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ΠΤΥΧΙΑΚΗ ΕΡΓΑΣΙΑ

ΕΠΙΒΛΕΠΩΝ ΚΑΘΗΓΗΤΗΣ: ΠΑΝΑΓΟΠΟΥΛΟΥ ΜΑΡΙΑ

ΘΕΜΑ: COMPARING THE VARIOUS TYPES OF BERTHS

ΤΩΝ ΣΠΟΥΔΑΣΤΩΝ: ΒΙΟΛΕΝΤΗ ΔΑΝΙΗΛ- ΓΕΩΡΓΙΟΥ,
ΚΑΛΥΒΙΑΝΑΚΗ ΜΙΧΑΗΛ
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Ημερομηνία ανάληψης της εργασίας:
Ημερομηνία παράδοσης της εργασίας:

Α/Α	*Ονοματεπώνυμο*	*Ειδικότητα*	*Αξιολόγηση*	*Υπογραφή*
1				
2				
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ΤΕΛΙΚΗ ΑΞΙΟΛΟΓΗΣΗ				

Ο ΔΙΕΥΘΥΝΤΗΣ ΣΧΟΛΗΣ : ΤΣΟΥΛΗΣ ΝΙΚΟΛΑΟΣ

Abstract

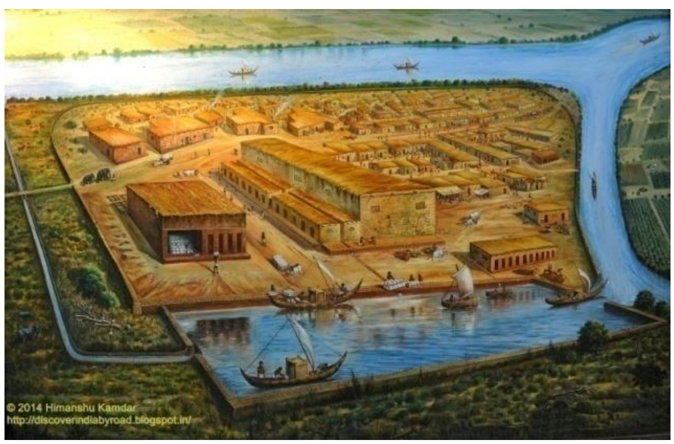
The purpose of this research is to emphasize a series of factors which determine a berth's type including essential definitions, main port facilities, information related to berth type by geometry, construction and cargo. Further development will be given in topics related to safety, security, guidance procedures and inspections conducted by responsible personnel integrated in port authorities. In addition, an extensive reference to the port's equipment will be given including vessel's loading and discharging systems, based on large suppliers' equipment in marine and offshore industries, occupational hazards involved in every port, safety measures and procedures regarding port facilities as per ILO Code, HSE and guidelines for port and harbour Risk Assessment.

CONTENTS

History

ANCIENT PORTS

The first known dock was discovered in Wadi al-Jarf, an ancient Egyptian harbor dating from 2500 BCE located on the Red Sea coast, where archeologist found items such as anchors and storage jars near the area. While in Lothal city of India the second oldest dock discovered, that dates a hundred years later (2400 BCE). It's location was away from the main current to avoid deposition of silt(soil of a size between sand and clay). Modern oceanographers have observed that the ancient civilization of Harappans (3300 BCE-1300 BCE) must have possessed great knowledge concerning tides, hydrography and maritime engineering to construct such a dock on the ever-shifting course of the Sabarmati rivers. The extraordinary about the certain dock is that it is the earliest known dock found in the world equipped to berth and service ships. It is believed that Lothal engineers had knowledge of tidal movements and their effects on brick-built structures, since the walls are made of kiln-burnt bricks. Also, their knowledge concerning tides, hydrography and maritime engineering is obvious due to the selected location of building the dock as the gulf of Khambhat has the highest tidal amplitude and ships can be sluiced through flow tides in the river estuary.



Wadi Al Jarf port, Egypt

Lothal port, India

<u>Etymology</u>

A variety of terms using nowadays in maritime idioms have prevailed from ancient times. Such idioms are port, starboard and monkey island. The term starboard side (right when facing the bow of a vessel) came up in ancient times, before the use of rudders on the centerlines of ships, they were steered with a steering oar (a board to control the direction of the watercraft). The man who was holding the steering oar was usually right handed and he was placed at the stern of the ship, so the steering side was the starboard side, in old English sterbord (by words styrl=rudder and bord=side of the ship). Due to the right handed man who was handling the steering oar from starboard side, the vessel used to approach the port from its left side to load or unload cargo/goods etc. So, the left side of the ship (when facing the bow of the vessel) named “port side”. Another term used for the left side of the vessel before 1844 was larboard or ladebord (lade = load). In 1844 the Royal Navy ordered to use only the term port because larboard sounds similar to starboard.

To continue with, the term “Monkey Island” is the highest accessible place of the ship. According to the theory, in ancient times monkey island was located the top of the main mast of sailing ships and sailors had to climb all the way up to free or to repair the sails and rigging or to keep a lookout for icebergs, reefs, or land. Because the sailors who usually climb up to this place should be agile as a monkey this place named “Monkey Island”.

Introduction- Definition of various Terms

“A **berth** is a designated location in a port or harbor used for mooring vessels when they are not at sea. Berths provide a vertical front which allows safe and secure mooring that can then facilitate the unloading or loading of cargo or people from vessels.”

“A **port** is a maritime commercial facility which may comprise one or more wharves where ships may dock to load and discharge passengers and cargo. Although usually situated on a sea coast or estuary, some ports, such as Hamburg, Manchester and Duluth, are many miles inland, with access from the sea via river or canal.”

West African port of Cotonou

“A **mooring** refers to any permanent structure to which a vessel may be secured. Examples include quays, wharfs, jetties, piers, anchor buoys, and mooring buoys. A ship is secured to a mooring to forestall free movement of the ship on the water. An anchor mooring fixes a vessel's position relative to a point on the bottom of a waterway without connecting the vessel to shore. As a verb, mooring refers to the act of attaching a vessel to a mooring.”

“A **dock** is the area of water between or next to one or a group of human-made structures that are involved in the handling of boats or ships (usually on or near a shore) or such structures themselves. The exact meaning varies among different variants of the English language. "Dock" may also refer to a dockyard (also known as a shipyard) where the loading, unloading, building, or repairing of ships occurs.”

Port Evolution and Development

"Old ports progression throughout the years: Conventionally, port terminals where located close to city cores as many where the initial rationale for the existence of the city. The proximity to downtown areas also insured the availability of large pools of workers to perform the labor-intensive transshipment activities that used to characterize port operations. But these activities tended to have low productivity levels as a stevedoring team could handle 10 to 15 tons per day and a berth could handle 150,000 tons per year. At their peak in the early 1950s ports such as London and New York each employed more than 50,000 longshoremen. Containerization had the dramatic impact of lowering the need for labor for port operations. For instance, the number of longshoremen jobs in the Port of New York and New Jersey declined from 35,000 in the 1960s to about 3,500 in the 1990s. Over time, changes in ships and handling equipment gave rise to new site requirements. By the post-World War II period a growing specialization of vessels emerged, especially the development of bulk carriers. These ships were the first to achieve significant economies of scale, and their size grew very quickly. For example, the world's largest oil tanker in 1947 was only 27,000 dwt, by the mid 1970's it was in excess of 500,000 dwt. There was thus a growing vessel specialization using semi-automated transshipment equipment and increase in size which resulted in new site requirements, especially the need for dock space and greater water depths."

Evolution of major ports

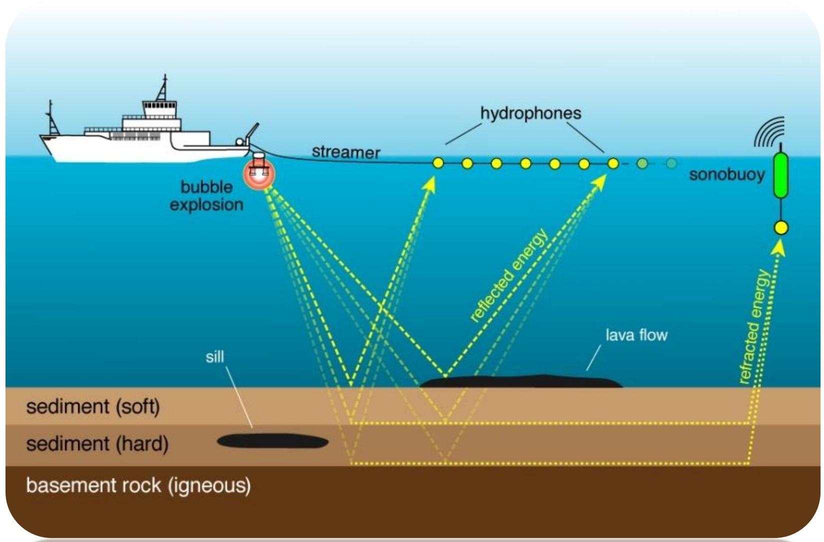
"The mechanization of cargo handling and the storage requirements because of greater vessel capacities have greatly extended the space demands for port activities. Many ports, such as Rotterdam and Antwerp are larger in area than the cities they serve. The expansion of Chinese ports, such as Shanghai, has required altogether the use of entirely new sites outside central areas. Further, growing ship sizes have implied several new constraints for port sites such as deeper waterways, larger terminal space, both for ship handling and warehousing, and more efficient inland road and rail access. Modern port infrastructures are often intensive in capital and several port authorities are struggling to keep up with large infrastructure investment requirements. However, the presence of infrastructures does not necessarily guarantee traffic as maritime companies can select the ports they service as business opportunities changes."

Types of Sounding

By reading all the above about major port facilities the question that comes in mind is the following: “How does the port owners ensure that the location chosen to build their facilities is stable enough in order to invest such great amounts of money?”

Prior building a port or a dock, not only the seabed should be checked. The layers underneath should be also checked with care. There are different ways to check the layers mentioned above, such as:

1) Seismic Reflection (Acoustic Profiling)



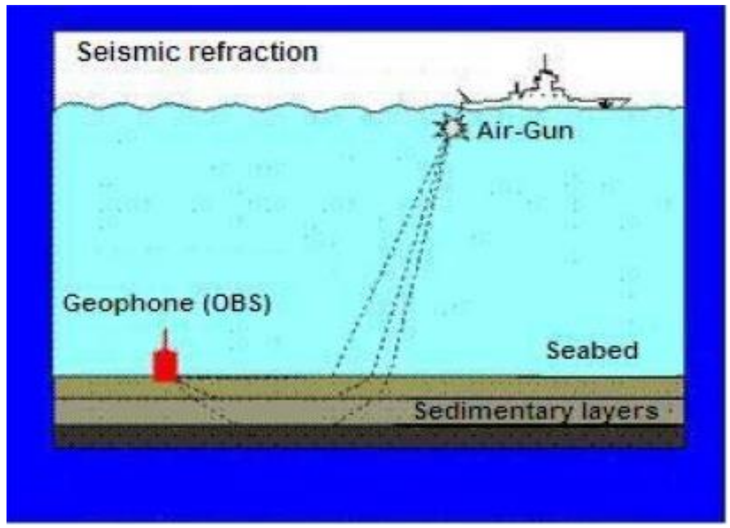
This method is performed by equipment towed by a vessel at a low speed (2-5 knots). It’s working principle is same as echo sounder that is used to depth recording, but operating in a different frequency which allows penetration into the seabed. A high-energy acoustic pulse passes through the water into the soil. It is reflected back by the seabed and by subsoil interfaces corresponding to changes in density and sonic velocity. A profile of the return times from the various reflecting horizons is continuously recorded and transformed to electric signals that are visualized by printing in a two-dimensional diagram (echogram), which has to be interpreted by a specialist.

Different types of equipment are available, each of which has different characteristics and capabilities. The main difference is the frequency, which determines the maximum penetration depth and the resolution accuracy. Low-frequency pulses achieve deep penetration but have a low resolution. The main types are:

a) Penetrating echo sounder (pinger): Frequency 3-10 kHz depth up to 25m and resolution about 0.5m.
b) Boomer: Frequency 0.5-2.5 kHz, penetration depth 100m, resolution of 1m. Boomer is consisting of a metal plate placed in a small catamaran.
c) Sparker: Frequency of 0.05—1.0 kHz, penetration depth 500m, resolution of 5m. Sparker is consisting of a metal frame with electrodes which is towed slightly below the water level.

The indicated penetration depths are valid for sediments of clay, slit and sand. The results achieved from such a survey are the thickness of soil above bedrock and borders between different soil types. Determination of soil layering is uncertain unless there are large and distinct changes in seismic velocities. In this particular method, the advantage is that a rough picture of the subsoil conditions in large areas can be obtained fast and at a modest cost. For example, with measured profiles at a distance of 10m, an area of around 20km² may be covered in a single day. The disadvantage is that the results are not accurate and need to be checked and calibrated by boring and or sampling.

2) Seismic refraction



This method can be used on land and in the sea. A system of seismometers (geophones) are placed along a profile and connected by cables to a recorder. A shock wave is initiated by explosives or by a hammer blow. The wave travels faster in more consolidated soil than in soft soil, and is fastest in compact bedrock. By recording the travel time of the direct and reflected waves to the geophones, a profile of soil boundaries and depth to bedrock can be obtained. Seismic refraction is more accurate than reflection survey but the capacity is less and it is therefore more costly. It is used for preliminary investigation in more limited areas and to supplement acoustic surveys. Also, the refraction results need to be checked and calibrated by borings and/or sampling.

Berth Types

By Construction

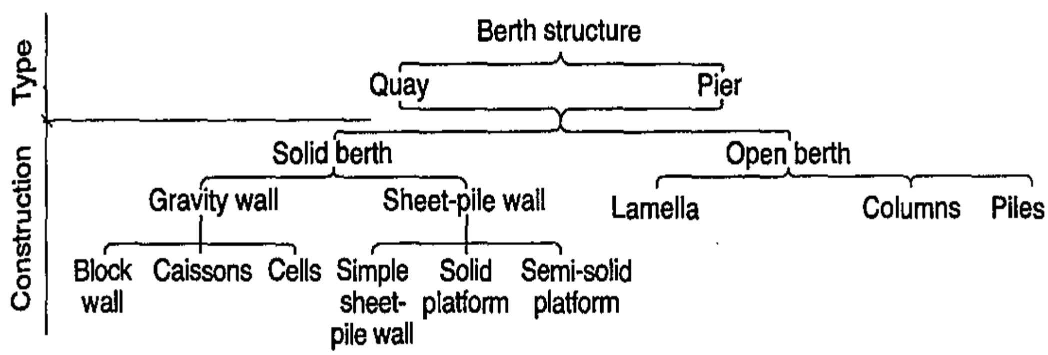
"Solid Structure Berth"

"In these berths, a solid vertical structure is created to contain fill material which is brought all the way to the structure. They can be constructed using either a gravity wall structure where the front wall of the structure uses its own weight and friction to contain the fill or with a sheet pile structure where an anchoring plate is used to contain the weight of the fill dirt."

"Open Structure Berth"

"Open berths feature structures supported by piles set slightly off shore from the natural extent of the land or the farthest extent of fill dirt. This style of berth can offer more flexibility in the specificity of construction but also presents more complicated dredging projects afterwards and also limits the amount of weight the berth is able to support and resist."

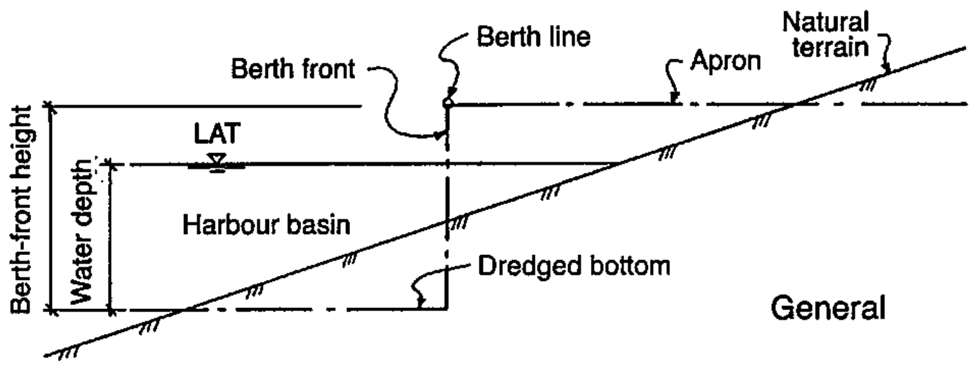
Types of berth structures



Types of berth structures

General

The purpose of a berth structure is mainly to provide a vertical front where ships can berth safely. The berth fronts are constructed according to one of the following two main principles, as illustrated:

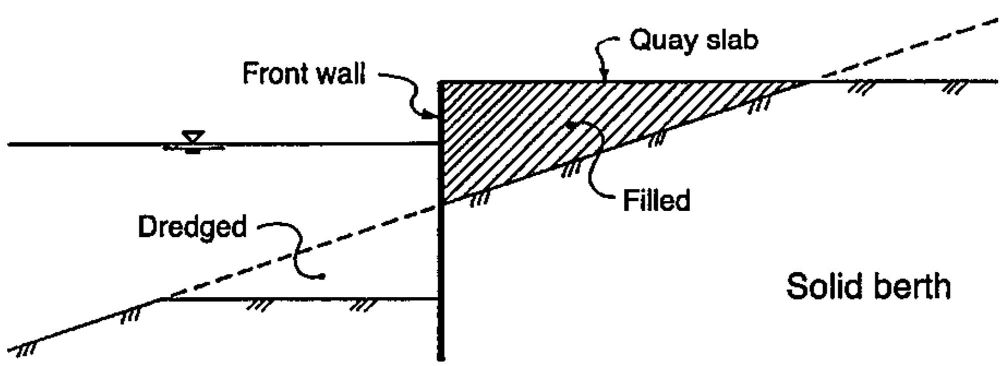


"Solid berth structure:"

"The fill is extended right out to the berth front where a vertical front wall is constructed to resist the horizontal load from the fill and a possible live load on the apron. The solid berth structures can be divided into two main groups, depending on the principle on which the front wall of the structure is constructed in order to obtain sufficient stability:

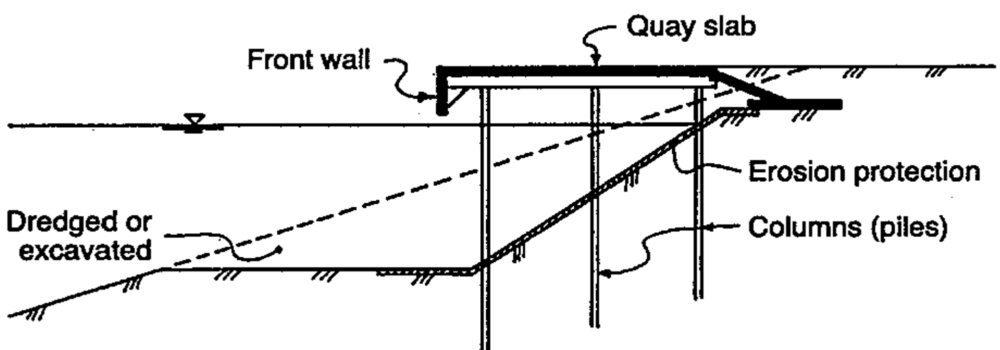
(a) Gravity wall structure: the front wall of the structure with its own deadweight and bottom friction will be able or self-sufficient to resist the loadings from backfill, useful load and other horizontal and vertical loads acting on the berth wall structure itself.

(b) Sheet pile wall structure: the front wall is not adequate to resist any horizontal loads acting on the structure and must, therefore, be anchored to an anchoring plate, wall or rock behind the berth."



