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Updates on the second draft of the Code of Practice for Packing of Cargo Transport Units

Second draft of the Code of Practice for Packing of Cargo Transport Units

Note by the secretariat

Addendum

Annexes to the second draft

1. The secretariat reproduces below the annexes to the second draft of the Code of Practice for Packing of Cargo Transport Units (CTUs), hereafter referred to as the CTU Code.

2. The main text of the CTU Code is reproduced in Informal document EG GPC No. 15 (2012).

3. Appendices to the CTU Code are reproduced in Informal document EG GPC No. 15 (2012) – Add.2.

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

(CTU Code)

Draft Version 2

17 September 2012

Annexes

Annex I. 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
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	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 UN ECE)
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
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-RO	Roll on- Roll Off
RP	Research Paper
RT	Revenue Ton
RVNX	Released Value Not Exceeding
S/D	Sight Draft
S/D	Sea Damage
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
UN ECE	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	UN ECE Working Party on the Transport of Dangerous goods (deals with ADR)
WP.24	UN ECE 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

Annex II. CONDENSATION DAMAGE

II.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.

II.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
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 II.1 below)
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 · 17.3 / 30.3 = 57%.
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/m3 absolute humidity) would be 20 °C, because at this temperature the 17.3 g/m3 represent the saturation humidity or 100% relative humidity
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
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
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).
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 2 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
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
Corrosion threshold	A relative humidity of 40% or more will lead to an increasing risk of corrosion of ferrous metals

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.

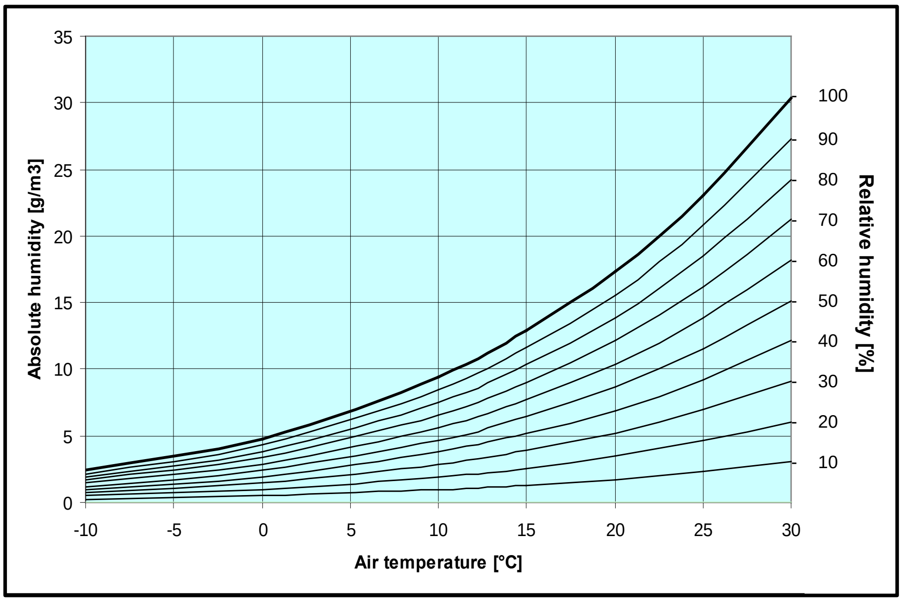


Figure II.1: Absolute and relative humidity

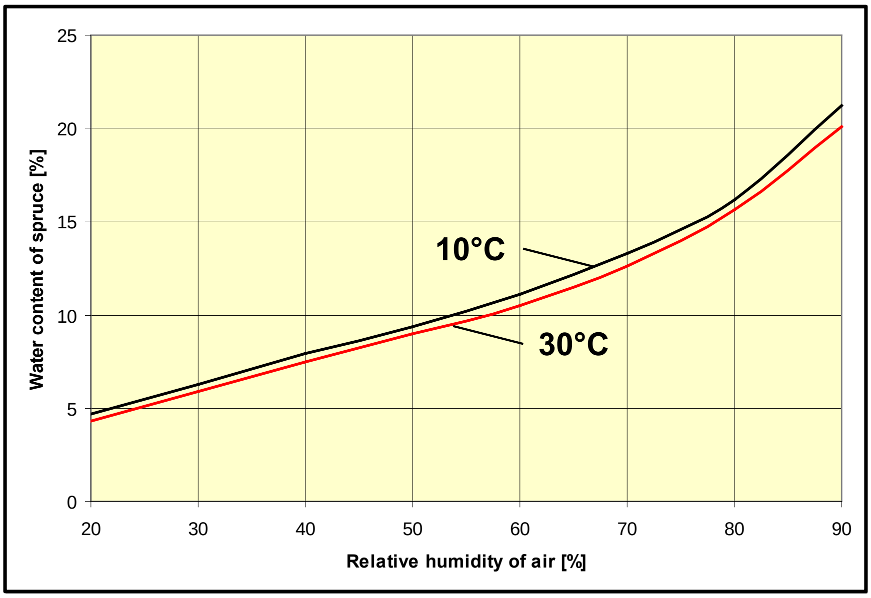


Figure II.2 : Sorption isotherms of Sitka spruce

II.3 Mechanisms of condensation

II.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.

II.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.

II.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.

II.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.

II.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.

II.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.

II.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.

II.4 Loss prevention measures

II.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%.

II.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.

II.4.3 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.

II.4.4 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.

II.4.5 Unpacking: Unpacking of 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 a vapour tight plastic sheeting and a sufficient stock of desiccants. The sheeting should be left in place until the cargo has completely climatised.

II.4.6 Unpacking of hygroscopic goods loaded in a warm climate on arrival in a cold climate with low absolute humidity should be carried 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.

II.4.7 More advice on loss prevention measures may be found under www.containerhandbook.de (Volume III).

Annex III. Friction coefficients

III.1 Different material contacts have different coefficients of friction. The table below shows recommended values for the coefficient of friction. 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.

Combination of materials in the contact surface	Friction coefficient μ
Sawn wood	
Sawn wood – fabric base laminate / plywood	0.45
Sawn wood – grooved aluminium	0.4
Sawn wood – shrink film	0.3
Sawn wood – stainless steel sheet	0.3
Plane wood	
Plane wood – fabric base laminate / plywood	0.3
Plane wood – grooved aluminium	0.25
Plane wood – stainless steel sheet	0.2
Plastic pallet	
Plastic pallet – fabric base laminate / plywood	0.2
Plastic pallet – grooved aluminium	0.15
Plastic pallet – stainless steel sheet	0.15
Steel	
Steel crate – fabric base laminate / plywood	0.45
Steel crate – grooved aluminium	0.3
Steel crate – stainless steel sheet	0.2
Concrete	
Concrete rough – sawn wood battens	0,7
Concrete smooth – sawn wood battens	0.55
anti – slip mat	
Rubber	0.6
Other material	As certified

III.2 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 it’s 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[1]. For oily and greasy surfaces or when slip sheets have been used, a static friction of μ = 0.1 applies.

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

ANNEX 4

SPECIFIC PACKING AND SECURING CALCULATIONS

1. Resistivity of transverse battens (paragraph 10.2.3.4)

The attainable resistance forces F of one such batten may be estimated by the formula:

$$F = \frac{w^2 \cdot h}{28 \cdot L} \text{ [kN]}$$

w = thickness of batten [cm]
h = height of batten [cm]
L = free length of batten [m]

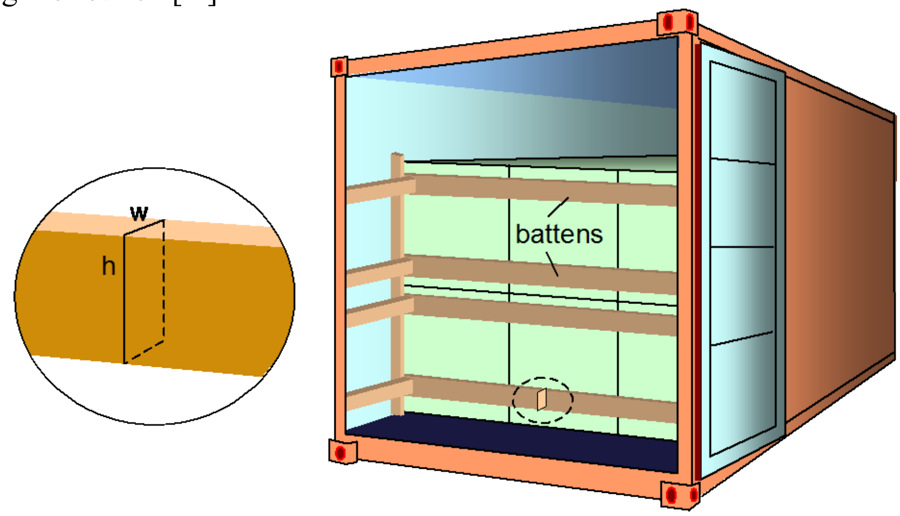


Figure 1: Transverse batten in an ISO box container

This formula presumes a homogeneously distributed load F over the length L of the batten. The battens are assumed to be slightly clamped at their ends. The permissible bending stress of the timber is assumed with 2.4 kN/cm^2. This applies to lower quality conifer timber.

Calculated example: A fence of four battens has been arranged. The battens have a free length L = 2.2 m and the cross-section w = 4.5 cm, h = 19 cm. The total attainable resistance force is:

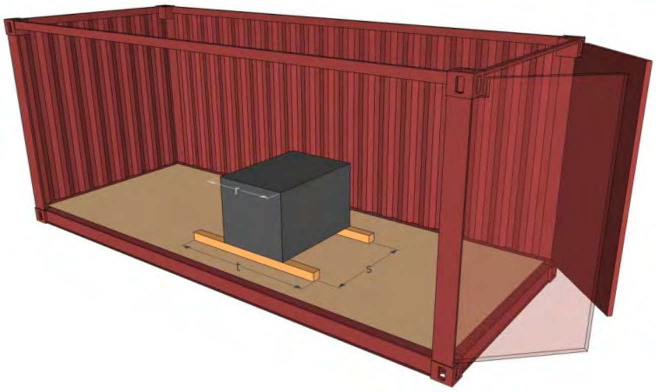
$$F = n \cdot \frac{w^2 \cdot h}{28 \cdot L} = 4 \cdot \frac{4.5^2 \cdot 19}{28 \cdot 2.2} = 23.7 \text{ kN}$$

This force of 23.7 kN would be sufficient to restrain a cargo mass of 7.5 t, subjected to accelerations in sea area 3 with longitudinal container stowage and μ = 0.4, by the following balance calculation:

$$0.4 \cdot m \cdot g < \mu \cdot m \cdot 0.2 \cdot g + F \quad \text{[kN]}$$
$$0.4 \cdot 7.5 \cdot 9.81 < 0.4 \cdot 7.5 \cdot 0.2 \cdot 9.81 + 23.7 \quad \text{kN}$$
$$29.4 < 5.9 + 23.7 \quad \text{kN}$$
$$29.4 < 29.6 \quad \text{kN}$$

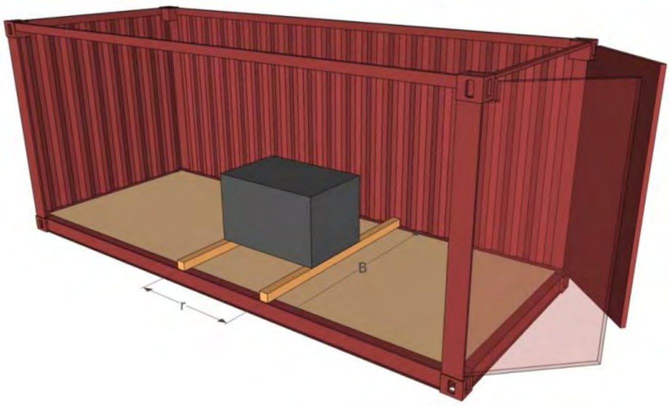
2. Beams for bedding a concentrated load in an ISO box-container (paragraph 10.3.1.2)

[Short or narrow cargoes may overload the floor structure. This may be prevented either by using longitudinal support beams underneath the cargo to distribute the load over more transverse flooring beams, or by the use of transverse beams, to distribute the load towards the strong side structures of the container.



Narrow cargo placed on longitudinal support beams.

When longitudinal support beams are used, their minimum length should be calculated in accordance with chapter 2.1 below. The beams should be placed as far apart as possible, near the edge of the cargo.



Narrow cargo placed on transverse support beams with a length equal to the inner width of the container.

When transverse support beams are used, their length should equal the inner width of the container.

2.1 Required length of longitudinal support beams]

[If loaded in a 20' container], the minimum length t of longitudinal beams shall be the greater of the two values of t_1 or t_2 to be determined as follows:

$t_1 = r$ [m] (for supporting the length of the cargo unit)

$t_2 = 0.1 \cdot f_{dyn} \cdot m \cdot (2.3 - s)$ [m] (for satisfying transverse strength requirements)

[If loaded in a 40' or 45' container, the longitudinal strength must be observed as well. The minimum length t of beams shall not be less than the value of t_3.

$t_3 = L \cdot (2 - \frac{1.8 \cdot P}{f_{dyn} \cdot m})$ [m] (for satisfying longitudinal strength requirements)]

r = bottom length of cargo unit in the container (footprint) [m]
m = mass of cargo unit [t]
P = payload of container [t]
s = spacing distance of beams [m]
t = length of beams [m]
L = inner length of container [m] (12.0 m for 40' and 13.7 m for 45')
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

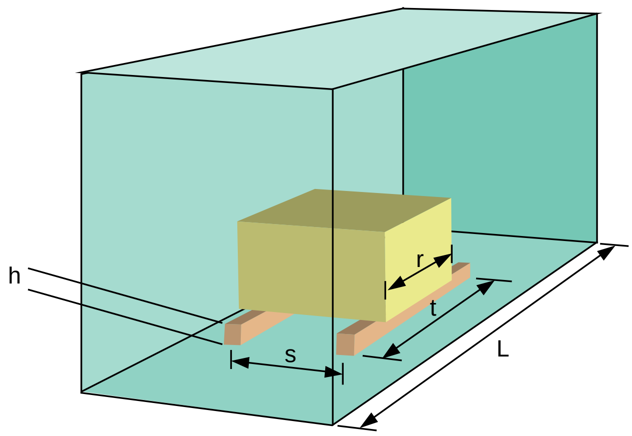


Figure 2: Bedding beams for concentrated loads in an ISO box container

Calculated example: A cargo unit of m = 18 t and a bottom length r = 1.8 m shall be placed into a 20' box container. The beams are placed at a transverse distance s = 1.4 m in the container. The transport route includes sea area 3 with f_{dyn} = 1.8.

$$t_1 = r = 1.8 \text{ m}$$

$$t_2 = 0.1 \cdot f_{dyn} \cdot m \cdot (2.3 - s) = 0.1 \cdot 1.8 \cdot 18 \cdot 0.9 = 2.9 \text{ m}$$

The observation of the longitudinal strength requires a length of beams t = 2.9 m.

Calculated example: A cargo unit of m = 24 t and a bottom length r = 3.8 m shall be placed into a 40' box container with a payload P = 28 t. The beams are placed at a transverse distance s = 1.2 m in the container. The transport route includes sea area B with f_{dyn} = 1.7.

$$t_1 = r = 3.8 \text{ m}$$

$$t_2 = 0.1 \cdot f_{dyn} \cdot m \cdot (2.3 - s) = 0.1 \cdot 1.7 \cdot 24 \cdot 1.1 = 4.5 \text{ m}$$

$$t_3 = L \cdot (2 - \frac{1.8 \cdot P}{f_{dyn} \cdot m}) = 12 \cdot \left(2 - \frac{1.8 \cdot 28}{1.7 \cdot 24}\right) = 9.2 \text{ m}$$

The observation of the longitudinal strength requires a length of beams t = 9.2 m.

3. Permissible concentrated loads on flatracks (paragraph 10.3.1.4)

If a cargo unit is placed with its entire foot print over the length r on the flatrack or platform, the permissible load m is:

$$m = \frac{1.8 \cdot P}{f_{dyn}} \cdot \frac{L}{2 \cdot L - r} \quad [t]$$

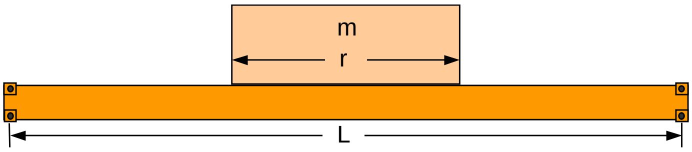


Figure 3: Concentrated load on an ISO platform

If the cargo unit is stiff and stowed on transverse beddings that bridge the distance r on the flatrack or platform, the permissible load m is:

$$m = \frac{1.8 \cdot P}{f_{dyn}} \cdot \frac{L}{2 \cdot L - 2 \cdot r} \quad [t]$$

(Note: m must not exceed P in this formula.)

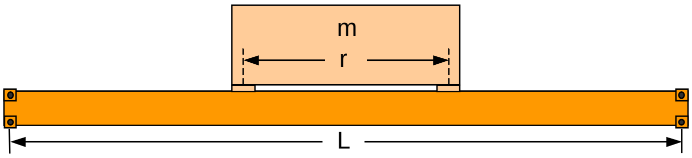


Figure 4: Concentrated load bridging the distance r

If the cargo unit is stowed on longitudinal beams that expand the bedding distance on the flatrack or platform, the necessary length t of those beams is:

$$t = L \cdot \left(2 - \frac{1.8 \cdot P}{f_{dyn} \cdot m}\right) \quad [m]$$

(Note: m must not exceed P in this formula.)

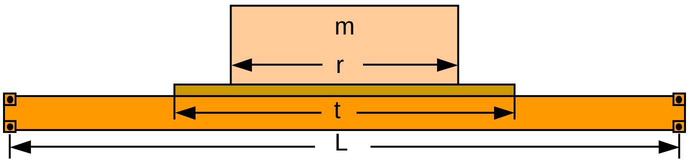


Figure 5: Bedding beams under a concentrated load

P = declared payload [t]
m = concentrated load [t]
L = full length of loading floor [m]
r = length of cargo foot print or bridging distance[m]
t = length of bedding beams[m]
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

Calculated example: A flatrack of a loading length L = 12 m and a payload of P = 40 t shall be loaded with a cargo unit of m = 28 t and a length r = 3.8 m. The transport route includes sea area B with f_{dyn} = 1.7. The permissible mass of a unit of that length would be:

$$m = \frac{1.8 \cdot P}{f_{dyn}} \cdot \frac{L}{2 \cdot L - r} = \frac{1.8 \cdot 40}{1.7} \cdot \frac{12}{24 - 3.8} = 25.2 \ t$$

This result shows that loading of 28 t is not permissible. If the same unit is placed on two transverse boards of a distance r = 3.6 m, the permissible mass of the cargo unit would be:

$$m = \frac{1.8 \cdot P}{1.7} \cdot \frac{L}{2 \cdot L - 2 \cdot r} = \frac{1.8 \cdot 40}{1.7} \cdot \frac{12}{24 - 7.2} = 30.2 \text{ t}$$

If this is not feasible because the cargo unit is not stiff enough to bridge the distance of 3.6 metre, the weight must be placed on longitudinal bedding beams with a length t as follows:

$$t = L \cdot \left(2 - \frac{1.8 \cdot P}{f_{dyn} \cdot m}\right) = 12 \cdot \left(2 - \frac{1.8 \cdot 40}{1.7 \cdot 28}\right) = 5.8 \text{ m}$$

4. Bending strength of beams (paragraph 10.3.1.3)

[4.1 Longitudinal support beams]

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:

$$n \cdot W = \frac{123 \cdot f_{dyn} \cdot m \cdot (t - r)}{\sigma_{perm}} \text{ cm}^3$$

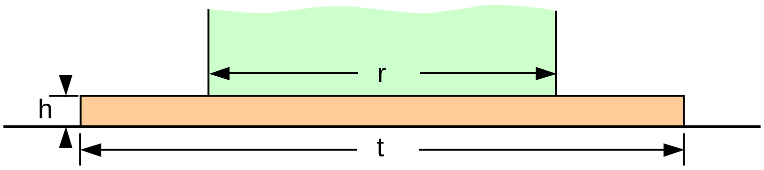


Figure 6: Beam for load spreading under a flexible cargo unit

If the cargo unit 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:

$$n \cdot W = \frac{123 \cdot f_{dyn} \cdot m \cdot (t - r)^2}{\sigma_{perm} \cdot t} \text{ cm}^3$$

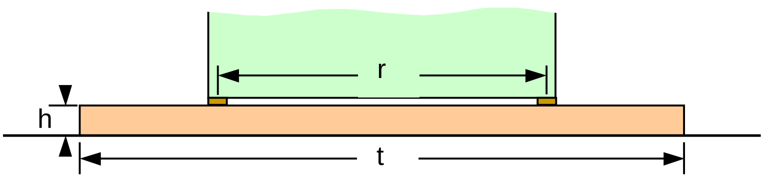


Figure 6: Beam for load spreading under a rigid cargo unit

W = section modulus of one beam [cm^3]
n = number of parallel beams
m = mass of cargo unit [t]
t = length of 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

The permissible bending stress σ should be taken as 2.4 kN/cm^2 for timber beams and 22 kN/cm^2 for steel beams. The section modulus for a single beam should be obtained from supplier's documents. The following tables may serve as a quick reference:

timber: 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: dimensions [cm]	12 x 12	14 x 14	16 x 16	18 x 18	20 x 20
section modulus [cm^3]	144	216	311	426	570

[The overlap of the beams from the cargo base at each end should not exceed five-times the base height h of timber beams or ten-times the base height h of the steel beams.]

Calculated example: A flexible cargo unit of m = 18 t and a bottom length r = 1.8 m shall be placed on timber beams of a length t = 3.2 m (see example above) for a sea passage in sea area A with f_{dyn} = 1.5. The overlap on each end is 0.75 m. Therefore the beams should have a minimum base height h = 0.75 / 5 = 0.15 m. The aggregate section modulus of the timber beams is:

$$n \cdot W = \frac{123 \cdot f_{dyn} \cdot m \cdot (t - r)}{\sigma_{perm}} = \frac{123 \cdot 1.5 \cdot 18 \cdot 1.4}{2.4} = 1937 \text{ cm}^3$$

Four beams of 15 x 15 cm cross-section would be sufficient.

If the cargo unit were rigid so that it can bridge a distance of r = 1.5 metres, the demanded strength of the bedding beams is reduced:

$$n \cdot W = \frac{123 \cdot f_{dyn} \cdot m \cdot (t - r)^2}{\sigma_{perm} \cdot t} = \frac{123 \cdot 1.5 \cdot 18 \cdot 1.7^2}{2.4 \cdot 3.2} = 1250 \text{ cm}^3$$

Three beams of 15 x 15 cm cross-section would be sufficient.

[4.2 Transverse support beams

The required bending strength of transverse bedding beams should be determined by the following formulae:

Rigid cargo: $$W = \frac{590 \cdot m \cdot (2.3 - s) - 3270 \cdot l_{effective}}{n \cdot \sigma_{perm}}$$

Flexible cargo: $$W = \frac{220 \cdot m \cdot (4.6 - s) - 2450 \cdot l_{effective}}{n \cdot \sigma_{perm}}$$

Where:

- W = *Section modulus of support beams [cm^3]*
- n = *Number of support beams*
- m = *Cargo weight, [ton]*
- s = *Cargo width, [m]*
- σ_{perm} = *Allowed stress in support beams, [kN/cm^2]*
- $l_{effective}$ = *Contributing length of container floor [m], taken as minimum of*
  - *Beams spaced **more** than 0.84 m apart:* $l_{effective} = 3 \cdot n \cdot 0.28$
  - *Beams spaced **less** than 0.84 m apart:* $l_{effective} = r + 0.56$]

5. Longitudinal position of the centre of gravity of a CTU (paragraph 10.3.1.5)

The longitudinal position of the centre of gravity within the inner length of a loaded container is at the distance d from the left end, obtained by the formula:

$$d = \frac{T \cdot 0.5 \cdot L + \sum(m_i \cdot d_i)}{T + \sum m_i}$$

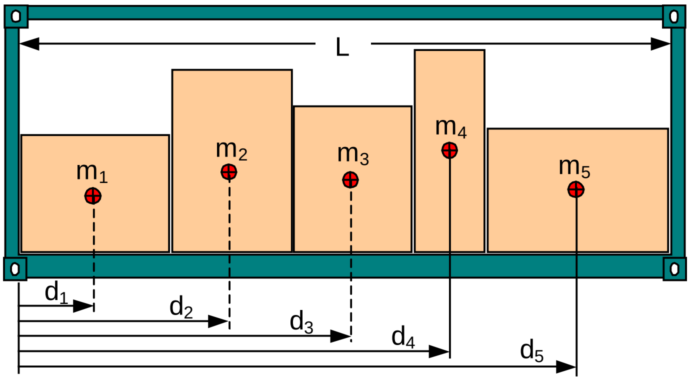


Figure 8: Determination of longitudinal centre of gravity

d = distance of common centre of gravity from left end of stowage area [m]
T = tare mass of CTU [t]
L = length of stowage area (inner length) [m]
m_i = mass of individual cargo unit or group of units [t]
d_i = distance of centre of gravity of mass m_i from left end of stowage area [m]

Calculated 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	6.70
4	2.2	3.8	8.36
5	4.9	5.1	24.99
	$\Sigma m_i = 15.5$		$\Sigma(m_i \cdot d_i) = 48.38$

$$d = \frac{T \cdot 0.5 \cdot L + \sum(m_i \cdot d_i)}{T + \sum m_i} = \frac{2.3 \cdot 0.5 \cdot 5.9 + 48.38}{2.3 + 15.5} = \frac{55.17}{17.8} = 3.10 \text{ m}$$

[6. Assessment of the load capacity of dunnage bags (paragraph 10.2.3.8)

Dunnage bags are usually delivered with a certified burst pressure given in units of bar = 1 daN/cm^2 or 0.01 kN/cm^2. This information may be used to assess the equivalent "breaking strength" of a dunnage bag by multiplying the burst pressure with the contact area to one side of the blocking arrangement. This contact area may be taken as (h – 20) · (w – 15) cm^2, where h = height and w = width of the dunnage bag.

Calculated example: A dunnage bag of h x w = 1.2 x 0.6 m provides a contact area of (120 – 20) · (60 – 15) = 100 x 45 = 4500 cm^2. The certified burst pressure is 2 bar. = 0.02 kN/cm^2. The equivalent breaking strength of this dunnage bag is 0.02 · 4500 = 90 kN. The MSL for single use is 0.75 · 90 = 67.5 kN, the MSL for multiple use is 0.5 · 90 = 45 kN.]

Annex V. Inspection criteria for freight containers

V.1 Damages which might affect the cargo in the CTU or impede effective transport

V.1.1 General:

- odour, infestation, debris
- vents blocked, not weathertight or missing

V.1.2 Floor:

- delamination of floor planks
- holes other than nail holes

V.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

V.1.4 Lashing rings:

- rings broken, cracked, missing or non-functional

V.1.5 Door:

- door holed, torn or broken
- missing or broken parts affecting door operation or weathertightness

V.1.6 Understructure:

- cross members bowed up by more than 50 mm or below line of corner castings

V.2 Damages which might impede safe transport of the CTU (structural deficiencies)

V.2.1 Top rail:

- local deformation to the rail in excess of 40 mm
- separation or cracks or tears in the rail material in excess of 10 mm in length.

V.2.2 Bottom rail:

- local deformation perpendicular to the rail in excess of 60 mm
- separation cracks or tears in the rail's material:
  - a) of flange in excess of 25 mm in length or
  - b) of web in any length

V.2.3 Header:

- local deformation to the header in excess of 50 mm
- cracks or tears in excess of 10 mm in length

V.2 Sill:

- local deformation to the sill in excess of 60 mm
- cracks or tears in excess of 10 mm in length

V.2.1 Corner posts:

- local deformation to the post in excess of 30 mm
- cracks or tears in any length

V.2.2 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 26 mm thick

V.2.3 Understructure:

- one or more cross members are missing or detached.

V.2.4 Door:

- one or more locking rods are non-functional

Annex VI. Practical inclination test for determination of the efficiency of cargo securing arrangements

VI.1 The efficiency of a securing arrangement can be tested by a practical inclining test according to the following description.

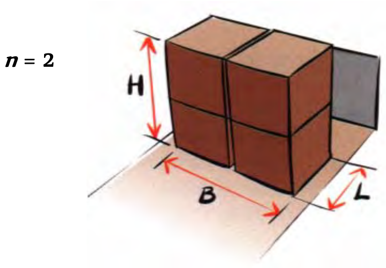
VI.2 The cargo (alternatively one section of the cargo) is placed on a lorry platform or similar and secured in the way intended to be tested.

VI.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.

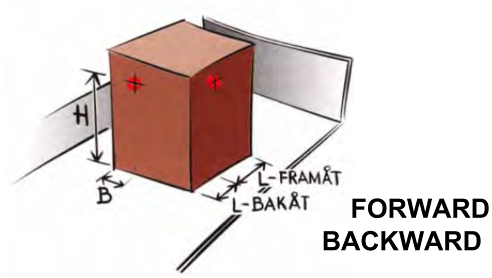
VI.4 The inclination angle to be used in the test is a function of the following parameters:

- 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).

VI.5 The lowest coefficient of friction, between the cargo and the platform bed or between cargo units if over-stowed should be used. The definition of *H*, *B*, *L* and *n* is according to the sketches below.

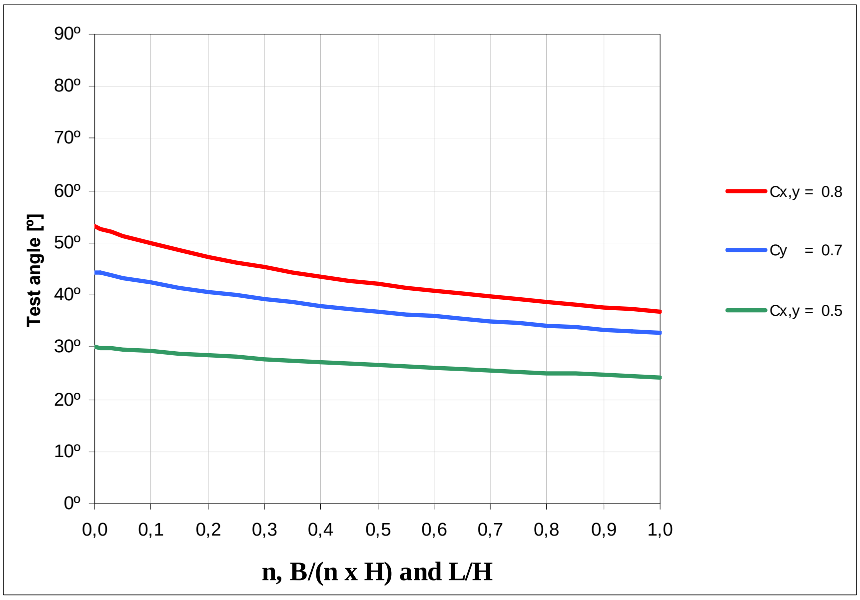


Cargo unit or section with the centre of gravity close to its geometrical centre (L/2, B/2, H/2).
The number of loaded rows, n, in above section is 2.
L is always the length of one section also when several sections are placed behind each other.



Cargo unit 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.



Example: If μ and $\frac{B}{n \cdot H}$ 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.

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.

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 weights are tested the entire platform should be prevented from tipping as well.

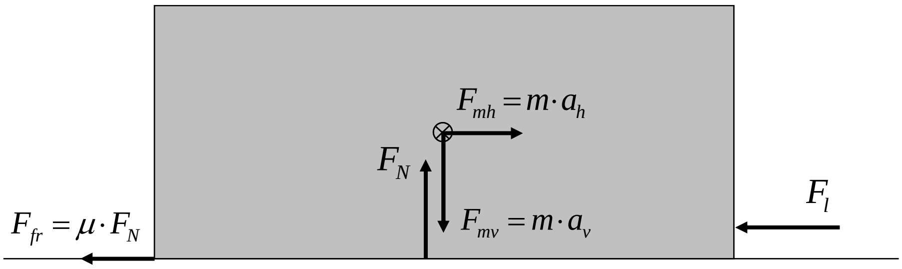
The cargo securing arrangement of a heat exchanger is here tested for acceleration forces forward and sideways.

Enclosure – Theoretical background

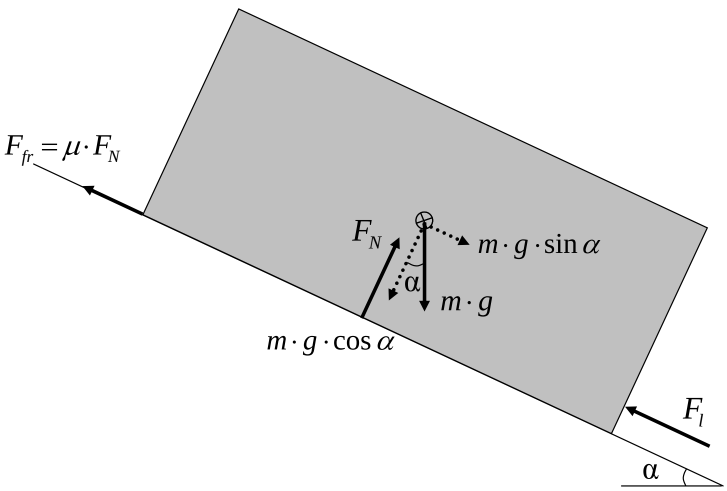
In this enclosure the equations are set up for the required static test angle to obtain the same forces in securing arrangements as in a real transport situation.

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.



$$\left.\begin{array}{l} \uparrow \; = \; \downarrow \quad F_N = m \cdot a_v \cdot g \\ \rightarrow \; = \; \leftarrow \quad m \cdot a_h \cdot g = F_l + \mu \cdot F_N \end{array}\right\} \quad F_l = m \cdot g \cdot \left(a_h - \mu \cdot a_v\right) \text{ (kN)} \qquad (1)$$



$$\left.\begin{array}{l} \uparrow \; = \; \downarrow \quad F_N = m \cdot g \cdot \cos\alpha \\ \rightarrow \; = \; \leftarrow \quad m \cdot g \cdot \sin\alpha = F_l + \mu \cdot F_N \end{array}\right\} \quad F_l = m \cdot g \cdot \left(\sin\alpha - \mu \cdot \cos\alpha\right) \text{ (kN)} \qquad (2)$$

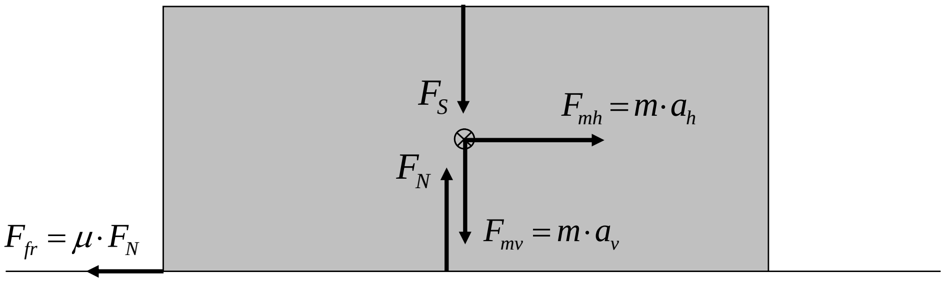
(1) = (2) =>

$$m \cdot g \cdot \left(a_h - \mu \cdot a_v\right) = m \cdot g \cdot \left(\sin\alpha - \mu \cdot \cos\alpha\right) \quad \Leftrightarrow \quad m \cdot g \cdot (\sin\alpha - \mu \cdot \cos\alpha) = m \cdot g \cdot (a_h - \mu \cdot a_v)$$

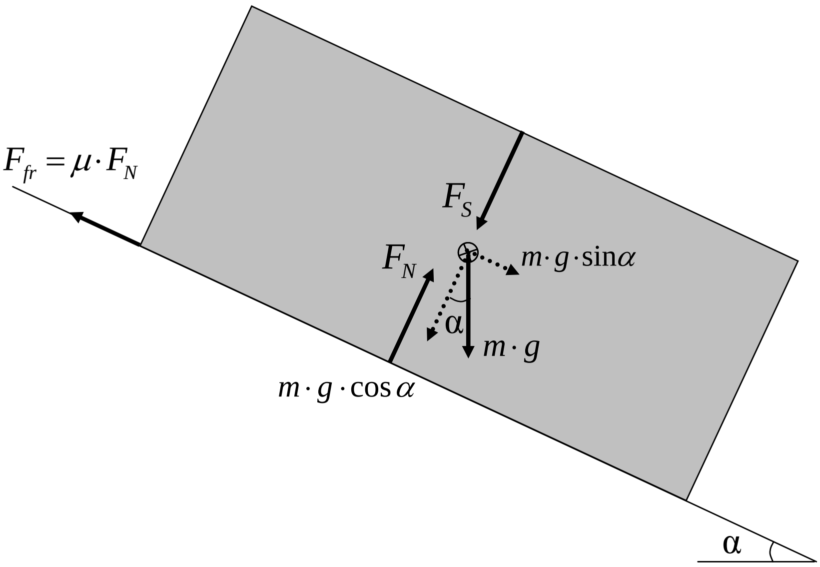
The solution of this equation with tables and diagrams of required inclination angle is shown in the section solution of equations below.

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.



$$\left.\begin{array}{l} \uparrow \; = \; \downarrow \quad F_N = F_S + m \cdot a_v \cdot g \\ \rightarrow \; = \; \leftarrow \quad m \cdot a_h \cdot g = \mu \cdot F_N \end{array}\right\} \quad F_S = \frac{m \cdot g \cdot (a_h - \mu \cdot a_v)}{\mu} \text{ (kN)} \qquad (1)$$



$$\left.\begin{array}{l} \uparrow \; = \; \downarrow \quad F_N = F_S + m \cdot g \cdot \cos\alpha \\ \rightarrow \; = \; \leftarrow \quad m \cdot g \cdot \sin\alpha = \mu \cdot F_N \end{array}\right\} \quad F_S = \frac{m \cdot g \cdot (\sin\alpha - \mu \cdot \cos\alpha)}{\mu} \text{ (kN)} \qquad (2)$$

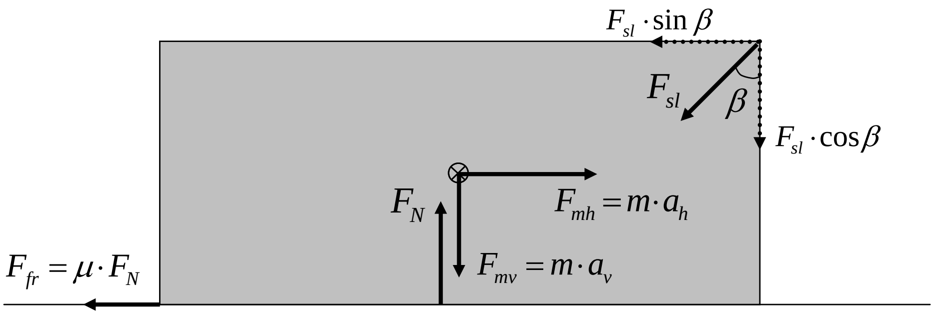
(1) = (2) =>

$$\frac{m \cdot g \cdot (a_h - \mu \cdot a_v)}{\mu} = \frac{m \cdot g \cdot (\sin\alpha - \mu \cdot \cos\alpha)}{\mu} \quad \Leftrightarrow \quad m \cdot g \cdot (\sin\alpha - \mu \cdot \cos\alpha) = m \cdot g \cdot (a_h - \mu \cdot a_v)$$

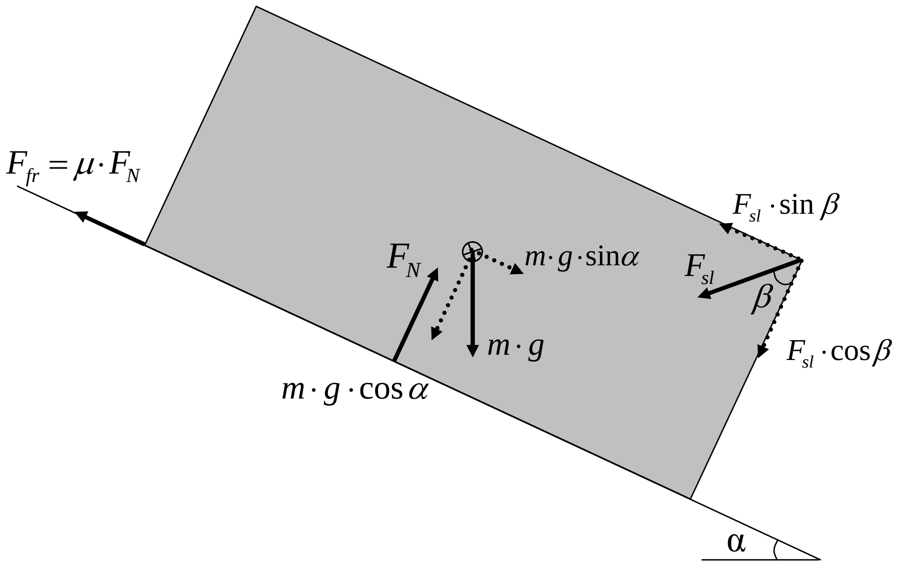
This is the same equation as in case 1.

