- the distance and consequences; or
- where it is not reasonably practicable to minimise the distance, the consequences, of a fall; and
- without prejudice to the generality of paragraph 2.2, provide such additional training and instruction or take other additional suitable and sufficient measures to prevent, so far as is reasonably practicable, any person falling a distance liable to cause personal injury.

3.3 The regulations can generally be interpreted to mean that wherever possible working at height should be avoided, but where that is not possible, then make it as safe as possible by providing facilities and equipment to minimise the risk of injury.

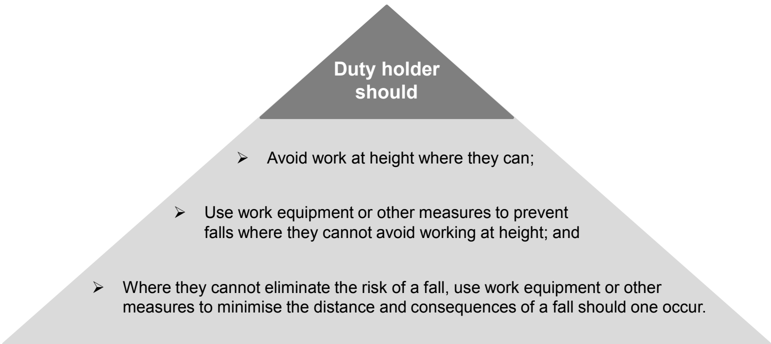


Figure 16.8 : Regulations hierarchy

4 Access and safety equipment

4.1 Where regular access is required to the top of CTUs at a number of different facilities, alternative access solutions should be considered. Some operators have provided more substantial access ladders attached to the trailer as shown in Figure 16.9. The ladder provided satisfies the step dimension recommendation and can be adjusted so that the lowest step is just off the ground. However there are no guard rails on the ladder or on the work platform so the operator will still be at risk of a fall. As an alternative mobile steps similar to those shown in Figure 16.10 can be used which can be positions beside the CTU and from which the operator can safely step.

Figure 16.9 : Trailer mounted access ladder

Figure 16.10 : Mobile access ladder

4.2 At facilities where regular access is required the CTU should be positioned next to a fixed access gantry (see Figure 16.12). Once the container is positioned next to the gantry the operator can lower the counterbalanced handrail / barrier to provide additional safety while working on the CTU top.

4.3 If the container is mounted on a chassis, the operator should not attempt to access the top of the container unless the tractor unit has been disconnected or immobilised to prevent accidental movement of the container.

Figure 16.11 : Access gantry

4.4 Use a fall arrest system, by far the best item of personnel safety equipment that can be employed. Operators should wear an approved harness and attach themselves to the overhead cables. In Figure 16.12 a number of "T" shaped stanchions are positioned about the area where an operator will work on the top of the container. The connecting overhead cables have counterbalanced arrest drums supported from them to which the operator will attach their harness.

Figure 16.12 : Fall arrest stanchions

4.5 Do not overcrowd the top of the container. The walkways are limited in size and strength. Furthermore with too many people on the top of the container moving about can be hazardous.

Annex 17.CTU Seals

1 Introduction

1.1 CTUs all have facilities for sealing them and packers and shippers may elect to seal them to protect the cargo against theft. That decision will depend on the mode of transport, the route that it follows and the cargo carried. Other agencies, such as the World Customs Organisation, may require CTUs on engaged in international transport to seal them against to improve security against the illegal movement of materials such as narcotics and weapons, and of persons.

1.2 Within this annex the responsibilities of parties within in the supply chain[1] are discussed, the types of seal available and why each may be used and the method of fixing and removal of the seals.

2 Responsibilities along the chain of custody

2.1 Cross-cutting responsibilities

2.1.1 There are responsibilities and principles that apply throughout the life cycle of a shipment of goods. The emphasis is on the relationships among parties upon changes in the custody or possession of the CTU. That emphasis does not reduce and should not obscure the fundamental responsibility of the shipper for the safe and secure stuffing and sealing of the container. Each party in possession of the CTU has security responsibilities while cargo is entrusted to them, whether at rest at a terminal or while moving between terminals.

2.1.2 Those responsibilities include :

- Protecting the physical goods from tampering, theft, and damage.
- Providing appropriate information to government authorities in a timely and accurate manner for security screening purposes.[2]
- Protecting the information related to the goods from tampering and unauthorised access. This responsibility applies equally to times before, during and after having custody of the goods.

2.1.3 Seals are an integral part of the chain of custody. The proper grade and application of the seal is addressed below. Where fitted, seals should be inspected by the receiving party at each change of custody for a packed CTU.

2.1.4 Inspecting a seal requires visual check for signs of tampering, comparison of the seal's identification number with the cargo documentation, and noting the inspection in the appropriate documentation. If the seal is missing, or shows signs of tampering, or shows a different identification number than the cargo documentation, then a number of actions are necessary:

2.1.4.1 The consignee should bring the discrepancy to the attention of the carrier and the shipper. The consignee should also note the discrepancy on the cargo documentation and notify Customs or law enforcement agencies, in accordance with national legislation. Where no such notification requirements exist, the consignee should refuse custody of the CTU pending communication with the carrier until such discrepancies can be resolved.

2.1.4.2 Seals may be changed on a container for legitimate reasons. Examples include inspections by an exporting Customs administration to verify compliance with export regulations; by a carrier to ensure safe blocking and bracing of the shipment; by an importing Customs administration to confirm cargo declarations; and by law enforcement officials concerned with other regulatory or criminal issues.

2.1.4.3 If public or private officials should remove a seal to inspect the shipment, they should install a replacement in a manner that meets the requirements specified below, and note the particulars of the action, including the new seal number, on the cargo documentation

2.1.4.4 All facilities listed in the next section may not be used in the transport route for the CTU and customs' requirements may not apply.

2.2 Packing site

2.2.1 The shipper is responsible for packing and securing the cargo within the CTU and for the accurate

[1] As described in the WCO SAFE Framework of Standards, June 2011

[2] This responsibility only refers to CTUs engaged in international transport.

and complete description of the cargo. Where required, the shipper is also responsible for affixing the cargo seal immediately upon the conclusion of the packing process, and for preparing documentation for the shipment, including the seal number.

2.2.2 For international transport the seal should be compliant with the definition of high-security mechanical seals in ISO 17712. The seal should be applied to the CTU in a manner that avoids the vulnerability of the CTU door handle seal location to surreptitious tampering. Among the acceptable ways to do this are alternative seal locations that prevent swivelling of an outer door locking cam or the use of equivalent tamper evident measures, such as cable seals across the door locking bars.

2.2.3 The land transport operator picks up the load. The transport operator receives the documentation, inspects the seal and notes the condition on the documentation, and departs with the load.

2.3 Intermediate terminal

If the CTU movement is via an intermediate terminal, then the land transport operator transfers custody of the CTU to the terminal operator. The terminal operator receives the documentation and should inspect the seal and notes its condition on the documentation. The terminal operator may send an electronic notification of receipt (status report) to other private parties to the shipment. The terminal operator prepares or stages the CTU for its next movement, which could be by road, rail or barge. Similar verification and documentation processes take place upon pickup or departure of the container from the intermediate terminal. It is rare that public sector agencies are involved in or informed about intermodal transfers at intermediate terminals.

2.4 Marine Terminal

2.4.1 Upon arrival at the loading ocean terminal, the land transport operator transfers custody of the CTU to the terminal operator. The terminal operator receives the documentation and may send an electronic notification of receipt (status report) to other private parties to the shipment. The terminal operator prepares or stages the CTU for loading upon the ocean vessel.

2.4.2 The carrier or the marine terminal as agent for the carrier should inspect the condition of the seal, and notes it accordingly; this may be done at the ocean terminal gate or after entry to the terminal but before the CTU is loaded on the ship. Public agencies in the exporting nation review export documentation and undertake necessary export control and provide safety certifications. The Customs administrations that require advance information receive that information, review it, and either approve the CTU for loading (explicitly or tacitly) or issue “do not load” messages for containers that cannot be loaded pending further screening, including possible inspection.

2.4.3 For those countries that have export declaration and screening requirements, the carrier should require from the shipper documentation that the shipper has complied with the relevant requirements before loading the cargo for export. (The shipper is, however, responsible for compliance with all prevailing documentation and other pertinent export requirements.) Where applicable, the ocean carrier must file its manifest information to those importing Customs agencies that require such information. Shipments for which “do-not-load” messages have been issued should not be loaded on-board the vessel pending further screening.