“Open berth structure:

From the top of a dredged or filled slope and out to the berth front a load-bearing slab is constructed on columns or lamella walls. It is difficult, however, to formulate precise guidelines for the choice of berth type in each individual case. With a view to choosing the technically and economically most favorable type, the factors mentioned in the following paragraphs should be considered. Berth structures should be designed and constructed to safely resist the vertical loads caused by live loads, trucks, cranes, etc., as well as the horizontal loads from ships' impacts, wind, fill behind the structure, etc. In general, the solid berth structures are considered more resistant to loadings than the open berth structures, both vertically and horizontally. Since the deadweight of the solid berth structure constitutes a greater part of the total structure weight than the deadweight of open berth structures, the former is less sensitive to overloading. On the other hand, the safety factor applied for solid structures is normally lower than for open structures. For instance, in an open column berth for ocean-going ships the deadweight of beams and slab is about 15 kN/m2 berth deck area, while the live load is normally 40 kN /m2Such a berth of length 50 mand width 15m weighs only about 1200 t, but will have to resist the impacts from ships of say 30 000 t displacement or more. Solid structures are usually more resistant to impact than open structures, i.e. the resistance to impact from ships decreases within creasing slenderness of the structure. For instance, a block wall wharf is far less vulnerable than a pier built as an open berth on piles. An exception to this rule is the open berth on wooden piles where the whole structure is flexible and yields, when ships come alongside, sufficiently to absorb a substantial part of the impact energy.”



Open berth

By Geometry

"Finger Pier"

"Used to maximize the berthing space per length of waterfront. Two Finger piers are often used for small to medium vessels associated with passenger travel. Finger piers can also be used for dangerous cargoes such as military munitions that cannot be used with offshore berths because of the weight and equipment requirements. In these instances, long finger piers allow for far reach far off shore with access for rail or other cargo moving methods on the pier."

Photo by Punj Lloyd Group

"Offshore Berth"

"Used when cargo handling/storage can be hazardous. Often offshore berths are created for berthing of oil and gas vessels. They contain stand-alone structures called dolphins which have fenders and bollards located to base on the geometry of the vessels which would call the berth."

Aurecon - Hay Point Coal Terminal

The difference between Mooring, Docking and Berthing

Regarding Sailing

The more you sail the better you become at it and this also applies to the knowledge you manage to acquire in the field. Expert sailors have a language of their own and it takes quite a long time to master it. Nonetheless, there are a few basic terms any novice should get acquainted with. Three of them are the object of this post. So, read on and discover the difference between mooring, docking, and berthing.

"Mooring"

Mooring is one of the buzzwords you will have to get used to if you want to become a sailor. The process of mooring a vessel implies securing it to a fixed-point with the help of ropes or lines. By mooring, you basically make sure your boat is secured on a single point which, in its turn, is attached to the seafloor. This single point is called a marina mooring and it consists of an anchor, a float and a rode. By getting a mooring reservation, your boat will practically be anchored on the water. Also, it's useful to remember that there is a particular type of mooring which is known as the Mediterranean mooring. This implies that the boat is secured to the anchor in a manner that resembles the berthing technique. With this method your boat's stern will be oriented towards a dock. The boat basically moves in reverse until it reaches the dock. Although it resembles a berthing maneuver, the point which keeps the vessel secured is not the dock, but an anchor, therefore, it is a mooring technique. As its name suggests, this technique is popular in Mediterranean marinas, more precisely those located in Europe where, due to lack of space, many boats need to be anchored to the same pier, occupying the space allocated to their width.

"Docking and Berthing"

Docking and mooring are often confused as they coincide up to a certain point. By docking your boat, you practically sail until you reach a fixed structure that allows you to get out on the land. This structure is called a dock and your boat is fastened to it. Berthing means placing your vessel in the fixed location known as a berth. To make it easier to understand, imagine that the berth is basically your boat's parking place. Berthing refers to the whole process of maneuvering your boat until it is secured in the fixed position in its berth. Therefore, we can say that berthing your boat means parking it in a designated area. A mooring reservation is different from a marina reservation as the latter enables you to disembark directly, while the first doesn't grant access to the shore.

"Docking and Mooring Equipment"

Both docking and mooring require typical equipment, let's see what you need for each one of them so that you know what you should bring aboard on every occasion. Marina moorings require you to have the following 3 essential components:

- anchor – it uses its heavy weight to keep the boat in a fixed position on the seafloor
- mooring chain – it connects the anchor to the floating buoy
- mooring buoy – the floating device connected to the anchor used to mark the place where the boat is moored


Docking also makes it necessary to equip your boat with the minimum gear which consists of

- fenders: these devices vary in size depending on each boat which they protect by acting as a buffer between the boat and the dock or other surrounding vessels
- lines: these are the ropes that help you fasten your boat to the shore

Other pieces of equipment such as dock steps, whips, hooks or other accessories are also a good addition aboard, especially if your boat spends a lot of time tied to the shore.



Harbor Facilities and Berth Types

"Basins"

"Many harbors consist of semi-enclosed basins:

Single Entrance basin. The basin's mouth may be aligned with the river embarkment, as in Figure 2.2 or may be protruding breakwaters, protecting the harbor from waves. Examples of the latter are the port of Zeebrugge (Belgium) and the port of Ijmuiden (The Netherlands). Single-entrance basins experience no net flow although they are subject to complicated three-dimensional circulation patterns (i.e. Horizontal/vertical eddies and layered density currents.)"

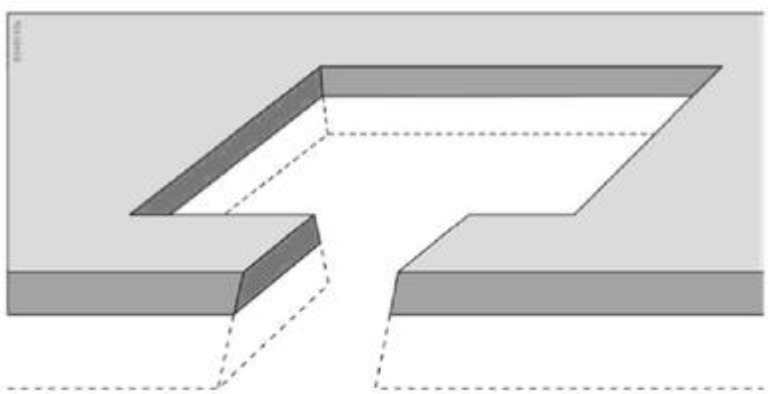


Figure 2.2: Single-entrance semi-enclosed harbour basin

"Harbor basins can also feature 2 or more entrances as shown in Figure 2.3. Such basins, which have developed in secondary river or estuary channels, experience a small, net through-flow. These basins also experience complicated three-dimensional circulation."

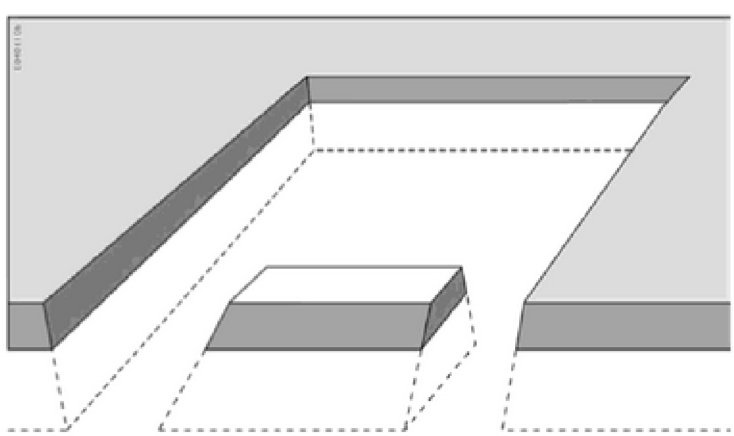


Figure 2.3: Multiple-entrance semi-enclosed harbour basin

Berth Types

Typical berth types include quay walls, jetties and floating pontoons. In areas characterized by a high tidal range ships may be berthed in lock-impounded basins.

“Jetties: These pile-supported structures are found in harbor basins, along river banks and the coast. Depending on geometry, flow through the piles may accelerate/decelerate, generate turbulence, or scour the bed. Dredging is seldom performed under jetties due to inaccessibility. As a result, a sediment mound typically accumulates under a jetty. There are indications that the increased turbulences induced by the jetty piles may, under specific conditions, affect flocculation processes, either increasing or decreasing floc size. The first case would result in a disproportionate increase in siltation rate underneath the structure. A sketch of a jetty facility is given in Figure 2.4.”

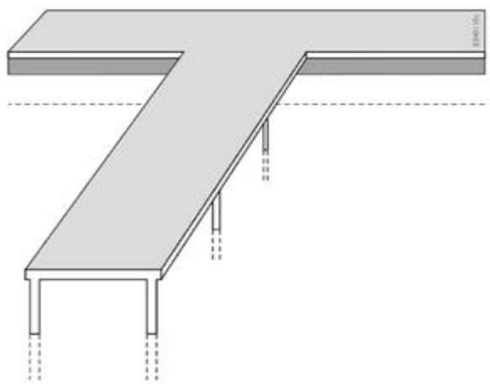


Figure 2.4: Sketch of berthing facility in the form of a jetty

“Quay walls: These structures have been constructed in harbor basins, along river banks, and occasionally at sea shore. A properly designed quay wall aligned to train flow can facilitate MHS. Conversely, some quay wall docking facilities present a problem in that dredgers cannot work too close to the walls, as dredging may undermine the wall foundations.”

“Floating Jetty/Pontoon: As distinct from a jetty, a floating pontoon can be removed to allow for maintenance.”

“Impounded docks: Notionally, a dock closed off from a river, estuary or coast by one or two gates will isolate it from exchanges and inputs of sediment from beyond, but various intrinsic operations provide pathways for incursion by fine sediment. Often the largest is densimetric exchanges associated with vessel movements, but the need for top-up water to replace volume losses during locking operations and any leaks via the lock gates or dock walls also permit sediment incursion. Occasional removal by conventional dredging necessitates multiple passages through the open locks, exacerbating silt input in the shorter time period. Consequently, the need for more sophisticated management has attracted much interest over a prolonged period. Impounded docks operate with access through locks. These locks may also give access to channels in the hinterland. Complicated flow patterns in the entrance to the lock (3D eddies, density currents) may occur, in particular during locking.”

By Cargo Type

“Bulk Berth”

“Used to handle either dry or liquid bulk cargo. Vessels are loaded using either excavators, conveyor belts, and/or pipelines. Storage facilities for the bulk cargo are often alongside the berth – e.g. silos or stockpiles.”

“Container Berth”

“Used to handle standard intermodal containers. Vessels are loaded and unloaded by container cranes, designed specifically for the task. These berths will feature large areas of land for container handling near the berth and will also have significant equipment on dock to facilitate rapid movement of containers on and off the vessels. Alongside the quay there is often a large flat area used to store both the imported and exported containers.”

“General Berth”

“Used to handle smaller shipments of general cargo. Vessels using these would usually have their own lifting gear, but some ports will provide mobile cranes to do this. These are common at smaller ports or ports where special project cargo is common.”

“Lay Berth”

“A berth used for idle (lay-up status) vessels. Three Vessels being put on the hook can use these as intermediate points between operational use and mothballing at an off shore mooring. These berths will feature very little land side access or equipment except what is needed to secure the vessel.”

“Lay-by Berth”

“A general berth for use by vessels for short term waiting until a loading or discharging berth is available. These berths can feature very basic amenities for fuel, provisions, and utilities to sustain a crew and vessel until the destination berth is available.”

“Liquid Berth”

“Used to handle oil and gas related products. Berths are placed offshore to keep safe zone of operation from rest of port operations. Vessels are loaded via loading arms containing the pipe lines. Cargo is the pumped back on shore through pipelines, which are usually submerged. Storage facilities for the products are usually some distance away from the berth and connected by these pipelines.”

“Marina Berth”

“Used to allow the owners of leisure craft on and off their boats. Generally, alongside pontoons and accessed by hinged bridges (in tidal locations) to the shore. Marina berths are often built with modular capabilities to adjust the berth size for various shapes and sizes of recreational craft. Specialized equipment for keeping boats out of the water is also a frequent feature. This allows the vessel to be removed from the negative effects of wave action on the hull and helps prevent organic growth on the hull.”

“X Berth”

“Suitable for nuclear-powered warships, and part of an operational Naval base or a building and refitting yard. All X-berths have as an integral part of their safety arrangements a permanent health physics department, a local emergency monitoring organization and a local safety plan prepared under the auspices of a local liaison committee.”

Port Specifications

To begin with, it’s necessary to dwell on to the general specifications about ports prior analyze about docks. First of all, in order to achieve a realistic port plan, it is of vital importance to record the user’s needs. This needs to be done in close cooperation with the client or port authorities. In order to organize a port these are the different approaches:

1. Resource (tool) port: The port owns the land, infrastructure, and fixed equipment, provides common user berths and rent out equipment and space on a short-term basis to cargo handling companies and commercial operators.
2. Operating (service) port: The port provides berths, infrastructure, and equipment together with services to ships and their cargo.
3. Landlord: For larger ports this is the most common system where the port owns the land and basic infrastructure and allows the private sector to lease out berths and terminal areas.

Another factor that importantly tributes to the port structure and berth facilities is the type of the ship as also as it’s specifications. Due to the increasing demands of the worldwide trade, shipping is spirally expanding. Tankers, container ships and cargo ships have become larger, so they require deeper water and highly mechanized cargo handling equipment and systems. For this reason, the following must be studied closely:

(a) Ship Type (i.e. RO-RO, Container etc.)
(b) Ship Size
(c) Frequency of arrivals and times of a day
(d) Ship’s origins and destinations
(e) Analysis of future conditions

Based on ship parameters, one can analyze the demand for berth facilities and determine the required water depths at the various berth structures. In order to make a port plan the following information should be included:

1. General conditions about navigation in open sea and berth facilities, tugs required, anchorage grounds and waiting grounds
2. Length, width & depth of access channel and basin area and depths alongside.
3. Recording of submarine cables etc.
4. Restrictions in maneuvering conditions due to wind & current and possibly waiting time until weather conditions get better.
5. Need for shelter.
6. Requirements regarding pilot services, beacons, safety zones, tug boat assistance etc.
7. Collision possibilities and other dangers such as height obstructions.
8. Possible restrictions regarding berthing and departure times.

Berth and Land area requirements

Port owners should always have in mind that future requirements may occur. Therefore, one of the most important items of a long-term port plan should be flexibility. A good plan is one which the basic strategy remains intact even when some of the details of the port plan need to be adjusted. In addition, probably the most important function of the port plan is to reserve land for the port to develop and to expand to meet future growth in traffic or changes in technology. Therefore, the following information should be obtained:

1) Location of the port area in relation to:
   a) Regional conditions
   b) Local conditions
   c) Local traffic (Railways, trucks, vehicles etc.)
   d) Car parks (public, private)
2) Location of berths
   a) General requirements
   b) Relationship to port area
   c) Natural conditions
   d) Neighborhood relationship.
3) Size of berth:
   a) Types and numbers of berths (general cargo, L.N.G, container etc.)
   b) Length and surface of each berth, depth alongside
   c) Dolphins
   d) Special mooring facilities
   e) Loads
   f) Utilization of the port facilities
   g) Utilization of berth capacities for separate berths
4) Land area:
   a) Present and future needs for land areas
   b) Indoor and outdoor storage capacity
   c) Access roads
   d) Development of land area (gravel, asphalt etc.)
   e) Area restrictions (building lines, cables etc.)
   f) Facilities for dockers, stevedores, service functions
   g) Local authorities demand and benefits

5) Demand for auxiliary services and installations:
   a) Electricity, water, and telephone connections
   b) Lighting
   c) Mooring facilities, fenders
   d) Life-saving equipment and ladders
   e) Refuse collection and disposal, cleaning of tanks, waste-water tanks, oil protection and firefighting equipment
   f) Water and fuel bunkering
   g) Maintenance facilities
   h) Repair workshop, slip

When evaluating potential sites, it is advisable to divide the port into activity zones. It's also necessary to have in mind that some port zones might need to extent later on. For this reason, it is of vital importance to evaluate some "Growth Factors", such as:

1) Population increase locally & regionally
2) Economic growth
3) Traffic growth and modified transport modes
4) Industrial developments
5) Environmental problems

Up next, we will analyze some of the biggest port facilities …

Major Port Facilities

Seven of the 10 biggest ports in the world by cargo volume are in China. The remaining three are in Singapore, the Netherlands and South Korea. Ship-technology.com profiles the world's ten biggest ports based on 2012 cargo volume.

Port of Shanghai

"The Port of Shanghai is the biggest port in the world based on cargo throughput. The Chinese port handled 744 million tons of cargo in 2012, including 32.5 million twenty-foot equivalent units (TEUs) of containers. The port is located at the mouth of the Yangtze River covering an area of 3,619km². Shanghai International Port Group (SIPG) owns the port facility. Wusongkou, Waigaoqiao and Yangshan are the three main container port areas. The port comprises of 125 berths with a total quay length of about 20km. It serves more than 2,000 container ships on a monthly basis and accounts for a quarter of China's total foreign trade. In 2010, Shanghai port overtook the Port of Singapore to become the world's busiest container port. Shanghai's port handled 29.05 million TEUs, whereas Singapore's was a half million TEU's behind. In 2016, Shanghai port set a historic record by handling over 37 million TEUs."

"Geography: The Port of Shanghai faces the East China Sea to the east, and Hangzhou Bay to the south. It includes the confluences of the Yangtze River, Huangpu River (which enters the Yangtze River), and Qiantang River."

"Administration: The Port of Shanghai is managed by Shanghai International Port which superseded the Shanghai Port Authority in 2003.Shanghai International Port Company Limited is a public listed company, of which the Shanghai Municipal Government owns 44.23 percent of the outstanding shares. The port of Shanghai includes 3 major working zones:"

- Yangshan Deep Water Port
- Huangpu River
- Yangtze River

Image courtesy of Bert Van Dijk

Port of Singapore

"The Port of Singapore, which handled 537.6 million tons of cargo in 2012, is the second biggest port in the world. The port's container throughput crossed the 30 million TEUs mark for the first time in 2012.The port terminals are located at Tanjong Pagar, Keppel, Brani, Pasir Panjang, Sembawang and Jurong. The terminals are managed by PSA Singapore and Jurong Port. The port receives an average of 140,000 vessels on an annual basis and connects to 600 ports globally. It is equipped with 204 quay cranes and a number of gantry cranes. A major terminal expansion project is currently underway at the Port of Singapore, which, when fully commissioned in 2020, will add 15 more berths."

Operations

"The port is the world's busiest port in terms of shipping tonnage handled, with 1.15 billion gross tons (GT) handled in 2005. In terms of cargo tonnage, Singapore is behind Shanghai with 423 million freight tons handled. The port retains its position as the world's busiest hub for transshipment traffic in 2005, and is also the world's biggest bunkering hub, with 25 million tons sold in the same year. Singapore is ranked first globally in 2005 in terms of containerized traffic, with 23.2 million Twenty-foot equivalent units (TEUs) handled. High growth in containerized traffic has seen the port overtaking Hong Kong since the first quarter of 2005, and has led the race ever since, with an estimated 19,335 kTEUs handled in the year up to October, compared to 18,640kTEUs handled in Hong Kong in the same period. A rise in regional traffic consolidating the port's position in Southeast Asia, and increases in transshipment traffic using the strategic East Asia-Europe route via Singapore helped the port to emerge tops at the end of the year, a title it had not held since overtaking Hong Kong once in 1998."

Port	Operator	Type	Berths	Quay length	Quay cranes	Area (Ha)	Capacity (kTEU)
Brani (BT)	PSA[10]	Container	8	2,400	29	84	
Cosco-PSA (CPT)	Cosco/PSA	Container	2	720 m		22.8	>1,000
Jurong	JTC	Multi-Purpose	32	5,600		155	
Keppel (KT)	PSA	Container	14	3,200	36	105	
Pasir Panjang (PPT 1)	PSA	Container	7	2,500	28	88	
Pasir Panjang (PPT 2)	PSA	Container	7	2,300	28	120	
Pasir Panjang (PPT 3)	PSA	Container	9	3,000	34	113	
Pasir Panjang (PPT 5)	PSA	Container	5	1,850	22	111	
Pasir Panjang Wharves	PSA	General					
Sembawang	PSA	General	4	660		28	
Tanjong Pagar (TPT)	PSA	Container	7	2,100	27	85	

Singapore Terminals

Operators

PSA Singapore's container facilities are as follows:

- Container berths: 52
- Quay length: 15,500 m
- Area: 600 hectares
- Max draft: 16 m
- Quay cranes: 190
- Designed capacity: 35,000 kTEU

"PSA Singapore has 13 berths which are part of the Pasir Panjang Container Terminal's Phase Two which are due for completion by 2009. Phase Three and Four will add another 16 berths and are expected to be completed by 2013."