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.



$$\left.\begin{aligned} \uparrow \;=\; \downarrow \quad & F_N = F_{sl} \cdot \cos\beta + m \cdot a_v \cdot g \\ \rightarrow \;=\; \leftarrow \quad & m \cdot a_h \cdot g = F_{sl} \cdot \sin\beta + \mu \cdot F_N \end{aligned}\right\} \quad F_{sl} = \frac{m \cdot g \cdot (a_h - \mu \cdot a_v)}{\sin\beta + \mu \cdot \cos\beta} \text{ (kN)} \qquad (1)$$



$$\left.\begin{aligned} \uparrow \;=\; \downarrow \quad & F_N = F_{sl} \cdot \cos\beta + m \cdot g \cdot \cos\alpha \\ \rightarrow \;=\; \leftarrow \quad & m \cdot g \cdot \sin\alpha = F_{sl} \cdot \sin\beta + \mu \cdot F_N \end{aligned}\right\} \quad F_{sl} = \frac{m \cdot g \cdot (\sin\alpha - \mu \cdot \cos\alpha)}{\sin\beta + \mu \cdot \cos\beta} \text{ (kN)} \quad (2)$$

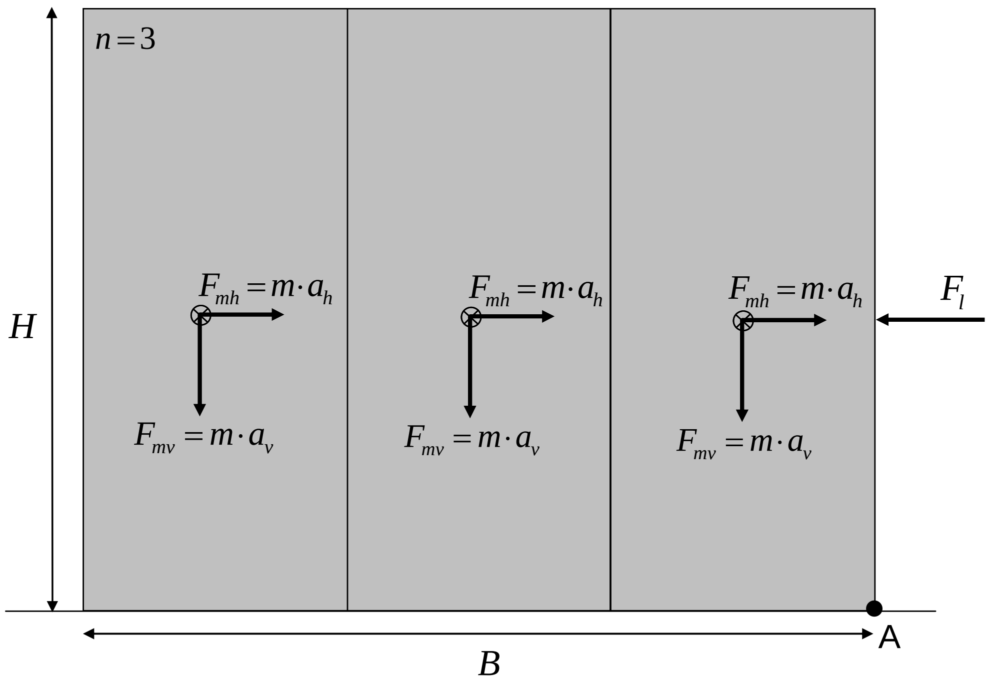
(1) = (2) =>

$$\frac{m \cdot g \cdot (a_h - \mu \cdot a_v)}{\sin\beta + \mu \cdot \cos\beta} = \frac{m \cdot g \cdot (\sin\alpha - \mu \cdot \cos\alpha)}{\sin\beta + \mu \cdot \cos\beta} \quad \Leftrightarrow \quad m \cdot g \cdot (\sin\alpha - \mu \cdot \cos\alpha) = m \cdot g \cdot (a_h - \mu \cdot a_v)$$

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.

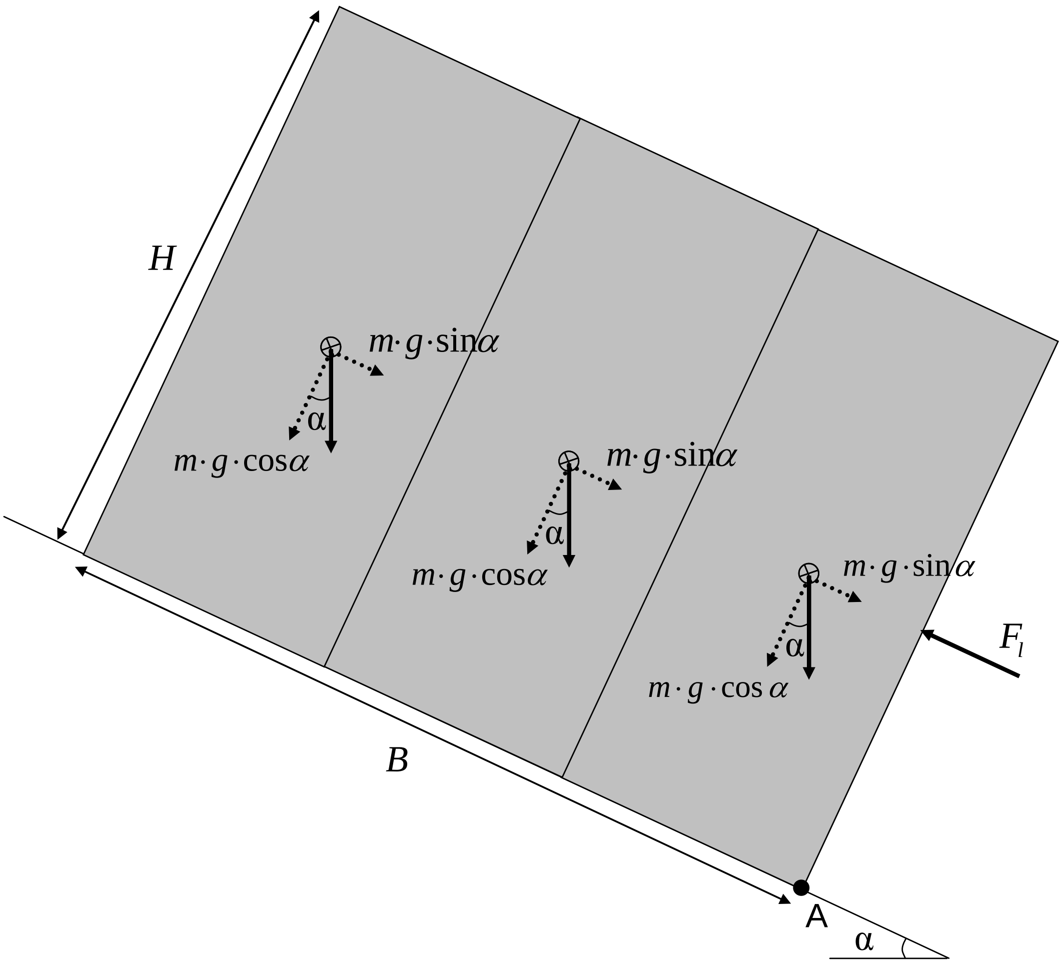


The centre of gravity is assumed to be in the geometrical centre.

↻A = ↺ A $\quad 3 \cdot m \cdot a_h \cdot g \cdot \frac{H}{2} = F_l \cdot \frac{H}{2} + 3 \cdot m \cdot a_v \cdot g \cdot \frac{B}{2 \cdot n}$

$$\Rightarrow \quad F_l = \frac{3 \cdot m \cdot a_h \cdot g \cdot \frac{H}{2} - 3 \cdot m \cdot a_v \cdot g \cdot \frac{B}{2 \cdot n}}{\frac{H}{2}} = \frac{3 \cdot m \cdot a_h \cdot g \cdot H - 3 \cdot m \cdot a_v \cdot g \cdot \frac{B}{n}}{H} =$$

$$= 3 \cdot m \cdot g \cdot (a_h - \frac{B}{n \cdot H} \cdot a_v) \text{ (kN)} \qquad (1)$$



↻A = ↺ A $\quad 3 \cdot m \cdot g \cdot \sin\alpha \cdot \frac{H}{2} = F_l \cdot \frac{H}{2} + 3 \cdot m \cdot g \cdot \cos\alpha \cdot \frac{B}{2 \cdot n}$

$$\Rightarrow \quad F_l = \frac{3 \cdot m \cdot g \cdot \sin\alpha \cdot H - 3 \cdot m \cdot g \cdot \cos\alpha \cdot \frac{B}{n}}{H} = 3 \cdot m \cdot g \cdot (\sin\alpha - \frac{B}{n \cdot H} \cdot \cos\alpha) \text{ (kN)} \qquad (2)$$

(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, $\frac{B}{n \cdot H}$ and $\frac{L}{H}$ 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:

$$\alpha = 2 \cdot \arctan\left(\frac{-1 + \sqrt{1 + \gamma^2 - \gamma^2 \cdot a_v^2 + 2 \cdot \gamma \cdot a_v \cdot a_h - a_h^2}}{\gamma + \gamma \cdot a_v - a_h}\right), \qquad \gamma \neq \frac{a_h}{1 + a_v}$$

$$\alpha = 2 \cdot \arctan\left(\frac{a_h}{1 + a_v}\right), \quad \gamma = \frac{a_h}{1 + a_v}$$

where

γ a factor representing the values of μ, $\frac{B}{n \cdot H}$ and $\frac{L}{H}$

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

VI.2

Annex VII. Cargo securing with dunnage bags

VII.1 Introduction

VII.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.

VII.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:

$$F_{\text{DUNNAGE BAG}} \geq F_{\text{CARGO}}$$

VII.2 Force on dunnage bag from cargo (F_{CARGO})

VII.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:

$$F_{\text{CARGO}} = m \cdot [a_h - \mu_{\text{static}} \cdot 0.7 \cdot a_v]$$

Tipping:

$$F_{\text{CARGO}} = m \cdot [a_h - b_p/h_p \cdot a_v]$$

F_{CARGO} = force in ton on the dunnage bag caused by the cargo

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 cargo units

b_p = Package width for tipping sideways, or alternatively the length of the cargo for tipping forward or backward

h_p = package height

VII.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.

It is only the cargo mass that actually impacts the dunnage bag that shall to be used in the above formulas.

VII.2.3 The movement forward, when breaking for example, the mass of the cargo behind the dunnage bag is to be used in the formulas.

VII.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 VII.1.

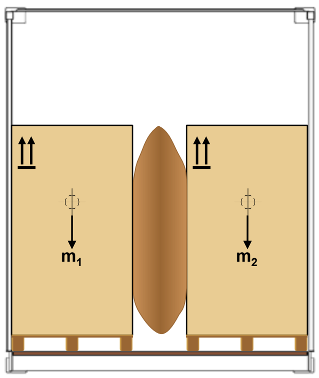


Figure VII.1 : Equal height packages

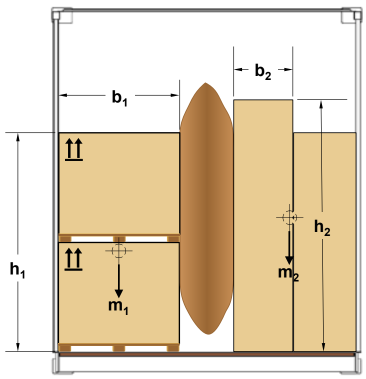


Figure VII.2 : Unequal height packages

VII.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.

VII.2.6 If the cargo unit 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 / h is chosen.

VII.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 (Figure VII.2).

VII.3 Permissible load on the dunnage bag (F_{DB})

VII.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:

$$F_{DB} = A \cdot 10 \cdot P_B / SF$$

F_{DB} =	force that the dunnage bag is able to take up without exceeding the maximum allowable pressure (t)
P_B =	bursting pressure of the dunnage bag (bar)
A =	contact area between the dunnage bag and the cargo (m^2)
SF =	safety factor

VII.4 Contact area (A)

VII.4.1 The contact area between the dunnage bag and the cargo depends on the size of the bag and the gap that the bag is filling. This area may be approximated by the following formula:

$$A = (b_{DB} - \pi \cdot d/2) \cdot (h_{DB} - \pi \cdot d/2)$$

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

VII.5 Pressure in the dunnage bag

VII.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.

VII.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 of 2 against bursting shall be used.

Annex VIII. Quick Lashing Guides

This Annex include Quick Lashing Guides for the three sea areas

CTU Code Draft QLG Sea Area A all
CTU Code Draft QLG Sea Area A road and sea
CTU Code Draft QLG Sea Area B
CTU Code Draft QLG Sea Area C

Packing 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** S	V	**Forward** F	V	**Backward** 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 isn'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.

Content

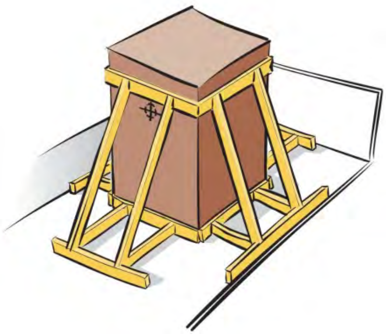
CARGO SECURING METHODS

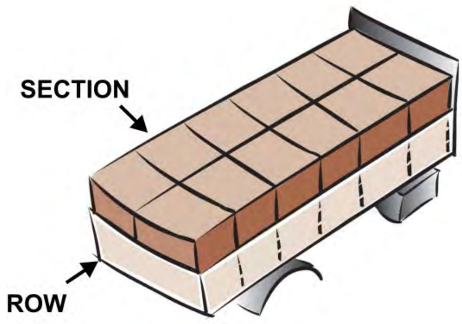
Goods shall be prevented from sliding and tipping in forward, backward and sideways directions by any of the following methods, combined in a proper way.

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.

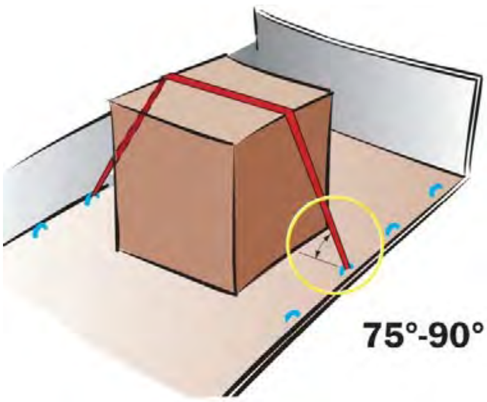
Blocking is primarily a method to prevent the cargo from sliding, but if the blocking reaches high enough, it also prevents tipping. Blocking is the primary method for cargo securing and should be used as far as possible.





The sums 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

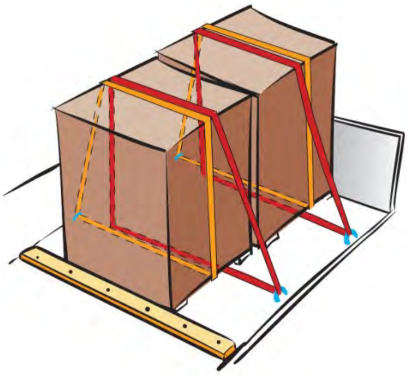


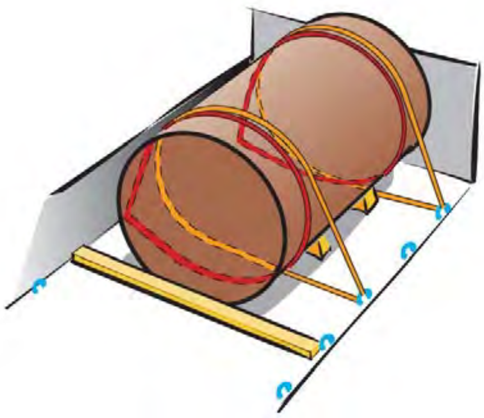
When using the tables for top-over lashing the angle between the lashing and the platform bed is of great importance. The tables are valid for an angle between 75°- 90°. If the angle is between 30°- 75° twice the number of lashings are needed. If the angle is less than 30°, another cargo securing method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

A top-over lashing preventing tipping forward **and** backward has to be placed centred on the cargo.

Half loop lashing

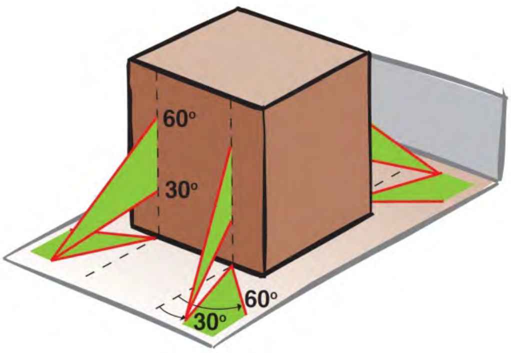
A pair of half loop lashings prevents cargo from sliding and tipping sideways. Minimum one pair of half loop lashings per section should be used.





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

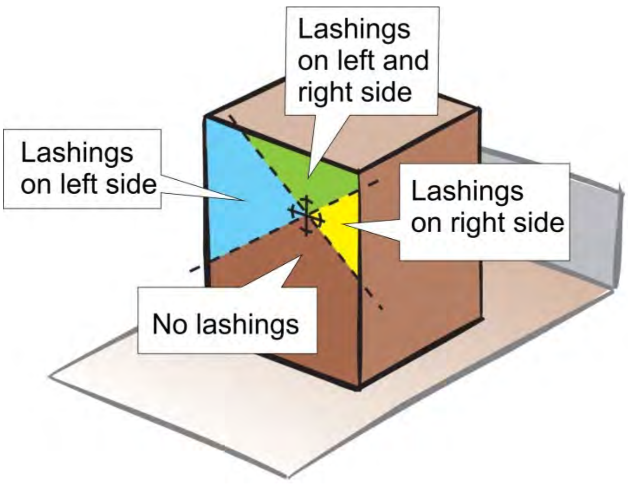


The tables are valid for an angle of 30 - 60° between the lashing and the platform bed.

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 weight in the tables may be doubled.

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°.



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

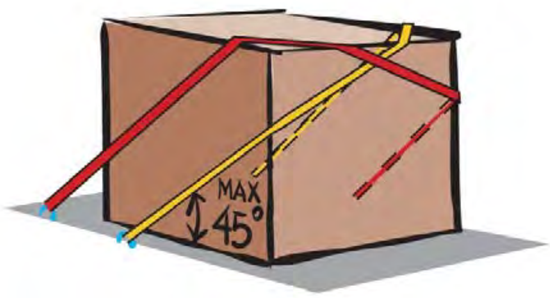
A spring lashing is used to prevent cargo from sliding and tipping forward or backward.

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 weight given in the lashing tables.

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

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

BASIC CARGO SECURING REQUIREMENTS

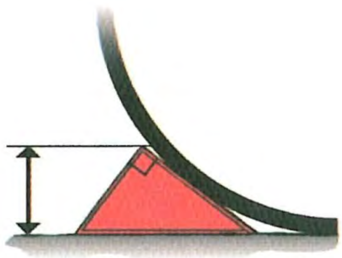
Non-rigid goods

If the goods is 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 out of the chocks, the chock height need not to be greater than 20 cm.



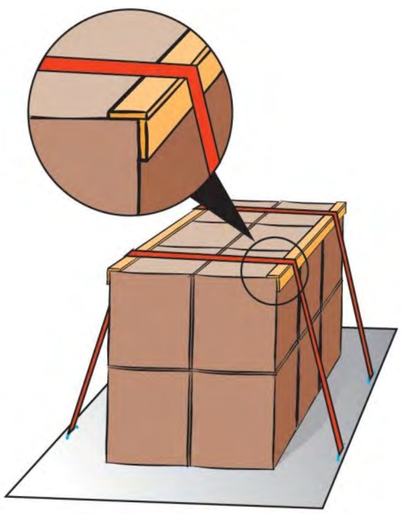
Bottom blocking

Bottom blocking preventing cargo from sliding must have a height of at least 5 cm, if the cargo isn't prevented to move above the block 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 and for other sections, at least one lashing per every second section shall be used.

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



LASHING EYES

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

SLIDING - FRICTION

Different material contacts have different coefficients of friction. The table below shows recommended values for the coefficient of friction. 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.

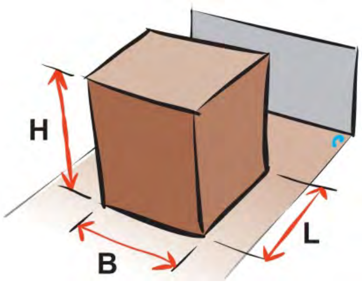
Material combination in contact area	Dry	Wet
SAWN TIMBER/WOODEN PALLET		
Sawn timber/wooden pallet against plywood/plyfa/wood	0.5	0.45
Sawn timber/wooden pallet against grooved aluminium	0.4	0.4
Sawn timber/wooden pallet against stainless steel sheet	0.4	0.3
Sawn timber/wooden pallet against shrink film	0.3	-
PLANE WOOD		
Plane wood – fabric base laminate/plywood	0.3	0.3
Plane wood – grooved aluminium	0.25	0.25
Plane wood – smooth steel sheet	0.3	0.3
PLASTIC PALLETS		
Plastic pallet against plywood/plyfa/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	-
Unpainted metal with smooth surface against unpainted smooth metal	0.2	-
Painted metal with smooth surface against painted smooth metal	0.2	-

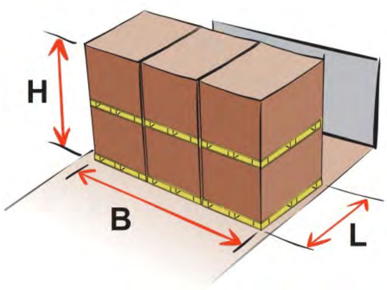
Material combination in contact area	Dry	Wet
STEEL CRATES		
Steel crate against plywood/plyfa/wood	0.45	0.45
Steel crate against grooved aluminium	0.3	0.3
Steel crate against smooth steel	0.2	0.2
CONCRETE		
Concrete with rough surface against sawn wood battens	0.7	0.7
Concrete with smooth surface against sawn wood battens	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 it's coefficient of friction can't be verified in another way, the maximum μ-static to be used 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[1]. For oily and greasy surfaces or when slip sheets have been used a static friction coefficient μ = 0.1 shall be used.

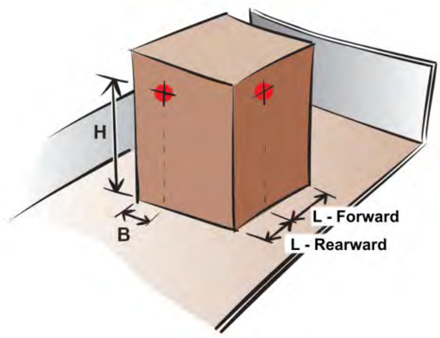
[1] For sea transport see CSS Code annex 13 subsection 7.2.

TIPPING - DIMENSIONS





The definition of **H**, **B** and **L** as shown above 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.

REQUIRED NUMBER OF LASHINGS

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

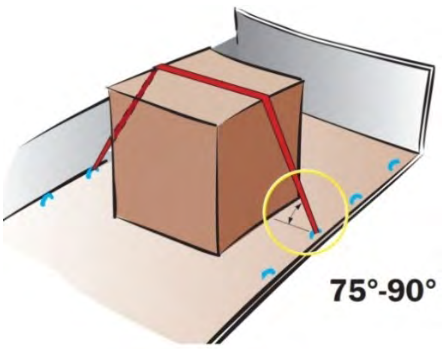
Even if there is neither sliding nor tipping risk, it is recommended to always use at least one top-over lashing per every 4 ton of cargo or similar arrangement to avoid wandering for non-blocked cargo.

WEBBING

TOP-OVER LASHINGS

The tables are valid for **webbing** with a pre tension of minimum 400 daN (400 kg).
The values in the tables are proportional to the lashings' pre tension.
The weights in the tables are valid for one top-over lashing.

TOP-OVER LASHING



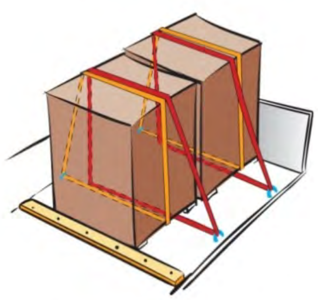
Cargo weight in ton prevented from sliding *per* top-over lashing			
μ - static	SIDEWAYS	FORWARD	BACKWARD
0.00	0.00	0.00	0.00
0.05	0.09	0.05	0.09
0.10	0.20	0.11	0.20
0.15	0.34	0.18	0.34
0.20	0.53	0.26	0.53
0.25	0.79	0.36	0.79
0.30	1.2	0.47	1.2
0.35	1.8	0.61	1.8
0.40	3.2	0.79	3.2
0.45	7.1	1.0	4.7
0.50	no slide	1.3	7.9
0.55	no slide	1.7	17
0.60	no slide	2.4	no slide
0.65	no slide	3.4	no slide
0.70	no slide	5.5	no slide

Cargo weight 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	6.9	3.1	0.6	no tip	no tip
0.8	no tip	no tip	5.9	2.3	1.6	0.8	no tip	no tip
1.0	no tip	no tip	2.4	1.4	1.0	1.0	no tip	no tip
1.2	no tip	4.9	1.5	0.98	0.79	1.2	no tip	no tip
1.4	no tip	2.5	1.1	0.76	0.63	1.4	6.6	no tip
1.6	no tip	1.6	0.84	0.62	0.52	1.6	2.8	no tip
1.8	no tip	1.2	0.69	0.53	0.45	1.8	1.8	20
2.0	no tip	0.98	0.59	0.46	0.39	2.0	1.3	7.9
2.2	7.9	0.82	0.51	0.40	0.35	2.2	1.0	4.9
2.4	3.9	0.70	0.45	0.36	0.31	2.4	0.86	3.6
2.6	2.6	0.61	0.41	0.33	0.29	2.6	0.73	2.6
2.8	2.0	0.55	0.37	0.30	0.26	2.8	0.64	2.0
3.0	1.6	0.49	0.34	0.27	0.24	3.0	0.56	1.6

The tables are valid for **webbing** with a MSL of 20 kN (2 ton) and a pre tension of minimum 400 daN (400 kg).

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

HALF LOOP LASHING SLIDING



Cargo weight in ton prevented from sliding *per* pair of half loop lashing	
μ-static	SIDEWAYS
0.00	4.1
0.05	4.5
0.10	5.1
0.15	5.7
0.20	6.5
0.25	7.4
0.30	8.5
0.35	10.0
0.40	12
0.45	14
0.50	no slide
0.55	no slide
0.60	no slide
0.65	no slide
0.70	no slide

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

Cargo weight 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	14	6.8
0.8	no tip	no tip	10	4.6	3.4
1.0	no tip	no tip	4.2	2.7	2.3
1.2	no tip	7.3	2.6	2.0	1.7
1.4	no tip	3.6	1.9	1.5	1.4
1.6	no tip	2.4	1.5	1.2	1.1
1.8	no tip	1.8	1.2	1.1	0.97
2.0	no tip	1.5	1.0	0.91	0.85
2.2	8.2	1.2	0.91	0.81	0.75
2.4	4.1	1.0	0.81	0.72	0.68
2.6	2.7	0.91	0.72	0.65	0.62
2.8	2.0	0.81	0.66	0.60	0.56
3.0	1.6	0.73	0.60	0.55	0.52

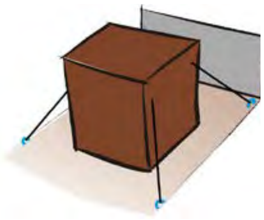
The values in the table are proportional to the lashings' pre tension.

The tables are valid for **webbing** with a MSL of 20 kN (2 ton) and a pre tension of minimum 400 daN (400 kg).

All weights are valid for one straight lashing.

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

STRAIGHT LASHING SLIDING



Cargo weight in ton prevented from sliding *per* straight lashing			
μ - static	SIDEWAYS per side	FORWARD	BACKWARD
0.00	1.0	0.64	1.0
0.05	1.2	0.75	1.2
0.10	1.5	0.87	1.5
0.15	1.8	1.0	1.8
0.20	2.1	1.1	2.1
0.25	2.5	1.3	2.5
0.30	3.0	1.5	3.0
0.35	3.7	1.7	3.7
0.40	4.6	1.9	4.6
0.45	5.8	2.2	5.8
0.50	no slide	2.5	9.0
0.55	no slide	2.9	11
0.60	no slide	3.3	no slide
0.65	no slide	3.8	no slide
0.70	no slide	4.4	no slide

Cargo weight 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

The tables are valid for **webbing** with a MSL of 20 kN (2 ton) and a pre tension of minimum 4000 N (400 kg).

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

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

SPRING LASHING

Cargo weight in ton prevented from sliding *per* spring lashing		
μ - static	FORWARD	BACKWARD
0.00	3.6	5.8
0.05	3.9	6.4
0.10	4.2	7.2
0.15	4.6	8.1
0.20	5.0	9.1
0.25	5.4	10
0.30	5.9	12
0.35	6.5	14
0.40	7.1	17
0.45	7.8	20
0.50	8.6	31
0.55	9.6	37
0.60	11	no slide
0.65	12	no slide
0.70	14	no slide

Cargo weight 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 Approx. cargo weight in ton prevented from sliding by one tag washer for wood on wood in combination with top-over lashing only							
μ - static**	SIDEWAYS						
	∅ 48	∅ 62	∅ 75	∅ 95	30×57	48×65	130×130
0.3	0.63	0.88	1.1	1.5	0.63	0.88	1.9
0.4	1.3	1.8	2.3	3.0	1.3	1.8	3.8
	FORWARD						
0.3	0.25	0.35	0.45	0.60	0.25	0.35	0.75
0.4	0.31	0.44	0.56	0.75	0.31	0.44	0.94
	BACKWARD						
0.3	0.63	0.88	1.1	1.5	0.63	0.88	1.9
0.3	1.3	1.8	2.3	3.0	1.3	1.8	3.8

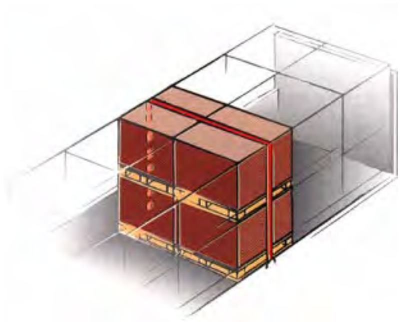
** *Between tag washer and platform bed/cargo. For tag washers in shrink film the rows for friction 0.3 to be used.*

4" – NAIL Approximate cargo weight in ton prevented from sliding by one nail in combination with top-over lashing only						
μ - static***	SIDEWAYS per side		FORWARD		BACKWARD	
	blank	galvanised	blank	galvanised	blank	galvanised
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.*

CARGO STOWED IN MORE THAN ONE LAYER

Method 1 (simple)



1. Determine the number of lashings to prevent sliding using the weight 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 are to be used.

Method 2 (advanced)

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

Quick Lashing Guide

Cargo securing on CTUs for transports on Road 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
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 isn'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.

Content

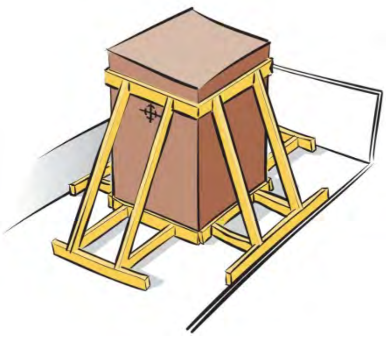
CARGO SECURING METHODS

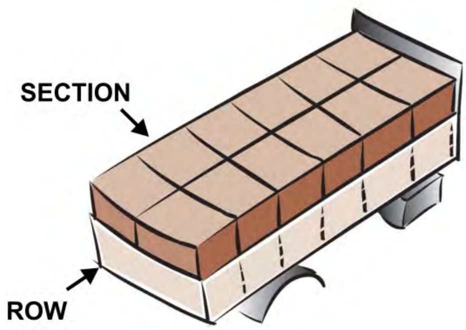
Goods shall be prevented from sliding and tipping in forward, backward and sideways directions by any of the following methods, combined in a proper way.

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.

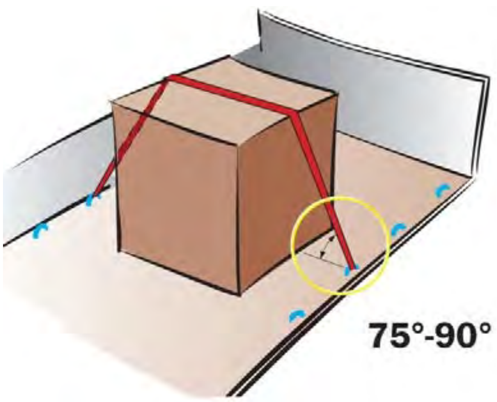
Blocking is primarily a method to prevent the cargo from sliding, but if the blocking reaches up to or above the cargo's centre of gravity, it also prevents tipping. Blocking is the primary method for cargo securing and should be used as far as possible.





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

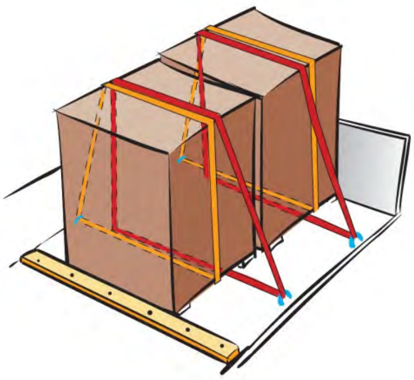
Top-over lashing

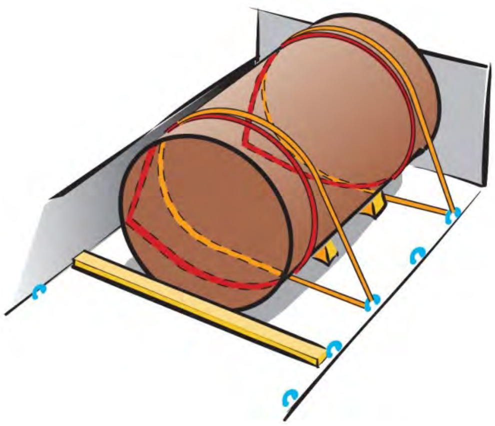


When using the tables for top-over lashing the angle between the lashing and the platform bed is of great importance. The tables are valid for an angle between 75°- 90°. If the angle is between 30°- 75° twice the number of lashings are needed. If the angle is less than 30°, another cargo securing method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

Half Loop lashing

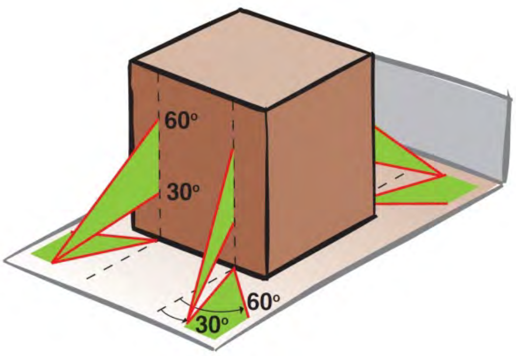
A pair of half loop lashings prevents cargo from sliding and tipping sideways. Minimum one pair of half loop lashings per section should be used.





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

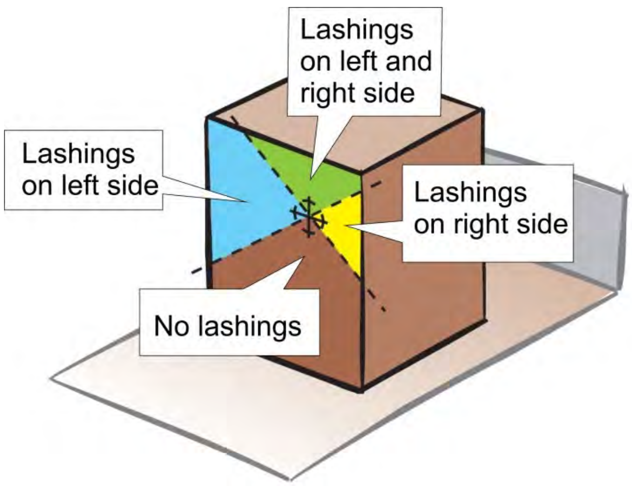


The tables are valid for an angle of 30 - 60° between the lashing and the platform bed.

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 weight in the tables may be doubled.

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°.



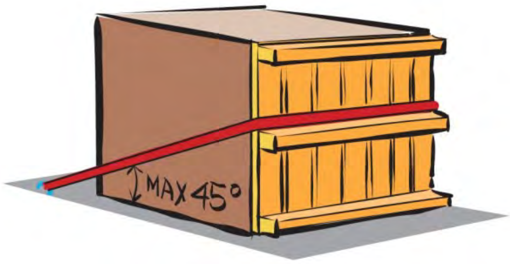
When the lashings are fixed above the centre of gravity, the unit may also have to be blocked in the bottom to prevent sliding.

Spring lashing

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

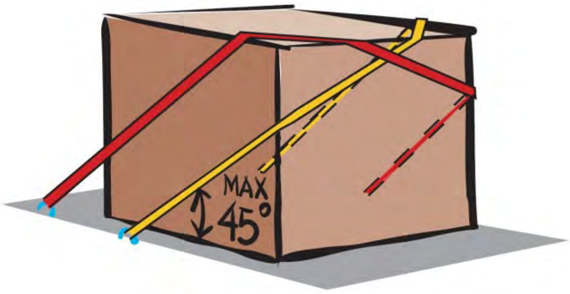
The angle between the lashing and the platform bed should be maximum 45°.

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 weight given in the lashing tables.

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

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

BASIC CARGO SECURING REQUIREMENTS

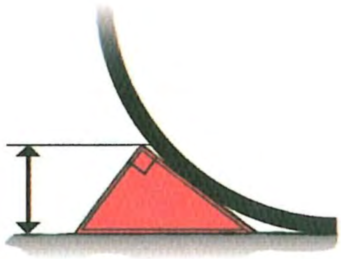
Non-rigid goods

If the goods is 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 out of the chocks, the chock height need not to be greater than 20 cm.



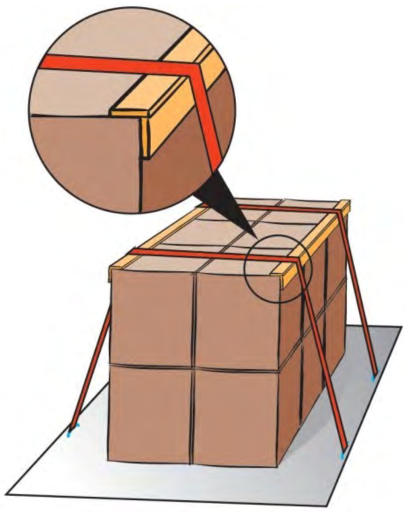
Bottom blocking

Bottom blocking preventing cargo from sliding must have a height of at least 5 cm, if the cargo isn't prevented to move above the block 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 and for other sections, at least one lashing per every second section shall be used.

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



LASHING EYES

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

SLIDING - FRICTION

Different material contacts have different coefficients of friction. The table below shows recommended values for the coefficient of friction. The values are valid provided that both contact surfaces are **dry, clean and free from frost, ice and snow**. The values are valid for the static friction.

Material combination in contact area	Dry	Wet
SAWN TIMBER/WOODEN PALLET		
Sawn timber against plywood/plyfa/wood	0.5	0.45
Sawn timber against grooved aluminium	0.4	0.4
Sawn timber against stainless steel sheet	0.4	0.3
Sawn timber against shrink film	0.3	-
PLANE WOOD		
Plane wood – fabric base laminate/plywood	0.3	0.3
Plane wood – grooved aluminium	0.25	0.25
Plane wood – stainless steel sheet	0.3	0.3
PLASTIC PALLETS		
Plastic pallet against plywood/plyfa/wood	0.2	0.2
Plastic pallet against grooved aluminium	0.15	0.15
Plastic pallet against 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 sheet metal against sawn timber	0.5	-
Painted rough sheet metal against sawn timber	0.5	-
Unpainted rough sheet metal against unpainted rough sheet metal	0.4	-
Painted rough sheet metal against painted rough sheet metal	0.3	-
Painted metal barrel against painted metal barrel	0.2	-

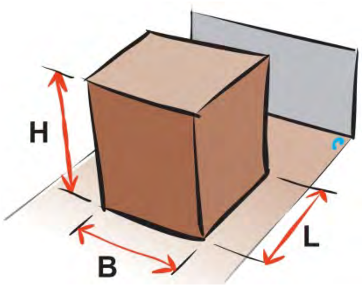
Material combination in contact area	Dry	Wet
STEEL CRATES		
Steel crate against plywood/plyfa/wood	0.45	0.45
Steel crate against grooved aluminium	0.3	0.3
Steel crate against steel sheet	0.2	0.2
CONCRETE		
Rough concrete against sawn wood battens	0.7	0.7
Smooth concrete against sawn wood battens	0.55	0.55
ANTI-SLIP MATERIAL		
Rubber against other materials	0.6	0.6
Forankra Friction board against other materials	0.7	0.7

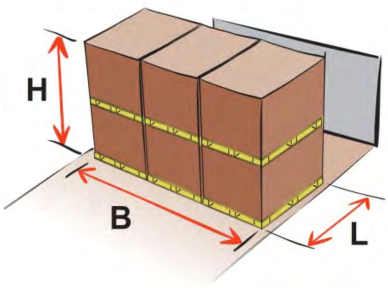
When a combination of contact surfaces is missing in the table above or if it's coefficient of friction can't be verified in another way, the maximum allowed μ-static to be used is 0.3*. μ-static used on open CTU:s to be maximum 0.3 as the surfaces can be wet during the sea transport.