2.5 Transhipment terminal

The transhipment terminal operator shall inspect the seal between the off-loading and re-loading of the CTU. This requirement may be waived for transhipment terminals which have security plans that conform to the International Ship and Port Facility Security Code (ISPS Code produced by the International Maritime Organization).

2.6 Off-loading marine terminal

2.6.1 The consignee usually arranges for a Customs broker to facilitate clearance of the shipment in the off-loading ocean terminal. Generally, this requires that the cargo owner provide documentation to the broker in advance of arrival.

2.6.2 The ocean carrier may provide advance electronic cargo manifest information to the terminal operator and to the importing Customs administration as required. Customs may select CTU for different levels of inspection immediately upon off-loading or later. Customs may inspect the condition of the seal and related documentation in addition to the cargo itself. If the CTU is to travel under Customs control to another location for clearance, then Customs at the off-loading terminal must affix a Customs seal to the CTU and note the documentation accordingly.

2.6.3 The consignee or Customs broker pays any duties and taxes due to Customs and arranges the Customs release of the shipment. Upon pickup for departure from the ocean terminal, the land transport operator inspects and notes the condition of the seal, and receives documentation from the terminal operator.

2.7 Intermediate terminal

The processes in intermediate terminals in the importing country are analogous to those in intermediate terminals in exporting countries.

2 Unpacking site

2.1 Upon receipt of the container, the consignee inspects the seal and notes any discrepancy on the documentation. The consignee unpacks the CTU and verifies the count and condition of the lading against the documentation.

2.2 If there is a shortage, damage, or an overage discrepancy, it is noted for claims or insurance purposes, and the shipment and its documentation are subject to audit and review. If there is an anomaly related to narcotics, contraband, stowaways or suspicious materials, the consignee Customs or another law enforcement agency must be informed.

3 Seal Types

3.1 Mechanical Seals[3]

3.1.1 Introduction

3.1.1.1 The choice of seal for a specific requirement will depend on many factors. It should be selected after full consideration of the user's performance requirements. The first decision is the appropriate seal classification (indicative, security or high security), followed by a decision on a particular type, make and model.[4]

3.1.1.2 In general terms, a low strength indicative seal should be used where only indication of entry is desired. Where a physical barrier is a definitive requirement either a security or high-security seal should be used.

3.1.1.3 All seals should be easy to fit correctly on the item to be sealed and once in situ be easy to check for positive engagement of the locking mechanism(s). Correct handling and fitting of seals is at least equal if not greater in importance than selection of the correct seal. A poorly chosen but correctly fitted seal may provide security; however, a well-chosen but incorrectly fitted seal will provide no security.

3.1.1.4 Security and high-security seals shall be sufficiently durable, strong and reliable so as to prevent accidental breakage and early deterioration (due to weather conditions, chemical action, vibration, shock, etc.) in normal use.

3.1.2 Marking

3.1.2.1 Seals shall be identified by unique marks (such as a logotype) and unique numbers that are readily legible; markings intended for unique identification of the seal shall be considered permanent. All seals shall be uniquely numbered and identified. The identity of the manufacturer or private label holder shall be evident on every seal, either name or logo.

3.1.2.2 Seals meeting the relevant criteria shall be marked or stamped in a readily legible way to identify their classification as indicative (“I”), security (“S”), or high-security (“H”) seals. Any modification of markings shall require obvious irreversible physical, chemical, heat or other damage to or destruction of the seal.

3.1.3 Identification marks

3.1.3.1 Regulatory authorities and private customers may require identifiers that go beyond the requirements of the International Standard, such as in the following cases.

- Seals intended for use on CTUs moving under customs laws shall be approved or accepted and individually marked as determined by the relevant customs organisation or competent authority.
- If the seal is to be purchased and used by customs, the seal or fastening, as appropriate, shall be marked to show that it is a customs seal by application of unique words or markings designated by the customs organisation in question and a unique identification number.

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3 ISO 17712 Freight Containers – Mechanical Seals.

4 Selection of a seal presumes the user has already considered the condition of the item to be sealed; some items, such as open flat or flatrack CTUs, are not suitable for any seal on the CTI itself. A seal is only one element in a security system; any seal will only be as good as the system into which it is introduced.

- If the seal is to be used by private industry (i.e. a shipper, manufacturer or carrier), it shall be clearly and legibly marked and uniquely numbered and identified. It may also be marked with a company name or logo.

3.1.4 Evidence of tampering

Seals may be designed and constructed so that tamper attempts create and leave evidence of that tampering. More specifically, seals may be designed and manufactured to prevent removal or undoing the seal without breaking, or tampering without leaving clear visible evidence, or undetectable re-application of seals designed for single use.

3.1.5 Testing for seal classification

3.1.5.1 There are four physical test procedures, tensile, shear, bending, and impact. The impact procedure is performed twice at different temperatures.

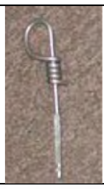
3.1.5.2 The lowest classification for any sample on any test shall define the classification for the seal being evaluated. To achieve a given classification, all samples must meet the requirements for that classification in all five tests.[5]

		Seal Classification		High Security	Security	Indicative
Test	**Test Criteria**		**Units**	'H'	'S'	'I'
Tensile	Load to failure		kN	10.00	2.27	<2.27
Shear	Load to failure		kN	3.336	2.224	<2.224
Bending	Cycles to failure	Flexible Seals		501	251	<251
	Bending moment to failure	Rigid Seals	Nm	50	22	<22
Impact	Impact load	Low Temperature	J	40.68	27.12	<27.12
	Impact load	High Temperature	J	40.68	27.12	<27.12
	Drop height	Dead blow mass	m	1.034	0.691	0.346

3.1.6 Types of mechanical seal

Wire seal	Length of wire secured in a loop by some type of seizing device Wire seals include: crimp wire, fold wire and cup wire seals.  NOTE The seizing device can be plastic or metal and its deformation is one indication of tampering.
Padlock seal locking body with a bail attached	Padlock seals include: wire shackle padlock (metal or plastic body), plastic padlock and keyless padlock seals.  NOTE The padlock itself is not an integral part of the CTU.
Strap seal	Metal or plastic strap secured in a loop by inserting one end into or through a protected (covered) locking mechanism on the other end  NOTE The seizing device can be plastic or metal and its deformation is one indication of tampering.

[5] The terms indicative, security and high security refer to the barrier capabilities of the seal (respectively, minimal, medium and meaningful barrier strength). The classification names do not imply any differences in security against tampering.

Cable seal	Cable and a locking mechanism On a one-piece seal, the locking or seizing mechanism is permanently attached to one end of the cable. A two-piece cable seal has a separate locking mechanism which slips onto the cable or prefabricated cable end. 
Bolt seal	Metal rod, threaded or unthreaded, flexible or rigid, with a formed head, secured with a separate locking mechanism 
Cinch seal Pull-up seal	Indicative seal consisting of a thin strip of material, serrated or non-serrated, with a locking mechanism attached to one end  NOTE The free end is pulled through a hole in the locking mechanism and drawn up to the necessary tightness. Cinch or pull-up type seals can have multiple lock positions. These seals are generally made of synthetic materials such as nylon or plastic. They can resemble, but are significantly different from, simple electrical ties.
Twist seal	Steel rod or heavy-gauge wire of various diameters, which is inserted through the locking fixture and twisted around itself by use of a special tool. 
Scored seal	Metal strip which is scored perpendicular to the length of the strip  NOTE The strip is passed through the locking fixture and bent at the score mark. Removal of the seal requires bending at the score mark which results in breakage of the seal.
Label seal	Frangible seal consisting of a paper or plastic backing with adhesive  NOTE The combination of backing and adhesive are chosen to cause the seal to tear when removal is attempted.
Barrier seal	Designed to provide a significant barrier to container entry  NOTE 1 A barrier seal can enclose a portion of the inner locking rods on a container. NOTE 2 Barrier seals can be designed to be reusable

3.2 Electronic Seals

3.2.1 An electronic seal[6] is described[7] as a read-only, non-reusable freight container seal conforming to the high-security seal defined in ISO 17712 and conforming to ISO 18185 or revision thereof that electronically evidences tampering or intrusion through the container doors.

Figure 17.1
Electronic Seal

3.2.2 In fact there are a number of reusable seals that provide the strength of the mechanical seals described in ISO 17712 with the added benefit of remote / automated reading at transport portals and interchange gates.

