Container-carrying vessels

Preface

Anyone using containers for maritime transport should have at least some kind of idea of what kinds of vessels are used for this purpose. When people who are not shipping professionals read press articles about gigantic new container ships, they find it hard to imagine that such ships could experience problems at sea. It is very often also forgotten that even containers which have been carried for the vast majority of their voyage on ultra-modern ships will have to be carried for the remainder of their voyage, quite possibly highly adventurously, on very different kinds of ships. This section of the Container Handbook is thus intended to provide a brief overview of the different kinds of ships which may be used to carry containers. Reference should be made to the appropriate specialist literature if detailed information is wanted or required.

Ships-general

Ships may be distinguished on the basis of various different criteria.For example, by

- type of propulsion;
- region of service;
- function;
- tonnage or measurement;
- arrangement of decks or superstructures etc.

Type of propulsion will not be a major concern for most maritime shipping customers. In most cases, users will assume that the goods will be carried by motor or turbine ships. The following and similar abbreviations are often found in the shipping documents prefixing the ship's designation: MS = motor ship; TS = turbine ship; CMV = container motor vessel; CTV = container turbine vessel.

However, it is still good to know whether containers will be carried onwards with other vessels, perhaps even sailing ships or open flatboats. This is not uncommon in some parts of the world, for example in the Indonesian archipelago.

Differentiation by region of service is often clear simply from the ship's name. Examples are lakers (for use on the Great Lakes and St. Lawrence Seaway), coasters (for coastal shipping), European inland waterway vessels, ocean-going vessels etc. For shipping professionals, the name is enough to give them a picture of the nature and appearance of the ship and how it accommodates cargo etc.

A ship's function is also generally reflected in its name, for example underwater vehicle, fishing vessel, tugboat, buoy-laying vessel, warship or the like. As their name would suggest, feeder ships, for example, carry goods for onward carriage by other ships.

Differentiation by tonnage, measurement, arrangement of superstructures etc. is generally only of interest to the specialist. Laypeople will be largely unconcerned whether goods are being carried on a full scantling, open-deck, shelter-deck or flush-deck vessel, a three-island or any other kind of vessel, although knowing the kind of vessel makes it possible to draw important conclusions about the type of carriage, transport risks, handling stresses etc.

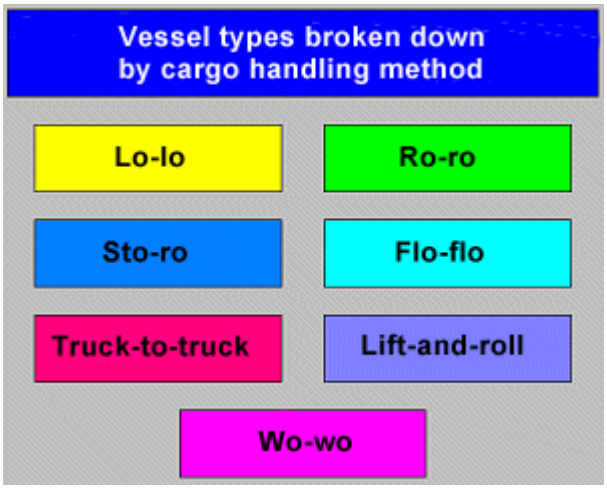
The interested layperson should, however, be aware that gross or net register tonnages are not directly indicative of the size of a vessel, while the more recent terms gross and net tonnage are little more help.

Every shipper or charterer should know the term deadweight, which is the ship's payload in metric tons. And it certainly does no harm to know that the ship's displacement or displacement tonnage is its total weight, i.e. the sum of the weight of the empty, operational ship plus all permitted payload.

This section of the Container Handbook will now outline some essential

distinguishing features of those merchant ships which carry containers and comparable "combined transport units". Press articles often refer to the "type of freight" in this connection, but strictly speaking this is incorrect as freight is the amount of money the shipowner or carrier receives for transporting the cargo.

Before taking a closer look at various types of ship, a breakdown by handling method may be helpful:



Breakdown by handling method

Lo/lo stands for lift-on/lift-off The cargo is lifted in and out of the ship (loaded and unloaded) using on-board lifting gear or loading gear, such as derricks, on-board cranes or gantries, or also on-shore lifting gear. This is the traditional handling method and is used for most ships throughout the world.

Ro/ro stands for roll-on/roll-off, meaning that the cargo is moved on and off the ship on wheels. This is achieved in various different ways. Loaded trucks drive on/off ship under their own power, the driver either traveling with the truck and continuing onward carriage or leaving the truck to continue its journey unaccompanied. In either case door-to-door transport is possible. The truck may travel unaccompanied when driven by a driver under contract. Door-to-door transport is again possible. Trailers or chassis are driven on board with special terminal tractors. Roll trailers are packed at the port of departure, hauled on board with special ro/ro tractors, hauled off at the port of destination and

unpacked there. A similar situation applies to cassettes or container bolsters packed in port, which are lifted up with special terminal vehicles and rolled on board and back off again. This method covers all types of ship involved, for example, in ferry traffic. Containers and swap-bodies are here (virtually) exclusively embarked and disembarked on roll trailers, chassis and similar means.

Sto/ro stands for stow and roll. In this case, the cargo is rolled on or off ship using one of the above methods, but is conventionally stowed when on board, usually by means of forklift trucks. This method is not used for container traffic.