If the cargo starts to slide the friction is changed from static to sliding friction. Sliding friction is lower than the static friction. When using a cargo securing method permitting the cargo to move a little the friction to be used should be 70% of the static friction. This effect is included in the tables for loop, spring and straight/cross lashings.

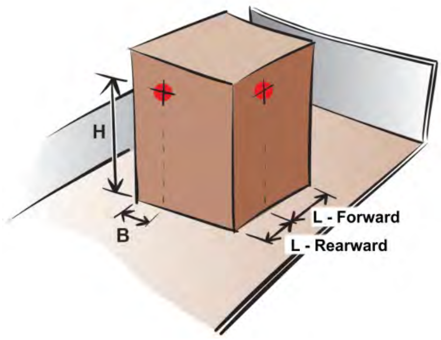
* See also CSS annex 13 § 7.2.1 and valid road regulations

TIPPING - DIMENSIONS





The definition of **H**, **B** and **L** 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** which 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.

REQUIRED NUMBER OF LASHINGS

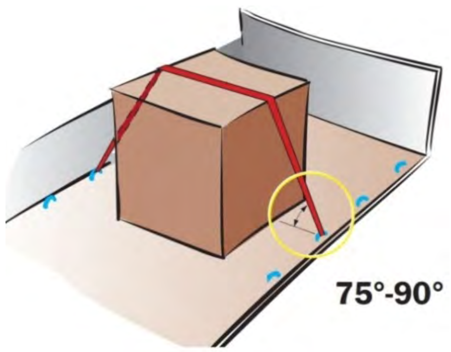
The required number of lashings to prevent sliding and tipping is calculated by the help of the tables on page 7 – 11 according to the following procedure:

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 arragement to avoid wandering for non-blocked cargo.

The tables are valid for **webbing** with a pre tension of minimum 400 daN (400 kg).
The values in the tables are proportional to the lashings' pre tension.
The weights in the tables are valid for one top-over lashing.

TOP-OVER LASHING



Cargo weight in ton prevented from sliding *per* top-over lashing			
μ - static	SIDEWAYS	FORWARD	BACKWARD
0.00	0.00	0.00	0.00
0.05	0.09	0.05	0.09
0.10	0.20	0.11	0.20
0.15	0.34	0.18	0.34
0.20	0.53	0.26	0.53
0.25	0.79	0.36	0.79
0.30	1.2	0.47	1.2
0.35	1.8	0.61	1.8
0.40	3.2	0.79	3.2
0.45	7.1	1.0	4.7
0.50	no slide	1.3	7.9
0.55	no slide	1.7	17
0.60	no slide	2.4	no slide
0.65	no slide	3.4	no slide
0.70	no slide	5.5	no slide

Cargo weight 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	6.9	3.1	0.6	no tip	no tip
0.8	no tip	no tip	5.9	2.3	1.6	0.8	no tip	no tip
1.0	no tip	no tip	2.4	1.4	1.0	1.0	no tip	no tip
1.2	no tip	4.9	1.5	0.98	0.79	1.2	no tip	no tip
1.4	no tip	2.5	1.1	0.76	0.63	1.4	6.6	no tip
1.6	no tip	1.6	0.84	0.62	0.52	1.6	2.8	no tip
1.8	no tip	1.2	0.69	0.53	0.45	1.8	1.8	20
2.0	no tip	0.98	0.59	0.46	0.39	2.0	1.3	7.9
2.2	7.9	0.82	0.51	0.40	0.35	2.2	1.0	4.9
2.4	3.9	0.70	0.45	0.36	0.31	2.4	0.86	3.6
2.6	2.6	0.61	0.41	0.33	0.29	2.6	0.73	2.6
2.8	2.0	0.55	0.37	0.30	0.26	2.8	0.64	2.0
3.0	1.6	0.49	0.34	0.27	0.24	3.0	0.56	1.6

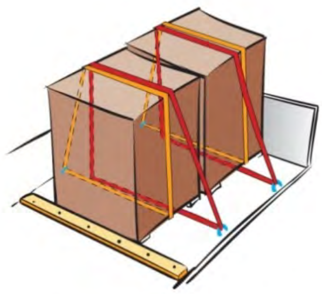
The lashing has to be dimensioned for the weight of the outer section only when there is risk of tipping in forward or backward directions. A top-over lashing preventing tipping forward ***and*** *backward has to be placed in center of the cargo.*

The tables are valid for **webbing** with a MSL of 20 kN (2 ton) and a pre tension of minimum 400 daN (400 kg).

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

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

HALF LOOP LASHING SLIDING



Cargo weight in ton prevented from sliding *per* pair of half loop lashing	
μ-static	SIDEWAYS
0.00	4.1
0.05	4.5
0.10	5.1
0.15	5.7
0.20	6.5
0.25	7.4
0.30	8.5
0.35	10.0
0.40	12
0.45	14
0.50	no slide
0.55	no slide
0.60	no slide
0.65	no slide
0.70	no slide

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

Cargo weight 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	14	6.8
0.8	no tip	no tip	10	4.6	3.4
1.0	no tip	no tip	4.2	2.7	2.3
1.2	no tip	7.3	2.6	2.0	1.7
1.4	no tip	3.6	1.9	1.5	1.4
1.6	no tip	2.4	1.5	1.2	1.1
1.8	no tip	1.8	1.2	1.1	0.97
2.0	no tip	1.5	1.0	0.91	0.85
2.2	8.2	1.2	0.91	0.81	0.75
2.4	4.1	1.0	0.81	0.72	0.68
2.6	2.7	0.91	0.72	0.65	0.62
2.8	2.0	0.81	0.66	0.60	0.56
3.0	1.6	0.73	0.60	0.55	0.52

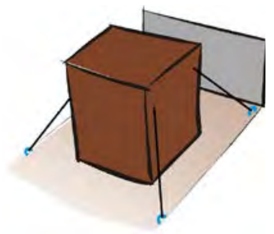
The values in the table are proportional to the lashings' pre tension.

The tables are valid for **webbing** with a MSL of 20 kN (2 ton) and a pre tension of minimum 400 daN (400 kg).

All weights are valid for one straight lashing.

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

STRAIGHT LASHING SLIDING



Cargo weight in ton prevented from sliding *per* straight lashing			
μ - static	SIDEWAYS per side	FORWARD	BACKWARD
0.00	1.0	0.64	1.0
0.05	1.2	0.75	1.2
0.10	1.5	0.87	1.5
0.15	1.8	1.0	1.8
0.20	2.1	1.1	2.1
0.25	2.5	1.3	2.5
0.30	3.0	1.5	3.0
0.35	3.7	1.7	3.7
0.40	4.6	1.9	4.6
0.45	5.8	2.2	5.8
0.50	no slide	2.5	9.0
0.55	no slide	2.9	11
0.60	no slide	3.3	no slide
0.65	no slide	3.8	no slide
0.70	no slide	4.4	no slide

Cargo weight 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

The tables are valid for **webbing** with a MSL of 20 kN (2 ton) and a pre tension of minimum 4000 N (400 kg).

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

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

SPRING LASHING

Cargo weight in ton prevented from sliding *per* spring lashing		
μ - static	FORWARD	BACKWARD
0.00	3.6	5.8
0.05	3.9	6.4
0.10	4.2	7.2
0.15	4.6	8.1
0.20	5.0	9.1
0.25	5.4	10
0.30	5.9	12
0.35	6.5	14
0.40	7.1	17
0.45	7.8	20
0.50	8.6	31
0.55	9.6	37
0.60	11	no slide
0.65	12	no slide
0.70	14	no slide

Cargo weight 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 Approx. cargo weight in ton prevented from sliding by one tag washer in combination with top-over lashing only							
Friction**	SIDEWAYS						
	∅ 48	∅ 62	∅ 75	∅ 95	30×57	48×65	130×130
Open CTU - (μ = 0.3)	0.63	0.88	1.1	1.5	0.63	0.88	1.9
Covered CTU - (μ = 0.4)	1.3	1.8	2.3	3.0	1.3	1.8	3.8
	FORWARD						
Open CTU - (μ = 0.3)	0.25	0.35	0.45	0.60	0.25	0.35	0.75
Covered CTU - (μ = 0.4)	0.31	0.44	0.56	0.75	0.31	0.44	0.94
	BACKWARD						
Open CTU - (μ = 0.3)	0.63	0.88	1.1	1.5	0.63	0.88	1.9
Covered CTU - (μ = 0.4)	1.3	1.8	2.3	3.0	1.3	1.8	3.8

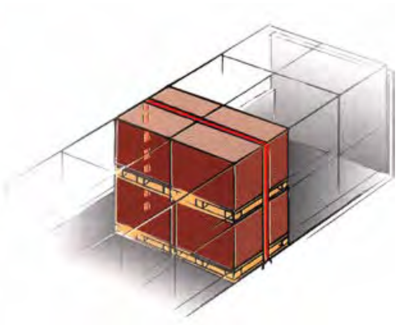
** *Between tag washer and platform bed/cargo. For tag washers in shrink film the rows for friction 0.3 to be used.*

4" – NAIL Approximate cargo weight in ton prevented from sliding by one nail in combination with top-over lashing only						
Friction***	SIDEWAYS per side		FORWARD		BACKWARD	
	blank	galvanised	blank	galvanised	blank	galvanised
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.*

CARGO STOWED IN MORE THAN ONE LAYER

Method 1 (simple)



1. Determine the number of lashings to prevent sliding using the weight 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 are to be used.

Method 2 (advanced)

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

Packing Code
Quick Lashing Guide B

Cargo securing on CTUs for transports in Sea Area B

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/B	V
Sea Area B	0.7	1.0	0.3	0.3

V = Vertical acceleration in combination with longitudinal or transverse acceleration

Goods; not rigid in form
If the goods isn'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.

Content

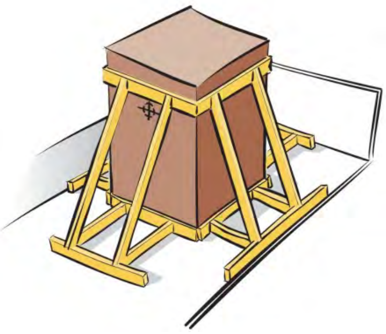
CARGO SECURING METHODS

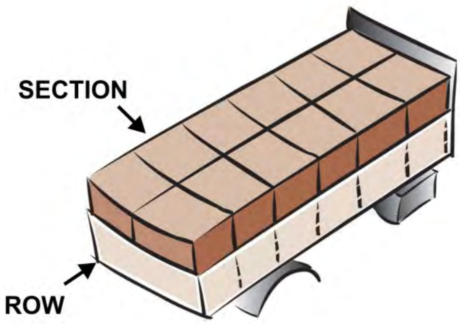
Goods shall be prevented from sliding and tipping in forward, backward and sideways directions by any of the following methods, combined in a proper way.

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.

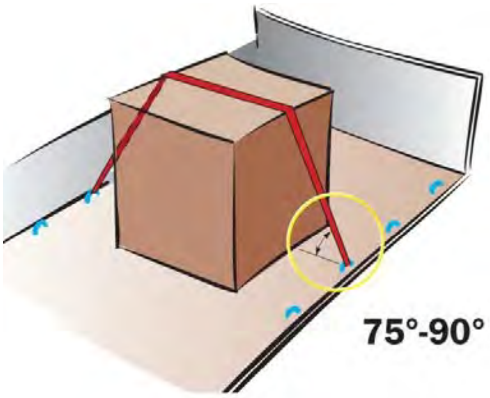
Blocking is primarily a method to prevent the cargo from sliding, but if the blocking reaches high enough, it also prevents tipping. Blocking is the primary method for cargo securing and should be used as far as possible.





The sums 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

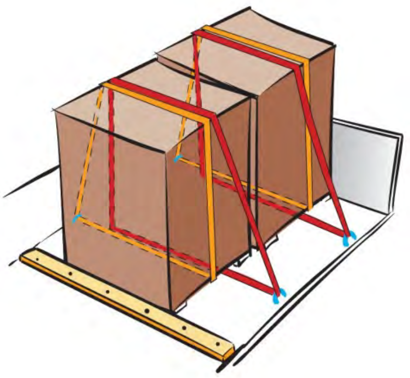


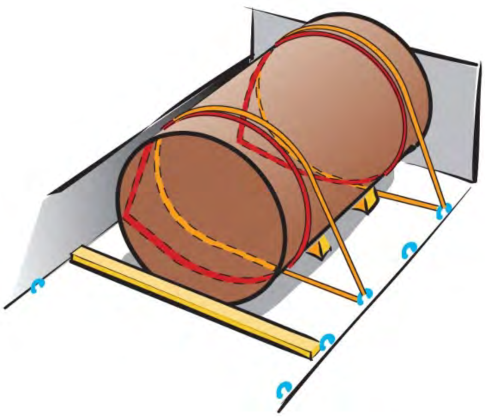
When using the tables for top-over lashing the angle between the lashing and the platform bed is of great importance. The tables are valid for an angle between 75°- 90°. If the angle is between 30°- 75° twice the number of lashings are needed. If the angle is less than 30°, another cargo securing method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

A top-over lashing preventing tipping forward **and** backward has to be placed centred on the cargo.

Half loop lashing

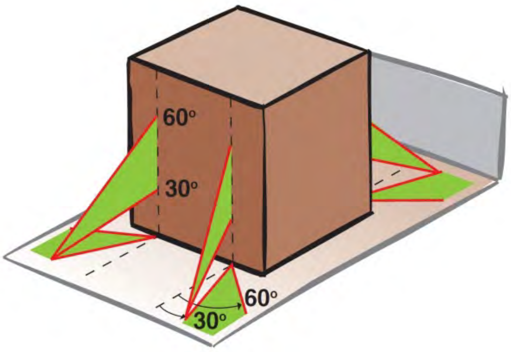
A pair of half loop lashings prevents cargo from sliding and tipping sideways. Minimum one pair of half loop lashings per section should be used.





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

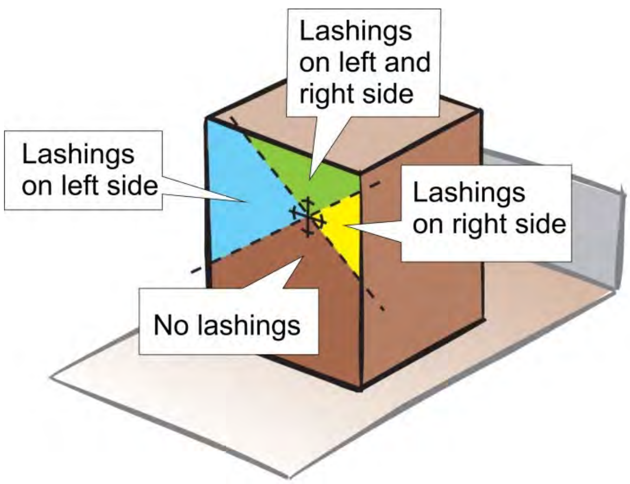


The tables are valid for an angle of 30 - 60° between the lashing and the platform bed.

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 weight in the tables may be doubled.

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°.



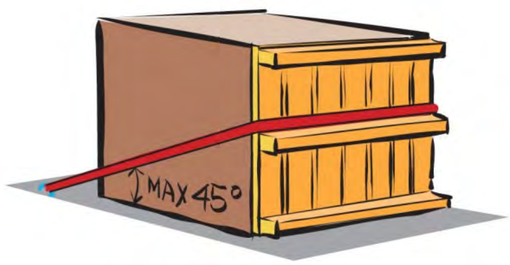
When the lashings are fixed above the centre of gravity, the unit may also have to be blocked in the bottom to prevent sliding.

Spring lashing

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

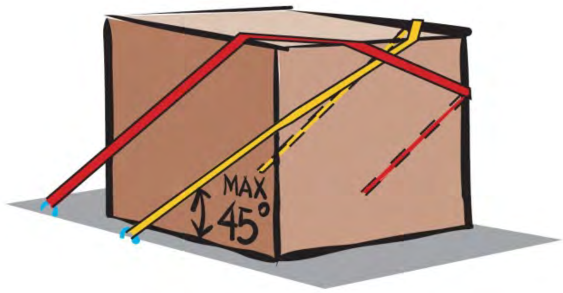
The angle between the lashing and the platform bed should be maximum 45°.

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 weight given in the lashing tables.

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

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

BASIC CARGO SECURING REQUIREMENTS

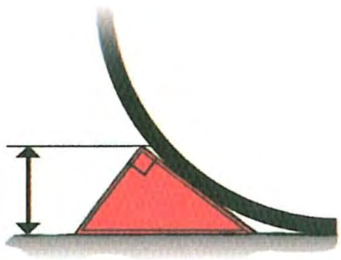
Non-rigid goods

If the goods is 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 out of the chocks, the chock height need not to be greater than 20 cm.



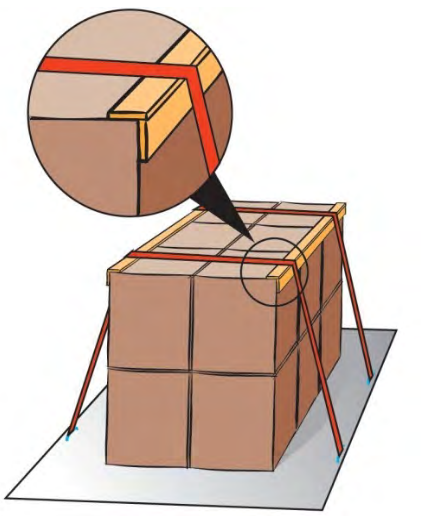
Bottom blocking

Bottom blocking preventing cargo from sliding must have a height of at least 5 cm, if the cargo isn't prevented to move above the block 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 and for other sections, at least one lashing per every second section shall be used.

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



LASHING EYES

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

SLIDING - FRICTION

Different material contacts have different coefficients of friction. The table below shows recommended values for the coefficient of friction. 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.

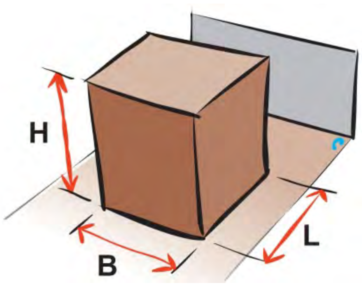
Material combination in contact area	Dry	Wet
SAWN TIMBER/WOODEN PALLET		
Sawn timber/wooden pallet against plywood/plyfa/wood	0.5	0.45
Sawn timber/wooden pallet against grooved aluminium	0.4	0.4
Sawn timber/wooden pallet against stainless steel sheet	0.4	0.3
Sawn timber/wooden pallet against shrink film	0.3	-
PLANE WOOD		
Plane wood – fabric base laminate/plywood	0.3	0.3
Plane wood – grooved aluminium	0.25	0.25
Plane wood – smooth steel sheet	0.3	0.3
PLASTIC PALLETS		
Plastic pallet against plywood/plyfa/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	-
Unpainted metal with smooth surface against unpainted smooth metal	0.2	-
Painted metal with smooth surface against painted smooth metal	0.2	-

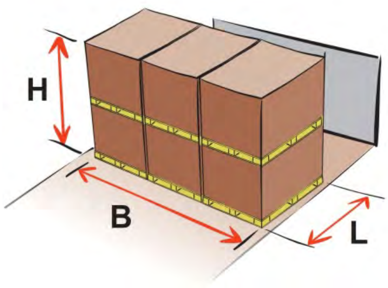
Material combination in contact area	Dry	Wet
STEEL CRATES		
Steel crate against plywood/plyfa/wood	0.45	0.45
Steel crate against grooved aluminium	0.3	0.3
Steel crate against smooth steel	0.2	0.2
CONCRETE		
Concrete with rough surface against sawn wood battens	0.7	0.7
Concrete with smooth surface against sawn wood battens	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 it's coefficient of friction can't be verified in another way, the maximum μ-static to be used is 0.3. If the surface contacts are not free from frost, ice and snow a static friction coefficient $\mu = 0.2$ shall be used[1]. For oily and greasy surfaces or when slip sheets have been used a static friction coefficient $\mu = 0.1$ shall be used.

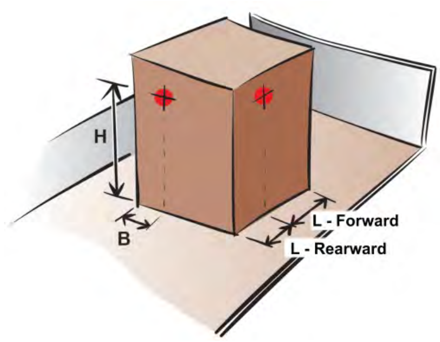
[1] For sea transport see CSS Code annex 13 subsection 7.2.

TIPPING - DIMENSIONS





The definition of **H**, **B** and **L** as shown above 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.

REQUIRED NUMBER OF LASHINGS

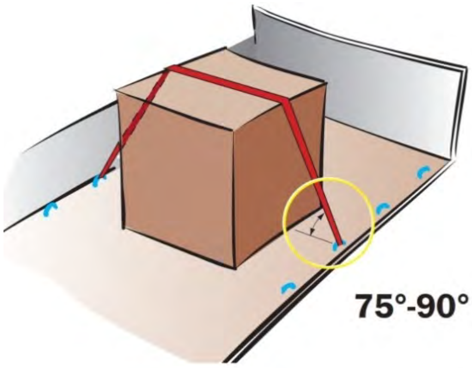
The required number of lashings to prevent sliding and tipping is calculated by the help of the tables on the following pages according to the following procedure:

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.

The tables are valid for **webbing** with a pre tension of minimum 400 daN (400 kg).
The values in the tables are proportional to the lashings' pre tension.
The weights in the tables are valid for one top-over lashing.

TOP-OVER LASHING



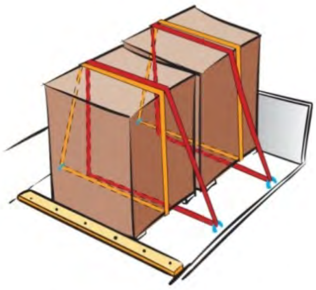
Cargo weight in ton prevented from sliding *per* top-over lashing		
µ - static	SIDEWAYS	FORWARD/BACKWARD
0.00	0.00	0.00
0.05	0.06	0.14
0.10	0.13	0.29
0.15	0.21	0.46
0.20	0.32	0.66
0.25	0.44	0.88
0.30	0.59	1.1
0.35	0.79	1.4
0.40	1.1	1.8
0.45	1.4	2.1
0.50	2.0	2.6
0.55	2.9	3.2
0.60	4.7	3.9
0.65	10	4.9
0.70	no slide	6.1

Cargo weight 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
0.6	no tip	no tip	4.5	2.0	1.4	0.6	no tip
0.8	no tip	8.2	1.7	1.1	0.87	0.8	no tip
1.0	no tip	2.5	1.1	0.76	0.63	1.0	no tip
1.2	no tip	1.4	0.78	0.58	0.49	1.2	13
1.4	no tip	1.0	0.61	0.47	0.40	1.4	6.6
1.6	6.6	0.79	0.50	0.40	0.34	1.6	4.4
1.8	3.0	0.65	0.42	0.34	0.30	1.8	3.3
2.0	2.0	0.55	0.37	0.30	0.26	2.0	2.6
2.2	1.5	0.47	0.33	0.27	0.23	2.2	2.2
2.4	1.2	0.42	0.29	0.24	0.21	2.4	1.9
2.6	0.96	0.37	0.26	0.22	0.19	2.6	1.6
2.8	0.82	0.34	0.24	0.20	0.18	2.8	1.5
3.0	0.72	0.31	0.22	0.19	0.17	3.0	1.3

The tables are valid for **webbing** with a MSL of 20 kN (2 ton) and a pre tension of minimum 400 daN (400 kg).

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

HALF LOOP LASHING SLIDING



Cargo weight in ton prevented from sliding *per* pair of half loop lashing	
μ-static	SIDEWAYS
0.00	2.9
0.05	3.2
0.10	3.5
0.15	3.8
0.20	4.2
0.25	4.6
0.30	5.0
0.35	5.6
0.40	6.2
0.45	7.0
0.50	7.9
0.55	9.0
0.60	10
0.65	12
0.70	no slide

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

Cargo weight 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	8.1	4.0	3.1
0.8	no tip	12	3.1	2.2	1.9
1.0	no tip	3.6	1.9	1.5	1.4
1.2	no tip	2.1	1.4	1.2	1.1
1.4	no tip	1.5	1.1	0.94	0.87
1.6	6.8	1.2	0.89	0.79	0.74
1.8	3.1	0.96	0.76	0.68	0.64
2.0	2.0	0.81	0.66	0.60	0.56
2.2	1.5	0.70	0.58	0.53	0.50
2.4	1.2	0.62	0.52	0.48	0.46
2.6	0.99	0.55	0.47	0.44	0.42
2.8	0.85	0.50	0.43	0.40	0.38
3.0	0.74	0.46	0.40	0.37	0.36

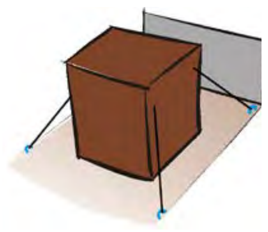
The values in the table are proportional to the lashings' pre tension.

The tables are valid for **webbing** with a MSL of 20 kN (2 ton) and a pre tension of minimum 400 daN (400 kg).

All weights are valid for one straight lashing.

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

STRAIGHT LASHING SLIDING



Cargo weight in ton prevented from sliding *per* straight lashing		
μ - static	SIDEWAYS per side	FORWARD/ BACKWARD
0.00	0.73	1.7
0.05	0.86	2.0
0.10	1.0	2.3
0.15	1.2	2.6
0.20	1.4	2.9
0.25	1.6	3.3
0.30	1.8	3.7
0.35	2.1	4.2
0.40	2.4	4.6
0.45	2.8	5.2
0.50	3.2	5.8
0.55	3.8	6.4
0.60	4.5	7.2
0.65	5.4	8.0
0.70	no slide	9.0

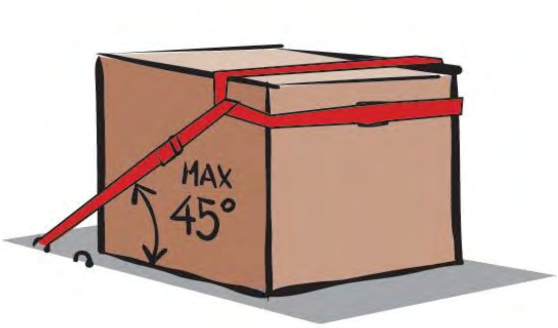
Cargo weight in ton prevented from tipping *per* straight lashing			
H/B	SIDEWAYS per side	H/L	FORWARD/ BACKWARD
0.6	no tip	0.6	no tip
0.8	no tip	0.8	no tip
1.0	no tip	1.0	no tip
1.2	no tip	1.2	19
1.4	no tip	1.4	10
1.6	11	1.6	7.4
1.8	5.5	1.8	5.9
2.0	3.8	2.0	5.1
2.2	3.0	2.2	4.5
2.4	2.5	2.4	4.1
2.6	2.2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

The tables are valid for **webbing** with a MSL of 20 kN (2 ton) and a pre tension of minimum 4000 N (400 kg).

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

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

SPRING LASHING

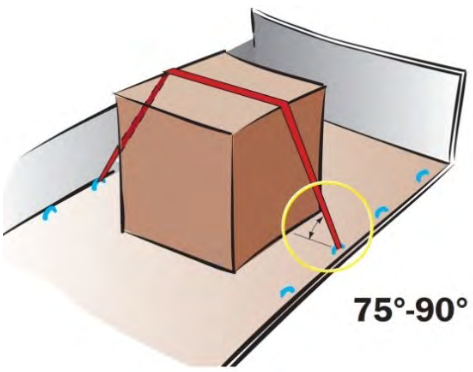


Cargo weight in ton prevented from sliding *per* spring lashing	
μ - static	FORWARD/BACKWARD
0.00	9.6
0.05	10
0.10	11
0.15	12
0.20	13
0.25	14
0.30	15
0.35	16
0.40	17
0.45	18
0.50	20
0.55	22
0.60	24
0.65	26
0.70	28

Cargo weight in ton prevented from tipping *per* spring lashing	
H/L	FORWARD/BACKWARD
0.6	no tip
0.8	no tip
1.0	no tip
1.2	115
1.4	67
1.6	51
1.8	43
2.0	38
2.2	35
2.4	33
2.6	31
2.8	30
3.0	29

The tables are valid for **chain (∅ 9 mm, class 8)** with a pre tension of minimum 10 kN (1000 kg).
The values in the tables are proportional to the lashings' pre tension.
The weights in the tables are valid for one top-over lashing.

TOP-OVER LASHING



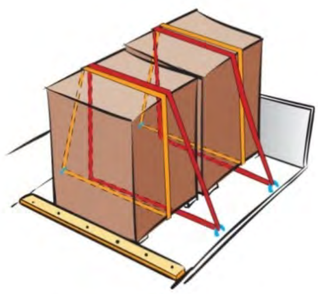
Cargo weight in ton prevented from sliding *per* top-over lashing		
μ - static	SIDEWAYS	FORWARD/BACKWARD
0.00	0.00	0.00
0.05	0.15	0.35
0.10	0.33	0.73
0.15	0.54	1.2
0.20	0.79	1.6
0.25	1.1	2.2
0.30	1.5	2.8
0.35	2.0	3.5
0.40	2.6	4.4
0.45	3.5	5.4
0.50	4.9	6.6
0.55	7.2	8.0
0.60	12	9.8
0.65	26	12
0.70	no slide	15

Cargo weight 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
0.6	no tip	no tip	11	5.1	3.6	0.6	no tip
0.8	no tip	20	4.3	2.8	2.2	0.8	no tip
1.0	no tip	6.1	2.7	1.9	1.6	1.0	no tip
1.2	no tip	3.6	1.9	1.5	1.2	1.2	33
1.4	no tip	2.6	1.5	1.2	1.0	1.4	16
1.6	16	2.0	1.2	0.99	0.85	1.6	11
1.8	7.6	1.6	1.1	0.85	0.74	1.8	8.2
2.0	4.9	1.4	0.92	0.75	0.65	2.0	6.6
2.2	3.6	1.2	0.81	0.67	0.59	2.2	5.5
2.4	2.9	1.0	0.73	0.60	0.53	2.4	4.7
2.6	2.4	0.93	0.66	0.55	0.48	2.6	4.1
2.8	2.1	0.84	0.60	0.50	0.45	2.8	3.6
3.0	1.8	0.77	0.56	0.46	0.41	3.0	3.3

The tables are valid for **chain (∅ 9 mm, class 8)** with a MSL of 50 kN (5.0 ton) and a pre tension of minimum 10 kN (1000 kg).

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

HALF LOOP LASHING SLIDING

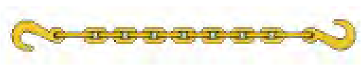


Cargo weight in ton prevented from sliding *per* pair of half loop lashing	
μ-static	SIDEWAYS
0.00	7.3
0.05	7.9
0.10	8.7
0.15	9.5
0.20	10
0.25	11
0.30	13
0.35	14
0.40	16
0.45	17
0.50	20
0.55	22
0.60	26
0.65	30
0.70	no slide

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

Cargo weight 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	20	10	7.7
0.8	no tip	30	7.7	5.5	4.7
1.0	no tip	9.1	4.8	3.8	3.4
1.2	no tip	5.4	3.5	2.9	2.6
1.4	no tip	3.8	2.7	2.3	2.2
1.6	17	2.9	2.2	2.0	1.8
1.8	7.8	2.4	1.9	1.7	1.6
2.0	5.1	2.0	1.6	1.5	1.4
2.2	3.8	1.8	1.4	1.3	1.3
2.4	3.0	1.5	1.3	1.2	1.1
2.6	2.5	1.4	1.2	1.1	1.0
2.8	2.1	1.2	1.1	1.0	0.96
3.0	1.9	1.1	0.99	0.93	0.89

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

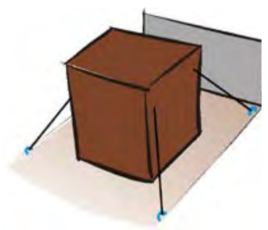


The tables are valid for **chain (∅ 9 mm, class 8)** with a MSL of 50 kN (5.0 ton) and a pre tension of minimum 10 kN (1000 kg).

All weights are valid for one straight lashing.

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

STRAIGHT LASHING SLIDING



Cargo weight in ton prevented from sliding *per* straight lashing		
μ - static	SIDEWAYS per side	FORWARD/ BACKWARD
0.00	1.8	4.2
0.05	2.1	4.9
0.10	2.5	5.7
0.15	2.9	6.5
0.20	3.4	7.3
0.25	3.9	8.3
0.30	4.5	9.3
0.35	5.2	10
0.40	6.0	12
0.45	6.9	13
0.50	8.1	14
0.55	9.4	16
0.60	11	18
0.65	13	20
0.70	no slide	22

Cargo weight 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
0.8	no tip	0.8	no tip
1.0	no tip	1.0	no tip
1.2	no tip	1.2	47
1.4	no tip	1.4	25
1.6	28	1.6	18
1.8	14	1.8	15
2.0	9.6	2.0	13
2.2	7.6	2.2	11
2.4	6.4	2.4	10
2.6	5.6	2.6	9.6
2.8	5.0	2.8	9.0
3.0	4.6	3.0	8.5

The tables are valid for **chain (∅ 9 mm, class 8)** with a MSL of 50 kN (5.0 ton) and a pre tension of minimum 10 kN (1000 kg).

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

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

SPRING LASHING

Cargo weight in ton prevented from sliding *per* spring lashing	
μ - static	FORWARD/BACKWARD
0.00	24
0.05	26
0.10	28
0.15	30
0.20	32
0.25	34
0.30	37
0.35	40
0.40	43
0.45	46
0.50	50
0.55	54
0.60	59
0.65	64
0.70	70

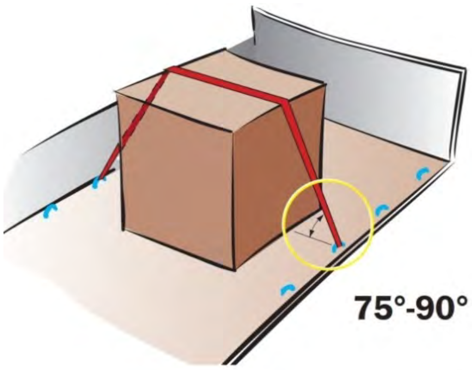
Cargo weight in ton prevented from tipping *per* spring lashing	
H/L	FORWARD/BACKWARD
0.6	no tip
0.8	no tip
1.0	no tip
1.2	288
1.4	168
1.6	128
1.8	108
2.0	96
2.2	88
2.4	82
2.6	78
2.8	75
3.0	72

STEEL STRAPPING

TOP-OVER LASHINGS

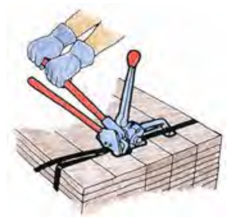
The tables are valid for **steel strapping** (**32 × 0,8 mm)** with a pre tension of minimum 240 daN (240 kg).
The values in the tables are proportional to the lashings' pre tension.
The weights in the tables are valid for one top-over lashing.

TOP-OVER LASHING



Cargo weight in ton prevented from sliding *per* top-over lashing		
μ - static	SIDEWAYS	FORWARD/BACKWARD
0.00	0.00	0.00
0.05	0.04	0.08
0.10	0.08	0.18
0.15	0.13	0.28
0.20	0.19	0.39
0.25	0.26	0.53
0.30	0.35	0.68
0.35	0.47	0.85
0.40	0.63	1.1
0.45	0.85	1.3
0.50	1.2	1.6
0.55	1.7	1.9
0.60	2.8	2.4
0.65	6.1	2.9
0.70	no slide	3.7

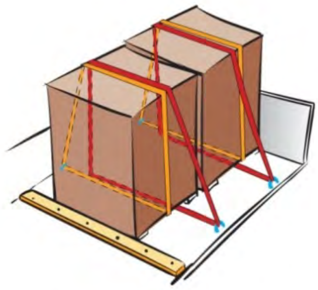
Cargo weight in ton prevented from tipping *per* top-over lashing							
SIDEWAYS						FORWARD/BACKWARD	
H/B	1 row	2 rows	3 rows	4 rows	5 rows	H/L	per section
0.6	no tip	no tip	2.7	1.2	0.86	0.6	no tip
0.8	no tip	4.9	1.0	0.67	0.52	0.8	no tip
1.0	no tip	1.5	0.64	0.46	0.38	1.0	no tip
1.2	no tip	0.87	0.47	0.35	0.29	1.2	7.9
1.4	no tip	0.61	0.36	0.28	0.24	1.4	3.9
1.6	3.9	0.48	0.30	0.24	0.20	1.6	2.6
1.8	1.8	0.39	0.25	0.20	0.18	1.8	2.0
2.0	1.2	0.33	0.22	0.18	0.16	2.0	1.6
2.2	0.88	0.28	0.20	0.16	0.14	2.2	1.3
2.4	0.70	0.25	0.18	0.14	0.13	2.4	1.1
2.6	0.58	0.22	0.16	0.13	0.12	2.6	0.98
2.8	0.49	0.20	0.14	0.12	0.11	2.8	0.88
3.0	0.43	0.18	0.13	0.11	0.10	3.0	0.79



The tables are valid for **steel strapping** (**32 × 0,8 mm)** with a MSL of 17 kN (1.7 ton) and a pre tension of minimum 240 daN (240 kg).

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

HALF LOOP LASHING SLIDING

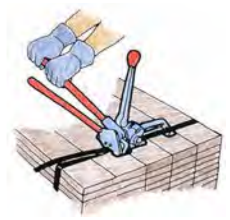


Cargo weight in ton prevented from sliding *per* pair of half loop lashing	
μ-static	SIDEWAYS
0.00	2.5
0.05	2.7
0.10	2.9
0.15	3.2
0.20	3.5
0.25	3.9
0.30	4.3
0.35	4.7
0.40	5.3
0.45	5.9
0.50	6.7
0.55	7.6
0.60	8.8
0.65	10
0.70	no slide

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

Cargo weight 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	4.8	2.4	1.8
0.8	no tip	7.3	1.9	1.3	1.1
1.0	no tip	2.2	1.1	0.91	0.81
1.2	no tip	1.3	0.83	0.70	0.63
1.4	no tip	0.91	0.65	0.56	0.52
1.6	4.1	0.71	0.53	0.47	0.44
1.8	1.9	0.58	0.45	0.41	0.38
2.0	1.2	0.49	0.39	0.36	0.34
2.2	0.91	0.42	0.35	0.32	0.30
2.4	0.72	0.37	0.31	0.29	0.27
2.6	0.60	0.33	0.28	0.26	0.25
2.8	0.51	0.30	0.26	0.24	0.23
3.0	0.44	0.27	0.24	0.22	0.21

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

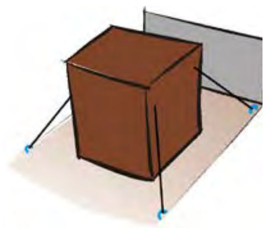


The tables are valid for **steel strapping** (**32 × 0,8 mm)** with a MSL of 17 kN (1.7 ton) and a pre tension of minimum 240 daN (240 kg).

All weights are valid for one straight lashing.

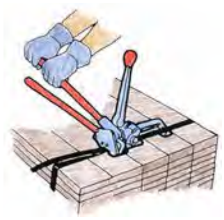
The values in the tables are proportional to the lashings' maximum securing load (MSL).

STRAIGHT LASHING SLIDING



Cargo weight in ton prevented from sliding *per* straight lashing		
μ - static	SIDEWAYS per side	FORWARD/ BACKWARD
0.00	0.62	1.4
0.05	0.73	1.7
0.10	0.85	1.9
0.15	0.99	2.2
0.20	1.1	2.5
0.25	1.3	2.8
0.30	1.5	3.2
0.35	1.8	3.5
0.40	2.0	4.0
0.45	2.4	4.4
0.50	2.7	4.9
0.55	3.2	5.5
0.60	3.8	6.1
0.65	4.6	6.8
0.70	no slide	7.6

Cargo weight 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
0.8	no tip	0.8	no tip
1.0	no tip	1.0	no tip
1.2	no tip	1.2	16
1.4	no tip	1.4	8.7
1.6	9.4	1.6	6.3
1.8	4.7	1.8	5.1
2.0	3.2	2.0	4.3
2.2	2.6	2.2	3.9
2.4	2.2	2.4	3.5
2.6	1.9	2.6	3.2
2.8	1.7	2.8	3.0
3.0	1.6	3.0	2.9



The tables are valid for **steel strapping** (**32 × 0,8 mm)** with a MSL of 17 kN (1.7 ton) and a pre tension of minimum 240 daN (240 kg).

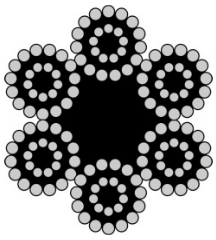
The weights in the tables are valid for one spring lashing.