3.2.3 Electronic seals can communicate either passively or actively with readers and other communication devices. The passive electronic seal relies on a signal from a reader to activate a response from the electronic seal while an active electronic seal is fitted with a battery and transmits a signal that can be interrogated by a reader or a communication device.

3.2.4 Active seals can be used in conjunction with a tracking / communication device that would enable a signal to be sent from the electronic seal to the communication device should the seal be damaged or tampered with. This will allow the shipper to be altered in real time should the seal be damaged.

3.3 Other Devices

3.3.1 Other devices that use satellite and mobile phone technology can report on the location of the CTU, condition of the cargo, and whether the CTU has been opened. This can be done in real time, when the CTU passes a communication portal or when the device data is downloaded.

3.3.2 Such devices are usually fitted by the shipper on their, or the consignee's, behalf.

3.4 Sealing CTUs

3.4.1 Introduction

3.4.1.1 Closed units used in each of the transport modes have similar securing methods. Box type CTUs with doors at the rear will have either vertically hinged swinging doors, sliding, drop down door / ramp, or roller shutter doors.

Figure 17.2 : Swing door
(Road vehicle))

Figure 17.3 : Sliding door
(Rail Wagon)

Figure 17.4 : Roller Shutter
(Swap Body)

3.4.1.2 The different types of CTU offers different door closing gear, swinging doors can be fitted with two or one locking bars per door which can be surface mounted or enclosed in the door structure and the locking handle can be in the bottom quarter of the door or below the doors.

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[6] Also known as eSeals, and RFID tags.

[7] ISO 18185-1:2007 Freight containers – Electronic seals – Part 1 communication protocol.

Figure 17.5 : Surface mounted handles

Figure 17.6 : Roller shutter lock

Figure 17.7 : Recessed handled with protruding eyes

3.4.1.3 All the door locking devices work on two principles. A seal can either:

- be passed through the handle and secured against a fixed item on the CTU (see Figure 17.5 and Figure 17.6); or
- the a fixed eye protruding from the CTU projects through the handle (see Figure 17.7).

3.4.1.4 Very often the choice for fixing the seal is obvious and where there are two or more handles generally the one that operates the inner lock rod of the right hand door. Some handles do not have apertures for seals,[8] while some CTUs will have multiple apertures suitable for seals.

Figure 17.8 : Handle without aperture

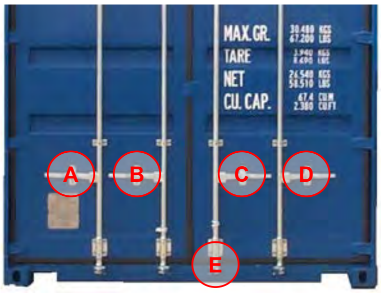

Figure 17.9 : Multiple apertures

3.4.1.5 In Figure 17.9 the first choice should be at ‘E’ or ‘C’ (inner lock rod right hand door) and for additional security position ‘B’ (Inner lock rod left hand door). Where the CTU is involved in international transport, a high-security bolt seal fitted at position ‘E’[9] provides the most secure solution especially for fitting and removal when a container is on a trailer.

3.4.1.6 The decision whether to seal the CTU and the choice of seal to be used will depend on the shipper, the value of the cargo, the type of CTU and the route. CTUs that are making a number of stops to un-pack one or more packages may decide that a clip is all that is needed. Singe drop off trips may require an indicative seal. However CTUs destined for international transport should be sealed with a high security seal and the usual choice is a bolt seal

3.4.2 Dry Bulk CTUs

3.4.2.1 Units designed to carry a dry bulk cargo may have a number of loading and discharge hatches. Depending on the design there may be many loading hatches in the roof and one or more discharge hatches incorporated into the rear doors or in the front wall.

3.4.2.2 Each of the arrowed locations in Figure 17.10 will require sealing. Figure 17.12 and Figure 17.13 discharge hatch sealing points. Figure 17.11 shows an internal slide bolt to a loading hatch in the roof of the CTU that can lock the hatch closed when the CTU is not being used to transport a cargo that requires loading from above.

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8 Generally left hand door handles

9 The security cam type fitting is not fitted to all CTU.

Figure 17.10 : Dry bulk sealing points

Figure 17.11 : Roof hatch internal lock

Figure 17.12 : Dry bulk discharge hatch (rear)

Figure 17.13 : Dry bulk discharge hatch (front)

3.4.3 Tank CTUs

3.4.3.1 Like CTUs for dry bulk cargoes, tank containers and trailers may have multiple openings for loading and discharging.

3.4.3.2 The loading hatches in tank containers are generally secured using a number of wing nuts tightening round the manway hatch. The seal is fitted through a tang fitted to the rim plate and the hatch seal fitting.

Figure 17.14 : Manway hatch seal

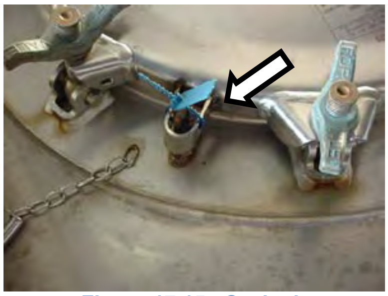

Figure 17.15 : Seal tab

3.4.3.3 Top valves in tank containers will also need to be sealed, some have wires welded to the fixing nuts, while other will be sealed in the closed position.

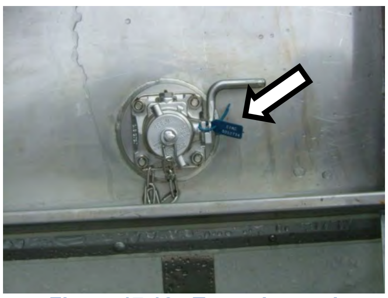

Figure 17.16 : Top valve seal

Figure 17.17 : Discharge vale seal

3.4.3.4 The discharge valve on many tanks may have one or two valves plus a closing cap. It is possible to seal all of these however the best sealing position is the main butterfly type valve, there the handle is seal to the adjacent tank.

3.4.4 Open sided units

3.4.4.1 The world customs organisation has now defined all sheeted CTUs as open units, therefore sealing them now has a lesser requirement.

3.4.4.2 There are two basic designs of sheeted attachment:

- 'Tautliner' where there are buckles used to tension the straps and the side sheet. Each buckle will have a hole through which the TIR cord will be passed (see Figure IV-18). The TIR cord may be secured with a sealing device at each end.
- The second design has eyes that are placed over rings and the TIR cord is passed through the rings (see Figure IV-19). This design is most often used with open sided and open top containers.

Figure 17.18 : Tautliner clip

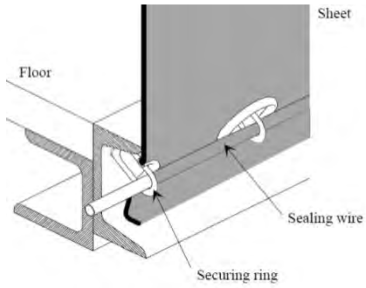

Figure 17.19 : TIR wire fitting

3.4.4.3 The tautliner buckles do not require the TIR cord to be in place to close the curtain, whereas the ring and eye design requires the cord or else the curtain or top tarpaulin / tilt will become easily detached.

3.4.5 Fitting seals

3.4.5.1 The type of handle, handle retainer and catch can also affect the security of the doors. While owners endeavour to make their equipment as secure as possible there are many methods that criminals can gain access to the interior of the CTU.

3.4.5.2 There have been a number of designs for the handle retainers and catches, but generally there are two generic designs in use illustrated in Figure 17.20 and Figure 17.21.

3.4.5.3 Figure 17.20 shows a design where the lock rod handle is attached to the catch which in turn is attached to the container using a rivet. As the catch has to rotate there is always a small gap between the catch and the retainer.

3.4.5.4 Figure 17.21 has the seal passing through the catch, the handle and a fixed arm on the retainer. This design means that there the seal is directly attached to the retainer and to remove the seal would require the seal or the retainer to be damaged. The type of handle, handle retainer and catch can also affect the security of the doors. While owners endeavour to make their equipment as secure as possible there are many methods that criminals can gain access to the interior of the CTU.

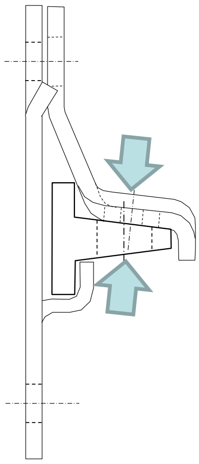

Figure 17.20 : 2 point seal

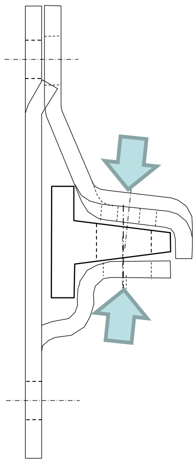

Figure 17.21 : 3 point seal

3.4.5.5 Before fitting the seal record the number of the CTU and the reference of the seal(s) to be fitted and where each is used (Right hand door inner cam keeper, rear hatch etc.).