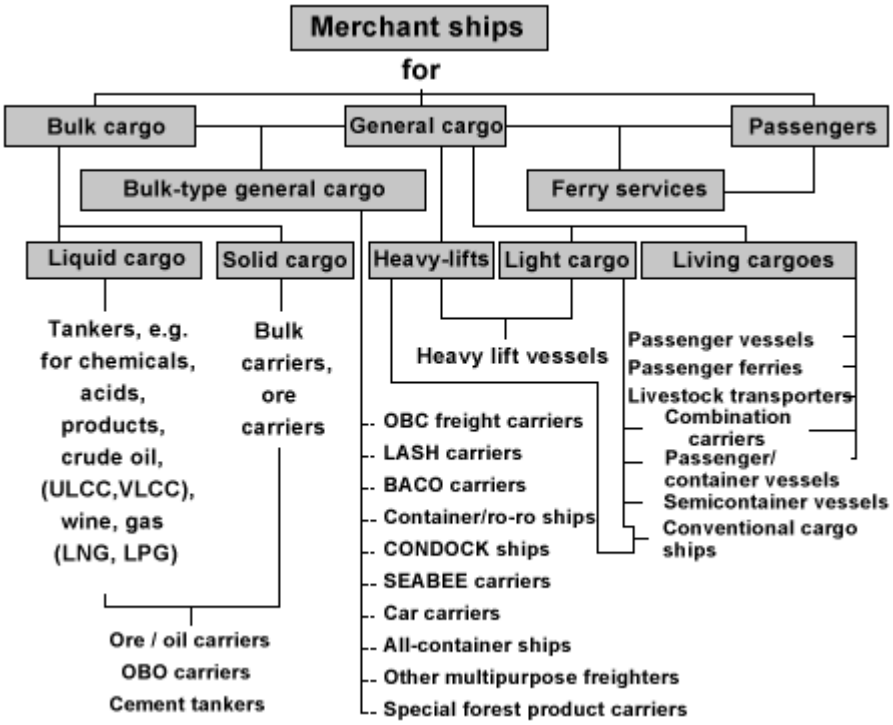
Flo/flo stands for float-on/float-off. Other variants are possible. Floating goods or goods loaded onto floating cargo carriers are floated in and out of dock-like holds in the ship. or Alternatively, the carrier vessel semisubmerges, moves under the cargo, refloats and lifts the cargo into the predetermined stowage space. The cargo is unloaded by performing the process in reverse. This method may be used for container transport if floating cargo carriers, such as barges, have already been loaded with containers.

In the **truck-to-truck** method, the cargo is set down using ground conveyors, such as forklift trucks, onto on-board lifts, raised/lowered to the appropriate loading level, where it is loaded using ground conveyors. Discharge proceeds in the reverse order. This method is not suitable for container traffic.

In the **lift-and-roll** method, the cargo is lifted on board with on-board loading gear or winch platforms and then rolled into place. This method is preferably used with a special type of barge carrier. This method is suitable for container traffic if the containers have previously been loaded onto or into the barges.

Wo/wo or walk-on/walk-off sounds comical, but is in fact the commonest handling method for livestock carriers. The animals walk onto and off the ship or into the containers or CTUs. The same principle applies to all passenger vessels.

A rough classification of ship type by kind of cargo carried could look as follows:



Overview of merchant ship types

The above list is not exhaustive, but does give a relatively good overview of common types of merchant vessel. In many ships, there is some overlap between the various options for carrying goods and the vessels cannot be assigned as strictly to one category or another as the list might suggest. There have always been many different kinds of vessel, but recent years have seen the introduction of many more. There is an unmistakable trend towards multipurpose ships. This makes it difficult to make general statements about what ships look like and how they are equipped.

Ships virtually always exhibit individual differences. Even sister and standard type vessels are not identical in every respect. In terms of naval architecture, there are no problems finding suitable vessels for cargo transport operations.

Organizationally, however, it is more difficult to find the correct ship. It may be that certain vessels only serve specific ports or that certain cargoes can only be carried in ships of a particular nationality. One major issue is the increasing lack of skilled crews and stevedores in some parts of the world. In relation to container shipping, ro/ro and ferry traffic, packing and securing in and on cargo transport units is a significant problem. Non-seafarers underestimate the hazards of maritime transport and so for the most part pack and secure cargoes inadequately.

The following paragraphs contain some comments on a selection from the huge range of different ships which may be of interest to container importers and exporters. General cargo ships are only included to the extent that they also carry containers in many regions. For the most part, the many different kinds of vessels will be described only briefly.

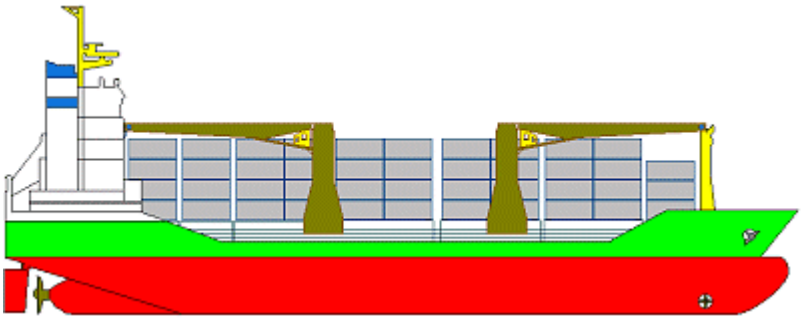
At the beginnings of container traffic, most containers were carried on conventional **general cargo vessels**.