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

SPRING LASHING

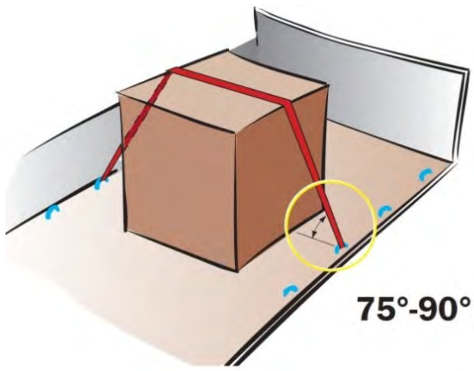
Cargo weight in ton prevented from sliding *per* spring lashing	
μ - static	FORWARD/BACKWARD
0.00	8.2
0.05	8.8
0.10	9.4
0.15	10
0.20	11
0.25	12
0.30	13
0.35	13
0.40	15
0.45	16
0.50	17
0.55	18
0.60	20
0.65	22
0.70	24

Cargo weight in ton prevented from tipping *per* spring lashing	
H/L	FORWARD/BACKWARD
0.6	no tip
0.8	no tip
1.0	no tip
1.2	98
1.4	57
1.6	44
1.8	37
2.0	33
2.2	30
2.4	28
2.6	27
2.8	25
3.0	25



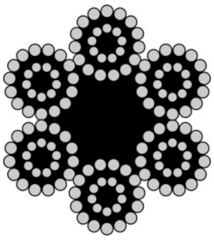
The tables are valid for **steel wire rope (∅ 16 mm/144 wires)** with a pre tension of minimum 10 kN (1000 kg). The values in the tables are proportional to the lashings' pre tension. The weights in the tables are valid for one top-over lashing.

TOP-OVER LASHING



Cargo weight in ton prevented from sliding *per* top-over lashing		
μ - static	SIDEWAYS	FORWARD/BACKWARD
0.00	0.00	0.00
0.05	0.15	0.35
0.10	0.33	0.73
0.15	0.54	1.2
0.20	0.79	1.6
0.25	1.1	2.2
0.30	1.5	2.8
0.35	2.0	3.5
0.40	2.6	4.4
0.45	3.5	5.4
0.50	4.9	6.6
0.55	7.2	8.0
0.60	12	9.8
0.65	26	12
0.70	no slide	15

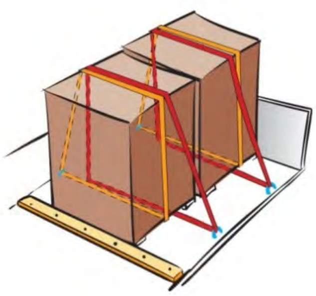
Cargo weight in ton prevented from tipping *per* top-over lashing							
SIDEWAYS						FORWARD/BACKWARD	
H/B	1 row	2 rows	3 rows	4 rows	5 rows	H/L	per section
0.6	no tip	no tip	11	5.1	3.6	0.6	no tip
0.8	no tip	20	4.3	2.8	2.2	0.8	no tip
1.0	no tip	6.1	2.7	1.9	1.6	1.0	no tip
1.2	no tip	3.6	1.9	1.5	1.2	1.2	33
1.4	no tip	2.6	1.5	1.2	1.0	1.4	16
1.6	16	2.0	1.2	0.99	0.85	1.6	11
1.8	7.6	1.6	1.1	0.85	0.74	1.8	8.2
2.0	4.9	1.4	0.92	0.75	0.65	2.0	6.6
2.2	3.6	1.2	0.81	0.67	0.59	2.2	5.5
2.4	2.9	1.0	0.73	0.60	0.53	2.4	4.7
2.6	2.4	0.93	0.66	0.55	0.48	2.6	4.1
2.8	2.1	0.84	0.60	0.50	0.45	2.8	3.6
3.0	1.8	0.77	0.56	0.46	0.41	3.0	3.3



The tables are valid for **steel wire rope (∅ 16 mm/144 wires)** with a MSL of 91 kN (9.1 ton) and a pre tension of minimum 10 kN (1000 kg).

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

HALF LOOP LASHING SLIDING

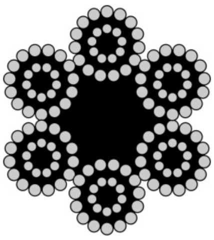


Cargo weight in ton prevented from sliding *per* pair of half loop lashing	
μ-static	SIDEWAYS
0.00	13
0.05	14
0.10	16
0.15	17
0.20	19
0.25	21
0.30	23
0.35	25
0.40	28
0.45	32
0.50	36
0.55	41
0.60	47
0.65	55
0.70	no slide

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

Cargo weight 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	20	10	7.7
0.8	no tip	30	7.7	5.5	4.7
1.0	no tip	9.1	4.8	3.8	3.4
1.2	no tip	5.4	3.5	2.9	2.6
1.4	no tip	3.8	2.7	2.3	2.2
1.6	17	2.9	2.2	2.0	1.8
1.8	7.8	2.4	1.9	1.7	1.6
2.0	5.1	2.0	1.6	1.5	1.4
2.2	3.8	1.8	1.4	1.3	1.3
2.4	3.0	1.5	1.3	1.2	1.1
2.6	2.5	1.4	1.2	1.1	1.0
2.8	2.1	1.2	1.1	1.0	0.96
3.0	1.9	1.1	0.99	0.93	0.89

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

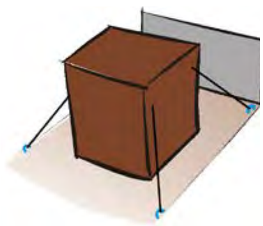


The tables are valid for **steel wire rope (∅ 16 mm/144 wires)** with a MSL of 91 kN (9.1 ton) and a pre tension of minimum 10 kN (1000 kg).

All weights are valid for one straight lashing.

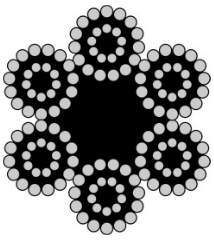
The values in the tables are proportional to the lashings' maximum securing load (MSL).

STRAIGHT LASHING SLIDING



Cargo weight in ton prevented from sliding *per* straight lashing		
μ - static	SIDEWAYS per side	FORWARD/ BACKWARD
0.00	3.3	7.7
0.05	3.9	9.0
0.10	4.6	10
0.15	5.3	12
0.20	6.1	13
0.25	7.1	15
0.30	8.2	17
0.35	9.4	19
0.40	11	21
0.45	13	24
0.50	15	26
0.55	17	29
0.60	20	33
0.65	24	37
0.70	no slide	41

Cargo weight 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
0.8	no tip	0.8	no tip
1.0	no tip	1.0	no tip
1.2	no tip	1.2	85
1.4	no tip	1.4	46
1.6	50	1.6	33
1.8	25	1.8	27
2.0	17	2.0	23
2.2	14	2.2	21
2.4	12	2.4	19
2.6	10	2.6	17
2.8	9.2	2.8	16
3.0	8.4	3.0	15



The tables are valid for **steel wire rope (∅ 16 mm/144 wires)** with a MSL of 91 kN (9.1 ton) and a pre tension of minimum 10 kN (1000 kg).

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

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

SPRING LASHING

Cargo weight in ton prevented from sliding *per* spring lashing	
μ - static	FORWARD/BACKWARD
0.00	44
0.05	47
0.10	50
0.15	54
0.20	58
0.25	62
0.30	67
0.35	72
0.40	78
0.45	84
0.50	91
0.55	98
0.60	107
0.65	117
0.70	128

Cargo weight in ton prevented from tipping *per* spring lashing	
H/L	FORWARD/BACKWARD
0.6	no tip
0.8	no tip
1.0	no tip
1.2	525
1.4	306
1.6	233
1.8	197
2.0	175
2.2	160
2.4	150
2.6	142
2.8	136
3.0	131

TAG WASHERS AND NAILS

TAG WASHER Approx. cargo weight in ton prevented from sliding by one tag washer for wood on wood in combination with top-over lashing only							
µ - static **	SIDEWAYS						
	∅ 48	∅ 62	∅ 75	∅ 95	30×57	48×65	130×130
0.3	0.31	0.44	0.56	0.75	0.31	0.44	0.94
0.4	0.42	0.58	0.75	1.00	0.42	0.58	1.3
	FORWARD/BACKWARD						
0.3	0.60	0.83	1.1	1.4	0.60	0.83	1.8
0.4	0.69	0.97	1.3	1.7	0.69	0.97	2.1

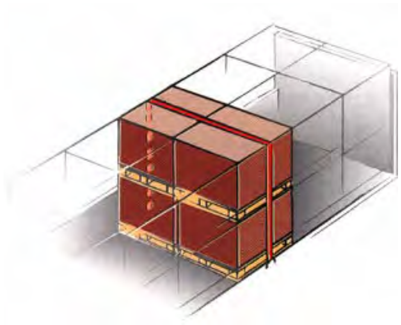
** *Between tag washer and platform bed/cargo. For tag washers in shrink film the rows for friction 0.3 to be used.*

4" – NAIL Approximate cargo weight in ton prevented from sliding by one nail in combination with top-over lashing only				
µ - static ***	SIDEWAYS per side		FORWARD/BACKWARD	
	blank	galvanised	blank	galvanised
0.00	0.16	0.23	0.37	0.53
0.05	0.17	0.25	0.39	0.56
0.10	0.18	0.27	0.41	0.59
0.15	0.20	0.29	0.43	0.63
0.20	0.22	0.32	0.46	0.67
0.25	0.24	0.36	0.49	0.71
0.30	0.28	0.40	0.52	0.76
0.35	0.31	0.46	0.56	0.82
0.40	0.37	0.53	0.61	0.89
0.45	0.44	0.64	0.67	0.97
0.50	0.55	0.80	0.73	1.1
0.55	0.73	1.1	0.81	1.2
0.60	1.1	1.6	0.92	1.3
0.65	2.2	3.2	1.0	1.5
0.70	no slide	no slide	1.2	1.8

*** *Between cargo and platform bed.*

CARGO STOWED IN MORE THAN ONE LAYER

Method 1 (simple)



1. Determine the number of lashings to prevent sliding using the weight 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 are to be used.

Method 2 (advanced)

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

Packing Code
Quick Lashing Guide C

Cargo securing on CTUs for transports in Sea Area C

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/B	V
Sea Area C	0.8	1.0	0.4	0.2

V = Vertical acceleration in combination with longitudinal or transverse acceleration

Goods; not rigid in form
If the goods isn'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.

Content

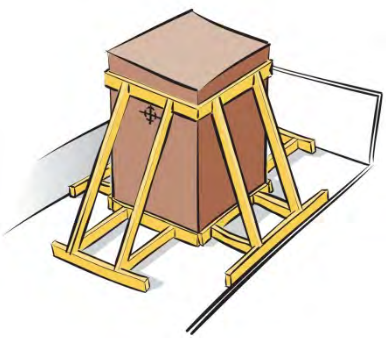
CARGO SECURING METHODS

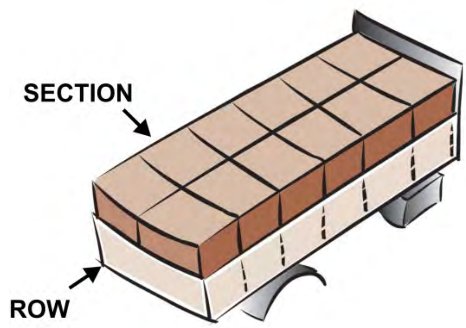
Goods shall be prevented from sliding and tipping in forward, backward and sideways directions by any of the following methods, combined in a proper way.

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.

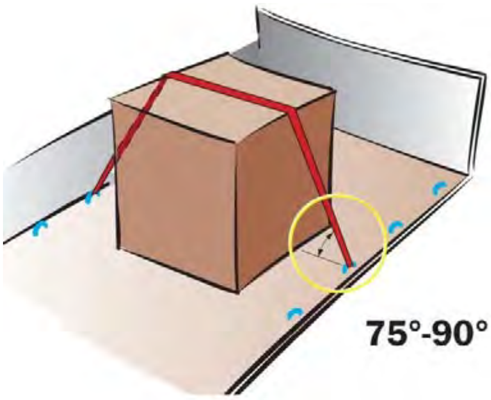
Blocking is primarily a method to prevent the cargo from sliding, but if the blocking reaches high enough, it also prevents tipping. Blocking is the primary method for cargo securing and should be used as far as possible.





The sums 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

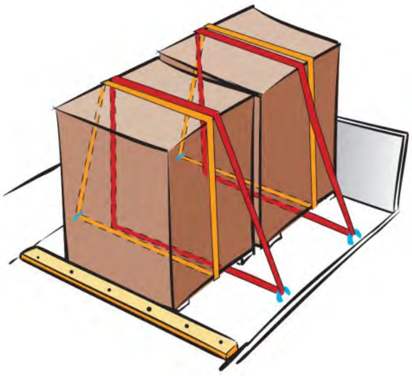


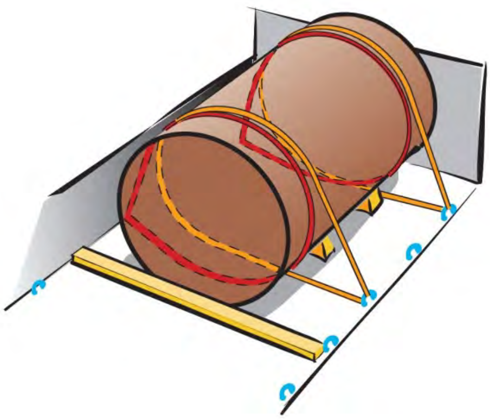
When using the tables for top-over lashing the angle between the lashing and the platform bed is of great importance. The tables are valid for an angle between 75°- 90°. If the angle is between 30°- 75° twice the number of lashings are needed. If the angle is less than 30°, another cargo securing method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

A top-over lashing preventing tipping forward **and** backward has to be placed centred on the cargo.

Half loop lashing

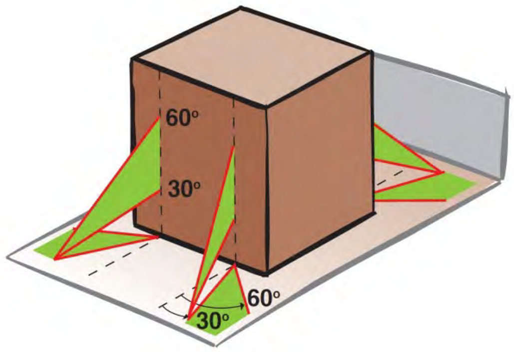
A pair of half loop lashings prevents cargo from sliding and tipping sideways. Minimum one pair of half loop lashings per section should be used.





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

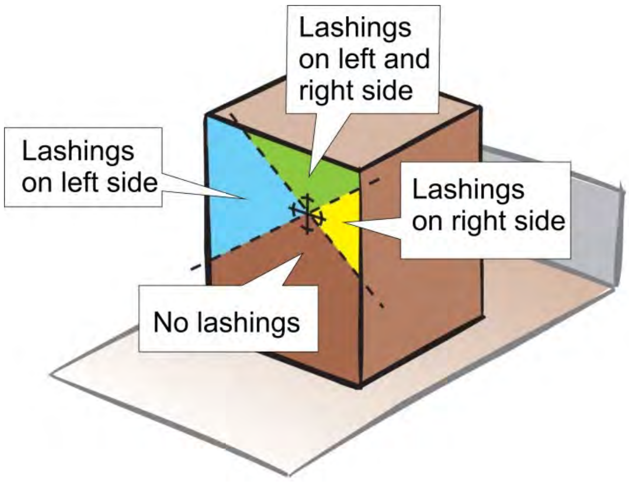


The tables are valid for an angle of 30 - 60° between the lashing and the platform bed.

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 weight in the tables may be doubled.

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°.



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

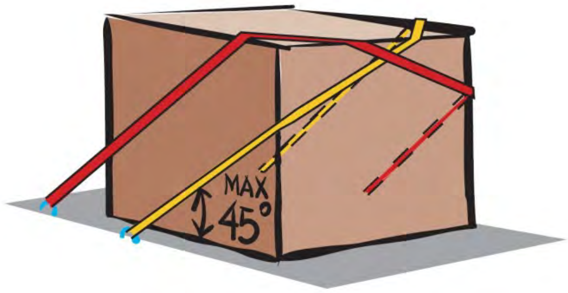
A spring lashing is used to prevent cargo from sliding and tipping forward or backward.

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 weight given in the lashing tables.

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

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

BASIC CARGO SECURING REQUIREMENTS

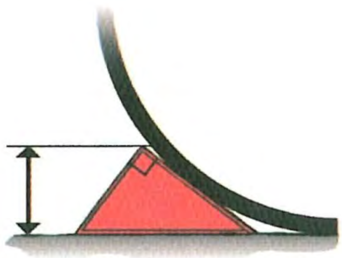
Non-rigid goods

If the goods is 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 out of the chocks, the chock height need not to be greater than 20 cm.



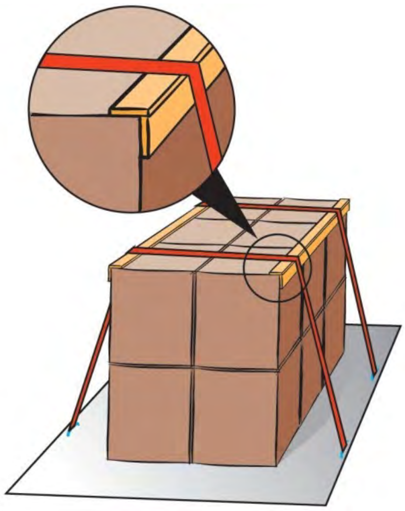
Bottom blocking

Bottom blocking preventing cargo from sliding must have a height of at least 5 cm, if the cargo isn't prevented to move above the block 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 and for other sections, at least one lashing per every second section shall be used.

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



LASHING EYES

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

SLIDING - FRICTION

Different material contacts have different coefficients of friction. The table below shows recommended values for the coefficient of friction. 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.

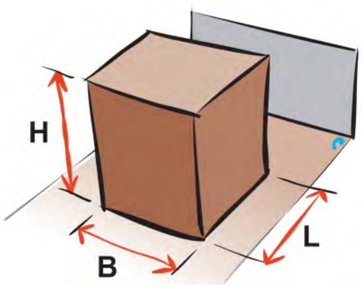
Material combination in contact area	Dry	Wet
SAWN TIMBER/WOODEN PALLET		
Sawn timber/wooden pallet against plywood/plyfa/wood	0.5	0.45
Sawn timber/wooden pallet against grooved aluminium	0.4	0.4
Sawn timber/wooden pallet against stainless steel sheet	0.4	0.3
Sawn timber/wooden pallet against shrink film	0.3	-
PLANE WOOD		
Plane wood – fabric base laminate/plywood	0.3	0.3
Plane wood – grooved aluminium	0.25	0.25
Plane wood – smooth steel sheet	0.3	0.3
PLASTIC PALLETS		
Plastic pallet against plywood/plyfa/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	-
Unpainted metal with smooth surface against unpainted smooth metal	0.2	-
Painted metal with smooth surface against painted smooth metal	0.2	-

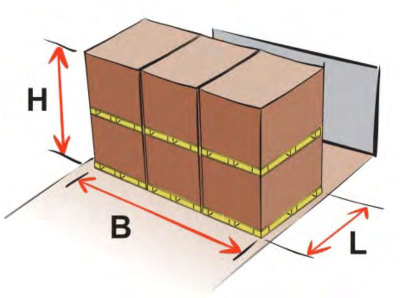
Material combination in contact area	Dry	Wet
STEEL CRATES		
Steel crate against plywood/plyfa/wood	0.45	0.45
Steel crate against grooved aluminium	0.3	0.3
Steel crate against smooth steel	0.2	0.2
CONCRETE		
Concrete with rough surface against sawn wood battens	0.7	0.7
Concrete with smooth against sawn wood battens	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 it's coefficient of friction can't be verified in another way, the maximum μ-static to be used 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[1]. For oily and greasy surfaces or when slip sheets have been used a static friction coefficient μ = 0.1 shall be used.

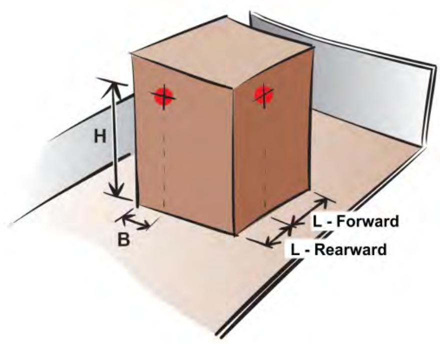
[1] For sea transport see CSS Code annex 13 subsection 7.2.

TIPPING - DIMENSIONS





The definition of **H**, **B** and **L** as shown above 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.

REQUIRED NUMBER OF LASHINGS

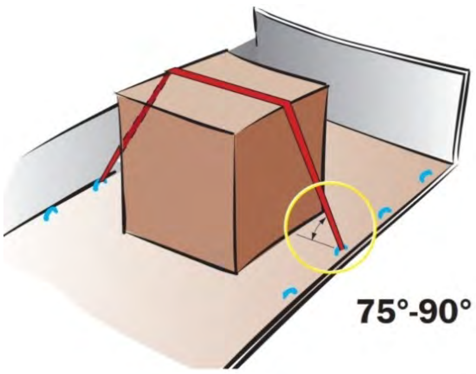
The required number of lashings to prevent sliding and tipping is calculated by the help of the tables on the following pages according to the following procedure:

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.

The tables are valid for **webbing** with a pre tension of minimum 400 daN (400 kg).
The values in the tables are proportional to the lashings' pre tension.
The weights in the tables are valid for one top-over lashing.

TOP-OVER LASHING



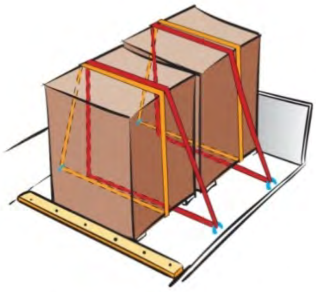
Cargo weight in ton prevented from sliding *per* top-over lashing		
μ - static	SIDEWAYS	FORWARD/BACKWARD
0.00	0.00	0.00
0.05	0.05	0.10
0.10	0.11	0.21
0.15	0.18	0.32
0.20	0.26	0.44
0.25	0.36	0.56
0.30	0.47	0.70
0.35	0.61	0.84
0.40	0.79	0.98
0.45	1.0	1.1
0.50	1.3	1.3
0.55	1.7	1.5
0.60	2.4	1.7
0.65	3.4	1.9
0.70	5.5	2.1

Cargo weight 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
0.6	no tip	no tip	2.7	1.5	1.1	0.6	20
0.8	no tip	3.5	1.3	0.88	0.71	0.8	6.6
1.0	no tip	1.6	0.84	0.62	0.52	1.0	3.9
1.2	no tip	1.1	0.63	0.48	0.41	1.2	2.8
1.4	6.6	0.79	0.50	0.40	0.34	1.4	2.2
1.6	2.8	0.63	0.42	0.33	0.29	1.6	1.8
1.8	1.8	0.52	0.36	0.29	0.25	1.8	1.5
2.0	1.3	0.45	0.31	0.25	0.22	2.0	1.3
2.2	1.0	0.39	0.28	0.23	0.20	2.2	1.2
2.4	0.86	0.35	0.25	0.21	0.18	2.4	1.0
2.6	0.73	0.31	0.23	0.19	0.17	2.6	0.94
2.8	0.64	0.28	0.21	0.17	0.15	2.8	0.86
3.0	0.56	0.26	0.19	0.16	0.14	3.0	0.79

The tables are valid for **webbing** with a MSL of 20 kN (2 ton) and a pre tension of minimum 400 daN (400 kg).

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

HALF LOOP LASHING SLIDING



Cargo weight in ton prevented from sliding *per* pair of half loop lashing	
μ-static	SIDEWAYS
0.00	2.5
0.05	2.8
0.10	3.0
0.15	3.2
0.20	3.5
0.25	3.8
0.30	4.2
0.35	4.6
0.40	5.0
0.45	5.5
0.50	6.1
0.55	6.8
0.60	7.6
0.65	8.6
0.70	9.8

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

Cargo weight 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	4.8	3.0	2.4
0.8	no tip	5.2	2.3	1.8	1.5
1.0	no tip	2.4	1.5	1.2	1.1
1.2	no tip	1.6	1.1	0.97	0.89
1.4	6.8	1.2	0.89	0.79	0.74
1.6	2.9	0.93	0.74	0.67	0.63
1.8	1.9	0.78	0.63	0.58	0.55
2.0	1.4	0.66	0.55	0.51	0.48
2.2	1.1	0.58	0.49	0.45	0.43
2.4	0.89	0.51	0.44	0.41	0.39
2.6	0.76	0.46	0.40	0.37	0.36
2.8	0.66	0.42	0.37	0.34	0.33
3.0	0.58	0.38	0.34	0.32	0.31

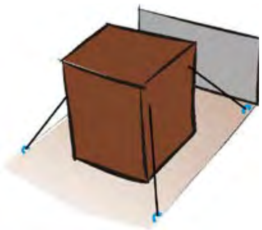
The values in the table are proportional to the lashings' pre tension.

The tables are valid for **webbing** with a MSL of 20 kN (2 ton) and a pre tension of minimum 400 daN (400 kg).

All weights are valid for one straight lashing.

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

STRAIGHT LASHING SLIDING



Cargo weight in ton prevented from sliding *per* straight lashing		
μ - static	SIDEWAYS per side	FORWARD/ BACKWARD
0.00	0.64	1.3
0.05	0.75	1.5
0.10	0.87	1.6
0.15	1.0	1.8
0.20	1.1	2.0
0.25	1.3	2.2
0.30	1.5	2.5
0.35	1.7	2.7
0.40	1.9	2.9
0.45	2.2	3.2
0.50	2.5	3.4
0.55	2.9	3.7
0.60	3.3	4.0
0.65	3.8	4.2
0.70	4.4	4.6

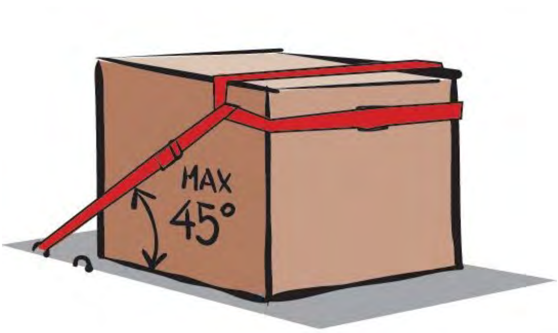
Cargo weight in ton prevented from tipping *per* straight lashing			
H/B	SIDEWAYS per side	H/L	FORWARD/ BACKWARD
0.6	no tip	0.6	20
0.8	no tip	0.8	7.6
1.0	no tip	1.0	5.1
1.2	no tip	1.2	4.0
1.4	10	1.4	3.4
1.6	4.7	1.6	3.0
1.8	3.2	1.8	2.7
2.0	2.5	2.0	2.5
2.2	2.1	2.2	2.4
2.4	1.9	2.4	2.3
2.6	1.7	2.6	2.2
2.8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

The tables are valid for **webbing** with a MSL of 20 kN (2 ton) and a pre tension of minimum 4000 N (400 kg).

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

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

SPRING LASHING

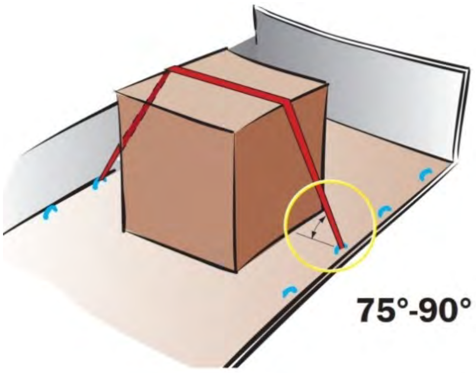


Cargo weight in ton prevented from sliding *per* spring lashing	
μ - static	FORWARD/BACKWARD
0.00	7.2
0.05	7.6
0.10	8.0
0.15	8.4
0.20	8.8
0.25	9.3
0.30	9.7
0.35	10
0.40	11
0.45	11
0.50	12
0.55	12
0.60	13
0.65	14
0.70	14

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

The tables are valid for **chain (∅ 9 mm, class 8)** with a pre tension of minimum 10 kN (1000 kg).
The values in the tables are proportional to the lashings' pre tension.
The weights in the tables are valid for one top-over lashing.

TOP-OVER LASHING



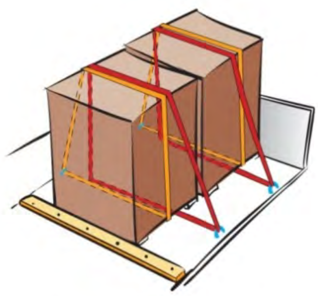
Cargo weight in ton prevented from sliding *per* top-over lashing		
μ - static	SIDEWAYS	FORWARD/BACKWARD
0.00	0.00	0.00
0.05	0.13	0.25
0.10	0.28	0.52
0.15	0.45	0.80
0.20	0.66	1.1
0.25	0.90	1.4
0.30	1.2	1.7
0.35	1.5	2.1
0.40	2.0	2.5
0.45	2.5	2.9
0.50	3.3	3.3
0.55	4.3	3.7
0.60	5.9	4.2
0.65	8.5	4.7
0.70	14	5.3

Cargo weight 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
0.6	no tip	no tip	6.7	3.7	2.8	0.6	49
0.8	no tip	8.8	3.2	2.2	1.8	0.8	16
1.0	no tip	4.1	2.1	1.6	1.3	1.0	9.8
1.2	no tip	2.7	1.6	1.2	1.0	1.2	7.0
1.4	16	2.0	1.2	0.99	0.85	1.4	5.5
1.6	7.0	1.6	1.0	0.83	0.73	1.6	4.5
1.8	4.5	1.3	0.89	0.72	0.63	1.8	3.8
2.0	3.3	1.1	0.78	0.64	0.56	2.0	3.3
2.2	2.6	0.98	0.69	0.57	0.50	2.2	2.9
2.4	2.1	0.87	0.62	0.51	0.46	2.4	2.6
2.6	1.8	0.78	0.56	0.47	0.42	2.6	2.3
2.8	1.6	0.71	0.52	0.43	0.38	2.8	2.1
3.0	1.4	0.65	0.48	0.40	0.36	3.0	2.0

The tables are valid for **chain (∅ 9 mm, class 8)** with a MSL of 50 kN (5.0 ton) and a pre tension of minimum 10 kN (1000 kg).

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

HALF LOOP LASHING SLIDING



Cargo weight in ton prevented from sliding *per* pair of half loop lashing	
μ-static	SIDEWAYS
0.00	6.4
0.05	6.9
0.10	7.5
0.15	8.1
0.20	8.8
0.25	9.6
0.30	10
0.35	11
0.40	13
0.45	14
0.50	15
0.55	17
0.60	19
0.65	21
0.70	24

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

Cargo weight 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	7.4	6.0
0.8	no tip	13	5.7	4.4	3.8
1.0	no tip	6.1	3.7	3.1	2.8
1.2	no tip	4.0	2.8	2.4	2.2
1.4	17	2.9	2.2	2.0	1.8
1.6	7.3	2.3	1.8	1.7	1.6
1.8	4.6	1.9	1.6	1.4	1.4
2.0	3.4	1.7	1.4	1.3	1.2
2.2	2.7	1.4	1.2	1.1	1.1
2.4	2.2	1.3	1.1	1.0	0.98
2.6	1.9	1.2	1.0	0.94	0.90
2.8	1.6	1.0	0.92	0.86	0.83
3.0	1.5	0.96	0.85	0.80	0.77

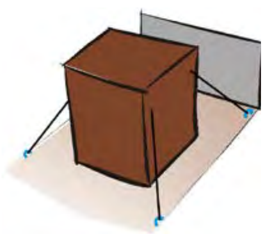
The values in the table are proportional to the lashings' pre tension.

The tables are valid for **chain (∅ 9 mm, class 8)** with a MSL of 50 kN (5.0 ton) and a pre tension of minimum 10 kN (1000 kg).

All weights are valid for one straight lashing.

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

STRAIGHT LASHING SLIDING



Cargo weight in ton prevented from sliding *per* straight lashing		
μ - static	SIDEWAYS per side	FORWARD/ BACKWARD
0.00	1.6	3.2
0.05	1.9	3.6
0.10	2.2	4.1
0.15	2.5	4.6
0.20	2.9	5.1
0.25	3.3	5.6
0.30	3.7	6.1
0.35	4.2	6.7
0.40	4.8	7.3
0.45	5.5	7.9
0.50	6.3	8.5
0.55	7.2	9.2
0.60	8.2	9.9
0.65	9.5	11
0.70	11	11

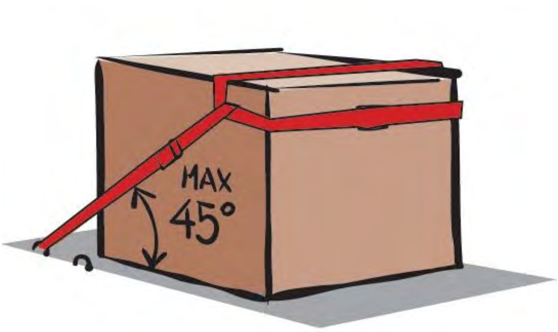
Cargo weight in ton prevented from tipping *per* straight lashing			
H/B	SIDEWAYS per side	H/L	FORWARD/ BACKWARD
0.6	no tip	0.6	51
0.8	no tip	0.8	19
1.0	no tip	1.0	13
1.2	no tip	1.2	10
1.4	25	1.4	8.5
1.6	12	1.6	7.5
1.8	8.1	1.8	6.9
2.0	6.4	2.0	6.4
2.2	5.4	2.2	6.0
2.4	4.7	2.4	5.7
2.6	4.2	2.6	5.5
2.8	3.9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

The tables are valid for **chain (∅ 9 mm, class 8)** with a MSL of 50 kN (5.0 ton) and a pre tension of minimum 10 kN (1000 kg).

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

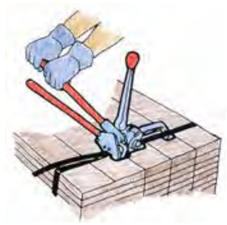
The values in the tables are proportional to the lashings' maximum securing load (MSL).

SPRING LASHING



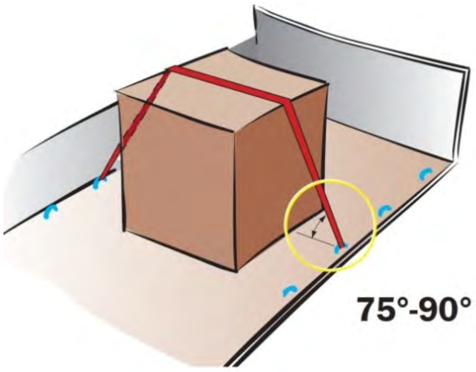
Cargo weight in ton prevented from sliding *per* spring lashing	
μ - static	FORWARD/BACKWARD
0.00	18
0.05	19
0.10	20
0.15	21
0.20	22
0.25	23
0.30	24
0.35	26
0.40	27
0.45	28
0.50	29
0.55	31
0.60	32
0.65	34
0.70	36

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



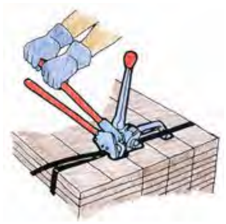
The tables are valid for **steel strapping (32 × 0,8 mm)** with a pre tension of minimum 240 daN (240 kg).
The values in the tables are proportional to the lashings' pre tension.
The weights in the tables are valid for one top-over lashing.

TOP-OVER LASHING



Cargo weight in ton prevented from sliding *per* top-over lashing		
μ - static	SIDEWAYS	FORWARD/BACKWARD
0.00	0.00	0.00
0.05	0.03	0.06
0.10	0.07	0.12
0.15	0.11	0.19
0.20	0.16	0.26
0.25	0.21	0.34
0.30	0.28	0.42
0.35	0.37	0.50
0.40	0.47	0.59
0.45	0.61	0.69
0.50	0.79	0.79
0.55	1.0	0.90
0.60	1.4	1.0
0.65	2.0	1.1
0.70	3.3	1.3

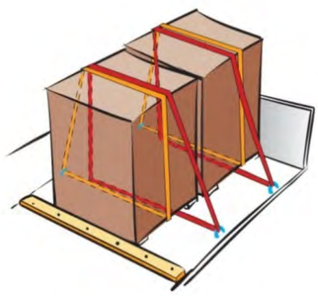
Cargo weight in ton prevented from tipping *per* top-over lashing							
SIDEWAYS						FORWARD/BACKWARD	
H/B	1 row	2 rows	3 rows	4 rows	5 rows	H/L	per section
0.6	no tip	no tip	1.6	0.90	0.67	0.6	12
0.8	no tip	2.1	0.77	0.53	0.43	0.8	3.9
1.0	no tip	0.98	0.51	0.37	0.31	1.0	2.4
1.2	no tip	0.64	0.38	0.29	0.25	1.2	1.7
1.4	3.9	0.48	0.30	0.24	0.20	1.4	1.3
1.6	1.7	0.38	0.25	0.20	0.17	1.6	1.1
1.8	1.1	0.31	0.21	0.17	0.15	1.8	0.91
2.0	0.79	0.27	0.19	0.15	0.13	2.0	0.79
2.2	0.62	0.23	0.17	0.14	0.12	2.2	0.70
2.4	0.51	0.21	0.15	0.12	0.11	2.4	0.62
2.6	0.44	0.19	0.14	0.11	0.10	2.6	0.56
2.8	0.38	0.17	0.12	0.10	0.09	2.8	0.51
3.0	0.34	0.16	0.11	0.10	0.09	3.0	0.47



The tables are valid for **steel strapping** (**32 × 0,8 mm)** with a MSL of 17 kN (1.7 ton) and a pre tension of minimum 240 daN (240 kg).

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

HALF LOOP LASHING SLIDING

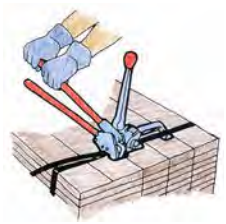


Cargo weight in ton prevented from sliding *per* pair of half loop lashing	
μ-static	SIDEWAYS
0.00	2.2
0.05	2.3
0.10	2.5
0.15	2.8
0.20	3.0
0.25	3.3
0.30	3.6
0.35	3.9
0.40	4.3
0.45	4.7
0.50	5.2
0.55	5.8
0.60	6.5
0.65	7.3
0.70	8.3

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

Cargo weight 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	2.9	1.8	1.4
0.8	no tip	3.1	1.4	1.1	0.92
1.0	no tip	1.5	0.90	0.75	0.68
1.2	no tip	0.95	0.67	0.58	0.53
1.4	4.1	0.71	0.53	0.47	0.44
1.6	1.7	0.56	0.44	0.40	0.38
1.8	1.1	0.47	0.38	0.35	0.33
2.0	0.82	0.40	0.33	0.30	0.29
2.2	0.64	0.35	0.29	0.27	0.26
2.4	0.53	0.31	0.26	0.25	0.24
2.6	0.45	0.28	0.24	0.22	0.22
2.8	0.39	0.25	0.22	0.21	0.20
3.0	0.35	0.23	0.20	0.19	0.18

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

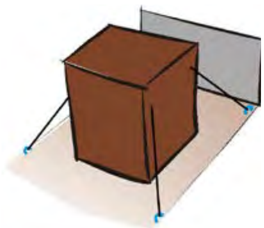


The tables are valid for **steel strapping** (**32 × 0,8 mm)** with a MSL of 17 kN (1.7 ton) and a pre tension of minimum 240 daN (240 kg).

All weights are valid for one straight lashing.

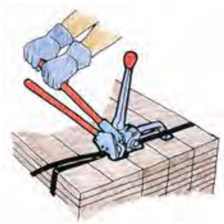
The values in the tables are proportional to the lashings' maximum securing load (MSL).

STRAIGHT LASHING
SLIDING



Cargo weight in ton prevented from sliding *per* straight lashing		
μ - static	SIDEWAYS per side	FORWARD/ BACKWARD
0.00	0.54	1.1
0.05	0.63	1.2
0.10	0.74	1.4
0.15	0.85	1.6
0.20	0.97	1.7
0.25	1.1	1.9
0.30	1.3	2.1
0.35	1.4	2.3
0.40	1.6	2.5
0.45	1.9	2.7
0.50	2.1	2.9
0.55	2.4	3.1
0.60	2.8	3.4
0.65	3.2	3.6
0.70	3.8	3.9

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



The tables are valid for **steel strapping** (**32 × 0,8 mm)** with a MSL of 17 kN (1.7 ton) and a pre tension of minimum 240 daN (240 kg).

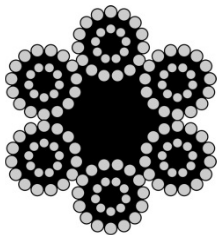
The weights in the tables are valid for one spring lashing.

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

SPRING LASHING

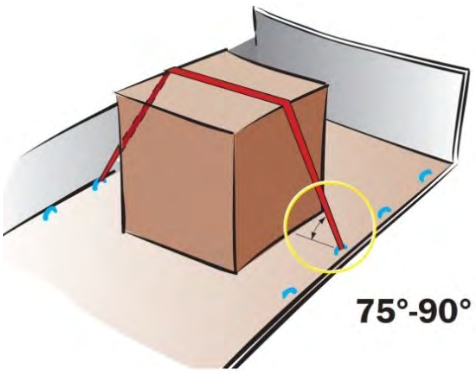
Cargo weight in ton prevented from sliding *per* spring lashing	
μ - static	FORWARD/BACKWARD
0.00	6.1
0.05	6.5
0.10	6.8
0.15	7.1
0.20	7.5
0.25	7.9
0.30	8.3
0.35	8.7
0.40	9.1
0.45	9.6
0.50	10
0.55	11
0.60	11
0.65	12
0.70	12

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



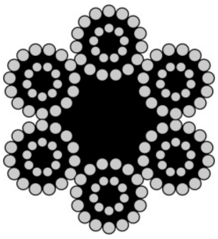
The tables are valid for **steel wire rope (∅ 16 mm/144 wires)** with a pre tension of minimum 10 kN (1000 kg). The values in the tables are proportional to the lashings' pre tension.
The weights in the tables are valid for one top-over lashing.