3.4.5.6 Push the seal through all elements of the retainer, handle and clip and snap the two halves together.

Figure 17.22 ; Fitting a bolt seal

3.4.5.7 Once the seal has been fitted, give the bottom a number of sharp tugs and twist the two components to confirm that the seal is fully and properly engaged.

3.4.6 Cutting seals

3.4.6.1 The following four pictures show various seals and the tools normally associated with cutting them. Indicative and security cable seals (Figure 17.23) can be generally cut with cable cutters (Figure 17.24) or small bolt cutters. High security cable seals (Figure 17.24) and twist seals (Figure 17.26) generally require 24 in (600 mm) cable or bolt cutters.

Figure 17.23 : Cable seals

Figure 17.24 : High Security Cabe seals

Figure 17.25 : Cutters for cable seal

Figure 17.26 : Cutters for twist seal

3.4.6.2 The design of cable cutters shearing edges (Figure 17.25) are such that the cable seal strands are captured during the cutting process which prevents strands from becoming separated from the cable.

3.4.6.3 Cable seals use Non Preformed Cable, that frays wildly when cut. Figure 17.27 shows two examples where cable seals have been cut, both have frayed. Cable seals are supplied with the cable permanently attached to one lug, in the case of the picture they are the lower lugs in both examples. The loose end of the cable is

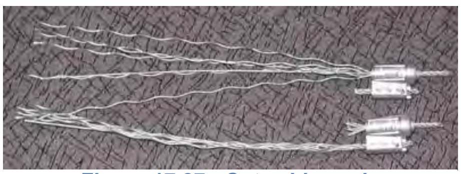

Figure 17.27 : Cut cable seals

passed through the upper lug and crimped closed.

3.4.6.4 In the top example the cable has been cut correctly, only a small length of cable remains staked (permanently attached) to the seal, whereas the bottom example has been cut close to the at the bottom lug. With patience the short end in the bottom example could be pulled out and the wire reformed and inserted into the crimping lug for re-use.

3.4.6.5 Bolts should be cut as close to the lock body as possible. The left hand bolt in Figure 17.28 was cut close to the lock body and is unlikely to be risk to walkers or vehicles as it is not likely to roll point upwards.

Figure 17.28 : Cut bolt seal - stems

Figure 17.29 : Cut bolt seals - head

3.4.7 Cutting tools

3.4.7.1 ⅝ in high security bolt seals (Figure 17.30) are generally the hardest to cut and will often require 36 in (900 mm) cutters. 42 in bolt cutters are considered too heavy[10] for this operation and should not be used.

Figure 17.30 : Typical bolt seal

Figure 17.31 : Bolt cutters

Figure 17.32 ; 42in bolt cutter

3.4.7.2 The picture shown left shows a version of the bolt seal seen on the previous page. It satisfies all the minimum test requirements for the seal to be designated as 'High Security'. However the shear strength is very high and cannot normally be cut with a bolt cutter.

Figure 17.33 ; Rail car bolt seal and breaking tool

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[10] In general hand held tools should not exceed 2 kg if operated by one hand and 5 kg for two hands. Bolt cutters with long handles also exert considerable strain on wrists. 42 in bolt cutters can easily weigh 8 kg or higher and some 36 in cutters may weigh up to 7 kg.

3.4.7.3 Bolt cutters are assemblies of four or five linked levers with magnifies the force applied at the handles via the fulcrum and into the shearing blades that cuts through the seal shaft. The fulcrum is point A in Figure 17.34 with a lever length D_L.

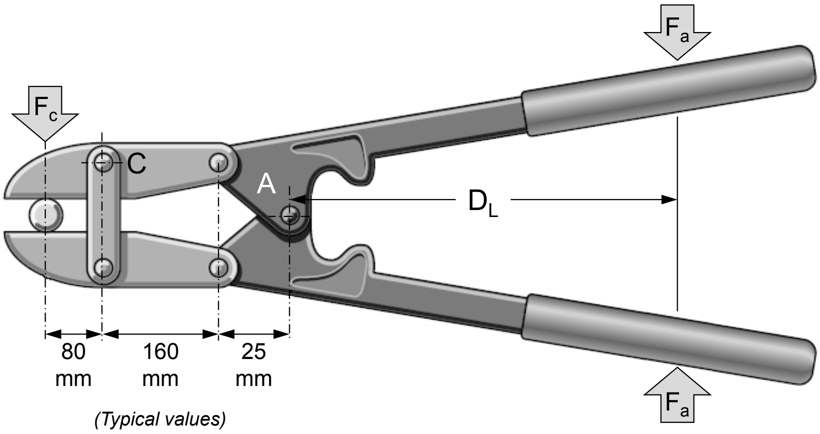


Figure 17.34 : Bolt cutter schematic

3.4.7.4 The length shown as D_L in the diagram below dictates the force that can be applied (F_c). Bolt cutters with 900 mm long handles would need an applied force of 46 N to cut a bolt seal with shear value of 3.336kN. Cutters with 600 mm long handles would require a force of 70N to cut the same bolt.

3.4.7.5 As an indication, the force that can be applied by an average fit man "squeezing" the arms inwards is approximately 70 N. Therefore many people may find attempting to cut a high security bolt seal with cutters with handles 600 mm or shorter will be able to cut through solid bolts without excessive force applied at the handles which may result in injury.

3.4.7.6 Operators who open CTUs with high security seals regularly may wish to use a mechanical bolt cutter. The left hand two pictures (Figure 17.35 and Figure 17.36) show the cutting head and compressor of a high volume bolt cutter. The right hand picture (Figure 17.37) shows a battery operated hand held cutter. Similar designs are available.

Figure 17.35 : Hydraulic cutting head

Figure 17.36 : Hydraulic pump and controller

Figure 17.37 : Battery operated bolt cutter

Annex 18.Fumigation

1 General

1.1 Fumigation is a method of pest control that completely fills an area with gaseous pesticides—or fumigants—to suffocate or poison the pests within. It is utilized for control of pests in buildings (structural fumigation), soil, grain, and produce, and is also used during processing of goods to be imported or exported to prevent transfer of exotic organisms. This method also affects the structure itself, affecting pests that inhabit the physical structure, such as woodborers and drywood termites.

1.2 Timber products used for dunnage can be treated under the requirements of ISPM 15, issued by the International Plant Protection Commission (IPPC), by fumigation. Some shippers believe, incorrectly, that they can achieve this by throwing in a fumigation bomb just before the container doors are closed. however is not permitted under ISPM 15 and does not achieve the required level of treatment.

1.3 Fumigated cargo transport units (UN3359) containing no other dangerous goods are not subject to any provisions of Dangerous Goods Codes or Notices other than that is included in this Annex.

1.4 When the fumigated CTU is packed with dangerous goods in addition to fumigant, any provisions of the Dangerous Goods Codes or Notices (including placarding, marking and documentation) applies in addition to the provisions of this Annex.

1.5 Only CTUs that can be closed in such a way that the escape of gas is reduced to a minimum should be used for transport of cargo under fumigations.

2 Training

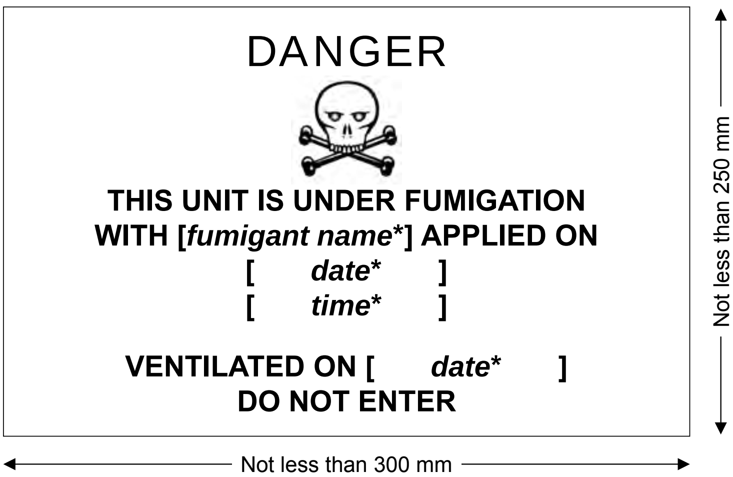
Persons engaged in the handling of fumigated CTUs should be trained commensurate with their responsibilities.

