INTERNATIONAL LABOUR ORGANIZATION

Sectoral Activities Department

Safety in the supply chain in relation to packing of containers

Report for discussion at the Global Dialogue Forum on Safety in the Supply Chain in Relation to Packing of Containers
(21–22 February 2011)

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Summary

The research carried out on container safety in the supply chain in relation to the packing of containers has clearly shown that there are many examples of good packing guidelines published by various stakeholders and other organizations. These publications have been around for some time and numerous copies made available – but despite this, incidents involving poorly secured or overweight containers continue to occur.

Many of the current guidelines are based on the IMO/ILO/UNECE *Guidelines for packing of cargo transport units* (CTUs) (hereafter referred to as the CTU packing guidelines), which were published in 1997. Much of this document could well be updated to take account of the most recent advances in packing practices. It is unlikely that amendments to the CTU packing guidelines would warrant dramatic changes to any of the other publications; indeed, the manual might be altered to reflect many of the comments in these other publications. This report suggests that consideration should be given to rewriting the CTU packing guidelines and producing good practice guidelines for the container supply chain that would be common to all modes of transport. Stakeholders from the various transport modes could then customize this document to suit their particular needs or point of view. The CTU packing guidelines and the good practices document might draw heavily on the *Container Handbook*, published by the German Insurance Association (GDV), which provides an excellent database of packing and securing methods.

It may come as no surprise that the greatest opportunity to ensure that the container cargo is safe and secured correctly is at the cargo consolidation and container packing stage of the supply chain. It is generally agreed that many of the organizations who would benefit most from access to good practice guidelines are small enterprises with little experience of container stresses and forces, which are scattered throughout the world, use a multitude of languages and are unsupported by any trade organizations. Most efforts on improving cargo safety should therefore be concentrated on this area, bearing in mind that some packers may not have access to written documentation, either in hard copy or electronic form, or may not possess the literacy skills necessary to comprehend published documentation. The challenge is to devise ways to disseminate information to the wide range of organizations involved in packing, transporting and unpacking containers, and to ensure that this information is understood, applied and monitored.

Given this diversity of packing organizations, there should be a consistent source of packing information, which is readily accessible, easy to use, and published in such a way as to meet the requirements of both small and large companies. Users of the good practice guidelines should be able to extract sufficient information to understand the stresses and forces to which the container carrying their cargo might be subjected, thus realizing the importance of employing appropriate securing methods. Packers could also draw on the detailed packing information to obtain best practice securing methods for their regularly shipped cargoes, and learn how to pack items of cargo that are new to them or irregularly shipped. Consideration should be given to the way in which the packing information might be used by organizations involved in packing, transporting and unpacking containers, and to the level of detail required by the good practice guidelines.

The use of containers continues to grow – and a greater proportion of them than ever is carrying cargoes from China to the United States and Europe. The majority of these containers are from established shippers with sophisticated despatch facilities, who understand the stresses and forces to which containers are subjected throughout the supply chain. However, there is evidence of shipments where the cargo has not been properly secured, implying an increased risk of incidents that might result in the injury or death of supply chain operators or serious damage to the infrastructure. It is recognized that China,

while being a major exporter, is not the only country to transgress in the area of poorly secured cargo; but the huge geographical size of the country and the disparate shipping locations mean that it constitutes one of the greatest threats to supply chain safety. Ways should be sought to capture these "remote" players and ensure that they fully adopt the good practice guidelines.

In order to verify improvements in packing effectiveness, there must be a means to quantify the scope of accidents to containers that are caused or made worse by improperly secured cargo. This database of information could be managed by one of the major stakeholders, or by an independent organization on behalf of all the stakeholders. Those managing the database should be able to provide a totally confidential service, available to all parties from all modes of transport, and to receive reports from throughout the world. They must have the ability to analyse the incidents reported, with a view to producing reliable information about the accident rates from all standpoints, such as the type of cargo, transport mode and shipping country. Consideration should be given to the need for such a database and to whom it should be entrusted.

Many organizations involved in packing containers may not fully understand the need for the effective loading and securing of cargoes. In a number of cases in which cargoes have moved, there is evidence to suggest that the packers who stuffed the containers did not appreciate to what extent containers can move and how forces change as they proceed along the supply chain. Videos like *Any fool can stuff a container*, produced by the United Kingdom P&I Club, provide simple and easy-to-understand information about some elements of the packing process, but they do not entirely explain the consequences of improper securing. For a better understanding of the forces, packers should be invited to participate in interactive training programmes that are readily accessible and appropriate. This training programme would satisfy the recommendations of the CTU packing guidelines, which identify an outline training syllabus for all those involved in packing, transporting and unpacking containers for all cargoes, not just dangerous goods. It would also be relevant to examine whether there is a need for accredited certification to demonstrate a candidate's successful completion of the course.

The development of improved CTU packing guidelines, good practice guidelines and an accompanying training programme will only be successful if packing organizations and others implement the recommendations. The means by which they are disseminated should therefore also be considered. One option is for the interested parties to distribute voluntarily the good practice guidelines, or web address, and require that containers be packed in accordance with these documents or programmes. Responsibility for the correct operation of the good practice guidelines would rely heavily on organizations such as shipping lines and terminal operators, who would need to monitor containers passing through their facility. The alternative would be to enact legislation, which would require packing organizations to comply with it – and shipping lines and terminals would have to receive certified packing notes before shipment was made. Consideration should be given to the need for legislation over voluntary codes and the opportunities and threats that each option would generate.

This paper shows that there are a multitude of stakeholders in the various sectors involved in the supply chain. An analysis of these findings demonstrates that the stowage and securing of goods, the establishment of responsibilities and implementation of rules, regulations and best practice, as well as the interlinking of all the players in the supply chain and communication (or lack thereof), will all have an impact on safety along the supply chain.

Abbreviations and acronyms

AAR	Association of American Railroads
AGV	automated guided vehicle
BS EN	British standard/European norm
CFS	container-freight station
CEN	European Committee for Standardization
CG	centre of gravity
CGPM	General Conference on Weights and Measures
COA	Container Owners Association
CoR	chain of responsibility
CPC	Certificate of Professional Competence
CSC	Convention for Safe Containers, 1972
CTU	cargo transport unit
DIOMIS	Developing Infrastructure and Operating Models for Intermodal Shift
DSC	Subcommittee on Dangerous Goods, Solid Cargoes and Containers
ECMT	European Conference of Ministries of Transport
ESPO	European Sea Ports Association
FCL	full container load
FIATA	International Federation of Freight Forwarders Associations
GDSA	Dangerous Goods Safety Adviser
GDV	German Insurance Organization
HSE	Health and Safety Executive (United Kingdom)
IATA	International Air Transport Association
IBC	intermediate bulk container
ICHCA	International Cargo Handling and Coordination Association
ILO	International Labour Organization
IMO	International Maritime Organization
IMDG Code	International Maritime Dangerous Goods Code
IOSH	Institute of Occupational Safety and Health
IRU	International Road Transport Union
ISO	International Organization for Standardization
ISP	International Safety Panel (of ICHCA)
ITF	International Transport Workers' Federation
ISCTA	Intermodal Safe Container Transportation Act (United States)
LCL	less than a container load
LO–LO	Lift-on–lift-off
NVOCC	non-vessel-operating common carrier/container carrier
OECD	Organisation for Economic Co-operation and Development
PDP	Port Workers' Development Programme
RHA	Road Haulage Association

ROLA	Rolling Highway
RO–RO	Roll-on–roll-off
SOLAS	International Convention for the Safety of Life at Sea
teu	Twenty foot equivalent unit
TT Club	Through Transport Mutual Insurance Association Limited
UIC	International Union of Railways
UNECE	United Nations Economic Commission for Europe

Introduction

In 1994, the International Transport Workers' Federation (ITF) held a conference to discuss the securing of loads on ships, trucks and rail cars. It was agreed at the meeting to take the initiative to bring about the introduction of international load security certificates.

The following year the ITF, disappointed that no progress had been made towards improving cargo safety, demanded that all personnel involved in the loading and unloading of goods should be trained and given instructions on problems that might occur in land, sea or air transport. [1]

Incidents of rollovers of vehicles transporting containers in Japan gave rise to further discussions over the next few years, during which more meetings and conferences on the subject were held. The ITF continued to lobby the International Labour Organization (ILO) to instigate a project on container safety. In 2009, the Governing Body proposed a two-day forum on container safety in the supply chain and in packing, based on research into container safety with regard to cargo stowing and securing. [2]

This research project was backed by other stakeholders and contributors who acknowledged that the poor stowage or packing of cargoes within containers might present a risk of injury to operators and bystanders. However, none of the parties could quantify the extent of their concerns, as they did not have any data that might reveal the extent of incidents involving poorly secured cargoes. Many of the stakeholders hoped that this project could provide that information.

Most of the findings of the research have been gathered from European, Japanese, United Kingdom and United States sources, although web-based research has also been carried out to identify incidents and sources of information from all over the world.

Improperly secured cargo is often hard to identify because of the nature of the container. Loose cargo within a "steel box" cannot be seen until the container's doors have been opened, often at the point of discharge. Consequently this type of incident is often unreported.

The most frequently reported incidents are those involving severe accidents, in which the container is either damaged or there has been a vehicle rollover. In the case of rollover accidents, there is clear anecdotal evidence that accident investigators have preconceived perceptions of why these accidents occur. In some parts of the world, they are generally attributed to poorly secured or loaded containers – while drivers leaving a United Kingdom port reported that local police always blame them if their vehicle rolls over when they are negotiating a notoriously difficult roundabout. Working with the accident investigators has changed the local police officers' perception, and now they undertake far more detailed investigations.

The research carried out to produce this report was obliged to focus on accidents, and most information was obtained from the road transport industry. The report does not set out to blame any party, but it recognizes that there are contributing factors and wider pressures in this "just-in-time" process that place undue stress on the truck driver. It is

[1] ITF: *Resolution on the securing of goods,* Section Committee Meeting (Stockholm, 1995).

[2] ILO: *Proposals for activities in 2010–11 under the Sectoral Activities Programme*, Governing Body, 304th Session, Geneva, Mar. 2009, GB.304/STM/1, para. 15.

further recognized that the research conducted by the International Road Transport Union (IRU), discussed in paragraphs 57–59, found that 75 per cent of the incidents investigated were caused by other road users.

Given the considerable amount of anecdotal evidence of frequent incidents at the start of the project, it was generally believed that it would be possible to gather sufficient data to quantify the volume of accidents caused by the poor securing of cargo. This proved to be erroneous because no single organization processed any significant data that could be used to build such a database; despite the fact that there were numerous examples of incidents where overloading or poor securing of the cargo may have contributed to the incident, very few could be directly attributed to these factors.

On the other hand, organizations were able to cite many anecdotal examples of cases in which the cargo had been directly responsible for the accident, but they were unable to provide actual data to support either the incident rate or the frequency of such accidents. For instance, some insurance companies were able to produce evidence of accidents and cite the occasional example of an accident involving the cargo, but they did not have systems in place that would enable a database of claims to be compiled. Other trade and governmental organizations either did not have any systems or did not record sufficient details to make any analysis worthwhile.

This research project has collated and analysed the limited available information on container packing and attempted to identify the extent to which poor packing affects the different modes of transport. Furthermore, it considers the repercussions that various examples of poor securing have on each mode of transport.

The report includes a summary of the readily available publications containing guidelines on packing. The uninitiated would find it difficult to locate these guidelines and code of practices; indeed, a web-based search of trade organizations and links to publications providing packing guidance proved to be very unsatisfactory. There is surely a need, in this current Internet-based society, to address the lack of acceptable links and easily found sites when searching for an answer to such a basic question as "How do I pack a container?" on the Internet.

The report also highlights a slightly worrying lack of referral to any of the publications by smaller freight forwarders.

The basic packing rules contained in packing guidelines often provide the packer with some very useful information, giving a considerable amount of detail. However, there is often a lack of detail about the sizing of braces and the strength and number of straps to suit the various cargoes, particularly the heavier items. Research reveals that large or heavy cargo packages present the greatest risk to safety in the supply chain – especially when they move within a container during a normal voyage, otherwise free from serious incident. This report has investigated the effects of stresses and forces on the mass of cargoes.

The safe packing of containers not only presupposes the accessibility to packing guidelines; it is also vital that this information should be passed on to those involved in the physical work of packing and unpacking containers. Research undertaken for this report looked into the availability of suitable training programmes and examples of good practice – but disappointingly few examples were found.

To ensure that a greater proportion of containers reach their destination without an incident being caused or damage inflicted by the cargo, it is essential that the container packing community should be educated about the means available and the ways to use them. All those involved in the process must be kept up to date, which requires identifying a better way of disseminating the necessary information. This report briefly explores training concepts and means to direct packers to suitable sources of information.

Finally, the research project sets out to recommend the way in which the current guidelines and practices may be integrated to form “best practices”, and how these should be adopted by international organizations such as the ILO and the International Maritime Organization (IMO).

1. The supply chain

1.1. Freight containers in the supply chain

1. "On April 26, 1956, a crane lifted 58 aluminium truck bodies aboard an aging tanker ship moored in Newark, New Jersey. Five days later, the *Ideal-X* sailed into Houston, where 58 trucks waited to take on the metal boxes and haul them to their destinations. Such was the beginning of a revolution." [1]

2. From these modest beginnings, the concept developed by Malcolm McLean has developed into a huge international industry that powers global trade. Fifty-four years later, the 24-ft long aluminium truck bodies have evolved into 20-, 40- and 45-ft long international freight containers, capable of carrying nearly 30 tonnes of cargo and supporting up to nine similarly loaded containers.

3. The original containers were simple aluminium boxes for carrying cargoes that would have traditionally been loaded into the back of a box van. These containers were suitable for dry freight or general purpose cargoes, but as the early shippers sought to increase the types of cargo that could be carried, many specialist containers were developed. These included the insulated and integrated refrigerated container for frozen and chilled cargoes, and the open top and platform containers for oversize and heavy cargoes.

4. On 14 April 1961, after lengthy discussions on standardizing the sizes of containers, it was agreed that the only standard containers would be 10-, 20-, 30- and 40-ft long, 8-ft high and 8-ft wide. [2] Over the years, the 10- and 30-ft long containers have generally disappeared from international transport, although the 30-ft long container is still used for the carriage of bulk powders and granules within Europe.

5. When the standard was being developed, the height was originally set at 8 ft to enable customers to squeeze more cargo into each container and allow room for forklifts to work inside. [3] In 1966 the standards bodies accepted this argument and the standard height for containers was increased to 8 ft 6 in. Since then there has been little change to the standard dimensions for the container apart from the adoption of the HiCube (9 ft 6 in), which is normally only used by the 40-ft long containers, and the introduction of a new length (45 ft) for light high volume cargoes.

6. International standards have been formulated for the dimensions (ISO 668) and the specification and testing (ISO 1496 series), but shippers' demands for containers designed to fit particular packages and freight routes continued to be made to the Technical Committee of the ISO (TC 104), which was set up to deal with the standardization of freight containers. Proposals for a series 2 design of freight containers, with a view to making them of a shorter length and wider, were initially discussed but later rejected for international transport. However, the Europeans have continued to develop their own standard lengths and widths, often for non-stackable or, more recently, stackable "swap bodies".

[1] M. Levinson: *The Box. How the shipping container made the world smaller and the world economy bigger* (Princeton and Oxford, Princeton University Press, 2000).

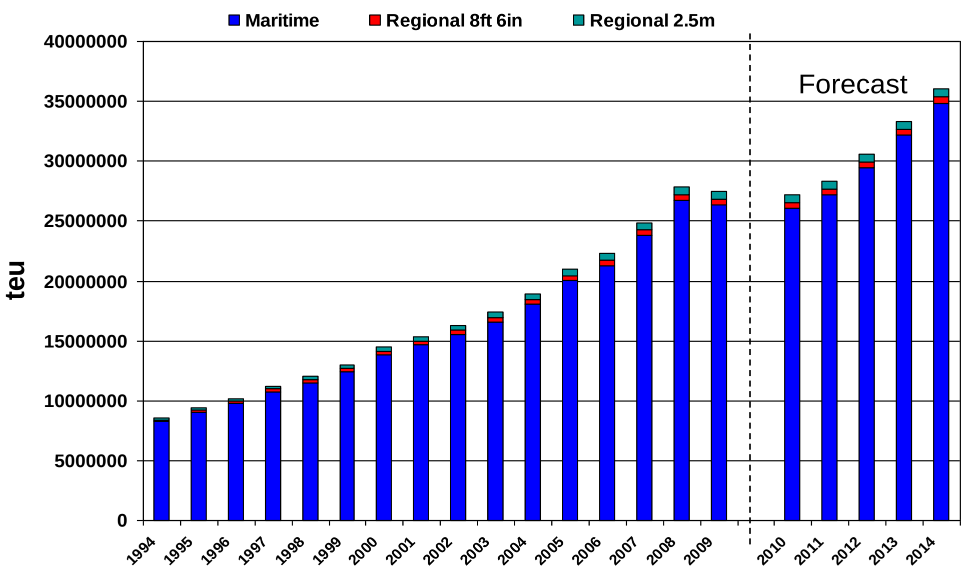
[2] United States Federal Maritime Board press release NR-35, 28 April 1961.

[3] Committee on Standardization of Van Container Dimensions: *Minutes*, 18 Nov. 1958.

7. A more detailed explanation of the types of container in use today can be found in Appendix I.

8. The unit used to measure container capacity is the teu ("twenty-foot equivalent unit"), which refers to the length of the standard container box. Given the prevalence of non-standard container sizes (ranging from 10 ft to 62 ft in length), teu figures are always greater than the actual number of containers in question. [4] The world container census 2010, covering the total international and regional fleet, gave the teu count at 27.5 million teu, made up of nearly 18 million units. [5] Figure 1.1 shows the change in the world fleet from 1994 to 2009 and the forecast growth until 2014.

Figure 1.1. Change in world teu fleet



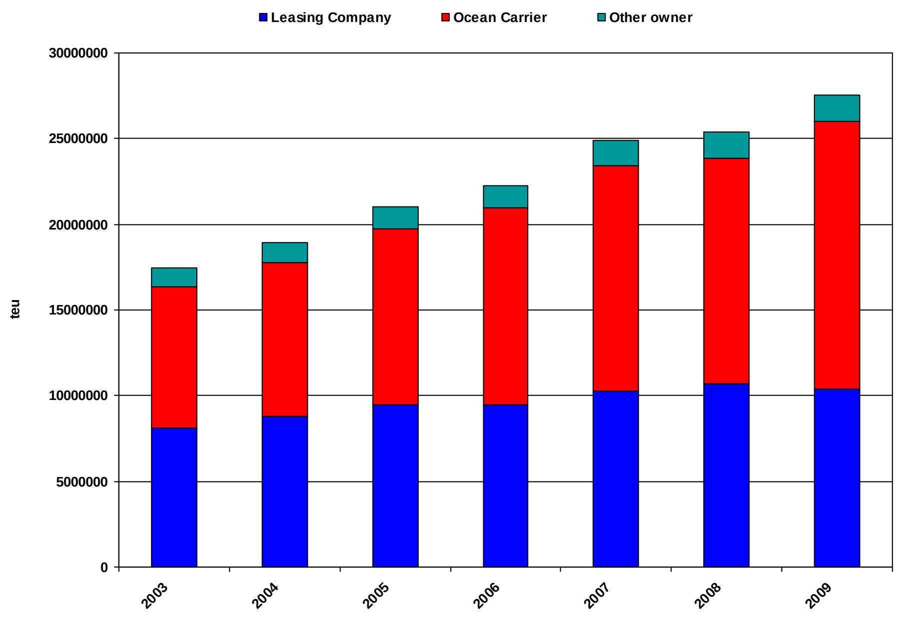
9. In 2003, the global container fleet was almost evenly divided between carriers' self-owned fleets and those of the many large container-leasing companies; since then the ocean carriers have expanded their fleet, so that in 2009 they held 56.5 per cent of all types of containers, as shown in figure 1.2. [6]

[4] One 40-ft container counts as two teu.

[5] Containerisation International: *Market analysis: World container census 2010* (London, 2010).

[6] ibid.

Figure 1.2. Change in world fleet by ownership



10. The workhorse of the container fleet – the 20-ft long container – accounts for 47 per cent of all maritime containers, and was traditionally the longest. However, 40-ft long containers now account for 51.4 per cent in terms of units, and 67.2 per cent in terms of teu.

11. Dry freight containers are the largest category of container, accounting for 89.2 per cent in terms of teu and 89.6 per cent in terms of units. Dry freight specials – for example flat-rack and open top containers – constitute only 3.5 per cent in terms of teu and 3.8 per cent in terms of units. Refrigerated and tank containers make up 6.4 per cent and 0.8 per cent, respectively, in terms of teu, and 5.3 per cent and 1.2 per cent in terms of units.

12. The Cargo Systems "Top 100 Container Ports 2009" [7] found that the volume of containers handled had risen to nearly 426 million in 2008, [8] an increase of approximately 63 per cent. Full container trade was estimated at 134.5 million teu in 2008; and, at the beginning of 2009, there were 4,638 container ships with a capacity of 12.14 million teu slots. [9]

13. The container shipping market represents about 16 per cent of the world's goods loaded in volume terms (tonnes). In 2008, the total world containerized trade was estimated at 1.3 billion tonnes, an increase of 4.6 per cent over the previous year. The share of containerized trade, as part of the world's total dry cargo, increased from 5.1 per cent in 1980 to 25.4 per cent in 2008. [10]

[7] Cargo Systems: *Top 100 Container Ports*, at: www.cargosystems.net.

[8] The information from Containerisation International and Cargo Systems (both online) account for all containers handled at the various ports, including transhipped containers and empty container moves on both the export *and* import sides.

[9] UNCTAD: *Review of maritime transport 2009* (Geneva, 2009).

[10] ibid.

14. In 2007 some 50 million teu were transported to and from Europe, 34 million of which were shipped through the so-called European North Range ports (Le Havre, Rotterdam, Antwerp, Bremerhaven, Hamburg, etc.). On average, two-thirds of hinterland traffic of the North Range ports is still carried out by road, while rail and inland water transport often account for less than 20 per cent. [11]

15. The International Union of Railways (UIC) undertook a survey of more than 105 European intermodal transport operators as part of its DIOMIS [12] project. In 2007, 18.07 million twenty-foot equivalent units (teu) were transported using intermodal road–rail transport, of which 17.11 million (94.7 per cent) was unaccompanied and 0.96 million (5.3 per cent) accompanied. This represented an increase of 35 per cent between 2005 and 2007 for total intermodal transport in Europe. [13]

16. Despite the turbulence of the financial markets in 2007, growth throughout the top 100 container ports increased overall by 6.4 per cent in 2008. [14] Twenty-nine of the top 100 ports showed a double-digit increase in that year, of which ten ports were in China. The 17 Chinese ports listed in the Cargo Systems report accounted for nearly 138 million moves – or 32 per cent of the total of the top 100 ports.

17. In July 2010 factory output in China was up 13.4 per cent from July of the previous year, but it was the fifth consecutive month that the annual pace had slowed and the lowest rate of 2010. Although figures showed that China's import growth had slowed in July, which economists took as a sign that the country's rapid economic expansion was cooling, exports rose by 38.1 per cent, from June's 35.2 per cent, as China's trade surplus increased. [15]

18. The significance of the Chinese economic and production figures will be discussed later in the report; however, the simple message that can be taken from this is that China is by far the largest exporter of loaded freight containers.

19. The revolutionary days of container shipping were over by the early 1980s. Yet the after-effects of the container revolution continued to reverberate. Over the next two decades, as container shipping began to drive international freight costs down, the volume of sea freight shipped in containers rose four times over. Hamburg, Germany's largest port, handled 11 million tonnes of general cargo in 1960; in 1996, more than 40 million tonnes of general cargo crossed the Hamburg docks, 88 per cent of it in containers, and more than half of it from Asia. The prices of electronics, clothing, and other consumer goods tumbled as imports displaced domestic products from store shelves in Europe, Japan and North America. Low-cost products that would not be viable to trade without container shipping

[11] UNECE: *Report of the Working Party on Intermodal Transport and Logistics*, Economic Commission for Europe, Inland Transport Committee, 49th Session, Geneva, 17–18 March 2008.

[12] Developing Infrastructure and Operating Models for Intermodal Shift.

[13] UNECE, op.cit.

[14] Cargo Systems, op. cit.

[15] *BBC Business News*, at: www.bbc.co.uk/news/business-10936024, 11 Aug. 2010.

diffused quickly around the world. Declining goods prices in the late 1990s, thanks largely to imports, helped bring three decades of inflation to an end. [16]

20. Global supply chains were not in anyone's mind when those first containers were shipped on board the *Ideal-X*. The reduction in the cost of handling freight by the use of containers has meant that a far greater diversity of cargoes are shipped internationally; indeed many cargoes, such as scrap materials, are carried in containers, whereas in the past they were shipped in break bulk or not shipped at all. Now low-value consumer products are loaded into containers and shipped from landlocked countries and locations requiring a wide range of transport modes. The consistent and common handling procedures of the freight container means that the time-consuming practice of unloading from one transport mode and loading onto another has been virtually eliminated. It is now possible for a company to load their products into a container and know that the goods will not be touched again until they reach their destination. However, a new supply chain infrastructure had to be developed to ensure that the goods arrived in a timely manner.

21. As shown in Appendix I, there are a variety of containers that have been designed to carry specialist cargoes such as bulk liquids (tank containers), bulk powders and granules (bulk containers), oversize (open top and flat-rack containers), and heavy items (flat-racks). HiCube containers are ideally suited to low-weight high-volume cargoes and the 20 ft container for dense cargoes. The general purpose freight container may nonetheless be used for a vast range of cargoes. It is precisely this mix of cargoes that may constitute one of the root causes of many incidents, as each cargo configuration requires its own securing method.

22. Many containers are loaded with a cargo that covers the entire floor, or fills the entire container. Such cargoes present the packing personnel with probably the easiest securing solution. Yet many cargoes, such as waste paper and scrap steel, are often loaded in such a way as to fill the entire container, and as a result they exceed the maximum gross mass of the container. A further risk is associated with methods of securing. Indeed, cargoes of this nature are often loaded without any securing at all, so that the load settles against the rear doors during the voyage, which can present a serious risk to those involved in unpacking the container at its place of destination.