TOP-OVER LASHING



Cargo weight in ton prevented from sliding *per* top-over lashing		
μ - static	SIDEWAYS	FORWARD/BACKWARD
0.00	0.00	0.00
0.05	0.13	0.25
0.10	0.28	0.52
0.15	0.45	0.80
0.20	0.66	1.1
0.25	0.90	1.4
0.30	1.2	1.7
0.35	1.5	2.1
0.40	2.0	2.5
0.45	2.5	2.9
0.50	3.3	3.3
0.55	4.3	3.7
0.60	5.9	4.2
0.65	8.5	4.7
0.70	14	5.3

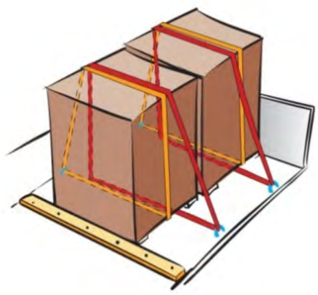
Cargo weight in ton prevented from tipping *per* top-over lashing							
SIDEWAYS						FORWARD/BACKWARD	
H/B	1 row	2 rows	3 rows	4 rows	5 rows	H/L	per section
0.6	no tip	no tip	6.7	3.7	2.8	0.6	49
0.8	no tip	8.8	3.2	2.2	1.8	0.8	16
1.0	no tip	4.1	2.1	1.6	1.3	1.0	9.8
1.2	no tip	2.7	1.6	1.2	1.0	1.2	7.0
1.4	16	2.0	1.2	0.99	0.85	1.4	5.5
1.6	7.0	1.6	1.0	0.83	0.73	1.6	4.5
1.8	4.5	1.3	0.89	0.72	0.63	1.8	3.8
2.0	3.3	1.1	0.78	0.64	0.56	2.0	3.3
2.2	2.6	0.98	0.69	0.57	0.50	2.2	2.9
2.4	2.1	0.87	0.62	0.51	0.46	2.4	2.6
2.6	1.8	0.78	0.56	0.47	0.42	2.6	2.3
2.8	1.6	0.71	0.52	0.43	0.38	2.8	2.1
3.0	1.4	0.65	0.48	0.40	0.36	3.0	2.0



The tables are valid for **steel wire rope (∅ 16 mm/144 wires)** with a MSL of 91 kN (9.1 ton) and a pre tension of minimum 10 kN (1000 kg).

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

HALF LOOP LASHING SLIDING

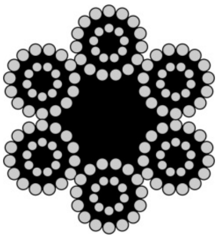


Cargo weight in ton prevented from sliding *per* pair of half loop lashing	
μ-static	SIDEWAYS
0.00	12
0.05	13
0.10	14
0.15	15
0.20	16
0.25	17
0.30	19
0.35	21
0.40	23
0.45	25
0.50	28
0.55	31
0.60	35
0.65	39
0.70	45

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

Cargo weight 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	7.4	6.0
0.8	no tip	13	5.7	4.4	3.8
1.0	no tip	6.1	3.7	3.1	2.8
1.2	no tip	4.0	2.8	2.4	2.2
1.4	17	2.9	2.2	2.0	1.8
1.6	7.3	2.3	1.8	1.7	1.6
1.8	4.6	1.9	1.6	1.4	1.4
2.0	3.4	1.7	1.4	1.3	1.2
2.2	2.7	1.4	1.2	1.1	1.1
2.4	2.2	1.3	1.1	1.0	0.98
2.6	1.9	1.2	1.0	0.94	0.90
2.8	1.6	1.0	0.92	0.86	0.83
3.0	1.5	0.96	0.85	0.80	0.77

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

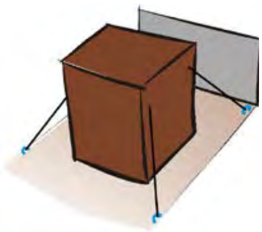


The tables are valid for **steel wire rope (∅ 16 mm/144 wires)** with a MSL of 91 kN (9.1 ton) and a pre tension of minimum 10 kN (1000 kg).

All weights are valid for one straight lashing.

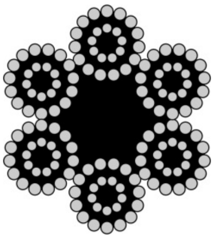
The values in the tables are proportional to the lashings' maximum securing load (MSL).

STRAIGHT LASHING SLIDING



Cargo weight in ton prevented from sliding *per* straight lashing		
μ - static	SIDEWAYS per side	FORWARD/ BACKWARD
0.00	2.9	5.8
0.05	3.4	6.6
0.10	3.9	7.5
0.15	4.6	8.3
0.20	5.2	9.3
0.25	6.0	10
0.30	6.8	11
0.35	7.7	12
0.40	8.8	13
0.45	10.0	14
0.50	11	16
0.55	13	17
0.60	15	18
0.65	17	19
0.70	20	21

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



The tables are valid for **steel wire rope (∅ 16 mm/144 wires)** with a MSL of 91 kN (9.1 ton) and a pre tension of minimum 10 kN (1000 kg).

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

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

SPRING LASHING

Cargo weight in ton prevented from sliding *per* spring lashing	
μ - static	FORWARD/BACKWARD
0.00	33
0.05	35
0.10	36
0.15	38
0.20	40
0.25	42
0.30	44
0.35	47
0.40	49
0.45	51
0.50	54
0.55	56
0.60	59
0.65	62
0.70	65

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

TAG WASHERS AND NAILS

TAG WASHER Approx. cargo weight in ton prevented from sliding by one tag washer for wood on wood in combination with top-over lashing only							
μ - static **	SIDEWAYS						
	∅ 48	∅ 62	∅ 75	∅ 95	30×57	48×65	130×130
0.3	0.25	0.35	0.45	0.60	0.25	0.35	0.75
0.4	0.31	0.44	0.56	0.75	0.31	0.44	0.94
	FORWARD						
0.3	0.37	0.51	0.66	0.88	0.37	0.51	1.1
0.4	0.39	0.55	0.70	0.94	0.39	0.55	1.2
	BACKWARD						
0.3	0.37	0.51	0.66	0.88	0.37	0.51	1.1
0.4	0.39	0.55	0.70	0.94	0.39	0.55	1.2

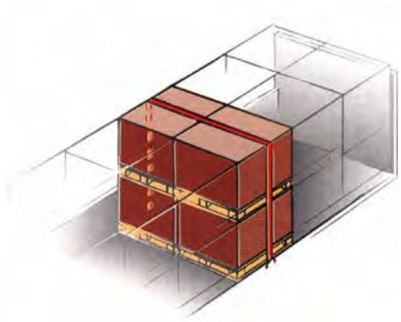
** *Between tag washer and platform bed/cargo. For tag washers in shrink film the rows for friction 0.3 to be used.*

4" – NAIL Approximate cargo weight in ton prevented from sliding by one nail in combination with top-over lashing only				
μ - static ***	SIDEWAYS per side		FORWARD/BACKWARD	
	blank	galvanised	blank	galvanised
0.00	0.14	0.20	0.28	0.40
0.05	0.15	0.21	0.28	0.41
0.10	0.16	0.23	0.29	0.42
0.15	0.17	0.25	0.30	0.43
0.20	0.18	0.27	0.31	0.44
0.25	0.20	0.29	0.31	0.46
0.30	0.22	0.32	0.32	0.47
0.35	0.24	0.36	0.33	0.48
0.40	0.28	0.40	0.34	0.50
0.45	0.31	0.46	0.35	0.52
0.50	0.37	0.53	0.37	0.53
0.55	0.44	0.64	0.38	0.55
0.60	0.55	0.80	0.39	0.57
0.65	0.73	1.1	0.41	0.59
0.70	1.1	1.6	0.42	0.62

*** *Between cargo and platform bed.*

CARGO STOWED IN MORE THAN ONE LAYER

Method 1 (simple)



1. Determine the number of lashings to prevent sliding using the weight 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 are to be used.

Method 2 (advanced)

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

Annex IX. Safe transport of containers at sea

Note: This annex is an extract of the International Chamber of Shipping (ICS) and World Shipping Council (WSC) publication Safe Transport of Containers at sea. Although many items are outside of the scope of the Code of practice, it provides those involved with the packing and handling of container CTUs with a better understanding of the requirements for safe transport of containers on maritime transport.

IX.1 Booking and assignment

IX.1.1 Overview

IX.1.1.1 This chapter highlights best practices with regard to the booking and assignment of containerised cargoes, particularly those concerning such critical matters as the accuracy of mass and measures, and declarations of Dangerous Goods, that can have serious implications for the safety of ships as well as the safety of personnel throughout the supply chain.

IX.1.1.2 The key concerns with regard to any cargo booking are as follows:

IX.1.1.3 Ensuring that the shipment and shipper are bona fide;

IX.1.1.4 The accuracy of mass and descriptions;

IX.1.1.5 The hazardous nature of the cargo;

IX.1.1.6 The correct handling instruction.

IX.1.2 Practical constraints

It should be observed that practical constraints may affect the accuracy and effectiveness of any cargo booking, and that this should be accounted for in operations relating to booking and assignment of container cargoes.

IX.1.2.1 Ensuring accuracy of the shipper's declaration

IX.1.2.1.1 Most major shipping lines have in place a standardised electronic booking system that precludes transaction discrepancies and errors between shippers, hauliers and carriers that might be caused, for example, by illegible handwriting or unintended repeat transmission of Shipping Instructions (SI).

IX.1.2.1.2 E-booking systems place the principal responsibility for ensuring bill of lading (B/L) accuracy on shippers from whom the cargo originates. In the interests of safety, security and the efficient movement of cargo, the use of such e-booking systems is strongly recommended. However, support of e-booking varies from region to region and country to country.

IX.1.2.1.3 It should be noted that government fines and penalties can be imposed on shippers if miss-declared, mismarked, improperly stowed or otherwise deficient loads are tendered for shipment.

IX.1.2.2 Undeclared dangerous goods

IX.1.2.2.1 Since virtually any shipper can approach a carrier's customer service staff to place a Dangerous Goods (DG) booking at any time, it is necessary that all relevant staff have received basic DG training so as to be able to process DG bookings in accordance with IMDG Code requirements. Whenever in doubt, staff should always seek professional assistance from the DG Controller in the shipping company's headquarters or regional offices.

IX.1.2.2.2 A minority of shippers, unintentionally or otherwise, may occasionally fail to declare the Dangerous Goods status of containerised cargo. It is therefore very important for carriers to establish the credibility of the shipper, and it is recommended that shipping lines carry out a step-by-step verification as described in 4.3.2.1 below.

IX.1.2.2.3 Shippers' personnel processing Dangerous Goods bookings should also receive DG training.

IX.1.2.3 Last Minute Changes to Outbound Lifting Figures

IX.1.2.3.1 Cargo cut-off requirements (the latest time at which cargo may be delivered) vary from port to port. In some cases where ships have a lengthy port stay, with imports far outstripping exports, there may be zero cut-off. By contrast, in ports that work around the clock, the cut-off may be as late as 4 hours before the ship's arrival. In ports that do not receive containers at night due to low volume, however, the cut-off may occur in the early evening on the day before the ship's arrival.

IX.1.2.3.2 Last minute changes (usually a shortfall) in outbound lifting figures are not uncommon for certain trades, mainly due to Customs clearance problems encountered by shippers arising from the nature of the trade. Finalising lifting figures in time for planning can thus be challenging unless the cargo cut-off time is brought forward.

IX.1.2.3.3 It should be noted that cargo security regulations introduced by many nations now require detailed cargo information to be transmitted to the Customs authorities, in the country of destination, at least 24 hours before containers are loaded on board the ship at the port of export.

IX.1.3 Operational recommendations

This section provides checklists to encourage best practice on the part of those involved in the booking and assignment of container cargoes. It is emphasised that adherence to this guidance is very important in the interests of safety, as well as commercial efficiency and the smooth delivery of cargo.

IX.1.3.1 Shippers

IX.1.3.1.1 In order to fulfil their responsibilities towards the safety of containerships, crews and other personnel, shippers must ensure that they:

- Write their Shipping Instructions (SI) clearly and legibly, so as to make them easy to read by shipping company personnel;
- Clearly indicate container sizes and types;
- Are always accurate in describing cargo dimensions and the extent of over-size, with respect to Out of Gauge (00G) cargo;
- Level stow packages to prevent free movement and the toppling of goods and packages;
- Secure the cargo by informed and competent blocking, bracing, chocking and lashing, to prevent free movement and the toppling of goods and packages;
- Evenly spread the cargo mass over the entire container floor, to avoid stressing the floorboard through mass concentration, ensuring that there are no concentrations of mass in a single place;
- Use suitable dunnage for dense cargoes that cannot be uniformly distributed over the entire length of the container, to ensure the load on the container's floor does not exceed 3.7 tonnes per linear metre;
- Ensure that the load is packed so that the centre of gravity is within the 5% eccentricity limit, or advise road hauliers and shipping lines of the discrepancy.;
- Weigh the cargo, ensuring the gross mass of the container is in accordance with the gross mass given on the shipping documents and provide this information to the carrier;
- Submit the Shipping Instructions (SI) to the carrier no later than 24 hours before the ship's ETA at the port of loading so as to facilitate the timely submission of the cargo manifest to Customs at the port of delivery. This is especially important on short haul voyages. A much earlier deadline may be necessary where Customs at the port of delivery require data to be submitted 24 hours before cargo is loaded on board the ship;
- Provide digital photographs of the stowage and securing of the cargo;
- Make every effort to abide by the outbound delivery window set by the ship and terminal operator, even though the delivery schedule may have to be adjusted to avoid peak hours in the terminal.

IX.1.3.2 Booking and verification processes

IX.1.3.2.1 Verifying the shipper's credentials

In order to ensure the reliability of the shipper's credentials and the general cargo information provided, carriers should seek to ensure that:

- The shipper is not a denied party;
- The place of destination is not in a denied country;
- If the shipper is a "first timer" endeavours are made to verify its credentials including, but not limited to, its type of business and physical premises;
- The cargo is not a controlled/banned commodity;
- Local regulations do not require the carrier to ensure clearance before loading on board and, where they do, that Customs clearance is verified and outbound lifting figures finalised prior to cargo cut-off.

IX.1.3.2.2 DG Cargoes

With respect to containers carrying Dangerous Goods (DG), it is important that carriers:

- Have trained personnel to manage the approval process and ship's planning, including designated Dangerous Goods Co-ordinators at headquarters and regional offices;
- Receive full commodity information from the shipper including, but not limited to, information concerning the hazard description, packaging type, cargo mass and volume;
- Receive the shipper's multimodal Dangerous Goods form with the shipper's declaration and container packing certificate;
- Ask for the relevant Material Safety Data Sheet (MSDS) as necessary in order to verify the details of the DG.

IX.1.3.2.3 Reefer cargoes

With respect to the carriage of reefer cargoes, it is important that carriers:

- Receive temperature and ventilation settings from the shipper;
- Ensure temperatures are standardised, preferably in degrees Celsius (C). If not, then C or F (Fahrenheit) must be clearly specified;
- For Shipper Owned (SO) containers only, receive from the shipper a copy of the reefer manual and all necessary machinery spares.

IX.1.3.2.4 Out of Gauge (OOG) cargoes

It is vital that a ship's officer inspects the lashing of OOG cargo before loading. The cargo should be rejected if:

- It is improperly and/or inadequately secured to the container;
- It overhangs too near the container corners - at least 30 cm from the outer end of the flat is needed for cell guide clearance if under deck stow is required;
- Corrective action cannot be performed on site for a safe loading and onwards carriage.

IX.1.3.2.5 Container release

Carriers should undertake the following when releasing containers to shippers:

- Provide appropriate containers to the shipper in terms of size and type;
- Check the condition of the containers to ensure the cargo worthiness before releasing them to the shipper.

IX.1.3.3 Future considerations

In the future, it is possible that standardised electronic booking and SI may be utilised by all shippers to ensure accurate input of shipping details, such as mandating mass entries up to one decimal digit (e.g. "15.5 tonnes") or standardising units of measurement to cm, kg and litres.

IX.2 Shipping line stowage co-ordination

IX.2.1 Overview

IX.2.1.1.1 This chapter addresses the principles of safe stowage of containerised cargoes. For the purposes of this Guide, the term "stowage co-ordinators" refers to all of a carrier's shoreside planning staff, and "terminal planners" refers to all terminal personnel involved in stowage planning. However, the following is also directly relevant to the crew of containerships involved in cargo operations (the responsibilities of the master and crew are addressed further in IX.4

IX.2.1.1.2 Stowage co-ordination is a vital part of a shipping line's logistics management process. As well as being central to operational efficiency, proper stowage management is essential for ensuring containership safety.

IX.2.1.1.3 Stowage pre-plans for each ship must take into account all booking information, the harbour situation at all ports of call, any restrictions of ship draft, ship stresses and stability, and restrictions on entering ports due to the carriage of Dangerous Goods, special cargo on board and seasonal weather conditions.

IX.2.1.1.4 The process of stowage co-ordination ordinarily involves the interaction of a number of shipping line personnel including ship managers, Dangerous Goods departments, agents and ships' masters, as well as communication with stevedores and other terminal representatives.

IX.2.1.1.5 In order to fulfil these functions in a professional, responsible and effective way, it must be ensured that all personnel involved in stowage co-ordination have appropriate experience and training and that the safety of ships and their crews is recognised as paramount above all other considerations.

IX.2.1.2 Operational space capacity and operational deadweight capacity

The volume of booked containers should comply with Operational Space Capacity (OSC) and Operational Deadweight Capacity (ODC) for the ship and service loop. ODC is determined by considering the ship's condition with respect to safety, restrictions at ports of call and during the passage, and the seasonal areas restricted by the International Convention on Load Lines, etc.

IX.2.1.3 Stowage co-ordination systems (SCS)

IX.2.1.3.1 Stowage co-ordinators use Stowage Co-ordination Systems (SCS) to assist stowage co-ordination and planning of the voyage of ships over multiple ports, to ensure that all booked cargo can actually be carried safely, and in order to minimise variable costs (e.g. re-stows of containers, lashing, and ballast related fuel consumption).

IX.2.1.3.2 The SCS works with both known data (where containers are already on board or have been received at the terminals) and projected data (where cargo is booked, but specific container numbers and cargo details may not be fully known).

IX.2.1.3.3 The SCS requires trim, stability, strength, visibility and hazardous segregation calculations to determine the practicality of the planned loading at each port and the ship's condition upon departure.

IX.2.1.3.4 More information on the SCS is included in IX.5.2.

IX.2.1.4 Rules of stowage planning

The stowage co-ordinator should follow the company's standing rules for stowage planning, and the ship's Document of Compliance for the Carriage of Dangerous Goods, while ensuring compliance with international regulations such as the IMDG Code, and other applicable local rules such as the US Department of Transport CFR 49. If the shipping line is part of a consortium, any agreed Joint Working Procedures (JWP) of the consortium are relevant when the company is in charge of technical judgements about the acceptance of cargo and the stowage planning of containers that may be loaded on board ship.

IX.2.2 Acceptance of containers and exceptional cargoes

The following section contains checklists for stowage co-ordinators to use when making judgements on accepting containers and exceptional cargoes for carriage on board a ship.

IX.2.2.1 General

In general, stowage co-ordinators should take into account:

- The space capacity of the ship;
- The container/cargo volume limitation by mass full or space full operating capacity. To judge the volume limitation, a stowage co-ordinator should establish the estimated homogeneous/average mass of containers with respect to their size and the port of discharge, based on the cargo forecast received;
- Restrictions due to ship structure, which should be confirmed by the ship's general arrangement, certificates of compliance and the ship's Cargo Securing Manual, for acceptance of all lengths, widths and heights of containers including 30', 45' and 53' containers;
- The overall trade pattern, including the frequency of port calls and the minimum crew required to operate the ship safely throughout the voyage, taking into account the need for crew to comply with international work hour regulations;
- The expected bunker consumption, including that required for safe arrival at the next port of call;
- The need for any vessel repairs while the ship is in port;
- The expected requirement for ballast water during the coastal voyage to enable reasonable,
- effective ballast water management as may be required by international and local rules;
- The need for a physical inspection to ensure that the Cargo Securing Manual is compatible with the physical restrictions of the ship and the equipment available on board.

IX.2.2.2 Dangerous Goods (DG)

IX.2.2.2.1 When making judgements on the acceptance of cargoes containing DG for loading, a stowage co-ordinator should follow the IMDG Code, company standing rules, any applicable Joint Working Procedures, and applicable local rules, taking into account the restrictions imposed by them.

IX.2.2.2.2 In particular, stowage co-ordinators should confirm:

- The IMDG Class and division where applicable, and any subsidiary risk, the UN Number, Packing Group, Outer Packing, Proper Shipping Name and total quantity of the DG to be loaded;
- The Stowage Segregation Rule of each DG under the relevant sections of the IMDG Code, including differences of restriction due to the container type;
- The on deck stowage requirements in accordance with the IMDG Code or standing rules;
- DG in a live reefer container;
- Any special provisions for the specific substance declared;
- The ship's Document of Compliance for the Carriage of Dangerous Goods.

IX.2.2.3 Uncontainerised cargo (Break Bulk)

IX.2.2.3.1 When making judgements on the acceptance of break bulk, stowage co-ordinators should take into account:

- The cargo description, including size, mass and packaging;
- Reserved safe loading space on board including top space in hold;
- The strength of the bed under the break bulk, e.g. the numbers of flat rack containers

used as a bed for break bulk, the strength of the tank top in the hold, the strength of hatch covers and mass distribution using dunnage;

- Whether the bed of flat racks is flat - different container heights below the head of flat racks can cause stowage beds to be uneven;
- If used, the limitations of the ship's cargo handling gear;
- The sling point, capacity of the gantry crane, and the arrangement of the floating crane at the loading/discharging port;
- The feasibility of handling break bulk at the loading/discharging port, when the break bulk is a specific size or shape;
- The handling hours available during the port stay;
- The availability of adequate and appropriate handling gear at load and discharge ports.

IX.2.2.4 Acceptance criteria for oversize cargoes which result in OOG containers

When making judgements on the acceptance of oversize cargoes which result in Out of Gauge (OOG) containers, stowage co-ordinators should:

- Confirm the structure of the hold, hatch clearance and cell guide size and the estimated void space;
- Assess the feasibility of making the top space in the hold safe for stowing OOG;
- Consider the handling method for loading/discharging OOG;
- Arrange a height adjuster and/or a void saver.

IX.2.2.5 Acceptance criteria for refrigerated containers

When making judgements on the acceptance of refrigerated containers, stowage co-ordinators should:

- Assess the ship's loadable capacity for reefer containers, confirming the availability and number of reefer receptacles on board;
- In cases where receptacles are not available, arrange the instalment of an electric power pack on board;
- Avoid stowing reefers in the outboard positions if possible;
- Establish the voltage supplied on board. If the voltage on board is 220V, the number of transformers required for reefer points should be considered;
- Establish the loadable capacity for exclusive air-cooled type reefer containers in the holds, according to the ship's general arrangement.

IX.2.3 Planning container stowage on board

The following section contains checklists for stowage co-ordinators to use when planning container stowage on board a ship.

IX.2.3.1 General

Stowage co-ordinators should observe the ship operator's standing rules and ship general arrangement particulars while establishing:

- That the ship draft is within the allowable maximum draft at the port. The density of the water at the port should be taken into consideration when calculating ship's draft;
- That all stability criteria are met, hull stresses are within allowable limits and that the ship's trim and draft are optimal for departure and a safe onward voyage;
- The crane split at the loading/discharging port;
- Any possible interference between the gantry crane and the ship's gear;
- That no hatch cover, tank top, stack or tier mass limits are exceeded;
- Ballast water management and any ballast exchange limitations.

IX.2.3.2 On deck stowage of cargo and containers

When making judgements on the on deck stowage of cargo and containers, stowage co-ordinators should take into account:

- The maximum permissible hatch cover load distribution and maximum permissible container stack mass limit, using whichever is the lower as the safe working limit for stowing containers in a stack;
- The rotational and racking forces on container components and ship's lashing gear and stack stability are within safety limits.
- Whether containers comply with the standards of strength defined by ISO standards (see Annex A of this Guide);
- That transverse and vertical forces are divided equally between the two ends of the container, and longitudinal forces between the two sides;
- That two ends or sides of the container do not interact;
- The strength of securing equipment used to restrain the containers;
- Whether any DG cargo requires on deck stowage in accordance with the IMDG code and/or inner row storage, e.g. marine pollutants;
- That, where possible, containers carrying animal hides and other similar cargoes have been stowed on deck at first tier wings and away from accommodation and active reefer containers, to allow washing in case of leakage;
- Where the shipper has expressed a preference for it, the on deck stowage of containers;
- That IMO visibility requirements are complied with (see Annex D of this Guide);
- That port restrictions on the stacking height of on deck containers and/or the height of the gantry crane at each port have been taken into account;
- That when uncontainerised cargoes and cargoes stowed in flat racks, open tops or side open containers, which are not weathertight, are required to be loaded on deck, they are loaded in such a way that they are protected from shipping spray, e.g. in front of the bridge house, under an acceptance by the shipper;
- That where flat rack containers, open top containers or uncontainerised cargo are to be loaded on deck, they should preferably be loaded in front of the accommodation to avoid soot/fire damage, even if they are empty.

IX.2.3.3 Under deck stowage of cargoes and containers

When making judgements on the under deck stowage of cargo and containers, stowage co-ordinators should take into account:

- That uncontainerised cargoes and cargoes stowed in flat racks, open tops or side open containers which are not weathertight are in principle to be loaded below deck;
- That bulk containers containing bulk cargoes, such as malt, should be stowed as far as possible under deck in the inner rows;
- That under deck stowage is recommended for marine pollutant DG containers. Where it is unavoidable that marine pollutant DG containers are to be stowed on deck, inner row stowage is required to minimise pollution in case of accidental leakage;
- Which containers should preferably be stowed under deck according to the shipper;
- That containers requiring under deck stowage and cooling should be stowed away from bulkheads adjacent to machinery rooms and fuel oil tanks, in order to keep them as cool as reasonably practicable during transit;
- That in cases where 20' containers are loaded in 20'/40' convertible bays, the 40' containers should be loaded on the top of secure 20' containers, unless stacking cones or other fittings are available for securing;
- That shipper owned tank containers with over dimensions are loaded on deck and surrounded by standard 20' and 40' containers in order to ensure protection from

heavy seas;

- That the container heights and port sequences are considered when the ship is fitted with a side bracing system for the lashing/securing of containers. This system requires the use of double stacking cones and port sequences, as container height can affect the proper use of this system;
- That the crane operator is made aware of the existence of 20' containers in 40' cells.

IX.2.3.4 Dangerous Goods (DG)

When making judgements on stowage of Dangerous Goods cargoes, stowage co-ordinators should ensure that:

- DG are stowed in accordance with the IMDG Code, all applicable local regulations, the ship's Document of Compliance for the Carriage of Dangerous Goods, and port restrictions;
- The Certificate of Fitness for Ship Carrying Dangerous Goods is observed;
- The charter party, where applicable, is carefully checked with regards to cargo exclusions.

IX.2.3.5 Half door containers

IX.2.3.5.1 Half door containers are units laden with one door removed in order to ensure ventilation for certain food cargoes (e.g. onions, pumpkins, etc). Such units are severely reduced in strength, and endurance against racking force decreases by two thirds. It is therefore necessary to restrict the stacking mass superimposed on a half door container as follows:

- On deck stow (avoid loading at end slot): less than 31 tonnes for 20' container, less than 29 tonnes for 40' container
- Under deck stow case: less than 96 tonnes.

IX.2.3.5.2 Half door containers either originating from or transiting the United States that have been neither tested nor marked on their CSC plate for operation with one door removed must comply with the US Coast Guard's Navigation and Vessel Inspection Circular No. 8-00. This circular only allows half door containers to be loaded at the top tier or underneath up to two containers. Half door containers possessing a CSC plate that denotes them as capable of operating with one door removed are subject to the restrictions detailed above.

IX.2.3.6 Both doors open containers

Containers which are stowed on deck with both doors open cannot have containers stacked on top of them.

IX.2.4 Guidelines for confirming proper loading of ship

The following sections contain checklists for stowage co-ordinators to use when making judgements relevant to the safety of ships under their control.

IX.2.4.1 Sailing condition

In order to ensure a proper loading condition, the following must, in liaison with the ship's master, be checked and confirmed:

- That the ship draft, under keel, air draft and bridge clearance meet local port and pilotage requirements;
- That the metacentric height is, at all stages, within the ship's design parameters subject to ship operator standing rules and the master's acceptance;
- That the metacentric height is reduced if deemed too high;
- The bending moment, shear force, torsion moment and stacking mass are less than 100%;
- The ship complies with the seagoing visibility requirements of SOLAS (see Annex D);
- Maximum tier and stack mass are not exceeded;
- Sufficient extra lashings have been added in cases where standard ISO boxes (20'/40') are stowed in 45', 48' or 53' bays (for 45' bays the compensation factor is approximately 27%);

- That all containers on deck are properly lashed and secured.

IX.2.4.2 Lashing strength

IX.2.4.2.1 Following receipt of the preliminary stowage plan information from the container terminal, it should be checked that the mass distribution of each row is correct for higher tiers as per the Cargo Securing Manual or the ship's stability/cargo handling software and the lashing strength as calculated.

IX.2.4.2.2 Terminal planners, stowage co-ordinators and ship's personnel should be advised of the respective computer capabilities available and what checks will be undertaken by them during the planning/loading process.

IX.2.4.3 DG segregation

In order to confirm safe and proper segregation of containers carrying Dangerous Goods, stowage co-ordinators should:

- Confirm, following receipt of the preliminary stowage plan information from the terminal, whether there is any difference/deviation from the Shipping Instructions (SI);
- Confirm proper segregation within the stowage plan, preferably through the auto-check feature in the Stowage Co-ordination System, where available;
- Ideally, cross check DG data received from the terminal with information available in the shipping line's booking system;
- Include container ID in the stowage instruction, preferably sent as MOVINS message (see Section 5.5) in order to control stowage;
- Confirm the segregation meets the requirements for specific commodity restrictions in the IMDG Code.

IX.2.4.4 OOG / break bulk

In order to confirm safe and proper stowage of Out of Gauge or break bulk cargoes, planners should confirm, after receipt of the EDI message from the terminal, that the location of the cargo stowed is as per the Shipping Instructions (SI).

IX.2.5 Ships stowage planning basic flow

IX.2.5.1.1 The following section addresses the basic actions necessary to ensure correct ship stowage planning throughout a voyage in one or more geographical or operational regions.

IX.2.5.1.2 In general, all exchange of information should be done via Electronic Data Interchange (EDI) standard messages:

- Bayplan: standard EDIFACT file format BAPLIE 2.0 message;
- Tank statements: preferably use EDIFACT file format TANKSTA 2.0 message;
- Stowage Instruction: preferably use EDIFACT file format MOVINS 2.0 message.

IX.2.5.1.3 It must be stressed that the BAPLIE information purely reflects the status of loading on board and is consequently not a discharge order to terminals.

IX.2.5.1.4 Cargo related data in such messages should be kept to a minimum, e.g. whether DG net mass or reefer ventilation settings are missing, or whether the cargo has incurred damage through neglect of such factors.

IX.2.5.1.5 Any discharge order should be communicated by means of COARRI Import message, as generated from the carrier's system.

IX.2.5.2 Developing the coastal schedule for next region

IX.2.5.2.1 After a ship sails from the previous region, the coastal schedule for the next region should be developed.

IX.2.5.2.2 When developing a ship coastal schedule, a stowage co-ordinator should:

- Confirm the berth window at each calling port;
- Confirm the allowable maximum draft of ship for entering/departing a port. If the draft is restricted, entering/sailing during high tide should be considered;

- Identify any restrictions on night time entry into ports due to Dangerous Goods being carried;
- Identify any repair/maintenance work required by the ship at the port;
- Confirm the bunker schedule in the region, if any;
- Send the coastal schedule to concerned parties.

IX.2.5.3 Confirming last port stowage EDI file from previous region

Using the Stowage Co-ordination System (SCS), the stowage co-ordinator should check the stowage and special cargo (DG/00G/break bulk), amending the EDI file if necessary. When the stowage co-ordinator checks the on-sail stowage plan of the last port in the previous region, the following items should be taken into consideration:

- Local restrictions for discharging Dangerous Goods;
- Restrictions on discharging 00G/break bulk, including the need to arrange for the provision of special equipment for their handling, e.g. a floating crane.

IX.2.5.4 Sending / confirming receipt of the on-sail stowage EDI file

On receipt of the on-sail stowage EDI file of the previous region, stowage co-ordinators should distribute it to each terminal in the next region at which the ship will call.

IX.2.5.5 Receiving the estimated ship tank condition from the Master

Stowage co-ordinators should establish, through contact with the master, the estimated ship's tank condition at each port in the region in which the ship is trading and, in particular, the estimated tank condition at the first port in the next region for input into the SCS, preferably using the EDIFACT file format TANKSTA 2.0 message.

IX.2.5.6 Actions prior to ship arriving at first port in a region

Prior to the arrival of a ship at the first port in a region, stowage co-ordinators should:

- In the SCS, make the base plan of each port using homogeneous/average mass, calculated using the last voyage data;
- Input the ship tank condition with the base plan and, if they are adequate, confirm the ship's condition (stability/draft/trim/longitudinal strength) and crane split;
- Check for Change of Discharge Port (COD) applications from booking lines, judge the acceptance of CODs, and inform result of this judgement to the applicants;
- Send the approval information of COD to terminals and ships.

IX.2.5.7 While ship is in the region

While a ship is trading in a region, stowage co-ordinators should:

- Check the applications for special cargo (DG/00G/break bulk/special stow) which are booked with the shipping line;
- Judge the acceptance of special cargo in accordance with official regulations, ship operator Standing Rules, JWP, local rules and stowage condition;
- Inform booking lines of the result of judgement. It should be noted that some lines/consortia have automatic acceptance rules where bookings are accepted unless advised otherwise;
- Confirm the list of special cargo which has been approved.

IX.2.5.8 Actions prior to ship arrival at each port

Prior to a ship's arrival at each port in a region (i.e. one or two days in advance) stowage co-ordinators should:

- Receive the booking forecast (BFC) or terminal built up (TBU) from the local agent or terminal;
- Compare the special cargo data in BFC/TBU with the list of approved special cargo. Any discrepancy between them must be resolved;
- Input or import BFC/TBU data into the Stowage Co-ordination System and plan the

container/cargo stowage for the port by adjusting the base plan;

- Calculate the ship's estimated condition and confirm it is in acceptable range;
- In the event that the ship's estimated condition is out of acceptable range and is difficult to adjust, the ship must be contacted with a view to establishing necessary measures to render the ship acceptable;
- Make a stowage instruction including remarks for special cargo;
- Send the stowage instruction to the terminal operator with remarks on how to follow the proper stowage pattern, and provide the stowage co-ordinator's emergency contact information and confirm receipt.

IX.2.5.9 When the ship arrives at way port

On the ship's arrival in port, stowage co-ordinators should:

- Check the pre-stow EDI file of the stowage plan upon starting cargo work from the terminal and confirm ship condition;
- Establish the ship's condition taking into account its stability, draft, trim, bending moment, shearing force, torsion moment, lashing strength, special cargo and visibility.

IX.2.5.10 When the ship sails from way port

After the ship departs a way port, stowage co-ordinators should:

- Check and confirm the final EDI stowage file from the terminal, and re-confirm ship's condition in the SCS;
- Provide updated EDI stowage file to the next terminal;
- If necessary, modify the container/cargo stowage instruction for the next port.

IX.2.5.11 Before the ship sails to last port in the region

Prior to a ship calling at the last port in a region, stowage co-ordinators must check the updated EDI file from the terminal, making revisions as required in order to confirm the ship's loading condition.

IX.2.5.12 When the ship arrives at last port in the region

On the ship's arrival at the last port in a region, stowage co-ordinators should:

- Check the pre-stow EDI file from the terminal in the SCS and confirm the ship's condition;
- Be ready to receive by telephone, on a 24 hour basis, advice as to defective stowage from the ship and/or terminal, taking countermeasures against defective stowage, and instructing the terminal accordingly.

IX.2.5.13 After ship sails from last port in the region

After a ship has sailed from the last port in a region, stowage co-ordinators should:

- Check the final EDI stowage file from the terminal and re-confirm ship condition in the SCS and with the ship. If passing operations responsibility to the next region, provide final on-sail EDI file to the next terminal planners, including any remarks for exceptional stowage and total number of containers on board;
- Make final coastal schedule and provide it to concerned parties.

IX.3 Marine terminal operations (MTOs)

IX.3.1 Overview

IX.3.1.1 This chapter 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.

IX.3.1.2 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.

IX.3.2 Shipper's booking

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

Comment [B1]: Is this true? Is there any formal link between t MTO and shipper, or does it go through the carrier?

- 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.

IX.3.3 Berth assignment

IX.3.3.1 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.

IX.3.3.2 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.

IX.3.4 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 (see also Section 4.2.3).

IX.3.5 Safety and security checks prior to entry

IX.3.5.1 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.

IX.3.5.2 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.

IX.3.6 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.

IX.3.7 Stowage instruction

IX.3.7.1 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.

IX.3.7.2 Should changes to the plan be necessary, then the terminal planner should liaise with the stowage co-ordinator.

IX.3.7.3 No major changes to the stowage layout should be carried out without acceptance from the stowage co-ordinator.

IX.3.8 Crane sequencing

IX.3.8.1 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.

IX.3.8.2 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.).

IX.3.8.3 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.

IX.3.8.4 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.

IX.3.9 Ship / shore communication

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

IX.3.10 Arrival condition

IX.3.10.1 Terminal planners must take into consideration the ship's arrival condition in order to develop the discharge/load sequencing.

IX.3.10.2 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.

IX.3.11 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.

IX.3.12 Discharging

IX.3.12.1 Discharge of containers must be sequenced to ensure that bending moments are not exceeded.

IX.3.12.2 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.

IX.3.13 Loading

IX.3.13.1 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.

IX.3.13.2 Any deviation from the loading plan must be agreed and accepted by the ship's master.

IX.3.13.3 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.

IX.3.13.4 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.

IX.3.14 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.

IX.3.15 Prior to departure

IX.3.15.1 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.

IX.3.15.2 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.

IX.3.16 Transhipment containers

IX.3.16.1 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.

IX.3.16.2 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.

IX.3.16.3 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.

IX.4 Responsibilities of the Master and crew

IX.4.1 Overview

This chapter identifies the responsibilities of the master and crew with respect to ship planning and cargo operations that are relevant to safety, prior to and during arrival at port and following the ship's departure. However, crew members involved with cargo stowage should also refer to the guidance in Chapter 5.

IX.4.2 Prior to arrival at way port

IX.4.2.1 Updating Stowage Co-ordinator with Actual Condition

The ship should, on request, advise the stowage co-ordinator of the tank condition and other relevant information.

IX.4.2.2 Receipt of Pre-stow Plan from Stowage Co-ordinator

The pre-stow plan should be forwarded to the ship and terminal from the ship planning department.

IX.4.2.3 Providing Lashing Pattern to the Terminal

The lashing pattern from the Cargo Securing Manual (CSM) should be provided to the terminal.

IX.4.2.4 Preparing Draft Ballast Water Management Plan

Based on pre-stow information, the ship may wish to execute a ballast water management plan for the coming port stay. This includes optimisation of ballast water distribution to allow for minimal discharges in port.

IX.4.2.5 Bunker Requirements

Bunker requirements should be provided to the ship operator/planning department/terminal to be taken into account for pre-stow layouts.

IX.4.2.6 Special Requirements

The stowage co-ordinator and terminal planners should be advised as to any special requirements of the ship such as main engine immobilisation for repairs, divers' inspections, store taking and other husbandry issues.

IX.4.3 During stay at way port

Ship's gear/cranes should be turned outboard and lowered accordingly to provide safe clearance to gantry cranes, and to prevent severe damage to crane jibs by gantry cranes.

IX.4.3.1 Checking stowage plan received from terminal

IX.4.3.1.1 The stowage plan received from the terminal planner should be entered into the Shipboard Loading Instrument (SLI). The draft ballast plan should also be entered and an initial evaluation of the ship's condition should be performed and consequential corrective actions identified.

IX.4.3.1.2 Stack mass limitations and lashing limitations should be identified. Any corrective actions or changes that need to be taken to ensure compliance should be discussed with the terminal planner and stowage co-ordinator as required.

IX.4.3.1.3 Bridge visibility rules in accordance with SOLAS must be observed and checked.

IX.4.3.2 Hazardous cargo stowage

The HAZMAT spotting plan should be updated for emergency preparedness. Segregation requirements should be confirmed in accordance with the IMDG Code.

IX.4.3.3 Preparing Ballast Water Management Plan

The draft ballast water management plan should be revised based on changes in actual stowage layout compared to the pre-stow arrangement.

IX.4.3.4 Carrying out spot check of actual loading against plan

During the loading operation, spot checking of the actual loading compared to the loading plan should be undertaken throughout the cargo area, with particular attention paid to OOG, DG and reefer containers. Discrepancies should be resolved with the terminal planner and stowage co-ordinator, paying due regard to the health and safety implications of any solution.