Jurong Port's facilities are as follows:

- Berths: 32
- Berth length: 5.6 km
- Maximum vessel draft: 15.7 m
- Maximum vessel size: 150,000 tons deadweight (DWT)
- Area: 127 Hectares Free Trade Zone, 28 Hectares non-Free Trade Zone
- Warehouse facilities: 178,000 m²

PSA Singapore also has a 40-year contract to operate the tax-free Gwadar Port on the southwestern coast of Pakistan. Gwadar started operation in March 2008, with 3 multi-purpose berths, a 602-meter quay, and 12.5-meter depth. Another 9 berths are under construction, with a 20-meter depth.

Image courtesy of Vinko T.

Port of Tianjin

“The Port of Tianjin, is the largest port in Northern China and the main maritime gateway to Beijing. The name "Tianjin Xingang", which strictly speaking refers only to the main seaport area, is sometimes used to refer to the whole port. The port is on the western shore of the Bohai Bay, centered on the estuary of the Haihe River, 170 km southeast of Beijing and 60 km east of Tianjin city. It is the largest man-made port in mainland China, and one of the largest in the world. It covers 121 square kilometers of land surface, with over 31.9 km of quay shoreline and 151 production berths at the end of 2010.

Tianjin Port handled 500 million tons of cargo and 13 million TEU of containers in 2013, making it the world's fourth largest port by throughput tonnage and the ninth in container throughput. The port trades with more than 600 ports in 180 countries and territories around the world. It is served by over 115 regular container lines. run by 60 liner companies, including all the top 20 liners. Expansion in the last two decades has been enormous, going from 30 million tons of cargo and 490,000 TEU in 1993 to well beyond 400 million tons and 10 million TEU in 2012. Capacity is still increasing at a high rate, with 550–600 Mt of throughput capacity expected by 2015.

The port is part of the Binhai New Area district of Tianjin Municipality, the main special economic zone of northern China, and it lies directly east of the TEDA. The Port of Tianjin is at the core of the ambitious development program of the BNA and, as part of that plan, the port aims to become the primary logistics and shipping hub of North China.”

“Geography: The Port of Tianjin is on the coast of Tianjin Municipality, in the former county of Tanggu, on the coast between the estuaries of the Haihe to the south and the New Yongding River to the north. To the west, the port borders the city of Tanggu (now the Urban Core of the Binhai New Area) and the TEDA. To the east, the port opens up to the Bohai Bay.”

Tianjin Port is divided into nine port areas: the three core ("Tianjin Xingang") areas of Beijiang, Nanjiang, and Dongjiang around the Xingang fairway; the Haihe area along the river; the Beitang port area around the Beitangkou estuary; the Dagukou port area in the estuary of the Haihe River; and three areas under construction (Hanggu, Gaoshaling, Nangang).

The coastal area of Tianjin municipality before development was dominated by mudflats, salt marshes (and salterns), and coastal shallows. This littoral zone is wide and slopes gently: The 0 m isobath (the intertidal flats) extends to 3–8 km from shore at a slope of 0.71–1.28%, the −5 m isobath extends 14–18 km from shore, and the −10 m isobath reaches 22–36 km from shore. These features make deep water navigation dependent on extensive dredging, and it means that land reclamation is a cost-effective option for construction. Tianjin Port is by necessity largely man-made through dredging and reclamation.”

“Anchorages: Tianjin Port has six main anchorage areas and two temporary anchorages. All anchorages are designated for all functions — berth waiting, quarantine, inspection and pilotage — and provide little shelter from weather or rough seas. Bottom hold is poor to very poor. Anchored vessels are advised to keep five cables of clearance, as anchor dragging is common (up to 5–10 NM in a day in winter, due to drifting ice).”

“Port operations: The subsidiaries and partial-ownership partners of TPG are involved in all facets of port operation, including stevedoring, shipping agency, cargo handling, storage and transportation, infrastructure management, communications and information services, financial services, power supply, real estate development, health care, personnel training, education, port security, transportation, fire protection, port facilities management, environmental management, etc. The core activity of the Port is, naturally, cargo handling and processing. As a comprehensive port, it handles all sort of cargoes, including dry and liquid bulk, general cargo, containers, vehicles, and passengers. Tianjin Port operates 365 days a year, 24 hours a day (on three shifts at 00:00–08:00, 08:00–16:00 and 16:00–24:00)

The third biggest port in the world is the Port of Tianjin (formerly Tanggu), which in 2012 witnessed remarkable increase of cargo and container throughputs by 5.3% and 6.2% respectively. It handled 476 million tons of cargo and 12.3 million TEUs of containers in 2012. Located in the mouth of Haihe River in northern China, the port covers an area of 336km² of water and 131km² of land. It connects to more than 500 ports and serves 189 countries. Tianjin Port Group Companies is the operator. The port features 159 berths and is made up of the northern port, southern harbor, Dongjiang Port, an economic zone in the southern region, the south-east region and other auxiliary harbors.”

Image courtesy of Gerald Byrnes

Port of Guangzhou

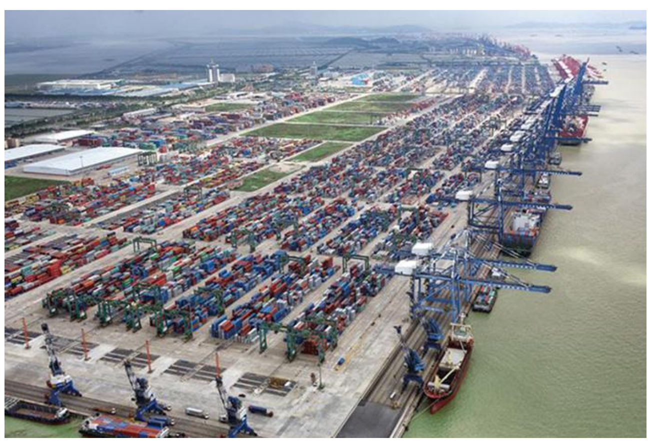
“Port of Guangzhou is the main seaport of Guangzhou city, Guangdong province, China. The port is operated by Guangzhou Port Group Co. Ltd which is a state-owned company. The company was established on February 26, 2004 from the former Guangzhou Harbor Bureau. It was approved by the Guangzhou Municipal Government. It is currently the largest comprehensive port in South China. Its international maritime trade reaches over 300 ports in more than 80 countries and districts worldwide. The port also incorporates the former Huangpu Port.

The port also serves as the important economic and transport center for the Pearl River Delta region and Guangdong province. It is also vital transport hub for industries located in neighboring provinces such as Guangxi, Yunnan, Guizhou, Sichuan, Hunan, Hubei and Jiangxi.

The Port of Guangzhou handled more than 460 million tons of cargo in 2012, making it the fourth biggest port in the world based on cargo traffic. The port is located in the middle of the Pearl River Delta. It is operated by Guangzhou Port Authority and handled the first 100 million tons of cargo in 1999. The cargo traffic has increased significantly since then. The port comprises four main areas including Downtown Port, Huangpu Port, Xinsha Port and Nansha Port Area. It is currently the largest loading and discharging port for coal in China.”

“Port infrastructure: Guangzhou Port comprises 4600 berths, 133 buoys and 2359 anchorages each of 1,000 tonnage class and the largest capacity is 3,000 tons. The government has approved of the dredging of the port to allow 100 000 tons vessels to enter Nansha at high tide in July 2009. The port is currently dredging to allow 100 000 tons vessels to enter Nansha terminal in low tide.”

“Port activities: The Port of Guangzhou plays a very important role in the economy. The port handles a range of activities which include loading and discharging, storage, bonded warehousing, container cargo services. Many agricultural, industrial and manufactured products are shipped through the port which include oil, coal, grain, chemical fertilizer, steel, ore and automobiles. The port also provides passenger services as well as logistics services. It also played a major role in contributing to the success of the missionary hospital, the Canton Hospital.”



Nansha Container Terminals

Geography

“Guangzhou Port is situated at the intersection of the three most important rivers of Dongjiang, Xijiang and Beijiang in South China. All the three rivers have the waterway, railway, expressway and air lines intersecting here, thus forming a critical transportation hub. It is the main port of focus in the Pearl River Delta Region.

The port's harbor area extends along the Pearl River coast and water areas in the cities of Guangzhou, Dongguan, Zhongshan, Shenzhen and Zhuhai. The port being situated beyond the entrance of Pearl River opening serve as a gateway for shipping activity for other Harbor area such as Nansha Harbor Area, Xinsha Harbor Area, Huangpu Harbor Area and Inner Harbor Area, and Nansha Harbor Area near Hong Kong.”

Image courtesy of Guangzhou Port Group

Port of Ningbo

"The Port of Ningbo-Zhoushan is a Chinese port that is the busiest in the world in terms of cargo tonnage, it handled 888.96 million tons cargoes in 2015, and keep ranking first of all the cargo ports around the world. The port is located in Ningbo and Zhoushan, on the coast of the East China Sea, in Zhejiang province south of Hangzhou Bay, across which it faces Jiaxing and Shanghai. The port is at the crossroads of the north-south inland and coastal shipping route, including canals to the important inland waterway to interior China, the Yangtze River, to the north. The port comprises several ports which are Beilun (seaport), Zhenhai (estuary port), and old Ningbo harbor (inland river port).

The operator of the port, Ningbo Zhoushan Port Co., Ltd. (NZP), is a listed company, but it is 76.31% owned by state-owned Ningbo Zhoushan Port Group Co., Ltd., as of 30 June 2017. Port of Ningbo, which handled more than 453 million tons of cargo in 2012, is the fifth biggest port in the world. The port's TEU capacity also reached 15.6 million tons in the same year. The port is located in the coastal province of Zhejiang and is comprised of Beilun Port Area, Zhenhai Port Area, Ningbo Port Area, Daxie Port Area and Chuanshan Port Area. Ningbo Port Group is the operator of the port. Comprising of 309 berths, the port connects to more than 600 ports in more than 100 countries. It was recently been merged with the Port of Zhoushan. The combined TEU capacity of the two ports reached 16.83 million tons in 2012."

Image courtesy of Ningbo Port Company

Port infrastructure

“The Port of Ningbo-Zhoushan complex is a modern multi-purpose deep water port, consisting of inland, estuary, and coastal harbors. There is a total of 191 berths including 39 deep water berths with 10,000 and more tonnage.

The larger ports include a 250,000-tonnage crude oil terminal and a 200,000+ tonnage ore loading berth. There is also a purpose-built terminal for 6th generation container vessels and a 50,000-tonnage berth dedicated for liquid chemical products.”

Geography

“The Port of Ningbo has ample intermodal connections that make it part of an extensive network for collection and distribution of goods. The Port of Ningbo's water-to-water transshipment capabilities allow it to cover the whole of East China and the Yangtze River Valley via the Yangtze River and the Grand Canal.

The Port of Ningbo has access to four important expressways: the Shanghai-Hangzhou-Ningbo Expressway, the Ningbo-Taizhou-Wenzhou Expressway, the Hangzhou-Nanjing Expressway, and the Ningbo-Jinhua Expressway. The great bridge that crosses Hangzhou Bay cuts the travel time from the Port of Ningbo to Shanghai to two hours.

In-dock railways link the Port of Ningbo to the national rail system through the Xiaoshan-Ningbo Railway. These connections make it easier to move export trade from inland cities and provinces through the Port of Ningbo. Regular air connections link the Port of Ningbo to Hong Kong through the International Airport of Ningbo.”

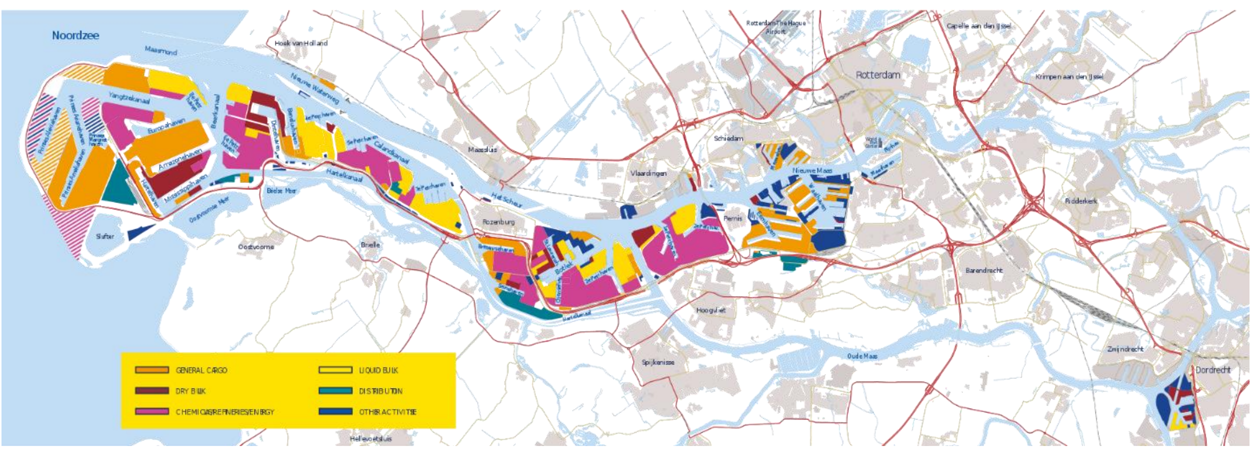
Port of Ningbo-Zhoushan

Port of Rotterdam

"The Port of Rotterdam is the largest port in Europe, located in the city of Rotterdam, Netherlands. From 1962 until 2004 it was the world's busiest port, now overtaken first by Singapore and then Shanghai. In 2011, Rotterdam was the world's eleventh-largest container port in terms of twenty-foot equivalent units (TEU) handled (2009: tenth; 2008: ninth, 2006: sixth). In 2012 Rotterdam was the world's sixth-largest port in terms of annual cargo tonnage.

Covering 105 square kilometers (41 sq. mi), the port of Rotterdam now stretches over a distance of 40 kilometers (25 mi). It consists of the city center's historic harbor area, including Delfshaven, the Maashaven/Rijnhaven/Feijenoord complex the harbors around Nieuw-Mathenesse, Waalhaven, Vondelingenplaat, Eemhaven, Botlek, Europoort, situated along the Calandkanaal, Nieuwe Waterweg and Scheur (the latter two being continuations of the Nieuwe Maas) and the reclaimed Maasvlakte area, which projects into the North Sea. Rotterdam consists of five distinct port areas and three distribution parks that facilitate the needs of a hinterland with 40,000,000 consumers."

"Characteristics: Most important for the port of Rotterdam is the petrochemical industry and general cargo transshipment handlings. The harbor functions as an important transit point for transport of bulk and other goods between the European continent and other parts of the world. From Rotterdam goods are transported by ship, river barge, train or road. Since 2000 the Betuweroute, a fast cargo railway from Rotterdam to Germany, has been under construction. The Dutch part of this railway opened in 2007. Large oil refineries are located west of the city. The river Maas and Rhine also provide excellent access to the hinterland."



Map of Rotterdam

“The EECV-quay of the port has a draft of 24 meters (78 feet), This made it one of only two available mooring locations for one of the largest bulk cargo ships in the world, the iron ore bulk carrier MS Berge Stahl when it is fully loaded, along with the Terminal of Ponta da Madeira in Brazil, until the opening of a new deep-water iron ore wharf at Caofeidian in China in 2011.The ship's draft of 23 meters (75 feet) leaves only 1 meter (3 feet) of under keel clearance, therefore it can only dock in a restricted tidal window. Such ships must travel in the Eurogeul. Much of the container loading and stacking in the port is handled by autonomous robotic cranes and computer-controlled chariots. The ECT pioneered the development of terminal automation. At the Delta terminal, the chariots—or automated guided vehicles (AGV)—are unmanned and each carry one container. The chariots navigate their own way around the terminal with the help of a magnetic grid built into the terminal tarmac. Once a container is loaded onto an AGV, it is identified by infrared "eyes" and delivered to its designated place within the terminal. This terminal is also named "the ghost terminal". Unmanned Automated Stacking Cranes (ASC) take containers to/from the AGVs and store them in the stacking yard. The newer Euromax terminal implements an evolution of this design that eliminates the use of straddle carriers for the land-side operations.”

The Port of Rotterdam is currently the biggest port in Europe and the sixth biggest in the world by annual cargo throughput. The port handled 441.5 million tons of cargo in 2012.The port, including an industrial complex within its vicinity, stretches across a length of about 42km, covering an area of approximately 12,426ha. It is managed and operated by the Port of Rotterdam Authority (PoRA). It is the only port in north-western Europe that offers unrestricted access to ships with the deepest draughts. A major port expansion project, dubbed as Maasvlakte 2, was launched in 2008. The first phase of the expansion was opened in May 2013 and will eventually double the port’s container transfer capacity.”

Image courtesy of Port of Rotterdam Authority

Port of Suzhou

"Port of Suzhou is the collective name of three ports around the city of Suzhou, Jiangsu Province, China. The three ports are located in Zhangjiagang, Changshu and Taicang, respectively, on the lower reaches of the Yangtze River. The total cargo throughput of 454 million tons in 2013. As of 2013, it is the busiest inland river port in the world by annual cargo tonnage and container volume, as well as the sixth-busiest port by annual cargo tonnage. The majority of the port trade is in coal, ore, steel, and construction materials such as cement."

"Port Infrastructure: As of 2011, Port of Suzhou consist of 224 production berths in total, 106 of them being above ten thousand tons in tonnage. The port has trade with over 400 international and domestic shipping lines."

Port of Suzhou, which achieved a cargo throughput of 428 million tons in 2012, an increase of 12.61% from 2011, is currently the seventh biggest port in the world by cargo throughput. It is also one of the busiest inland river ports in the world. The port is owned by Suzhou Municipal Government. It comprises of Zhangjiagang, Changshu and Taicang ports, located on the lower reaches of the Yangtze River in Jiangsu province. The port features 224 berths and deals with hundreds of international and domestic shipping lines. It mainly trades in cargo including coal, steel and construction materials. The port authority is with Suzhou Harbor Administration Department."

Image courtesy of Cruise mapper

Port of Qingdao

“The Port of Qingdao is a seaport on the Yellow Sea in the vicinity of Qingdao, Shandong Province, People's Republic of China. It is one of the ten busiest ports in the world (7th in 2010 considering total cargo volume according to the Institute of Shipping Economics & Logistics).

Qingdao port consist of four areas (often themselves referred to as port due to their being very large) - Dagang port area, Qianwan port area, Huangdong oil port area (for oil tankers) and Dongjiakou port area, the latter being located 40 kilometers south of Qingdao city.

Beside including the Qingdao Qianwan Container Terminal and the Qingdao Cosport International Container Terminal, located in different areas, Qingdao also has a large terminal for handling iron ore.

Port of Qingdao, located at the entrance to Jiaozhou Bay on the south coast of Shadong Peninsula, overlooking the Yellow Sea, handled more than 400 million tons of cargo in 2012. It currently ranks as the eighth biggest port in the world. The port is touted as the world’s largest port for iron ore and China’s largest port of crude oil. The port merges Qingdao Old Port, Huangdao Oil Port and Qianwan New Port, and is connected to more than 450 ports in more than 130 countries and regions across the world. Qingdao Economic and Technological Development Area, Qingdao Free Trade Zone and Qingdao High-tech Industrial Zone are located within the vicinity of the port. The port is operated by Qingdao Port Group.”

Image courtesy of Klauss Ottes

Port of Dalian

"The Port of Dalian (38° 55' N 121° 41' E) founded in 1899 lies at the southern tip of Liaodong Peninsula in Liaoning province and is the most northern ice-free port in China. It is also the largest multi-purpose port in Northeast China serving the seaports North Asia, East Asia and the Pacific Rim. It is the trade gateway to the Pacific. It is the second largest container transshipment hub in mainland China."

"Geography: The Port of Dalian is located on the Yellow Sea at 38°55′44″N and 121°39′17″. The port covers a water area of 346 km2 and a land area of nearly 15 km2. There are 160 km of specialized railway lines, 300,000 m2 of warehouses, 1.8 million km2 of stacking yards and over 1,000 units of different types of loading and discharging machinery and equipment. The port is around 503.55 mi (932.58 km, from Koje (South Korea) To Dalian (China). The sailing time is estimated 1-day sea."