General cargo ship

Such vessels are designed to carry dry cargoes. Each hold comprises one or more relatively low 'tween decks and a lower hold. The ships generally have a relatively large quantity of light cargo handling gear. Virtually every ship is equipped with appropriate loading gear for heavy-lift cargoes in the central hatch area. Lockers are provided for carrying particularly valuable cargoes. Some ships also have relatively small capacity sweet oil tanks.

General cargo ships of this old design are no longer being built, but many are still in use throughout the world. The seakeeping ability of most such vessels at sea, low stowage heights and the like generally mean that carriage is safe and loss-free if individual containers are located in favorable stowage spaces and carefully secured. Further information in this connection is provided in the shipping stresses section.

Modern general cargo ships are built to perform different transport functions; to distinguish them from other multipurpose freighters, they are sometimes known as break-bulk freighters. In addition to the equipment which makes them suitable for carrying break-bulk cargoes, they generally also have facilities to allow them to accommodate containers. Such ships are of open construction, i.e. the hatch area is very large relative to the deck area. This ensures that lifting gear can gain direct access to containers. The same applies to general cargo or access is at least facilitated to such an extent that below deck stowage can (very largely) be avoided. Specific construction features may increase handling efficiency in port and reduce the loss ratio.



Multipurpose container vessel

Semi-container vessels are suitable for carrying both normal general cargo and containers. Hold dimensions, deck loading values, the load-carrying capacity of the loading gear etc. are tailored to the carriage of standard shipping containers. Such vessels have 'tween decks generally with flush-closing mechanical hatch covers.

Semi-container vessel

All-container ships are in principle of open construction as it must be possible to gain direct access to each container with lifting gear such as top spreaders and similar gear. In order to obtain smooth, squared holds, these vessels are often constructed with a double hull. Any holds which are unsuitable for carrying containers are often fitted out as tanks. There are no 'tween decks. All-container ships primarily carry containers and are specially equipped for this purpose.

If the ports of the region of service are equipped with sufficiently powerful lifting gear, container ships are generally operated without loading gear. In other regions of service, container ships too need loading gear in the form of derricks, cranes or gantries.

Particular attention must be paid to the hydrodynamic design of container ships which operate at high cruising speeds. The tall, heavy deck loads cause problems with righting capacity. In order to ensure adequate stability, most all-container ships thus have to carry special solid or liquid ballast and/or be broader amidships. The capsize risk of the vessels can be kept within acceptable limits by high values of the roll moment of inertia. Large ballast capacities and high power pumps are absolutely essential, both for trimming the ships and for offsetting longitudinal bending moments. Shipbuilders can tailor characteristics by selecting appropriate ratios between length, beam, molded depth, draft and other dimensions.

The deadweight and hold capacity of container ships may also be stated in

metric tons and cubic meters. The number of available slots for 20' or 40' containers, however, is more meaningful. TEU means "Twenty foot Equivalent Unit", while FEU means "Forty foot Equivalent Unit". More details are given in the section entitled "Container traffic terminology".

All-container ships are divided into generations depending upon their container capacity. Roughly speaking, the generations can be divided as follows:

1st Generation up to 1,000 TEU

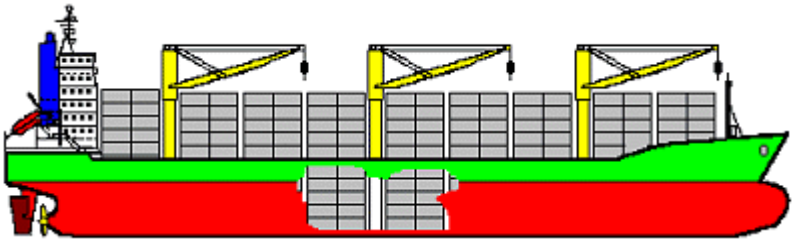
2nd Generation up to 2,000 TEU

3rd Generation up to 3,000 TEU

4th Generation more than 3,000 TEU

5th Generation more than 6,000 TEU

6th Generation more than 8,000 TEU



Second generation container ship

This Figure shows a second generation container ship. This is a Bremer Vulkan standard vessel which was built in various sizes over several generations. (BV 1000, BV 1600, BV 1800, BV 1800 S, BV 1900 and BV 2200, 2200 OH and BV 3800). The variant shown has on-board lifting gear.

Third generation container ship

CTV "Bremen Express" is a third generation vessel and has a container capacity of 2,950 TEU, while CMV "Frankfurt Express", which was built in 1981, has a capacity of more than 3,400 TEU.

Fourth generation container ship

One of the first fourth generation vessels, which have slots for more than 4,000 TEU, was put into service by American President Lines.