3 Marking and placarding

3.1 A fumigated CTU should be marked with a warning mark, (see Figure 18.1) affixed at each access point in a location where it will be easily seen by persons opening or entering the CTU. This mark shall remain on the CTU until the following provisions have been met:

- the fumigated CTU has been ventilated to remove concentrations of fumigant gas; and
- the fumigated goods or materials have been unpacked.

3.2 The fumigation mark shall be rectangular and shall not be less than 300 mm wide and 250 mm high. The markings shall be black print on a white background with lettering not less than 25 mm high.



*** Insert details as appropriate**

Figure 18.1 Fumigation mark

3.3 Class 9 placards should not be affixed to a fumigated CTU except as required for other Class 9 substances or articles packed therein.

4 Ventilation

4.1 After the fumigant has performed its function it can be ventilated before it is transported if required. When the fumigated CTU has been completely ventilated either by opening the doors of the CTU or by mechanical ventilation after fumigation, the date of ventilation shall be marked on the fumigation mark.

4.2 Care should be taken even after a CTU has been declared as ventilated. Gas can be held in packages of cargo, then desorbed over a long period of time, even over many days, raising the level of gas inside the cargo transport unit to above the safe exposure level. Bagged cereals and cartons with large air spaces are likely to produce this effect. Alternatively, gas and the fumigant sachets or tablets can become 'trapped' at the far end of a cargo transport unit by tightly packed cargo.

4.3 In reality any container that has carried dangerous or fumigated goods cannot be considered as safe until it has been properly cleaned and all cargo residues, gaseous and solid, have been removed. The consignee for such goods should have the facilities to carry out this cleaning process safely.

4.4 When the fumigated CTU has been ventilated and unpacked, the fumigation mark should be removed.

5 Documentation

5.1 Documents associated with the transport of CTUs that have been fumigated and have not been completely ventilated before transport shall include the following information:

- “UN 3359, fumigated CTU, 9”, or “UN 3359, fumigated CTU, Class 9“;
- the date and time of fumigation; and
- the type and amount of the fumigant used.

5.2 The transport document may be in any form, provided it contains the information required in 4.1. This information shall be easy to identify, legible and durable.

5.3 Instructions for disposal of any fumigants including fumigation devices (if used) should be provided. A document is not required when the fumigated CTU has been completely ventilated and the date of ventilation has been marked on the fumigation mark.

Annex 19.Testing CTUs for hazardous gases

1 Introduction

1.1 The risk of "hazardous gases in shipping containers" is relevant to all companies that handle shipping containers, such as distributors, warehouses, wholesalers, transportation companies, importers, retailers and manufacturing companies. It includes both acts that fall within the internal business processes (manufacturing), and actions performed on behalf of third parties (service providers and logistics companies).

1.2 This action plan focuses on employees of companies, involved in opening and unpacking of shipping containers. Wherever this action plan refers to 'the company', it refers to the company, not necessarily the ultimate consignee, with responsibility and authorization for opening and unloading the container, which can occur at different points in the supply chain.

1.3 Hazardous gases in containers can come from:

- Deliberately adding gases to prevent decay and deterioration of the load or containers by pests
- The evaporation of substances used in the manufacture of products or dunnage
- (Chemical) processes in the cargo

1.4 In addition, incidents can occur through leakage of containers with hazardous substances. Several substances are often found simultaneously in containers.

2 Action plan[1]

2.1 The action plan "Safe handling of gases in containers" includes a policy process and an operational process. The policy process indicates how a company can design a policy to deal safely with gases in containers. The operational process leads to the 'safe' opening and entering of containers.

2.2 At the end of the description of the process steps, the activities, the moments of choice and the required information are presented in flowcharts. The flowcharts are part of this action plan and cannot be used separately from the description.

2.3 The action plan consists of the following steps:

2.3.1 The drawing up of a company policy (flowchart: policy process)

2.3.2 Taking delivery of shipping containers (flowchart: operational process 1)

2.3.3 Measurement Survey (flowchart: operational process 2)

2.3.4 Measures (flowchart: operational process 2)

2.3.5 Safe opening and entering of shipping containers (flowchart: operational process 3)

2.3.6 Registration

3 Action plan

3.1 Step 1. Drawing up of a company policy

3.1.1 The company starts gathering information about the container issue and the chain approach. Then an inventory of the containers to be received will be made. These are so-called container flows. Finally the company will draw up a risk profile for every container flow.

3.1.2 Based on this preliminary examination, the shipping containers are placed in one of the following categories. This category classification determines the further processing of the container (flow):

3.1.2.1 Category A: The shipping container contains hazardous gases. The gases in question and their expected concentration are known.

A shipping container falls into category A if, based on a so-called historical research - i.e. a previous measurement survey, analysis of the container flow and the shipping documents - it has been determined which harmful substances are to be found. In such a case, there is a homogenous[2] shipping container flow. Upon receipt of the shipping containers, random controls (incl. measurement survey) must confirm that no changes have occurred in the chain.

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[1] This is an example of a suitable action plan for checking for hazardous gasses.

3.1.2.2 Category B: It is not known if the shipping container contains hazardous gasses.

A shipping container falls into category B if it is not known whether the container contains hazardous gases. That is certainly the case for every container that is not part of a homogeneous shipping container flow and that cannot be shown to belong to category A or C.

3.1.2.3 Category C: The shipping container does not contain any hazardous gases.

A shipping container falls into category C if the following four conditions are met:

- The preliminary examination shows that the container flow cannot contain hazardous substances.
- There is a homogenous container flow.
- Previous measurement research shows that no measurable hazardous gases have been found in this container flow. The data are statistically sound.
- Upon receipt of the shipping containers, random controls (incl. gas measurements) confirm that no changes have occurred in the chain.

Based on the preliminary examination, the company draws up a company policy regarding container gases, a company procedure and an employee-training programme. Where possible, the company makes arrangements with companies that are part of the same logistics chain to limit or manage the risks when opening and entering the shipping containers.

The company periodically evaluates the company policy “Safe handling of gases in shipping containers”. Reasons for adjustment of the policy include:

- (abnormal) readings
- Incidents
- Changes in current knowledge and legislation
- Changed agreements with chain partners

3.2 Step 2 Taking receipt of shipping containers

This marks the start of the operational process. A company that receives shipping containers has verified in step 1 to which category a shipping container belongs. Once the category has been determined, the shipping container is dealt with according to the corresponding procedure:

- Operational Process: category A shipping containers
- Operational Process: category B shipping containers
- Operational Process: category C shipping containers

The action plan and the procedures described in the operational process do not distinguish between different origins of the hazardous substances that are present.

3.3 Step 3 Measurement Survey

3.3.1 A gas measurement expert sets up a measuring strategy and carries out the measurement survey. The company is free to decide whether it outsources the reading or asks one of its own employees to carry it out. One requirement is that the gas measurement expert has been properly trained and keeps his or her knowledge and skills up to date. The gas measurement expert sets down the measurement results, the findings (in relation to the acceptable limits[3]) and the recommendations in a measurement report. The recommendations also focus on:

- Release of shipping container, with or without conditions[4]
- Ventilation/ degassing of the shipping container

3.3.1.1 Category A shipping containers:

Handling a container from category A the company follows the flowchart Operational process 2A.

[3] The evaporation problem rarely concerns one single risky substance. Whoever carries out the measurement survey (gas measurement expert), applies the additional rule if necessary.

[4] One of these conditions can be the carrying out of repeat measurements during the entering of the shipping container.

The first consideration is to check whether a limited or an extensive measurement survey will take place. In a limited survey only the hazardous substances are measured on the basis of a previous measurement survey. However, the company will have to demonstrate that the assumptions are correct. This is done by randomly carrying out a comprehensive measurement survey for a wider range of substances. If the spot check shows that the assumptions are correct, the procedure for a category A container is followed. If the assumptions are not correct, the container flow no longer belongs to category A, but to category B. Two actions must then be taken:

- The company determines why the measurement results do not correspond with the assumptions. Based on these results, the company again assigns the container flow to a specific category (Category A or B) (see flowchart for Policy process),
- The company follows Operational Process (2B).

For a category A shipping container, based on available data, it may be decided to ventilate first (16) and to then do a reading instead of starting with the measurement survey.