"Port Infrastructure: The port has 80 modern berths in production. Out these 38 are deep water berths for vessels of over 10,000 tons deadweight (DWT). The annual throughput was 64.17 million tons in 1995.In 2016, cargo throughput for the Port of Dalian reached 355 million tons, which was up 5.5% from 2015.Lifting capabilities are between 3 – 120 tons at working radius 3 – 30 meters. The Port of Dalian's DCT, DPCM, and DICT have a total of 13 berths with alongside depths from 9.8 to 16 meters (32.2 to 52.5 feet)."

Image courtesy of Dalian Port PDA Company

“Port of Dalian, located in the Liaodong Peninsula in Liaoning province, handled more than 303 million tons of cargo in 2012 ranking as the ninth biggest port in the world. Owned and managed by Dalian Port Company, the port comprises of seven areas, namely Daliangang, Dalianwan, Xianglujiao, Nianyuwan, Ganjinzi, Heizuizi, Si’ergou and Dayaowan. The port handles around 70% of the region’s cargo and 90% of the region’s container transportation. It features approximately 80 berths and is connected to approximately 99 shipping lines around the world.”

Image courtesy of dmytrok

Port of Busan

“The Port of Busan the largest port in South Korea, located in the city of Busan, South Korea. The Port of Busan was established in 1876 as a small port with strict trading between Korea, China and Japan. It is situated at the mouth of the Nakdong River facing the Tsushima Island of Japan. During the Korean War (1950-1953), Busan was among the few places North Korea did not invade, causing war refugees to flee to the city of Busan. At that time Busan’s port was crucial to receive war materials and aid, such as fabrics and processed foods to keep the economy stable. In the 1970s, a rise in the footwear and veneer industries caused factory workers to migrate to Busan, bringing Busan’s population from 1.8 million to 3 million.

The Port of Busan continued to grow and by 2003 the port was the fourth largest container port in the world. South Korea accounted for 0.7% of global trade in 1970, but by 2003 it went up to 2.5%. 50% of the Busan’s manufacturing jobs are related to exports, and 83% of the country’s exports are containerized, making Busan the country’s largest container and general cargo port. Compared to the Port of Busan, Inchon port handles only 7% of containers. Easy access to the Port of Busan between Japan, Singapore, and Hong Kong contribute to its vast growth.

Currently the Port of Busan is the fifth busiest container port in the world and the tenth busiest port in North-east Asia. It is developed, managed, and operated by the Busan Port Authority (BPA) established in 2004. Today the Port of Busan consists of four ports- North Port, South Port, Gamcheon Port, and Dadaepo Port, an International Passenger Terminal and the Gamman container terminal. The North Port provides passenger handling facilities and cargo, and with Gamcheon Port’s help more cargo volumes can be handled (Ship Technology). The South Port is home to the Busan Cooperative Fish Market which is the largest fishing base in Korea, and it handles 30% of the total marine volume. The Dadaepo Port located west of the Busan Port, mainly handles coastal catches.

In 2007 the Busan Port handled cargo containing fertilizers, meat, scrap metal, petroleum and other gases, crude petroleum, coal, leather, fats and oils, iron ore, rough wood, natural sand, milling industry products, and sugar. In 2016, South Korea exported a total of $515B and imported $398B. Top exports of South Korea are integrated circuits, cars, refined petroleum, passenger and cargo ships, and vehicle parts. South Korea exports the most to China, the United States, Vietnam, Hong Kong, and Japan. Imports to South Korea mainly come from China, Japan, the United States, Germany, and other Asian countries. In 2017 Busan processed more than 20 million TEUS, twenty-foot equivalents (a measure used to estimate the compacity of container ships).”

"Its location is known as Busan Harbor. Port of Busan, located in mouth of the Naktong River in South Korea, is the tenth biggest port in the world based on cargo throughput. The port handled 298 million tonnes of cargo in 2012.Managed and operated by the Busan Port Authority (BPA), the port is made up of North Port, South Port, Gamcheon Port and Dadaepo Port, an international passenger terminal and six container terminals. The South Korean port handles 40% of the total marine export freights, 80% of container freights and 42% of fisheries production of the entire nation. It is spread over an area of 840,000m² and is capable of handling 169 vessels simultaneously."

United Nations Photo

Map Ta Phut Tank Terminal Co., Ltd.

“"Map Ta Phut Tank Terminal" (MTT) is a commercial port and storage terminal, dedicated for liquid and gaseous petrochemical products. MTT was established in 1995, is located on the East side of Map Ta Phut Port, Rayong province, Thailand. The company is owned and operated by Map Ta Phut Tank Terminal Company Limited as one of SCG subsidiaries.

MTT terminal, comprising of 4 marine jetties and 33 storage tanks, is able to support more than 20 varieties of petrochemical products. The operation is controlled by a Distributed Control System (DCS) which has been installed to enable operators to centralize the process controls and continuously monitor all the operations from a single room. This system has been implemented to ensure the safety and efficiency of the operation since its first start.

- Charts: The port area is shown on Royal Thai Navy (RTN) Chart no. 157 with the approaches on RTN chart 141 and on British Admiralty (BA) chart 3966 respectively.
- Anchorage: An anchorage area (Harbor Department Announcement No. 447/2537 dated 27.9.94) exists, covering a circular area width 1 nautical mile radius around

Latitude : 12 Degrees 35.0 Minutes North

Longitude : 101 Degrees 13.5 Minutes East

For any vessel which has arrival draft exceeding 10.5 m., berthing time will depend on government pilot's consideration for safety, with concern of the tide level in arrival period.

- Approaches: The distance from the Fairway Buoy to the harbour's Western breakwater is 2 nautical miles. The minimum width of the approach channel is 250 m. and the water depth is 13.0 m reduced to Lowest Low Water (LLW). The water depth in the Berth box for jetties no.1, No.2, No.3, and No.4 is 15.5 m., 10.4 m., 11.1 m., and 8.5 m. respectively.
- Restrictions: The minimum under-keel clearance is required by the Pilot Office at 10 percent of vessel's static draft at all times.
- Weather:

Tidal Conditions The tidal factors in Map Ta Phut Port have been reviewed and set out as follows:

Highest Astronomical Tide (HAT)	+ 3.5 m.
Mean Higher High Water (MHHW)	+ 3.0 m.
Mean High Water (MHW)	+ 2.8 m.
Mean Sea Level (MSL)	+ 2.2 m.
Mean Low Water (MLW)	+ 1.6 m.
Mean Lower Low Water (MLLW)	+ 1.4 m.
Lowest Astronomical Tide (LAT)	+ 0.5 m.
Chart Datum Line (C.D.)	+/-0.0 m.

- Tidal Currents: Tidal and the permanent coastal currents off the East Reclamation flow in an East-West direction across the outer channel. Current measurements at the 10-meter contour adjacent to the outer navigation channel indicate the maximum current velocities as shown below.

Ebb tide : Easterly direction at 0.4 Knots to 0.6 Knots

Flood tide : Westerly direction at 0.6 Knots to 0.8 Knots

- Wave Motion: According to the wave analysis, in the outer channel, the waves higher than 1.5 m occur for 1.5% of the year, and greater than 1.0 m for 9.0% of the year. In general, the critical wave height in terms of efficient and safe cargo handling inside the port is less than 0.5 m or 2 feet. The inner harbor is protected by the West break water.
- Wind direction:

Period	Predominant directions
November to January	: N.E.and Variable
February to March	: South and East
April	: Variable
June to October	: S.W. Monsoon

Mean monthly wind speed of 13.9 km/hr. or 3.9 m/sec - Weak breeze Mean of maximum velocity of 135.3 km/hr. or 37.6 m/sec - Typhoon in November from the North.”

Berthing Procedure

Vessel qualification

“All vessels planned to berth at MTT shall get approval in writing from terminal officer and vessel shall apply with the following requirements:

- Owner reputation must be positive reported and TMSA rating required at least stage 2 for any contract.
- Age: Ship age less than 25 years will be considered.
- New building, dry docking: at least 2 voyages required after delivery or latest dry dock. (UWS-Under water survey, require permission on case by case basis)
- Registry and changes: Hold for 2 months after changed date and new inspection is required after hold period.
- Port state inspection recorded:
  - Recent recorded must not show in detention list.
  - The PSC closed out or rectification report are required before reconsideration.
- Vessel class: required IACS classification.
- P & I Club: required International group.
- Ship inspection report (SIR):
  - Validity of the report is 12 months from the date of last inspection which carried out by accredited either OCIMF or CDI inspectors.
  - Inspection required during loading or discharging operation.
  - SIR for MTT or other.
  - Same Inspector will be accepted only 2 times consecutive inspections.

5. Specific inspection checklist will be limited to product that she planned to carry i.e. oil, chemical and gas, latest inspection should be the same checklist of carrying product.

- Good terminal/charterer feedback: reported of positive terminal acceptance history.
- No report of recently casualty history.
- Officers matrix (senior ranks)
  - [1] Master + Chief Officer
  - [2] Chief Engineer + Second Engineer
  - [1] and [2] year service at least:
    - Year with operator: 1 Year
    - Year in rank: 2 Years
    - Year on this type of tanker: 3 Years
- English proficiency: the results indicate that average English proficiency of ship crew is good.
- Following documents are required for our initial review:
  - Ship Particular: Q88 and Form C, if any.
  - Certificate of Fitness.
  - Gas Rule Form (for Liquefied Gas Carrier).”

Pilotage

“Government Pilotage is compulsory for all vessels. Pilot exemption for regular local traders has been introduced. The pilots also serve as docking masters, berthing the vessel with the assistance of tugs. The Pilot embarks approximately 1 nautical mile South of the Fairway Buoy in position Lat. 12 Degrees 35.0' N., Long. 101Degrees 13.5' E. The Pilot Office can be contacted on VHF channel 16. Once contact is established the vessel is Requested to stand by on VHF channel 14. VHF Channel 13 is used for communication between MTT, vessels, Tugs, Pilot, Harbor Master and mooring boats for berthing or unberthing.”

Mooring

“Mooring gangs and mooring boats are arranged by the ship's agent. Vessels berth starboard side alongside, heading west towards the port entrance. Minimum Number of Mooring Lines

- Up to 10,000 tons d.w.t. - 4 breast lines and 2 springs forward and 2 springs after.
- Over to 10,000 tons DWT. - 6 breast lines and 2 springs forward and 2 springs aft.
- Minimum mooring wire/rope breaking strength shall be 75 MT.

Quick release hook system: At jetty no.1 all mooring dolphins are equipped with manually handled quick release hooks (breasting dolphins are equipped with bollard)”

Tugs

“The use of Tugs is compulsory in the port for both berthing and unberthing as follows: Vessels over all (LOA) up to 492 /700 feet or 150 /213 m. requires 2/3 tugs respectively. Tug lines are used for towing. The tug and its crew are regarded as employed by the ship being towed. All the damage and costs to the tug arising during the 'assistance' and for which the tug could be made responsible must be compensated for by the ship in question. Tug service is arranged for by Ship's Agent and in monsoon season at least one tug must standby in the vicinity nearby whilst vessel alongside.”

Harbor Activities

"(A) Port State Control: Map Ta Phut port is open to ships in national and foreign going trade. Thailand is a signatory to the memorandum for Port State Control Governmental inspections can be expected.

(B) Inspections: Alongside MTT installations inspections of vessels are carried out before and during cargo operations by the MTT loading Master in accordance with MTT's Terminal Information and Regulations, which are handed out to every vessel calling at its facilities, and the ship/shore safety check list. MTT's Safety Regulations are in accordance with the 'International Safety Guide for Oil Tankers and Terminal' (ISGOTT). Safety rules in case of chemicals and liquefied gas are based on 'Tanker Safety Guide (Chemicals)' and 'Tanker Safety Guide (Liquefied gases)' respectively, published by the 'International Chamber of Shipping' (ICS)."

MTT Safety System

"MTT installs Safety Equipment and implements regulations for safety of people, reliability and integrity of equipment. The security system of our jetties is followed ISPS Code since July 1st, 2004 to ensure that all berthing vessels are always safe. Safety Equipment followed NFPA Standard consists of:

- Safety Detectors: More than 125 safety detectors are installed around MTT area.
  - Frame Detectors
  - Gas Detectors
  - Smoke Detectors
- Fire Fighting System
  - Water/Foam Fix Monitors
  - Hydrants
  - Fire Extinguishers
  - Fire Fighting Pumps: 4 x 1,394 m3/h
- Oil Spill Protection System
  - Speed Boat
  - Oil Boom with 400-meter length
  - Sand Bags

In addition, there is the Emergency Generator stand-by for supplying all main safety equipment in MTT area."

MTT Tank Farm and Facilities

"The 33 tanks whose capacities to store various liquid chemical vary from 1,000 up to 70,000 ton are well-equipped with reliable systems for detecting leaks, recording dead stock, monitoring tank status, and making transfers among tanks. Additional capacities can be created to suit specific requirements of the customer at attractive commercial terms."

Jetty Specification

"Our jetty could support up to 100,000 DWT of vessel, together with monitoring and controlling movement throughout its entire journey, from storage at tank farms to distribution at marketing terminals into marine vessels and also truck loading. Moreover, the jetty performance is now controlled by key performance indicators under international standard, ISO 9001. Since the jetties are equipped with various types of loading arms, they should therefore be used in accordance with their operating limits seen below."

Jetty No.1

Product	DWT	Allowable draft at all times	LOA	Max. Beam	Parallel Body Length	Distance from bow to center manifold	Distance from stern to center manifold	Distance from rail to manifold	Distance from deck to center manifold	Loading arm size
Naphtha	1,000-100,000	14.0 m.	85-260 m.	46 m.	>48.5 m.	27.25-132.25 m.	22.75-127.75 m.	>1.5 m.	>0.5 m.	2x16 inch ANSI 150
Light Reformate / Raw Pygas	1,000-100,000	14.0 m.	85-260 m.	46 m.	>39.5 m.	22.75-127.75 m.	27.25-132.25 m.	>0.95 m.	>0.45 m.	1x8 inch ANSI 150
Benzene	1,000-100,000	14.0 m.	85-260 m.	46 m.	>39.5 m.	22.75-127.75 m.	27.25-132.25 m.	>0.95 m.	>0.45 m.	1x8 inch ANSI 150 1x4 inch ANSI 150 (vapor)
Toluene	1,000-100,000	14.0 m.	85-260 m.	46 m.	>39.5 m.	22.75-127.75 m.	27.25-132.25 m.	>0.95 m.	>0.45 m.	1x8 inch ANSI 150 1x4 inch ANSI 150 (vapor)
Mixed Xylene	1,000-100,000	14.0 m.	85-260 m.	46 m.	>39.5 m.	22.75-127.75 m.	27.25-132.25 m.	>0.95 m.	>0.45 m.	1x8 inch ANSI 150 1x4 inch ANSI 150 (vapor)
Paraxylene	1,000-100,000	14.0 m.	85-260 m.	46 m.	>39.5 m.	22.75-127.75 m.	27.25-132.25 m.	>0.95 m.	>0.45 m.	1x8 inch ANSI 150
MMA	1,000-100,000	14.0 m.	85-260 m.	46 m.	>29.5 m.	38.25-143.25 m.	11.75-116.75 m.	>1.0 m.	>0.4 m.	1x6 inch ANSI 150
Propane	1,000-100,000	14.0 m.	85-260 m.	46 m.	>33.5 m.	18.75-123.75 m.	31.25-136.25 m.	>1.5 m.	>0.5 m.	1x12 inch ANSI 150
Butane	1,000-100,000	14.0 m.	85-260 m.	46 m.	>33.5 m.	18.75-123.75 m.	31.25-136.25 m.	>1.5 m.	>0.5 m.	1x12 inch ANSI 150

Jetty No.2

Product	DWT	Allowable draft at all times	LOA	Max. Beam	Parallel Body Length	Distance from bow to center manifold	Distance from stern to center manifold	Distance from rail to manifold	Distance from deck to center manifold	Loading arm size
Ethylene	1,000-20,000	9.5 m.	60-170 m.	30 m.	>31.5 m.	39.25-92.25 m.	13.75-77.75 m.	>1.06 m.	>0.35 m.	1x8 inch ANSI 300
Propylene	1,000-20,000	9.5 m.	60-170 m.	30 m.	>31.5 m.	39.25-92.25 m.	13.75-77.75 m.	>1.06 m.	>0.35 m.	1x8 inch ANSI 300 1x4 inch ANSI 150 (vapor)
Butadiene	1,000-20,000	9.5 m.	60-170 m.	30 m.	>23.5 m.	32.00-96.25 m.	9.75-73.75 m.	>0.868 m.	>0.35 m.	1x6 inch ANSI 300 1x4 inch ANSI 150 (vapor)
Butene-1	1,000-20,000	9.5 m.	60-170 m.	30 m.	>23.5 m.	32.00-96.25 m.	9.75-73.75 m.	>0.868 m.	>0.35 m.	1x6 inch ANSI 300 1x4 inch ANSI 150 (vapor)
Mixed C4	1,000-20,000	9.5 m.	60-170 m.	30 m.	>23.5 m.	32.00-96.25 m.	9.75-73.75 m.	>0.868 m.	>0.35 m.	1x6 inch ANSI 300 1x4 inch ANSI 150 (vapor)
MMA	1,000-20,000	9.5 m.	60-170 m.	30 m.	>23.5 m.	25.25-78.25 m.	27.75-91.75 m.	>0.87 m.	>0.3 m.	1x6 inch ANSI 150
TBA	1,000-20,000	9.5 m.	60-170 m.	30 m.	>23.5 m.	28.75-81.75 m.	24.25-88.25 m.	>0.87 m.	>0.3 m.	1x6 inch ANSI 150
Methanol	1,000-20,000	9.5 m.	60-170 m.	30 m.	>23.5 m.	28.75-81.75 m.	24.25-88.25 m.	>0.87 m.	>0.3 m.	1x6 inch ANSI 150
MEG	1,000-20,000	9.5 m.	60-170 m.	30 m.	>30.5 m.	21.75-74.75 m.	31.25-95.25 m.	>0.85 m.	>0.4 m.	1x6 inch ANSI 150
AA	1,000-20,000	9.5 m.	60-170 m.	30 m.	>37.5 m.	18.25-71.25 m.	34.75-98.75 m.	>0.87 m.	>0.3 m.	1x6 inch ANSI 150

Jetty No.3

Product	DWT	Allowable draft at all times	LOA	Max. Beam	Parallel Body Length	Distance from bow to center manifold	Distance from stern to center manifold	Distance from rail to manifold	Distance from deck to center manifold	Loading arm size
Naphtha	1,000-80,000	10.1 m.	85-220 m.	40 m.	>44 m.	21.0-115.68 m.	16.0-104.32 m.	>1.5 m.	>0.5 m.	2x16 inch ANSI 150
Benzene	1,000-80,000	10.1 m.	85-220 m.	40 m.	>23 m.	5.5-100.18 m.	31.5-119.82 m.	>0.95 m.	>0.45 m.	1x8 inch ANSI 300 1x4 inch ANSI 150 (vapor)
C9+ / C8+	1,000-80,000	10.1 m.	85-220 m.	40 m.	>23 m.	5.5-100.18 m.	31.5-119.82 m.	>0.95 m.	>0.45 m.	1x8 inch ANSI 300 1x4 inch ANSI 150 (vapor)
Paraxylene	1,000-80,000	10.1 m.	85-220 m.	40 m.	>23 m.	5.5-100.18 m.	31.5-119.82 m.	>0.95 m.	>0.45 m.	1x8 inch ANSI 300
Methanol	1,000-80,000	10.1 m.	85-220 m.	40 m.	>23 m.	5.5-100.18 m.	31.5-119.82 m.	>0.95 m.	>0.45 m.	1x6 inch ANSI 150
Octene	1,000-80,000	10.1 m.	85-220 m.	40 m.	>30 m.	9.5-104.18 m.	27.5-115.82 m.	>0.95 m.	>0.4 m.	1x8 inch ANSI 300 1x4 inch ANSI 150 (vapor)
Hexene	1,000-80,000	10.1 m.	85-220 m.	40 m.	>30 m.	9.5-104.18 m.	27.5-115.82 m.	>0.95 m.	>0.4 m.	1x8 inch ANSI 300 1x4 inch ANSI 150 (vapor)
Solvent	1,000-80,000	10.1 m.	85-220 m.	40 m.	>37 m.	13.5-108.18 m.	23.5-111.82 m.	>0.95 m.	>0.4 m.	1x8 inch ANSI 300 1x4 inch ANSI 150 (vapor)

Jetty No.4

Product	DWT	Allowable draft at all times	LOA	Max. Beam	Parallel Body Length	Distance from bow to center manifold	Distance from stern to center manifold	Distance from rail to manifold	Distance from deck to center manifold	Loading arm size
Toluene	1,000-10,000	7.7 m.	60-115 m.	25 m.	>23 m.	11.5-69.08 m.	24.5-57.92 m.	>0.709 m.	>0.35 m.	1x8 inch ANSI 300 1x4 inch ANSI 150 (vapor)
Mixed Xylene	1,000-10,000	7.7 m.	60-115 m.	25 m.	>23 m.	11.5-69.08 m.	24.5-57.92 m.	>0.709 m.	>0.35 m.	1x8 inch ANSI 300 1x4 inch ANSI 150 (vapor)
Mixed C4	1,000-10,000	7.7 m.	60-115 m.	25 m.	>30 m.	15.0-72.58 m.	21.0-54.42 m.	>0.868 m.	>0.7 m.	1x8 inch ANSI 300 1x4 inch ANSI 150 (vapor)
Butene-1	1,000-10,000	7.7 m.	60-115 m.	25 m.	>30 m.	15.0-72.58 m.	21.0-54.42 m.	>0.868 m.	>0.7 m.	1x8 inch ANSI 300 1x4 inch ANSI 150 (vapor)

TTS GROUP Marine Supplier

RO-RO/Cruise ship Port Equipment

RoRo: TTS supplies both ship-based and land-based installations designed to ensure smooth cargo handling. Ship based equipment typically includes stern ramps for access to a vessel's main lower and upper decks, as well as ramp covers to protect access to the lower hold and internal areas of these vessels. We also have many references for installation of large quarter ramps, internal ramps for distribution of cargo between decks, liftable/hoistable car decks, and watertight ramp covers and bulkhead doors to ensure the required compartmental division for water- and gas-tight integrity.