Hapag-Lloyd's Hannover Express class container ships, which were put into service in 1992, are similar to the American President Line vessels and were designed as Panamax ships. Technical data:

Class: GL + 100 A 4 E + MC AUT "container ship"		
Length overall	294.00	m
Length between perpendiculars	281.60	m
Molded beam	32.25	m
Depth to main deck	21.40	m
Design draft	12.00	m
Maximum draft	13.52	m
Deadweight, 12.00 m draft	52,600	metric tons
Deadweight, 13.52 m draft	64,500	metric tons

Cruising speed	23	kn
Cruising range	24,000	sm
Fuel consumption at 12 m draft and 23 kn	138	metric tons/day
as above with auxiliary diesel engines	148	metric tons/day
Container capacity on deck	2,125	TEU
Container capacity below deck	2,282	TEU
Total container capacity	4,407	TEU
Reefer connections on deck	348	units
Reefer connections below deck	104	units
Total reefer connections	452	units
Main engine: MAN B&W 9K 90 MC + TCS (Hyundai license)		
Power output at 93 rpm	36,500	kW
Power output at 93 rpm	49,640	HP
Diesel generators, total of 4, of which 2 Daihatsu/Taiyo	2,200	kW
Diesel generators, total of 4, of which 2 Daihatsu/Taiyo	1,650	kW
Emergency diesel generator, one	350	kW
Total diesel generator power output	8,050	kW
Bow thruster, power output	2,500	kW
Bow thruster, thrust	324,000	kN
Heavy oil tank capacity	7,360	m^3
Diesel oil tank capacity	360	m^3

Ballast water tank capacity	16,770	m³
Fresh water tank capacity	280	m³

Approx. 48.25% of the containers can thus be carried on deck and approx. 51.75% below deck. A special design makes it possible to carry up to eleven rows of containers below deck and up to thirteen rows on deck up to heights of ten tiers below deck and five tiers on deck. The forebody has twenty-nine bays available, while the afterbody has six. The versatility of the ships is enhanced by the possibility of lowering "flaps" in the guide system so that containers can be stopped at a certain height. Ordinary general cargo can be stowed in the resultant holds. This option is, however, also available in other ships. Hapag-Lloyd was the first to install the system on the "Humboldt-Express". In order, as required by regulations, to be able to transport hazardous cargo containers of certain classes below deck, five holds are specially fitted out for this purpose. Better segregation also makes it possible to increase the dangerous goods capacity in general relative to other ships.

There is a huge variety of different container ships in operation, as is shown, for example, by the ten new container vessels built in 1998 in Japan for the United Arab Shipping Company (UASC), Kuwait, each with a slot capacity of 3,802 TEU, 2,068 TEU of which, or 54.4% of the containers, can be carried in the hold.

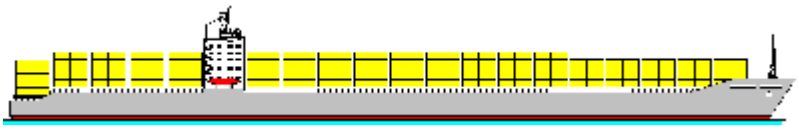
Vessel characteristics:

Length overall	276.5	m
Length between perpendiculars	259.9	m
Beam	32.2	m
Molded depth	21.2	m
Design draft	12.5	m

Propulsion	34,348	kW
Speed	24.1	kn

When loading container vessels, the ship's command must comply with the maximum stacking load of the containers. This is especially important with the latest design of "hatchless" container ships. According to ISO minimum requirements, six fully loaded containers can be stacked one on top of the other. However, many containers are designed for a stack height of nine or more full containers.

In 1998, the first container ships with slot capacities of more than 6,000 TEU came into service. Examples are the "Karen Maersk", "Regina Maersk" and the Maersk shipping company's "Sovereign Maersk", which has a stated capacity of 6,600 TEU. With a length of 347 m, a beam of 42.8 m and a design draft of 14.50 m, it may be assumed that this vessel actually has a slot capacity of the order of 8,000 TEU.



Silhouette of a 5th generation container ship

Aftermost container bay on the "Regina Maersk "

In the silhouette, the containers in the aftermost bay are stacked "only" five high, while in the photograph of the Regina Maersk it can be seen that they have been stacked as high as six high on deck. The M˝ller group shipping company currently known as Maersk-SeaLand is the world's largest container ship operator.

November 2001 saw the launch of what is, to date, Hapag-Lloyd's largest container ship, the "Hamburg-Express". With a length of 320 meters and a beam of 42.8 meters, seventeen containers can be stowed side by side across a single bay. Molded depth is 24.5 meters, which means that containers can be stacked nine high in the hold. When fully laden, the ship has a draft of 14.5 m.

The freighter can carry 7,500 standard containers (TEU) or 100,000 metric tons, a distinct increase over earlier vessels. Propulsion is provided by a 68,640 kilowatt marine diesel engine, corresponding to approx. 93,000 horsepower, which is capable of propelling these giant container vessels at a cruising speed in excess of 25 knots. Three further vessels in this series are to be delivered by spring 2003.

2002 itself saw the launch of what are to date the world's largest container ships of approx. 8,000 TEU.

Container ships of the future with lengths of approx. 400 m and a capacity of

approx. 12,000-14,000 TEU are no longer purely in the realms of fantasy. Future generations of container ships with capacities of more than 15,000 TEU and lengths exceeding 400 m are already on the drawing board. These colossi will probably have beams of 64 m, and will require drafts of approx. 18 - 21 m. Such vessels would not at present be able to call at any European ports.