23. Many packers are not fortunate enough to have such cargo configurations, as the mass of the container prevents more being loaded, or the total volume of the cargo is insufficient to completely fill the container; despite this, shippers often prefer to ship the cargo as a full container load (FCL). It is these cargoes and the variety of packages and overpacks that require the most attention and packing experience.

24. There are very few products that are not shipped in containers and many shippers are exploring methods of increasing the range of products that can be carried in all types of containers, such as bulk liquids in flexitanks, or bulk powders and granules in liners in general purpose containers.

[16] The increase in shipping volume is cited in R. Carruthers and J. Bajpai: *Trends in Trade and Logistics: An East Asian Perspective*, Working Paper No. 2, Transport Unit (Washington, DC, World Bank, 2002); and, for Hamburg, see: D. Läpple: "Les mutations des ports maritimes et leurs implications pour les dockers et les régions portuaires: l'example de Hamburg", in *Dockers de la Méditerranée a la mer du Nord: des quais et des hommes dans l'histoire* (Aix-en-Provence, Sarl Edisud, 1999).

25. The general purpose container is also used for carrying a variety of dangerous goods, obviously requiring special packing instructions concerning other products that can be carried together in the same container. The securing of these packages should not, however, be different from that of a similar package carrying non-hazardous goods.

26. The container has also found a role outside of transporting cargoes from door to door. Many shippers use the container as temporary storage rather that investing in warehousing or storage silos. The stacking ability and the weather-tight nature of the container mean that substantial quantities of cargo can be stored in relatively small areas.

1.2. Elements in the supply chain

27. The first and most obvious element is that concerning the physical movement of the container and its contents from place to place and from mode to mode. As containers move along the container transport chain they can be in any one of three states:

- they can be empty (in which case they are most likely being repositioned for a new voyage);
- they can be loaded with one single consignment from one single shipper (FCL); or
- they can be loaded with multiple consignments, each from a different shipper (less than full container load (LCL)).

28. There are instances when a dry freight container may be declared “empty” but, due to an administrative error, it is actually loaded with a cargo. Furthermore, tank containers can be “emptied” but still contain a substantial amount of residue material. Therefore, while the majority of empty moves are simply positioning moves from areas of surplus to areas of demand, there is a risk that a very small proportion will contain a “cargo”.

29. Containers that are “emptied” can move to one of three destinations:

- an empty container depot which acts on behalf of the owner or operator to ensure that the container is clean and safe;
- a port or inland terminal for positioning to a demand location; or
- a customer for loading with a LCL or FCL cargo without being returned to a container depot or terminal.

30. Empty containers being positioned to a demand location will run alongside loaded containers within the logistics chain and should present no risk to handlers, operators and parties due to packing. There is still a risk of injury or damage due to the condition of the container itself.

31. There is no single “standard” pathway for containers to move through the logistics chain. The interactions between the various parties involved in the supply chain, the specific geographical situations and the multitude of possible commercial and contractual obligations governing container moves give rise to any number of possible transport chains. Generally speaking, the network of nodes and links that constitute the supply chain may be categorized according to their principal function. These are fourfold:

- consignment assembly;
- consignment consolidation;

- carriage (either local drayage or longer distance transport); and
- port handling.

32. These functions are not necessarily sequential – for instance, carriage can occur at many points along the network and consignment consolidation can occur during the port handling process. By way of illustration, these will each be described in turn with reference to the simplified figure (1.3) representing the container transport chain.

1.2.1. Consignment assembly

33. This first stage in the physical movement of goods occurs well downstream of the actual start of the commercial transaction that gives rise to the container shipment. Beforehand, a buyer and seller will have identified each other, agreed on the terms of the sale and formalized these through a contract, and will have agreed on the manner in which the goods will be shipped. At that point, the actual physical movement of the good(s) will commence. The decision on the transport method has to be made at this stage. The shipment may constitute one or more full container loads or one or more pallets/overpacks that would not fill a container.

34. The shipper then has to decide how the consignment is to be packed. Shippers may have the desire, knowledge or facilities to pack or stuff a container on their own premises, whereas others may employ the services of a freight forwarder or non-vessel operating common carrier (NVOCC) to pack the cargo into a container and/or facilitate the container movement to enjoy more advantageous freight rates. In other words, some shippers will load a container on their premises and then either physically or virtually "move" the container to the consolidation centre where the NVOCC takes over "control" of the container(s).

35. In the case of both LCL and FCL moves, an empty container will be dispatched from an empty container depot to the shipper's premises. The supplier of the container is expected to deliver a clean, fit-for-purpose container to the shipper/packing company. Here, the container will be stuffed, the doors shut and a seal affixed. The loading of the container at a shipper's premises will most likely be at the manufacturing plant or warehouse – but it really could be anywhere. Anecdotal evidence indicates that, in some countries, it is not uncommon for containers to be stuffed directly in open courtyards or in the street.

36. It should be remembered that the supply chain may not physically start at this point, and there may be several movement of components required to assemble the final cargo item before it can be stuffed into the container. These movements are recognized as part of the overall supply chain, but are excluded from this project.

37. As demonstrated earlier, a vast number of loaded container moves take place during the year and the risk to safety depends very much on where the container is packed. The majority of loaded containers are likely to originate from a shipper or packer who regularly loads and ships containerized cargo, and these facilities are likely to be part of a large group, or members of organizations such as the International Federation of Freight Forwarders Associations (FIATA), which is represented worldwide. Such shipping and packing facilities will have access to industry or in-house guidance and/or training packages.

38. Nonetheless, there are a proportion of shippers who do not have access to these guidelines, either because they lack the knowledge or do not belong to an association or trade organization that can provide guidance. Without access to this guidance, there is a severe risk that the cargo will not be packed safely.

1.2.2. Consignment consolidation

39. The alternative to the FCL loading of containers at the shippers'/packing companies' premises is an LCL load, which is packed at a freight consolidation facility or into a container that arrives at a packer's premises partially loaded, or is due to be taken after loading to another packing location.

40. Freight consolidation facilities come in various forms and sizes, ranging from small freight forwarder warehouses to large, multifunction container freight stations (CFS). Again, the scale of the consolidation centre may dictate the ability of the facility to load a container safely. In many cases shippers deliver pallets, overpacks or packages of cargo to a consolidation facility. The consolidator's role is to ensure that the various packages are loaded and secured correctly.

41. The alternative solution that some consolidators adopt is to move the container from shipper to shipper, with each loading their cargo into the container and securing their items. This presents each packing location with its own intrinsic problems, because individual packers can only take responsibility for securing their own cargo and must rely on the planning of the consolidator to ensure that the container centre of gravity and "packing rules" are acceptable for international transport. There is a risk that individual packers may be unable to stuff a container properly to ensure that the centre of gravity is kept as low and as near as possible to the transverse and longitudinal centres.

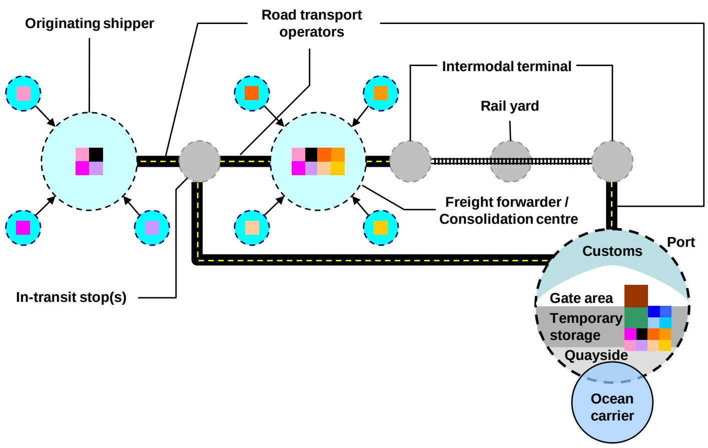
42. Consolidated loads can be a major contributor to poor stowage within containers. Each cargo will need to be integrated into the final load distribution plan for the container. However, many consolidators may not have the luxury of being able to fit the disparate individual consignments into a common container without compromising the ideal load distribution plan.

1.2.3. Carriage

43. The inland transport of containers involves both links (infrastructure) and nodes (handling centres). The actual physical movement of the container involves the transit from shipper to port (typical for FCL consignments), shipper to consolidation centre (for LCL and some FCL consignments) and/or consolidation centre to port (again, for LCL and some FCL consignments). These transit legs nearly always commence by road and may be single mode (usually road) or include multimodal moves (involving road and rail or inland waterways).

44. Each mode operates on its own infrastructure (roadway, railway and/or navigable waterways) and appears to adhere to its own, basically similar but unique to each mode, procedures and guidelines. It may be that the plethora of guidelines actually confuse the packer, or that the packer reads one and assumes that it is good for all.

Figure 1.3. Supply chain model



45. Intermodal carriage of containers consists of the following operations (figure 1.3): [17]

- pick-up or initial road leg: transport of containers from the shipper's or forwarder's freight centre to the combined transport terminal;
- terminal transfer: transfer from road to rail mode in departure terminal;
- transport by rail: long-distance rail transport;
- terminal transfer: Transfer from rail to road vehicle in arrival terminal;
- transport by road to the port of the exporting country;
- departure port terminal: customs clearance, temporary storage, loading on container vessels;
- transport by sea;
- arrival port terminal: unloading on container vessels, customs clearance, temporary storage;
- inland transport process in the importing country, similar to the one described above;
- delivery or terminal road leg: transport from arrival terminal to receiver.

46. Combined transport can take a variety of forms: rolling roads, which allow full road vehicles to be carried on trains comprising low-floor wagons; roll-on–roll-off (ro–ro), which enables road vehicles, a wagon or an intermodal transport unit to load and unload straight on or off a vessel; and lift–on-lift-off (lo–lo), which involves lifting equipment to load and unload transport units on or off a vessel. Containers may be handled and transferred by simple equipment such as a crane at inland intermodal facilities or port terminals. Containers may be interchanged not only among the different modes but also among carriers of the same mode to optimize the operation, depending on the destinations. Standardized containers enable cargo to be quickly handled and transferred from ships to trucks and rail wagons with mechanical handling equipment.

[17] OECD: *Container transport security across modes*, European Conference of Ministers of Transport (Paris, 2005).

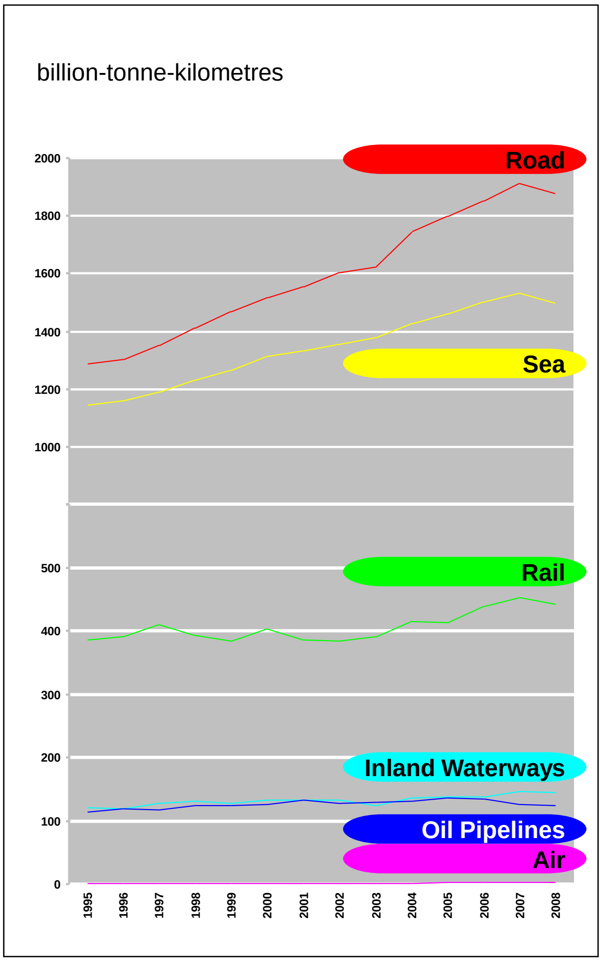
47. Once the container is stuffed and sealed and enters into intermodal transport flow, transport carriers and those physically handling the container are physically unable to verify the nature of the container packing, or its contents, against the commercial documents or bills of lading.

1.2.3.1. Container transport by road

48. Aggregate figures for the road carriage of containers are difficult to come by; nonetheless, most containers are at some point transported by road, often at the beginning and/or the end of the transport chain.

49. An approximate idea of the scale of road container transport may be gleaned by looking at the importance of the road sector in international freight transport. Road transport's overall share of the freight market has been growing constantly (figure 1.4). [18] From 1995 to 2008, the proportion of road traffic rose from 42.12 per cent to 45.91 per cent, with an average of 44.22 per cent. Its advantages such as its unique flexibility to meet just-in-time delivery at a low price and its freedom to carry goods to all destinations have led to growing road freight transport demand, despite the negative environmental consequences of road transport.

Figure 1.4. EU-27 performance by mode for freight transport



[18] European Commission: *EU energy and transport in figures. Statistical pocketbook 2010* (Luxembourg, 2010).

50. Road transport is usually involved in either door-to-door, long-distance haulage or in the first/middle/final legs of intermodal carriage. There are a variety of vehicles that can be used for transporting containers:

- flatbed vehicles with or without twistlock connectors;
- flatbed vehicles with close-coupled trailers, with and without twistlock connectors;
- flatbed vehicles with full trailers, with and without twistlock connectors;
- flatbed type vehicles with self-loading capability for Class C self-supporting swap bodies;
- flatbed type vehicles and close-coupled or full trailers, both with self-loading capability for Class C self-supporting swap bodies;
- flatbed type vehicles with side-lifting capability;
- tractor units and flatbed semi-trailers, with or without twistlock connectors;
- tractor units with skeletal semi-trailers;
- tractor units with full trailers;
- tractor units with drop frame semi-trailers;
- tractor units with B-Train trailer combination.

51. With the exception of the drop frame trailers, all of the above have a deck height of approximately 1.2 m (48 ins) (as shown in the photo in figure 1.5). The drop frame has a deck height of approximately 1 m (40 ins) or lower (as shown in the photo in figure 1.6).

Figure 1.5. Gooseneck trailer

Figure 1.6. Drop frame trailer

52. Semi-trailers can come in a variety of formats, such as extendable, multi-positional and tipping.

- Flatbed vehicles and trailers may be fitted with corner recesses into which the corner fittings locate, stubs which protrude into the corner fittings and twistlocks.
- Semi- and full trailers may be fitted with stubs and twistlocks.
- Tipping trailers must be fitted with screwdown twistlocks.

53. When considering the type and design of road transport for containers, there are safety issues that need to be addressed:

- There is an increased risk of the container sliding or falling off vehicles and trailers if they do not have stubs or twistlocks.

- There is a risk of the container falling off at corners, or during sharp manoeuvres, on vehicles and trailers with stubs or twistlocks that are not properly engaged.

54. It is therefore important that the driver of the road vehicle recognizes the limitations of the attachment devices and ensures that, where fitted, twistlocks are properly engaged.

55. To ensure the safety of the driver and other road users, the driver should be informed of:

- The details of the stowage and securing of the contents of the container, which are essential for safe driving in accordance with the status of the cargo. In this regard, the shippers'/packers' responsibility should be emphasized, taking into account Regulation 5.2 of the International Convention for the Safety of Life at Sea (SOLAS), which requires the contents of a container to be properly packed and secured.

- The mass of the cargo so that the appropriate trailer can be selected to ensure safe haulage. The shipper could verify the gross mass of the loaded container by the use of local, container line or terminal weighing facilities and convey that information to the driver. In addition, Regulation 2 of Chapter VI of the SOLAS Convention requires the shipper to provide such information.

- Dangerous goods or hazardous materials, especially those that do not require placarding as required by the International Maritime Dangerous Goods Code (IMDG Code), so that the driver can take appropriate action in the case of an accident.

56. The design of the trailer can also have an effect on the stability of the load. With a trailer truck designed to carry a container, the cab and the trailer are combined and fixed by a kingpin. This is how the truck and the trailer are joined. The weight of a container atop a trailer is only supported by three fulcrums, namely the kingpin on the front and rear tyres on the back. This peculiar structure of a container trailer truck makes it vulnerable to side forces. [19] This is particularly sensitive during off-ramps and downward curves.

57. There are conflicting reports about incidents on the road involving freight vehicles. The International Road Transport Union (IRU) carried out a scientific study into the causes of accidents involving trucks in Europe. During the preparation of the report expert teams conducted detailed and thorough investigations into 624 incidents involving at least one truck. [20] Only 1.4 per cent (nine incidents) of the accidents could be attributed to the load of the truck. Of these, only three accidents resulted in the truck rolling over. But the report acknowledges that the cargo may have contributed to the severity of the accident.

58. The report looked at five different accident configurations:

- accident at intersection;

- accident in a queue;

- accident due to a lane departure;

[19] S. Machida: *Video presentation to the IFT*, June 2010.

[20] IRU: *A scientific study "ETAC" European Truck Accident Causation* (Geneva, 2007).

- accident during an overtaking manoeuvre;
- single truck accident

59. Approximately 7 per cent of the accidents involved a single truck (44), and of these 43 per cent rolled over (15 incidents). Rollover frequency for the other four categories was found to be only 1 or 2 per cent, which resembled the findings of the Zenkowan [21] survey (see paragraph 61). The report may have attributed the root cause for the accident to a number of factors, but a high centre of gravity may have caused the truck to trip on a curb or pavement.

60. Tripping occurs often at entrance or exit (on or off) ramps that have a curb on the inside of the curve. When a driver is travelling a little too fast, the trailer wheels will track inside of the tractor wheels. Even though the tractor takes the curve without brushing the inside curb, the trailer wheels may swing in a little closer, hit the curb and "trip" the unit, thereby causing the trailer to swerve violently and possible to roll over. [22]

61. The survey conducted by Zenkowan revealed that during a period of ten years starting in 1998, 175 overturn accidents occurred, killing 13 people. [23] However, more recent research has identified 28 incidents on Japanese roads in four years (2006–09 inclusive). The table in Appendix II identifies each of the accidents and provides details of the cargo and circumstances of the incident. An analysis of these incidents shows that 16 (57 per cent) involved trucks travelling at 60 km/h or higher and 13 of these vehicles were negotiating a curve or sharp bend at the time. [24]

62. These two surveys culminated in physical tests involving a 40 ft container loaded onto a tractor and a semi-trailer being driven around a fairly sharp curve at a number of set speeds. At 30 km/h the truck already tilted outward. At 45 km/h, one of the rear tyres was lifted off the ground and the truck almost tipped over. A loaded container with an eccentrically loaded cargo with a high centre of gravity was also driven around a similar test curve and at 37 km/h the truck/trailer combination rolled over. [25]

63. In relation to an overturn accident of a container trailer in 1998, Masaaki Kato, the Director of the Japan Highway Safety Centre testified: "The curve at the accident site should have been safe enough for a trailer truck driving at such a speed (75 km/h) to take a turn. So the speed alone could not be the cause of the accident. There must have been other reasons." [26]

64. There is a similar concern in the United States. In the video *Cargo tank driver's rollover prevention*, the commentator states that speed signs at the side of the road are "for passenger cars travelling in good weather. Fleet safety experts say that when you enter this

[21] All Japan Dockworkers' Union.

[22] United States Department of Transportation. Federal Motor Carrier Safety Administration: *Cargo tank driver's rollover prevention* (Washington, DC, 2010)

[23] S. Machida, op. cit.

[24] Ministry of Land, Infrastructure, Transport and Tourism.

[25] S. Machida, op. cit.

[26] S. Machida, idem.

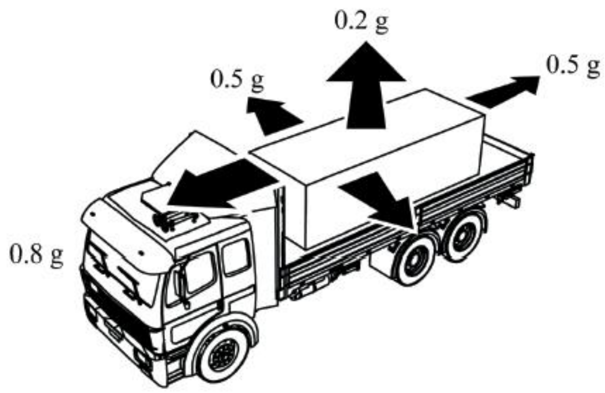
curve you should drop your speed at least 10 mph (16 km/h) below" the indicated speed limit. [27]

65. The nature of the standard container conveyance equipment means the centre of gravity will be higher than normal truck/trailer combinations. Furthermore, drivers of trucks carrying containers are generally unaware of the load placement within the container and the height of the cargo's centre of gravity. It is therefore probable that speed did play an important part in these accidents whilst the driver was negotiating bends in the road, but the situation was exacerbated by the high centre of gravity.

66. Anecdotal evidence from various parts of the world shows that some road routes, particularly those associated with poorly surfaced roads and multiple sharp corners, can cause the cargo to shift substantially and potentially place undue pressure on the side walls.

67. Forces associated with road transport are shown in figure 1.7. [28] There does appear to be some difference of opinion with respect to the force that a load could apply in the forward direction, varying from 0.4 ***g*** [29] to 1.0 ***g*** (full weight of cargo). [30] Long-distance journeys may also cause cargo settlement due to the vibration from the road surface. It is recommended that the load must be packed tightly before applying the restraints, which should be arranged so that no part can accidentally be released by vibration or road shocks while the vehicle is in motion. [31]

Figure 1.7. Road transport forces



[27] United States Department of Transportation, op. cit.

[28] United States Department of Transportation. Federal Motor Carrier Safety Administration: *Driver's Handbook on Cargo Securement. A Guide to the North American Cargo Securement Standard* (Washington, DC, 2009).

[29] European Committee for Standardization: *Securing of cargo on road vehicles – Body structure of commercial vehicles – Minimum requirements*, EN 12642 (Brussels, 2006).

[30] idem.

[31] United Kingdom Department for Transport: *Code of Practice. Safety of loads on vehicles*, third edition (London, 2002).

68. Recent changes to road transport regulations within Europe require shippers to provide their logistic partners with documentation detailing the type and mass of the cargo and type of pallet used (where applicable). Shippers are also obliged to provide safe packaging while the whole load has to remain stable even when tilted to an angle of 26 degrees. [32] This regulation refers to non-containerized cargo – but assuming that the container is secured adequately to the road vehicle, it could be argued that the cargo within the container should be governed by the same requirement.

1.2.3.2. Container transport by rail

69. Generally, the trend in rail goods transport has been downward or stable in European Conference of Ministries of Transport (ECMT) and OECD countries over the past decade in favour of road transport. Rail goods transport accounted for about 32 per cent of the total in ECMT and OECD countries in 2000. The share is high in the United States and the Russian Federation, which accounted for about 39 per cent of total goods transport in 2000 in both countries (table 1.1).

Table 1.1. Modal split in 2000 – World freight transport (percentage)

	Rail	Road	Inland waterways	Pipeline	Sea (national transport)
Total ECMT	32.2	27.0	3.5	33.6	3.7
Total OECD	32.0	38.2	9.6	10.8	9.3
Western Europe	13.1	63.4	6.1	6.9	10.5
Central and Eastern Europe	39.2	48.7	2.1	9.9	0.1
CIS	42.0	4.6	2.2	50.9	0.3
EU15	14.1	63.2	7.1	4.9	10.7
United States	39.0	28.6	9.6	15.3	7.5
Japan	3.8	54.2	0.0	0.0	41.9
Russian Federation	39.0	4.3	2.0	54.4	0.2

Note: Data not available for Iceland, Malta, Armenia and Mexico.

70. Intermodal traffic on United States railroads – the number of international containers, domestic containers, intermodal truck trailers, and road-railers handled by the railroads – tripled over the last two decades (1991 to present) from 3.0 million to 8.7 million. [33] Because of the relative advantages of rail transport (for example, its environmental and safety benefits over that of road transport, and one train can carry the equivalent of up to 50–60 truckloads), a modal shift in favour of rail is being strongly promoted by government policy in many countries.

71. In the case of longer distance journeys, the modal share of rail transport freight is particularly strong compared to that of road transport (table 1.2). [34] In the EU in general, the trend for rail shows an increase in the share of international transport and a decrease in national transport in 2001, compared to 1990.

[32] Roadtransport.com: *Belgium tightens up its load laws* (23 Nov. 2009).

[33] Association of American Railroads (AAR), see: www.aar.org.

[34] European Commission: *EU energy and transport in figures. Statistical pocketbook 2003* (Luxembourg, 2003).

Table 1.2. Distance classes by mode of transport (percentage)

Km	Rail		Road		Inland waterways	
	t/km	Tonnes	t/km	Tonnes	t/km	Tonnes
0–49	2.3	24.1	5.1	53.7	5.3	29.2
50–149	9.3	22.7	16.4	22.8	29.0	39.6
150–499	49.1	40.4	41.9	18.4	54.1	28.9
500+	39.2	12.8	36.5	5.1	11.5	2.3
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

72. Table 1.2 shows that 53.2 per cent of cargoes by mass carried by rail is transported for more than 150 km, which indicates that rail is the mode of choice for long distances and often across borders – particularly in Europe. Freight trains fall into three categories: [35]

- trainload (or block trains), where a complete train (usually of one type of goods) goes from origin to destination without any re-marshalling on the way;
- wagonload, where wagons are loaded by different senders at various points and forwarded in ones or twos for different destinations. In the traditional way they may be shunted two or three times during the journey, and will form part of different trains at various stages of their journey;
- a combination of the two (consolidated wagonload), where wagonload traffic is marshalled into a train at as early a stage as possible, and then run as a full train before being split up for final delivery. When it is necessary to remove or add wagons on the way, this is done by adding or removing a block of wagons according to a pre-arranged schedule at a point fixed in advance. The principal sections of the journey are therefore covered without disruption in the manner of a full train.

73. The nature of rail transport makes containers rolling over less likely; however, there are still risks associated with this mode of transport.