Cruise ships: Today's cruise ships are very large vessels with high demands on logistic systems and passenger and cargo access equipment. They also operate in environmentally sensitive areas. Therefore, TTS has developed reliable, fast and environmentally-friendly doors and platforms that are optimized for the cruise ship industry and available with either hydraulic or electric operation. TTS can also provide land based logistic systems, such as gangways and provision and luggage handling systems.

Naval vessels: In addition to supplying the world's merchant fleet, TTS has a long history of designing and supplying equipment for navies worldwide. Vessel types such as logistics support ships, all types of docking and landing ships and pre-positioning ships are covered by the TTS portfolio. Typical TTS equipment installed on these vessels are ramps of all types, side loading systems, cranes, deck machinery, hatch covers and internal doors and lifts. OPV's and other combat vessels are also well suited to TTS equipment due to the increased emphasis on hull access points such as hangar doors and USV/UUV Mission Bay doors. TTS Naval expertise makes it the ideal partner for government newbuild and conversion projects.

The fast and efficient transfer of cargo between ships and land-based modes of transport is the goal of ports throughout the world. Customized ship to shore solutions is required to enhance the efficiency of traffic movement through RoRo terminals where local tidal variations dictate the need for flexibility in design. The TTS range of port equipment offers a number of flexible options for access and for the management of traffic when loading or unloading ships. Short harbor stop is a benefit to allow for cost saving operations at sea.

Auto mooring

wThe time, cost, labour and risks associated with traditional methods of mooring with ropes, which have otherwise remained unchanged for thousands of years, can be significantly reduced using an automatic mooring system. The modern mooring facilities are operated as an unmanned robot or man-operated by joystick without heavy physical work and the connection between the vessel and quay is created by mechanical elements or suction function.

Floating Linkspan

Loading and unloading ships in port involves the transportation of cargo across the water to the ship's deck. Different levels between the deck and the quay can slow down the loading and unloading process. TTS Linkspans provide a level access way for loading and unloading RoRo and RoPax vessels.

Fully Mobile Linkspan

The fully mobile Linkspan is a fast, efficient, economic and flexible structure designed to provide mobile berthing. In ports where the development of a berth needs to be unrestricted by a permanently fixed structure the fully mobile Linkspan provides a powerful solution. It can be quickly moved into position along any length of quay, converting it into a RoRo berth and thus maximizing quay space.

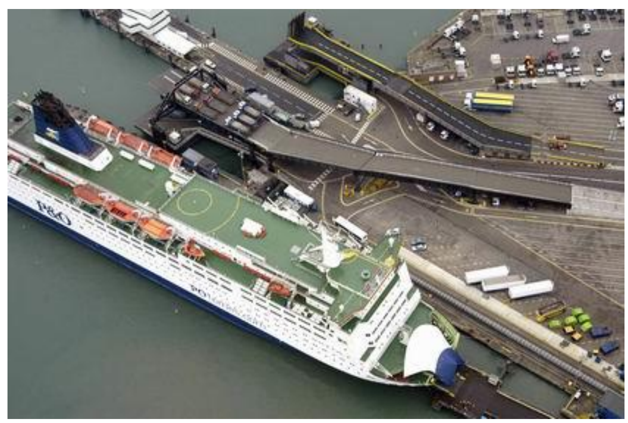
Grip-based Auto mooring

Automatic mooring systems are remotely controlled and require no quay-side personnel. The safety and efficiency of mooring procedures are improved by the system as its performance is monitored and its status reported to operations staff in real-time. The TTS grip-based auto-mooring system consists of a vertical guiding mechanism, a wagon including an eye and hydraulic cylinders, electric control system, hydraulic system and control panel. It can be designed with a mooring force to suit varying customer requirements. The system requires a bollard and recess to be fitted onboard the vessel. An operating panel with an alarm function is easily fitted on the bridge of the vessel as the operator will usually be onboard.

Integral Tank Linkspan

The first integral tank Linkspan was developed in 1989 and installed on the Tees, UK. The integral tank Linkspan offers the greatest stability and flexibility in accommodating vessels that are unrestricted in their beam, freeboard and ramp configuration. With the use of TTS' integral tank Linkspan structure the revenue generated by a RoRo berth can be maximized and the need for the involvement of port management reduced.

Linkspan



Linkspans act as a bridge linking ship to shore, providing the access way for transferring cargo and passengers on and off RoRo vessels in port. The TTS range of linkspans includes fully mobile, integral tank, submerged tank, floating and mechanical support varieties, and all offering flexible, reliable, safe and economic means for this transfer. A ballasting system, unique to TTS designs, resolves the problems arising from interfacing a fixed quay with a structure in constant movement. One of the main issues is to create a smooth cargo handling.

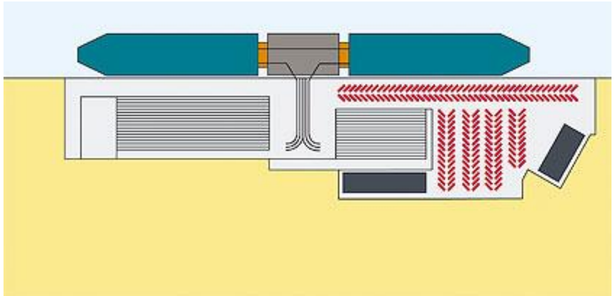
Mechanical Support Linkspan

The function of Linkspans is to level the height difference between the quay and the cargo deck of the vessel in order to provide smoother, safer and faster access for loading and unloading. The Linkspan can either rest directly on the vessel or be used to support the vessel's ramp. The TTS mechanical support Linkspan, operated by lifting equipment, for example hydraulic cylinders.

Passenger Gangway

Foot passengers need to be provided with a safe path to the accommodation deck when a ship is also being loaded or unloaded with heavy cargo. The access walkways helps to optimize the safety and efficiency of both passenger boarding and cargo handling by keeping passengers separate from the rolling cargo as it is being loaded. The passenger gangway will follow the movement of the vessel. Safety devices are built into the walkway to ensure a safe operation.

Port and Terminal Consulting



Consultancy services are provided to optimize and create cost, time and quality efficient solutions in an early stage of the developing process for handling of the total flow of the passengers and cargo. Our simulation tools quickly facilitate a realization of the most efficient layout and cargo flow for the terminal. For instance, when a double tier Linkspan is to be used to fulfil a given operation in a RoRo or RoPax Port.

Semi-automatic Mooring

In order to reduce the number of personnel needed on shore during the mooring operation, the semi-automatic bollard has been designed to operate as a vertical telescopic moving bollard that can be tilted against the ship's hull. The semi-automatic bollard system consists of hydraulically operated vertical telescopic arm including a tilting cylinder and tiltable bollard, electric control system, hydraulic system and control panel erected on a rigid steel frame. The bollard is operated by radio control from the winch deck for easy mooring from the vessel.

Stop Fender

The TTS stop fender has been developed to protect shore-based structures when a vessel is approaching its berth as well as ensuring the safety of the ship while moored. The stop fender is designed to maintain the longitudinal position of the ship while moored and is a key element in an automated mooring berth.

Submerged Tank Linkspan

The submerged tank Linkspan was invented in 1968 and, since then, over 50 have been installed. The submerged tank itself acts as a counterweight to support the weight of the outer end of the bridge that spans from vehicle ferry to quay. But unlike a conventional counterweight system it requires no supporting civil works and has no wires or mechanism to maintain.

Container Vessel, Bulk Carrier, Tanker Port Equipment

Containerships: TTS supplies a wide range of functional products for the world's container fleet. Since the development of the first containership, we were involved in the creation of lift-on/lift-off hatch cover systems. Use of advanced stress-calculation systems and computer-aided design technology for the steel structure enables these hatch cover panels to accommodate higher container loadings, while keeping panel weights within the permitted maximum for handling by shore cranes.

Bulkers: Onboard equipment for the bulk shipping sector must be specially designed to take into account the hazardous nature of unpackaged bulk cargoes and the wide variation in port facilities to handle the loads. Bulker equipment must therefore be built to maximize capacity and efficiency as well as safety. Among our targeted solutions is a loading/unloading system which provides a range of tools, including options for handling a variety of self-discharge cargoes, thereby streamlining bulk operations considerably. This system is designed to help short-sea shippers load and unload more cargoes faster, thus increasing ships' revenue.

Tankers: It is our objective to develop and supply high quality solutions and equipment to tanker owners and operators, in order to support their productivity and value generation.As the world's leading supplier of hose handling cranes for tankers, we know that standardized design and cost efficiency in production are key elements in this market segment. All our cranes are designed in accordance with Oil Companies International Marine Forum (OCIMF) requirements. Specialized needs for compliance, such as for tankers carrying explosive substances or other matters related to safety, are handled by the company's team of experienced designers.

Sideloading System

The principle of side loading systems is founded on the premise that the best way to load or discharge cargo is by the shortest possible path – through the ship's side. Key benefits of side loading systems are: compact stowage of cargo, low damage rates; operation independent of tidal variations; small demand on port facilities and increased turnaround speed in port. Depending on the intended use and specified degree of automation, TTS Ships Equipment can deliver any system perfectly adjusted to suit specific needs.

Cargo Cranes

At TTS we are responsible for the design and installation of a wide range of cargo handling systems. We understand that customer requirements are particular to vessel type, so we offer custom solutions alongside a wide range of standard products, all designed to equip a variety of vessels from short-sea traders to reefers and specialized combination carriers.

Bulker cranes

TLB – Electro-hydraulically driven Bulker cranes up to SWL 50t

- Capacity: SWL 30 - 50t
- Operation: Bulk Carrier

Characteristics:

The TLB bulker crane is characterized by high cycle times and robust design. Like all TTS cranes, the TLB has an unlimited slewing range of 360˚ and the equipment and machinery is mounted inside the crane housing to protect it against maritime atmosphere. Operation in the first layer on the winch drum ensures a long lifetime of the wires.

The TLB crane is equipped with proven TTS electronic control PLC (programmable logic controller) and digital operation display in the crane cabin as standard. All movements can be done simultaneously and are step less operated. To ensure a safe workflow the TLB has an automatic speed reduction of hoisting and luffing before the limit switch is activated. Additionally, the driver's cabin is protected by a security cage.

Additional features:

- Air condition in drivers' cabin
- Anti-collision system
- Remote maintenance system

TLB – e – Electrically driven bulker cranes up to SWL 45t

- Capacity: SWL 30 - 45t
- Operation: Bulk Carrier

Characteristics:

Based on successful TLB design the TLB-e is a further development in TTS crane portfolio. As part of the TTS e-line, all major parts of the TLB-e (hoisting- and luffing winch as well as slewing motors) are electrically driven.

One of the major benefits of the TLB-e crane is an improved energy efficiency compared to a conventional hydraulically driven crane. One the one hand it is based on less absorbing energy conversions, means that energy from ship generator must not be modified to hydraulic pressure and can be used directly for crane operation.

On the other hand, the TLB-e needs no permanent basic hydraulic pressure, means that energy is consumed only if the crane moves. In combination with usage of reverse power during lowering cargo the benefits for bulk operation are significant.

Another major aspect is the reduction of running costs for maintenance as changing of hydraulic oil, filter and hoses is not needed anymore. High cycle times, a lower noise level and easy operation due to standard controller complete the TLB-e characteristic.

Additional features:

- Air condition in drivers' cabin
- Anti-collision system
- Remote maintenance system

Type V – 4 rope bulker cranes up to SWL 40t

- Capacity: SWL 25 - 40t
- Operation: Bulk Carrier, Transshipment Barges

Characteristics:

This 4-rope grab crane is designed to provide excellent visibility for the crane operator as well as safe and efficient cargo handling. TTS 4-rope grab cranes are designed to operate under rough environmental conditions and to handle with a higher volume of cargo compared to conventional deck cranes.

Additional features:

- Air condition in drivers' cabin
- Anti-collision system
- Remote maintenance system

Container Cranes

Designed for handling of containers, TTS cranes are available as optimized container cranes (type KS) as well as all-round cranes (type DK II Light).Like all TTS NMF cranes, the KS and DK II Light has an unlimited slewing range of 360˚ and the equipment and machinery is mounted inside the crane housing to protect it against maritime atmosphere. Furthermore, loads steps can be changed easily in crane driver’s cabin and each load step is working with 2-fall operation on the hook to avoid changing of wires. Each load step can operate with high speeds for hoisting, luffing and slewing. To guarantee a long lifetime of wires there are only one or two layers on the drum.The DK II Light can be self-locking without jib support to maximize load capacity on board the vessel. Also available in slim edition: Due to extremely narrow footprint (breadth 2.45m; clearance radius 1.225 m), the slim edition crane allows a very high cargo handling capacity.With more than 1200 deliveries the DK II is one of our best sellers.

- Capacity: SWL 36-50t
- Operation: Multipurpose Vessels, Container Vessels

Additional features:

- Auxiliary Hoist
- Personal transport (main- or auxiliary- hook)
- Anti-collision system
- Additional cooler for grab operation
- Monitoring camera system
- Reverse power system
- Remote maintenance system

Cylinder Luffing Cranes

TTS Cargo Cranes are designed to handle a wide variety of lifting applications. The range comprises standard designs and tailor-made solutions as required by the customer. The cranes are designed and built to meet all requirements from ILO as well as relevant authorities, and can be certified by any recognized Classification Society.

Heavy Lift Cargo Cranes

The DK SL is a cargo crane for project, and heavy cargo loads based on the proven DK II Heavy design. As an innovation pioneer, TTS NMF is the undisputed market leader in this segment.The crane is equipped with two pump units for operation redundancy. Even with one pump maximum loads can be handled with half speed. Several design features ensure efficiency and guarantee the reliability and profitability of the equipment.

Like all TTS NMF cranes, the DK SL has an unlimited slewing range of 360˚ and the equipment and machinery is mounted inside the crane housing to protect it against maritime atmosphere. Furthermore, loads steps can be changed easily in crane driver's cabin and each load step is working with 2-fall operation on the hook to avoid changing of wires. Each load step can operate with high speeds for hoisting, luffing and slewing. To guarantee a long lifetime of wires there are only one or two layers on the drum.

- Capacity: SWL 400-1.000t
- Operation: Heavy Lift Vessels, Offshore Operations

Additional features:

- AHC-winch preparation
- Auxiliary Hoist
- Sling Hoist
- Tugger winch system
- Jib locking device
- Slewing gear locking device
- Personal transport (main- or auxiliary- hook)
- Anti-collision system
- Additional cooler for grab operation
- Monitoring camera system
- Reverse power system
- Park assistant system
- Remote maintenance system

Offshore Cranes

The quality of onboard equipment is vital in the efficient performance of an offshore vessel, ensuring smooth operation and minimizing downtime. From the inception of the offshore industry in the North Sea, TTS has been an active partner in developing cranes that can withstand the extremes of such a harsh environment. TTS has developed advanced and reliable system technologies. A comprehensive portfolio of cranes and winches – including advanced active heave compensated solutions – is available to meet the wide range of requirements. In line with tomorrow's lifting requirements and performance demands, TTS also has developed an exclusive portfolio for offshore lift operations.

A-frames: TTS offers a complete range of A-frames with lifting capacities up to 350 tons and a working radius tailor made to suit any vessel design. The A-frames is designed for offshore applications on all types of vessels operating under offshore conditions.

Options:

- Integrated power packs
- Separate power packs
- Remote control
- Additional wire sheaves
- Winch to work with A-frame (with and without AHC)

Our A-frames can be delivered to operate either with anchor handling/towing winches or by active heave compensated subsea winches.

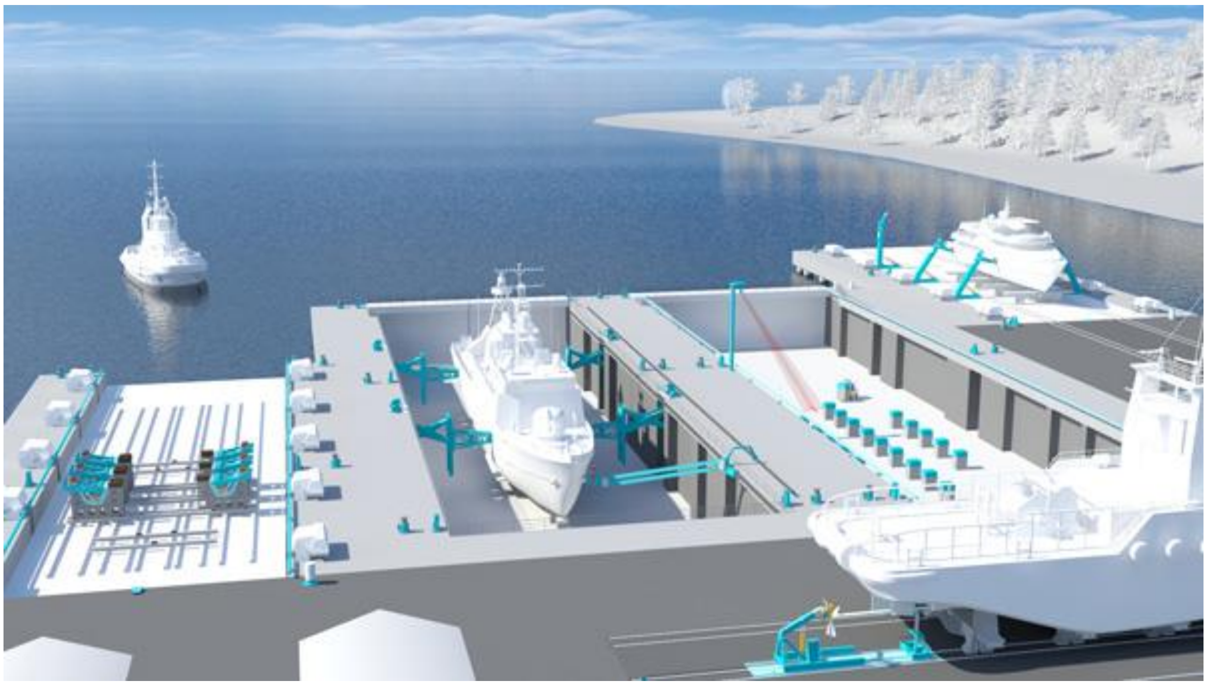
Active heave compensated: TTS offers a complete range of active heave compensated offshore cranes. All our cranes are tailor made to meet our customers' requirements and can be delivered in several configurations. With large customer base operating in the harsh environment of the North Sea, TTS has developed products known for their rugged construction, with functionality and safety as key design factors. Our active heave compensated system is among the most advanced in the marked and can offer your vessel substantial operating conditions.