The reading can lead to the following findings:

- The expected gases are not detected. Based on the preliminary examination, it is ascertained if the classification in category A is correct. For example, the company can determine whether measurements were carried out correctly by carrying out additional measurements.
- The expected gases are detected and the concentrations are below the limits. The concentration deeper inside the shipping container may be higher. A gas measurement expert notifies the company on whether the shipping container can be released and what measures the company is to take, such as performing a repeat reading or the ventilation of the shipping container, to ensure that its employees can safely open and enter the container (via step 4 to 5).
- The expected gases are detected and the concentrations exceed the limits. The shipping container is neither safe to open nor enter. Measures need to be taken first before employees can open and enter the container. (via step 4 to 5).

3.3.1.2 Category B shipping containers:

To handle a shipping container from Category B, the flow chart for Operational process 2B must be followed.

A measurement survey is always carried out on a shipping container from category B. The reading can lead to the following findings:

- No gases are detected. The shipping container can be released and can be opened and entered ($\rightarrow$ step 5).
- Gases are detected but the concentrations are below the limits. The concentration deeper inside the shipping container may be higher. A gas measurement expert notifies the company on whether the shipping container can be released and what measures the company is to take, such as performing a repeat reading or the ventilation of the shipping container, to ensure that its employees can safely open and enter the container (via step 4 $\rightarrow$ 5).
- The company acts on the basis of this advice (via step 4 to 5).
- Gases are detected and the concentrations exceed the limits. The shipping container is not safe to neither open nor enter. Measures need to be taken first before employees can open and enter the container (via step 4 $\rightarrow$ 5).

3.3.1.3 Category C shipping containers:

To handle a shipping container from category C, the flowchart for Operational process 2C must be followed.

It is highly unlikely that the shipping container from category C contains hazardous gases. However the company will have to demonstrate this by randomly carrying out a measurement (14). If the spot check shows that the assumptions are correct, the procedure for a category C container is followed (step 5). If the assumptions are not correct, the container flow no longer belongs to category C but to category B. Two actions must then be taken:

- The company determines why the measurement results do not correspond with the assumptions. Based on these results, the company again classifies the container flow (in category B or C) (see flowchart Policy process).
- The company follows the Operational Process (2B).

3.4 Step 4 Measures

The company must take measures based on the results of step 3. Examples of such measures are:

- Carrying out new measurements.
- The removal of “phosphine residues”. The company must take measures to ensure that employees cannot be exposed to phosphine. The employee who deals with shipping containers that have been intentionally fumigated must be properly trained and ensure that the waste substances concerned are removed in accordance with relevant regulations and legislation.
- Ventilation of the shipping container.
- After ventilation, a gas measurement is carried out to determine whether a shipping container can be entered safely.
- The company allows the shipping container to be unloaded by a specialized company if the container remains “unsafe[5]” or refuses / returns the shipping container.
- Wearing additional personal protection equipment. Employees should wear personal protection equipment when the limit(s) is (are) exceeded or when there is a risk that the limits will be exceeded. Such a risk arises for instance when the container doors are opened for the purpose of ventilating the shipping container, when residues are removed, and when measurements are carried out in the shipping container. You should determine the appropriate personal protection equipment beforehand.

3.5 Step 5 Safely opening and entering shipping containers

3.5.1 The company may release the shipping container and it may be opened and entered if:

- Previous research shows the container is safe to enter (category C),
- The gas measurement expert indicates in his recommendations that employees can safely open and enter the shipping container (category A, B and C (spot check)),
- The history and knowledge of the container flow corresponds with the measurement results and the recommendations of the gas measurement expert (category A and C (spot check)).

3.5.2 If a company releases a shipping container, it must be able to demonstrate that it has done so on the basis of sufficient research and analysis. At this stage, the company also decides, after the gas measurement expert has submitted a recommendation, whether additional measures are needed during the unloading process, in which case the shipping container is released subject to conditions.

3.5.3 The company must also carry out repeat measurements if the following situations arise or if there is a suspicion that such situations will arise:

- In the case of intentionally fumigated shipping containers where residues of pesticides or herbicides, such as magnesium or aluminium phosphide powder, are still present in the shipping container.

[5] This could be the case when it is not possible to get concentrations below the limits

- If measurements on the outside of the rubbers indicate the presence of hazardous substances at concentrations below the permissible limit(s). Practical experience has shown that, in such cases, the concentration inside the shipping container can be higher.
- If there is a possibility that the gas can collect beneath and/or inside the packaging material and may be released only at a later stage.
- If the shipping container consists of more than one compartment.
- If there is a possibility that a hazardous substance will be released as a result of damage to the packaging.
- If a gas is involved that is tightly bound to the goods being shipped.
- If the nature of the goods present is such that it is difficult or impossible to degas them.
- If the gas measurement expert submits a recommendation to that effect.

3.5.4 An employee opens a shipping container only if research has indicated that the container in question has been declared safe or safe subject to conditions. If the recommendation submitted by the gas measurement expert, based on the measurement report, indicates that the shipping container can be released subject to conditions, the company takes appropriate measures so as to open and unload the container safely and inform the employee(s) involved accordingly. Nevertheless, the employee still has the obligation to keep paying attention. There is always the possibility that a hazardous work situation will arise, which can only be discovered after opening the doors and during the unloading of the containers. The employee always carries out an employee check (visual inspection).

3.5.5 If employees identify a hazardous work situation, they immediately leave the shipping container. They report the incident to the person responsible within the company (4). The doors are closed as soon as possible and the immediate vicinity is cordoned off so co-workers cannot enter the shipping container. The employee who carries out these operations wears personal protection equipment to stay out of harm's way. The company determines the next steps. Choices are for example (see also step 4):

- (Renewed) Ventilation / degassing of the shipping container
- Refuse the shipping container and send it back
- Have the shipping container unloaded by a specialized company. This can be at a specifically designed degassing location and/or unloading by specialized personnel
- Continuous measuring during unloading and if necessary active ventilation.

3.6 Step 6 Registration

The company stores the data collected. These are:

- The registration of container flows and category classification
- The measurement reports
- The measures taken

Annex 20.Topics to be included in a training programme

<table>
<tr><th colspan="2">Topics to be included in a training programme</th></tr>
<tr><td>1</td><td>Consequences of badly packed and secured cargo
Injuries to persons and damage to the environment
Damage to chips and CTUs
Damage to cargo
Economic consequences</td></tr>
<tr><td>2</td><td>Liabilities
Different parties involved in cargo transport
Legal responsibility
Goodwill responsibility
Quality assurance</td></tr>
<tr><td>3</td><td>Forces acting on the cargo during transport
Road transport
Rail transport
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<tr><td>4</td><td>Basic principles for cargo packing and securing
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Prevention from tipping
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Basic principles for cargo securing
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<tr><td>5</td><td>CTUs – types
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Swap-bodies
Road vehicles
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<tr><td>6</td><td>Cargo care consciousness and cargo planning
Choice of transport means
Choice of CTU type
Check of CTU prior to packing
Cargo distribution in CTUs
Requirements from the receiver of cargo regarding cargo packing
Condensation risks in CTUs
Symbols for cargo handling</td></tr>
<tr><td>7</td><td>Different methods for cargo packing and securing
Lashing
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Increasing friction</td></tr>
<tr><td>8</td><td>Equipment for securing and protection of cargo
Fixed equipment on CTUs
Reusable cargo-securing equipment
One-way equipment
Inspection and rejection of securing equipment</td></tr>
</table>

9	Packing and securing unitized cargo • Cases • Palletized cargoes • Bales and bundles • Bags on pallets • Big bags • Slabs and panels • Barrels • Pipes • Cartons
10	Packing and securing of non-unitized cargo • Different types of packaged cargoes loaded together • Packing of heavy and light cargoes together • Packing of rigid and non-rigid cargoes together • Packing of long and short cargoes together • Packing of high and low cargoes together • Packing of liquid and dry cargoes together
11	Packing and securing of paper products • General guidelines for the packing and securing of paper products • Vertical rolls • Horizontal rolls • Sheet paper on pallets
12	Packing and securing of cargo requiring special techniques • Steel coils • Cable drums • Wire rolls • Steel slabs • Steel plates • Big pipes • Stone blocks • Machines
13	Packing and securing of dangerous cargoes • Regulations for the transport of dangerous goods • Definitions • Packing regulations • Packing, separation and securing • Labelling and placarding • Information transfer when transporting dangerous cargoes • Liabilities