IX.4.3.5 Signing off completed lashing per bay

The lashing arrangement of each bay should be inspected and adjusted if necessary by the crew following completion of work by the terminal personnel.

IX.4.3.6 Stowaway search prior to departure

It is good practice to keep cargo holds, where no cargo operation is being performed, sealed off during port stays to limit the amount of work involved in the stowaway search that should be conducted throughout the ship prior to departure.

IX.4.3.7 Confirming Departure Condition

IX.4.3.7.1 Before departure, the final cargo should be received on board and the ship's final departure condition must be confirmed as being within limits for bending moment, shear force, stack mass, lashing forces and visibility. The loading plan should be approved by the master.

IX.4.3.7.2 In order to confirm sufficient visibility conditions, a check of the arrival conditions for the next port should also be made.

IX.4.3.7.3 Prior to departure, a check should be made to confirm proper stowage and segregation of DG cargo. If the stowage position deviates from the one given on the DG manifest, then an update must be made.

IX.4.3.7.4 Departure from port may take place when the ship is in the harbour condition, subject to weather and the anticipated impact on the ship from swell and waves, but it is entirely the responsibility of the master to decide whether to take such action.

IX.4.4 After departure from way port

IX.4.4.1 Updating stowage co-ordinator with actual sailing condition

The final departure condition of the ship should be communicated to the stowage co-ordinator to form the basis of the next pre-stow arrangement.

IX.4.4.2 Checking lashings

It is good practice to verify the tightening of the lashings after departure once the lashings and containers have settled in. This is especially the case before ocean crossings, after receipt of bad weather outlooks, and after bad weather has been encountered.

IX.5 Information Technology

IX.5.1 Overview

IX.5.1.1 This final chapter is intended to provide an introduction to the sophisticated information technology systems currently used by those involved in the transportation of containers by sea. It is recommended that all concerned should have a basic understanding of these systems.

IX.5.1.2 The importance of shippers using the electronic booking systems that are provided by the majority of container shipping lines is particularly emphasised, in order to eliminate cargo discrepancies, not least those that might threaten safety (see Section IX.1.2)

IX.5.2 Computer systems used in container stowage

The following systems are typically involved in the export of cargo culminating in the loading and securing of the container on the ship.

IX.5.2.1 Shipping Line Booking System (SLBS)

IX.5.2.1.1 The primary purpose of the Shipping Line Booking System (SLBS) is to book cargo shipments, route each shipment, and reserve space for each shipment on one or more of the conveyances that will carry it.

IX.5.2.1.2 The SLBS supports ship stowage by providing detailed information about the commodities in the shipment and the containers required to carry it. This information should include as a minimum all of the information required by the bill of lading, and the number, size and types of containers required to carry the cargo.

IX.5.2.1.3 For hazardous cargo, a full declaration of each hazardous commodity is required.

IX.5.2.1.4 For refrigerated cargo, maximum and minimum temperatures must be specified. Out of Gauge (00G) cargo dimensions must be noted, although these are normally only confirmed upon arrival of the cargo at the terminal of loading.

IX.5.2.1.5 The function of the SLBS is to:

- Authorise the release of empty containers of specified sizes and types for a booking from depots and/or terminals;
- Provide the projected number and type of containers to be loaded at each port, and the relevant stowage details of the cargo, to the Stowage Control System (SCS);
- Support equipment forecast planning.

IX.5.2.1.6 It should be noted that because stowage planning often commences before the full details of the cargo are available, the complete booking information is often not available when the booking is first made and accumulates over time as the shipper provides it. Similarly, it should be recognised that the accuracy of cargo mass may vary widely, despite shippers being required to attest to it.

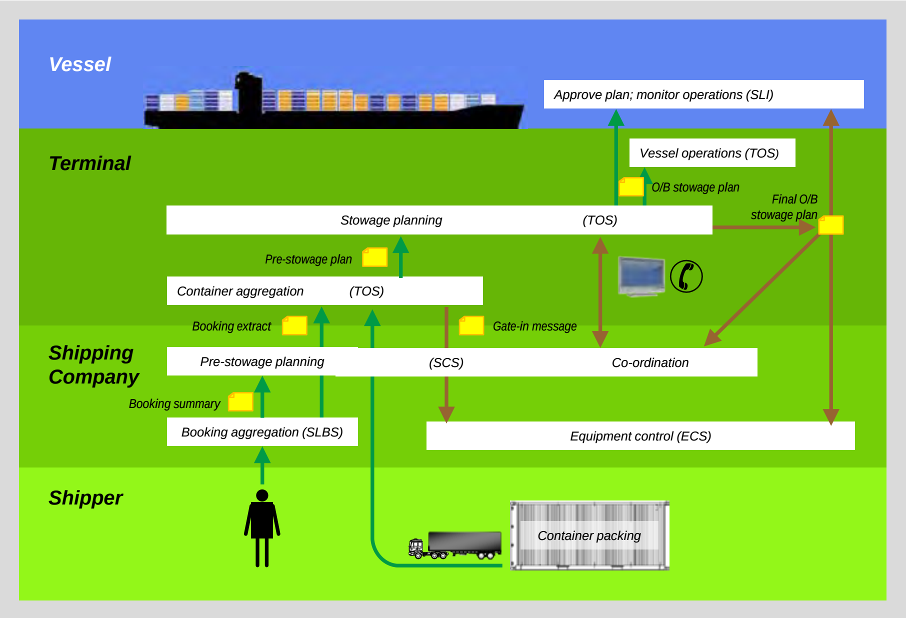


Figure VIII.1 : Sequence of major activities that determine final stowage

IX.5.2.2 Stowage control system (SCS)

IX.5.2.2.1 The Stowage Control System (SCS) is a vital part of a shipping line's logistics management process. It assists the stowage co-ordinator in planning the ship's voyage to ensure that all the booked cargo can be carried safely, while minimising the variable costs of the passage (e.g. re-stows of containers, lashing, and ballast related fuel burn).

IX.5.2.2.2 The SCS works with both known data (containers already on the ship or received at the terminal) and projected data (cargo booked, but when specific container numbers and cargo details are not fully known).

IX.5.2.2.3 The SCS requires trim, stability, strength, visibility and hazardous segregation calculations to determine the effective capacity of the ship and the practicality of the planned loading at each port.

IX.5.2.2.4 The SCS:

- Receives booking information from the SLBS;
- Receives inbound stowage plan;
- Creates pre-stowage plan comprised of actual containers and projected containers;
- Transmits pre-stowage plan to the Terminal Operating System (TOS) to guide the terminal's stowage planning of containers available;
- Receives the final outbound stowage plan from the TOS.

IX.5.2.3 Shipping line equipment control system (ECS)

IX.5.2.3.1 The Equipment Control System (ECS) maintains an inventory of containers, both owned and leased, and third party containers not known to the system. It also maintains an inventory of other equipment (chassis, generator sets, external reefer units, etc).

IX.5.2.3.2 The ECS is the source of information on the location and history of the equipment, its characteristics (size, type, height, tare mass, material strength, etc) and condition (damage, cleanliness, suitability for certain cargoes, etc).

IX.5.2.3.3 The ECS:

- Provides authoritative container information to internal shipping line systems;
- May provide such information to Terminal Operating Systems (TOS).

IX.5.2.4 Terminal operating system (TOS)

IX.5.2.4.1 The Terminal Operating System (TOS) has many functions, but is essentially a container inventory control system that authorises and tracks container movements in, out and within the terminal.

- The key functions of the TOS related to stowage planning are to:
- Receive inbound stowage plans from the ECS or SCS;
- Dispatch empty equipment in accordance with bookings;
- Receive full containers for export and append booking information (routeing, etc);
- Collect variable cargo details: mass, hazardous details, reefer temperatures, etc;
- Deliver import containers against delivery orders;
- Receive empty equipment belonging to customer shipping lines.

IX.5.2.4.2 The following EDIFACT messages (or equivalent ANSI x12 messages) should be supported by TOS:

- BAPLIE Version 2.0: Bayplan message from terminal to ship operator, to the ship and, if required, to the next terminal;
- MOVINS Version 2.0: Stowage instructions from ship operator to terminal;
- COPRAR Version 1.0: Loading and/or discharge instruction from carrier to terminal;
- COARRI Version 1.0: Load/discharge report from terminal to carrier;
- COPARN Version 1.0: Container announcement message from carrier to terminal, or empty containers from carrier to terminal;
- COREOR Version 1.0: Container release message for full and/or empty containers from carrier to terminal;
- CODECO Version 1.4: Gate in/out movements from terminal to carrier;
- TPFREP Version 2.0: Terminal performance report message;
- INVOIC Version 2.0: Invoice from terminal operator to carrier;
- APERAK Version 1.0: Application error and acknowledgement message.

IX.5.2.4.3 Unless stated to the contrary in the message specifications, the messages used are based on the messages contained in the UN-EDIFACT directory 95B and/or directory OOB.

IX.5.2.5 Shipboard loading instrument (SLI)

IX.5.2.5.1 The Shipboard Loading Instrument (SLI) is a computer (almost invariably a PC) and software capable of calculating the trim, stability, maximum shear force, bending moment and torsion moments exerted on the ship by the buoyancy forces of the water, the ship's own structure, all other mass on board (the cargo, crew and effects) and all fluids contained in tanks (fuel, ballast, fresh water, lube oil, etc).

IX.5.2.5.2 The SLI (both hardware and software) must be approved by the ship's current classification society.

IX.5.2.5.3 The SLI should:

- Receive the outbound stowage plan;
- Allow entry of tankage information (it may also receive measures of ullage from instrumented tanks);
- Compute trim, stability, maximum shear, bending and torsion forces and visibility, compare values of this data with prescribed limits and flag any errors;
- Implement calculations required by the ship's Cargo Securing Manual, compare with prescribed limits and flag errors.

IX.5.2.5.4 Typically, the SLI is procured by the ship yard as a requirement of the contract to build a ship. Shipowners must ensure that any SLI installed on their ships is class approved with respect to the stability and strength of the ship.

IX.5.2.5.5 However, ease of use, speed and the implementation of Cargo Securing Manual calculations are also important considerations when selecting SLIs. The SLI should implement the class approved Container Stowage Manual calculations for lashing, stack mass and visibility. A side letter from the classification society confirming the accuracy and sufficiency of these calculations should be available.

IX.5.2.5.6 The SLI and Stowage Co-ordination System should implement all calculations for stability, strength, lashing, visibility and hazardous cargo segregation from data input provided via standard EDI formats, and calculation mismatches should be avoided.

IX.5.2.5.7 The terminal planners should have access to the ship's SLI or the ship operator's stowage plan, and stowage co-ordinators should be available to receive the terminal stowage plan from the terminal and check all constraints against the ship's SLI. Alternatively, a plug-in module containing the SLI's calculations can be used by the terminal's planning systems.

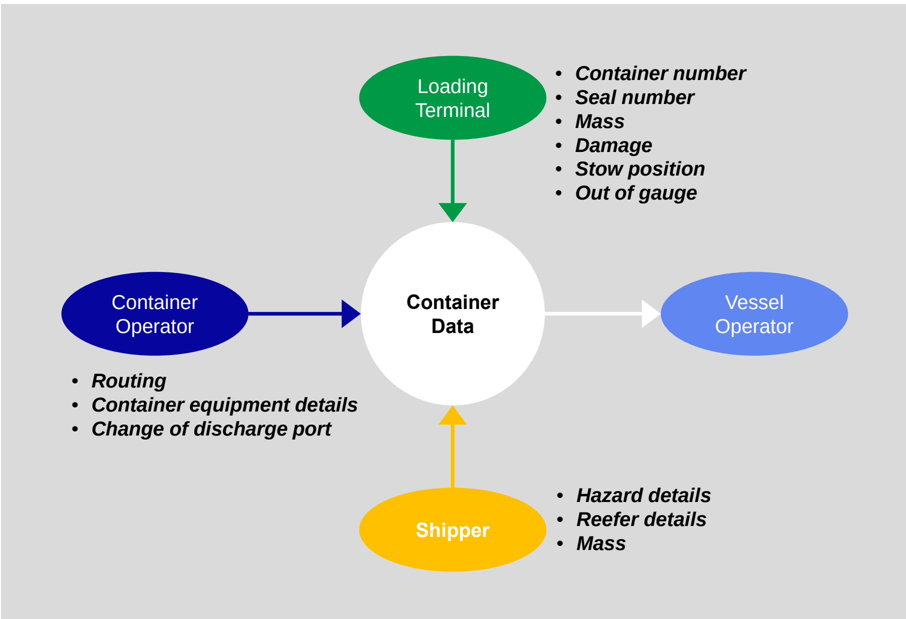


Figure VIII.2 ; Container data must be aggregated from multiple sources

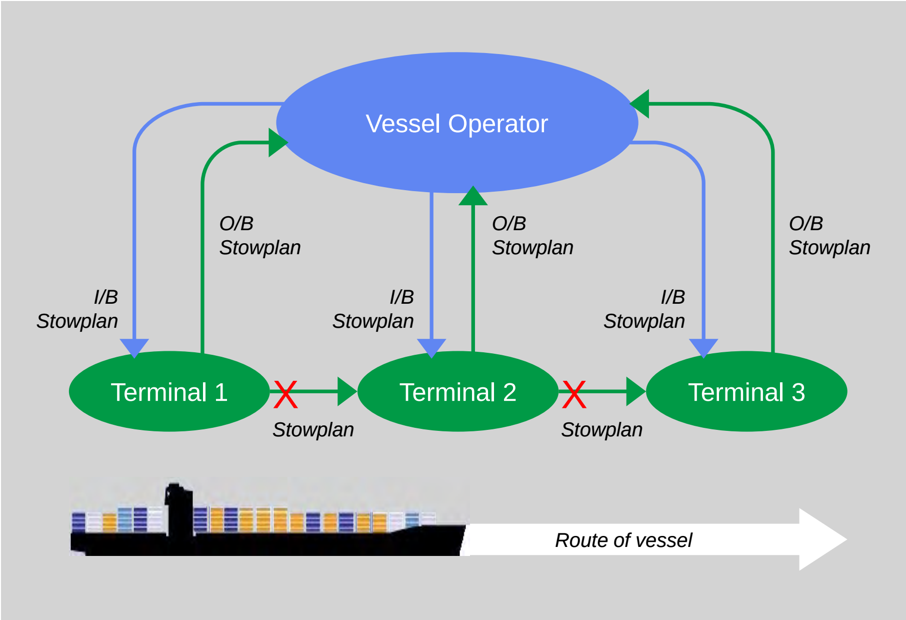


Figure VIII.3 : terminals should receive inbound stow plans from ship operator not the up-stream terminal

IX.5.3 Designing and enforcing effective business processes

IX.5.3.1 It is recommended that companies involved in the movement of containers by sea analyse the business processes of others in the transport chain. An understanding of how data is processed at each step, starting with the shipper and ending with the receiver, is key to this analysis, and will assist in determining the likely accuracy of data from these various providers.

IX.5.3.2 Similarly, responsibilities with respect to the required level of accuracy of information (e.g. hazardous details, mass, container characteristics, Out of Gauge dimensions, etc) should be clearly defined and agreed amongst business partners. The times at which each action is to be taken and when information must be received should also be clearly defined.

IX.5.3.3 In order to confirm the reliability of information streams, periodical testing should be undertaken to confirm that responsible partners are actually providing accurate data (for example, by periodically selecting a randomly discharged container, loaded in a previous port, and comparing its mass to that reported in the inbound stowage plan).

IX.5.3.4 Where authoritative data is not available when planning needs to begin, available data should be used and updated later in light of more authoritative data. For example, an inbound stowage plan might only show the IMDG Class for hazardous cargo when the terminal stowage planning needs to begin. In such a case, the operator should proceed with planning, updating the Remain on Board (ROB) hazardous data with the hazardous manifest from the ship operator when available, re-planning as necessary to meet hazardous segregation requirements.

IX.5.4 Ensuring data quality

IX.5.4.1 It is essential to obtain stowage data from the authoritative source, and all stowage planning staff should be aware of what constitutes such a source.

IX.5.4.2 It should be ensured that EDI systems do not permit authoritative data to be overwritten by non-authoritative data. For example, if a container's scaled mass is received from a terminal, it should not be overwritten with a mass from any other source such as a container status EDI update that contains a mass field.

IX.5.4.3 Conversely, the authoritative mass when received must overwrite any existing mass data. If a mass update is received from the authoritative terminal, then it should also overwrite the existing value, including a mass previously received from the authoritative source (the terminal in this example). This EDI "posting logic" is critical to data integrity and should align with the business process.

IX.5.5 Use of good IT tools

IX.5.5.1 IT tools must be sufficient for the company's business requirements and the needs of personnel.

IX.5.5.2 The various computer systems must ensure that the required features always remain compatible with changing legal requirements without creating their own rules.

IX.5.5.3 The systems should suit the capabilities of the users, and be able to perform the task in the time allowed by the business process. For example, a feeder line with small ships, experienced former ships' officers to undertake the stowage planning, and voyage legs long enough to allow ample time for planning, can manage with a basic SLI and reference to the IMDG Code. On the other

IX.5.5.4 hand, a terminal stowage planner without sea experience, only a basic knowledge of hazardous segregation and a large container ship to plan, will need a very sophisticated stowage planning system with extensive error checking, built in high level hazardous segregation logic, and very productive tools to speed the allocation of containers into stowage positions.

IX.5.5.5 The SLI, SCS and TOS planning systems should implement automated and detailed hazardous cargo segregation checking.

IX.5.5.6 Quality data and good tools are of no use if the data is not available at the time when critical decisions affecting the safety of ships need to be made. Communication systems must be available that can deliver the information required at the time required by the business process.

Annex X. Access to tank and bulk tops, working at height

X.1 CTU ladders

X.1.1 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 X-1 : Full frame ladder

Figure X-2 : Partial frame ladder

Figure X-3 : Road tanker

X.1.2 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 X-3, while others may appear as a climbing frame see Figure X-2.

X.1.3 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.

X.1.4 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 X-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 X-4 : Bulk container rungs

Where access is required to the top of the container, they will be marked with a warning decal as shown in Figure X-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 X-5 : Overhead warning sign

X.1.5 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.

X.1.6 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.

X.1.7 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.

X.1.8 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 X-6) making the manoeuvre hazardous. An operator climbing onto the top of the tank container shown in Figure X-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 X-6 : Container handhold

Figure X-7 : Transitioning

X.2 Working at height safety

X.2.1 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.

X.2.2 The measures should include:

X.2.2.1 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 X.2.2.1, his providing sufficient work equipment for preventing, so far as is reasonably practicable, a fall occurring.

X.2.2.2 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 IV.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.

X.2.3 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.

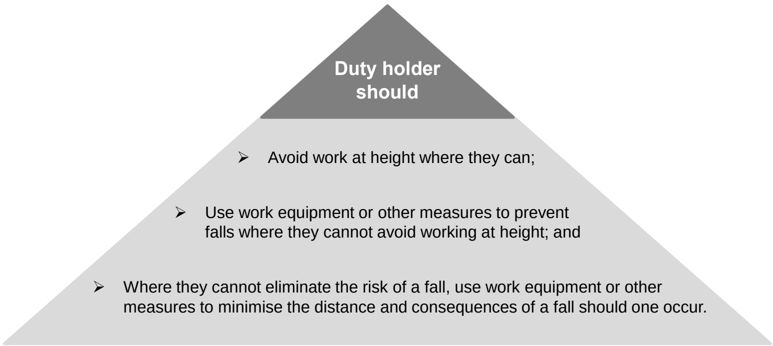


Figure VI-8 : Regulations hierarchy

X.3 Access and safety equipment

X.3.1 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 X-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 X-10 can be used which can be positions beside the CTU and from which the operator can safely step.

Figure X-9 : Trailer mounted access ladder

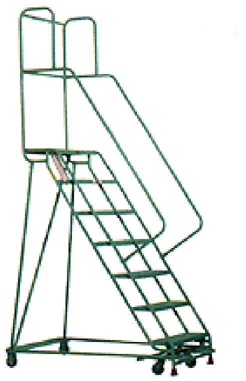


Figure X-10 : Mobile access ladder

X.2 At facilities where regular access is required the CTU should be positioned next to a fixed access gantry (see Figure X-11. 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.

X.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 X-11 : Access gantry

X.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 X-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 X-12 : Fall arrest stanchions

X.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 XI. CTU Seals

XI.1 Introduction

XI.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.

XI.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.

XI.2 Responsibilities along the chain of custody

XI.2.1 Cross-cutting responsibilities

XI.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.

XI.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.

XI.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.

XI.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:

XI.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.

XI.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.

XI.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

XI.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.

XI.2.2 Packing site

XI.2.2.1 The shipper is responsible for packing and securing the cargo within the CTU and for the accurate and complete description of the cargo. Where required, the shipper is also responsible

[1] As described in the WCO SAFE Framework of Standards, June 2011

[2] This responsibility only refers to CTUs engaged in international transport.

for affixing the cargo seal immediately upon the conclusion of the packing process, and for preparing documentation for the shipment, including the seal number.

XI.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.

XI.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.

XI.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.

XI.2.4 Marine Terminal

XI.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.

XI.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.

XI.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.

XI.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).

XI.2.6 Off-loading marine terminal

XI.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.

XI.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.

XI.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.

XI.2.7 Intermediate terminal

The processes in intermediate terminals in the importing country are analogous to those in intermediate terminals in exporting countries.

XI.2 Unpacking site

XI.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.

XI.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.

XI.3 Seal Types

XI.3.1 Mechanical Seals[3]

XI.3.1.1 Introduction

XI.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]

XI.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.

XI.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.

XI.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.

XI.3.1.2 Marking

XI.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.

XI.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.

XI.3.1.3 Identification marks

XI.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,

[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.

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.

- 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.

XI.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.

XI.3.1.5 Testing for seal classification

XI.3.1.5.1 There are four physical test procedures, tensile, shear, bending, and impact. The impact procedure is performed twice at different temperatures.

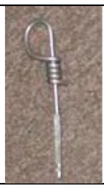
XI.3.1.5.2 The lowest classification for any sample on any test shall define the classification for the seal being evaluated. To achieve a given classification, all samples must meet the requirements for that classification in all five tests.[5]

		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

XI.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 

[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.

	NOTE The seizing device can be plastic or metal and its deformation is one indication of 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

XI.3.2 Electronic Seals

Figure XI-1 : Electronic Seal

XI.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.

XI.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.

XI.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 an communication device.

XI.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.

XI.3.3 Other Devices

XI.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.

XI.3.3.2 Such devices are usually fitted by the shipper on their, or the consignee's, behalf.

XI.3.4 Sealing CTUs

XI.3.4.1 Introduction

XI.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 XI-2 : Swing door (Road vehicle))

Figure XI-3 : Sliding door (Rail Wagon)

Figure XI-4 : Roller Shutter (Swap Body)

XI.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.

[6] Also known as eSeals, and RFID tags.

[7] ISO 18185-1:2007 Freight containers – Electronic seals – Part 1 communication protocol.

Figure XI-5 : Surface mounted handles

Figure XI-6 : Roller shutter lock

Figure XI-7 : Recessed handled with protruding eyes

XI.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 XI-5 and Figure XI-6); or
- the a fixed eye protruding from the CTU projects through the handle (see Figure XI-7).

XI.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 XI-8 : Handle without aperture

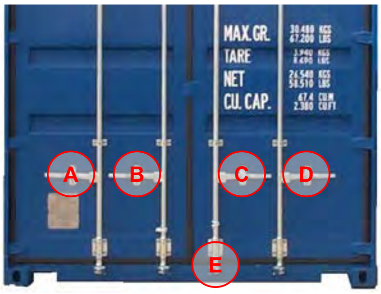


Figure XI-9 : Multiple apertures

XI.3.4.1.5 In Figure XI-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.

XI.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

XI.3.4.2 Dry Bulk CTUs

XI.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.

XI.3.4.2.2 Each of the arrowed locations in Figure XI-10 will require sealing. Figure XI-12 and Figure XI-13 discharge hatch sealing points. Figure XI-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.

[8] Generally left hand door handles

[9] The security cam type fitting is not fitted to all CTU.

Figure XI-10 : Dry bulk sealing points

Figure XI-11 : Roof hatch internal lock

Figure XI-12 : Dry bulk discharge hatch (rear)

Figure XI-13 : Dry bulk discharge hatch (front)

XI.3.4.3 Tank CTUs

XI.3.4.3.1 Like CTUs for dry bulk cargoes, tank containers and trailers may have multiple openings for loading and discharging.

XI.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 XI-14 : Manway hatch seal

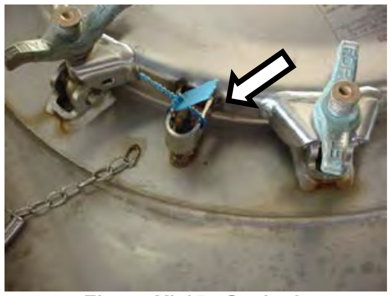


Figure XI-15 : Seal tab

XI.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.

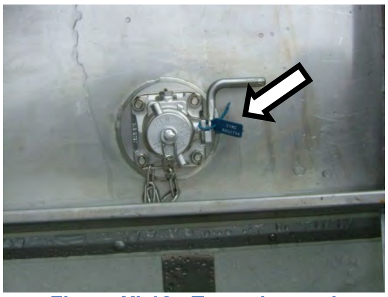


Figure XI-16 : Top valve seal

Figure XI-17 : Discharge vale seal

XI.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.

XI.3.4.4 Open sided units

XI.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.

XI.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 XI-18 : Tautliner clip

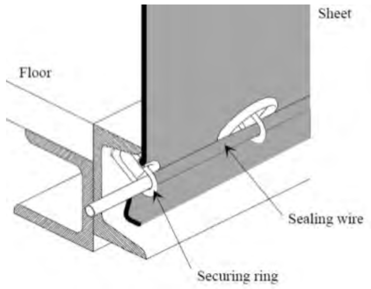


Figure XI-19 : TIR wire fitting

XI.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.

XI.3.4.5 Fitting seals

XI.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.

XI.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 XI-20 and Figure XI-21.

XI.3.4.5.3 Figure XI-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.

XI.3.4.5.4 Figure XI-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.

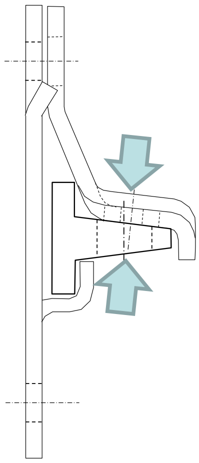


Figure XI-20 : 2 point seal

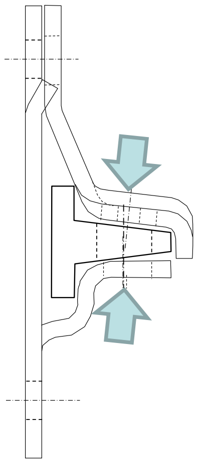


Figure XI-21 : 3 point seal

XI.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.).

XI.3.4.5.6 Push the seal through all elements of the retainer, handle and clip and snap the two halves together.

Figure XI-22 ; Fitting a bolt seal

XI.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.

XI.3.4.6 Cutting seals

XI.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 XI-23) can be generally cut with cable cutters (Figure XI-24) or small bolt cutters. High security cable seals (Figure XI-24) and twist seals (Figure XI-26) generally require 24 in (600 mm) cable or bolt cutters.

Figure XI-23 : Cable seals

Figure XI-24 : High Security Cabe seals

Figure XI-25 : Cutters for cable seal

Figure XI-26 : Cutters for twist seal

XI.3.4.6.2 The design of cable cutters shearing edges (Figure XI-25) are such that the cable seal strands are captured during the cutting process which prevents strands from becoming separated from the cable.

XI.3.4.6.3 Cable seals use Non Preformed Cable, that frays wildly when cut. Figure XI-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 passed through the upper lug and crimped closed.

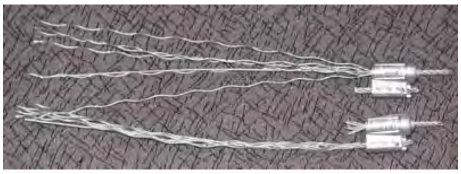


Figure XI-27 : Cut cable seals

XI.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.

XI.3.4.6.5 Bolts should be cut as close to the lock body as possible. The left hand bolt in Figure X-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 XI-28 : Cut bolt seal - stems

Figure XI-29 : Cut bolt seals - head

XI.3.4.7 Cutting tools

XI.3.4.7.1 ⅝ in high security bolt seals (Figure XI-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 XI-30 : Typical bolt seal

Figure XI-31 : Bolt cutters

Figure XI-32 ; 42in bolt cutter

XI.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 XI-33 ; Rail car bolt seal and breaking tool

[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.

XI.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 XI-34 with a lever length D_L.

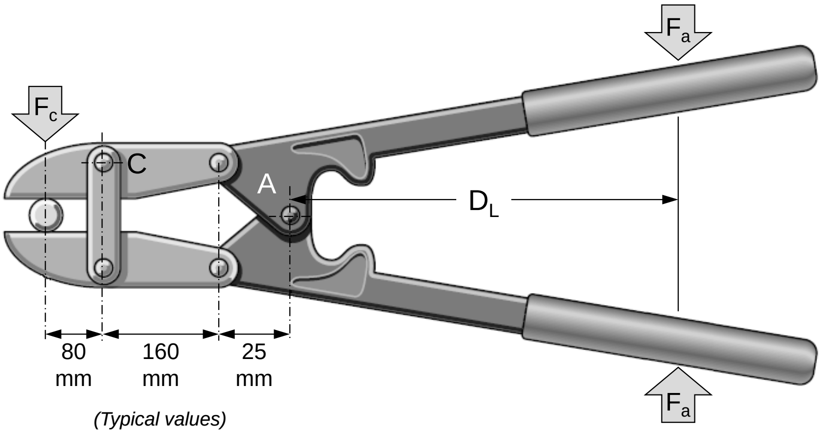


Figure XI-34 : Bolt cutter schematic

XI.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.

XI.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.

XI.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 XI-35 and Figure XI-36) show the cutting head and compressor of a high volume bolt cutter. The right hand picture (Figure XI-37) shows a battery operated hand held cutter. Similar designs are available.

Figure XI-35 : Hydraulic cutting head

Figure XI-36 : Hydraulic pump and controller

Figure XI-37 : Battery operated bolt cutter

Annex XII. Receiving CTUs

XII.1 Introduction

XII.1.1 This annex covers a number of actions, activities and safety advice for persons involved in the reception and unpacking of a CTU.

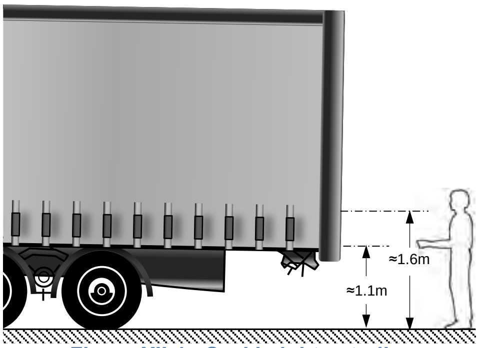


Figure XII-1 : Seal heights - trailer

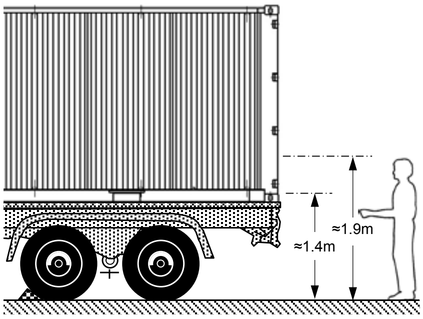


Figure XII-2 : seal heights - container

XII.2 Removing seals

XII.2.1 Stance

XII.2.1.1 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

XII.2.1.2 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.

XII.2.1.3 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.

XII.2.1.3.1 Avoid positions where the elbows are behind the body or above the shoulder.

XII.2.1.3.2 When gripping the cutting tool, the wrist should be kept as straight as possible.

XII.2.1.3.3 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.

XII.2.1.4 Figure XII-3 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 XII-3 : Cutting a seal on the ground

XII.2.1.5 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.

XII.2.1.6 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.

XII.2.2 Height adjustment

XII.2.2.1 As stated in V.2.1.3.3 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.

XII.2.2.2 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.

XII.2.2.3 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.

XII.2.2.4 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 XII-4). Such platforms should also be fitted with fall protection by way of barriers.

Figure XII-4 : Work platform

Figure XII-5 : Mobile work platform

Figure XII-6 : Mobile work device

Figure XII-7 : Mobile work station

XII.2.2.5 Mobile work platforms similar to the one shown in Figure V-6 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 V-8.

XII.2.2.6 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.

XII.2.2.7 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.

XII.2.2.7.1 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.

XII.2.2.7.2 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.

XII.2.2.7.3 Therefore if there is a choice only between a ladder and a step ladder the step ladder will probably provide the better work position.

XII.2.2.8 The diagram Figure XII-8, shows the correct position for the operator with the bolt cutters held between the step ladder and the CTU.

XII.2.2.9 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.

XII.2.2.10 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.

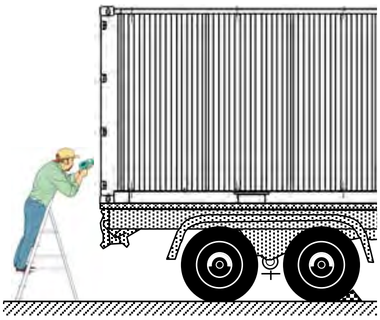


Figure XII-8 : Working on container doors

XII.3 Opening the doors

XII.3.1 External Checks

XII.3.1.1 Once the seal has been removed (see Annex XI.3.4.6) the CTU doors may be opened, however before doing so, a few more checks should be made.

XII.3.1.1.1 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 XII-9 : Flexitank label

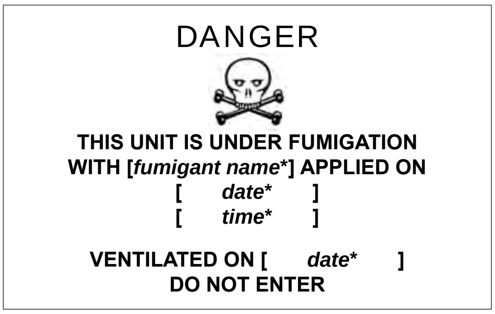


Figure XII-10 : Fumigation label

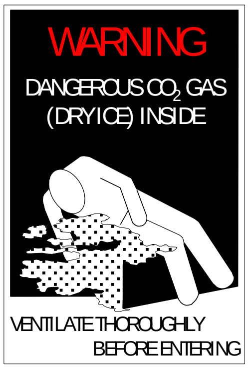


Figure XII-11: Dangerous atmosphere label

XII.3.1.1.2 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 XII-9). Cargo spaces that have been fumigated (Figure XII-10) or where there is CO_2 gas should be opened and ventilated before entering the CTU (Figure XII-11).

XII.3.1.2 Dangerous Atmospheres

XII.3.1.2.1 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.

XII.3.1.2.2 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.

XII.3.1.2.3 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.

XII.3.1.2.4 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.

XII.3.1.2.5 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.

XII.3.1.2.6 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 XII-12) may be taped over indicating that there is a risk of a fumigant being used recently.

Figure XII-12 : Vent tapped over

XII.3.1.2.7 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].

XII.3.1.2.8 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.

XII.3.1.3 If there are concerns that there are signs of a dangerous atmosphere, sampling the air inside the CTU before opening could be considered.

XII.4 Measuring Gases

XII.4.1 Gases found in CTUs

XII.4.1.1 Surveys carried out in Europe in 2007 and 2008 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. Annex XIII Table XIII-1 shows a number of commonly found gases.

XII.4.1.2 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.

XII.4.2 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.

XII.4.3 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 XII-13).

XII.4.4 If the concentration of gas within the CTU is above the TLV then the atmosphere should be considered as dangerous and those who are involved in opening the doors may consider the use of breathing apparatus and other PPE.

Figure XII-13 : Sampling gas

XII.5 Opening the doors

XII.5.1 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.

XII.5.2 The first action for steel doors is to "ring" them - that is to tap the flat surface of both doors. If the

[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

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.

XII.5.3 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 XII-14). 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 XII-14 : Safety chain

XII.5.4 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 XII-15 : Container doors

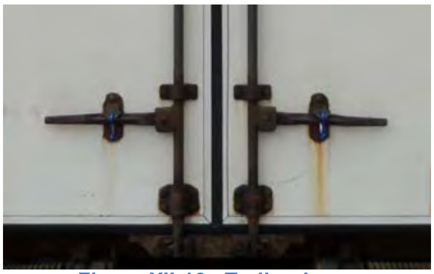


Figure XII-16 : Trailer doors

Figure XII-17 : Trailer doors

XII.5.5 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 XII-15 to Figure XII-17.

Figure XII-18 : Handles on same side

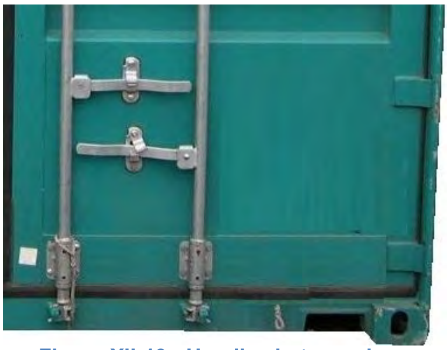


Figure XII-19 : Handles between bars

XII.5.6 They may be in the format where the handle is on the same side of the locking rod (Figure XII-18) or between the rods (Figure XII-19).

XII.5.7 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.

XII.5.7.1 Figure XII-20 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).

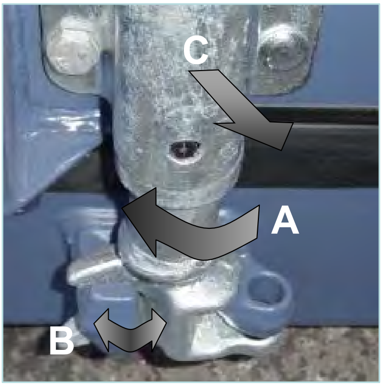


Figure XII-20 : Door cam operation

XII.5.8 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.

XII.5.9 If the doors do not open easily:

XII.5.9.1 check that the cams are clear of the keepers;

XII.5.9.2 check that the CTU is level and the doors are not binding on the frame;

XII.5.9.3 gain assistance to pull the doors open;

XII.5.10 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.

XII.5.11 As the door opens be prepared to step back quickly if:

XII.5.11.1 the contents of the CTU start to fall out; or

XII.5.11.2 the door appears to be pushing you, not you pulling the door.

XII.5.12 If you need to step out of the way move away from the hinged side of the door.

XII.5.13 Doors in the various types of CTU may open with different degrees of difficulty. The following contribute to this difficulty:

XII.5.13.1 Corrosion to the door component and hinge pins

XII.5.13.2 Damage to the door component, including door gear, or corner post resulting in the misalignment of the hinges.

XII.5.13.3 Condition of the gaskets which does not seat properly on the door.

XII.5.13.4 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 XII-21)

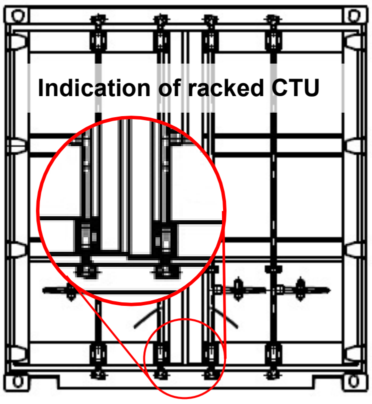


Figure XII-21 : Racked CTU

XII.5.14 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.

XII.5.15 DO NOT ENTER THE CTU YET


Figure XII-22 : Door retaining strap

XII.6 Ventilation

XII.6.1 Introduction

XII.6.1.1 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.

XII.6.1.2 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.

XII.6.2 Planning

XII.6.2.1 When ventilating CTUs a number of factors will determine the action required:

XII.6.2.1.1 The concentration of the gas. The greater the concentration the longer the CTU will require for ventilation.

XII.6.2.1.2 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.

XII.6.2.1.3 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.

XII.6.2.1.4 The size of the CTU. A 12 m long CTU has approximately twice the internal volume of a 6 m unit, and if the doors are only at one end, the circulation of gas has to travel considerably further.

XII.6.2.1.5 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.

XII.6.2.1.6 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.

XII.6.2.1.7 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.

XII.6.3 Ventilation of containers can happen in two ways, natural or forced ventilation.

XII.6.3.1 Natural ventilation:

XII.6.3.1.1 This can be done by simply opening the doors.

XII.6.3.1.2 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.

XII.6.3.1.3 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.

XII.6.3.2 Forced ventilation

XII.6.3.2.1 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.

XII.6.3.2.2 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.

XII.6.3.3 General Safety

XII.6.3.3.1 Do not enter the CTU during ventilation.

XII.6.3.3.2 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 20 meters all around the CTU should be set.

XII.6.3.3.3 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.

XII.6.3.3.4 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.

XII.6.3.3.5 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.

XII.6.3.3.6 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.

XII.6.3.3.7 If in doubt, or for questions always contact a local company who specialises in the ventilation and de-gassing of CTUs.

XII.6.3.4 Environment

XII.6.3.4.1 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.

XII.6.3.4.2 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.

XII.6.4 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.

Annex XIII. Common Hazardous Gases

XIII.1 The following chart shows limits of common hazardous gases in shipping containers. For part of these gases there is a legal limit. Substances for which no legal limit exists, the limit (formerly MAC value) used is the one that was in force until January 1, 2007 in the Netherlands.