A-frames cranes

AHC Cranes

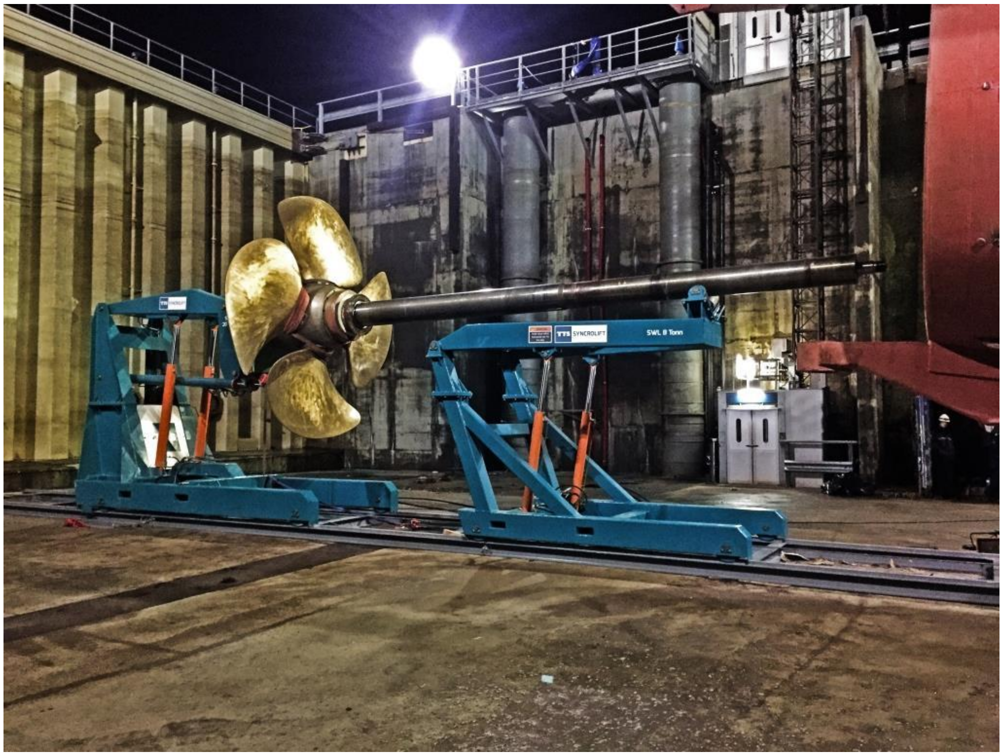
Fast Docking

Efficiency in docking, launching and repair operations of ships is influenced by which solutions are used. TTS is continually developing smarter solutions which will improve productivity and speed of operations. An example is blocking solutions. The blocking wood used for stabilizing a ship is not a value gain seen from a shipowner point of view. It is possible to source solutions which avoids these cost and TTS have several options available. The Propeller Puller is another example of a bulky not easy to handle operation. The TTS Propeller Puller is custom designed to quickly and efficiently handle propellers/shafts/rudder.



Propeller Puller

TTS Syncrolift Propeller Puller is used for inserting and extracting propellers and axle shafts for new build projects or maintenance on existing vessels. The Propeller Puller does not require welding of pad eyes for time consuming chin block operations. It saves time, increases safety and allows the operators to control the angle of the shaft to ensure there is sufficient clearance to the main bearing. In addition, the Propeller Puller can be utilized for a number of other uses around the shipyard including rudder removal, bow thruster replacement and stabilizer fin maintenance.

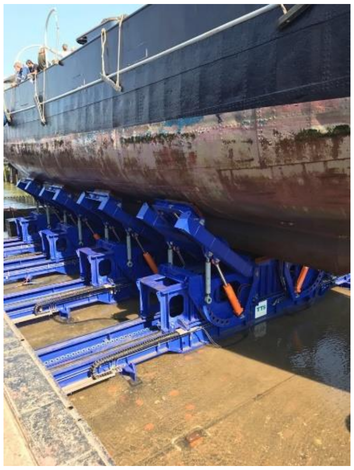


Standard Specification

- Propeller Puller max 20 tons
- Propeller Shaft Support max 8 tons
- Propeller Shaft Diameter min 150 mm / max 500 mm
- Propeller Diameter max 6 m
- Height to Propeller Shaft min 1,8 m / max 4 m
- Length of Shaft max 20 m

Multi-Vessel Docking

This uniquely designed TTS Syncrolift system, can handle the most demanding vessels. It is a flexible system which can adjust to accommodate different hull types and propeller/skeg locations. This system is ideal for docking tugs with high keels and/or low rotor propellers. This system has TTS Syncrolift's automatic Bilge Support Arms to simplify the blocking process. It can be fitted on existing as well as new shiplifts, and can be integrated with a transfer system to move the ship into a dry working berth.

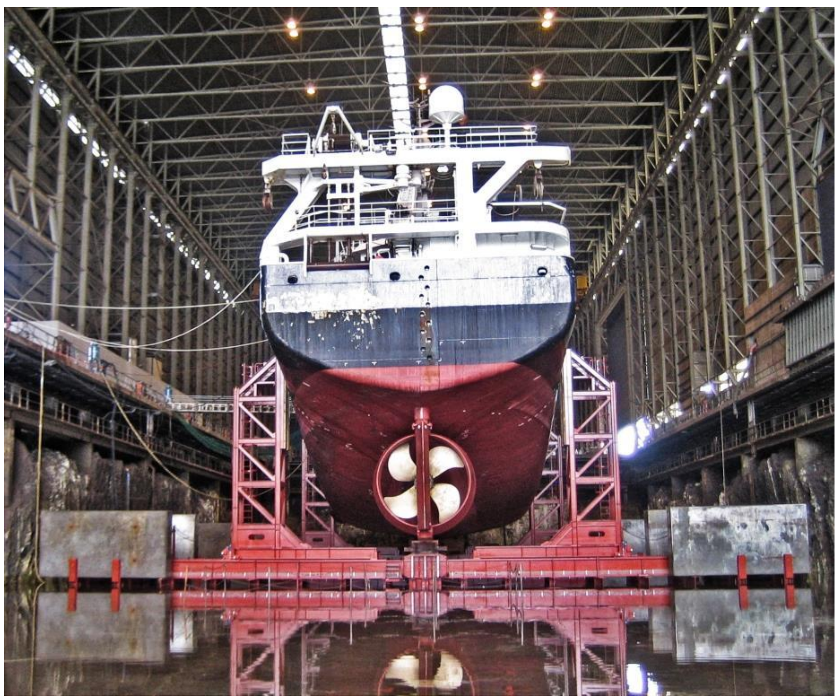


- Interchangeable Modular Blocks for height adjustment
- Modular Blocks move along the Transverse Beam to allow vessels to enter
- Live monitoring of distance that the Modular Blocks move
- Live monitoring of loads on the Bilge Support Arms
- Bilge Support Arms conform to the hull curvature

Dock Side Support Arms

TTS Syncrolift AS has developed efficient Side Support Arms for both dry and floating docks. The Side Support Arms can be installed as part of a new build project or integrated into an existing dock. This system is visible above the water surface so you can see the ship is supported before the water is removed. It also centers the vessel to ensure it is aligned with the blocks on the dock floor.

- Synchronized arm operation for vessel centering
- Supports the vessel whilst docked
- Advanced control system with live monitoring of arm loads and distance
- Increases productivity
- Improves safety



Bilge Support Arms

TTS Syncrolift Bilge Support Arms can be incorporated into the TTS Transfer System, or be delivered as individual units to be placed, for example, in a drydock. The Bilge Support Arms consists of a basic cradle design with a keel blocks and hydraulically operated tilting arms. The tilting arms have wooden bilge blocks gimbaling at the end. This support conforms to the shape of the hull. During docking, the tilting arms rise and press on to the hull with a minor force of one metric tons, while they resist the force of 50 metric tons. When the ship is dry, the arm is secured with a bolt. The TTS Bilge Support Arms are operated from a mobile hydraulic power pack.

- TTS Bilge Support Arms can significantly increase your docking capacity by increasing the docking productivity
- The systems save human power and gives the ship an exact docking position
- Portable units that are easy to install
- Live monitoring of arm loads

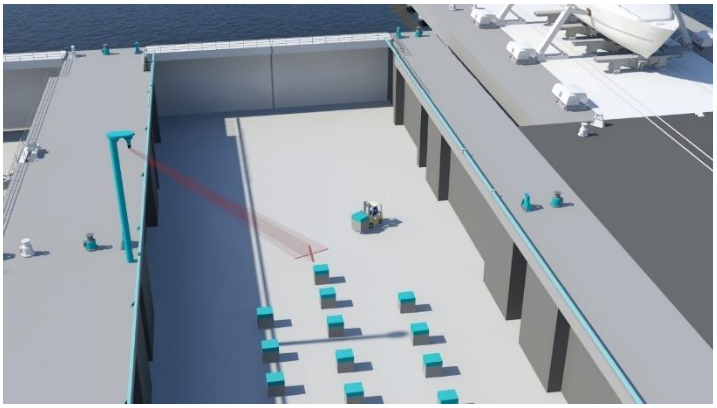
Shiplift Support Arms

Shiplift support arms enable primarily, man-hour savings, a higher blocking accuracy and a faster docking. The shiplift support arms allow the ship to be drydocked without the need for bilge blocking. Once the ship is on the shiplift platform/land level, workers may start inserting bilge blocks to stabilize the vessel ready for transfer. To carve bilge blocks directly to the ships profile is faster time wise, require less man-hours and is more accurate than estimating blocking for a "virtual" ship.

Inhaul & Positioning System

The Inhaul System guides the ship in over the shiplift, this ensures that the ship does not make contact with the shiplift piers/foundations. The Positioning System positions the vessel correctly above the shiplift, therefore when the shiplift and trestles are hoisted up, the ship lands accurately on the trestles. This prevents the ship from being damage in the lifting process.

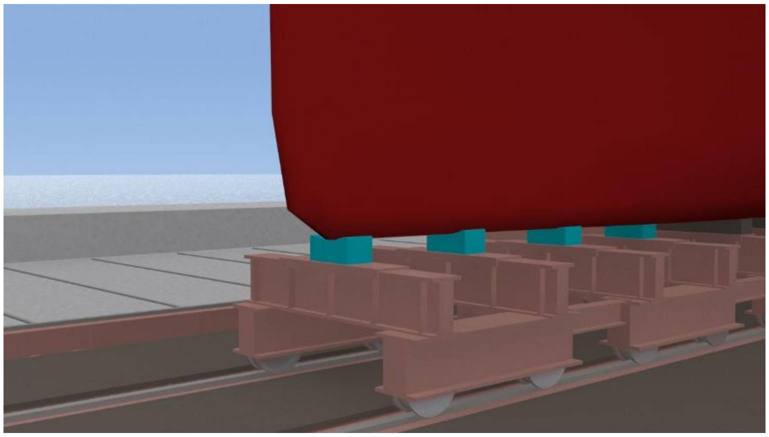
Auto Block Guiding



Blocks have to be placed on the dock floor before the ship can enter the dry dock. These blocks have to be placed accurately according to the docking plan, to ensure the ship is not damaged. This takes time. To simplify this process, TTS Syncrolift has designed a Laser system, that from the docking plan plots out where to place the block, thereby makes the whole process faster and more accurate.

Flex Pad

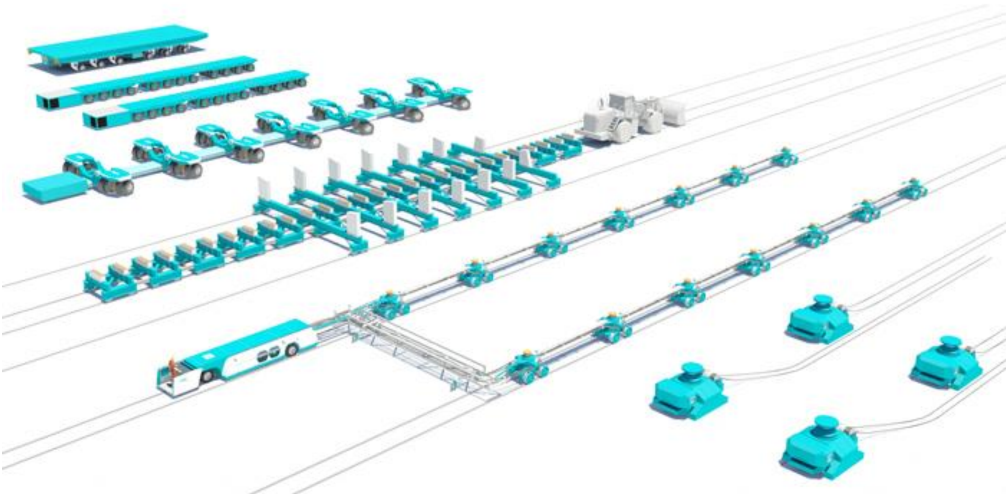
TTS Syncrolift believes that smart green thinking is the best solution for the earth and us, it can make products and work processes better and smarter. Usually hard and soft wood is used in blocking, The wood has to be replaced regularly. Our green solution is to replace the hard and soft wood with a rubber block. This rubber blocking lasts longer, and will in the long turn be a cheaper, better and greener solution.



Transfer Systems

TTS Syncrolift AS supply vessel and heavy load transfer systems tailored specifically to meet individual customer requirements. The transfer systems offered by TTS can be customized based on a number of factors, including:

- Lifting Capacity
- Lifting Length
- Zone Support (Fluid Bed)
- Wheel System, Rail wheel or Rubber tire



Required Port Facilities and Equipment for Major Ports

(The Study on the Red River Inland Waterway Transport System)

(1) Required length and depth of berth

In order to handle increasing cargoes at major ports of Hanoi, Khuyen Luong, New North and New East, 1.5 km of berth (additional length: 0.8km) and 3.0km of berth (additional length: 2.3km) will be required in 2010 and in 2020respectively

Required water depth of berth is 2.5m below the 95% water level for vessels/barge trains deployed in the RRD by 2010 and 3.6m for Sea-cum-river vessels by 2020.

(2) Required handling equipment

For handling bulk cargoes, quayside mobile crane, grab bucket, shovel loader, bulldozer and dump truck will be used and for non-bulk cargoes, quayside mobile crane, forklift, truck and pallet will be needed. For handling containers, quayside mobile crane (heavy type), forklift (heavy type), tractor and trailer will be used.

(3) Required land space

Space for storage yard (construction material and coal), warehouse, road, utility and reserve area are required. And in a port handling containers, ICD (inland container/clearance depot) consisting of CY (container yard), CFS (container freight station) and DC (distribution center) is also needed.(4) Required number of access road lanes133.Access roads between major ports and dyke road or Ring Road No.3 will have to be constructed. Two lanes will be required for all major ports.

(5) Required elevation of port facilities

Crown elevation of berths in major ports shall be set at a level slightly higher than Warning Water Level III (+11.5m at Hanoi Station). Ground elevation of roads, storage yards and warehouses shall be set at a level higher than that of berths in order to avoid traffic blockade and/or degradation of commodity value due to flooding.

LIBHERR Group Port/ Cargo Handling Equipment

Ship to shore container cranes

In the modern port environment, reliability and productivity are the key parameters. Ship to shore container cranes (STS) from Liebherr achieve up to 99.6% availability during actual vessel operation. Ship to shore container cranes are custom designed with a range of outreaches and specification detail according to individual customer requirements from panamax size through to the largest megamax cranes. Safe working loads from 40 to 120 metric tons are available in single, twin and tandem lift configuration.

Super efficienct post panamax cranes, Khorfakkan

Super post panamax cranes work vessels with up to 19 containers across on deck. This selection of Liebherr super post panamax and megamax cranes have earned Khorfakkan (United Arab Emirates) a reputation for being one of the world's most efficient ports.

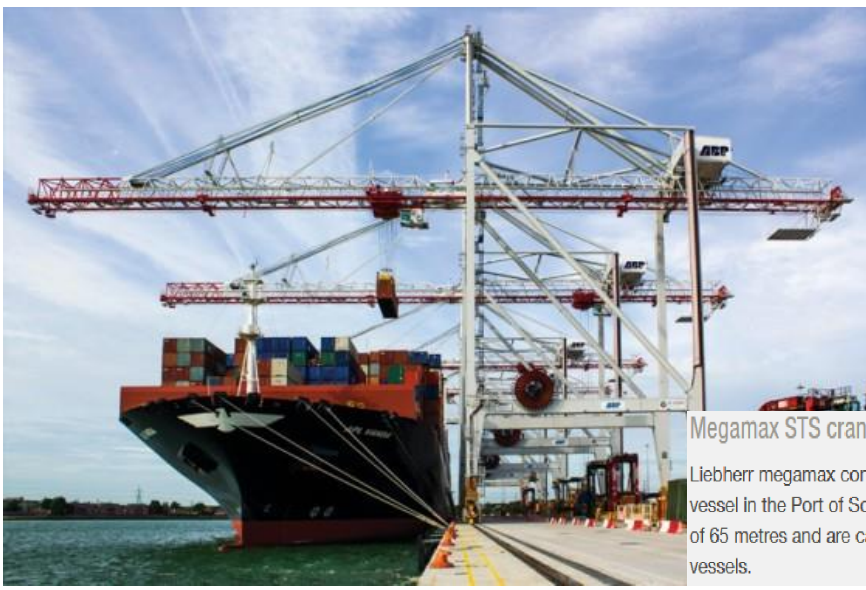
Product Information

Features

- Design utilizes high tensile steel with lattice main beam and boom using box profiles
- Unique boom/beam hinge point
- Simultaneous drive motion of gantry, trolley and hoist
- Power regeneration
- High performance trim/list/skew and anti-snag technology
- Self-powered trolley
- Rigid robust structure - Optimum for automation
- Direct driven travel systems
- Liebherr designed and built drive systems
- Reputable European sub suppliers

Advantages and Benefits

- Designed and built by Liebherr in Ireland for over 45 years
- Industry leading availability
- High performance cranes with a lower self-weight and center of gravity
- Liebherr drive systems
- Increased productivity compared with alternative designs
- High reliability and low downtime
- Rigid and stable structure
- Improved performance where high in-service winds prevail
- Accurate spreader positioning
- Anti-sway reeving
- Optimum driver comfort due to ergonomic cabin and unique Liebherr hinge point design
- Precision simultaneous drive motion in three axes
- Low lifecycle costs



Megamax STS cranes at DPWorld Southampton

Liebherr megamax container cranes working an ultra large container vessel in the Port of Southampton (UK). These cranes have an outreach of 65 metres and are capable of working the world's largest container vessels.

Mobile Harbor Cranes

Unique technology such as the optimized undercarriage concept or the inhouse-developed crane control system make Liebherr mobile harbor cranes among the most powerful material handling equipment in the world. The flexibility of the mobile harbor crane makes it effective for all areas of application in the harbor and thereby guarantee the highest level of effectiveness.

LHM 120

Mobile Harbor Crane

The LHM 120 has been designed especially for coaster ships. The primary focus is on speed, precision and safety. The flexibility of the LHM 120 mobile harbor crane also enables the handling of all types of goods with a cubic capacity of up to 42 tons. The undercarriage with rubber types ensures mobility at ports.

- Lifting capacity (max.)42 t
- Jib length 30 m
- Total weight 124 t
- Hoisting/lowering max.90 m/min

Features

- Stage IV / Tier 4 final engine
  The Liebherr mobile harbor crane is equipped with the latest generation of diesel engines for the exhaust emissions standards of EU stage IV or EPA Tier 4 final.
- Driver's cab
  Noise protection, windshield wiper, air conditioning. The ergonomic and comfortable features of the cab increase the concentration and reduce the fatigue of the crane operator – for consistently high productivity and a high level of safety.
- Four-rope grab control
  The synchronization of the winches is monitored and optimized by the four-rope grab control.
- Hydrostatic drive
  Closed hydraulic loops are used for all main functions such as lifting, turning and luffing. The crane operator benefits from extremely precise control, the service personnel benefit from a minimum number of components and the operating company benefits from reduced fuel consumption.
- Pull cylinder
  The pull cylinder over the boom offers many advantages: no collision with swinging load, no buckling of the cylinder and full protection of the piston rod in park position.