74. At around 2.20 a.m. on 10 August 2007, two wagons forming part of a freight train in the United Kingdom became derailed (as shown in the picture in figure 1.8). [36] During the derailment, which took place at just under 15 mph (24 km/h), all wheels of the seventh and eighth wagons from the locomotive left the rails. No one was injured in this accident. [37]

[35] OECD: *Report on the current state of combined transport in Europe*, European Conference of Ministers of Transport (Paris, 1998).

[36] Picture from Google Earth.

[37] United Kingdom Department for Transport: Rail accident report. *Derailment at Duddeston Junction, Birmingham, 10 August 2007*, Rail Accident Investigation Branch, Report No. 16 (London, 2008).

Figure 1.8. Derailed container wagons

75. The immediate cause of the accident was the climbing of the front right-hand wheel flange of one of the wagons over the right-hand closure rail of a set of points as a result of the interaction between a combination of track twists and the unevenly loaded wagon.

76. Amongst the causal factors found was that one of the wagons was running loaded in a way that made it very susceptible to derailment over track twist faults. A full 20-ft container loaded to its maximum gross mass was positioned next to an empty 40-ft container. The combined mass of the two containers did not exceed the permissible loading on the wagon, but it did mean that the load was concentrated above one set of bogies. This uneven distribution of load had not been detected and remedied before the wagon left the terminal.

77. An additional casual factor found was that the 20-ft container load was likely to have been offset to the left (as shown in the picture in figure 1.9). The picture also shows that the strapping securing the cargo within the container has broken despite the container not falling from the wagon. The report states “It is likely that the banding broke and the load lozenged forward during the derailment. Given that this container remained upright on its spigots, it is likely that the centre line of the load was to the left of the centre line of the container at the time of derailment. This is supported by no obvious right to left slide marks being seen on the container floor. Estimates from photographs suggest the offset to be between 0.25 and 0.4 m.”

Figure 1.9. Lozenged steel sheets

78. Cargo movement within the container as a result of sudden acceleration due to shunting or derailment is a real risk to the safe operation of railways. This example shows that a minor derailment could have resulted in a serious accident, especially if the train had been passing another train.

79. In the same way as road transport, repeated vibrations can cause the load securement to loosen as the cargo "settles".

80. Apart from incidents on the track, many rail terminals/yards involve transhipping containers from road vehicle to rail wagon, wagon to wagon and wagon to road vehicle. Terminals which rely on top pick or side pick trucks to move containers have the added difficulty that the ground may be uneven and eccentric loading within the container could result in the vehicle overturning.

1.2.3.3. Container transport by inland waterway

81. The modal share of inland waterways has decreased overall, falling short of the growth in other modes of transport. Inland navigation's share of goods transport is roughly 6 per cent in Western Europe, 3.5 per cent in ECMT countries, and 10 per cent in OECD countries in 2000 (table 1.1).

82. While inland waterways are used for both short- and long-distance freight transport, inland navigation tends to cover longer distances than road (table 1.2). In 2000, national and international transport by inland waterways accounted for 48 per cent and 52 per cent of the total, respectively. Crude and manufactured minerals and building materials account for almost half of the commodities carried by inland waterway transport. [38]

83. Inland waterway transport mainly involves the carriage of sea containers from and to ports and their hinterland. Container barge operations have to be intermodal, as road and/or rail is always necessary to carry them from and to the hinterland.

[38] European Commission: *Inland waterways freight transport in 1990–2001 in the European Union and the candidate countries* (Eurostat).

84. Intermodal transport using European inland waterways consists, to a large extent, of the transport of maritime (ISO) containers on board specially equipped inland navigation vessels. Most of these vessels have a length of 63–135 m, a width of 7–17 m and a draught of 2.5–3 m. They can transport between 32 and 500 teu, depending on the inland water infrastructure. Standard container vessels on the Rhine have a length of 110 m, a width of 11.4 m and a draught of 3 m, and could carry 200 teu.

85. Ro-ro transport on inland waterways is used to a lesser extent, also on the Danube. A typical ro-ro inland water vessel has a length of 110 m, a width of 11.4 m and a draught of 2.5 m. It could carry around 70 trucks or road trains.

86. Two-thirds of European E-waterways (14,700 km) fulfil the necessary minimum requirements for efficient international container transport as required under the AGTC Protocol on Combined Transport on Inland Waterways (AGTC Protocol) [39] and belong to inland waterway Class Vb or higher (Large Rhine Vessels).

87. These E-waterways should allow vessels with a length of 110 m and a width of 11.4 m to carry containers in three or more layers. If only two layers of containers are possible, a permissible length of pushed convoys of 185 m should be ensured.

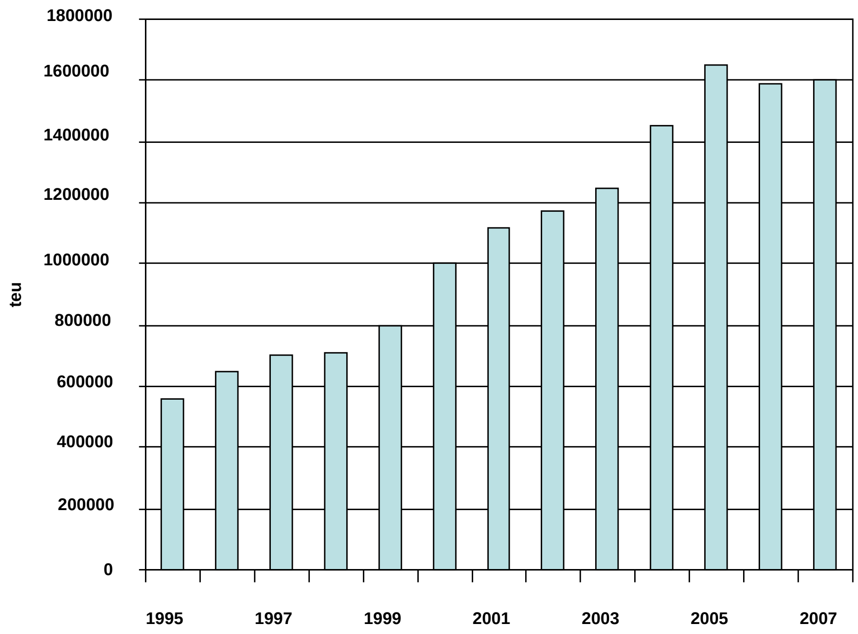
88. European intermodal transport is to a large extent characterized by road–rail transport operations. In 2007, around 18 million 20-ft equivalent units (teu) were transported by road–rail, using mainly containers, swap-bodies and semi-trailers. Accompanied transport, i.e. the transport of complete road trains on railway wagons (ROLA), constitutes only around 5 per cent of such traffic.

89. Compared to road–rail transport, intermodal transport by inland waterways is significantly smaller and mainly confined to hinterland traffic of maritime containers to and from European seaports. Most of the traffic takes place on the Rhine and has increased nearly threefold since 1995. In 2007 around 1.6 million teu were moved (see figure 1.10). [40]

[39] UNECE: *Protocol on combined transport on inland waterways to the European Agreement on Important International Combined Transport Lines and Related Installations (AGTC) of 1991* (Geneva, 17 Jan. 1997).

[40] UNECE: *Opportunities and challenges for intermodal transport by inland waterways*, Economic Commission for Europe, Inland Transport Committee, 53rd session (Geneva, 2010).

Figure 1.10. Container transport on the Rhine



90. While road and rail transport infrastructures, particularly along major European North–South corridors are increasingly congested, inland water transport still offers untapped capacities in the order of 20 to 100 per cent in many United Nations Economic Commission for Europe (UNECE) countries, 24 hours a day, seven days a week. However, adequate capacity on inland waterways is not sufficient to increase its market share and modal split vis-à-vis road and rail transport.

91. In order to capture future growth markets, such as the transport of containers, the inland water transport industry needs to comply with the increasingly sophisticated requirements of supply chain and distribution managers and must integrate better into seamless door-to-door transport chains. This includes efficient transhipment operations and terminal hauls as the benchmark in terms of cost and service quality is door-to-door road transport.

92. The boom in container traffic on the Rhine has shown that, given favourable inland water conditions and infrastructures, intermodal transport using inland waterways could be competitive. Since 1995 container transport on the Rhine has nearly tripled, mainly driven by maritime port hinterland traffic.

93. In contrast to this rapid development on the Rhine, container transport on the Main-Danube canal, linking the Rhine with the Danube, has never attained more than 10,000 teu per year and has declined steadily since its peak in 2000. This could indicate the limitations of inland water transport over long distances where numerous locks need to be used, resulting in long transport times and costs compared to viable alternatives – such as rail and road transport.

94. There is evidence to show that inland water transport is a growing sector within the supply chain. Furthermore, there is little evidence to show that there are serious risks associated with this transport mode. Nonetheless, overloaded containers loaded onto a smaller barge could have serious repercussions on the operation of the inland waterways and on the environment of the river and those living along its banks.

95. A report in *Toytown Germany* [41] stated that: "The Rhine is blocked for traffic between Cologne-Porz and Cologne-Niehl after a barge drew water on Sunday (25 March 2007), threatening to capsize. The containers began to slip, the captain attempted to stop and anchor the barge and lost 32 containers in the procedure, some of them loaded with chemicals and industrial strength glue. Seventeen of them beached several kilometres downstream while 15 sank – right in the middle of the navigation channel. One of the containers was damaged and tannic acid has been leaking into the Rhine." [42]

96. While this incident was probably the result of a split in the hull, overweight containers or those with a poor load distribution could cause a barge to become swamped with similar consequences.

97. Other limited risks that might arise in handling containers and the effects of the cargo during inland waterway transport, apart from those associated with handling between the shore and the barge and ashore, will be discussed in the next section.

1.2.3.4. Port handling

98. Not all these ports serve the same function in the world trading system – even among the larger ports that anchor the principal east–west trade lanes. While many ports serve extensive hinterlands that reach across entire continents (as in the case of the European North Sea ports), others serve local/regional markets only. Furthermore, some ports operate mainly as trade "gateways", while others serve principally as transhipment "hubs". It is estimated that transhipment accounts for approximately one quarter of all container port throughput, although in some specialized ports such as Singapore and Colombo, transhipment may represent up to 70 per cent of port throughput. These movements have grown in importance as liner operators have invested heavily in larger capacity ships on the main trunk routes. These ships are serviced by a number of smaller vessels operating regional feeder routes connecting the main hub ports to their surrounding region. While this "hub and spoke" system remains a dominant feature in many regions, certain global carrier alliances have recently started to offer a blend of main trunk services calling on major ports, along with second-level services calling on a string of secondary ports.

99. While a port authority may represent a single actor, the port area itself may often assemble a number of different actors that may or may not have a direct link to containerized trade. Individual quays and jetties are often operated by independent terminal operators who specialize in servicing a wide range of vessel types. Across a large port, one might find oil and gas terminals, bulk iron ore and chemical terminals, grain and livestock terminals along with container terminals. However, many ports now tend to specialize in one type of operation. While port operations are often (but not always) in the hands of the private sector, in many cases the ownership of the port is not. Depending on local and national arrangements, the port and its infrastructure may be owned either by national, regional or local authorities or by private operators.

100. Ports represent one of the principal control gates in the international container transport chain. As noted earlier, some containers involved in international trade do not voyage by sea and thus do not pass through ports, but most do. The area under the control of a single port authority is typically comprised of a number of dedicated terminals and cargo handling facilities. In addition, many ports harbour other trade-related activities such as multimodal transfer centres, warehouses, container freight stations, logistics service

[41] *Toytown Germany*, an English-language website in Germany, at: www.toytowngermany.com.

[42] "Rhine river blocked after a barge accident", in: *Toytown Germany*, idem.

providers, etc. Ports also house some of the trade-related regulatory authorities – such as customs. Finally, while ports are normally associated with a waterfront, tight space constraints have led many ports to develop and/or use inland container depots where many of the main container handling tasks (such as container stacking and staging and customs processing) can be carried out away from the quayside.

101. The actual physical handling of the container within the container terminal is carried out by a number of cranes, vehicles and other machinery. Smaller ports tend to operate individual container-stacking vehicles ("toplifts", "sidepickers", "reach stackers" and/or "straddle carriers") to stack or unstack containers and manned delivery vehicles that move these containers to the quayside. In larger ports, there are usually larger gantry cranes (either manned or automatic) that pass over container stacks in order to pick and place containers onto delivery vehicles. In the largest ports, the latter tend to be unmanned automated guided vehicles (AGVs) whose movements are controlled by the container yard management system under the supervision of a central "control tower" facility. Finally, quayside cranes vary in sophistication from simple swing units to more sophisticated straddle arm units that extend over the entire vessel bay.

102. A general risk assessment should be undertaken by each terminal to determine the safest way to handle, carry and stack the various design of container likely to transit the terminal. Arising from that assessment, the terminal should have procedures for receiving and identifying such containers and for determining how to handle them safely. The procedures should include ensuring that container handlers are provided with all relevant information, instructions and training for dealing with the various types of containers. Training should be based upon the risk assessment and include alertness on the part of the drivers of lifting and carrying equipment in regard to the risks. [43] To ensure that there is a consistent standard, it is important that international risk assessment guidelines are available and that national and terminal specific variations are based on these. Global terminal networks already have developed and implemented strict procedures which could form an element in any international guideline.

103. Documents such as the ICHCA International's *Container Terminal Safety* were produced to identify the need for terminals, deep sea and inland, to ensure that they had systems capable of handling all types of containers likely to transit the port. Terminal operators should understand the design and safety features of each container and devise handling methods and storage procedures that minimize the risk of an incident occurring. The guidelines contained in the various documents do not specifically identify containers with improper stowage as a discrete subject, but with the increasing volume of containerized cargo, the possibility of receiving containers that are improperly stowed or overweight is likely to rise.

104. Handling within a terminal can be made by:

- fork truck, empty or full capacity;
- empty container carrier, side or top pick;
- full container carrier, side or top pick;
- reach stacker, full or empty;

[43] ICHCA International Limited: *Container Terminal Safety*, International Safety Panel Safety Briefing Pamphlet Series No. 5, Revised (Romford, United Kingdom, 2010).

- straddle carrier;
- rubber-tyred gantry;
- rail-mounted gantry;
- automated guided vehicle;
- yard tractors and “bomb” carts;
- quay crane;
- quayside jib crane;
- ship-mounted derrick.

105. Lifting devices employing a single jib boom, full container carrier, reach stacker, quayside jib crane and ship-mounted derrick are very susceptible to eccentrically loaded containers, which could cause the container to tip – and in the case of a full container carrier, to fall over.

106. Containers where the cargo is loose and free to move can have a similar destabilizing effect on the full container carrier and reach stacker, especially when cornering, starting and stopping. These two vehicles can carry 4- or 5-ft high containers when stacking and even small movements or eccentricity of load can be exaggerated, increasing the risk of overturning.

107. There are approximately 60 terminals that operate straddle carriers, and accidents involving them appear to be increasing and have the potential for serious personal injury and substantial equipment damage. Research carried out by the Through Trading Mutual Insurance Association Limited (TT Club) into straddle carrier accidents during 2006 and 2007 found that 6.8 per cent of claims made by terminal operators using this type of equipment were the result of them toppling over. [44] Toppling occurs when the straddle carrier encounters an uneven surface or makes a tight turn, especially when travelling at speed. Unfortunately, the research statistics do not include any reference to cargo-related incidents, but loose or eccentrically loaded cargo will have an effect on these vehicles when manoeuvring, especially when the container is being transported in the fully elevated position.

108. Much of the terminal handling equipment employs a spreader controlled by multiple control wires, which attempts to ensure that the container does not twist or turn during the lifting process. The multiple control wires also reduce the power required to lift heavily laden containers, or even multiple laden containers. The lifting speed can therefore be quite fast. In the combined ports of Singapore, there are 204 quay cranes [45] that handled 29,973,000 teu in 2008. [46] Assuming that every container was handled by these quay cranes, one container was moved every 3.7 minutes. The port of Felixstowe’s 30 quay cranes lifted one of the 3.1 million teu handled in 2008 every 5 minutes.

[44] L. Jones: *Safe working with straddle carriers*, the International Safety Panel (ISP) 55, Aug. 2008.

[45] *Port of Singapore, Singapore*, at: www.shiptechnology.com/projects/portofsingapore/specs.html.

[46] Cargo systems, op.cit.

109. The forces exerted onto the load during the handling cycle – especially as the container lift commences and when the container is landed, either ashore or on the ship – can be high, which means that ineffective cargo securing can be tested to the full and perhaps may fail.

110. Once the container has been sealed, terminals are probably the only location where the contents of the container may be examined under the supervision of local customs authorities. Inspections can be made of containers where there is intelligence or other evidence that the container is carrying contraband or other illegal materials, or if the container is carrying dangerous goods. There does not appear to be any procedure for the container to be opened just because there is a belief that the contents of the container are unsafe.

111. Marine and rail terminals have lifting equipment capable of handling fully laden containers, which generally have some means of measuring the gross mass of the lifted container. The development of a system that measures the load on each of the four lifting twistlocks would provide crane operators with a tool allowing them to measure more accurately the gross mass of the container and in addition the eccentricity of the load. [47]

1.2.3.5. Container transport by marine carrier

112. Maritime carriers are the most visible link in the international movement of containers – principally because they concentrate and move so many containers per voyage. Not all international moves include a maritime leg, especially in the case of North American and trans-European trade; but given the current configuration of world trade, most container moves include at least one sea leg.

113. There are approximately 450 maritime carriers operating vessels that can accommodate containers. The majority of these vessels (as well as the majority of the available capacity) are fully cellular ships – i.e., ships designed for the exclusive purpose of transporting containers. A small minority of these carriers only operate container barges and as such do not participate in ocean trade. The remaining vessels are either mixed-used vessels that carry vehicles and cargo containers (roll-on–roll-off) or mixed use general cargo vessels.

114. The world container vessel fleet is dominated by the presence of several large carriers that operate high-capacity vessels (up to 8,000 teu) in a few selected trades. The top 20 operators account for 61 per cent of the total fleet capacity and the top 40 operators account for 72 per cent of total capacity. The corresponding figures for the fully cellular fleet are 78 per cent and 92 per cent, respectively. Smaller carriers are more likely to operate in lower volume trades that service major transhipment centres.

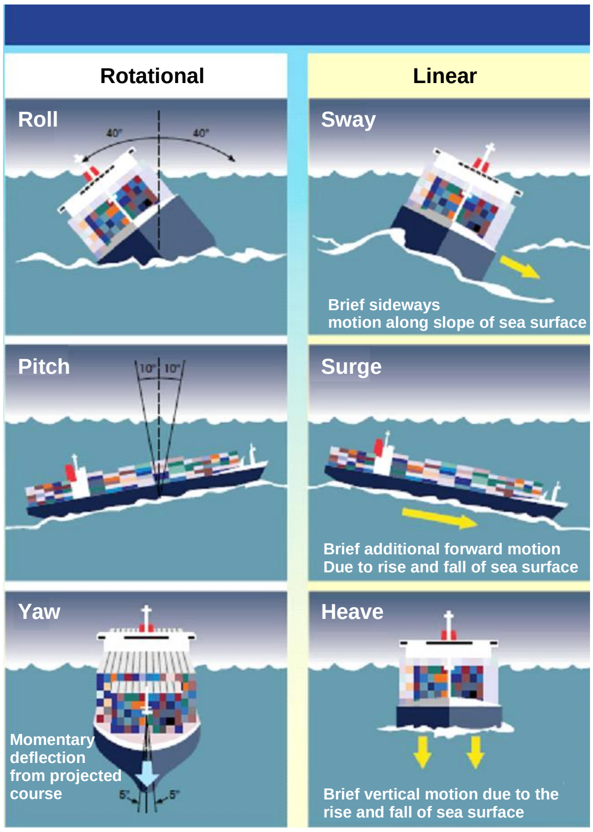
115. Fully cellular vessels can store containers both above and below deck in a series of racks made to fit standard container sizes. Once stored on board a fully cellular vessel, crew members have extremely limited access to most containers – especially when these are stored below deck and/or inside full stacks.

116. The core role of the maritime carrier in the container transport chain has traditionally been to provide "liner" services – that is, services that are provided on a regularly scheduled basis to pre-determined ports. Recently, however, several major carriers have begun to reposition themselves as door-to-door transport and logistics services providers. These carriers offer door-to-door transport services that are supported by a network of commercial partners and/or wholly owned subsidiaries on the land side. Furthermore, carriers have also sought to acquire and/or develop expertise in terminal operations.

[47] LASSTEC, Lemantec International Sarl (Sciez, France) at: www.lasstec.com

117. Ocean going and coastal vessels are subjected to six movements, as shown in figure 1.11. [48] But there are extremes and variations that relate to the various designs of containership.

Figure 1.11. Ship's motions in heavy seas



118. Container ships can be divided into development generations based on capacity, which is determined by the number of teu to carry on board. Generally, there are six generations, each of which has a distinct time period and capacity range (see figure 1.12). [49] The largest class of container ship is said to be the Maersk E Class with the Ebba Maersk reported as carrying 15,011 teu. [50]

[48] International Chamber of Shipping: *Safe transport of containers by sea. Industry guidance for shippers and container stuffers* (London, 2008).

[49] Container ships at: www.container-transportation.com.

[50] Ebba Mærsk slår verdensrekord i containerlast Ingeniøren/ 28 May, 2010.

Figure 1.12. Container vessel generations

Generation	Vessel	Length	Draft	teu
First (1956 - 1970)	Converted Cargo Vessel Converted Tanker	135 m 200m	< 9 m < 30 ft	500 800
Second (1970 - 1980)	Cellular Containership	215 m	10 m 33 ft	1,000 - 2,500
Third (1980 - 1988)	Panamax Class	250 m 290 m	11 - 12 m 36 - 40 ft	3,000 4,000
Fourth (1988 - 2000)	Post Panamax	275 - 305 m	11 - 13 m 36 - 43 ft	4,000 - 5,000
Fifth (2000 - 2005)	Post Panamax Plus	335 m	13 - 14 m 43 - 46 ft	5,000 - 8,000
Sixth (2006 +)	New Panamax	397 m	15.5 m 50 ft	11,000 14,500

119. Large container ships are some of the largest vessels afloat, the Maersk E Class having a length of 397 m, a beam of 56 m and a draught of 30 m. The deadweight of the ship is 156,907 metric tonnes. Such vessels could be assumed to be very stable while at sea. Unfortunately the reality is that the design of the large Post-Panamax container has to balance two requirements: maximizing container capacity and minimizing the hull's resistance through the water. Consequently, the hull features a wide beam and large bow flares in order to carry more containers on deck, while ensuring that the underwater shape is streamlined to minimize resistance. As the ship moves forward, a wave travels backwards along the hull; the stability of the vessel will vary, depending upon the position of the wave along the hull – which causes it to roll, pitch and yaw. Waves approaching from the front at a slight angle to the direction of travel will result in a combined pitching and rolling movement. As the first wave nears the stern of the vessel, the bow will be forced down and the hull will roll towards the direction of the next wave, presenting the now almost horizontal surface of the large bow flare to the upward movement of the wave crest. In turn, the bow flare will now be supported and forced upwards by the next wave, which changes the vessel's stability once again. The restored buoyancy force caused by the bow flare, supported by the next wave plus the upward force of the wave, "pushes" the ship to the other side – so that the bow flare crashes into another wave crest. A similar action occurs to the other side, so that the bow flare crashes into another wave crest. This will be repeated as the bow pitches down in the next cycle. This coupled, synchronous motion could lead to large roll angles in a few cycles, even with moderately high waves. [51]

120. All this might result in a vessel rolling to 30 degrees or even further (as shown in the photo in figure 1.13). Such extremes of angle place considerable stress on the container, the securing devices holding it to the vessel and the cargo within the container. In addition to rolling fore and aft forces caused by the ship driving through heavy seas, this could cause the load to move forwards (as shown in the photo in figure 1.14).

[51] Ocean systems: *Parametric roll*, at: www.ocean-systems.com.

Figure 1.13. 30-degree heel

Figure 1.14. Heavy weather

121. Another severe motion associated with the larger container ships with a very flat aft section is associated with stern seas, when the stern section can slap down onto approaching waves inducing a rapid deceleration of the containers stowed above.

122. It does need severe weather to affect the contents of a container; on an average voyage from Hamburg to Oakland, a passage of 26 days, of which 24 are at sea, a container may experience 190,080 movements [52] varying in severity from mild to strong. Inadequate securing methods will result in the cargo becoming loose, causing potential damage to the cargo itself and/or the container. A container which undertook a similar voyage carrying electrical generators was found to be severely damaged when adjacent containers were removed (as shown in the photo in figure 1.15). [53] It was revealed that the shipper had failed to provide sufficient and adequate securing to ensure that the cargo remained safe.

Figure 1.15 Displaced generator

[52] H.-J. Grasshof: *Flexi tank chance or danger?* (Hamburg, Hapag-Lloyd, Nov. 2009), at www.hapag-lloyd.com.

[53] Allianz Global Corporate & Specialty.

1.3. Supply chain risks

123. Risk factors are those transport properties to which the consignor should pay attention when preparing to transport a cargo, so as to minimize or rule out any possible risks from the outset.

124. The following risk factors [54] can affect cargoes carried in containers:

- temperature;
- humidity/moisture;
- ventilation;
- biotic activity;
- gases;
- self-heating/spontaneous combustion;
- odour;
- contamination;
- mechanical influences;
- toxicity/hazards to health;
- shrinkage/shortage/theft;
- insect infestation/diseases.

125. As this report is concerned with safety in relation to the packing of cargoes, we shall concentrate on the risk factors related to mechanical influences.

126. Since container transport involves multimodal carriage, the goods carried in this manner are also subject to the various stresses of the individual means of transport. When evaluating stresses, the container should be viewed as being a replacement for the cargo/load carrying area of the particular means of transport, such as the case body on a truck, a freight car in a train or a ship's hold in maritime transport.

127. Consequently, any problems that arise during these various forms of transport will also occur in the container itself. The most frequent misconception is to view the container as a replacement for packaging – an error which repeatedly causes major losses or even jeopardizes the means of transport. The fact that a standard container is being used does not make it possible to cut down on either load/cargo securing measures or packaging.