It remains to be seen whether such vessels can be operated economically. It is indisputable that transport costs per container or "slot costs" will drop in line with "economies of scale". A fundamental requirement for still larger ships is regular and continual growth in cargo volumes to be carried on the relevant routes. Such growth is also anticipated in coming years. However, it should not be forgotten that operating risks increase hand in hand with vessel size. Such still larger ships will have longer container handling times. In order to cut operating costs, the still larger vessels will have to lengthen their sailing intervals, i.e. they will call into fewer ports than the smaller vessels. As a result, more containers will have to be transported in precarriage and onward carriage operations to and from the ports which they do serve. Many other factors will also have to be taken into account, but these are outside the scope of this Container Handbook.

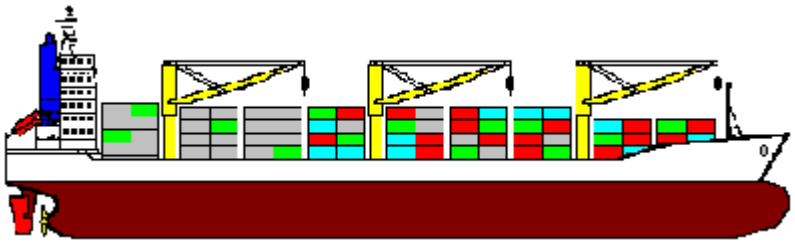
Delivery of super post Panamax gantries to the Stromkaje at Bremerhaven.

The North Sea Terminal Bremerhaven (NTB), for example, has already adjusted to the dimensions of future vessels. These "super post Panamax" container gantry cranes were installed as long ago as 2000 and are capable of handling vessels with up to twenty-two containers stowed side by side. With raised crane

jibs, the gantries are more than 110 meters high and weigh approx. 1,600 metric tons.

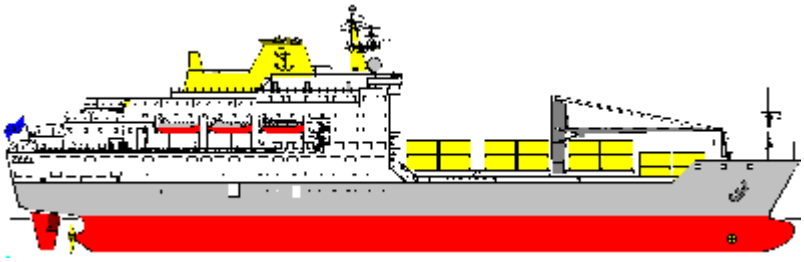
Hatchless container ship with rain roofs

Hatchless container ships first appeared around the beginning of the 1990s. They were intended to make cargo handling more economic. In 1993 and 1994, Howaldstwerke-Deutsche Werft AG (HDW) delivered four hatchless container ships to the Swiss shipping company Norasia Line. These vessels were equipped with an innovative cargo protection system. These 2,780 TEU vessels are a further development of the "ship of the future". Except for holds 1 and 2, which are equipped with pontoon hatch covers to allow the carriage of hazardous materials, these vessels have no hatch covers. Since, on their usual route between Europe and Far East, these vessels are exposed to heavy tropical rain, the shipping company decided to equip holds 3 to 7 with twelve rain protection roofs of lightweight steel construction. Each rain roof rests on the transverse coaming of the container cell guides and is secured by rapid fastenings. The coamings extend in each case up to the highest container which, in some holds, amounts to twelve tiers. Before and after cargo handling, the roofs have to be removed and replaced by on-shore lifting gear. Moreover, the roofs constitute part of the aerodynamic hull shape. Windtunnel testing revealed that the shape of the forecastle deck in conjunction with the rain roofs and the deckhouse will save fuel. The rain roofs protect not only the stowed containers, but the ship as well, as large quantities of rain water in the holds cause stability problems. Other owners of "open top" container ships use high power bilge pumps to combat this problem.



Reefer container vessel

Reefer container vessel: Reefer container vessel: almost all container ships have separate connections for refrigerated containers. If these connections are present in relatively large numbers and in a certain ratio to the total TEU capacity, this is reflected in the ship's designation.



Container passenger vessel

Container passenger vessels are a relatively recent phenomenon. In certain countries such as China, Indonesia, Russia and others, they are becoming increasingly important in coastal or island traffic.

Feeder ship off the Stromkaje at Bremerhaven

Feeder ships: These ships carry containers between major container terminals and other ports which are not served by the major shipping lines. Most Indian ports, for example, are served by feeder ships from Colombo, while the ports of western Denmark are served from Bremerhaven. The term "feeder ship" provides no indication as to the size of the vessels, nor as to whether they are equipped with on-board lifting gear. Most feeder ships, however, are relatively small or medium-sized vessels.