LHM 800

Mobile Harbor Crane

The LHM 800 is the most powerful mobile harbor crane in the world. Owing to its huge dimensions, the crane handles large freighters with a width of up to 22 rows of containers. Thanks to its maximum lifting capacity of over 300 tons, the crane is particularly suitable for the handling of heavy industrial goods. The bulk cargo capacity of this giant is also unique at 2,300 tons per hour.

- Lifting capacity (max.) 308 t
- Jib length 64 m
- Total weight 742 t
- Hoisting/lowering max. 120 m/min

Features *(similar to LHM 120)*

Areas of Application in the Harbor

- **Container handling:** Speed and precision. Transportation in standardized containers characterizes the worldwide goods traffic.
- **Stacking**
- **Bulk handling:** Maritime cranes ensure trouble-free handling of bulk goods in harbor areas. Reliability and economy during operation are at the forefront here.
- **Scrap handling:** Sturdy machines are decisive for cost effective scrap handling. With the focus on high quality during production, the service life of our equipment is thereby prolonged.
- **Heavy Lift:** These days, harbor-based heavy-duty cranes are simply indispensable in the logistics chain of modern goods traffic. They are the right tools for all kinds of cargo.
- **General cargo:** For cargo handling, it is above all flexibility that is required. The fast and uncomplicated exchange of lifting gear makes Liebherr cranes all-round talents.

Fixed Port Solutions

Space-saving crane installations for use on quaysides, in harbors and in dockyards are part of our extensive portfolio. These cranes are mounted on fixed pedestals and are deployed throughout the world.

FCC 230

The FCC-230 is particularly suitable for the rapid handling of general cargoes and containers on ships up to Handymax class. Its low weight means it can be used in areas with low load-bearing capacities. The cylinder luffing design is very maintenance-friendly and enables load-bearing capacities up to 45 tons at a working radius of maximum 29.5 meters.

- Max. lifting capacity 45 t
- Jib length 29 m
- Hoisting/lowering max. 44 m/min
- Slewing max. 0.70 rpm
- Mobility fixed
- Fields of application   Container handling / Bulk handling / General cargo operation

FCC 320R

With a maximum load-bearing capacity of 200 tons, the FCC 320R is suitable for heavy-duty use at ports and quays. The rope-grab design makes the crane very rigid, which makes heavy-duty use stable and safe.

- Max. lifting capacity   200 t
- Jib length 24 m
- Hoisting/lowering max. 44 m/min
- Slewing max. 0.56 rpm
- Mobility fixed
- Fields of application General cargo operation / Heavy lift

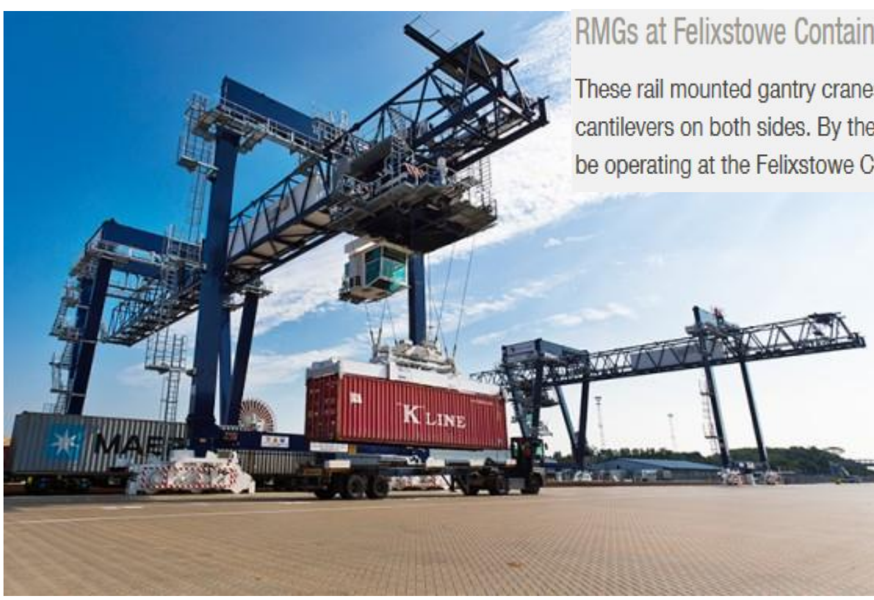
Rail mounted gantry cranes

Rail mounted gantry cranes (RMGs) are manufactured to individual customer needs in a variety of different stacking heights and spans. Supplied with Liebherr's 8 rope reeving anti-sway and drive systems, the Liebherr rail mounted gantry crane delivers exceptional productivity and reliability. Available with stacking heights of up to eight containers high, with custom spans in excess of 70 meters and outreaches up to 20 meters, each RMG features Liebherr’s crane management and reporting software and is designed for manual, semi-automatic or automatic operation. The application of Liebherr’s eight rope reeving anti-sway system and simultaneous motion of all drives leads to increased productivity when compared with alternative designs.

Product Information

Features

- Liebherr's unique eight 8 rope reeving anti-sway system
- Simultaneous drive motion
- Power regeneration
- Rigid robust structure - Optimum for automation
- Direct driven travel systems
- Liebherr designed and built drive systems
- Reputable European sub suppliers
- Anti-crabbing technology in gantry travel direction



RMGs at Felixstowe Container Terminal

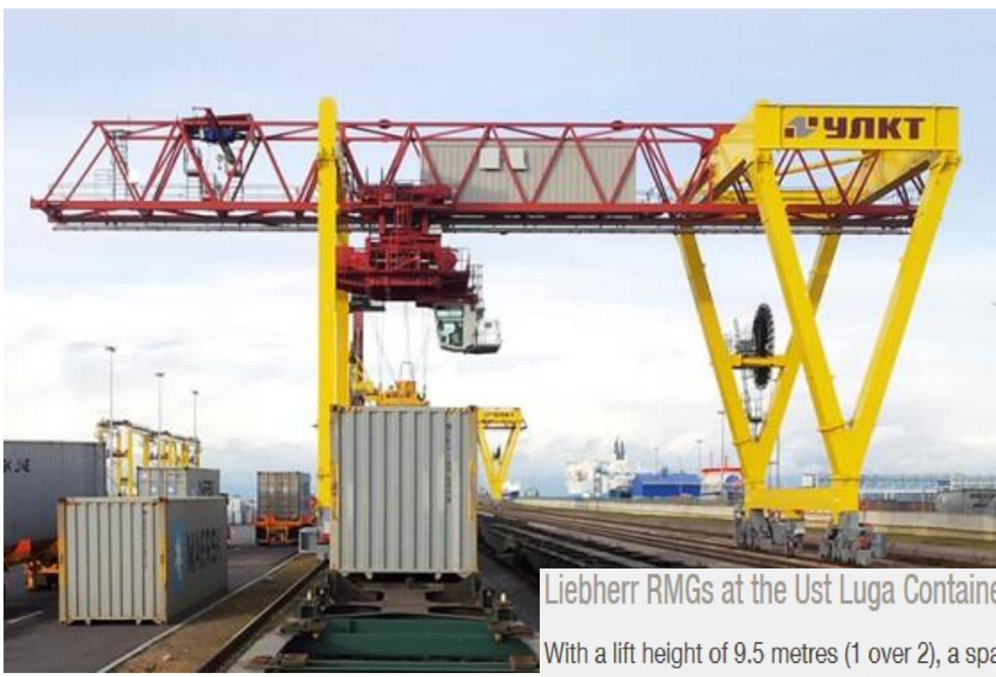
These rail mounted gantry cranes have a span of 31 metres and feature cantilevers on both sides. By the middle of 2015, five Liebherr RMGs will be operating at the Felixstowe Container Terminal (UK).

Advantages and Benefits

- Exceptional anti-sway performance
- Accurate spreader positioning - no headblock - better visibility
- No headblock, reduced tare weight
- Increased productivity compared with alternative designs
- Low maintenance and spare part costs
- Smooth gantry operation
- Improved performance where high in-service winds prevail
- Optimum design for automation
- In-house expertise and excellent aftersales service
- Lower energy costs
- Spreader side shift eliminated due to simultaneous motion

Options

- Rotating machinery trolley
- Remote control
- Remote access to crane management
- Interface with TOS
- Destination control
- Container stack profiling
- Container positioning system
- Automation | Semi automation



Liebherr RMGs at the Ust Luga Container Terminal (Russia)

With a lift height of 9.5 metres (1 over 2), a span of 22.3 metres and a small cantilever outreach these RMGs are ideally suited to working a rail fed intermodal terminal.

Dockyard cranes

Electro-hydraulic slewing cranes from Liebherr for deployment in dockyards offer cost effective and space-saving handling solutions for the shipbuilding industry. Dockyard cranes are available on rail-mounted, travelling gantries (TCC) and are particularly suitable for operation in areas with restricted space. Due to their design, the Liebherr dockyard cranes are also ideal for sites where only low ground pressures are permissible. The lattice boom, with its low self-weight, achieves the requisite high outreaches. Auxiliary hoists, which are available as an option, enable low loads at extended outreaches with extremely fast hoisting speeds.

- Load bearing capacity 5 - 60 tons (higher load bearing capacity possible)
- Reach 6.5 - 60 meters

TCC 6000-600 Dockyard crane in Operation in Philippines

“Hazards in Ports and Docks”

HEALTH AND SAFETY AUTHORITY

“Chemical Agents”

“Risk of:

- Adverse health effects e.g. respiratory problems.
- Fire.
- Death.

Possible causes:

Exposure to:

- Dusty cargoes or respiratory sensitizers.
- Flammable, toxic, poisonous or corrosive cargoes.
- Fumigated cargoes.
- Gases due to decomposition or bacterial action of some cargoes.
- Vehicle exhaust emissions.”

“Environmental Conditions”

“Risk of:

- Increased risk of an accident or incident.

Possible causes:

- Weather: cold or wet weather can reduce concentration and make manual tasks more difficult.
- Tidal movements can have an effect on the safety of access to ships and increase the risk of collision between dockside equipment and the vessel.”

“Fatigue”

“Risk of:

- Increased risk of accident or incident through poor perception or physical exhaustion.

Possible causes:

- Lack of job rotation.
- Unpredictable ship arrival times.
- Requirement for a fast turnaround.
- Long hours, pace and intensity of the work.
- Physically demanding nature of the job - close to sailing time the work becoming more frantic.
- Excessive glare or inadequate lighting.
- Working in cramped, confined conditions.”

“Lifting Operations”

“Risk of:

- Serious injury or death due to being hit by falling or moving object.

Possible causes:

- Loose, incorrectly or poorly slung fittings and fixtures.
- Unstable or poorly loaded cargo.”

“Mooring”

“Risk of:

- Sprains, strains and musculoskeletal disorders.
- Serious injury or death.

Possible causes:

- Manual handling of heavy, awkward or wet ropes.
- Being caught in the ropes or winches on board the vessel.
- Back lash if the rope breaks on the dock or jetty.”

“Slips, Trips and Falls”

“Risk of:

- Minor injury, concussion, serious injury or death.

Possible causes:

- Wet or icy surfaces.
- Poor housekeeping.
- Badly stowed ropes, cables, lashing gear.
- Inadequate lighting.”

“Manual Handling / Ergonomics”

“Risk of:

- Sprains, strains and musculoskeletal disorders.

Possible causes:

- Operating container cranes, straddle carriers, tug masters and so on.
- Lifting, carrying and maneuvering loads, lifting gear and attachments.”

“Work at Height”

“Risk of:

- Serious injury or death due to a fall from height.

Possible causes:

- Carrying out trimming, sheeting, container lashing operations, securing loads, accessing the hold and working on board the ship.
- Working around unfenced dock edges.
- Inadequate access to the ship.”

“Workplace Transport”

“Risk of:

- Serious injury or death e.g. being run over, crushed or falling from a vehicle.
- Property damage.

Possible causes:

- Lack of traffic management.
- Unsafe systems of work.
- Mounting and dismounting from vehicles.
- Lack of pedestrian and vehicle segregation.”

"HSE: A quick guide to health and safety in ports"

Introduction

"Ports are often challenging places to work. You may be dealing with a whole range of cargoes and working alongside a wide variety of people, including some who don't speak English. Work at ports takes place throughout the day and night and in all types of weather. There are often pressures to load or unload a ship's cargo quickly to catch a tide or to free up a wharf. Visiting drivers want to pick up or drop off their cargo as quickly as possible and get back on the road. These factors make it an exciting but also a potentially high-risk industry to work in. Ever-changing circumstances lead to ever-changing risks. Companies must put appropriate health and safety measures in place to manage these risks properly."

"Main legal requirements"

"Under the Health and Safety at Work etc. Act 1974 (HSW Act), employers, people in control of premises, the self-employed and employees must ensure the health and safety of others and themselves."

"There are also regulations that apply to all industries because many of the hazards will be the same. But some industries do have specific pieces of legislation. In the port industry, these include:

- the Docks Regulations 1988
- the Dangerous Substances in Harbor Areas Regulations 1987
- the Loading and Unloading of Fishing Vessels Regulations 1988.

The Approved Code of Practice Safety in Docks (COP25) covers the Docks Regulations 1988 but much of that material has been repealed and replaced by more recent legislation. See 'Want to know more?' at the end of this guide for details.

The HSW Act and associated regulations do not apply to seamen working onboard ship under the control of the ship's master. Comparable Merchant Shipping Health and Safety Regulations do apply to ships' crew and are enforced by the Maritime and Coastguard Agency (MCA)."

Health and safety Management in ports

"Port work often involves a number of different employers and/or contractors who can all affect each other's activities. These may include harbor authorities, port operators, stevedoring firms, hauliers, ships' masters and crew. Companies need to have strong and effective health and safety systems in place. These should ensure co-operation, co-ordination and communication between all employers and their workers. The Management of Health and Safety at Work Regulations 1999 set out a number of requirements for employers to ensure they are adequately managing health and safety. These include:

- a risk assessment of their activities. This should identify the measures they need to have in place to comply with their duties under health and safety law and reduce risks so far as is reasonably practicable
- making sure there is effective planning, organization, control, monitoring and review of the measures they put in place
- appointing a competent person to provide health and safety assistance.
- A competent person is someone with the necessary skills, knowledge and experience to manage health and safety
- providing employees with information they can understand – including people whose first language is not English and
- co-operation and co-ordination with other employers sharing a workplace.

HSE's Managing health and safety in dockwork (HSG177) provides more detailed guidance on the management responsibilities of the many employers and contractors involved in the industry."

"Consulting with workers"

"By law, employers must consult with all their employees on health and safety matters. Consulting employees about health and safety can result in:

- healthier and safer workplaces – as worker input is valuable to identify hazards, assess risks and develop ways to control risks
- better decisions about health and safety – because they are based on the input of workers who have knowledge of the job
- stronger commitment to implementing decisions or actions – because employees have been actively involved in reaching these decisions
- greater co-operation and trust.

In some instances, subsidies may be available for training safety representatives."

"Which laws apply?

- Safety Representatives and Safety Committees Regulations 1977 – for employers where trade unions are recognized by the employer and representatives have been appointed.
- Health and Safety (Consultation with Employees) Regulations 1996 – for employers where trade unions are not recognized."

ILO code of practice: Safety and health in ports

Responsibilities

General requirements

"Safety in ports is the responsibility of everyone who is directly or indirectly concerned with work in ports and needs to cooperate to develop safe systems of work and ensure that they are put into practice. The introduction of new ideas and concepts in cargo handling demands that special attention be paid to safety requirements. The guidance given in this code of practice relates to both new and existing working practices."

Competent authorities

"When more than one authority is responsible for drawing up relevant legal requirements that apply to ports, it is essential that they liaise in order to ensure that their requirements are consistent with the relevant international instruments.

Competent authorities should ensure that legal requirements on safety and health in ports are put into practice. These should clearly define the bodies responsible for enforcing them and clearly identify duty holders. Enforcement bodies should also carry out accident and injury prevention activities, including the provision of appropriate information.

It is highly desirable that occupational safety and health regulations in each country be based on relevant international texts, including instruments adopted by the International Labour Organization (ILO), the International Maritime Organization (IMO) and the International Organization for Standardization (ISO). The legal requirements relating to port work should implement the provisions of Convention No. 152 and should apply to ships of all flags when in a port.

Legal requirements should be framed in goal-setting terms, specifying the objectives to be achieved, rather than being prescriptive, thus allowing flexibility in the methods of achieving the objectives. This code will help competent authorities to publish guidance on how the objectives of their legal requirements based on Convention No. 152 can be achieved."

Port infrastructure, plant and equipment

General provisions

Separation of people and vehicles

“With the mechanization of cargo-handling operations, the design, layout and maintenance of port infrastructure and plant and equipment have become increasingly important. As vehicles and mobile plant are now one of the main elements in fatal and serious accidents in ports, people should be separated from vehicles whenever this is practicable.”

Surfaces

“The surface of port areas should be:

- of adequate strength to support the heaviest loads that
- will be imposed on them
- level, or with only a slight slope
- free from holes, cracks, depressions, unnecessary kerbs or other raised objects
- continuous
- skid resistant.”

“The possible need for future repair should be considered when selecting surface materials. As asphalt can be damaged by oil, fuel and other solvents, spillages should be cleaned up immediately to preventor minimize damage. Plain metal surfaces, such as those on brows or ramps, can become slippery, particularly when wet. The use of chequer plate or other plates with raised patterns or non-slip coatings should be considered. Wooden structures should be built of wood that is suitable for use at the location in question. Additional protection may be provided by the use of suitable preservatives. Wood should not be covered with asphalt or other materials that will hide its condition and may lead to accelerated hidden rot or other deterioration. Plastic surface coverings can include a variety of non-slip finishes. All surfaces other than ramps, etc., should be as level as reasonably practicable while providing adequate drainage. Any slope on quays or other operational areas should not exceed 1 per cent and should not slope towards the edge of a quay. Drainage systems should include appropriate interceptors to prevent maritime pollution. Ramps or slopes used by lift trucks or other cargo handling vehicles should not have a gradient steeper than 1in 10 unless the vehicles have been designed to operate safely on such a gradient.”

Lighting

“Adequate lighting of all working port areas should be provided during the hours of darkness and at times of reduced visibility. Different levels of lighting may be appropriate in different areas. On access routes for people, plant and vehicles, and in lorry parks and similar areas, the minimum level of illumination should not be less than 10 lux. In operational areas where people and vehicles or plant work together, the minimum level of illumination should not be less than50 lux. Light meters should be able to read to an accuracy of1 lux. Meters should have a wide angle of acceptance in order to minimize errors due to directionality or low sensitivity to differing types of light sources, or be provided with the relevant correction factors. Light measurements should normally be taken in the horizontal plane 1 m above the ground or other working surface. Measurements at a lower level may be necessary where there are obstructions that might conceal a tripping hazard. The meter should not be oriented towards a light source. Records should be kept of all lighting measurements. These should include the date, time, weather conditions, location and details of the lighting and light meter. Higher levels of lighting may be required at particularly dangerous places, such as shore gangways, accommodation ladders, steps and other breaks in quays or where detailed work is necessary. Where a higher level of lighting is required only occasionally, it may be provided by mobile or portable equipment. Lighting should be as uniform as practicable. Sharp differences in lighting levels should be avoided. The choice and positioning of light sources and each installation should be planned individually. Lamps emitting monochromatic light, such assodium-vapor lamps, give a good light in foggy weather but distort colors and may lead to confusion. They should be confined to non-operational areas. In operational areas, fluorescent or other lamps, which give a light more similar to daylight, should be used. Tall lamp standards (over 12 m high) carrying several lamps can each illuminate a large area, cause less obstruction and reduce areas of shadow between containers. Lamp fittings should be provided with shades and diffusers to prevent light pollution and glare. Particular attention should be paid to preventing dazzle to small ships from reflection of light on water. Lamp standards should be designed to allow the lamps to be cleaned and changed in safety. At ports where operations do not take place for24 hours per day, arrangements should be made to ensure that crews of ships berthed in the port have safe access to and from their ships. This may be ensured by the provision of sensors or switches on lamp standards on authorized walking routes that turn on lights for an appropriate period."