128. The one exception to this is the "stackability" of packages. Since the container acts as a "hold" that has been designed to be carried in stacks in ships, packaging requirements may be simplified in that the packaging need only be able to withstand the stack pressures

[54] German Insurance Association (GDV): *Cargo loss prevention information from German marine insurers, Container Handbook*, Vol. III.

within the interior of a single container, rather than the stack pressures of 8 to 10 m of overstowed cargo in the ship's hold.

129. This comment applies only to goods that are transported in a container and not subjected to any pre- or post-carriage operations.

130. If, on account of their mass or dimensions, packages are not overstowed in the container, packaging requirements are simplified as the packages are not exposed to any stack pressure. In this case, the packaging serves "only" to protect the cargo and, if necessary, to permit cargo securing.

131. Packaging, stowage and cargo securing in the container must be carried out in such a way that they can:

- withstand the stresses of each individual leg of the journey; and
- withstand the stresses of the individual means of transport used during the various legs of the journey.

132. Frequent, physical handling operations (for example, transfer of cartons, cases, bales, etc., from a truck onto a rail freight car, ocean-going vessel, inland waterway vessel and back on to a truck), which previously exposed the cargo to considerable risk of damage, have been replaced by much gentler container handling operations. Thanks to its standardized dimensions, the container as a cargo unit also benefits from standardized handling, of which a very high percentage is carried out by container bridges with spreaders.

133. However, when containers are being packed, levels of stress are frequently higher than was the case with conventional packing. Since closed standard containers are very often selected on cost grounds, goods have to be pushed into the containers and pulled out again during unpacking, due to their dimensions or mass. This is necessary because crane packing is not possible, or the floor loading capacity would be exceeded, if industrial conveying equipment were to be used. As a guide, a package or overpack with a mass greater than 3 tonnes is likely to overstress the cross members if loaded by a counterbalance forklift truck.

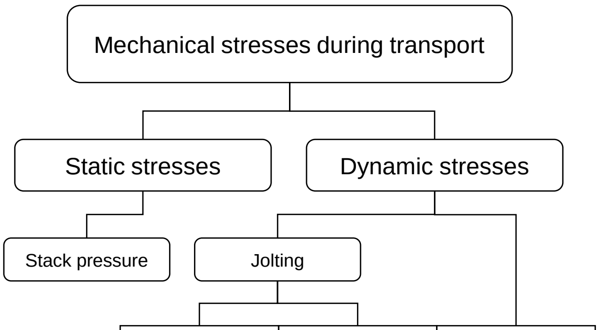
134. The mechanical stresses which occur during transport are usually stated in fractions or multiples of acceleration due to gravity (for example 0.4 ***g*** or 1.8 ***g***). Nonetheless, high ***g*** forces do not necessarily have the greatest effect on the cargo. Depending upon their pulse strength, even very small ***g*** values may cause considerable destruction. By contrast, very high ***g*** values acting over only a few milliseconds may have absolutely no effect on the goods. For example, a long, slow roll of a cargo on board a container vessel (say 0.4 ***g***) may have a greater effect on the cargo than a sudden high ***g*** force (say 2.0 ***g***) on a road trailer as it goes over a small bump or series of bumps.

135. Especially when assessing the damaging effects to the cargo of vibration and impacts, it is necessary to take the pulse length of the ***g*** values into account.

136. If vibration, jolting and impacts can cause damage to the goods under normal transport conditions in the planned means of transport, packaging must attenuate these effects to such an extent that damage to the goods is ruled out. Packaging specialists can devise suitable solutions to such problems.

137. Figure 1.16 [55] shows a schematic of the mechanical stresses likely to affect cargoes during transport. Static stresses are limited to the stack pressure generated by the goods themselves. This stack pressure load is caused by overstowing of the goods. The maximum "overstowing pressure" is a function of goods height and the internal height of the container.

Figure 1.16. Mechanical stresses during transport



	Impact	Vibration	Acceleration
Rail	Switching in transit, coupling and switching, impact during switching in hump yard, kicking, travelling through switches, rail joints	Slight while in transit, travelling through switches, when passing over rail joints	Braking and cornering
Road	Potholes, loading from combined road road/rail transport	While in transit depending upon the road surface	Braking and cornering
Maritime transport	Extreme pitching of the ship in heavy weather, tipping of containers during rolling	Machinery and propeller vibration, hull vibration due to rough seas	Rough seas, rolling, pitching and yawing
Cargo handling	Picking up and setting down by container cranes, stowing and packing the container, pushing or pulling a container	While being carried by straddle carriers or container handling equipment	Picking up and setting by container cranes, while being carried by straddle carrier / container handling machinery, insertion into ship cells.

138. Vertical, dynamic acceleration forces are superimposed on these static stresses. In unfavourable stowage positions, the acceleration caused by the pitching motion of the ship in maritime transport may amount to 1 ***g*** and, in extreme cases, even more. In order to withstand this additional load, the measured static pressure must be multiplied by a factor of two. When packaging is designed or calculated, further factors such as changing humidity, "untidy" stacking etc., are taken into account. Suitable packaging experts should be consulted when planning and packaging.

139. Since 2005, European directives and other national legislation have required that wooden packaging of imported goods should be free of insects. In order to achieve this, many countries treat their containers with toxic gases on a large scale. It has been reported that up to 95 per cent of all containers treated with the gas are not marked with the mandatory fumigation label and the paperwork does not include any reference to the substance.

[55] ibid.

140. These gases are not only dangerous for workers who handle the containers, but also for shop workers and consumers, because many products absorb these fumigant gases. For example toxic gases have been found in clothing, mattresses and shoes. In addition, gases that have emanated from the cargo itself have been found.

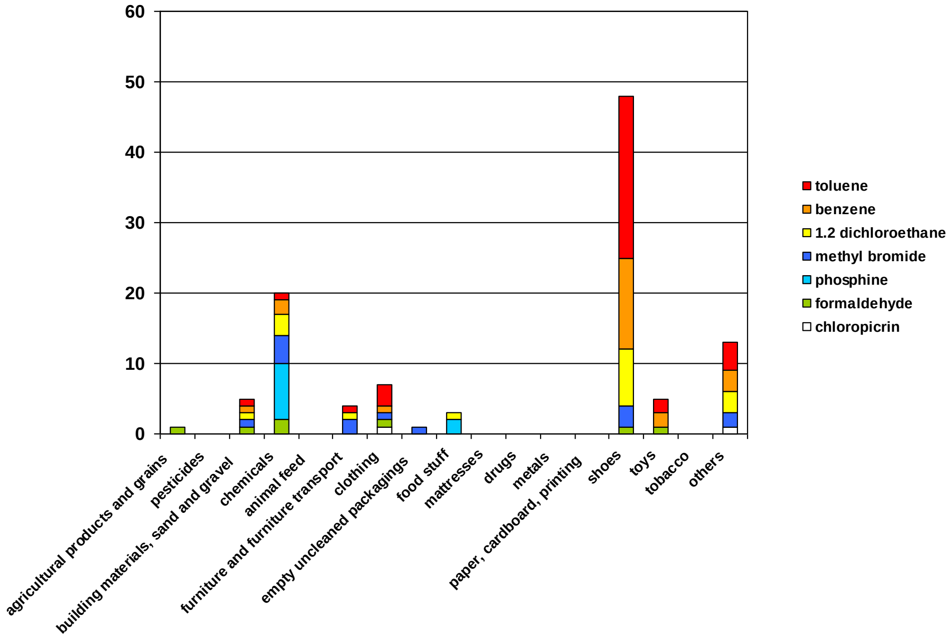
141. Substances such as methyl bromide and agents that produce phosphoretted hydrogens are acceptable for the treatment of stocks of raw materials by means of fumigation in the Netherlands. The term "fumigation" is understood to mean the application of a (chemical) pesticide, which is, and remains, gaseous at the prevailing temperature and pressure – but which is deadly for the organism to be controlled in the concentration applied for the duration of the fumigation (see also paragraph 197).

142. A research project carried out on behalf of the Ministry of Housing, Planning and Environment in the Netherlands investigated over 1,000 containers that arrived in domestic ports between 1 October 2008 and 1 October 2009. [56]

143. Of the 1,035 containers studied, 106 (10 per cent) were found to have a dangerous concentration of hazardous or dangerous gases. Seventeen (2 per cent of the total sample population) of these had been actively fumigated, but only one had the mandatory warning label and/or the appropriate notation of the shipping documents.

144. The remaining 89 containers (8 per cent) were found with a gas that had been used as part of the manufacturing process (see figure 1.17).

Figure 1.17. Number of containers with hazardous gas detected



[56] Ministry of Housing, Communities and Integration (VROM): *Uitvoering motie Poppe/Boelhouwer containers met gevaarlijke gassen. Rapportage van de samenwerkende inspecties* (The Hague, 2010).

145. Persons involved in opening containers must therefore be fully aware of the dangers of entering a container. ICHCA International Limited (ICHCA) has published a safety briefing pamphlet which gives advice on unseen dangers in freight containers. It recommends that “before portworkers are permitted to work in an intermodal container under fumigation, the container should be certified clear of fumigants by a competent person”. [57] In fact the container should be opened and the atmosphere checked not only for fumigants and other chemicals, but also to ensure that there is sufficient oxygen for safe working.

[57] ICHCA International Limited: *Unseen dangers in freight containers*, International Safety Panel Briefing Pamphlet No. 20 (Romford, United Kingdom, 2005).

2. Cargo-related incidents

2.1. Rollover incidents

146. On 31 July 2010, at least 20 people died and several were injured in a tragic road accident when a truck with a six-tonne container overturned in an open market in the western part of Addis Ababa, the Ethiopian capital, hitting several traders and vendors at the market. There was no indication why the truck overturned or whether the cargo contributed to the accident. [1]

147. The rollover of heavy vehicles is an important road safety problem worldwide. A number of studies have reported that a significant proportion of the serious heavy vehicle accidents involve this type of incident. Rollover accidents of commercial vehicles are especially violent and cause greater damage and injury than any others. The relatively low roll stability of commercial trucks promotes this phenomenon and contributes to the number of truck accidents.

148. There are over 15,000 rollovers of commercial trucks each year in the United States, i.e., approximately one for every million miles of truck travel. About 9,400 of these – one for every four million miles – are rollovers of tractor semi-trailers. In the United Kingdom in 1993, 545 heavy vehicles were involved in rollover accidents, accounting for 6 per cent of all accidents to articulated heavy vehicles and 30 per cent of accidents to heavy vehicles at roundabouts. [2]

149. Commercial truck rollovers often result in severe injuries and fatalities. About 4 per cent of all truck accidents involve rollovers, but more than 12 per cent of fatalities occur in this type of accident.

150. The association of rollover incidents incurring injuries to the truck driver is even stronger. While only 5 per cent of large truck accidents are rollovers, 55.3 per cent of the fatal injuries to the truck driver occur in incidents of this nature. [3] Rollover accidents result in a disproportionate number of injuries, of all forms, to the truck driver, exceeding figures in any other type of accident. The severity of the injuries is also disproportionately high. Research on data on rollover accidents from the Fatality Analysis Reporting System (FARS), administered by the National Highway Traffic Safety Administration (NHTSA), showed that approximately 18 per cent of rollover accidents resulted in a fatality or serious incapacity. [4] Other data also demonstrate that rollover incidents involving all types of heavy trucks result in a serious risk of a fatality or type A injury (serious incapacity). It is

[1] Agence de Presse Africaine (APA): *Ethiopia Road Accident*, 31 July 2010, at: www.apanews.net/spip.php?article129322.

[2] V.G. Goru: *Application in the roll stability of heavy-duty elliptical tankers using trammel pendulum to simulate fluid sloshing*, Erasmus Memoire Thesis, June 2007.

[3] Intelligent Transportation Systems (ITS): *Freightliner trucks field operational test: Freightliner/meritor WABCO roll stability advisor and control at Praxair. Appendix A-A. The Target population of rollovers for RA&C* (University of Michigan, 2000), at: www.itsdocs.fhwa.dot.gov/JPODOCS/REPTS_TE/14287_files/AppendixA.htm.

[4] J.L. Evans, S.A. Batzer, S.B. Andrews: *Evaluation of heavy truck rollover accidents* (Renfroe Engineering, Inc., United States) at: www-nrd.nhtsa.dot.gov/pdf/esv19/05-0140-W.pdf.

vital to ensure that the cargo is stable and that the centre of gravity is kept as low and as close to the centre of the container as possible.

151. There are many reasons for the frequency of these rollover incidents on roadways throughout the world, and they can be categorized into three distinct groups:

– **High centre of gravity** – the chassis or trailers used to transport containers are generally designed with a deck height that is suitable for alignment with standard height loading/unloading docks.

– **Loose or eccentric cargo** – packages that are free to move within a container will alter the position of the centre of gravity.

– **Driver error** – drivers of road vehicles are not always aware of the nature of the cargo packed into the containers, and this lack of awareness may affect the handling characteristics of the road vehicle. Consequently there is a risk of rollover should the load be subjected to high centripetal forces during manoeuvring, such as going round bends and roundabouts/traffic circles and changing carriageways.

2.2. Overweight containers

152. There seems to be a growing problem with freight containers imported into the United Kingdom; the Health and Safety Executive (HSE) is receiving an increasing number of enquiries asking for advice. Over the past two years, 7,760 containers stopped in roadside checks were found to be overweight, and one company had to call the HSE when a container overturned while being unloaded. Shippers are obliged by law to declare the correct weight to shipping lines, and there is no incentive to under-declare as shipping freight rates are based on the size of the container, not the weight. There have been accidents due to overloaded containers bursting open, and there is to be an international effort to revise the guidelines on loading. [5]

153. The UK P&I Club defines a container as overweight when it weighs more than the declared maximum gross weight written on the manifest, or when it is over the maximum weight allowed for the container.

154. The consequences of these two descriptions of an overweight container are considerably different. A container that weighs more than the declared gross mass written on the manifest will be within the safe operational limits of the container, that is to say less than the maximum gross mass/weight shown on the safety approval plate.

155. The audit of the containers removed from *MSC Napoli* and the dead load calculated on departure, indicate that the declared weights of many of the containers carried by the vessel were inaccurate. [6] This discrepancy is reported regularly within the container ship industry and is due to many packers and shippers not having the facilities to weigh containers on their premises. It is also due to shippers deliberately under-declaring containers' weights in order to minimize import taxes calculated on cargo weight.

[5] *Shipping safety threatened by overloading* (RW Freight Services, Romford, United Kingdom) at: www.rwfreight.co.uk/pages/index/ref/home/list_item_id/484.

[6] Marine Accident Investigation Branch: *Report on the investigation of the structural failure of MSC Napoli, English Channel, on 18 January 2007*, Report No. 9/2008 (Southampton, United Kingdom, 2008).

156. In view of the fact that container ships invariably sail very close to the permissible seagoing maximum bending moments, the additional undeclared weight has the potential to cause vessels to exceed these maxima. Container shipping is the only sector of the industry in which the mass of a cargo is not accurately known. If the stresses acting on container ships are to be controlled, it is essential that containers are weighed before embarkation.

157. Many countries have proposed new legislation that would require the consignor to ensure the accuracy of mass details on the transportation documentation accompanying the container. However, all those involved in consigning, packing, loading and receiving the container, in addition to the driver, would have legal responsibilities with respect to mass limit compliance.

158. The legislation under the United States Intermodal Safe Container Transportation Act 1992 (amended) (ISCTA), which came into effect on 9 April 1997, was designed to overcome this problem. It requires that all intermodal containers be accompanied by documentation at the beginning of a domestic or international movement.

159. The risk to the supply chain from overweight containers (but not exceeding the maximum gross mass shown on the safety approval plate) is very limited. The *MSC Napoli* report found that 20 per cent of the containers examined had a maximum gross mass greater than that declared on the manifest. But assuming that the cargo was well secured, this would have presented no greater danger than a container with a properly declared maximum gross mass. The risk to the container vessel and inland water barges is therefore that they may become overloaded. Road and rail transport and land-based handling equipment would not normally be affected at all – although there is the danger of an accident due to the unexpected handling characteristics of an overweight container.

160. The second definition of a container being overweight relates to local and national road and rail regulations. United States regulations state that the maximum gross vehicle weight shall be 80,000 pounds except where lower gross vehicle weight is dictated by the bridge formula, [7] which can be modified by State legislation to permit heavier loads. California provides operators with permits for container loads up to 95,000 pounds. [8] Similar exemption schemes operate near to ports in many parts of the world.

161. Containers loaded onto road and rail vehicles with a maximum gross mass exceeding the limit permitted by local and national legislation, but which are still below the maximum load shown on the safety approval plate, present little risk to safety – except where the road or rail infrastructure is not strong enough to support the vehicle's axle loading.

162. The third and final definition of a container being overweight is when the combined mass of the cargo and the container exceed the maximum mass shown on the safety approval plate. For the purposes of this report, this form of overweight container will be referred to as "overloaded".

[7] Electronic Code of Federal Regulations (e-CFR): *Title 23: Highways. Part 658 – Truck size and weight, route designations – length, width and weight limitations* at: www.gpoaccess.gov/cfr/index/html.

[8] California Department of Transportation: *Container weight exemption*, at: www.dot.ca.gov/hq/traffops/exemptions/container.html.

163. Shipping lines are guided by the maximum gross and tare masses shown on the safety approval plate, and which are marked on each container. Containers with a total mass greater than the maximum gross should be stopped by the shipping line prior to movement.

164. In many trades, containers are loaded on board ship by shore gantries or shore cranes, with a view to being discharged by ship cranes. There have been many cases in which damage has been caused to a ship crane because the actual weight of the container being discharged exceeds its safe working load, a fact which is only realized at the discharge port. There is a danger of serious injury to the ship's crew and shore personnel in such a situation.

165. Operators should also be aware that some containers may be "end-heavy", with most of the cargo weight loaded at the back of the container, away from the doors. End-heavy containers can be loaded normally by shore gantries which lift the container by its four corners, but can swing wildly and be difficult to control when lifted by a crane with a single hook and swivel.

166. Overloaded containers often carry scrap material such as waste steel and are often packed by standing the container vertically with the doors at the top; the cargo is then poured in until the container is filled, whereupon the doors are closed and the container "pushed" over for loading onto a road or rail vehicle. Other high-density cargoes such as slate, ceramic tiles, steel sheets and dense minerals in powder or granule form can also be easily overloaded by the shipper's attempt to reduce the consignment's shipping cost.

167. An overloaded container in the supply chain will often exceed the maximum permissible mass in rail and road transport, thus increasing the risk of a failure to the infrastructure.

168. Many quay cranes used to load containers on board or off container ships are often designed to be able to lift the heaviest container likely to be encountered, or to lift two or more containers simultaneously. In these cases, the overloaded container will have little effect on the safe operation. However, smaller or less well-equipped terminals, including many rail terminals, will only have the ability to lift loads that do not exceed the authorized limits on local road and/or rail networks. The overloaded container could cause the container handling equipment to overturn or tip up – and there is anecdotal evidence that this occurs on a fairly regular basis.

169. Overloaded containers may also have a high centre of gravity, thereby increasing the risk of the container overturning. They could also overstress the carrying vehicle's suspension and decrease its stability.

170. When a container is completely filled by cargo, such as scrap materials, it presents a serious danger to those required to open its doors for inspection or unloading. Pressure on the doors from the cargo may cause the doors to burst open when the lock rods are released.

171. Overloaded containers may also overstress the container fabric itself, potentially causing a failure to the main lifting elements such as the corner fittings and end post assemblies. In addition, overloading the floor assembly may cause the floor to pull away from the side walls, as shown in the photo in figure 2.1.

Figure 2.1. Detached bottom side rail

172. Such containers might also cause stack failures if one or more overloaded containers are stacked above a container with a low stacking ability, or when there is acceptable damage to the corner posts. Such failures below deck in cells would cause severe disruption to the operation of the container vessel; but on deck they could result in one or more stacks collapsing overboard, potentially releasing dangerous goods – not necessarily those in the overloaded container – into the maritime environment.

173. There are no international laws governing the maximum permissible weights of containers, other than the international standard ISO 668 Series 1 freight containers – classifications, dimensions and ratings. Over the years, since the container was first introduced, the rating of containers has increased from 20,000 kg, and 24,000 kg to 30,480 kg. Recent amendments to container standards have increased the rating to 32,500 kg for 40-ft and 45-ft long containers.

174. There is no maximum value for the gross mass of any container; many specialist containers have a rating of 34,000 kg for dry freight containers, up to 38,000 kg for bulk powder/granule and liquid tank containers, and up to 50,000 kg for flat-rack containers.

2.3. Concentrated loads

175. The maximum payload of a container is calculated by subtracting the tare from the maximum gross mass shown on the safety approval plate.

176. When a heavy indivisible load is to be shipped in a container, due regard should be given to the localized weight-bearing capabilities of the unit. If necessary, the weight should be spread over a larger area than the actual bearing surface of the load, for example by use of properly secured baulks of timber. [9]

177. This also applies to consignments of dense materials that can be easily stacked such as sheet or plate steel. Containers are built to carry the payload evenly distributed across the floor; a concentrated load approaching the maximum payload of the container and positioned so that the centre of gravity is above the centre of the container will therefore increase the risk of failure.

[9] IMO: *IMO/ILO/UN ECE guidelines for packing of cargo transport units (CTUs)* (London, 1997).

178. A packer may position a heavy load adjacent to one side or end wall in the belief that the wall panel will restrain the cargo and that the floor will be stronger at the intersection of the floor and wall assemblies. As mentioned above, container design is such that the load needs to be evenly distributed over the entire floor, and the mass of the cargo supported on both sides by the combination of the bottom rails and the side panels. In addition, the side walls are designed to withstand forces equivalent to 60 per cent of the maximum payload evenly spread over the entire side wall. A concentrated load placed against a portion of the entire side wall may, during handling or transport movement, exert a force that is greater than the designed loads. When the load is positioned against a side wall, it can increase the instability of the container on the vehicle – which could result in a rollover.

179. Some cargoes, such as steel wire drums, can be very heavy, but easy to load, and packers may be more concerned about preventing the drums from rolling than the load "footprint". The footprint is the area through which the weight of the cargo is transferred to the container floor. Solid stone spheres and steel cable drums with solid rims are two examples of cargoes known to have caused serious damage to the dry freight container during carriage.

180. Correctly positioned concentrated loads that are secured to keep the centre of gravity at, or as close to, the centre of the container should present no additional risk of an accident. But it should be remembered that a concentrated load does place extraordinary forces on the container structure during handling; should an incident occur, these forces and the potential momentum of the load may cause structural failure and increase the severity of the accident.

2.4. Unsecured cargo

181. Unsecured cargo inside a container can have a physical manifestation or remain undetected.

182. The photos in figures 2.2 [10] and 2.3 show two examples where the packer considered that the cargo was properly secured, but in both cases the method of securing the cargo inside the container was inadequate.

Figure 2.2. Improperly secured cargo

Figure 2.3. Unsecured steel pipe bundles

[10] German Insurance Association (GDV): *Container Handbook: Cargo loss prevention information from German marine insurers*, Vols I–III (Berlin, 2007).

183. In the photo in figure 2.2, the packer attempted to restrain the cargo by placing the cargo firstly on home-made pallets and then banding each with a top panel of plywood. The transverse restraint appears to be strips of plywood nailed to the top and bottom. The packer positioned the bulk of the cargo so as to maintain the centre of gravity close to the lateral centre of the container by positioning the pallets on the centre line and then placing small crates to the left and right. There appears to be no strapping to hold the pallets in place and total reliance on the nailed side strips. Vibration or rolling action overstressed the nails and they pulled out – and since there was no transverse strapping, the cargo packages slipped out and the load collapsed.

184. In this example the cargo presented little risk to those involved in the supply chain, although a potentially unstable container could increase the risk of a road incident during a sudden manoeuvre.

185. The photo in figure 2.3 shows a 40-ft container loaded with 15 bundles of 24-ft long steel tubing. The steel tubes were inadequately banded at the outset and, during the voyage, each bundle appears to have remained intact. However, the steel tubes are far shorter than the length of the container and were, at the time of inspection, at the rear of the container. This may have been due to the movement of the cargo during the trans-Pacific voyage, or because the packer placed them there as they were difficult to handle further inside the container.

186. The container shown in the picture was part of a consignment of 25 containers carrying steel tubes and had suffered some damage due to the very eccentric load. It was opened under customs supervision; before the consignment was permitted to continue its journey, the terminal repacked the containers with proper bracing.

187. Unsecured cargo inside a container presents an unstable/eccentric load risk that might result in the handling and transport incidents mentioned in the sections on rollovers and loose cargo. The other consequence of unsecured cargo is the danger of it breaking through the container during transport.

188. The photos in figures 2.4 [11] and 2.5 show examples where the unsecured cargo broke through the side walls of the respective containers. In the case of figure 2.4, the entire cargo was lost overboard and no traces of cargo or securing methods remained.

[11] G. Uitbeijerse: *Cargo handling*, Report to the Container Owners Association (COA) Working Group (Maersk Line, Rotterdam, 2009).

Figure 2.4. Cargo lost overboard

Figure 2.5. Side wall damaged

189. Figure 2.5 shows a container where the cargo was insufficiently secured and the heavy items slid against the side wall, tearing the panel from the bottom side rail.

190. These examples demonstrate the severe risk that unsecured cargoes can present to those involved in the supply chain and the general public.

191. Anecdotal reports from a recent German police's half-yearly survey taken at nine roadside inspection locations across the country found that the cargo in 90 per cent of freight vehicles stopped was not secured to the inspectors' satisfaction. Furthermore, between 50 and 60 per cent of the vehicles were, in the inspectors' opinion, so unsafe that the vehicle had to be repacked and resecured before it was allowed to continue on its way.

2.5. Combinations

192. There are numerous reported examples of incidents in the supply chain, many of which have been caused or exacerbated by poorly stowed and secured cargo. In many of the cases the root cause of the accident is not just one improper cargo securing method, as detailed above, but rather the result of a combination of deficiencies in cargo securing.

3. Current publications

3.1. Legislation

193. A number of countries have enacted legislation with the expectation that risks resulting from cargo transport would be reduced. The laws cover such areas as detailing the requirements for cargo reporting to enforcing rules of container fumigation.