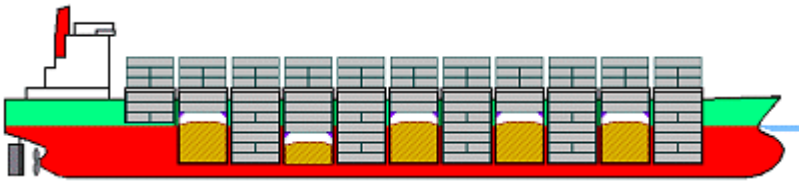
The vessels used in feeder service to and from container ports are often customized, as least when put in service. For example, a ship built in 1998 for Caribbean container trade has the following data:

Length	90.95	m
Beam	15.40	m
Molded depth	7.35	m
Draft	5.65	m
Deadweight	4,150	tdw
Container capacity	312	TEU
Engine power	3,520	kW
Speed	15	kn
Loading gear: on-board cranes	2	units

Ore Bulk Container carrier: The multipurpose "OBC" freight carriers developed in the former GDR are highly versatile. The abbreviation stands for Ore, Bulk and Container. Double hull construction means that all the internal surfaces of the hold are smooth. Since these vessels are fitted with high capacity on-board electrohydraulic cranes with a long reach, even poorly equipped ports can be served. In one specific

class of vessel, alternate holds (I, III and V) are suitably reinforced for carrying ore. Due to their high strength and large hatches without tween decks, these vessels are well suited to carrying rolling mill products and long goods.

A half-height, double-walled longitudinal girder fitted below deck acts as a grain bulkhead. With the exception of hazardous materials and cement, all possible kinds of bulk cargoes may thus be carried. 576 TEU can be stowed in the holds and on deck. There are also thirty-six reefer connections available.



Open bulk container carrier

Open bulk container carriers also have several unusual features which make such vessels highly versatile, even suiting them for container traffic. These bulk carriers are designed like pure container ships, i.e. a very large proportion of the deck area can be opened and the hatch lengths are arranged in a 40 foot grid. Structures delimiting the hold, such as double bottoms, transverse bulkheads and wing bulkheads are designed to withstand the pressure applied by bulk cargoes. Smooth walls and floors are required to allow straightforward loading and unloading with grabs and wheel loaders, which is why the container foundations are recessed in the double bottom and the ISO holes are covered with plastic or steel lids.

In the vessel shown, containers can be stowed up to seven high in the holds. The stacks are secured at the bottom by twist locks in the tank deck. Container guides providing lateral restraint are folded out from the bulkheads. In each hold, three blocks are formed using single and double stacking cones, with container guides providing guidance and restraint in two planes, so making it possible to withstand the forces arising when the vessel rolls. Such stacking aids are generally provided between the 3rd and 4th and between the 5th and 6th tiers of containers and are sized

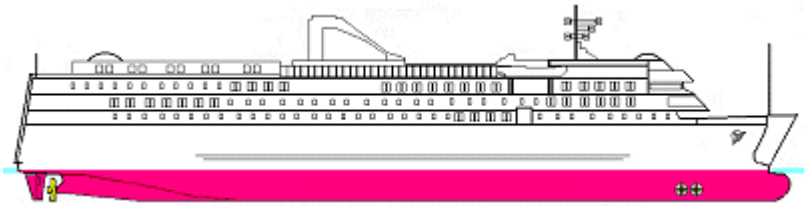
in line with the maximum admissible container corner loading of 600 kN. A combination of general cargo and/or bulk cargo plus containers may also be stowed in the holds. This is achieved by folding "container brackets" out from the bulkheads onto which a maximum of four tiers of containers, each applying a load of 300 kN, may be loaded over the bulk cargo or general cargo.

As has already been mentioned, ro/ro stands for **roll-on/roll-off**, i.e. it is a description of how the cargo is handled. The type of cargo being carried is not automatically known as it may comprise any kind of rolling cargo or cargo which has been made rollable. In many cases ro/ro ships also carry other cargoes without this being clear from the vessel's designation.

There is, however, one feature common to all ro/ro ships - they can be loaded via bow, stern or side ports. If the ships have several decks, access is provided by elevators or ramps.

Ferries are equipped to carry both passengers and rolling cargo, which may comprise automobiles, trucks, chassis, trailers or railroad vehicles. In many cases, cargo is carried on "cassettes" which are packed and unpacked in port and transferred on and off the vessel with special tractors. Containers are only loaded or unloaded indirectly using roll trailers or the like. Stern, bow and/or side ports ensure rapid cargo handling. In many types of vessel, a one-way system is used, ensuring "first in first out" traffic flow.

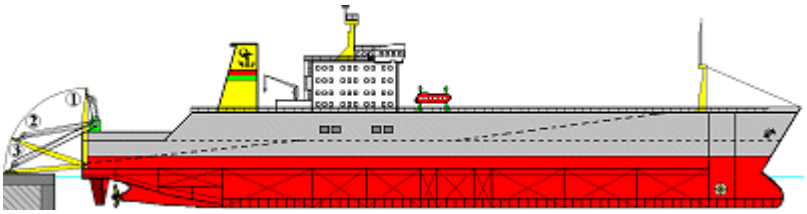
In ferry transport, a distinction is drawn between accompanied vehicles, where the driver drives on board, travels with the vehicle and drives off again, and unaccompanied vehicles. Only auxiliary loading gear is usually present.



Ferry with bow and stern doors

Many passenger/railroad ferries and ferries capable of carrying both railroad vehicles and trailers, chassis or other road vehicles are in service in short-sea ro/ro traffic in the North Sea, Baltic and also Mediterranean.