Name of substance	UN Number	CAS-number	TWA 8 hour		TWA 15 min	H
			mg/m3	ppm	mg/m3	
Ammonia[1]	2967	7664-41-7	14	20	36	
Benzene[1]	1114	71-43-2	3.25	1		H
Hydrocyanic acid[1]	1051	74-90-8	1	0.9	10	H
Chloropicrin[2]	1580	76-06-2	0.7	0.1		
1,2-Dichloroethane[1]	1150	107-06-2	7	1.5		
Formaldehyde[1]	1198	50-00-0	0.15	0.1	0,5	
Phosphine[1]	2199	7803-51-2	0.14	0.1	0,28	
Carbon dioxide[1]	1361	124-38-9	9000	5000		
Carbon monoxide[1]	1016	630-08-0	29	25		
Methyl bromide[2]	2416	74-83-9	1	0.3		H
Sulfuryl fluoride[2]		2699-79-8	10	2.5		
Styrene[2]	2055	100-42-5	86	20	172	
Toluene[1]	1294	108-88-3	150	40	384	
Xylene[1]	1307	1330-20-7	210	48	442	H

1 Legal limit under the Working Conditions Decree

2 Applicable MAC limit until January 1, 2007. Sometimes called the indicative limit.

Notes

CAS - number To facilitate unequivocal identification every substance has had a so-called CAS-number added, i.e. the number under which the 'Chemical Abstract' Service registers the substance

TWA Time Weighted Average. In addition to the maximum allowable concentration for an exposure time of 8 hours a day, for some substances a limit is also set for short-term exposure of up to 15 minutes.

H Skin absorption
Substances that are absorbed relatively easily by the skin, which could mean a substantial contribution to the total internal exposure, are designated with an H. In addition to measures against inhalation of these substances, appropriate measures need to be taken to avoid skin contact

Table XIII-1 : Gases found in CTUs

Annex XIV. In-service repair criteria

Comment [B1]: Lars K Please see comment 14.3.4.4

There are a number of inspection and repair criteria available and many owners operated their own version. However the Common Interchange Criteria (CIC) has been published by the Container Owners Association and represents an inspection criteria used by leasing companies (for interchange) and is almost identical to the International Chamber of Shipping's in-service Unified Container Inspection and Repair Criteria (UCIRC).

Comment [B2]: Al Le M Where ISO dimensional tolerances are referenced, the actual dimensions should be stated. If not the shipper or consignee will ignore it.

	Component	Damage	Action Required
Rail Inspection Criteria	All rails, including side rails, headers and sills	Holed, cut, torn or cracked; broken component and/or weld	REPAIR
		Missing or loose parts or fasteners	REPAIR
		Any deformation, such as bend, bow, dent, etc.	If exceeding ISO dimensional tolerances, see Table A
	Top and bottom rails	Bend or dent within 250 mm (10 in) of a corner fitting	The weld or other connection to the corner fitting must be carefully examined and repaired if it gives any evidence of a break, cut, tear, crack, hole or other damage
	Top side rails	Any deformation such as bend, bow, dent, etc. EXCEPT on a header extension plate or corner protection plate	If more than 30 mm (1-3/1 6 in) deep, REPAIR
	Front and rear headers	Any deformation such as bend, bow, dent, etc. EXCEPT on a header extension plate or corner protection plate	If more than 40 mm (1-9/1 6 in) deep, REPAIR
	Rain gutters	Any deformation such as bend, bow, dent, etc.	If door operation or securement is impaired, REPAIR
	Bottom side rails, front and door sills	Any deformation such as bend, bow, dent, etc. ON A WEB	If more than 50 mm (2 in) deep, REPAIR
		Any deformation, such as bend, bow, dent, etc. ON A FLANGE	If torn, cracked or cut, REPAIR
	Door headers and sills	Interference with door closure, securement and/or weather tightness weather tightness	REPAIR
Corner post inspection criteria	All corner posts, including J-bars	Holed, cut or torn; broken component and/or weld	REPAIR
		Missing or loose parts or fasteners	REPAIR
		Any deformation, such as bend, bow, dent, etc.	If exceeding ISO dimensional tolerances, see Table A
	All corner posts, front and rear	Any deformation, such as bend, bow, dent, etc.	If more than 20 mm (1 3/16 in), regardless of length or location, REPAIR
		Cracks	REPAIR
	Rear corner posts	Any deformation causing interference with door operation, securement or weather tightness	REPAIR
	J -bars	Any deformation such as bend, bow, dent, etc.	Door must be able to open fully (27O°). If door operation is impaired, REPAIR

Side / Front Panel Inspection Criteria	All side/front panels	Holed, cut, torn or cracked; broken component and/or weld	REPAIR
		Missing or loose parts or fasteners	REPAIR
		Any deformation, such as bend, bow, dent, etc.	If exceeding ISO dimensional tolerances, see Table A
		Any deformation such as bend, dent, etc. on a flat portion of a marking panel, or on an inboard or outboard face of a corrugation	If internal CUBE INTRUSION is GREATER than 35 mm (1-3/8 in), REPAIR Measured on exterior recessed corrugations as a 35 mm (1-3/8 in inward deformation
		Any bow involving the length or height of a wall	If internal dimensions are reduced by more than 50 mm (2 in), REPAIR
	Interior panel liners	Holes in full-height liners NOTE: Holes in partial-height liners are permitted and do not require repair, providing they do not interfere with cargo. Full-height liners, however, must be repaired per TIR regulations, i.e. if any hole has a diameter of more than 10 mm (3/8 in).	REPAIR
		Cut, torn, cracked or broken; missing or loose fasteners	REPAIR
	Ventilator covers	Broken, missing, etc.	If cracked or broken in raised, non-perforated area of ventilator enclosing air passage, REPAIR OR if damage exceeds TIR opening

Door inspection criteria	Door assembly, including hardware	Holed, cut, torn or cracked; broken component and/or weld	REPAIR
		Missing or loose parts or fasteners	REPAIR
		Any deformation, such as bend, bow, dent, etc.	If door operation or securement is impaired, REPAIR OR if exceeding ISO dimensional tolerances, see Table A
		Seized, frozen or stiff	If door operation or securement is impaired, REPAIR
		Lack of water-tightness	REPAIR
	Door panels	Any deformation such as bend, bow, dent, etc.	If internal CUBE INTRUSION is GREATER than 35mm (1-3/8 in), REPAIR
		Any bow involving the length or height of a panel	If internal dimensions are reduced more than 50 mm (2 in) at any point, REPAIR
	Door gaskets	Loose or missing	REPAIR
		Cut, torn, cracked or burned	If not light-tight AND water-tight, REPAIR

	Component	Damage	Action Required
Roof inspection criteria	Roof panels, header extension plates, corner protection plates and roof bows	Holed, cut, torn or cracked; broken component and/or weld	REPAIR
		Missing or loose parts or fasteners	REPAIR
		Any deformation, such as bend, bow, dent, etc.	If exceeding ISO dimensional tolerances, see Table A
	Roof bows	Any deformation, such as bend, bow, dent, etc.	If more than 50 mm (2 in) in any direction, REPAIR
	Corner protection plates and header extension plates	Any deformation, such as bend, bow, dent, etc.	If internal dimensions are reduced by more than 50 mm (2 in), REPAIR
	All roof panels	Any deformation such as bend, dent, etc.	If internal CUBE INTRUSION is GREATER than 50 mm (2 in), REPAIR
		Any bow involving the length or width of the roof	If internal dimensions are reduced by more than 50 mm (2 in), REPAIR

Floor inspection criteria	Floor, including threshold plate and centre spacer	Holed	If light leaks, regardless of diameter of hole, REPAIR
		Broken component and/or weld; missing, loose or protruding fasteners NOTE: No repair is necessary to cracked or broken welds of centre spacers if light does not leak	REPAIR
		Light leakage gaps between boards	REPAIR
	Wooden flooring	Delamination or splinters	REPAIR
		Gouges (regardless of length)	If more than 1 5 mm (9/1 6 in) deep, REPAIR; OR if more than 5 mm (3/16 in) deep, throughout a width of more than 1 50 mm (6 in) of the gouge, REPAIR
		Different heights of surfaces of adjacent planks or panels or between top plates of tunnel and fork pockets and floor boards	If difference is more than 10 mm (3/8 in), REPAIR
	Plank flooring	Cracked or split	If light leaks, REPAIR
	Threshold plate	Bent upwards	If more than 5 mm (3/16 in), REPAIR

	Component	Damage	Action Required
Under-structure inspection criteria	Cross members, forklift pocket components (including straps), outriggers and gooseneck tunnel components	Holed, cut, torn or cracked; broken component and/or weld	REPAIR
		Missing or loose parts or fasteners	REPAIR
		Any deformation, such as bend, bow, dent, etc.	If exceeding ISO dimensional tolerances, see Table A
		Any deformation such as bend, bow, dent, etc. ON A WEB	If more than 50 mm (2 in) in any direction, REPAIR
		Any deformation such as bend, bow, dent, etc. ON A BOTTOM FLANGE	If torn, cracked or cut, REPAIR
	Cross members, forklift pocket components (including straps), outriggers and gooseneck tunnel components (continued)	Any deformation such as bend, bow, dent, etc. ON A TOP FLANGE	If intrusion into container is more than 50 mm (2 in), REPAIR
		TOP FLANGE separated from bottom of wood or steel flooring	If separation at point of attachment to floor, measured at the formed edge of the top flange, is more than 10mm (3/8 in), REPAIR
	Gooseneck tunnel assembly and fork- lift pocket top plate	Any deformation such as bend, bow, dent, etc.	If more than 50 mm (2 in), REPAIR

Miscellaneous inspection criteria	Lash fittings	Broken parts and/or welds; missing or loose parts or fasteners	REPAIR
		Bent	If more than 50 mm (2 in) into the interior space of the container, REPAIR
	Markings required by regulations, international standard	Missing, loose or defaced	REPAIR
	Markings required by owner	Missing, loose or defaced	Consult with owner
	Marking plates	Loose, broken, missing plate or fasteners; illegible data	REPAIR
	Corner fittings and their weld attachments	Cracked, loose, broken; apertures outside ISO dimensional tolerances	REPAIR
	Entire container	Any deformation such as bend, bow, dent, etc. that affects ISO required diagonal dimensions between comer fitting apertures	If deformation exceeds ISO tolerances, REPAIR
	End frame components (corner posts, front panel, doors, headers, sills, corner fittings)	Any deformation such as bend, bow, dent, etc. that affects other ISO required dimensions	If deformation exceeds ISO tolerances plus 5 mm (3/16 in) on end faces or plus 10 mm (3/8 in) on side faces, REPAIR
	Entire container, EXCEPT end frame components	Any deformation such as bend, bow, dent, etc. that affects other ISO required dimensions	See Table A, below

	Components	CIC + ISO Damage Limits
Tolerance limits for damage (ISO and CIC tolerance)	Side panels	* OUTWARDS: Maximum 20 mm (1 3/16 in) beyond plane of side surfaces of corner fittings * For side panels, measured on interior recessed corrugations as a 30 mm (1 -3/16 in) outward deformation
	Top side rails	OUTWARDS: Maximum 10 mm (3/8 in) beyond plane of side surfaces of corner fittings UPWARDS (rails): Maximum 4 mm (5/32 in) above plane of upper surfaces of top corner fittings
	Bottom side rails	OUTWARDS: Maximum 10 mm (3/8 in) beyond plane of side surfaces of corner fittings DOWNWARDS: Not below the plane of the lower surfaces of the bottom corner fittings
	Front and door headers Front and door panels	OUTWARDS: Maximum 5 mm (3/16 in) beyond plane of end surfaces of corner fittings UPWARDS (headers): Maximum 4 mm (5/32 in) above plane of upper surfaces of top corner fittings
	Front and door sills (20' containers) Door sill (40' containers)	OUTWARDS: Maximum 5 mm (3/16 in) beyond plane of end surfaces of corner fittings DOWNWARDS: Not below the plane of the lower surfaces of the bottom corner fittings
	Front sill (40' containers)	OUTWARDS: Sill face must be at least 1 mm (1/32 in) behind plane of end surfaces of corner fittings DOWNWARDS: Not below the plane of the lower surfaces of the bottom corner fittings
	Corner posts	INWARDS: Follow criteria in Corner Post Inspection Criteria table [20 mm (1 3/16 in)] maximum. OUTWARDS: Maximum 5 mm (3/16 in) beyond plane of end surfaces or 10 mm (3/8 in) beyond plane of side surfaces of corner fittings
	Roof panels	DOWNWARDS: Follow Roof Inspection Criteria table [50 mm (2 in)] maximum internal dimension reduction) UPWARDS: Maximum 1 5 mm (5/8 in) above plane of upper surfaces of top corner fittings
	Cross members, outriggers, fork-lift pocket sides and gooseneck tunnel rails	DOWNWARDS: Lower flange cannot be lower than [15mm (9/16 in)] from its original position or below the plane of the lower surfaces of the bottom corner fittings INWARDS (fork-lift pocket sides): See "Fork-lift pocket opening WIDTH" below
	Fork-lift pocket strap	DOWNWARDS: Minimum 1 0 mm (3/8 in) above plane of the lower surfaces of the bottom corner fittings UPWARDS: See "Fork-lift pocket opening HEIGHT" below
	Fork-lift pocket opening	WIDTH: "LOADED" pockets: Minimum 345 mm (1 3 5/8 in) "EMPTY" pockets: Minimum 295 mm (11 5/8 in)
		HEIGHT: "LOADED" pockets: Minimum 105 mm (4 1/8 in) "EMPTY" pockets: Minimum 92 mm (3 5/8 in)
	Gooseneck tunnel	LENGTH: Minimum 3140mm (123 7/8 in); Maximum 3510mm (138 1/4 in)
		WIDTH of tunnel opening X: Minimum 1019 mm (40 1/8 in); Maximum 1042 mm (41 in)
		HEIGHT of tunnel opening B: Minimum 107mm (41/4 in); Maximum 130mm (5 1/8 in)
	Door opening	WIDTH: Minimum 2281 mm (89-13/16 in)
		HEIGHT: 8' high container: Minimum 2129mm (83-13/16 in) 8'6" high container: Minimum 2256 mm (88-13/16 in) 9'6" high container: Minimum 2560mm (98-1 3/1 6)

Annex XV. **CTU types**

XV.1 ISO Containers

XV.1.1 Containers – General

XV.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 (35,3 ft^3)

XV.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 (150 ft^2) or
  - at least 7 m^2 (75 ft^2) if it is fitted with top corner fittings.

XV.1.1.3 Container types

World container fleet at end 2011 by operating category and summarised type				
	Teu		**Container**	
	Number	**Share (%)**	**Number**	**Share (%)**
Maritime - 8' width				
Dry freight standard	26,849,672	89.25	17,719,244	89.91
Dry freight special	956,906	3.18	665,771	3.38
Refrigerated	2,048,028	6.81	1,094,908	5.56
Tank (liquid bulk)	229,517	0.76	227,517	1.15
Subtotal	30,084,123		19,707,440	
Regional - 8' 6" width (North Americam domestic)				
Dry freight standard	551,275	94.40	210,480	94.11
Dry freight special	13,014	2.23	5,445	2.43
Refrigerated	19,696	3.37	7,731	3.46
Subtotal	583,985		223,656	
Regional - 2.5m width (non cellular pallet-wide, swapbody and swaptank)				
Dry freight standard	423,310	72.73	286,270	70.79
Dry freight special	109,956	18.89	81,156	20.07
Refrigerated	12,237	2.10	6,355	1.57
Swaptank	36,516	6.27	30,639	7.58
Subtotal	582,019		404,420	
Grand total	31,250,127		20,335,516	

Figure XV.1 : World container fleet

A teu (twenty foot equivalent) refers to a standard unit based on an ISO container of 20 feet length (6.10 m), used as a statistical measure of traffic flows or capacities.
One standard 40' ISO Series I container equals 2 teu
A dry freight special generally refers to open top, open side and platform based containers.

[1] ISO 830:1999 Freight containers - vocabulary

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

XV.1.1.4 ISO container dimensions

ISO Freight container sizes																	
Freight container description	Freight container designation	ISO Size Code	Length, *L*					Width, *W*					Height, *H*				
			mm	tol	ft	in	tol	mm	tol	ft	in	tol	mm	tol	ft	in	tol
45ft long x 9ft 6in high	1EEE	L5	13,716	0 / -10	45		0 / - 3/8	2,438	0 / -5	8		0 / -3/16	2,896	0 / -5	9	6	0 / -3/16
45ft long x 8ft 6in high	1EE	L2											2,591	0 / -5	8	6	0 / -3/16
40ft long x 9ft 6in high	1AAA	45	12,192	0 / -10	40		0 / - 3/8	2,438	0 / -5	8		0 / -3/16	2,896	0 / -5	9	6	0 / -3/16
40ft long x 8ft 6in high	1AA	42											2,591	0 / -5	8	6	0 / -3/16
40ft long x 8ft high	1A	40											2,438	0 / -5	8		0 / -3/1
40ft long half height	1AX	48											1,295	0 / -5	4	3	0 / -3/16
30ft long x 9ft 6in high	1BBB	35	9,125	0 / -10	29	11 ¼	0 / - 3/8	2,438	0 / -5	8		0 / -3/16	2,896	0 / -5	9	6	0 / -3/16
30ft long x 8ft 6in high	1BB	32											2,591	0 / -5	8	6	0 / -3/16
30ft long x 8ft high	1B	30											2,438	0 / -5	8		0 / -3/1
30ft long half height	1BX	38											1,295	0 / -5	4	3	0 / -3/16
20ft long x 9ft 6in high	1AAA	25	6,058	0 / -10	19	10 ½	0 / - 3/8	2,438	0 / -5	8		0 / -3/16	2,896	0 / -5	9	6	0 / -3/16
20ft long x 8ft 6in high	1AA	22											2,591	0 / -5	8	6	0 / -3/16
20ft long x 8ft high	1A	20											2,438	0 / -5	8		0 / -3/1
20ft long half height	1AX	28											1,295	0 / -5	4	3	0 / -3/16
10ft long x 8ft high	1A	10	12,192	0 / -10	9	9 ¾	0 / - 3/8	2,438	0 / -5	8		0 / -3/16	2,438	0 / -5	8		0 / -3/1
10ft long half height	1AX	18											1,295	0 / -5	4	3	0 / -3/16

Figure XV.2 : ISO container sizes

XV.1.1.5 In addition to the standard lengths there are regional / domestic variations which include 48ft, 53ft and longer.

XV.1.1.6 The standard width is 8ft (2.438mm), with regional variations of 8ft 6in (USA) and 2.5m.

XV.1.1.7 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
- 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.

XV.1.1.8 Fork-lift pockets

- May be provided on 20ft and 10ft containers
- Are not generally fitted on 30ft and longer containers.

XV.1.1.9 On 20ft are generally fitted with 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.

XV.1.2 General Purpose Containers

XV.1.2.1 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.

XV.1.2.2 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 XV.3 : 20' GP

Figure XV.4: 40' GP

Figure XV.5: 45' GP

XV.1.2.3 The GP container is by far the largest container type in the intermodal fleet comprising 89.7% of the ISO series I (maritime) fleet (see **Error! Reference source not found.**). The 20ft x 8ft 6in GP container is the largest single container type forming just under half of the GP fleet and about 41% of all container types and sizes.

World fleet of maritime dry freight

		Containers	Share (%)
20ft	**(8ft 6in)**	8,627,254	48.69
20ft	**(9ft 6in)**	11,600	0.07
40ft	**(8ft 6in)**	2,731,038	15.41
40ft	**(9ft 6in)**	6,145,000	34.68
45ft	**(9ft 6in)**	203,352	1.15
Others		1,000	0.01
Total		17,719,244	

Figure XV.6 World General purpose fleet by length and height

GP containers generally have passive ventilation, provided by two high level vents mounted on the side walls and have a ISO Type code G1.

XV.1.2.4 Typical cargoes

XV.1.2.4.1 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.

XV.1.2.4.2 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.

XV.1.2.4.3 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 XV.7 Hand stacking

Figure XV.8 Using fork truck

Figure XV.9 Unit load packing

XV.1.2.4.4 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 XV.10 Individual cars

Figure XV.11 Car racks

Figure XV.12 Solid bulk

Figure XV.13 Bulk liquid

XV.1.2.4.5 The GP container is also becoming a major transporter of bulk powders, granules and liquids, within dry liner bags or flexitanks.

XV.1.2.5 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.

XV.1.2.5.1 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
40ft long x 8ft high	1A							2,197.0	7	2 ½	61.4	2,495
40ft long half height	1AX							1,054.0	3	6 ½	29.5	1,236
30ft long x 9ft 6in high	1BBB	8,931	29	3 ⅝	2,330	7	7 ¾	2,655.0	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
20ft long x 8ft high	1A							2,197.0	7	2 ½	30.0	1,000
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 XV.14ISO container sizes and dimensions

XV.1.2.5.2 Minimum door openings

- 9ft 6in high – 2,585 mm high x 2,330 mm wide.
- 8ft 6 in high – 2,280 mm high x 2,330 mm wide
- 8ft high – 2,136 x 2,330 mm wide

XV.1.2.5.3 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:

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 XV.15 Guide for load distribution

XV.1.2.6 Variations

XV.1.2.6.1 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 **Error! Reference source not found.** shows the doors above the gooseneck tunnel and fork pockets for handling when empty.

Figure XV.16 40ft 8ft 6in high double ended container

Figure XV.17 With doors open

XV.1.2.6.2 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.

XV.1.3 Closed vented or ventilated containers:

XV.1.3.1 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 XV.18 20ft passive ventilated container

Figure XV.19 Ventilated container inner grill

XV.1.3.2 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.

XV.1.3.3 This is a very specialised piece of equipment and was quite popular in the 1990's with in excess of 5,000 in service. In 2012 the exact numbers is of these and forced ventilated containers are not known.

XV.1.3.4 The type codes for the simplest forms of these containers are:

- V0 for those specifically designed for carriage of cargo where natural ventilation is required, and
- V2 for those having mechanical ventilation.

XV.1.3.5 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.

XV.1.3.6 Dimensions and volume

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

XV.1.3.7 Minimum internal dimensions and volume

Similar to the 20ft GP Container

XV.1.3.8 Minimum door openings

Similar to the 8ft 6in high GP containers

XV.1.3.9 Rating and load distribution

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

XV.1.3.10 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.

XV.1.4 Bulk and bulk capable:

XV.1.4.1 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[3]."

XV.1.4.2 Within that standard two sub types are described:

"Box type – dry bulk non-pressurised container for tipping discharge having a parallelepiped[4] 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."

Figure XV.20 30ft dry bulk box container

XV.1.4.3 Many owners needing a box type dry bulk container have built general purpose containers with bulk capabilities. These are constructed to meet the requirements of ISO 1496/1[5]. The difference between the two standards is the strength of the front and rear walls. In ISO 1496 part 4 the walls are to be tested to a minimum of 0.6 of the payload, whereas part 1 only requires 0.4 of payload.

XV.1.4.4 Loading hatches are generally round, 600 mm in diameter varying in number from one centrally up to six along the centre line.

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

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

[5] ISO 1496-1:1991 as amended, Freight containers – specification and testing – Part 1 General cargo containers for general purposes.

XV.1.4.5 Discharge hatches come in a number of forms:

XV.1.4.5.1 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.

XV.1.4.5.2 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 XV.20, or as shown in Figure XV.22, 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 XV.21 Letterbox type hatch in container front wall

Figure XV.22 letterbox type hatch in fixed rear end

Figure XV.23 Cat flap type hatch in rear doors

XV.1.4.5.3 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.

XV.1.4.5.4 Box and hopper type dry bulk containers comprise 5.1% of the dry freight special fleet or 0.2% of the entire maritime fleet of containers.

XV.1.4.5.5 New type code designations are being introduced for all categories of dry bulk containers.

XV.1.4.5.6 Typical cargoes

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

XV.1.4.5.7 Dimensions and volume

The majority of bulk containers in Europe are 30ft long and often 2.5 m 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.

XV.1.4.5.8 Minimum internal dimensions and volume

Similar to the 30ft GP Container

XV.1.4.5.9 Minimum door openings

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

XV.1.4.5.10 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.

XV.1.4.5.11 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.

XV.1.5 Open top containers:

XV.1.5.1 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 XV.2420ft open (soft) top container

Figure XV.25 20ft open hard top container

XV.1.5.2 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.

XV.1.5.3 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.

XV.1.5.4 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 XV.26 20ft open top with tilt removed and rear header open

XV.1.5.5 Open top containers forms the largest type within dry freight specials, amounting to 189,203 containers or 0.96% of the total maritime fleet.

XV.1.5.6 Open tops are generally 20ft or 40ft long and 8ft 6 in high. There are few 9ft 6 in high to cater for some cargoes and which will enable standard tarpaulins or hard tops to be used.

World fleet of maritime dry freight special

		Containers	Share (%)
20ft	Open top	79,458	11.93
40ft	Open top	109,745	16.48
20ft	Folding flatrack	52,046	7.82
40ft	Folding flatrack	97,006	14.57
20ft	Cellular palletwide	22,990	3.45
40 / 45ft	Cellular palletwide	63,883	9.60
20 / 30 / 40ft	Dry bulk / silo	39,406	5.92
20 / 24 / 40ft	Fixed flatrack	17,240	2.59
20 / 24 / 40ft	Platform	12,031	1.81
20ft	Ventilated	3,090	0.46
20 / 40 / 45	Others†	168,876	25.37
Total		665,771	

† Open-side, car rack and military module

Figure XV.27 Dry freight special world-wide fleet

XV.1.5.7 The simplest form of this type of container is given the ISO type code U).

XV.1.5.8 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 XV.28 20ft open top with scrap steel

Figure XV.29 20ft open top with extra large tyres

XV.1.5.9 Dimensions and volume

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

XV.1.5.10 Minimum internal dimensions and volume

Similar to the GP Container

XV.1.5.11 Minimum door openings

Similar to the 8ft 6in high GP containers

XV.1.5.12 Rating and load distribution

As GP container.

XV.1.5.13 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 XV.30 20ft coil carrier

Figure XV.31 40ft ingot and bar carrier

Annex 3 - 1

Hard top open top containers have been adapted to carry large steel coils or long bars.[6] These specialist open top containers may have higher maximum gross mass values.

XV.1.6 Open side containers:

XV.1.6.1 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.[7] As a consequence of the self-supporting floor the tare generally increased.

XV.1.6.2 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.

XV.1.6.3 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 XV.32 45ft curtain sided swap body

Figure XV.33 20ft side door container

[6] Langh Ships

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

XV.1.6.4 Typical cargoes

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

XV.1.6.5 Dimensions

As GP container.

XV.1.6.6 Minimum internal dimensions and volume

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

XV.1.6.7 Minimum door openings

Reduced height to match the reduction of internal height.

XV.1.6.8 Rating and load distribution

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

XV.1.6.9 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 XV.34 20ft open side with mezzanine deck

XV.1.7 Platform based containers

XV.1.7.1 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 XV.35 20ft platforms

Figure XV.36 40ft fixed post flatrack

XV.1.7.2 The simplest form of platform container is given an ISO type code P0.

XV.1.7.3 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.

XV.1.7.4 There are approximately 17,000 fixed end flatracks in the maritime fleet.

XV.1.7.5 Fixed end flatracks are given a ISO type code P1 for containers with full end walls and P2 for fixed flatracks with posts (see Figure XV.36).

XV.1.7.6 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 XV.37 20ft with portal end frame

Figure XV.38 40ft folding flatrack

Figure XV.39 40ft folding super rack

XV.1.7.7 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.

XV.1.7.8 Folding end flatracks are given an ISO type code P3 for units with full end walls and P4 for those with folding posts with or without removable top transverse member.

XV.1.7.9 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.

The modern flatrack is manufactured to transport heavy project equipment either as a discrete transport unit, or as part of a temporary ‘tween deck where the heavy equipment can be loaded over two or more flatracks.

XV.1.7.10 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 XV.40 Stack of 40ft folding end flatracks

XV.1.7.11 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 1,953 mm (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.

XV.1.7.12 Minimum door openings

No doors fitted

XV.1.7.13 Rating and load distribution

Flatrack maximum gross mass values have increased over the past years, rising from 30,480 kg to 45,000 kg 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.

XV.1.7.14 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 XV.41 45ft car carrying folding flatrack

XV.1.8 Thermal containers:

XV.1.8.1 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.

XV.1.8.2 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.

XV.1.8.3 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 XV.42 20ft refrigerated container

Figure XV.43 40ft refrigerated container

XV.1.8.4 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.

XV.1.8.5 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.

XV.1.8.6 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.

XV.1.8.7 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.

XV.1.8.8 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.

XV.1.8.9 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.

Integral reefer containers have been given an ISO type code of R0.

World integrated reefer fleet			
		Containers	Share (%)
20ft	(8ft 6in)	132,618	12.11
20ft	(9ft 6in)	8,955	0.82
40ft	(8ft 6in)	21,323	1.95
40ft	(9ft 6in)	930,730	85.01
45ft	(9ft 6in)	772	0.07
Others		510	0.05
Total		1,094,908	

Figure XV.44 World reefer fleet

XV.1.8.10 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.

XV.1.8.11 Dimensions and volume

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

XV.1.8.12 Minimum 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	2,554.0	8	4 ½	81.5	2,878
40ft long x 9ft 6in high	1AAA	11,590	38		2,294	7	6 ½	2,554.0	8	4 ½	67.9	2,398
40ft long x 8ft 6in high	1AA							2,350.0	7	9 ½	62.5	2,697
20ft long x 9ft 6in high	1AAA	5,468	17	11	2,294	7	6 ½	2,554.0	8	4 ½	32.0	1,003
20ft long x 8ft 6in high	1AA							2,350.0	7	9 ½	29.5	1,081

Figure XV.45 ISO reefer container dimensions

XV.1.8.13 Minimum door openings

- Door width 2,290 mm 7ft 6in,
- Height for 9ft 6in high 2,570 mm 8ft 5in.
- Height for 8ft 6in high 2,265 mm 7ft 5in.

XV.1.8.14 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

XV.1.8.15 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).

XV.1.9 Tank containers:

XV.1.9.1 A tank container comprises two basic elements, the tank (barrel) or tanks and the framework and complies with the requirements of ISO 1496-3.[8]

XV.1.9.2 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.

XV.1.9.3 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.

XV.1.9.4 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.

XV.1.9.5 The ISO tank type codes are being changed at the time of writing.

XV.1.9.6 General information

More information on tanks can be found below.

XV.1.9.7 Typical cargoes

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

XV.1.9.8 Dimensions and volume

Practically all maritime tank containers are 20ft long and 8ft 6in high.

XV.1.9.9 Minimum internal dimensions and volume

Volume vary from 9,000 litres to 27,000

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

XV.1.9.10 Minimum door openings

No doors fitted

XV.1.9.11 Rating and load distribution

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

XV.1.9.12 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

XV.1.9.13 ISO Tank Containers

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.

XV.1.9.13.1 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.

Figure XV.46 20,000l frame tank

Figure XV.47 25,000 l frame tank

The two pictures above show a 20,000 litre (Figure XV.46) and a 25,000 litre design (Figure XV.47). Both are insulated. Both pictures show the cut away castellated light weight main beam. It is also possible to see that the beam is elevated above the level of the corner fitting in Figure XV.47 whereas Figure XV.46 shows the beam is lower with the bottom face of the beam about 16 mm above the lower face of the bottom corner fitting. This also shows a top rail significantly lower than its top corner fittings.

XV.1.9.13.2 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 XV.48 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 XV.48 Beam tank no top rail

Figure XV.49 Beam tank with top rail

Figure XV.49 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 XV.50 Four 10ft ISO beam tanks

Figure XV.50 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.

XV.1.9.13.3 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 XV.51 25,000 l collar tank

Figure XV.51 shows an insulated 25,000 litre collar tank. Once insulated it is virtually impossible to distinguish between the inset and outset collar design.

XV.1.10 Named cargo containers:

XV.1.10.1 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 XV.52 Double height car carrier

Figure XV.53 Single height car carrier

Figure XV.54 Livestock carrier

Figure XV.55 Genset container

XV.1.10.2 One particular container type is the Power Pack, which can be used to supply electrical 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.

XV.1.10.3 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.

XV.1.10.4 Externally it will be the same as a 20ft GP container

XV.2 European Swap Body

XV.2.1 General

XV.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;

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

XV.2.1.3 Swap bodies generally fall into three length categories:

XV.2.1.3.1 Class A: 13.6 or 13.712 m (45 ft) long

XV.2.1.3.2 Class B: 30 ft long

XV.2.1.3.3 Class C: 7.15, 7.45 or 7.8 m long. The most commonly used length in this class is 7.45 m

XV.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,

XV.2.1.5 Stackable swap bodies will have top fittings, where the external faces are 2.438 m (8 ft) when measured across the unit and 2.259 m between aperture centres. The placing of the top corner fittings is such that the container can be handled using standard ISO container handling equipment. In addition the container can be handled using grapple arms, although this lifting method appears to be becoming less common.

XV.2.1.6 They may be stacked although the stacking capability is likely to be well below that of the ISO container. Before stacking the container handler must check the stacking strength shown on the Safety Approval Plate, but the stackable swap body can be handled in the same way that series 1 ISO containers can Swap bodies will have bottom castings that are either the same width as the swap body itself, or 2.428 m apart when measured across the unit to the external faces of the castings. They will also a distance of 2.259 m between aperture centres when measured across the unit.

XV.2.1.7 Class C swap bodies, can be transferred from the road vehicle to their supporting legs and re-turned to them by on-board means.

XV.2.2 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 XV.56 Class C Swap body

XV.2.3 Open side swap body:

XV.2.3.1 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.

XV.2.3.1.1 Curtain side unit: swap body with movable or removable canvas or plastic material side walls normally supported on movable or removable roof bows.

XV.2.3.1.2 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.

XV.2.3.1.3 Tautliner: swap body with flexible, movable side walls (e.g. made of canvas or plastic material normally supported on movable webbing).

XV.2.3.1.4 Gated tautliner – swap body fitted with a swinging gate at either end to provide top lift or stacking capability at the 20 or 40 ft positions. A flexible, movable side wall may be fitted between the gates or over the full length of the swap body.

Figure XV.57 Class C side door swap body

XV.2.3.1.5 Full length side door: swap body with full length concertina doors to one or both sides

XV.2.4 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.

XV.2.5 Tank Swap Bodies (Swap Tanks)

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).

XV.2.5.1 Stackable

XV.2.5.1.1 The majority of recently built swap tanks are now stackable and 85 % of all swap tanks have top and side lifting capability.

XV.2.5.1.2 When considering stacking swap tanks it is important to differentiate between swap tanks and ISO containers which can be done by looking at the configuration of the top fitting and the side post. One of the characteristics that will be seen on the majority of all of these units is the double side lifting aperture, one in the post and the other in the fitting as shown in Annex 3 - 34. The second aperture in the post is required so that the unit can be lifted using a side lifter.

Figure XV.58 Swap tank corner post stepped back fitting

XV.2.5.1.3 The second identifying characteristic is the stepped back top fitting. As the top fittings are generally the same as those found on ISO tank containers, the positioning must be identical to that of the 20ft / 40ft ISO container; the fitting is set back from the post face to accomplish this.

Figure XV.59 Swap tank showing exposed ends

XV.2.5.1.4 A typical example of a swap tank is shown in Figure XV.59. The pressure vessel is attached to the “end” frames and there is a protective bottom rail / end frame to ensure that the risk of direct contact with the pressure vessel is minimised.

XV.2.5.1.5 The unit is insulated.

XV.2.5.1.6 The example shown in Annex 3 - 36 is a 12.192m long powder tank with top lift capabilities. Note the presence of the two apertures in the side posts and corner fittings indicating that the container is wider than ISO. This design is similar to that of the ISO collar tank.

Figure XV.60 Pressurised powder swap tank

XV.2.5.1.7 The swap tank should never be lifted from the side when loaded.

XV.2.5.2 Non Stackable

XV.2.5.2.1 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 XV.61 Non stackable swap tank

XV.2.5.2.2 Figure XV.61 shows an example of a modern non stackable demountable swap tank. The notable features are the two grapple lift points (highlighted in yellow and arrowed). The second feature is the legs which are shown in the erected (down) position. Legs of this design enable the swap tank to be demounted from the transport truck / trailer and left for loading, unloading or storage.

XV.2.5.3 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.

XV.2.6 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.

XV.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 2.6 m or 8ft 6 in 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 as defined in 5.1 or 5.2 above.

Annex XVI. Unsafe Containers

XVI.1 Introduction

XVI.1.1 This section only refers to containers engaged in the carriage of international transport covered by the International Convention for Safe Containers. Regional and domestic containers may be covered by local regulations or legislation that requires the container to be maintained in line with the requirements of the CSC.

XVI.1.2 The International Convention for Safe Containers (CSC), 1972 includes information on unsafe containers and serious structurally sensitive components and the definition of serious structural deficiencies. While the recommendations are aimed at Control Officers, it is important that the responsible person at the packer's facility undertakes structural checks that include all of the structurally sensitive components.

XVI.1.3 Control officers who find a container that is in a condition that creates an obvious risk to safety should stop the container until it can be ensured that it is in a safe condition to continue in service.

XVI.1.4 All containers with serious structural deficiencies in structurally sensitive components (see section XVI.2) should be considered to be in a condition that creates an obvious risk to safety.

XVI.1.5 Control officers should notify the container owner whenever a container is placed under control.

XVI.1.6 Control officers may permit the onward movement of a container that has been stopped to its ultimate destination providing that it is not lifted from its current means of transport.

XVI.1.7 Empty containers with serious structural deficiencies to structurally sensitive components are also deemed to place a person in danger. Empty containers are typically repositioned for repair at an owner-selected depot provided they can be safely moved; this can involve either a domestic or an international move. Any damaged container being so repositioned should be handled and transported with due regard to its structural deficiency. Clear signage should be placed on all sides and the top of the damaged container to indicate it is being moved for repairs only.

XVI.1.8 Empty containers with severe damage that prevents safe lifting of the container, e.g., damaged, misplaced or missing corner fittings or a failure of the connection between side walls and bottom side rails, should only be moved when carried on a platform-based container, such as a flatrack.

XVI.1.9 Major damage may be the result of significant impact which could have been 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.

XVI.1.10 Damage to a container may appear serious without creating an obvious risk to safety. Some damage, such as holes, may infringe customs requirements but may not be structurally significant.

XVI.2 Structurally sensitive components (and definition of serious structural deficiencies for consideration by authorized control officers only)

XVI.2.1 The structurally sensitive components of a container that should be examined for serious deficiencies are the:

- top rail;
- bottom rail;
- header;
- sill;
- corner posts;
- corner and intermediate fittings;
- understructure; and
- locking rods.

XVI.2.2 The following criteria should be used to make immediate out-of-service determinations by authorized control officers. They should not be used as repair and in-service criteria under a CSC ACEP or a periodic examination scheme. Figure XVI.5 : Control Flow Chart is a flow chart that illustrates the actions to be taken by an authorized control officer

Structurally Sensitive Component	**Serious Structural Deficiency**
Top rail	Local deformation to the rail in excess of 60 mm or separation or cracks or tears in the rail material in excess of 45 mm in length. Note: On some designs of tank containers the top rail is not a structurally significant component.
Bottom rail	Local deformation perpendicular to the rail in excess of 100 mm or separation or cracks or tears in the rail's material in excess of 75 mm in length.
Header	Local deformation to the header in excess of 80 mm or cracks or tears in excess of 80 mm in length.
Sill	Local deformation to the sill in excess of 100 mm or cracks or tears in excess of 100 mm in length.
Corner posts	Local deformation to the post exceeding 50 mm or tears or cracks in excess of 50 mm in length.
Corner and intermediate fittings (Castings)	Missing corner fittings, any through cracks or tears in the fitting, any deformation of the fitting that precludes full engagement of securing or lifting fittings, any deformation of the fitting beyond 5 mm from its original plane, any aperture width greater than 66.0 mm, any aperture length greater than 127.0 mm, any reduction in thickness of the plate containing the top aperture that makes it less than 23.0 mm thick or any weld separation of adjoining components in excess of 50 mm in length.
Understructure	Two or more adjacent cross members missing or detached from the bottom rails. 20% or more of the total number of cross members missing or detached. Note: If onward transportation is permitted, it is essential that detached cross members are precluded from falling free.
Locking rods	One or more inner locking rods are non-functional. Note: Some containers are designed and approved (and so recorded on the CSC Plate) to operate with one door open or removed.