194. The Chain of Responsibility (CoR) Regulations were enacted in Australia following interventions by trade unions and extend the general liability for offences to road freight consignors, receivers, packers and loaders. Rather than pursue the "soft target" on the roadside – truck drivers and operators – authorities can investigate along the supply chain and up and down the corporate chain of command.

195. Another piece of legislation instigated by local trade unions is "The international intermodal container safe road transport bill", in preparation in Japan, which requires that consignors provide a description of goods, weights and stowage/packing information of containers that should be passed down the supply chain.

196. These two examples of national legislation demonstrate the concerns of national governments, as a result of intervention by workers' representatives, relating to the risk to those involved in the supply chain – and mainly those involved in road transport. Both place a responsibility on all parties in the supply chain to ensure that the container is safe. The Australian CoR makes the packer responsible for ensuring that the load does not exceed dimensional and mass limits and is stable and does not fall or move in the vehicle.

197. Methyl bromide and phosphoretted hydrogen are very dangerous and toxic pesticides. Furthermore, methyl bromide has detrimental effects on the ozone layer. Very strict regulations are therefore attached to the use of these substances in the Netherlands and other countries. Fumigation with the abovementioned substances must be conducted by experts, within the meaning of the Pesticide Act, and may only take place with respect to goods referred to in the legal instructions for use, unless the goods are intended for export to a country which prescribes that goods be fumigated prior to import.

198. Legislation in the Netherlands now requires that, where a fumigant gas has been used or a dangerous or harmful gas is present, the container must be marked with a "toxic gas" decal until an expert has declared that the container and its cargo are "gas free".

199. Much of the legislation being introduced in the Netherlands is a direct result of the work and lobbying that has been carried out by FNV Bondgenoten who have been leading research into fumigation and toxic gases in containers.

200. A fumigated cargo transport unit shall be marked with a warning mark, as specified in the IMDG Code, and affixed at each access point in a location where it will be easily seen by persons opening or entering the cargo transport unit. [1]

[1] IMO: *IMDG Code*, DSC 15/INF.4/Add. 2, para. 5.5.2 (London, 2010).

3.2. Guidelines and codes of practice

201. As will be seen in this report many of the guidelines available in the public domain are based on the CTU packing guidelines. These guidelines are described as "essential to the safe packing of CTUs by those responsible for the packing and securing of the cargo and by those whose task it is to train people to pack such units". [2]

202. The IMO Editorial and Technical Group's report to the DSC 15 included a revision developed by an internal drafting group which added, "Guidance on the security aspects of the movement of cargo transport units (CTUs) intended for carriage by sea may be found in a variety of documents including the International Convention for the Safety of Life at Sea, 1974, as amended; the International Ship and Port Facility Security Code; the ILO–IMO code of practice on security in ports; and the Standards and the Publicly Available Specifications developed or being developed by the International Standards Organization (ISO) to address cargo security management and other aspects of supply chain security." [3]

203. Furthermore the DSC report to the IMO Maritime Safety Committee proposed that references to *IMO/ILO/UNECE Guidelines for packing of cargo transport units (CTUs)* should be inserted as a footnote to SOLAS regulation VI/5.2. [4]

204. Appendix IV lists 27 different publications and websites that provide a degree of guidance or codes of practice related to the safety of the cargo in containers in the supply chain. They can be divided into four categories:

- Guidelines for packing of containers based on the IMO/ILO/UNECE publication;
- Legislation and interpretations of that legislation;
- Guidance sheets issued by shipping lines and trade organizations;
- Reports on supply chain elements by governmental organizations.

205. The *Guidelines* include a considerable amount of common material, some more up to date than the rest, and vary in the level of details from basic to extremely detailed, covering a vast variety of cargo types.

206. All but the web-based version of the *Container Handbook*, published by GDV, the German marine insurers, are available as a hard copy or as a pdf file, which means that users tend to buy or download a copy that may be many years old. While it is probable that many securing techniques do not change, there are examples where a particular practice has been superseded.

207. A small telephone survey of freight forwarders around five towns in the United Kingdom found some surprising results (75 companies were approached, with 52 respondents). The respondents were asked "Are you aware of or do you use any of the following?": the

[2] IMO: *IMO/ILO/UNECE Guidelines for packing of cargo transport units (CTUs), 2007* (London, 2010).

[3] ibid.

[4] IMO: *Report to the Maritime Safety Committee*, Dec. 2009, para. 5.5, DSC 14/22 (London, 2009).

results illustrate that many were totally unaware of many of the useful publications (table 3.1).

208. Most of the respondents felt that they had sufficient experience to pack containers without relying on any of the publications, but where they did, they often approached the shipping line for guidance first.

209. A web search for “packing containers” provided a number of articles on vacuum packing but little on packing a freight container. A similar search for “packing a freight container” generated sites for freight forwarders, but again gave little guidance. However, the marisec.org (International Chamber of Shipping) site did appear with a link to their document “Safe Transport of containers by sea – Industry guidance for shippers and stuffers”.

Table 3.1. Are you aware of, or do you use, any of the following?

	Aware (%)	Use (%)	Not aware (%)
IMO/ILO/UNECE Guidelines for packing of CTUs	23.08	15.38	76.92
Cargo securing for road transport – European best practice guidelines – published by the European Commission	30.77	28.85	69.23
Safe transport of containers by sea – Guidelines on best practice – published by the International Chamber of Shipping	19.23	7.69	80.77
Safe transport of containers by sea – Industry guidance for shippers and stuffers – published by the International Chamber of Shipping	38.46	9.62	61.54
Container Handbook – published by GDV	11.54	7.69	88.46
Containerhandbuch.de – web-based – published by GDV	21.15	15.38	78.85
Freight best practices – Department for Transport (DfT)	46.15	30.77	53.85
Health and safety in road haulage – Health and Safety Executive	57.69	57.69	42.31
Shipping line guidance	67.31	40.38	32.69

210. Comments from those who used the GDV *Container Handbook* website referred to it as “very useful and easy to use” to “far too complicated”.

211. The majority of the respondents were unaware of the CTU packing guidelines. Those who were aware considered them as rules applying to shipping lines, which were not really useful for their purposes.

212. Shipping line documents had been requested, or downloaded, from one or more of the companies that supplied containers, often some time ago.

213. Most worrying was that 9.62 per cent of the respondents claimed that they were unaware of any of the publications.

3.3. National and international standards

214. The other form of publications available to packers and shippers are the international and national standards, shown in Appendix V.

215. British standard 5073, published in 1982, provides basic guidance on the general rules that should be followed when packing a container, but perhaps understandably, provides no actual guidance on best practice.

216. The 2003 edition of BS EN 12195 is being revised but includes a number of useful calculations for the lashing forces of some basic methods – but is probably too complicated for the majority of the packers involved. Associated with this standard is BS EN 12640, which covers the number and strength of lashing points in commercial vehicles. BS EN 12642 stipulates the strength of the commercial vehicles to ensure that the lashing points are secure.

217. These three standards are published by CEN, the European standards body, and there appears to be no comparable standards published by ISO.

218. The United States standard ASTM D 5728 is a similar standard to BS 5073 and is intended to serve as a guide to shippers, carriers and consignees for load planning, loading, blocking, and bracing of intermodal and unimodal cargo in surface transport.

219. These national and international standards are useful to provide to equipment designers and manufacturers, to ensure that the physical transport vehicles are strong enough to secure cargoes. The guides for packing containers provide basic information on the general rules for packing and securing. The former has been reproduced in many of the guidelines and codes of practice described above.

220. The production of standards is generally a very lengthy process and lags behind actual practice – for example standards, such as BS EN 12195, where the revision was published in 2008 but which has not been completed. Therefore, while the information covered by standards is extremely relevant and can be detailed, it is likely that the actual information will have been published elsewhere.

221. The information gathered by the small telephone survey (see table 3.1) shows that, despite the large number of publications available, they do not appear to be regularly used. This may be one of the reasons why there are a number of incidents involving poor securing; but, as may be seen in the following section, there is insufficient data available to verify this supposition.

4. Analysis of incident case studies

222. One of the objectives of this research project was to ascertain the scope of cargo-related incidents in the supply chain. However, it has been very hard to find any consistent data that provides this information.

223. The scientific study carried out by the International Road Transport Union (IRU) found that only 1.4 per cent of the incidents investigated were caused by the cargo. In three of the nine accidents, the truck tipped over. Research by the University of Michigan found very similar results where cargo shift caused between 1 and 2 per cent of the accidents. [1]

224. The IRU study did agree that the cargo had contributed to the severity of the accident. It is probable that the mass of the cargo, should it remain within the road vehicle, is likely to add to the severity of the accident just by increasing the gross mass of the vehicle. On the other hand, loose cargo may break away from the vehicle and cause secondary incidents and block roads.

225. Research by the Japanese Government has found that there were 28 rollover incidents between March 2006 and August 2009 (see Appendix II). A review of these accidents shows that 15 of the incidents involved the vehicle travelling at 60 km/hr or faster. Many of the accidents occurred on off ramps from expressways and where there was a sharp curve. There appears to be little correlation between cargoes, but the average mass of the cargo was 20.6 tonnes, which is well above the worldwide average for freight container cargo mass.

226. An in-depth study of work-related road traffic accidents carried out by the Department for Transport in the United Kingdom in 2005 [2] found that approximately half of the accidents in their data involved large goods vehicles. Truck drivers were found to have a higher proportion of near misses due to fatigue/illness and accidents resulting from the type of load/handling problems that might be expected of this type of vehicle. The second highest factor in accidents was related to load problems, although there is no data to clarify the influence of loads on the accident.

227. Shipping lines are unable to provide any history of incidents, but can and do occasionally report specific accidents.

228. Organizations such as the TT Club are unable to provide any data, although they confirm that they do have the data somewhere in their files, but have no means of retrieving it.

229. Insurance companies likewise can provide information on a case-by-case basis, but have no means of retrieving the data. This includes GDV, which has produced the detailed *Container Handbook*, and which claims that the reason that it was produced was due to the number of incidents reported by the underwriters. GDV is not able to quantify the number or frequency of incidents.

230. All of the incidents showed examples where the packer could not have fully understood the forces and movements that containers are subjected to in their journey.

[1] University of Michigan: *Freightliner trucks field operational test* at www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/14287_files/appendixA.htm.

[2] Department for Transport: *An in-depth study of work-related road traffic accidents*, Road Safety Research Report No. 58 (London, Aug. 2005).

231. Anecdotal evidence of a reported incident involving a large boulder of marble showed a total disregard for any basic rules. During midstream transfer in Hong Kong harbour, the boulder broke through the flooring of the container and was lost. On investigation it was found that the load had been rolled/slid into the container and retained by small chocks nailed to the flooring. There had been no attempts to spread the load from the very small footprint, or to secure the load to prevent movement. The small chocks were found to be too low and the nailing inadequate.

232. Banding used to secure steel sheets in the rail accident quoted in paragraphs 74–78 appears to be totally inadequate. Although the container remained on the wagon after derailment, the steel sheets stack had collapsed. The report found that it was "likely that the banding broke and the load lozenged forward during the derailment". [3] From the photo shown in figure 1.9 there is little sign of any banding, and certainly there is no evidence of bracing to prevent sideways or fore and aft movement.

233. Figures 4.1, 4.2 and 4.3 contain photos of an incident reported by an insurance company. They show some large generators that had been shipped from the United States to the United Kingdom through Felixstowe port, where the cargo was found to have broken through the side wall during the voyage.

Figure 4.1. Poorly secured cargo

[3] Department for Transport: *Derailment at Duddeston Junction,* op. cit.

Figure 4.2. Loose blocking

Figure 4.3. Displaced generator

234. Since the container had been severely damaged the container had to be made safe before it could be lifted from the ship's cells.

235. During the voyage one of the generators in the container had torn through the forward left-hand side wall so far that it was almost totally out of the container. It is not clear whether there had been a container in the adjacent cell during the voyage but it is likely that there was not.

236. On inspection the insurer's surveyor found that the diesel engines which formed part of the load weighed up to 8 tonnes. However, the only method of securing was by 4 or 6 nailed timber chocks around the bases and there were no additional tie downs or bracing. The nails used to secure the chocks appear to have only just penetrated the flooring.

237. The photos show that lightweight packing cases used to transport other equipment had been used as bracing, but these had been damaged due to the sideways movement of the generators.

238. This reported incident and that discussed in paragraphs 182 and 183 demonstrate that there is clearly a lack of understanding between mass and weight. There may be a belief that since it takes so much effort to get the items into the container there is no need to secure it as it "isn't going anywhere".

239. The IMO circular 1202 [4] details the requirements for the regular inspection of containers carrying dangerous goods to identify deficiencies, which are reported to the IMO annually. Included in the report is a requirement to report on the stowage of the cargo in the container. It was reported that there were 3,455 (5.5 per cent) stowage/securing deficiencies found out of the units inspected. [5]

240. Unfortunately, it is impossible to find more precise information about the nature of the deficiencies but a more detailed examination of the United States figures showed that there were 12 containers identified with improper preparation for transportation. This amounts to 2.2 per cent of the total stowage deficiencies – or 0.003 per cent of all units inspected.

[4] IMO: *Inspection programme for cargo transport units (CTUs) carrying dangerous goods* (London, 2006).

[5] IMO: *Casualty and incident reports analysis*, DSC 14/6/12 (London, 2009).

241. Bearing in mind that these inspections take place on containers that are carrying dangerous goods, if this rate of deficiency was extrapolated to include all container movement, there would have been over 15,000 containers being transported with poor stowage in 2008.

242. Discussions with players within the supply chain have highlighted some areas of concern that may require further research.

243. Using Pareto's theory it is possible that 80 per cent of those involved in packing containers will pack their containers properly, while 20 per cent will not. Those 20 per cent of organizations involved in packing containers could possibly generate 80 per cent of the accidents. But with the reporting and data collection systems available at present, this is impossible to confirm.

244. Since there is already a process in place to report on poor stowage of dangerous goods, some players have suggested that it could be expanded to include all loaded containers. The current IMO reporting system is used by less than 15 countries and many of those countries only inspect a proportion of the containers carrying dangerous goods. Expanding the programme to cover larger quantities of containers would include a proportional increase in customs officials and cargo surveyors to carry out the inspection.

245. The IMO's scope or operation is from port to port and therefore would exclude any operation ashore or for containers travelling internationally by road, rail or inland waterways.

246. The IRU European truck accident causation study perhaps provides a way forward, where a standardized inspection questionnaire would be developed to capture all of the information, which could then be reported to an independent body who could ensure anonymity when reporting information.

5. Load distribution

5.1. Introduction

247. In analysing incidents, it is important to understand the major factors that need to be addressed by packers. This section looks at load distribution and how poor attention increases the risk of an accident.

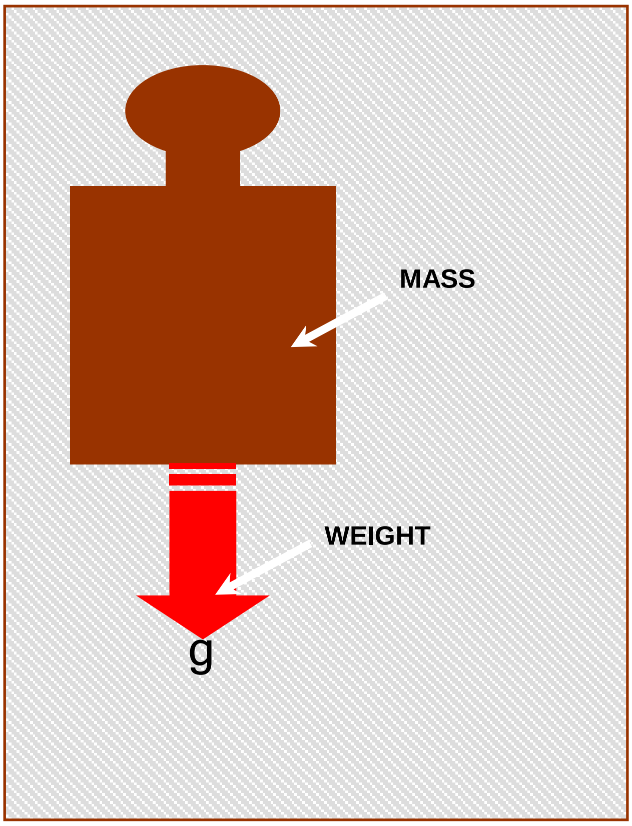
248. A number of incidents described in this report have occurred as a result of poor load distribution and anecdotal evidence suggests that it is probably this single factor that results in the majority of the incidents.

249. When preparing to load a container, it is essential that a load distribution plan be developed for placing individual cargo elements within the container. Consideration should be given to three elements of the load's centre of gravity (CG).

5.2. Weight and mass

250. Weight is often used to describe mass and it is important to understand the difference between the two. Mass is a property of matter (see figure 5.1). All objects have a mass, which is not affected by its environment; for example, an object with a mass of 100 kg will have the same mass on the surface of the earth or the moon.

Figure 5.1. Mass vs weight

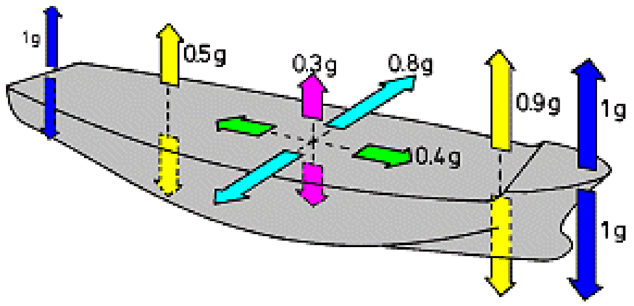


251. Weight, on the other hand, is used to denote either the mass of a body or the force of gravity acting on it. In the United Kingdom, in terms of the Weights and Measures Act, it has been used in the sense of a mass. According to the General Conference on Weights and Measures (CGPM) and various other technical works, it is used in the sense of a force. In this definition of weight, it is a measure of the gravitational force acting on a material object at a specific location. That means that an object with a mass of 100 kg will have a weight of 100 kgf on the surface of the earth but only 17 kgf on the surface of the moon.

252. Changing the effect of gravity will change the weight. Allow the container to fall downwards with an acceleration greater than 9.8 m/sec and the mass becomes weightless. Move the container upwards at a similar speed and the weight of the mass doubles.

253. This means that during an ocean voyage where the vessel pitches, it is possible that the weight of the cargo will have changed considerably. Figure 5.2 [1] shows the forces associated with maritime transport. It can be seen that the vertical acceleration may be between 03**g** and 1**g**, which means that in certain circumstances the cargo mass will be approaching weightlessness. Add to this the effect of surging, it is possible for the container to be moved forwards relative to any unsecured cargo during this moment of weightlessness.

Figure 5.2. Maritime motion forces



254. To overcome these moments of reduced weight, it is important that a system of lashing be employed to simulate gravity and to counter the other forces experienced during transport.

5.3. Centre of gravity

255. The CG of individual packages can be identified using techniques such as those described in the European standard BS EN 13054:2001. These techniques work well with regular shaped packages and rely on the packer's ability to balance the package on a balancing edge or bar and to rotate the package so that three reference planes can be determined.

256. In practice, determining the CG using these, or perhaps any other method, is impracticable due to the number of packages involved or the time constraints on loading the container.

[1] German Insurance Association (GDV): *Cargo loss prevention information from German marine insurers, Container Handbook*, Vol. I.

257. If the mass of the cargo is not evenly distributed, its CG will be closer to where the cargo is heaviest. It is also possible that the CG of an object is not within the object, for example a boomerang-shaped object will have a CG between its arms.

258. To ensure that packages are secured effectively, it is important to fully understand where the CG is for each package and the entire cargo within a container.

259. Many of the guidance notes give general rules that relate to the loading of containers and the IMO/ILO/UNECE *Guidelines for packing of CTUs* [2] states:

> The weight of the cargo should be evenly distributed over the floor of a container. Where cargo items of a varying weight are to be packed into a container or where a container will not be full (either because of insufficient cargo or because the maximum weight allowed will be reached before the container is full), the stow should be so arranged and secured that the approximate CG of the cargo is close to the mid-length of the container. If it is not, then special handling of the container may be necessary. In no case should more than 60 per cent of the load be concentrated in less than half of the length of a container measured from one end. For vehicles, special attention should be paid to axle loads.

260. The above is a variation of text from the ISO version:

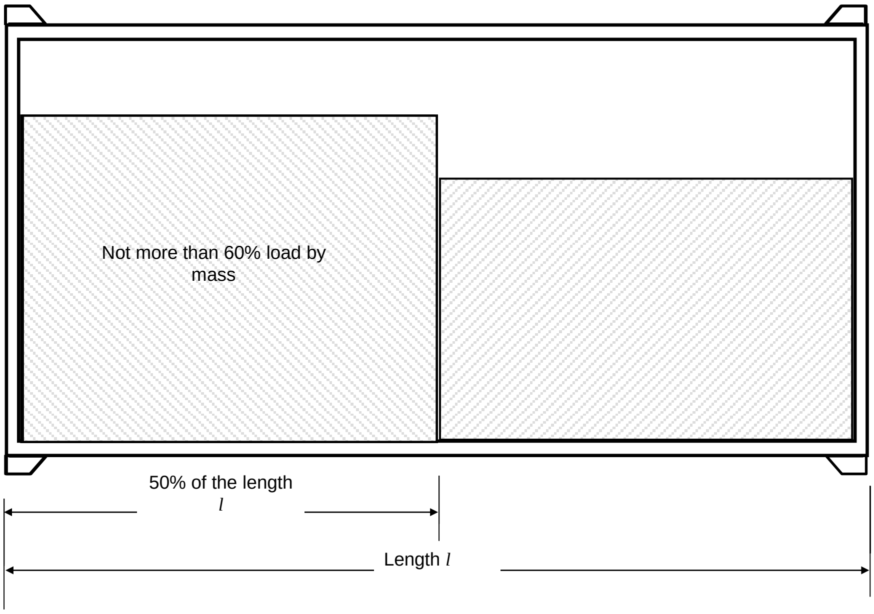
> The cargo shall be distributed throughout the container to ensure that the CG is kept as central and as low as possible:
>
> - to avoid excessive tilting;
> - to avoid overstressing either the container or the handling equipment;
> - to avoid unacceptable vehicle axle loading;
> - to avoid lack of vehicle stability; and
> - to avoid unacceptable load concentrations.

261. Eccentricity of the CG for the loaded container varies with the distribution of load within the container, and designers of containers and handling equipment should take this fact into account. As an example, when 60 per cent of the load by mass is distributed in 50 per cent of the container length measured from one end (figure 5.3), the eccentricity corresponds to 5 per cent. [3]

[2] IMO: *IMO/ILO/UNECE Guidelines for packing of container transport units (CTUs)*, op. cit. para. 3.2.5.

[3] BSI: ISO 3874:1997 *Series 1 Freight containers – Handling and securing*, para. 4.2.4 (London, 2006).

Figure 5.3. Loading guideline schematic



262. There is a very important difference between the two versions of the guidance notes. The ISO text refers to an example of load distribution, whereas the CTU packing guidelines prohibit more than 60 per cent of the cargo's mass within 50 per cent of the container length – and many other publications also make this stipulation. Ideally, correct load distribution is of great importance and the mass distribution should not have an eccentricity of greater than 5 per cent in any direction, but there are instances where it is impossible to achieve this due to the nature of the cargo. Therefore, it is important that packers of containers understand the implications of the eccentric load.

263. On rail and maritime transport, the direction of the longitudinal eccentricity makes little difference. However, to ensure that axle loads are not exceeded when being transported by road, it is essential that the position of the CG be suitable for the road vehicle being used. An example demonstrating the positioning of the cargo is shown in the European best practice guidelines on cargo securing. [4]

5.4 Eccentric loading (CG_{EL})

264. Unless the cargo package(s) are uniform and can be evenly distributed across the floor of the container, there is a risk that the CG will not be above the exact centre (longitudinally and laterally) of the floor.

265. The terminal handling community has experienced serious incidents where the container has not been properly released from the road trailer, resulting in fatalities and near misses to the driver. As a consequence of this, development work has been started to develop a monitoring system that would alert the crane driver when the trailer was still attached. It works through monitoring the load placed on each of the four lifting twistlocks on the spreader and, should the load be abnormal on one or more corners, an alarm would permit the driver to stop before the lift has progressed too high. The development work has

[4] European Commission: *European best practice guidelines on cargo securing for road transport*, pp. 93–95 (Luxembourg, 2009).

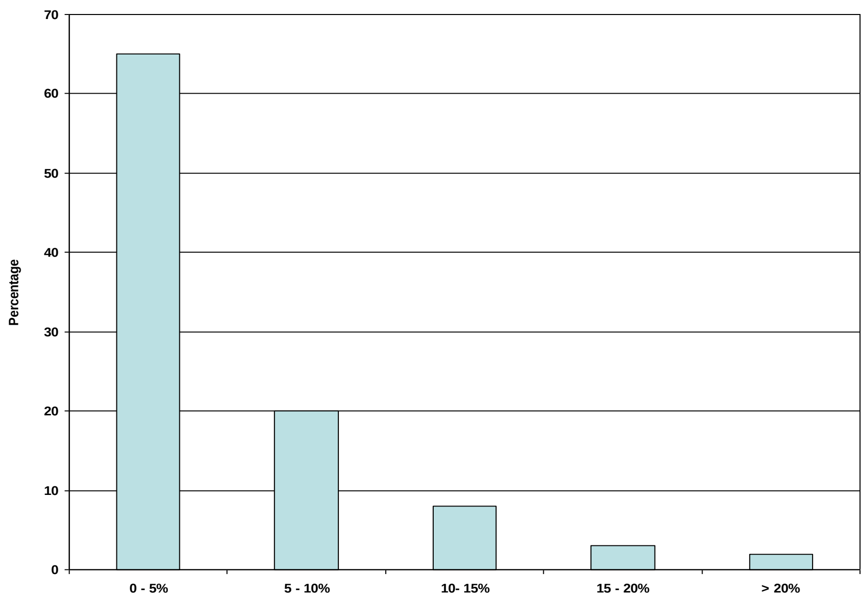
progressed well and the system is being marketed and fitted on equipment at various terminals across the world. The system can also be used to quickly show when a container becomes snagged as it is lifted from a cell.

266. Consideration should also be given to a similar system for weighing containers using the corner fittings on road trailers.