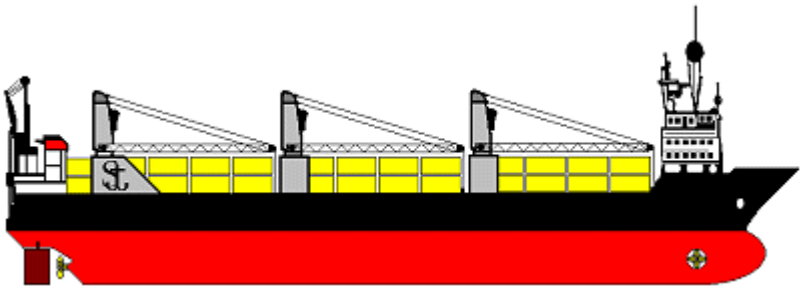
These vessels have bow thrusters to ensure rapid berthing and casting off. Maneuvering is often facilitated by pitch propellers or a multiscrew design of the vessel. Ferries are often symmetrical in structure and may be operated and accessed from either end. Special cargo securing systems are provided, but are often used only in poor weather. Most cargo damage and sinkings are caused by inadequate stowage and securing on the vehicles, as has been shown by many incidents of loss and accidents in recent years.



Container-ro/ro ship

Container-ro/ro ships (conro) carry both containers and rolling cargo. Ro/ro cargoes are mainly loaded below deck, while containers are primarily stowed on deck. In some vessels, e.g. ACL or Polish Ocean Line, special container shafts are provided in the forward third of the ship to accommodate containers below deck. In regions of service with high cargo volumes, container handling is carried out by on-shore gantry cranes. The ships rarely have their own loading gear. The "Finnsailor" is one such ship which carries rolling or rollable cargo below deck and containers, plant, general cargo etc. on deck. However, these facts were not taken into account by the shipyard when determining the ship's designation.

Ro/ro-lo/lo carriers are ships which are capable of loading and stowing cargoes both via ramps using roll-on/roll-off methods and with on-board lifting gear using the lift-on/lift-off method. Such vessels accordingly also have upper deck hatches and, in some cases, holds divided by transverse bulkheads.



Ro/ro-lo/lo Carrier

Ro/ro-lo/lo-container ship

This double hull ship is an example of a **ro/ro-lo/lo-container vessel**. It has a ro/ro component in the form of a stern door. On the port side it has an internal vehicle ramp to provide access to the two 'tween decks. The fitted on-board cranes allow containers to be handled in ports without on-shore lifting gear.

Barge carriers are specialized container transport vessels. Barge carriers are very largely capable of operating independently of ports, they depend on relatively calm areas of water or "floating areas" for transferring the barges. This fact explains the great strategic significance of the system because barges can be set down and picked up at virtually any coast. Barge transport operations are only worthwhile between

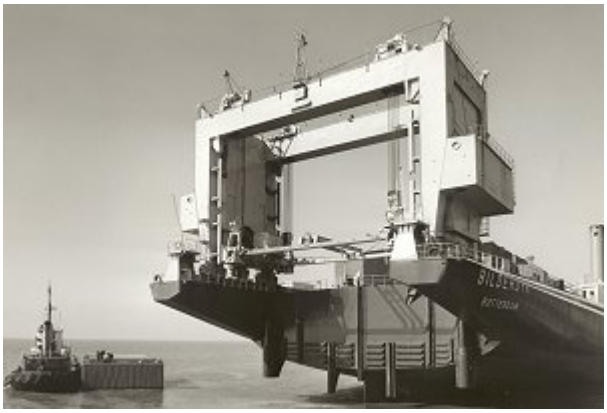
economic areas which have virtually identical volumes of goods passing in each direction, and in particular where inland waterways lead inland so that good use can be made of the advantages of the floating containers. The high cost of building the ships and the capital expenditure for three sets of barges mean that such systems are not economically viable everywhere. There are various different systems:

LASH carrier

LASH stands for **L**ighters **A**board **SH**ip. In the LASH system, barges are carried athwartships in holds and on deck. The barges are picked up and set down at the stern by the LASH's on-board gantry crane using spreaders. Distinguishing external features of these carriers are the far forward location of the superstructures or deck houses, the location of the exhaust stacks to the aft and sides, the stern outriggers and the large gantry crane with a lifting capacity of more than 500 metric tons. This type of vessel hit the headlines some years ago with the sinking of the "München". Twenty-six vessels of this class are still in operation worldwide. Deadweight is approx. 43,000 metric tons, i.e. approx. 73 - 83 barges can be carried in addition to equipment, bunker fuel and stores.

Embarking LASH barges in the floating area

The dimensions of the barges are 18.50 m x 9.50 m x 3.90 m. Fully laden, the draft is 2.61 m. With a tare weight of approx. 140 metric tons, the deadweight of the barges is 376 metric tons. The difference in draft between bow and stern or "trim" must not exceed one foot as the barges otherwise can no longer be lifted by the spreader.



Stern embarkation of LASH barges by gantry crane

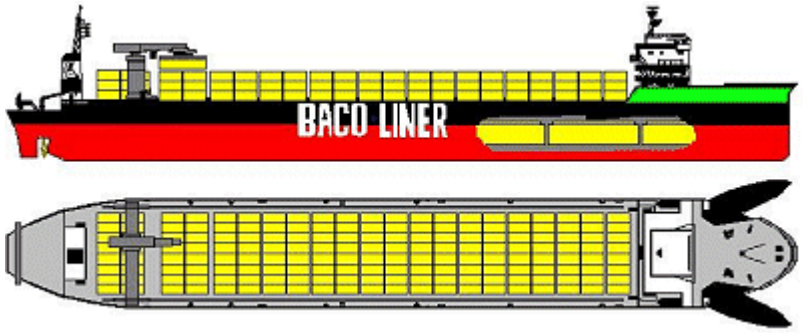
Special framework platforms have been developed so that not all goods need to be carried in the barges with their high tare weight. Floored platforms of this kind are available for general cargo, automobiles etc., while there are also floorless versions for containers. For cargo handling purposes, these platforms are set down on "feeder" barges which are towed to and from the ship. The framework platforms are also handled by the gantry crane.