Annex 21.Acronyms

ACRONYM	**Full Title**
3PL	Third Party Logistics
AA	Always Afloat
AAPA	American Association of Port Authorities
AAR	Association of American Railroads
AAR	Against All Risks (insurance clause)
ABC	Activity Based Costiong
ABI	Automated Broker Interface
ACE	Automated Commercial Environment system
ACEP	Approved continuous examination programme
ADN	European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways
ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road
AEI	Automatic electronic identification
AI	All Inclusive.
AID	Agency for International Development.
AIS	Automated Identification System
AMSA	Australian Marine Safety Authority
ANOA	Advanced Notice of Arrival
ANSI	American National Standards Institution
AQ	Air Quality
AQI	Agriculture Quarantine Inspection.
ASC	Automated Commercial Systems
ASEAN	Association of South East Asian Nations
ATA	American Trucking Association.
ATD	Artificial Tween Deck
ATDNSHINC	Any time Day or Night Sundays & Holidays Included.
AWWL	Always within Institute Warranties Limits
B/L	Bill of Lading
BAF	Bunker Adjustment Factor
BB	Ballast Bonus
BB	Bare Boat
BBL	Barrel
BCO	Beneficial Cargo Owner
BIC	Bureau International des Conteneurs et du Transport Intermodal.
BIFA	British International freight Association
BIMCO	Baltic and International Maritime Council
Bls	Bales

BLU	CoP for Safe Loading & Unloading of Bulk Carriers
BP	Safety Briefing Pamphlet
BSI	British Standards Institute
C&F	Cost and Freight
CAD	Cash Against Documents
CAF	Cost, Assurance and Freight.
CAF	Currency Adjustment Factor.
CBM	Cubic Metre
CCC	International Customs Convention for Containers (1972)
CCNR	Central Commission for the Navigation of the Rhine
CDI-mpc	Chemical Distribution Institute – Marine Packed Cargo
CE	Consumption Entry
CEFIC	Conseil Européen des Federations de l'Industrie Chimique (European Trade Association for Chemicals)
CEN	European Committee for Standardization (Comité Européen de Normalisation)
CFD	Continuous Flow Distribution
CFR	Cost and Freight
CFS	Container Freight Station
CG	Correspondence Group
CGPM	Comité International des Poids et Mesures (General Conference on Weights and Measures)
CI	Cost and Insurance
CIA	Chemical Industries Association
CIA	Cash in Advance
CIF	Cost, Insurance and Freight.
CIF&C	Price includes commission as well as CIF.
CIF&E	Cost, Insurance, Freight and Exchange.
CIFCI	Cost, Insurance, Freight, Collection and Interest.
CIFI&E	Cost, Insurance, Freight, Interest and Exchange.
CIM	International Convention concerning the Carriage of Goods by Rail
CIP	Carriage and Insurance Paid.
CIRIA	The Construction Industry Research and Information Association
CKD	Completely Knocked Down
CL	Carload or Container load
CLECAT	European Association for Forwarding, Transport, Logistics and Customs Services
CM	Cubic Meter
cm	Centimeter
CMPH	Gross Crane Moves per Hoir
CMR	Convention on the Contract for the International Carriage of Goods by Road
COA	Container Owners Association
COD	Collect on Delivery

COD	Carried on Docket (pricing).
COFC	Container On Flat Car.
CofG	Centre of Gravity
COGSA	Carriage of Goods by Sea Act
COP	Code of Practice
COP	Customs of the Port
COU	Clip on Unit
CPC	Certificate of Professional Competence
CPD	Carnet de Passage en Douane
CPT	Carriage Paid To.
CRP	Continuous Replenishment Program
CSC	International Convention for Safe Containers (CSC) 1972
CSI	Container Security Initiative
CSL	Container Stuffing List
C-TPAT	Customs Trade Partnership Against Terrorism.
CTU	Cargo Transport Unit
Cu	Cubic
CWO	Cash with Order
cwt	Hundred weight (mass)
CWT	Deadweight Tonnage
CY	Container Yard
D&H	Dangerous and Hazardous cargo.
D/A	Documents against Acceptance
D/P	Document against Payment
DBA	Doing Business as
DDC	Destination Delivery Charge
DDP	Delivery Duty Paid.
DDU	Delivery Duty Unpaid.
DE	Ship Design & Equipment Sub-Committee (IMO)
DEMDES	Demurrage/Despatch money
DEQ	Delivery Ex Quay.
DES	Delivered Ex Ship.
DG	Dangerous Goods
DG	Drafting Group
DG MOVE	European Commission’s Directorate-General for Mobility and Transport
DG VII	Directorate/General VII Transport
DIS	Draft International Standard
DIT	Destination Interchange Terminal
DMT	Destination Motor terminal
DnV	Det Norske Veritas

DOL	Department of Labour
DOT	U.S. Department of Transportation
DSC	Dangerous Goods Solid Cargoes and Containers Sub-Committee (IMO)
DSU	Delay in Start Up
DWT	Deadweight Tonnage.
E&T	Editorial and Technical Group
ECE	Economic Commission for Europe (see also UNECE)
ECH	Empty container handler
ECMC	U.S. Exporters Competitive Maritime Council.
ECMCA	Eastern Central Motor Carriers Association.
ECOSOC	Economic and Social Council (UN Agency)
EDI	Electronic Data Interchange.
EFFA	European Freight Forwarders' Association
EFIPA	European Federation of Inland Ports Association
EFT	Electronic Funds Transfer
EIA	European Intermodal Association
EIR	Equipment Interchange Receipt
EMSA	European Maritime Safety Agency
ESA	European Agency for Safety and Health at Work
ESC	European Shippers' Council
ESCAP	Economic and Social Commission for Asia and the Pacific (UN Agency)
ESPO	European Sea Ports Organization
ETA	Estimated Time of Arrival.
ETA	Estimated Time of Availability
ETD	Estimated Time of Departure.
ETR	Estimated Time of Readiness
ETS	Estimated Time of Sailing
EU	European Union
EVA	Economic Value Added
EWIB	Eastern Weighing and Inspection Bureau.
EXW	Ex-works
FAF	Fuel Adjustment Factor, see also BAF
FAK	Freight All Kinds
FAL	Facilitation Committee (IMO)
FAS	Free Along Side
FAS	Free Alongside Ship.
FAT	Fully automated twistlock
FCA	Free Carrier
FCC	Flexitank / Container Combination
FCL	Full container load

FD	Free Discharge.
FDA	Food and Drug Administration.
FDIS	Final Draft International Standard
FEPORT	Federation of European Private Port Operators
FEU	Forty-foot Equivalent Unit
FFE	Forty-Foot Equivalent unit
FIATA	International Federation of Freight Forwarders Associations
FIFO	First In, First Out
FIFO	Free In – Free Out see FIO
FIO	Free In and Out
FMC	Federal Maritime Commissions
FMCSA	Federal Motor Carrier Safety Administration
FO	Free Out
FOB	Free On Board
FOR	Free on Rail.
FPA	Free of Particular Average.
FPPI	Foreign Principal Party of Interest.
FTA	Freight Transport Association
GATT	General Agreement on Tariffs and Trade.
GBL	Government Bill of Lading.
GDSM	General Department Store Merchandise.
GMPH	Gross Moves per Hour
GO	General Order
GOH	Garment on Hanger
GP	General Purpose
GRI	General Rate Increase
GSF	Global Shippers' Forum
GT	Gross Tonnage
GVW	Gross Vehicle Weight
HAZMAT	Hazardous Materials
HNS	Hazardous and Noxious Substances Convention
HS	Harmonized System of Codes
HSE	Health and Safety Executive
I.T.	In-Transit Entry
IA	Independent Action
IACS	International Association of Classification Societies
IAEA	International Atomic Energy Authority
IAPH	International Association of Ports and Harbours
IATA	International Air Transport Association
IBC	Intermediate Bulk Container