267. Another bi-product of the system is that it can calculate the degree of eccentricity of the CG and the operator is shown this on a screen by a dot within the plane of the lifted load (one or more containers). Data collected during the development work at a United Kingdom terminal has shown that approximately 65 per cent of the containers lifted had an eccentricity of less than 5 per cent, which is considered as within acceptable limits.

268. The values in figure 5.4 show that the remaining 35 per cent had varying degrees of eccentricity. Three per cent of those containers lifted exhibited an eccentricity of 20 per cent or higher. This degree of eccentricity can make handling and transport dangerous under certain circumstances and will cause handling problems both to crane operators and road transport companies, but may also cause problems when being transported by rail.

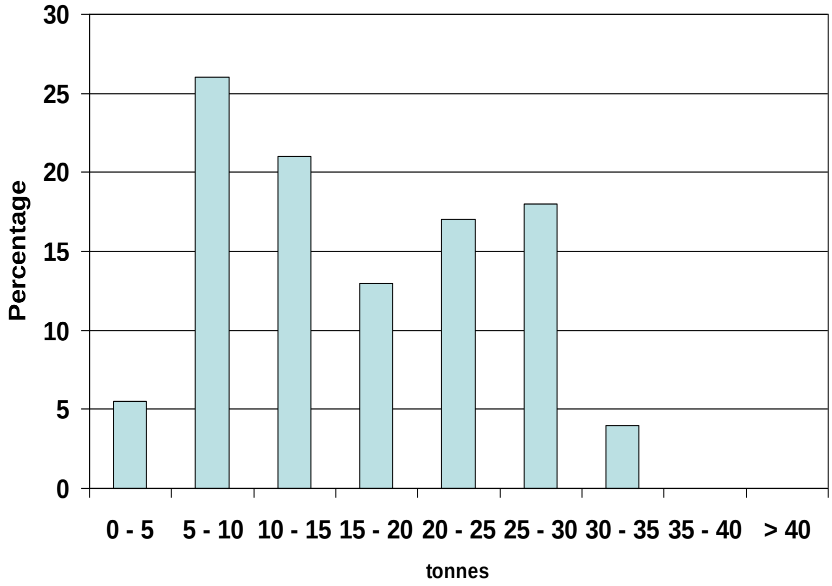
Figure 5.4. Eccentricity



269. The graph does not show the direction of the eccentricity – for example, towards the front or rear ends of the container or to one side. Eccentricity towards the front and to one side will cause a chassis trailer to become unstable when turning sharply, braking, or if the trailer should trip on a kerb.

270. The same research also provided further evidence that containers are being overloaded (see figure 5.5). Approximately 17 per cent of the containers included in the data collected had a total mass of between 25 and 30 tonnes. About 4 per cent of the data showed a gross mass of between 30 and 35 tonnes; many containers no doubt exceeded their maximum rated gross mass.

Figure 5.5. Total mass



5.5. Centre of gravity height (CG_H)

271. Research carried out by TYA, [5] a Norwegian vehicle training organization, into the stability of road tankers and timber trailers, has established a relationship between the speed of the road vehicle, the curve radius and the height of the CG above the road surface.

272. If the car's CG is 1.6 m, above the road surface and curve, or the traffic circle has a radius of 33 m, the car will tip over at a speed of 76 km/h. If the CG is raised to 2.3 m above the roadway, there is a risk of the trailer overturning at 64 km/h.

273. If the curve radius is reduced to 25 m, the trailer with a CG 1.6 m above the road surface will overturn at 38 km/h, and with the CG at 2.3 m above the road surface the critical speed is further reduced to 32 km/h.

274. The majority of trailers and chassis used to transport containers have a bed height of 1.2 m (48 inch), which means that the CG of a well-packed and fully laden 40-ft container could be as much as 2.6 m above the road surface.

275. The higher the CG of the cargo, the more it tends to tip when subjected to horizontal forces. If the CG is vertically off-centre relative to the cargo's footprint, the cargo will tend to tip over in the direction where the CG is closest to the footprint limits. The higher the CG of the combined vehicle and container, the greater the risk of rollover.

5.6. Planning

276. Many of the documents and guidelines have a section devoted to planning. The CTU packing guidelines starts the planning process much earlier, looking not only at the container selection, but also at the safety of the loading process, especially the loading of

[5] Transportfackens Yrkes & Arbetsmiljönämnd: *Säkrare körning med tank- och timmerbil* (2005).

swap bodies which are mounted on legs. This aspect of the planning process is essential to ensure the safety of the staff at the packing facility.

277. A short description of a cargo loading plan is shown in the UK P&I Club's video.[6] It is essential that planning the load be in line with the basic planning rules.

278. A container stowage plan should be worked out for the container before any packing is commenced. A plan should make it possible to produce either a tight or a secured stow, in which the compatibility of all items of cargo and the nature (for example type and strength) of any packages or packaging involved, is taken into account.

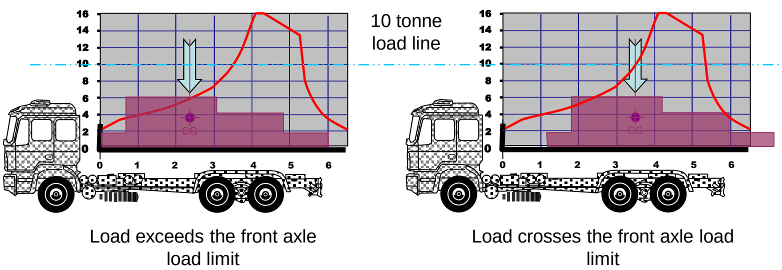
279. The use of freight containers may allow a reduction in the amount of packaging given to a particular commodity. This, however, will seldom apply to items of a fragile nature or dangerous goods, and in any case each type of cargo should be given individual consideration. It should always be remembered that a certain amount of shock or impact is likely to be encountered during loading or discharge.

280. Appendix III lists the ten steps to load, stow and secure a freight container and these are similar to the key requirements for container stuffing as described in the *Safe transport of containers by sea*.[7]

281. An important feature is ensuring that the CG is positioned as close to the centre of the container and the EG_{EL} (paragraphs 264–270) is minimized. If there is a need for an eccentric load, and the container is to be transported by road, proper attention should be paid to loading a road vehicle.

282. Figure 5.6[8] shows two sketches of the same load to demonstrate the importance of correctly positioning the CG in a road vehicle. The left hand sketch shows an example of a plan developed by a container packer or someone without knowledge of axle loading. The load has been positioned so that the bottom package is up against the front of the CTU. Nonetheless, the CG is too far forward for the particular road vehicle.

Figure 5.6. Load distribution planning



[6] United Kingdom P&I Club: Video – *Any fool can stuff a container*.

[7] International Chamber of Shipping: *Safe transport of containers by sea. Guidelines on best industry practice* (London, 2008).

[8] European Commission, 2009, op. cit.

283. To suit the road vehicle load distribution curve the load is therefore moved towards the rear, effectively turning it through 180 degrees and bringing the CG within the curve. Consequently, cargo planners must take account of the load distribution requirements of all modes of transport.

284. The differences between the various guidelines published on behalf of each mode within the supply chain must be rationalized so that a single message can be presented to the packer/shipper.

6. Cargo securing manual ten commandments

285. Some publications come with a section entitled something like "The ten most important commandments for cargo securing", [1] which provides "rules" for road transport and includes such items as:

- Before the vehicle is loaded, check that the load platform, bodywork and any load-securing equipment are in sound and serviceable condition.
- Secure the cargo in such a way that it cannot shove away, roll over, wander because of vibrations, fall off the vehicle or make the vehicle tip over.
- Determine the securing method(s) best adapted to the characteristics of the cargo (locking, blocking, direct lashing, top-over lashing or combinations of these).

286. BS 5073 has 15 paragraphs, each describing a different aspect of stowing and securing cargoes.

287. Annex 5 of the Guidelines for packing of CTUs [2] lists 11 "Dos and don'ts".

288. The *Container Handbook* [3] lists 16 packing rules.

289. The abovementioned three examples have many common "rules" but there are variations and additions in each. Developing a common list, for "ten commandments" may therefore prove difficult, yet there may be scope within various aspects of the supply chain; for example, ten commandments for container reception, ten commandments for compatible products, and ten commandments for load distribution.

290. If supply chain safety ten commandments were to be adopted, they should cover all modes, drawing on established best practice guidelines. For example the United Kingdom's Department for Transport has launched a programme "Freight best practice" and issued a series of publications such as "Safe driving tips", [4] covering a number of practices to which road users should adhere. These, in turn, are slightly different to those included in the European best practice guidelines. Bringing them all together into a unified publication would reduce confusion and widen the audience.

[1] ibid.

[2] IMO: IMO/ILO/UNECE, 2007, op. cit.

[3] German Insurance Association, op. cit., part 4.2.5.

[4] Department for Transport: *Safe driving tips* (London, 2009).

7. Training

7.1. Current training packages

291. The *Guidelines for packing of CTUs* states that the regulatory authority should establish minimum requirements for training and, where appropriate, qualifications for each person involved, directly or indirectly, in the packing of cargo in CTUs, particularly in relation to dangerous cargoes. [1]

292. Training for dangerous goods is now an established course, and there are numerous organizations, including the ILO's Portworker Development Programme (PDP), providing packages for the various modes of transport. Typical courses include:

- ADR regulations;
- Dangerous Goods Safety Advisor (GDSA);
- IATA courses; and
- IMDG courses.

293. A typical IMDG course given by a commercial training organization will be a two-day event where students are given a thorough understanding of the practical requirements of the code in relation to classification, packaging, marking, labelling, documentation, container and vehicle packing and vessel stowage. Modules include:

- UN system general layout of the code;
- classification;
- dangerous goods list, special provisions, limited and excepted quantities, supplement;
- packing and tank provisions;
- consignment procedures;
- construction and testing of packaging, IBCs and portable tanks; and
- transport operations.

294. Included in the course will be a section on how the packaging is chosen for the particular material, using UN specification packaging in almost every case, and how the packages are marked and labelled. Ideally it should include proper securing of the packages. However, within a typical two-day IMDG course, there would be insufficient time to go through all the different package types to ensure that the cargo is secure from the stresses that they might encounter.

295. Unsecured non-classified (dangerous) goods present a serious risk to supply chain safety, and dangerous goods, packed in identical packages, further increases the risk. Therefore, it is important that properly securing dangerous goods is an absolute priority.

[1] IMO: IMO/ILO/UNECE, 2007, op. cit., para. 7.1.1.

296. The ILO, through the PDP, have produced some PowerPoint presentations covering:

- C3.4 Packaging of goods in containers, part 1 – Principles and planning.
- C3.5 Packaging of goods in containers, part 2 – Working practices.

297. These two presentations visualize the text of the *Guidelines for packing of CTUs* and provide an overview of packing containers, focusing on packing rules and good working practices, such as container selection and inspection, mechanical and manual handling and packing techniques.

298. A programme developed by Maritimes Competenzcentrum e.V (Ma-Co) based in Hamburg covers subjects like container selection and container packing. Both training courses have a considerable practical input.

299. The PDP and the Ma-Co programmes are terminal-based and intended for portworkers, and even though they may provide excellent training they appear to be inaccessible to organizations such as freight forwarders located away from the port.

300. A web search for training programmes revealed plenty of examples for dangerous goods, but no sites which catered for general or specialized non-classified/dangerous cargoes.

301. As part of the telephone survey of freight forwarders around five towns in the United Kingdom, another question asked was "For those involved with loading containers and other road vehicles, what level of training have they been given?" The possible answers were:

- in-house training covering container/vehicle safety;
- in-house training on cargo chocking and securing;
- ILO PDP – packing of goods in containers;
- third-party training covering container/vehicle safety;
- third-party training covering cargo chocking and securing.

302. No respondents knew about the ILO PDP. The majority claimed that in-house training had been given for container safety and that, in general, on-the-job training was given for cargo chocking and securing. Many of the respondents said that their drivers had recently achieved a Driver CPC qualification. [2]

7.2. Ease of access by organizations and workplace operators

303. Many organizations are finding that financial constraints are restricting their ability to undertake staff training. Indeed, the workers appear to be restricting themselves.

[2] The Driver Certificate of Professional Competence is intended to raise the standard of all professional drivers by improving the skill and knowledge they need to carry out their day-to-day work. It is not just about practical driving skills.

304. In an edition of the British Broadcasting Corporation (BBC) television series "The Undercover Boss", the CEO, Stephen Martin, went undercover in his company, the construction company Clugston Group. During the episode, Stephen mixed with the joiners and heard stories of tradesmen wishing to be moved around the company more, to learn more about the different work on offer at Clugston. During the recession, staff did not feel confident enough to be open with their manager to talk about training and job rotation, for fear of redundancy. [3]

305. Training is an important feature when considering the value associated with a job, taking into account both formal training provided by courses and the more informal training provided via apprenticeships and on-the-job training. Nearly all workers interviewed in the BBC programme expressed their opinion that learning new skills added to their own sense of well-being.

306. On the other hand, many managers see that training is essential to assist companies out of recession. Simon Bartley, chief executive of United Kingdom Skills, said that prior to the recession there had been a prolonged period in which skills had been the "poor relation" of business development in the United Kingdom.

307. He noted that both bosses and employees had been forced to change their priorities, adding: "Everybody now realises that for the United Kingdom, as a country, as employers and as individuals, the development of skills is something that is core to their future." [4]

308. This dichotomy needs to be addressed to satisfy the requirements of the *Guidelines for packing of CTUs*. Training should be directed at all persons engaged in the transport or packing of cargo in CTUs, and in a format that meets the needs of both the trainee and the company.

309. Many training organizations are now exploring web-based modular programmes for practical subjects. An example of this is the IMDG Code e-learning package where users can dip in when they have the time, and as often as required. [5] This approach would be particularly appropriate for loading bay operatives, who may require access to securing training modules for new cargo or package configurations but may not have the time to commit to a two- or three-day course away from the workplace.

7.3. Training needs

310. Following the concept of the "Chain of Responsibility (CoR)" (see paragraph 194), a similar chain of training could be considered. The packers should be trained so that they are able to identify a suitable and safe container and to be able to pack and secure the cargo. This training should extend to the packers' supervisors and managers to ensure that cargo documentation is completed correctly.

311. All parties involved in the supply chain, including road drivers, should be trained to understand the effects of a high CG and the handling characteristics expected from poorly

[3] Stephen Martin undercover at Clugston Group, Adi Gaskell, CMI blog, 26.06.2009.

[4] The recession "has focused minds on training and development, Steve Myers CMI blog, 08.02.2010.

[5] Available at www.imdge-learning.com/download.asp.

secured and unstable cargoes, such as bulk liquid cargoes in tanks and in flexitanks carried in dry freight containers.

312. Terminal operators handling containers should be trained to understand the handling characteristics of containers with poorly secured or unstable cargoes. The training should include guidance on actions that should be taken when a cargo is found to be improperly packed, which may include returning the container to the packer or quarantining it until the cargo has been made safe.

313. When opening a container there are at least two hazards to be considered: loose or unstable cargo and the possibility of an asphyxiating or hazardous atmosphere. Therefore, training should be directed towards those involved in opening containers, not only at the destination, but also in terminals and port locations where customs or port control officers wish to open the container for examination purposes.

314. Finally, in order that consistency be maintained in the reporting of poorly secured cargoes, it is important that cargo surveyors and container inspectors should be trained to understand cargo securing and dangerous goods packing rules, container safety and serious structural deficiencies.

7.4. E-learning

315. This is an online course to which trainees usually log on. Typically, it involves some form of interactivity, which may include online interaction between learners, their "virtual" trainer or their "virtual" groups.

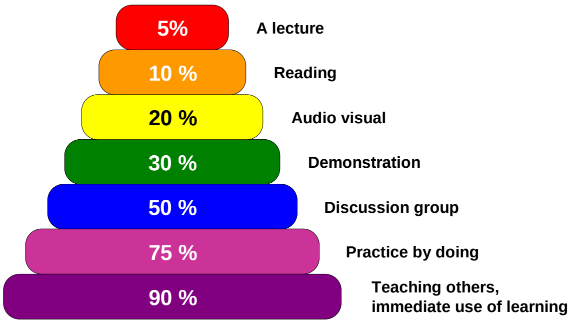
316. Just because training is helping people to learn about a serious subject, it does not mean they cannot have fun. Trainers and delegates acknowledge that games and quizzes are the best parts of the course because they get everyone involved (figure 7.1).

Figure 7.1. Training tools

317. To keep the trainees interested, it is important to include plenty of interactivity – that way they will enjoy learning and remember what they have learnt.

318. People learn in many different ways – research into how people learn reveals that they enjoy learning which is varied, interactive and fun. Figure 7.2 [6] shows that the best way for people to learn is to get involved and put into practice what they have been taught.

Figure 7.2. Average retention rates



319. Training must reflect best practice procedures for selecting containers, preparing them for packing, and packing and securing the cargo as well as transport guidance. Furthermore, once trained, the certificate/passport presented on successful completion, must be internationally recognized and backed by a global authority on safety issues, such as the certified courses offered by the Institute of Occupational Safety and Health.

[6] Institute of Occupational Safety and Health: *Training guidance book* (Leicester, 2010).

8. Dissemination and implementation

320. The production of best practice guidelines, codes of practice and training packages is relatively easy. Collating the different publications produced for each mode across the world will require some considerable negotiation. However, as was found during this research, getting the information to the right person in a format that is both easy to access and totally informative may prove extremely difficult.

321. There are two basic routes:

- voluntary; and
- legislative.

322. By far the most acceptable option to all players in the supply chain would be a voluntary code of practice backed up with suitable and appropriate training. To ensure "take-up", shipping lines could require shippers to provide evidence that the packers of the container have been trained and certified. Containers that are not supported by such evidence could be subject to random contents inspection and/or supplementary transport charges to cover the risk of carrying improperly packed cargoes.

323. The second option is to develop a Convention that could be adopted by member States as local statutory instruments, requiring packers to comply with a specified packing document and/or to be trained to a certain standard. This option has its pitfalls, namely that for a Convention to be ratified, it requires a large number of member States to adopt the Convention or subsequent amendment. The latest amendment to the CSC has not been implemented due to a slow "take-up" by member States.

324. The current guidelines and codes of practice that are published in hard copy have been widely distributed, but it is important to understand where these document end up. Many will find their way into a loading bay or dispatch office, but all too often they, like so many publications, end up on a manager's shelf. In some cases the manager may not alert the packers/dispatch office of their existence.

325. It is important that those who are involved in packing containers have immediate access not only to the training mentioned in paragraphs 303–309 but also to the publication, such as they would have access to the web-based version of the *Container Handbook.*

8.1. Options for stakeholders

326. If an "all modes" best practice for the freight container supply chain is adopted, then it is important that the information provided to those involved in the loading, transport and unloading of cargoes in freight containers should be consistent for all modes of transport.

327. Many stakeholders have produced their own guidelines or best practice which are available to their member or constituents. Stakeholders can consider a number of options:

- retain their current publication;
- adopt a new publication covering all modes for the entire supply chain; and
- amend their publication to adopt those elements of the new document that caters for their particular mode.

328. Particular stakeholders will have different roles to play within the container supply chain. Road and rail transport organizations will need to ensure that their publications cater for all types of road/rail transport vehicles, not just freight containers.

329. Shipping lines and terminal operators may have a role which requires them to "police" adherence to the best practice when freight containers pass through a terminal or are loaded on board a container vessel. This may be in the form of a safe loading certificate (with a traceable responsible person clearly defined), where the shipper includes details of the international accepted or approved qualifications of those involved in packing containers, before the containers can be transhipped between transport modes.

330. Indications from those freight forwarders approached as part of the telephone survey are that many of them would approach the shipping line to gain information about packing containers. Therefore, shipping lines may have an important role to play as principal disseminator of the publication or where to find the best practice guidelines.

331. It is recognized that many organizations do not have the knowledge or the staff to be able to provide their own information or guidelines, in which case they should be encouraged to direct packers to a common publication.

332. Since the Web is becoming a major source of information, it seems appropriate that it should be the home of the "all modes" best practice for the freight container supply chain, hosted either by a stakeholder, or by an independent organization, on behalf of all stakeholders. If this is the case, then owners of containers could direct packers to that website as part of their documentation or affix a decal to the inside of the container with the website address.

333. It is clear from the research carried out that there is a problem associated with poorly stowed and secured cargoes in freight containers and, as a consequence, there is a need for an "all modes" best practice for the freight container supply chain. Once developed, and along with its accompanying training package, all stakeholders would be responsible for proactively promoting it to reduce the risk to those involved in the supply chain.

8.2. Options for other bodies

334. It is recognized that the work undertaken by GDV in the production of their very detailed *Container Handbook* is an excellent tool for those involved in packing containers. It is improbable that this work would be discarded, so the development of an "all modes" best practice for freight container supply chain should include a large part of this *Handbook*.

335. If the *Handbook* is adopted, as suggested, it would be appropriate that the management of the website should include representatives from the different modes and that it be subjected to periodic review to ensure that it remains current and appropriate to all modes.

336. Other organizations, such as the Container Owners' Association (COA), could be excellent vehicles for publicizing the best practice. Similarly the best practice could include work items that they have developed such as the COA Recommended Code of Practice for Flexitanks. [1]

[1] Container Owners' Association: *COA Code of Practice, 2010* at www.containerowners association.org/resources/COA+Flexitank+CoP+1Jan2010_Revised+20May2010.pdf.

337. Publications produced by other safety organizations, such as the container terminal safety pamphlet, [2] could be amended to include reference to the all modes best practice.

[2] ICHCA International Limited: *Container Terminal Safety*, ISP Briefing Pamphlet (London, 2009).

Appendix I

Container types

ISO series 1 freight containers

General cargo containers	A general cargo container is any type of container that is not intended for use in air mode transport. It is not primarily 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. General cargo containers include the following types:
General purpose (GP) containers	A GP container is totally enclosed and weather-proof, has 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 the widest possible variety of cargo. A GP container with an opening roof may be used for the same specific purpose as an open top container.
Specific purpose containers	A specific purpose container has constructional features specifically designed for facilitating packing or emptying the container other than by means of doors at one end of the container, or constructional features for other specific purposes such as ventilation. Closed vented or ventilated containers, open top containers, platform containers and platform based containers are all types of specific purpose containers.
Closed vented or ventilated containers	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. Vented containers are containers that have passive vents at the upper part of their cargo space. Most containers are now built with two or more vents fitted in the front or side walls. Ventilated containers 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. An example of the non-mechanical ventilated container is the SeaVent, designed for the carriage of cargoes such as coffee beans. The Fantainer built by P&O Containers is an example of the mechanical ventilated container.
Bulk and dry-bulk containers	A dry bulk container is a container which consists of a cargo-carrying structure for the carriage of dry solids in bulk without packaging and which is firmly secured within an ISO series 1 framework. This unit is tested against the requirements of ISO 1496/4. In general these containers will have stronger front and rear ends and are often operated within a closed loop trade. The more readily available, but still rare version, is the general purpose container with the capability of carrying dry bulk cargoes. 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. This unit is tested to the requirements of ISO 1496/1.
Open top containers	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. 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 or slid off the top of the open top container. Containers thus built have been known as “solid top” containers. Open top containers may have movable or removable end transverse members (known as swinging headers) above their end doors.
Platform containers	A platform container is a loadable platform that has no superstructure whatsoever, but has the same length and width as a container of the same series. It is equipped with top and bottom corner fittings which are located in plain view as on series 1 container, so that the same securing and lifting devices can be used. Variations to the platform container are those that are based on a similar base structure but fitted with end walls or corner posts. It may have a complete superstructure with a permanent fixed longitudinal load-carrying structure between the two ends at the top or it may have an incomplete superstructure without such a longitudinal structure at the top. A platform based container which incorporates a complete superstructure may have a rigid roof and rigid end walls, an open top and rigid end walls or an open top and open ends (a skeletal container). A platform based container which incorporates an incomplete superstructure may have fixed ends or folding ends. The latter are often referred to as flat-racks.

Specific cargo containers

A specific cargo container is primarily intended for the carriage of particular categories of cargo. Specific cargo containers include the following types:

Thermal containers

A thermal container has insulating walls, doors, floor and roof. Thermal containers 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. They are often referred to as insulated containers.

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

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.

There are thermal containers that can operate at higher temperatures by means of internal heating devices, the design of which can be based on a thermal container as described above (except with a heating device). They often service areas of extreme cold such as Alaska.

Tank containers

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

However, the tank container industry has developed a number of containment designs that carry all sorts of bulk liquids, powders, granules and liquefied gases. Tank containers come in various ISO and European sizes and can be pressurized or non-pressurized. They may be carried as a discrete CTU or carried within another container.

Named cargo containers

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

European swap bodies

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 utilization of the dimensions specified for road traffic.

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

Swap bodies generally fall into three length categories:

– Class A: 13.6 or 13.712 m (45-ft) long;

– Class B: 30-ft long;

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

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.

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.

They may be stacked although the stacking capability is likely to be well below that of the ISO container. Before stacking the container, the handler must check the stacking strength shown on the safety approval plate, but the stackable swap body can be handled in the same way as series 1 ISO containers. Swap bodies 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 also have a distance of 2.259 m between aperture centres when measured across the unit.

Class C swap bodies can be transferred from the road vehicle to their supporting legs and returned to them by onboard means.

Box type swap body

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

Open side swap body	The open side swap body has a number of different variations, all designed to provide a similar access to standard trailer bodies. All designs have an enclosed structure with a rigid roof and end walls, as well as a floor. The end walls may be fitted with doors. – *Curtain side unit:* swap body with movable or removable canvas or plastic material side walls normally supported on movable or removable roof bows. – *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. – *Tautliner:* swap body with flexible, movable side walls (e.g., made of canvas or plastic material normally supported on movable webbing). – *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. – *Full length side door:* swap body with full length concertina doors to one or both sides.
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.
Swap tank	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 framework which may present a risk of damage to another container or object falls onto the exposed tank barrel.
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 30-ft long.
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; – can be of any width and/or length to suit national legislation for better utilization of the dimensions specified for road traffic. In general they are 2.5 or 2.6 m or 8 ft 6 in wide; – may have castings, at least at each corner, and be 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 above.