SEABEE carrier in a floating area

SEABEE carriers are capable of embarking barges at the stern using winch-driven lift platforms with a load-carrying capacity of more than 2,000 metric tons. Barges are loaded, usually in pairs, by being floated into the dock-like afterbody of the ship over the lowered lifting platforms, then lifted up to deck height, from where they are rolled into the ship on very flat rail-mounted trolleys. This type of transfer is thus known as "lift and roll". The Lykes Line's SEABEE ships can stow thirty-eight barges on three decks. Special fittings allow the upper deck to be loaded with containers instead of barges. SEABEE ships are able to carry containers and other cargoes on deck, but these ships do not have on-board lifting gear for such cargoes.

Floating a barge over the lowered winch platform

SEABEE barges measure 29.72 m x 10.67 m x 5.18 m. With a tare weight of 171.5 metric tons, the unladen draft is 0.62 m. With a full payload of 844 metric tons, the maximum draft is 3.22 m. There may be slight differences depending upon the particular type and lighter. The barges can accommodate six FEU or twelve TEU. Sixteen FEU can be located on the barge's hatch covers.



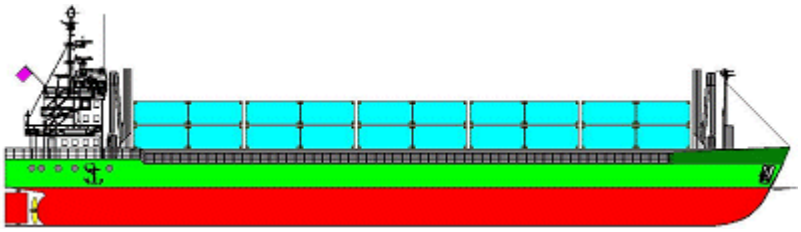
Side view and plan view of a BACO liner

BACO liners (barge/container liners) operate in accordance with the dock principle. In this German-developed system, the barges are floated through bow doors into the carrier, which has been lowered by taking on ballast. Once the bow doors have been closed, the water is pumped out of the dock and the barges are secured with special fittings. The special BACO barges measure 24 m x 9.50 m and, at a deadweight of 800 metric tons, have a draft of 4.10 m. However, the particular dimensions of the carrier ships are such that other types of barge and even inland waterway vessels and lighters can also be carried. Several tiers of containers can be carried on deck and be loaded and unloaded with on-board lifting gear.

CONDOCK is derived from container and dock ship. A large hold can be loaded with rolling cargo via a stern ramp as well as from above using the lo/lo method. These vessels have their own, very high capacity lifting gear for carrying heavy-lift cargoes. Containers can be carried in three tiers on deck. By flooding their ballast tanks, they can be lowered in the water like floating docks, and can take on floating cargoes. The dimensions of those vessels which are in service are such that LASH, BACO and sometimes even SEABEE barges can be accommodated. This class of

vessel is still more versatile. Its gantry cranes are capable of handling individual items of cargo of up to 1,000 metric tons by the lo/lo method. Using the ro/ro method, heavy items of up to 2,000 metric tons can be loaded into the hold via a 20 m x 10 m ramp, while heavy and bulky items can be rolled on deck via two stern outriggers and self-propelled bogies. Floating cargo can be stowed either in the hold using the flo/flo method or on deck using the piggyback system.

The following examples are intended to illustrate how good design can enormously increase the versatility of modern ships.



Coastal motor vessel capable of navigating the Rhine and canals

Coastal motor vessels capable of navigating the Rhine and canals have a continuous box shaped cargo hold and a deadweight of 1,550 metric tons. The essential difference between other classes of sea/river-going vessels resides in this vessel's crane, which is of collapsible construction and so does not exceed the maximum height for navigating the Rhine and canals. The vessel's hatch covers can accommodate 20' or 40' containers in several bays. The wheel house can be lowered and raised hydraulically, while the masts can be folded down.

The majority of the **inland waterway motor vessels** in service in Germany are used to carry dry cargoes. Lengths vary between 38.50 m and 110 m, beams between 5 m and 11 m and drafts between 2 m and 3.50 laden. The deadweight of such vessels is between 220 metric tons and 3,000 metric tons. Many of these vessels are equipped to carry containers. Some **single hold motor freighters** have been specially tailored to the conditions prevailing on the Rhine on the way to Basel. They have the largest possible hold volume for light bulk cargoes, but can also carry heavy-lifts and bulky

cargoes. Heavy goods can be rolled from land via an external ramp onto the forebody, from where they can be rolled into the hold via an internal ramp with a gradient of 5°. Low loaders, trailers or other special purpose trucks and crawlers can be used for this purpose. Loading and unloading operations can be assisted by hydraulic equipment, trim tanks and a pump system.

Resource: containerhandbuch.de