IBC	See BIC
IBTA	International Bulk Terminals Association
ICAO	International Civil Aviation Organisation
ICC	International Chamber of Commerce
ICC	Interstate Commerce Commission (US)
ICGB	International Cargo Gear Bureau, Inc.
ICHCA	ICHCA International Limited
ICS	International Chamber of Shipping
IE	Immediate Exit
IFA	International Freight Association
IFCOR	International Intermodal Freight Container Reporting Organisation
IFM	Inward Foreign Manifest
IFPTA	International Forest Products Transport Association
IHMA	International Harbour Masters Association
IICL	Institute of International Container Lessors
IIMS	International Institute of Marine Surveyors
IISPCG	Inter Industry Shipping & Ports Contact Group
ILA	International Longshoremen's Association
ILO	International Labour Organisation
ILWU	International Longshoremen's and Warehousemen's Union
IMC	Intermodal Marketing Company
IMCO	International Maritime Control Organisation. See IMO.
IMDG	International Maritime Dangerous Goods
IMMTA	International MultiModal Transport Association
IMO	International Maritime Organisation. Formally IMCO.
IOSH	Institute of Occupational Safety and Health
IPI	Inland Point Intermodal
IRU	International Road Transport Union
ISA	Information System Agreement
ISO	International Organization for Standardization
ISP	International Safety Panel of ICHCA
ISPS	International Ship and Port Facility Security Code
ISTDG	International Symposium on the Transport of Dangerous Goods by Sea and Inland Waterways
IT	Immediate Transport
IT	Information Technology
IT Entry	Immediate Transportation Entry
ITCO	International Tank Container Owners Association
ITF	International Transport Workers' Federation
ITF	International Transport Forum

ITIGG	International Transport Implementation Guidelines Group.
IUMI	International Union of Marine Insurers
JIT	Just in Time
JOC	Journal of Commerce
KD	Knocked Down
KT	Kilo tonne
L/C	Letter of Credit.
LASH	Lighter Aboard Ship.
lbs	Pounds (mass)
LC	Letter of Credit
LCL	Less than a container load
LIFO	Last In First Out
LNG	Liquefied natural Gas
LOLO	Lift on Lift Off
LR	Lloyds Registry
LT	Long Ton
LTL	Less than Trailer Load
MAIIF	Marine Accident Investigators' International Forum
MARPOL 73/78	International Convention for the Prevention of Pollution from Ships 1973, as modified by the Protocol of 1978
MCA	Maritime and Coastguard Agency (UK)
MCFS	Master Container Freight Station. (see CFS)
MDA	Maritime Domain Awareness
MEPC	Marine Environment Protection Committee
MGM	Maximum Gross Mass
MHD	Mechanical handling device
MLB	Mini Land Bridge
MMFB	Middlewest Motor Freight Bureau (US)
MOU	Memorandum of Understanding
MSA	Maritime Security Act.
MSC	Maritime Safety Committee (IMO)
MSD	Musculoskeletal disorders
MSL	Maximum securing load
MSSIS	Maritime Security and Safety Information System
MT	Metric Ton
MTO	Multimodal Transport Operator
MTSA	US Maritime Transportation Security Act 2002
NCB	National Cargo Bureau Inc
NCITD	National Committee on International Trade Documentation.
NEC	Not Elsewhere Classified.

NES	Not Elsewhere Specified.
NI	Nautical Institute
NMFC	National Motor Freight Classification.
NMPH	Net Moves per Hour
NMSA	National Maritime Safety Association
NOE	Not Otherwise Enumerated
NOI	Not Otherwise Indexed.
NOIBN	Not Otherwise Indexed By Name.
NOR	Notice of Readiness (when the ship is ready to load.)
NOS	Not Otherwise Stated.
NOS	Not Otherwise Specified.
NPC	National Ports Council
NSC	National Safety Council
NT	Net Tonnage
NVOCC	Non Vessel Owning Common Carrier
O/N	Order-Notify
OBL	Original Bill of Lading
OCIMF	Oil Companies International Marine Forum
OCP	Overland Common Port
OCP	Overland Common Points.
ODS	Operating Differential Subsidy.
OECD	Organization of Economic Cooperation and Development
OGMSA	Office of Global Maritime Situational Awareness
OMT	Origin Motor Terminal
OOG	Out of Gauge
OPIC	Overseas Private Investment Corporation,
ORFS	Origin Rail Freight Station.
ORT	Origin Rail Terminal
OS&D	Over, Short or Damaged
OSHA	Occupational Safety and Health Administration
P	Payload
P&I	Protection and Indemnity,
PADAG	Please Authorize Delivery Against Guarantee.
PAG	Polyalkylene Glycol
PAS	Publicly Available Specification
PDG	Packaged Dangerous Goods
PDP	Port workers Development Programme
PEMA	Port Equipment Manufacturers Association
POD	Port of Discharge.
POD	Port of Destination.

POD	Proof of Delivery
POE	Polyolester oil
POL	Port of Loading.
POL	Petroleum, Oil, and Lubricants.
PPI	Principal Party of Interest (see USPPI and FPPI).
PSGP	Port Security Grant Program
PTI	Pre-Trip Inspection
PTSC	Port & Terminal Service Charge
QR	Quick Response
R	Rating (Maximum Gross Mass)
RFP	Request for Proposal
RFQ	Request for quotation.
RHA	Road Haulage Association
RID	Regulations concerning the International Carriage of Dangerous Goods by Rail
ROLA	Roll on Roll off Trains
Ro/Mo	Rolling Motorway
RO / RO	Roll on- Roll Off (vessel)
RP	Research Paper
RT	Revenue Ton
RVNX	Released Value Not Exceeding
S/D	Sight Draft
S/D	Sea Damage
SDS	Safety Data Sheet
SAFE	
SATLs	Semi Automatic Twistlocks
SC	Sub Committee
SCAC	Standard Carrier Abbreviation Code
SED	Shipper's Export Declaration
SFI	Secure Freight Initiative
SHEX	Saturday and Holidays Excluded.
SHINC	Saturday and Holidays Included.
SIC	Standard Industrial Classification
SIGTTO	Society for International Gas Tanker & Terminal Operations Limited
SITC	Standard International Trade Classification
SKU	Stock Keeping Unit
SL&C	Shipper's Load & Count
SL/W	Shippers load and count
SOLAS	International Convention for the Safety of Life at Sea (SOLAS), 1974
SPA	Subject to Particular Average
SPI	Ship Port Interface

SS	Steamship.
SSHEX	Saturdays, Sundays and Holidays Excepted
ST	Short Ton
STB	Surface Transportation Board
STC	Said to Contain.
STCC	Standard Transportation Commodity Code
STW	Said to weigh.
SWIFT	Society for Worldwide Interbank Financial Telecommunication
SWL	Safe Working Load
T	Tare
T&E	Transportation and Exportation.
T&E	Transportation and Exit
TBN	To Be Nominated (when the name of a ship is still unknown).
TC104	International Standards Organization Technical Committee 104 –freight containers
TEU	Twenty-foot Equivalent Unit
THC	Terminal Handling Charge
TIR	Transport Internationaux Routiers System
TL	Trailer Load
TOA	Technical and Operational Advice document
TOFC	Trailer on Flat Car Rail
TOS	Terms of Sale (i.e. FOB/CIF/FAS).
TRC	Terminal Receiving Charge
TREMCARD	Transport Emergency Card issued by CEFIC (Intended to comply with the “instructions in writing” requirements in certain road transport regulations, eg: ADR)
TSR	Top Side Rail
TT Club	Through Transport Mutual Insurance Association Limited
TWIC	Transportation Worker Identification Credential
UCP	Uniform Customs and Practice for Documentary Credits
UFC	Uniform Freight Classification
UIC	Union Internationale de Chemins de Fers
UIRR	Union Internationale des Societes de Transport Combine Rail-Route
ULCC	Ultra Large Crude Carrier
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNCTAD	United Nations Commission for Trade and Development
UNEP	United Nations Environment Programme
UNISTOCK	European Federation of Silo Operators
UPC	Universal Product Code
USCG	United States Coastguard
USPPI	United States Principal Party of Interest

UTITI	University of Toledo Intermodal Transportation Institute
VISA	Voluntary Intermodal Sealift Agreement
VLFO	Vessel Load Free Out
VSA	Vessel Sharing Agreement
VSIE	Vessel Supplies for Immediate Exportation
VTL	Vertical Tandem Lifting
W/B	Waybill
W/M	Weight or Measurement
WCO	World Customs Organisation
WDEX	Warehouse Withdrawal for Transportation Immediate Exportation
WDT	Warehouse Withdrawal for Transportation
WDT&E	Warehouse Withdrawal for Transportation Exportation
WG	Working Group
WHO	World Health Organization
WIBON	Whether In Berth or Not.
WMU	World Maritime University
WP.15	UNECE Working Party on the Transport of Dangerous Goods (deals with ADR)
WP.24	UNECE Working Party on Intermodal Transport and Logistics
WPA	With Particular Average.
WSC	World Shipping Council
WTL	Western Truck Lines.
WWD	Weather Working Days.
YTD	Year to date
Zn	Azimuth