Appendix II

Rollover accidents of trailers carrying international intermodal containers

No.	Month/ year	Accident summary	Goods loaded	Import/ export	Container		Speed km/hr	Casualties		
					Size (feet)	Weight (tonne)		Fatalities	Severe	Minor
1.	Mar. 06	A truck was unable to come to the end of the left sharp curve of the Hanshin Expressway exit, and it overturned on its right side and crashed into the side wall. A truck driver was seriously injured.	Rice flour	Import	20	19.47	60	0	1	0
2.	June 06	A truck was unable to come to the end of the right curve descent and came off the road. A truck driver died.	Grass	Import	40	26	65	1	0	0
3.	July 06	When a truck turned right at a crossing, it overturned to the left. A person waiting at the stop light was crushed and died.	Dry wood	Import	40	28	40	1	0	0
4.	Aug. 06	A truck overturned onto its right side in the slow left curve of the Metropolitan Expressway. A truck driver was seriously hurt.	Plastic bags	Import	20	16	70	0	1	0
5.	Aug. 06	A truck was unable to come to the end of the right curve of the Metropolitan Expressway, and it overturned. A vehicle driver was slightly injured.	Manhole covers	Import	20	18	80	0	0	1
6.	Nov. 06	A truck crashed into a side wall of the curve of the Metropolitan Expressway, and it overturned. There were no casualties.	Canned olive oil	Import	20	20.1	40	0	0	0
7.	Feb. 07	A truck was unable to come to the end of the right curve descent of the Metropolitan Expressway, and it crashed into a side wall and came off the road. A truck driver died.	Steel furniture	Import	40	25.2	60	1	0	0
8.	May 07	A truck overturned in the left curve of the Metropolitan Expressway, a driver was slightly injured.	Wood	Import	40	29.98	45	0	0	1
9.	July 07	A truck driver stepped on the brakes in the left sharp curve descent at the top of the hill, and the truck side-slipped and came off the road. A truck driver was seriously injured.	Grass	Import	40	24	60	0	1	0

No.	Month/ year	Accident summary	Goods loaded	Import/ export	Container		Speed km/hr	Casualties		
					Size (feet)	Weight (tonne)		Fatalities	Severe	Minor
10.	Mar. 08	A truck driver was unable to come to the end of the left sharp curve descent in the junction road of Tohohu Expressway, and it overturned. There were no casualties.	Crude rubber	Import	20	20	50	0	0	0
11.	Mar. 08	A truck overturned in the right curve descent. A truck driver died.	Canned food	Import	20	18	75	1	0	0
12.	Apr. 08	A truck was unable to come to the end of the left sharp curve, and it broke through a right-side guardrail and came off the road and landed in water. A truck driver died.	Work gloves	Import	20	8	70	1	0	0
13.	Jan. 09	When a truck turned right at a crossing, it overturned to the left. A truck driver was slightly injured.	Wooden goods (half-split chopsticks)	Import	40	23.7	30	0	0	1
14.	May 09	A truck crashed a street light on a straight road, and ran over a right-hand side safety zone and crashed with an oncoming car and overturned. A truck driver was seriously injured. A driver of the crashed car was slightly injured.	Soy beans	Import	20	20	60	0	1	1
15.	May 09	A container dropped from a trailer and fell on the opposite lane in the left sharp curve of the Hanshin Expressway, and three cars and a truck crashed into the dropped container. A person was seriously injured, five persons were slightly injured. 	CDs	Import	20	12	75	0	1	5
16.	May 09	A container dropped from a trailer and fell on a car, travelling side-by-side in the descending curve, because the front part of the container came off a trailer. Three people in the car were dead or injured (two persons died and one person was seriously injured). 	Flowerpots	Import	40	23.39	47	2	1	0

No.	Month/ year	Accident summary	Goods loaded	Import/ export	Container		Speed km/hr	Casualties		
					Size (feet)	Weight (tonne)		Fatalities	Severe	Minor
17.	May 09	A truck crashed into the left-side wall in the left curve of the harbourside road and it overturned. A truck driver tried to escape and died. 	Coffee beans	Import	20	19	40	1	0	0
18.	Nov. 09	A truck fell to the left in avoiding a collision with an oncoming car which had crossed the centre line. A truck driver was slightly injured.	Plastic particles	Import	20	19	40	0	0	1
19.	Jan. 07	A truck overturned in the right curve of the Metropolitan Expressway. A driver was seriously injured.	Televisions	Export	40	12	70	0	1	0
20.	Jan. 07	A truck left the road in the slow right curve descent. A truck driver died.	Tyres	Export	40	17.27	61	1	0	0
21.	July 07	A truck overturned in the right curve descent in the junction road of the Joban Expressway. There were no casualties.	Miscellaneous goods	Export	40	18.55	50	0	0	0
22.	July 07	When a truck turned right at a crossing, it overturned to the left. There were no casualties.	Waste paper	Export	40	20.11	15	0	0	0
23.	Aug. 07	When turning right at a crossing, a truck overturned to the left. There were no casualties.	Pulp	Export	40	24	10	0	0	0
24.	Apr. 08	Because a driver felt danger in the right curve of the Metropolitan Expressway and suddenly braked, the steering wheel moved slightly, and the truck side-slipped and touched a side wall and overturned. A truck driver was slightly injured.	Motor parts	Export	40	20	90	0	0	1
25.	June 08	A truck overturned in the right sharp curve descent of the Tomei Expressway exit. There were no casualties.	Paper (rolled paper)	Export	40	26.96	48	0	0	0
26.	Feb. 09	A truck overturned in the sharp curve of the Metropolitan Expressway, and it crashed into a side wall. A truck driver died.	Compressed PET bottles (recycling)	Export	40	21	70	1	0	0

No.	Month/ year	Accident summary	Goods loaded	Import/ export	Container		Speed km/hr	Casualties		
					Size (feet)	Weight (tonne)		Fatalities	Severe	Minor
27.	Aug. 09	When a truck drove in a diagonally forward left curve at the crossing of five paths, the front part of the container came off the truck, and the container dropped. A car in the opposite lane was crushed under the dropped container. Four people were slightly injured. 	Tyres	Export	40	18	68	0	0	4
28.	Aug. 09	The body of a truck inclined into the left curve of the Hanshin Expressway, and ran about 30 metres, having leaned against a safety zone and stopped. A truck driver was seriously injured. A driver of the car in the opposite lane was slightly injured.	Disposable plastic	Export	40	30	70	0	1	1

Appendix III

Ten steps to load, stow and secure a freight container

Capt. James J. McNamara, National Cargo Bureau, Inc.

The goals

The safe shipment of cargoes is a primary objective, of course. This is especially important when hazardous cargoes are carried. A related goal is the delivery of the cargo in complete, clean and undamaged condition.

The following are ten steps and issues to beware when loading, stowing and securing (stuffing) a freight container:

1. The key person is the shipper and/or the person responsible for loading (packing/stuffing) the container

The right container for the job should be selected. Does the cargo need refrigeration, ventilation, special handling equipment, securing devices or special dunnaging in the container? Is it for exclusive use? If in doubt, consult your ocean carrier or container leasing firm.

2. Container condition

Check your container when it arrives. Is it the type you ordered? Examine it for:

– Cleanliness. Is it odour free? Is it weatherproof? If it happened to be raining (or there is melting snow on top) that is a good time to check for leaks. Otherwise a visual check can be made by inspecting the freight container from within. If any light enters, then water will. (If in doubt, spray it with a hose.) Take particular note of the door gaskets and how well the doors close. This is often a vulnerable point.

– If it is fitted with cargo restraint devices, are they in good condition and in sufficient supply?

– Examine the container carefully for physical condition just as if you were buying it. (You are, in a sense – even if only for one trip.) Has it been repaired? If so, does the repair quality restore the original strength and weather-proof integrity?

– Look at the sides. Examine them carefully to see if there are any holes or fractured welds. Is the container racked (twisted) or out of line? If so, it has been misused and will probably be inadequate for the safe carriage of your cargo. (Distorted containers are unlikely to fit properly with chassis and handling equipment that must lock into all corner fittings.) Have all placards and markings applicable to previous hazardous cargoes, precautions or destinations been removed from sides and doors?

If it does not pass these tests, call for another container. Remember, if you do not give your cargo the right start, it has little chance of arriving in good condition.

3. About stowing and "stuffing"

In a sense, the shipper is now stowing the ship because a container ship is loaded with hundreds of small portable cargo "compartments" (i.e. freight containers) offered by numerous shippers of many containerized cargoes.

"Stuffing" has become a commonly used term for the loading of cargo into freight containers. The International Maritime Organization refers to that operation as "packing." To "stow" is to place or arrange compactly and put safely in place. This is a traditional seafaring word meaning to make things ready for sea – to prepare and place cargo and equipment properly for the sea voyage. "Load", as used by the railroad and trucking industries, is generally synonymous with "stow".

Whatever you call it, "stow" your cargo properly in the correct freight container and secure it well ("stow" and "secure" are two distinct operations you will note).

4. Weight distribution and space utilization

IMPORTANT: Pre-plan the stowage of the cargo in container. The weight should be spread evenly over the entire length and width of the floor of the container.

For example, if you have a 40-ft. container with a cargo capacity of 55,000 pounds and a cubic capacity of

2,090 cubic feet, and your cargo weighs 55,000 pounds but measures only 1,000 cubic feet, it should be stowed about half the height of the container over the entire floor, rather than to the top for one half the length.

If you are stowing cargoes of uniform density (other than heavily concentrated packages), then a proper, even weight distribution is not a problem. Cargoes of various densities are more of a problem.

5. Compatibility of cargoes

If the container is loaded with packages of various commodities, give careful attention to their proper segregation and stowage. The commodities' physical characteristics (such as weight, size, density) must be considered, as well as whether they are liquids or solids.

Cargo can be of high density, hard-to-damage commodities such as galvanized metal sheets, or low density – but also hard-to-damage goods. Cargoes can be high density, easily damaged electronic components, or low-density items such as lampshades. There are numerous possibilities.

A shipper should be aware of previous commodities stuffed in the container, especially if foodstuffs are to be in it.

6. Improper stowage can cause damage to any cargo, including so-called hard-to-damage commodities

Each commodity must be considered on the basis of its characteristics and properties when planning its packaging and stowage in containers for shipment. The commodity's compatibility with other cargo in the same container must always be considered.

To achieve the proper cube utilization, a compatible configuration of cargo packaging units is also essential. Exposure to damage by chafing, crushing, odour or fume taint and wetting by condensed moisture or leakage also must be avoided.

Segregation of hazardous materials/dangerous goods within the same or adjacent containers is regulated. Compatibility with other hazardous commodities (and certain non-regulated cargoes) must be in compliance with general and sometimes also specific segregation requirements.

7. Hazardous cargoes

US regulations applicable to the transportation of packaged hazardous materials are contained in Title 49 of the Code of Federal Regulations, Parts 100–178. Those regulations apply to all modes.

The international recommendations for such shipments, but as applicable only to the water mode, are published in the International Maritime Dangerous Goods Code. That IMDG Code takes on the force of regulations in each of the countries that have adopted the Code into their own laws. Thus it should be regarded as a set of international "regulations".

The above-referenced US regulations, usually referred to as "49CFR," apply to packaged hazardous materials for all modes of transportation. Regulations specifically applicable to "Carriage by Vessel" are contained in Part 176 of 49CFR, Parts 100–177.

Both the 49CFR and IMDG Code specify the regulatory requirements for packaged hazardous materials (the US term) and dangerous goods (the international term).

8. Stowage of wet and dry; heavy and light cargo

– Wet and dry cargo

When the container is to be stowed with both packaged wet and dry cargo, the wet goods should never be stowed above the cargo that is liable to damage from moisture or leakage, nor in an adjacent position where leakage might spread along the floor. The dry goods should either be stowed over the wet or, if on the same level, raised off the floor by an extra layer of dunnage. Leakage is most likely to occur in cargoes of barrelled or drummed goods. Due care must always be given to proper stowage and securing of drums to prevent movement within the container.

– Heavy and light cargo

Improper stowage of heavy and light cargo together causes crushing and damage to contents. Heavy packages, such as cases of machinery parts and heavy, loose or skidded pieces, should always be stowed on the bottom or floor of the container with lighter goods on top.

Each tier should be kept as level as possible. Lateral crushing should be avoided by carrying the stow out to the sides and ends of the container and filling void spaces with dunnage or an adequate substitute.

If packages are stowed loosely, chafing damage is likely to occur due to the motion or vibration of the truck, train or ocean vessel. They can rub against each other and against boundaries of the container unless secured from movement. Cargo with little or no covering is especially susceptible to chafing damage. A cushioning material should be used to protect against this type of damage.

9. Stowage of heavy concentrated weight

When planning the stowage of heavy concentrated weights, careful consideration must be given to the maximum permissible weight and the floor loads allowed in the container. The bedding required to properly spread the weight should be arranged with weight distribution factors in mind.

This bedding should consist of lumber of sufficient thickness that will not deflect under the planned load, with the bottom bearers placed longitudinally in the container. The cargo piece or pieces should be bolted to cross members resting on the longitudinals. The cross members must be adequately bolted or fastened to the bottom pieces with backup cleats placed where necessary.

10. Securing

Fill it or secure it. Use dunnage. Block it out. Leave no void spaces or loose packages on top. Smooth metal-to-metal contact should be avoided as this causes a slippery surface. The slogan “Pack it tight to ride right” is a good one. Remember, typical trucking and railroad cargo securing guides stress stowing to prevent the longitudinal movement in the container. For ocean transport, however, the same rules should be applied to prevent additional sideways movement.

Avoid direct pressure on doors, use a proper fence or gate to fill any void space.

When stowing or loading the cargo in the container, you have a regulatory responsibility to do it correctly. The securing techniques and materials used should be more than just “adequate”, when ocean shipments are involved.

Check that package hazard labels and container placards, if required, have been applied.

Finally, secure the doors, lock and seal them, note the seal numbers for insertion on the bill of lading.

Appendix IV

Guidelines and codes of practice

Title		Published by	Date	Pages	Summary
1.	Ten-steps to load, stow and secure a freight container	National Cargo Bureau Inc.		3	See Appendix III.
2.	49CFR Parts 392 and 393 Development of a North American standard for protection against shifting and falling cargo; final rule	US Department of Transportation Federal Motor Carrier Safety Administration	2002	25	The FMCSA revises its regulations concerning protection against shifting and falling cargo for commercial motor vehicles (CMVs) engaged in interstate commerce. The new cargo securement standards are based on the North American Cargo Securement Standard Model Regulations, reflecting the results of a multi-year comprehensive research program to evaluate current US and Canadian cargo securement regulations; the motor carrier industry's best practices; and recommendations presented during a series of public meetings involving US and Canadian industry experts, federal, state and provincial enforcement officials, and other interested parties.
3.	Any fool can stuff a container	UK P&I Club			31-minute video, providing a short introduction into packing a container.
4.	Bulletin 46 – 5/98 – Overweight containers – worldwide	UK P&I Club	1998	1	Warnings on overweight containers.
5.	Code of practice – Safety of loads on vehicles	UK Department for Transport	2002	121	This code of practice covers the load being carried by the vehicle and any equipment on the vehicle such as loader cranes, landing legs, tailgates, etc. All of these must be stowed and secured to manufacturer's instructions so as not to be a danger to other road users and pedestrians.
6.	*Container Handbook*	GDV – German Insurance Association	2003	1 515	Detailed information on packing containers.
	www.containerhandbuch.de/chb_e/index.html				
7.	Container transport security across modes	Organisation for Economic Co-operation and Development	2005	127	This study highlights vulnerabilities in both inland and maritime container transport. Maritime containers are the focal point as opposed to other types of containers because they are the most numerous container type in international trade, are truly intermodal, and are ubiquitous. In addition, the study specifically focuses on the potential threat of containers being used by terrorists as a delivery vehicle for chemical, biological, radiological or nuclear (CBRN) weapons, as this scenario largely underpins the national and international policy agendas at this time.

Title		Published by	Date	Pages	Summary
8.	Containers – Stuffing plan	OOCL	2010	1	Summary of OOCL guidance on packing a container.
	www.oocl.com/eng/ourservices/containers/stuffingplan.htm?printPage=true				
9.	Driver's guide to cargo securement – A guide to the North American securement standard	US Department of Transportation's Federal Motor Carriers Safety Administration	2004	138	Guidance on the securement requirements in the North American cargo securement standard.
10.	European Best practice guidelines for abnormal road transport	European Commission Directorate-General for Energy and Transport (DG TREN)	2007	61	This document presents a set of best practices related to abnormal road transports. These guidelines constitute a new instrument complementing European legislation and standards, a list of rules and procedures considered the best in their area, compiled by professionals for the benefit of professionals.
11.	European best practice guidelines on cargo securing for road transport	European Commission Directorate-General for Energy and Transport (DG TREN)		208	The purpose of these guidelines is to provide basic practical advice and instructions to all persons involved in loading/unloading and securing a cargo on vehicles, including carriers and shippers (see also 2008 version).
12.	European best practice guidelines on cargo securing for road transport	European Commission	2008	171	Updated version.
13.	Guidelines for packing of cargo transport units	IMO/ILO/UNECE	1997	68	These guidelines are essential to the safe packing of CTUs by those responsible for the packing and securing of the cargo and by those whose task it is to train people to pack such units.
14.	Load security	Roadtransport.com	2010	3	Summary of publications available.
	www.roadtransport.com/Articles/2010/06/22/124786/load-security.htm				
15.	Overweight containers	Australian Chamber of Shipping	1999	3	Fact sheet 03/99 Guidance on responsibility for ensuring that containers are not overweight.
16.	Proper stowage of intermodal containers for ocean transport in a secure maritime environment	Maritime Administration, US Department of Transportation	2004	24	This guide has been prepared in an effort to further the successful intermodal carriage of cargo in answer to requests of shippers.
17.	Protocol on combined transport on inland waterways to the European Agreement on important international combined transport lines and related installations (AGTC) of 1991	United Nations Economic Commission for Europe	1997	25	This document contains the text of the Protocol on combined transport on inland waterways to the AGTC Agreement as notified in Depositary Notification C.N. 444.1997.TREATIES-1, dated 7 November 1997.

Title		Published by	Date	Pages	Summary
18.	Report on the current state of combined transport in Europe	European Conference of Ministers of Transport	1998	164	This report on the state (April 1998) of combined transport in Europe needs to be set within the general context of the ECMT's development as an organization.
19.	Rule 25 – Overweight container and/or over the road limitation	OOCL	2010	2	OOCL's operational rules concerning overweight containers.
20.	Safe transport of containers by sea – Guidelines on best practice	Marisec Publications	2008	78	The best practices in this guide are intended to cover the various parts of the transport chain that have an impact on the safe movement of containers at sea.
21.	Safe Transport of containers by sea – Industry guidance for shippers and container stuffers	Marisec Publications	2009	6	The Guidelines have been produced to minimize the dangers to container ships, their crews, and all personnel involved with containers throughout the transport chain, and were developed by an expert industry working group, meeting in London and Washington, DC during 2008.
22.	Sea freight container – Code of conduct	Port of Brisbane	2009	20	The aim of this document is to provide guidance to parties in the sea freight container supply chain concerning the carriage of containers on heavy vehicles, and particularly the responsibilities of all parties for Container Weight Declarations (CWDs).
23.	Standard 10: Cargo securement	National Safety Code for Motor Carriers	2003	53	The standard was drafted with the objective to provide jurisdictions with a standard which can be adopted by reference.
24.	Strengthening inland waterway transport, Pan-European co-operation for progress	European Conference of Ministers of Transport	2006	133	"Pan-European co-operation towards strong inland waterway transport: On the move" was a workshop organized by the ECMT, together with the UNECE, the Central Commission for Navigation on the Rhine and the Danube Commission, held on 22 and 23 September 2005. This publication gives a summary of discussions at the workshop and the conclusions it reached.
25.	The safe operator's guide	Vehicle and Operators Safety Administration	2009	71	This is part of a suite of VOSA publications dedicated to giving useful information to operators, drivers and other staff involved in the use of goods- and passenger-carrying vehicles. The Guide covers the introduction of digital tachographs and graduated fixed penalties and deposits for offences relating to drivers' hours, record keeping, overloading and construction and use.
26.	Understanding the Federal Motor Carriers Safety Administration's cargo securement rules	US Department of Transportation's Federal Motor Carriers Safety Administration	2003	40	Guidance on the securement requirements in the North American cargo securement standard.

Title		Published by	Date	Pages	Summary
27.	Working manual for rail staff – Handling and carriage of dangerous goods – Section G Safe loading of freight	Rail Safety and Standards Board	2003	16	This section identifies general loading and securing requirements for those involved in train preparation and operation to enable identification of any actual or potential hazards with freight loads.

Appendix V

International and national standards

Standard	Number	Description
ASTM	D 5728 – 00	Standard practices for securement of cargo in intermodal and unimodal surface transport
ASTM	D 6179 – 07	Standard test methods for rough handling of unitized loads and large shipping cases and crates
BS	5073:1982	Guide to stowage of goods in freight containers
BS EN	283:1991	Swap bodies. Testing
BS EN	284:2006	Swap bodies. Non-stackable swap bodies of Class C. Dimensions and general requirements
BS EN	452:1996	Swap bodies. Swap bodies of Class A. Dimensions and general requirements
BS EN	1432:1997	Swap bodies. Swap tanks. Dimensions, requirements, test methods, operating conditions
BS EN	12195-1:2003	Load restraint assemblies on road vehicles – Safety – Part 1: Calculation of lashing forces
BS EN	12406:1999	Swap bodies. Thermal swap bodies of Class C. Dimensions and general requirements
BS EN	12410:1999	Swap bodies. Thermal swap bodies of Class A. Dimensions and general requirements
BS EN	12640:2001	Securing of cargo on road vehicles, lashing points on commercial vehicles for goods transportation. Minimum requirements and testing
BS EN	12642:2006	Securing of cargo on road vehicles – Body structure of commercial vehicles – Minimum requirements
BS EN	13044:2001	Swap bodies. Coding, identification and marking
BS EN	13054:2001	Packaging – Complete, filled transport packages – Test methods for the determination of the centre of gravity of a package
BS EN	13876:2002	Transport – Logistics and services – Goods transport chains – Code of practice for the provision of cargo transport services
DD CEN TS	14993:2005	Swap bodies for combined transport. Stackable swap bodies type A 1371. Dimensions, design requirements and testing
BS ISO	668:1995	Series 1 Freight containers. Classification, dimensions and ratings
BS ISO	830:1999	Freight containers. Vocabulary
ISO	1161-1984	Freight containers. General. Specification for corner fittings for series 1 freight containers
ISO	1496-1:2006	Series 1 freight containers – specification and testing – general cargo containers for general purposes
ISO	1496-2:2008	Series 1 freight containers – specification and testing – thermal containers
BS ISO	1496-3:1995	Series 1 freight containers – specification and testing – tank containers for liquids, gases and pressurized dry bulk
BS ISO	1496-4:1991	Series 1 freight containers – specification and testing – non-pressurized containers for dry bulk
BS ISO	1496-5:1991	Series 1 freight containers – specification and testing – platform and platform-based containers
BS ISO	3874:1997	Series 1 freight containers – handling and securing
BS EN ISO	6346:1996	Freight containers. Coding, identification and marking
BS ISO	9711-1:1990	Freight containers. Information related to containers on board vessels. Bay plan system
BS ISO	9711-2:1990	Freight containers. Information related to containers on board vessels. Telex data transmission
BS ISO TR	15069:1997	Series 1 freight containers. Handling and securing. Rationale for ISO 3874
BS ISO TR	15070:1996	Series 1 freight containers. Rationale for design and structural test criteria

Appendix VI

Definitions

Articulated vehicle	Any motor vehicle with a trailer having no front axle and so attached that part of the trailer is superimposed upon the motor vehicle and a substantial part of the mass of the trailer and its load is borne by the motor vehicle. Such a trailer may also be called a semi-trailer.
Barge	A non-seagoing watercraft used on inland or protected coastal waters.
Box	Another (less formal) name for a shipping container. This is how they are often referred to in the industry.
Block train	A number of permanently coupled railway wagons, normally running directly between two selected terminals or entities without shunting.
Break-bulk	Loose cargo, such as cartons, stowed directly in the ship's hold as opposed to containerized or bulk cargo. The volume of break-bulk cargo has declined dramatically worldwide as containerization has grown.
B-Train	Two trailers linked together by a fifth wheel, and up to 26 m (85 ft) long. The fifth wheel coupling is located at the rear of the lead, or first trailer, and is mounted on a "tail" section commonly located immediately above the lead trailer axles.
Bulk cargo	Commodity cargo that is transported unpackaged in large quantities. These cargoes are usually dropped or poured as a liquid or solid, into a bulk carrier's hold. Examples of bulk cargo are grain, seed, and coal and iron ore.
Cargo	Any goods, wares, merchandise and articles of any kind which are intended to be transported.
Cargo transport unit (CTU)	A freight container, swap-body, vehicle, railway wagon or any other similar unit; see also intermodal transport unit (ITU).
Carrier	Any person or entity who, in a contract of carriage, undertakes to perform or to procure the performance of carriage by rail, road, sea, air, inland waterway or by a combination of such modes.
Centre of gravity (CG)	The point in or near a body at which the gravitational potential energy of the body is equal to that of a single particle of the same mass located at that point and through which the resultant of the gravitational forces on the component particles of the body acts.
Chassis	See skeletal trailer.
Close-coupled trailer	A close-coupled trailer is fitted with a rigid tow bar which projects from its front and hooks onto a hook on the tractor. It does not pivot in the same way as a full/drawbar trailer.
Consignee	The party to whom the cargo is consigned or entrusted, is often used to define the party that will receive or has bought the goods.
Consignment	Freight sent under a single contract of carriage.
Consignor	The party who has released or sold the goods.
Container	Generic term for a box to carry freight, strong enough for repeated use, usually stackable and fitted with devices for transfer between modes.
Container terminal	A docking, unloading and loading area within a port designed to suit the sizes and needs of container ships.
Dangerous goods	Packaged dangerous, hazardous or harmful substances, materials or articles, including environmentally hazardous substances (marine pollutants) and wastes, covered by the International Maritime Dangerous Goods (IMDG) Code; the term dangerous cargoes includes any empty uncleaned packaging.
Deep sea (service)	Maritime route between two or more major hub ports. Similar to liner service.
Door-to-door	Through transportation of a container and its contents from consignor to consignee – also known as house-to-house.