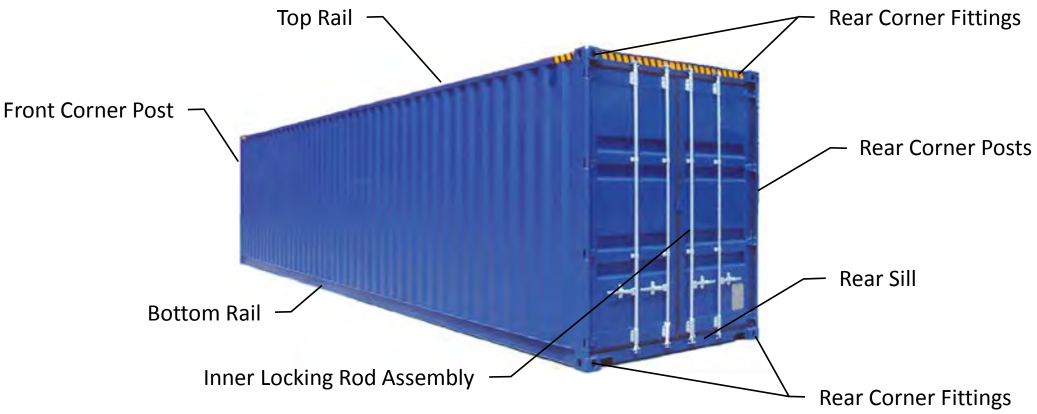


Figure XVI.1 : Container components

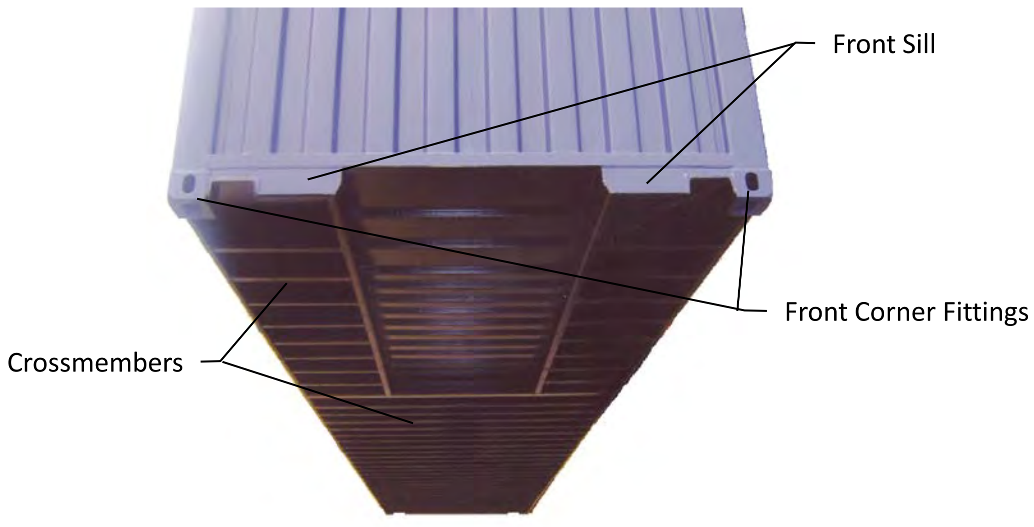


Figure XVI.2 : Dry Freight Container Underside

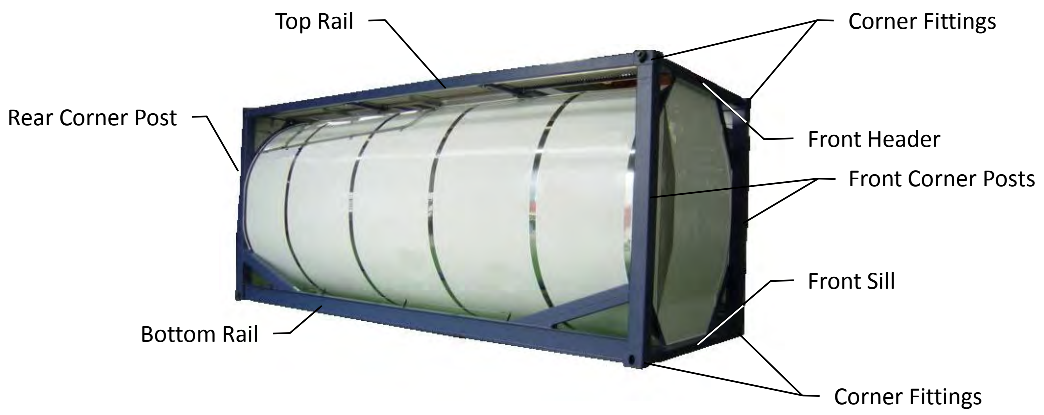


Figure XVI.3 : Collar Tank Container

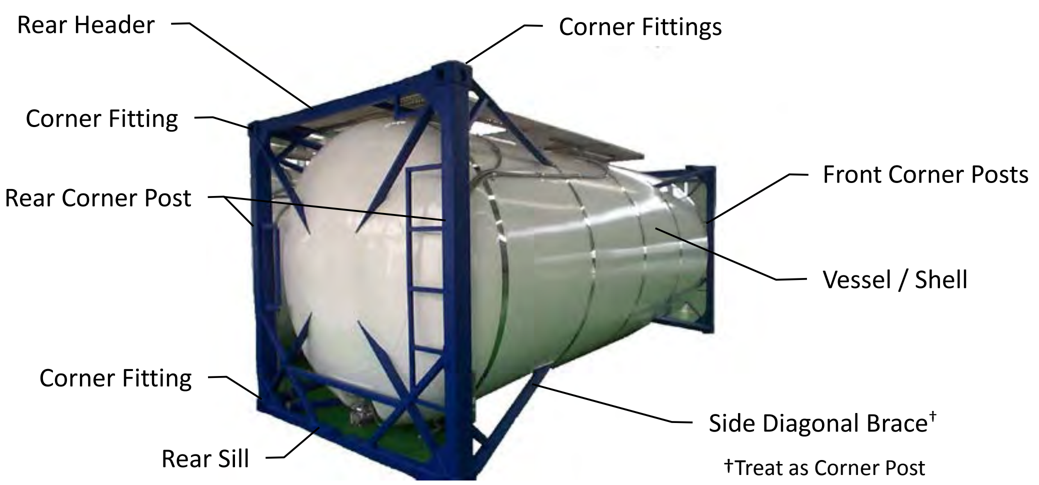


Figure XVI.4 : Beam Tank Container

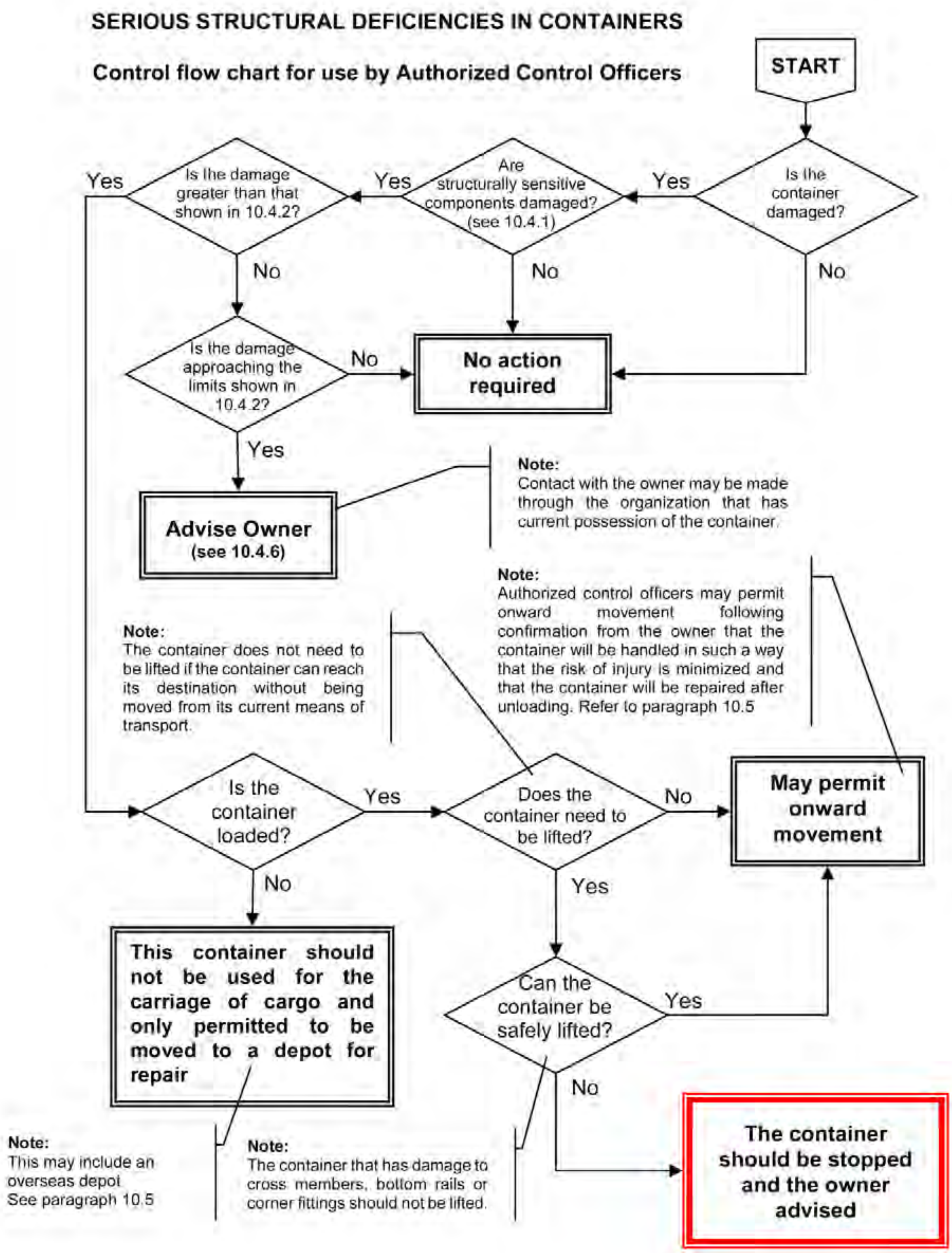


Figure XVI.5 : Control Flow Chart

XVI.2.3 The effect of two or more items of damage in the same structurally sensitive component, even though each is less than that specified in the above table, could be equal to, or greater than, the effect of a single item of damage listed in the table. In such circumstances, the control officer may stop the container and seek further guidance from the Contracting Party.

XVI.2.4 For tank containers, the attachment of the shell to the container frame should also be examined for any readily visible serious structural deficiency comparable to that specified in the table. If any such serious structural deficiency is found in any of these attachments, the control officer should stop the container.

XVI.2.5 The end frame locking mechanism of platform containers with folding end frames and the hinge pins about which the end frame rotates are structurally sensitive components and should also be inspected for significant damage. Containers with folding end walls that cannot be locked in the erect position should not be moved with the end walls erect.

XVI.2.6 The deficiencies listed in paragraph XVI.2.1 are not exhaustive for all types of containers or all possible deficiencies or combination of deficiencies.

XVI.2.7 When an authorized control officer is concerned that a container is found to be approaching the limit of a serious structural deficiency the officer should advise the owner to take precautions as necessary to allow container movement

Annex XVII. Packing Marks

XVII.1 Introduction

XVII.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.

XVII.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.

XVII.1.3 The use of pictorial symbols does not provide any guarantee of satisfactory handling; proper protective packaging is therefore of primary importance.

XVII.1.4 The symbols shown in this annex are those most regularly exhibited and there others available in the international standard 7000.[1]

XVII.2 Symbols

XVII.2.1 Display of symbols

XVII.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.

XVII.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.

XVII.2.2 Colour of symbols

XVII.2.2.1 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.

XVII.2.2.2 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.

XVII.2.3 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.

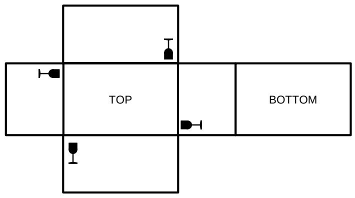
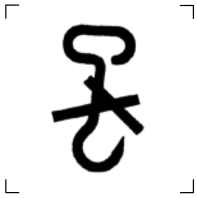
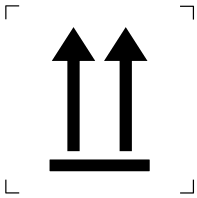
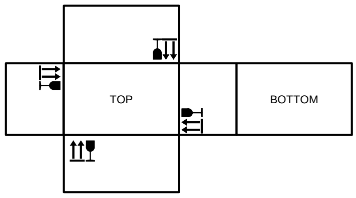
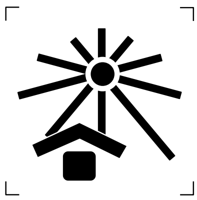
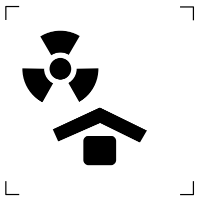
XVII.2.4 Positioning of symbols

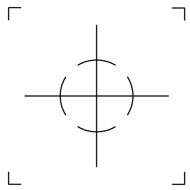
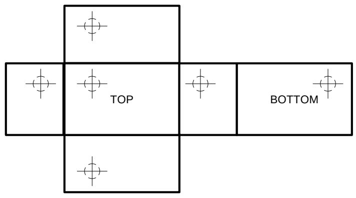
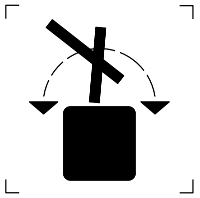
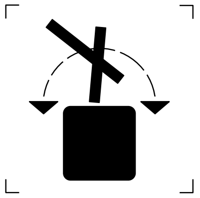
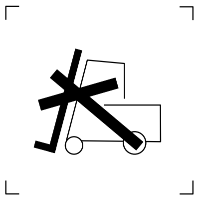
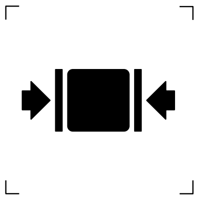
Particular attention shall be paid to the correct application of the symbols, as faulty application may lead to misinterpretation. Symbols No. 7 and No. 16 shall be applied in their correct respective positions and in appropriate respective places in order to convey the meaning clearly and fully.

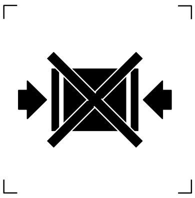
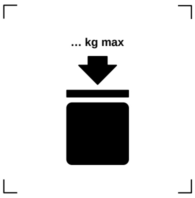
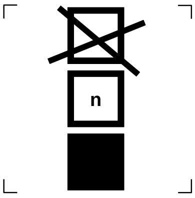
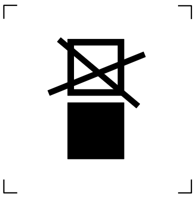
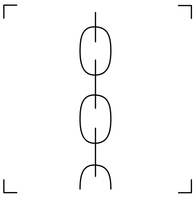
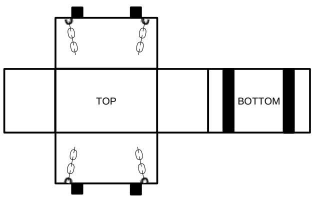
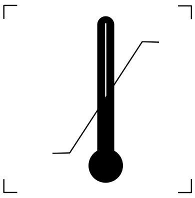
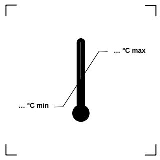
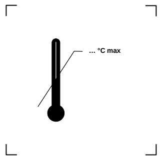
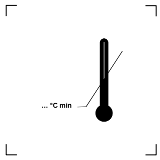
XVII.3 Handling instructions

Handling instructions shall be indicated on transport packages by using the corresponding symbols given in the following table.

[1] 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.	  

Annex XVIII. Load distribution guidance

XVIII.1 Objectives and conditions

XVIII.1.1 This annex applies to all trucks, trailers (full trailers and close-coupled trailers), tractor-trailer rigs (semi-trailers) and also to special vehicles and is intended for the use of shippers, drivers and vehicle owners. Their areas of responsibility derive from the statutory provisions of national road traffic and industrial safety legislation and also from the corresponding legislation and regulations.

XVIII.1.2 A load distribution plan is the basis for placing load in a CTU so that, when transported on the road, individual axles are neither under or over loaded. For a single vehicle, the load distribution plan will only need to be drawn once and will depend on its maximum total weight and the minimum/maximum axle loads. Recalculation of the load distribution plan will need to be carried out if any characteristics of the vehicle are changed, such as a body change for example. Any machinery mounted on the vehicle (vehicle mounted cranes, forklifts) and vertical loads from trailers also need to be considered in a load distribution plan.

XVIII.1.3 While it may appear that this section refers only to road vehicles, it also applies to containers carried on road vehicles so ensuring that the cargo's centre of gravity within the container is correctly positioned relative to the axles is essential.

XVIII.1.4 When loading trucks and trailers, care should be taken to avoid exceeding the permitted axle loads or failing to reach the minimum steering-axle load or minimum drive-axle load if safety on the road is not to be impaired while transporting goods. Roadway overloading, caused by exceeding the permitted axle loads, is also to be avoided. Assistance in complying with permitted axle loads and minimum axle loads is provided by the load distribution plan, from which the required information can be obtained.

XVIII.1.5 Trucks that are equipped with a trailer coupling device must be treated according to their usual operating conditions. Vertical coupling loads may be considered as load (in cases where a trailer is not usually drawn) or as part of the vehicle weight (if the truck is usually used with a trailer).

XVIII.2 Preparation of the load distribution plan

XVIII.2.1 The preparation of a load distribution plan is described taking a two-axle truck as an example. It is absolutely essential that the following boundary conditions are taken into consideration when working out the load distribution plan:

XVIII.2.1.1 The permissible front-axle load must not be exceeded.

XVIII.2.1.2 The permissible rear-axle load must not be exceeded.

XVIII.2.1.3 The vehicle load capacity must not be exceeded.

XVIII.2.1.4 The minimum steering-axle load must be observed.

XVIII.2.1.5 The minimum drive-axle load must be observed.

XVIII.2.2 Conditions a to d are boundary conditions which are required by road traffic regulations. The minimum steering-axle load must be observed in order to maintain the manoeuvrability of the vehicle.

XVIII.2 The data required for working out a load distribution plan can be collected with the aid of the data sheet. The data are obtained from information on the vehicle registration document and by measuring, weighing and calculations. Proper linking of the data to the load distribution plan and the vehicle itself will require the registration number to be listed. If the vehicle does not actually have a registration number the vehicle identification number (VIN) can be used instead. Since the vehicle data required for working out a load distribution plan can vary a great deal depending on the type of vehicle, a data collection sheet covering all vehicle types would be confusingly complex. For this reason each vehicle types should be treated separately. It should be noted that a change in the vehicle body may mean that the load distribution plan needs to be recalculated.

XVIII.2.1 With multi-axle configurations the resulting wheelbase should be taken into consideration in the case of different axle or wheel pressures

XVIII.2.2 To derive the equilibria of moments the following values must be obtained:

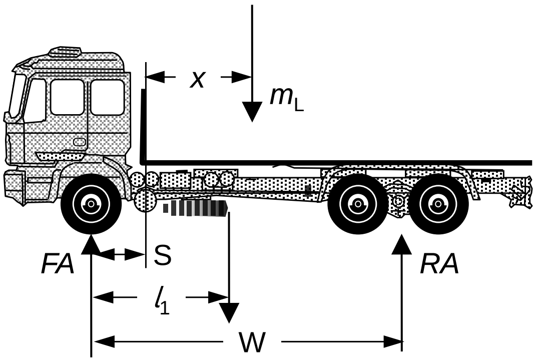


Figure XVIII.1 Masses and axle loads

Symbol	Term	Unit
m_F	mass of unladen vehicle	t
m_{Fx}	mass of unladen vehicle at point “x”	t
$m_{Lx,y}$	mass of payload	t
$FA_{unladen}$	front-axle load of unladen vehicle	t
FA_{laden}	front-axle load of fully-laden vehicle	t
$RA_{unladen}$	rear-axle load of unladen vehicle	t
RA_{laden}	rear-axle load of fully-laden vehicle	t
W	wheelbase	m
S	distance between front axle and front of cargo bed	m
l_1	centre of gravity of unladen vehicle	m
S^p	track width	m
SL_x	assured steerability, minimum steering-axle load	%
SL_y	assured steerability, minimum wheel load	%
ST	assured traction, minimum drive-axle load	%
x	control variable from front end of cargo bed	m
y	control variable from start of mid-line of tyre footprint (transversely to vehicle longitudinal axis)	m

Figure XVIII.2 Symbols, forces and dimensions

Note: For the sake of simplicity, force is set equal to mass here. In physical terms “load” and “weight” are inertial forces. Since gravitational acceleration forces are static forces they can be omitted for the sake of simplicity.

XVIII.3 Using the load distribution plan

XVIII.3.1 Before the vehicle is loaded and a loading plan is developed, the weight/dimensions and the horizontal location of the centre of gravity for each piece of load carried must be determined.

XVIII.3.2 A virtual loading plan may then be drawn. The horizontal location of the whole load has to be calculated, for example by calculating a torque balance around the foremost point of the load panel (or any other point of reference if more convenient).

XVIII.3.3 As described hereafter, the load distribution plan will determine whether the vehicle has sufficient capacity to carry the total weight of the load at the calculated centre of gravity.

XVIII.4 Developing a load distribution plan.

XVIII.4.1 Vehicle centre of gravity

Once the wheelbase or the technical wheelbase (in the case of multi-axle units) has been determined, the next step is to identify the centre of gravity of the unladen vehicle. The vehicle's centre of gravity is calculated by the principle of angular momentum:

$$l_1 = \frac{RA_{unladen} \cdot W}{m_F}$$

Equation XVIII-1

XVIII.4.2 Determining the curves

XVIII.4.2.1 Front curve

When calculating the course of the front curve "a" it is assumed that the sum of all moments about the rear axle is equal to zero.

$$m_{Lx} = \frac{RA_{unladen} \cdot W - m_F \cdot (W - l_1)}{W - S - x}$$

Equation XVIII-2

Curve "a" is limited by the maximum permissible front-axle load (Figure XVIII.3). The figure for the maximum permissible front-axle load is supplied by the vehicle manufacturer.

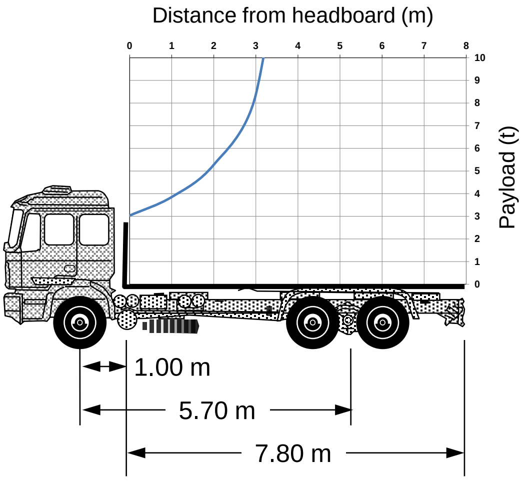


Figure XVIII.3 - Curve "a"

x is a running coordinate, beginning at the headboard and finishing at its intersection with the connecting line "c" (maximum permissible payload).

m_y describes the course of the curve taking into consideration the maximum load to be applied at this position with due regard to the centre of gravity of the total cargo.

XVIII.4.2.2 Rear curve

When calculating the course of the rear curve “b” it is assumed that the sum of all moments about the front axle is equal to 0.

$$m_{Lx} = \frac{RA_{laden} \cdot W - m_F \cdot}{l_1)}$$

Equation XVIII-3

Curve “b” is limited by the maximum permissible rear-axle load (Figure XVIII.4).

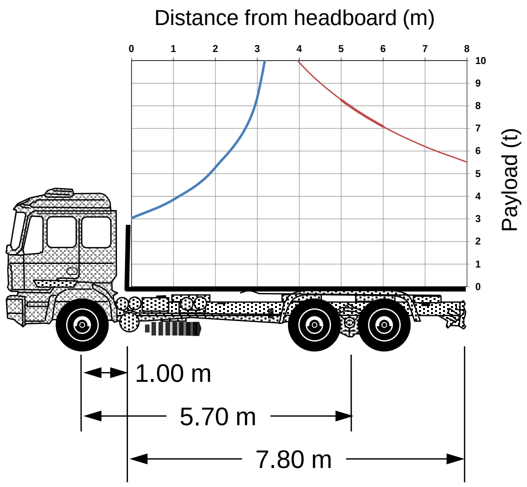


Figure XVIII.4 - Curves "a" & "b"

XVIII.4.2.3 Connection between the front and rear curves

Both of the preceding calculations are implemented up to the curve maximum. This is limited by the maximum permissible vehicle payload. The connecting line “c” connects curves “a” and “b” at the height of the maximum permissible vehicle payload (Figure XVIII.5).

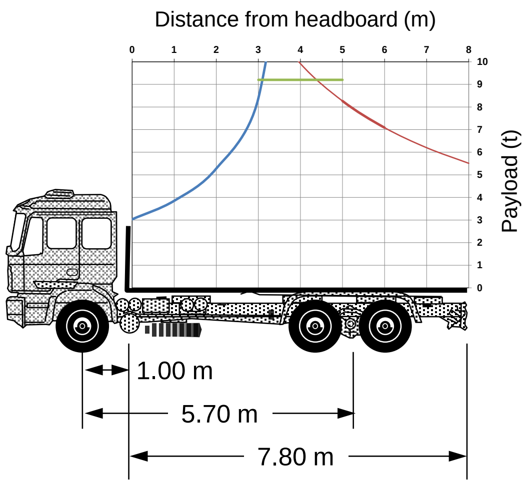


Figure XVIII.5 - Curves "a" to "c"

XVIII.4.2.4 Curve for minimum steering-axle load

Depending on the type of vehicle, between 20 % and 35 % of the vehicle's momentary weight must be applied when calculating curve "d" – which is used for ensuring compliance with the minimum steering-axle load (Figure 10). A corresponding assessment of the individual vehicles as regards the relative percentages for the minimum steering-axle load (axle loads) and the vehicle's momentary weight must be obtained from the vehicle manufacturer.

$$m_{Lx} = \frac{m_F \cdot (W - l_1 - SL_x \cdot W)}{(SL_x \cdot W + S + x - W)}$$

Equation XVIII-4

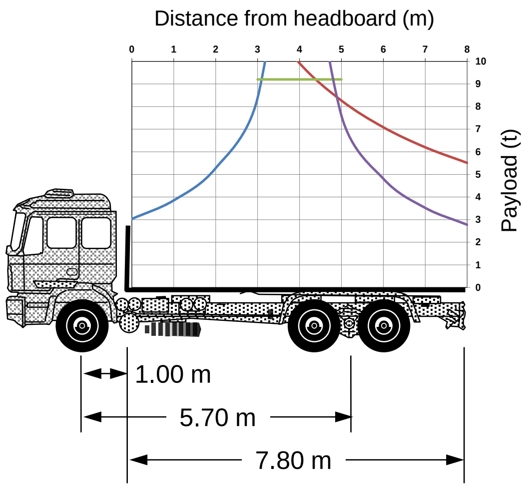


Figure XVIII.6 - Curves "a" to "d"

XVIII.4.2.5 Curve for minimum rear-axle load

The minimum axle load, rear-axle load or drive-axle load amounts to 20 % to 25 % of the vehicle's momentary weight. The curve starts at the front cargo space delimiter and as it progresses intersects curve "a" (Figure 11).

The minimum axle load and here in particular the minimum drive-axle load are used for the truck's traction.

$$m_{Lx} = \frac{m_F \cdot (ST \cdot W - l_1)}{(S + x - ST \cdot W)}$$

Equation XVIII-5

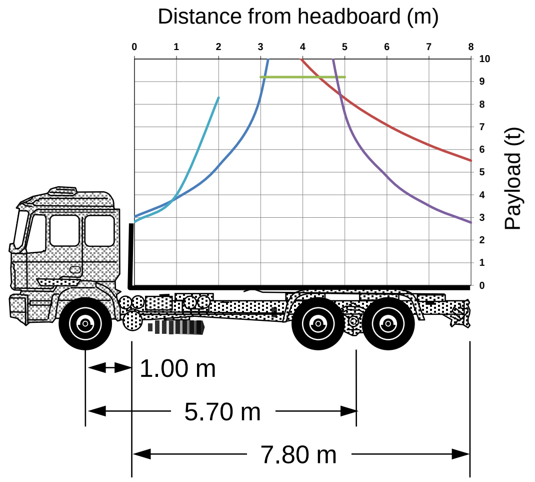


Figure XVIII.7 - Curves "a" to "d"

XVIII.5 Example

XVIII.5.1 A heavy cargo with a total mass of 8.5 t needs to be loaded on a truck with a total capacity of 9.2 t. The centre of gravity of the cargo is so far unknown and has to be calculated first. The mass and position of the three parts of the cargo, intended to be loaded on the truck, are known as well as the centre of gravity of all three parts.

XVIII.5.2 The distance from the headboard to the cargoes centre of gravity is shown as *x* and the yblue arrow represents the total mass of the cargo located at its centre of gravity. If the cargo is placed on the vehicle as shown, the graph of the load distribution plan shows that the vehicle is overloaded - although the mass of the load (8.5 t) is below the total capacity of the vehicle (9.2 t), the maximum front axle load is exceeded, since the blue arrow crosses curve “a” of the graph.

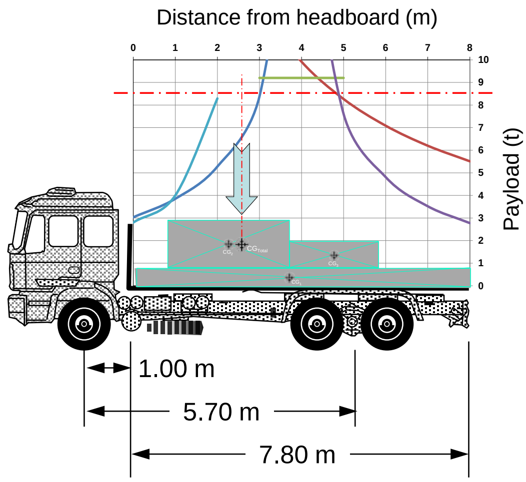


Figure XVIII.8 - Incorrectly packed

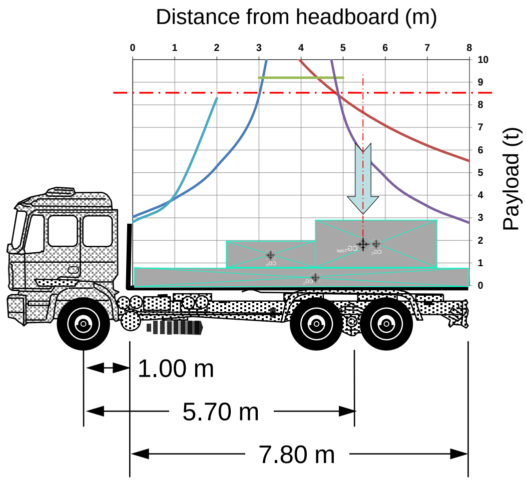


Figure XVIII.9 - Incorrectly packed

The cargo could be shifted to the rear of the vehicle, but two other problems will occur:

- The cargo overhangs the rear of the vehicle.
- The cargo can’t be correctly secured because of the gap between the headboard and the load.

If the cargo is turned around 180° the centre of gravity of the packages is too far to the rear thus reducing manoeuvrability.

XVIII.5.3 In the case of container transportation the load distribution within the container and on the carrier vehicle should be observed. An off-centre positioning in the container of 60 % to 40 % is permissible.

When the semi-trailer is loaded this permissible off-centre positioning in the container can result in an impermissible load distribution on the carrier vehicle. Even when the centre of gravity is positioned centrally in the container an impermissible loading on the semi-trailer can still occur (Figure XVIII.11).

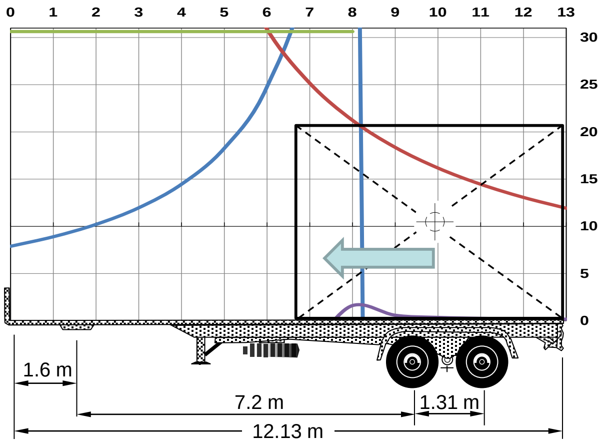


Figure XVIII.11 - Single 20' container on semi-trailer

Moving the container forwards approximately 2 m would bring the centre of gravity within the area enclosed by the curves "a" to "d".

Annex XIX. Minimising the risk of re-contamination

XIX.1 Introduction

XIX.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:

XIX.1.1.1 storing the container an appropriate distance away from pest habitats or resident pest populations (the distance will depend on the pest),

XIX.1.1.2 storing the clean container in areas free of risk from re-contamination by vegetation, soil, free standing water or unclean containers,

XIX.1.1.3 taking species' specific measures where quarantine pests are nominated by importing countries

XIX.1.1.4 fully paved/sealed storage and handling areas

XIX.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

XIX.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.

XIX.2 Definitions

XIX.3 Safeguards

XIX.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 XIX.1 : Lighting tower

XIX.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.

XIX.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.

XIX.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. For more information about gas discharge lamps and the spectrum they emit, see Appendix B.

XIX.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.

XIX.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.

XIX.3.2 Seasonal pest emergence

XIX.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.

XIX.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).

XIX.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.

XIX.3.3 Forecasting Using Plant Phenology

XIX.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.

XIX.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.

XIX.3.4 Occasional pest outbreaks

XIX.3.4.1 Occasional invaders are insects and other arthropods that sporadically enter facilities and in particular CTUs, sometimes in large numbers.

XIX.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.

XIX.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

[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.

pests, and is an important component of integrated pest management.

XIX.3.4.4 How to stop occasional invaders

XIX.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.

XIX.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.

XIX.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.

XIX.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.

XIX.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.

XIX.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.

XIX.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.

XIX.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.

XIX.4 Pests, Insects animals etc. that can cause re-contamination

XIX.4.1 Soil

XIX.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 XIX.2 : Mud in corner fitting

Figure XIX.3 : Mud in fork pocket

XIX.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.

XIX.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.

XIX.4.1.4 Soil should be swept out and bagged for incineration or washed out using a high pressure spray.

XIX.4.2 Plants/ plant parts/debris and seeds

XIX.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 XIX.4 : Previous cargo debris

XIX.4.2.1.1 Moths

Figure XIX.5 : Asian gipsy moth

XIX.4.2.1.2 Snails and slugs

Figure XIX.6 : Giant African snail

XIX.4.3 Ants

XIX.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 XIX.7 : Pharaoh ant

Figure XIX.8 : Carpenter ant nest

XIX.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.

XIX.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.

XIX.4.4 Bees and wasps

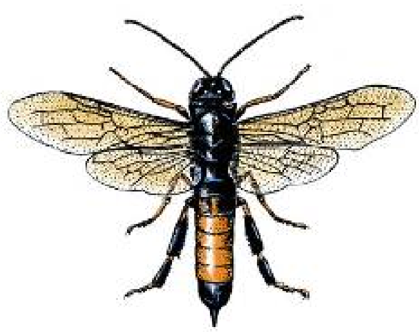


Figure XIX.9 : Sirex wasp

Figure XIX.10 : Sirex wasp nest

XIX.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.

XIX.4.6 Spiders

Figure XIX.11: Wolf spider

Figure XIX.12 : Spider eggs

XIX.4.7 Frass

XIX.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.

XIX.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 XIX.13 : Wood frass from boring insect

XIX.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.

XIX.4.8 Animals (including frogs)

Figure XIX.14 : Squirrels and frogs

XIX.5 Contaminant Treatment

XIX.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 NPPO may request the specimen be collected for identification purposes.

XIX.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

XIX.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.

XIX.5.4 Operators may have contracts with pest control organisations and these may be employed to remove serious re-contamination.

XIX.5.5 If any plants or animals shown in Appendix B are found within the CTU then the CTU supplier [NPPO] should be informed.

XIX.5.6 Examples of Contaminant Disposal methods

XIX.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 XIX.15 : Quarantine waste

XIX.5.6.2 Incineration

XIX.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.

XIX.5.6.2.2 Low temperature

Incineration within a local incinerator for general waste may be suitable for timber and other non animal waste.

XIX.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.

Annex XX. Manual handling

XX.1 Introduction

XX.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.

XX.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.

XX.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.

XX.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).

XX.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.

XX.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.

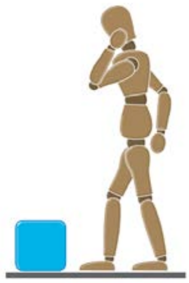
XX.1.7 Packers have duties too. They should:

- 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

XX.2 Manual handling practice

When involved in manual handling the following practical tips should be considered:

XX.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.



XX.2.2 Keep the load close to the waist.

XX.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.

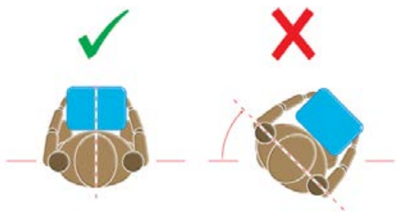
XX.2.4 Adopt a stable position. The feet should be apart with one leg slightly forward to maintain balance (alongside the load, if it is on the ground). The worker should be prepared to move their feet during the lift to maintain their stability. Avoid tight clothing or unsuitable footwear, which may make this difficult.

XX.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

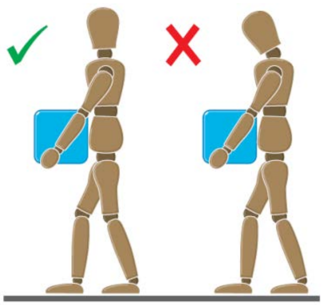
XX.2.6 Start in a good posture. At the start of the lift, slight bending of the back, hips and knees is preferable to fully flexing the back (stooping) or fully flexing the hips and knees (squatting).

XX.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.

XX.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.



XX.2.9 Keep the head up when handling. Look ahead, not down at the load, once it has been held securely.



XX.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.

XX.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.

XX.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.

XX.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:

XX.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.

XX.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

XX.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.

XX.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.

XX.3.5 Lift truck – as an alternative a fork truck can be used to position pallets within the CTU.

XX.4 Mechanical handling techniques

Mechanical handling devices should comply with the following guidelines:

XX.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.

XX.4.2 Ensure that the correct equipment is provided for the task and it is fit for purpose.

XX.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.

XX.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.

XX.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

XX.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.

XX.5 Mechanical handling safety

XX.5.1 Material handling devices should be maintained as part of a regular programme and a well promoted fault reporting system.

XX.5.2 The use of mechanical handling devices described above presents the packer of CTUs with additional risks and handling issues.

XX.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:

XX.5.3.1 injuries to the packer as the device jerks or stops suddenly;

XX.5.3.2 damage to the package if it should fall off the device;

XX.5.3.3 damage to the device; and / or

XX.5.3.4 damage to the CTU.

XX.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.

XX.5.5 When people push and pull, for example trollies, there may be risk of other musculoskeletal disorders which are discussed below.

XX.5.6 The UK produced the following statistics on reported incidents related to pushing and pulling:

XX.5.6.1 11% of manual handling - reported accidents investigated by HSE involved pushing and pulling.

XX.5.6.2 The most frequently reported site of injury was the back (44%).

XX.5.6.3 Followed by the upper limbs (shoulder, arms, wrist and hand) accounted for 28.6%.

XX.5.6.4 12% more accidents involved pulling than pushing (where the activity could be identified within the reports).

XX.5.6.5 35% of pushing and pulling accidents involved wheeled objects.

XX.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**:

XX.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

XX.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.

XX.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.

XX.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.

XX.6 Packaging information for manual handling

XX.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.

XX.6.1.1 Consignors should label a load if there is a risk of injury and it is reasonably practicable to do so.

XX.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.

XX.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.

XX.6.2 What information should be included

XX.6.2.1 If it is reasonably practicable to give precise information the consignor should do so

XX.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.†

XX.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.

XX.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 XXI. Testing CTUs for hazardous gases

XXI.1 Introduction

XXI.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).

XXI.1.2 This action plan focuses on employees of companies, involved in opening and unloading 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.

XXI.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

XXI.1.4 In addition, incidents can occur through leakage of containers with hazardous substances. Several substances are often found simultaneously in containers.

XXI.1.5 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.

XXI.1.6 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.

XXI.1.7 The action plan consists of the following steps:

XXI.1.7.1 The drawing up of a company policy (flowchart: policy process)

XXI.1.7.2 Taking delivery of shipping containers (flowchart: operational process 1)

XXI.1.7.3 Measurement Survey (flowchart: operational process 2)

XXI.1.7.4 Measures (flowchart: operational process 2)

XXI.1.7.5 Safe opening and entering of shipping containers (flowchart: operational process 3)

XXI.1.7.6 Registration

XXI.2 Action plan

XXI.2.1 Step 1. Drawing up of a company policy

XXI.2.1.1 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.

XXI.2.1.2 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):

XXI.2.1.2.1 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[1] shipping container flow. Upon receipt of the shipping containers, random controls (incl. measurement survey) must confirm that no changes have occurred in the chain.

XXI.2.1.2.2 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.

XXI.2.1.2.3 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

XXI.2.2 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.

XXI.2.3 Step 3 Measurement Survey

XXI.2.3.1 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[2]) and the recommendations in a measurement report. The recommendations also focus on:

- Release of shipping container, with or without conditions[3]

[2] The evaporation problem rarely concerns one single risky substance. Whoever carries out the measurement survey (gas measurement expert), applies the additional rule if necessary.

[3] One of these conditions can be the carrying out of repeat measurements during the entering of the shipping container.

- Ventilation/ degassing of the shipping container

XXI.2.3.1.1 Category A shipping containers:

Handling a container from category A the company follows the flowchart Operational process 2A.

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).

XXI.2.3.1.2 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).

XXI.2.3.1.3 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).

XXI.2.4 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[4]" 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.

XXI.2.5 Step 5 Safely opening and entering shipping containers

XXI.2.5.1 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)).

XXI.2.5.2 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.

XXI.2.5.3 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

[4] This could be the case when it is not possible to get concentrations below the limits

the shipping container.

- 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.

XXI.2.5.4 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).

XXI.2.5.5 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.

XXI.2.6 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