Drop-frame trailer	A form of intermodal transportation for portable bulk liquid containers or ISO tank containers. It is characteristically longer and has a lower deck height ideal for transporting constantly shifting payloads.
Feeder service	Cargo to/from regional ports are transferred to/from a central hub port for a long-haul ocean voyage.
Feeder vessel	A short-sea vessel which transfers cargo between a central "hub" port and smaller "spoke" ports.
FEU	"Forty-foot equivalent unit". This is a container that is the same height and width as a teu but twice the length. As a result, it has twice the capacity.
Freight container	An article of transport equipment that is of a permanent character and accordingly strong enough to be suitable for repeated use; it is designed to transport a number of receptacles, packages, unit loads or overpacks together from the packing point to its final destination by road, rail, inland waterway and/or sea without intermediate separate handling of each package, unit load or overpack.
Freight forwarder	A person or company that organizes shipments for individuals or other companies and may also act as a carrier. A forwarder is often not active as a carrier and acts only as an agent, in other words as a third party (non-asset-based) logistics provider who dispatches shipments via asset-based carriers and books, or otherwise arranges, space for these shipments.
Full trailer	A full trailer is a term for a trailer supported by front and rear axles and pulled by a drawbar. In Europe this is known as an A-frame drawbar trailer. The full trailer may comprise of a semi-trailer and a detachable dolly.
Fumigated container	A closed cargo transport unit containing goods or materials that either are or have been fumigated within the unit. The fumigant gases used are either poisonous or asphyxiant. The gases are usually evolved from solid or liquid preparations distributed within the unit.
Handling	Includes the operation of loading or unloading/discharging of a ship, railway wagon, vehicle or other means of transport.
Hub port	A port that is the destination of liner services where containers are transhipped onto feeder services for maritime transport onto small container ports.
Intermediate bulk container (IBC)	A rigid, semi-rigid or flexible portable packaging that: (1) has a capacity of not more than 3.0 m^3 (3,000 ℓ) for solids and liquids; (2) is designed for mechanical handling; and (3) is resistant to the stresses produced in handling and transport, as determined by tests.
Intermodal	Refers to the movement of CTUs on all forms of surface transport modes (road, rail, short sea and liner service) without the need for adjustment or alteration to the CTU or transport mode.
Intermodal transport unit (ITU)	A container, swap body or trailer suitable for intermodal transport.
Pallet	A term used for a load-carrying platform onto which loose cargo is stacked before being placed inside a container. It is designed to be moved easily by fork-lift trucks.
LASSTEC	Innovative load measuring system that allows to weigh containers during the handling cycle and to minimize accidents in ports operations.
Lift truck	A truck equipped with devices such as arms, forks, clamps, hooks, etc. to handle any kind of cargo, including cargo that is unitized, overpacked or packed in CTUs.
Liner service	Maritime route between two or more major hub ports.
LO–LO	Lift-on–lift-off. Loading and unloading of ITU using lifting equipment.
Marine carrier	Any person or entity who, in a contract of carriage, undertakes to perform or to procure the performance of carriage by deep sea, coastal or feeder vessel.
Maximum gross	The maximum permissible mass of cargo packed into a CTU combined with the mass of the CTU, also referred to as the rating; it would normally be marked on to CTUs as appropriate.
Maximum payload	The maximum permissible mass of cargo to be packed into or on to a CTU. It is the difference between the maximum gross mass or rating and the tare weight, which are normally marked on CTUs as appropriate.
Multimodal	Refers to CTUs that are designed for use on more than one mode of transport.

NVOCC	(1) Non-vessel operating common carriers: a company that ships goods on behalf of a client, especially internationally, but does not own its own ships or aeroplanes. It operates much like any other carrier, issuing its own bills of lading or air waybills. (2) Non-vessel operating container carrier: A company that ships goods on behalf of a client, especially internationally, but does not own its own ships or aeroplanes; it owns or operates a number of containers for shipping FCL or LCL cargoes for third-party shippers.
Overpack	An enclosure used by a single shipper to contain one or more packages and to form one unit for convenience of handling and stowage during transport. Examples of overpacks are a number of packages either: (1) placed or stacked on to a load board such as a pallet and secured by strapping, shrink-wrapping, stretch-wrapping or other suitable means; or (2) placed in a protective outer packaging such as a box or crate.
Overloaded	A container where the combined mass of the cargo and the container is greater than the maximum gross mass shown on the safety approval plate.
Overweight	A container where the combined mass of the cargo and the container is less than the maximum gross mass shown on the safety approval plate but exceeds either: – the maximum gross mass shown on the shipping manifest; or – the road or rail maximum masses when combined with the tare of the container-carrying vehicle.
Packing	The stowage, securing and verification of the mass of packaged and/or unitized or overpacked cargoes into CTUs.
Unpacking	The removal of cargo from CTUs.
Packaging(s)	Receptacles and any other components or materials necessary for the receptacle to perform its containment function.
Packages	The complete product of the packing operation, consisting of the packaging and its contents as prepared for transport.
Packer	The party that places the goods within the container, trailer or packaging.
Reefer	Industry term for a temperature-controlled container. Inside each one is a complex system of coils, wires and electrical fittings, which are managed by a computer that controls everything from the temperature and humidity to ventilation and gas levels, all working to prevent the deterioration of fresh food or other sensitive goods over long distances and periods of time.
Responsible person	A person appointed by a shore-side employer who is empowered to take all decisions relating to his/her specific task, having the necessary current knowledge and experience for that purpose, and who, where required, is suitably certificated or otherwise recognized by the regulatory authority.
ROLA	Roll-on–roll-off trains. Similar to a piggyback train but the entire road vehicle, tractor unit and trailer, is driven on and off special rail wagons.
RO–RO	Roll-on–roll-off. Loading and unloading of a road vehicle, a wagon or an ITU on or off a ship on its own wheels or wheels attached to it for that purpose. In the case of rolling road, only road vehicles are driven on and off a train.
Safety approval plate	A plate permanently affixed to every approved container at a readily visible place, adjacent to any other approval plate issued for official purposes, where it cannot be easily damaged. The safety approval plate may be combined together with other official plates but all must show: – the words “CSC safety approval plate”; – the country of approval and approval reference; – date (month and year) of manufacture; – the manufacturer’s identification number; – maximum operating gross mass;

	– allowable stacking mass for 1.8 ***g***;
	– transverse racking test load;
	also known at the CSC plate.
Semi-trailer	A semi-trailer is a trailer without a front axle. A large proportion of the combined mass of the trailer and its load is supported by a road tractor, by a detachable front axle assembly known as a dolly, or by the tail of another trailer. A semi-trailer is normally equipped with landing gear (legs which can be lowered) to support it when it is uncoupled.
Ship	A seagoing or non-seagoing watercraft, including those used on inland waters.
Shipper	Any person or organization paying for its cargo to be shipped from one place to another.
Short sea	Maritime route between two or more coastal ports normally undertaken by small coastal ships or barges.
Shunting	The operation when single railway wagons or groups of railway wagons are pushed to run against each other and be coupled together.
Skeletal trailer	A skeletal trailer composed of a simple chassis comprising of longitudinal main beams, rolling gear and container support (transverse) beams for the mounting of an intermodal container, sometimes known as a chassis.
Stowage	The positioning of packages, IBCs, containers, swap-bodies, tank-containers, vehicles or other CTUs on board ships, in warehouses and sheds or in other areas such as terminals.
Stuffing	The act of packing goods within a container or trailer.
Swap-body	A CTU not permanently attached to an underframe and wheels or to a chassis and wheels, with at least four twistlocks that take into account ISO standard 1161:1984. A swap-body need not be stackable but is usually equipped with support legs, designed especially for combined road–rail transport.
Tare mass/weight	The mass of the empty container including permanently affixed ancillary equipment.
Terminal	A place equipped for the transhipment and storage of ITUs.
Twenty-foot equivalent unit (teu)	A standard unit based on an ISO container of twenty-feet length (6.10 m), used as a statistical measure of traffic flow or capacity.
Trailer	Any road vehicle without a motive power unit, and includes semi-trailers, semi-trailers with front axle dollies, full trailers and drawbar trailers.
Transport	Movement of cargo by one or more modes of transport.
Twistlock	A twistlock and corner casting together form a standardized rotating connector for securing shipping containers. The primary uses are for locking a container into place on a container ship, semi-trailer truck or railway container train; and for lifting of the containers by container cranes and sidelifters.
Unit load	A number of packages that are:
	(1) placed or stacked on and secured by strapping, shrink-wrapping or other suitable means to a load board such as a pallet;
	(2) placed in a protective outer enclosure such as a pallet box; or
	(3) permanently secured together in a sling.
Vehicle	A road vehicle or railway freight wagon, permanently attached to an underframe and wheels or to a chassis and wheels, which is loaded and unloaded as a unit. It also includes a trailer or similar mobile unit except those used solely for the purposes of loading and unloading.
Vessel	Another word for a boat or ship. Container ships are sometimes referred to as vessels.

Appendix VII

Stakeholders and contributors

Accident investigation

Accident Investigation Board of Finland	In Finland the Accident Investigation Board investigates all major accidents, regardless of their nature, as well as all aviation, maritime and rail accidents and their incidents.	http://www.onnettomuustutkinta.fi/en/Etusivu
BMT Marine & Offshore Survey	BMT Marine & Offshore Surveys Ltd is a leading international marine surveying and technical consultancy, operating from a worldwide network of offices. The company incorporates the world-renowned casualty expertise of the Salvage Association and BMT Murray Fenton.	http://www.bmtmarinerisk.com/
Health and Safety Executive (HSE)	Under the Health and Safety at Work, etc. Act 1974 (as amended) (HSWA), the HSE has been set up in order to support the Government's strategic aims and current targets for occupational health and safety. Its main aim is to secure the health, safety and welfare of people at work and protect others from risks to health and safety arising from work activity.	http://www.hse.gov.uk/
International Institute of Marine Surveyors (IIMS)	The IIMS is an independent, non-political organization. Membership is open to qualified mariners, cargo surveyors, yacht and small craft surveyors, and marine consultants from around the world. Individuals, with specialized knowledge, experience or skills able to contribute and enhance the aims and objectives of the Institute are also invited to join.	http://www.iims.org.uk/
Marine Accident Investigation Branch (MAIB)	The MAIB examines and investigates all types of marine accidents to or on board UK ships worldwide, and other ships in UK territorial waters.	http://www.maib.gov.uk/home/index.cfm
Marine Accident Investigators' International Forum (MAIIF)	The MAIIF is an international non-profit organization dedicated to the advancement of maritime safety and the prevention of marine pollution through the exchange of ideas, experiences and information acquired in marine accident investigation. Its purpose is to promote and improve marine accident investigation, and to foster cooperation and communication between marine accident investigators.	http://www.maiif.org/
Occupational Health and Safety Administration (OSHA)	With the Occupational Safety and Health Act of 1970, the US Congress created the Occupational Safety and Health Administration (OSHA) to ensure safe and healthy working conditions for working men and women by setting and enforcing standards and by providing training, outreach, education and assistance.	http://www.osha.gov/
Rail Accident Investigation Branch (RAIB)	The RAIB is the independent railway accident investigation organization for the UK. It investigates railway accidents and incidents on the UK's railways to improve safety, not to establish blame.	http://www.raib.gov.uk/home/index.cfm

Cargo handlers

British International Freight Association (BIFA)	The BIFA is the trade association for UK-registered companies engaged in international movement of freight by all modes of transport – air, road, rail and sea. BIFA has around 1,400 corporate members, known generally as freight forwarders, which offer a wide range of services within these various modes.	http://www.bifa.org/content/Home.aspx
European Association for Forwarding, Transport, Logistics and Customs Services (CLECAT)	CLECAT's members voice the interests of more than 19,000 companies employing in excess of 1 million staff. In rough figures, European freight forwarders and customs agents clear 95 per cent of all goods in Europe and handle 65 per cent of the cargo transported by road, 95 per cent of the cargo transported by air and 65 per cent of the maritime. CLECAT also plays a major role in rail and inland waterways. Intermodal transport, extensive use of IT and dedicated terminals and warehouses are the main tools the Association's members use to address customers' requirements. CLECAT also works in close cooperation with FIATA, the World Federation of Freight Forwarders, and is the exclusive voice of our sector on European issues.	http://www.clecat.org/index.php
European Freight Forwarders' Association (EFFA)	EFFA provides a forum for good quality, independent, freight forwarders, and provides them with a global network of quality agents to make each member better able to compete in the growing global economy. Unlike the multinational freight concerns EFFA agents are positioned to offer personalized and varied services to a varied market.	http://www.effa.com/
European Intermodal Association (EIA)	The EIA is an international independent platform promoting sustainable intermodal mobility in Europe by combining innovative rail, waterway, road, air and maritime transport solutions.	http://www.eia-ngo.com/
Freight Transport Association (FTA)	FTA represents the transport interests of companies moving goods by road, rail, sea and air. FTA members operate over 200,000 goods vehicles – almost half the UK fleet. In addition, they consign over 90 per cent of the freight moved by rail and over 70 per cent of sea and air freight.	http://www.fta.co.uk/
International Federation of Freight Forwarders Associations (FIATA)	FIATA, a non-governmental organization, represents today an industry covering approximately 40,000 forwarding and logistics firms, also known as the "Architects of Transport", employing around 8–10 million people in 150 countries.	http://www.fiata.com/
International Freight Association (IFA)	The IFA is a global association of independent, locally-owned logistics and transportation specialists founded in 1985. The IFA combines local expertise with a global network covering over 160 locations around the world.	http://www.ifa-online.com/web/index.asp

Coastguard

Marine and Coastguard Agency (MCA)	This Agency is responsible throughout the UK for implementing the Government's maritime safety policy. That includes coordinating search and rescue at sea through Her Majesty's Coastguard, and checking that ships meet UK and international safety rules. The MCA works to prevent the loss of lives at the coast and at sea, to ensure that ships are safe, and to prevent coastal pollution: *Safer Lives, Safer Ships, Cleaner Seas*.	http://www.mcga.gov.uk/c4mca/mcga07-home

United States Coast Guard	The US Coast Guard is one of the five armed forces of the United States and the only military organization within the Department of Homeland Security. The Coast Guard protects the maritime economy and the environment, defends US maritime borders, and saves those in peril.	http://www.uscg.mil/
Legislation and government		
European Commission Directorate for Energy and Transport (DGTREN)	The DGTREN has been split into the Directorate-General for Energy and the Directorate-General for Mobility and Transport.	
European Commission's Directorate-General for Mobility and Transport (DG MOVE)	Transport policy directly affects everyone in Europe. Whatever age we are, and whatever activities we undertake, transport and mobility play a fundamental role in today's world. The issues and challenges connected to this require action at European level; no single national government can address them successfully alone. By working in concert, European Union Member States and European industry can ensure our transport infrastructure meet the needs of citizens and our economy, whilst minimizing damage to our environment. The European Commission's DG MOVE manages work in this area.	http://ec.europa.eu/dgs/transport/index_en.htm
International Labour Organization (ILO)	The ILO is devoted to advancing opportunities for women and men to obtain decent and productive work in conditions of freedom, equity, security and human dignity. Its main aims are to promote rights at work, encourage decent employment opportunities, enhance social protection and strengthen dialogue in handling work-related issues.	http://www.ilo.org/global/lang--en/index.htm
International Maritime Organization (IMO)	A specialized agency of the United Nations with 169 Member States and three Associate Members, the IMO is based in the United Kingdom with around 300 international staff. The IMO's specialized committees and subcommittees are the focus for the technical work to update existing legislation or develop and adopt new regulations, with meetings attended by maritime experts from Member Governments, together with those from interested intergovernmental and non-governmental organizations.	http://www.imo.org/
United Nations Economic Commission for Europe (UNECE)	UNECE'S major aim is to promote pan-European economic integration. To do so, it brings together 56 countries located in the European Union, non-EU Western and Eastern Europe, South-East Europe and Commonwealth of Independent States (CIS) and North America. All these countries dialogue and cooperate under the aegis of the UNECE on economic and sectoral issues. To this end, it provides analysis, policy advice and assistance to governments, it gives focus to the United Nations global mandates in the economic field, in cooperation with other global players and key stakeholders, notably the business community.	http://www.unece.org/

Insurance

Allianz Global Corporate & Specialty	Allianz Global Corporate & Specialty was formed from the merger of Allianz Global Risks and Allianz Marine & Aviation in November 2005 and was launched as a fully owned entity of Allianz SE. It is now uniquely equipped to serve its clients' needs, providing not only financial strength but also an unequalled global network of specialists with established industry records who support a diverse array of products and services.	www.agcs.allianz.com
Gesamtverband der Deutschen Versicherungswirtschaft e.V. (GDV)	The General Insurance Association (GDV), based in Berlin, is the umbrella organization of private insurers in Germany. Its 457 member companies, with around 226,000 employees and trainees, offer comprehensive risk protection and provisions to households, trade, industry and public institutions, through more than 400 million contracts. As a risk taker and major investor (investment portfolio approximately €1.17 trillion) the insurance industry has an outstanding significance in connection with investment, growth and employment in the German economy.	http://www.gdv.de/index.html
International Group of P&I Clubs	The 13 principal underwriting member clubs of the International Group of P&I Clubs ("the Group") between them provide liability cover (protection and indemnity) for approximately 90 per cent of the world's ocean-going tonnage. Each Group club is an independent, non-profit-making mutual insurance association, providing cover for its shipowner and charterer members against third party liabilities relating to the use and operation of ships. Each club is controlled by its members through a board of directors or committee elected from the membership. Clubs cover a wide range of liabilities including personal injury to crew, passengers and others on board, cargo loss and damage, oil pollution, wreck removal and dock damage. Clubs also provide a wide range of services to their members on claims, legal issues and loss prevention, and often play a leading role in the management of casualties.	http://www.igpandi.org/
International Union of Marine Insurance (IUMI)	The IUMI is a professional body run by and for its members. It provides an essential forum to discuss and exchange ideas of common interest and to protect and advance members' interests. It also provides – through its worldwide communication network – a platform from which views on matters of concern to its members are disseminated to the marine and shipping industry, international organizations and international media.	http://www.iumi.com/
Through Transport Mutual Insurance Association (UK) Ltd (TT Club)	The TT Club is the international transport and logistics industry's leading provider of insurance and related risk management services. Established in 1968, as a mutual association, the TT Club specializes in the insurance of liabilities and equipment for multimodal operators. Customers range from some of the world's largest shipping lines, busiest ports, biggest freight forwarders and cargo handling terminals, to companies operating a handful of vehicles. With so many different categories of customer around the world, the TT Club has learned to work closely with brokers to tailor insurance packages that meet individual needs.	http://www.ttclub.com/ttclub/public.nsf/html/index?OpenDocument

UK P&I Club	The UK P&I Club is the world's largest mutual insurer of third party liabilities for oceangoing ships. Over 150 million gross tons of owned and chartered shipping is collectively insured through the Club for its liabilities in respect of passengers, crew, cargoes, collisions, pollution and a variety of other injuries, damages and losses.	http://www.ukpandi.com/ukpandi/infopool.nsf/HTML/index?OpenDocument
Maritime transport		
Container Owners' Association (COA)	The COA was established in November 2004 as an international organization representing the common interests of all owners of freight containers. The principle aims of the COA are to provide global expertise, to promote common standards and to facilitate international lobbying. The Association is also intended to enhance cooperation between its members and other associated industry bodies in a number of fields.	http://www.containerownersassociation.org/
Hapag-Lloyd AG	The company transported more than 120 modern ships, almost 5 million containers (teu) in a year; it employs over 6,800 motivated staff at 300 locations in 114 countries, networking through an IT system that is the industry leader: Hapag-Lloyd is among the leading liner shipping companies of the world and a powerful partner in global logistics. It offers about 80 liner services between all continents, a fleet with a total capacity of about 550,000 teu, as well as a container stock of around 1 million teu, including one of the world's largest and most modern reefer container fleets. For more than 160 years Hapag-Lloyd has set industry-wide benchmarks for reliability, service, productivity and environmental protection.	http://www.hapag-lloyd.com/en/home.html
International Shipping Federation / International Chamber of Shipping	The International Chamber of Shipping (ICS) and the International Shipping Federation (ISF) are the principal international trade association and employers' organization for merchant ship operators, representing all sectors and trades and over 75 per cent of the world merchant fleet.	http://www.marisec.org/
Maersk Line	Maersk Line is one of the leading liner shipping companies in the world, serving customers all over the globe. The Maersk Line fleet comprises more than 500 vessels and a number of containers corresponding to more than 1,900,000 teu: it ensures reliable and comprehensive worldwide coverage.	http://www.maerskline.com/appmanager/
World Shipping Council (WSC)	The WSC's goal is to provide a coordinated voice for the liner shipping industry in its work with policy-makers and other industry groups with an interest in international transportation. The WSC and its member companies partner with governments and other stakeholders to collaborate on actionable solutions for some of the world's most challenging transportation problems. In particular, the WSC plays an active role in the development of programmes that improve maritime security without impeding the free flow of commerce.	http://www.worldshipping.org/

Ports and terminals		
American Association of Port Authorities (AAPA)	AAPA promotes the common interests of the port community, and provides leadership on trade, transportation, environmental and other issues related to port development and operations. AAPA also works to educate the public, media, local, state and federal legislators about the essential role ports play within the global transportation system.	http://www.aapa-ports.org/home.cfm
DP World	DP World is one of the largest marine terminal operators in the world, with 50 terminals and 11 new developments across 31 countries. Its dedicated, experienced and professional team of nearly 30,000 people serves customers in some of the most dynamic economies in the world.	http://webapps.dpworld.com/portal/page/portal/DP_WORLD_WEBSITE
European Sea Ports Organisation (ESPO)	ESPO represents the seaports of the Member States of the European Union and has observer members from several other European countries. The EU simply cannot function without its seaports. Almost all of the Community's external trade and almost half of its internal trade enter or leave through the more than 1,200 seaports existing in the 22 maritime Member States of the EU.	http://www.espo.be/Home.aspx
Hutchinson Ports (UK) (HPUK)	HPUK is a member of the Hutchison Port Holdings (HPH) Group. HPH, a subsidiary of the multinational conglomerate Hutchison Whampoa Limited (HWL), is the world's leading port investor, developer and operator with interests in a total of 51 ports, spanning 25 countries throughout Asia, the Middle East, Africa, Europe, the Americas and Australasia. HPH also owns a number of transportation-related service companies.	http://www.hpuk.co.uk/
The International Association of Ports and Harbors (IAPH)	The Association's principal objective is to develop and foster good relations and cooperation among all ports and harbours in the world by proving a forum to exchange opinions and share experiences on the latest trends of port management and operations. IAPH strives to emphasize and promote the fact that ports form a vital link in the waterborne transportation and play such a vital role in today's global economy.	http://www.iaphworldports.org/
Roadways Container Logistics	Roadways Container Logistics is one of the UK's leading multimodal transport and container handling specialists. It is an independent business and works with shipping lines, freight forwarders and end customers directly.	http://www.roadways.co.uk/index.html
Transport organizations		
Association of American Railroads (AAR)	America's freight railroads operate the safest, cleanest, most efficient and most environmentally sound rail system in the world – and the Association of American Railroads is committed to keeping it that way. AAR members include the major freight railroads in the United States, Canada and Mexico, as well as Amtrak. Its mission is to work with elected officials and leaders in Washington, DC on critical rail transportation issues to ensure that the railroads meet America's transportation needs today and in the future. The AAR is the standard-setting organization for North America's railroads. The primary focus is the interoperability of rolling stock, including locomotives, and their components.	http://www.aar.org/homepage.aspx

International Road Transport Union (IRU)	The IRU, through its national associations, represents the entire road transport industry worldwide. It speaks for the operators of coaches, taxis and trucks, from large transport fleets to driver–owners. In all international bodies that make decisions affecting road transport, the IRU acts as the industry's advocate. By working for the highest professional standards, the IRU improves the safety record and environmental performance of road transport and ensures the mobility of people and goods. Among its practical services to the industry, the IRU is international guarantor of the TIR carnet system under which trucks are sealed by customs upon departure and can cross several borders without further checks until they reach their destinations.	http://www.iru.org/
International Transport Forum	The International Transport Forum is a strategic think tank for the transport sector. Each year, it brings together ministers from over 50 countries, along with leading decision-makers and actors from the private sector, civil society and research, to address transport issues of strategic importance. An intergovernmental organization linked to the Organisation for Economic Co-operation and Development (OECD), the Forum's goal is to help shape the transport policy agenda, and ensure that it contributes to economic growth, environmental protection, social inclusion and the preservation of human life and well-being.	http://www.internationaltransportforum.org/
Road Haulage Association (RHA)	The RHA regional directors are responsible for looking after the members in their respective regions, as well as implementing regional policy as drawn up by each of the regional councils.	http://www.rha.uk.net/
International Union of Railways (UIC)	The UIC's mission is to promote rail transport at world level and meet the challenges of mobility and sustainable development.	http://www.uic.org/spip.php?id_article=757&page=home
Shipper/packer organizations		
European Shippers' Council (ESC)	The ESC represents the interests of companies represented by 12 national transport user organizations and a number of key European commodity trade associations. The ESC is the principal recognized voice of European shippers.	http://www.europeanshippers.com/
Global Shippers' Forum (GSF)	The GSF's aims and objectives are to share information about developments and issues of critical importance to shippers and, where possible through a common voice, seek to facilitate the optimization of transport efficiency and service quality for shippers by aligning government policy, industry practice and shippers' objectives for mutual advantage.	http://www.globalshippersforum.org/
International Chamber of Commerce (ICC)	The ICC is the voice of world business championing the global economy as a force for economic growth, job creation and prosperity.	http://www.iccwbo.org/
Worker organizations		
International Transport Workers' Federation (ITF)	The ITF is an international trade union federation of transport workers' unions. Any independent trade union with members in the transport industry is eligible for membership of the ITF; 759 unions representing over 4,600,000 transport workers in 155 countries are members of the ITF. It is one of several Global Union federations allied with the International Trade Union Confederation (ITUC).	http://www.itfglobal.org/index.cfm