Fire precautions

General requirements

"Fire precautions in ports should be provided in accordance with national legal requirements. These should consist of:

- fire protection
- fire alarms
- fire-fighting equipment
- means of escape in case of fire.

Advice on fire-related matters should be obtained from fire authorities and insurance companies. Industry specific advice may be available from appropriate industry organizations."

Fire protection

"The principles of fire protection at ports are no different from those in other industries. Whenever practicable, buildings and structures at ports should be constructed of non-combustible materials. Where this is not practicable, structures and construction materials that will reduce the probability of fire and limit the consequences of any that do occur should be selected. National or local legal requirements generally set out standards for buildings or compartments (subdivisions of a building), particularly those where flammable or other dangerous substances are kept. Generally, fire separation walls should have a fire resistance of at least two hours. Large buildings should be partitioned into fire resistant compartments that do not exceed 9,000 min area. Fire separation walls of a building or compartment should not have holes or gaps in them. Any doors that are necessary in such walls should be fire-resistant and self-closing. Spaces where services pass through fire separation walls should be fire protected. Sources of ignition should be rigorously controlled, particularly in warehouses and other places where flammable materials are likely to be present."

Fire alarms

"An effective fire alarm system should be provided throughout port areas. This may be by "break glass" fire alarm points or otherwise. If the system involves the use of a radio or telephone system, the system should operate at all times. Automatic systems can be arranged to sound alarms in relevant areas, alert the fire authority and operate automatic fire-extinguishing appliances, as appropriate. In large premises, it may not be necessary to alert all persons in the port area immediately in the event of a fire, and a staged fire alarm system that allows different areas to be alerted may be appropriate. The fire alarm system in any building should be audible throughout the entire building. The fire alarm system should be maintained in a fully operational condition at all times, particularly when maintenance work or alterations to premises are in progress."

Fire-fighting equipment

"Appropriate means for fighting fire should be provided throughout port areas. These should include both portable first-aid fire extinguishers and fixed systems such as hoses and hydrants. The location, type and number of fire-fighting equipment should be determined in accordance with national and local legal requirements. Portable fire extinguishers should be grouped at clearly marked fire points. Fire points should be identified by clear and conspicuous signs or markings. These should be visible at all times and not obstructed by cargo or plant. If necessary, signs should be raised so that they can be seen above stored goods. Fire points should be located in such away that the equipment can be brought into use quickly. Hydrants at warehouses should be close to doors. All fire-fighting equipment and systems should be tested at regular intervals. The choice of fire-fighting agent is determined by the type of fire that is likely to occur and the nature of materials that are likely to be involved. The use of an inappropriate fire-fighting agent can be extremely dangerous. The most commonly used fire-fighting agents are:

- water
- foam
- carbon dioxide
- powders.

Water is the most common fire-fighting agent and is suitable for use on most general fires. As well as extinguishing most fires, it also cools the surrounding area thus reducing the chance of the fire re-igniting or spreading. The intake of a fixed fire main that takes water from a port should be below water at all states of the tide. Hydrants should not be more than 80 m apart. International ship–shore connections to enable fire mains to be connected to those on ships (figure 2) should be available at all berths in accordance with IMO Resolution A.470(XII),and should conform to the dimensions in regulation II-2/19of IMO International Convention for the Safety of Life at Sea (SOLAS), 1974.Water pipes and hoses should be protected against collapse, impact by wheeled traffic or falling goods and frost. Water and water-based foams should never be used to fight fires involving electrical equipment or chemicals that may react violently with it. The shelf life of all chemicals used to make chemical foams should be determined and stocks renewed periodically. Portable carbon dioxide extinguishers should not be used in confined or unventilated spaces. If a total flooding system is installed, it should provide an audible prewarning of discharge in the protected space. This should be distinguishable from the fire alarm and give sufficient time for persons to escape before the discharge."

Means of escape in case of fire

"Adequate means of escape in case of fire should be provided from all places in ports and should lead to safe places outside buildings. Escape should normally be available by at least two different routes, except where very small travel distances are involved. Fire assembly points to which persons can safely go in the event of a fire should be clearly identified. Suitable access routes for emergency services in the event of fire should be provided throughout the premises. These should be clearly signed and kept clear of obstructions at all times."

Traffic routes

Roadways

"Suitable roadways should provide safe access for vehicles to all parts of port areas. Wherever practicable, vehicles and pedestrians should be separated. The width of roadways should be suitable for the traffic that is likely to use them. This should take into account the width of vehicles and their loads, and their ability to maneuver. Traffic lanes should generally be at least 5 m wide. Under gantry quay cranes and in other restricted locations, a width of 7 m may be necessary to provide adequate clearances. Lanes wide enough for road traffic should be provided between rail tracks and rubber-tired gantries along quays. A 2 m clearance should be left along quaysides to enable a 1 m unobstructed access for personnel to be available. Roadways should be sited so as to allow the road ahead to be clearly visible for an appropriate distance. Sightlines should not be obstructed by corners of buildings, stacked goods or other obstructions. Roadways should be separated from any fixed obstacles by a clearance of at least 900 mm. Roadways should be unidirectional. Where this is not practicable, separation of the traffic streams by traffic cones, or otherwise, is desirable on all main traffic routes. The edges of roadways should be clearly delineated by pavements or other clear markings. These should be clearly visible by both day and night. Yellow or white reflective road paint can be used for this purpose. Particular attention should be paid to the design of any roundabouts (traffic circles) found to be necessary. Elongating the traffic island in the roundabout, rather than making it circular, can help to prevent overturning of vehicles. Wherever practicable, the layout of roadways should be standardized throughout the port areas. Provision for the safe parking of vehicles should be provided in appropriate places. Appropriate warning signs should be provided on roadways in ports. These should conform to the national legal requirements for road signs. Wherever possible, standard international road signs should be used."

Walkways

"Safe walkways should be provided to all parts of port areas to which persons with legitimate access have to walk. Such people include ships' crew members, pilots, passengers and contractors. Wherever practicable, walkways should be separated from operational areas and vehicular traffic. Walkways should be wide enough for the number of persons expected to use them at any one time. The edges of walkways should be clearly delineated. The markings should be clearly visible by both day and night. Yellow or white road paint can be used for this purpose. Markings to identify walkways should be clear and unambiguous (figure 3). There should be no doubt whether markings indicate a walkway, a plant crossing or other dangerous area, such as the track of plant. Signs or markings should be provided at the ends of walkways and repeated at intervals along them as necessary. Appropriate signs should be provided where walkways cross roadways. International symbols and warning signs should be used whenever practicable. Pictorial symbols should be used on signs and on the surface of walkways to ensure that they are understood by users of all nationalities. Obstructions in a walkway should be clearly marked or signed."

Cargo-handling areas

Layout

"Cargo-handling areas should be well surfaced and, where applicable, should comply with the provisions of sections (Surfaces) and (Lighting), above. Lamp standards and similar structures that may necessarily be present should be protected with barriers against accidental damage by cargo-handling equipment and vehicles. Low doorway markings with maximum heights practicable. Any crossing points that are necessary should be marked and signed to warn both drivers and pedestrians of the potential presence of each other."

Edge protection

"Secure fencing should generally be provided at all places from which a fall is likely to result in serious injury. This includes openings where there are sudden changes in level, such as the tops of steps, and open edges from which it is possible to fall more than 2 m or into water."

Quay edges

"It is recognized that it is not practical to provide fencing along all the open edges of quays. Fencing should be provided at all dangerous corners and breaks in quay edges, such as those at the sides of gangways, ramps or brows giving access to ships, pontoons or landing stages, walkways over lock gates or caissons, and the edges of quays over looking open stretches of water. Fencing should be provided at quay edges where a large number of passengers are likely to be present. All edges of quays on which vehicles are used close to the edge should be protected by a continuous coping wall or robust rigid barrier of sufficient strength to prevent trucks and most other vehicles from accidentally falling into the water. In general, the wall or barrier should be as high as practicable, but not less than 300 mm high. Highway-type barriers may be suitable for the purpose.

On quays where only cars and other small vehicles are used, a lower barrier may be sufficient but this should not be less than200 mm high. Gaps may be left in the wall or barrier where this is necessary to work capstans, use bollards or carry out other operations. The gaps should be no wider than is necessary and less than the width of a vehicle. If vehicles are only very occasionally used near a quay edge, suitable temporary arrangements may be made. These may involve the provision of a temporary barrier or the positioning of a person to signal to the driver when a vehicle is operating close to the edge of the quay. Where an existing rail-mounted crane passes close to the water's edge and it is not practical to provide fencing on the quay, it may be advisable to put a fixed handrail on the crane. This should not project in such a way as to dangerously reduce the clearance between the crane and the edge of the quay or any fencing that the crane may pass."

Fencing

"All permanent fencing should be robustly constructed. Fencing should generally consist of metal railings. Reinforced concrete barriers may be appropriate on structures alongside bodies of water and where there is heavy vehicular traffic for ro-ro or container operations. Other fencing should depend on the nature of the hazard to be protected, the general layout of the immediate area and any nearby structures. Chains between stanchions provide only limited protection and should not be used as permanent fencing. Fencing should not stop immediately at the end of the danger zone but should continue a few meters beyond it. The construction and location of fencing should allow for ships to be made fast and cast off easily. Fencing should be at least 1 m high (figure 8). Metal railings should have a middle rail 500 mm above the quay between stanchions that are placed not more than 2 m apart. Toe boards 150 mm high should be fitted where necessary. Movable fencing may be used around temporary hazards and on the edges of berths. It can be removed while work is going on when necessary to avoid the fencing itself becoming a hazard. Movable fencing should be used to protect stairs or steps at the water's edge or the edges of gangways where permanent fencing is not practicable."

Quayside ladders

"Permanent ladders should be provided at the edge of any structure in a port from which persons may fall into deep water to enable them to climb out of the water. Such structures may include quays, jetties and dolphins and large mooring buoys. Ladders should be spaced at intervals of not more than 50 m from each other or from steps. Ladders should conform to section 3.5.3, where appropriate. The bottom rung of ladders should be at least 1 m below the lowest level of the water at any time, or on the bed of the dock if there is less than 1 m of water at low tide. Where the stringers of the ladder extend above the quayside, they should be opened out sufficiently to enable a person to pass through them, and should be sloped or curved in from the quay edge. Where it is not practical for the ladder to extend at least 1 m above the top of the quayside, the stringers should extend as high as is practicable. Where no such extension is practicable, adequate handholds should be provided on the surface of the quayside in front of the ladder. If these are recessed in the surface, the recess should be designed so that it allows drainage and does not fill with water or dirt. If handholds projecting above the surface of the quay and recesses are necessary, they should be clearly marked to draw attention to possible tripping hazards. A permanent ladder should be protected on each side against damage from ships, unless it is recessed into the wall of the quay.

The top of a ladder recessed into a wall should never be obstructed by the edge of the quay side. Ladders from the water should be conspicuous so as to be easily seen by anyone falling into the water. The tops of the ladder should be clearly visible to persons on the quayside. At ports where it is not practicable to fit permanent ladders, or at quays that are used only occasionally and persons do not have to pass when no ship is berthed, temporary ladders should be provided and secured fore and aft of each ship loading or unloading."

Life-saving equipment

"Adequate and suitable life-saving equipment should be provided and maintained for the rescue of anyone in danger of drowning. Rescue equipment should consist of lifebuoys, throwing buoys or lines, grapnels, boathooks or other suitable equipment. Throwing-lines fitted to lifebuoys or similar equipment should be of suitable size and length, and should be made of polypropylene or other suitable material so that they will float. Life-saving equipment should be located at suitable places at intervals of not more than 50 m. Such locations should be near the quay edge close to the tops of ladders or steps to the water, wherever practicable, and should include landing stages. The equipment should be prominently mounted at a location painted in a conspicuous color. The locations should be kept free of obstructions soars to be easily visible at all times. Lifebuoys and similar equipment should be hung up or contained in a case or cupboard of adequate size and conspicuous color. Cases and cupboards can be arranged to alert a central point when opened or when the equipment is removed. This can aid calling the emergency services and reduce theft and vandalism. Where theft and vandalism are serious problems, it may be satisfactory for life-saving equipment to be kept just inside nearby sheds or other buildings, provided that its location is clearly marked and it is immediately available at all times when work is in progress. Suitable notices should be displayed with life-saving equipment giving clear instructions for raising the alarm in the event of an emergency and for the resuscitation of a person rescued from drowning. Facilities to enable persons who have fallen into the water to support themselves while awaiting rescue should be provided between quayside ladders. The structure of the quay may be able to serve this purpose. More often chains are used. In enclosed quays, or where there is a very small tidal range, chains looped between fixed points may be provided. Where there is a large tidal range or in locks, vertical chains should be hung on the face of the quay. At least one such chain should be provided between adjacent quay side ladders."

Terminal plant and equipment

General requirements

"All terminal plant and equipment should be of good design and construction, of adequate strength, suitable for the purpose for which it is used, and maintained in a safe and efficient condition. The maintenance should be carried out on a planned preventive basis."

Mobile equipment

"Mobile equipment used in ports, including various types of vehicles which are one of the most common elements in fatalities and serious injuries in ports, should be properly maintained and kept in good order. Special attention should be paid to the maintenance of brakes and braking systems."

Internal movement vehicles

"Internal movement vehicles (vehicles that only work within a port or belong to the ship), including skeletal trailers, should comply with appropriate minimum standards for construction and maintenance, particularly with regard to such items as tires, brakes, lights, steering, warning signals and general vehicle safety. Cargo-handling vehicles should have a high degree of stability under working conditions. Vehicles should be conspicuously painted or marked and fitted with a flashing or rotating yellow beacon. Safe access should be provided to the driver's cab and to other parts of the vehicle as necessary. Drivers' cabs on vehicles should provide protection from adverse weather conditions and have good all-round visibility, with minimal obstruction of the driver's view. Where vehicles have blind spots and there is a risk of injury, closed-circuit television or other suitable detection device should be considered. All exposed dangerous parts of vehicles, such as power take-offs, chain drives and hot exhausts, should be securely guarded. Vehicles, including trailers used to transport containers, should be constructed in such a way that the containers are supported by their corner fittings or other parts designed for that purpose. Containers should not be supported on their side rails. Consideration should be given to the fitting of speed limiters to heavy-duty tractors and other plant for handling containers or similar large cargo."

Visual display screens in vehicles

"Visual display screens in vehicles should be fitted in a location that is not prone to glare and reflection, and will provide the minimum distraction to the driver of the vehicle while it is moving but still be easily readable. The display should be kept concise and require as little interaction from the driver as possible when the vehicle is moving. Any acknowledgement required from the driver should be simple and, where possible, interaction should only require the operation of a simple button, switch or touch screen. Logistical systems should be designed so that any data input or complex keyboard operation by the driver can be carried out while the vehicle is stationary."

Skeletal trailers

"Trailers used in port operations should be constructed so as to be able to withstand the continuous impacts when loaded by cranes or other container-handling equipment. The safe working load (or maximum load rating) of trailers should be adequate for their use. Trailers used in container terminals may need to be constructed for a maximum load rating in excess of 50 tons. Where trailers operate at night or in poorly lit areas, lighting and adequate reflectors for the trailers should be considered. Consideration should be given to light-emitting diode (LED) lighting systems. These have greatly improved lighting efficiency and are not prone to loading impact damage. All trailers should be fitted with devices to secure or retain loads on them. Trailers should preferably be painted a conspicuous color or otherwise be conspicuously marked. The braking systems on trailers should be compatible with those on the tractors that are to move them. Trailers that do not have conventional twist lock securing devices, and are used in container terminals where loads travel only short distances at slow speeds without negotiating sharp bends on roads, should be fitted with substantial corner plates or other restraints of sufficient height to retain the load in position."

Trestles

"Trestles should be used to support trailers that are not attached to other vehicles when the trailers are:

- laden
- being loaded or unloaded by a lift truck from a loading bay
- stowed on board ship.

The correct type of trestle with adequate strength for the task should be selected. Trestles should preferably have wheels or rollers so that they can easily be moved. Wheels or rollers on heavy duty trestles can be spring-loaded and not load-bearing when in use. Trestles should be regularly inspected and maintained."

Goosenecks

"All goosenecks should be regularly inspected and properly maintained, particular attention being given to the wear of the kingpin and the squared-off edge of the toe plate. A gooseneck with a missing or damaged toe plate should not be used. Storage frames for goosenecks should be located so that tractor units do not have to emerge directly into a traffic stream when leaving the frame. Storage frames for goosenecks may restrain them between vertical frames or by a shoe over the toe. Both are prone to damage and should be inspected and maintained accordingly. Many roll trailers have attachment arms suitable for laden and unladen conditions. Goosenecks may be modified or purchased with corresponding attachment lugs to ensure improvement of security, particularly when pulling up gradients."

Roll trailers and cassettes

"Port operators should ensure that arrangements with roll trailer and cassette owners include procedures for their inspection and maintenance. Roll trailers, and cassettes (used for forest products), should always be stored on firm and level ground."

Hand trucks and trolleys

"Hand trucks used for transporting gas cylinders, carboys or similar objects should be designed and constructed for that specific purpose. Hand trucks or trolleys used on slopes should be provided with effective brakes. If it is advisable to prevent hand trucks and trolleys from moving when they are left standing, they should be provided with effective handbrakes, chains or other appropriate devices. Three-wheeled or four-wheeled hand trucks should be provided with spring clips or other locking devices by which the handles can be secured in an upright position. Port workers should be required to use these devices when the trucks are stationary. Handles of hand trucks and trolleys should be designed to protect the hands of the user. This may be by the provision of knuckle-guards."

Cargo platforms

"Cargo platforms should be robustly constructed of sound metal or wood. If the platforms are designed to be movable, perforated sheeting, expanded metal or metal grating should be used to minimize the weight of the platform. Platforms should be designed to bear the weight both of the loads to be made up or received and of the workers. A factor of safety should be allowed for the dynamic loads that will occur when cargo is landed on them.

Cargo platforms should be:

- adequately supported and, where necessary, securely fastened
- of sufficient size to receive cargo and to ensure the safety of persons working on them
- provided with safe means of access, such as ladders or steps
- securely fenced on any side that is not being used for receiving or delivering cargo, if the platform is more than 1.5 m high
- maintained in good repair.

Any portable trestles used to make up cargo platforms should be so placed as to be steady. Cargo platforms should not be overloaded. Hatch covers should not be used in the construction of cargo platforms."

Access or lashing cages

"The framework of most access or lashing cages is similar to that of an ISO container. The location of corner fittings in the top framework should conform to ISO668 Series 1 freight containers – Classification, dimensions and ratings to enable the cage to be lifted by a container spreader. Most cages are 20 or 40 feet long but some telescopic cages have also been built. Smaller cages, sometimes known as gondolas, are used for work in narrow aisles between stacks of containers.

Access or lashing cages should have:

- guard rails and toe boards. The top rail should be recessed or an additional handrail provided inside the guard rail, in order to prevent hands being trapped between the guard rail and a container or other object. The distance between a handrail and guardrail should not be less than 90 mm in order to allow for workers wearing gloves
- robust doors or gates that open inwards and are self-closing. Chains should not be used instead of doors
- mesh or other suitable protection on the sides and ends of the cage to prevent accidental trapping
- where practicable, protection from objects falling from above
- suitable bins and hooks to stow equipment normally carried in the cage. Such equipment includes twist locks and other inter-box connectors and twist lock poles. Covers for bins may form seats. The use of seats enables workers to be more stable during transfer to or from a quay
- a secondary means of locking onto a spreader when the cage is in use The following possibilities may be considered:

- o manual attachment of a chain at each corner
- o the use of hand-operated locking pins
- provision of an additional automatically operated twist lock at both ends of the spreader
- a notice giving instructions for safe use.

The bottom corners of the cage may be recessed and the end of the cage floor may be hinged to allow safe access to twist locks, etc., below the cage. Any area of floor where workers kneel should be suitable for the purpose and not of open-grid construction. A handrail should be provided in front of the kneeling position. An emergency stop button should be provided, where possible. Radio communication with the crane operator should be provided."

Conveyors

"All dangerous parts of conveyor systems should be securely guarded. Enclosure of such parts also prevents the ingress of dust or other materials. The dangerous parts include:

- all drives
- in-running nips between belts and end rollers or tension rollers
- intakes between belts and other moving parts and stationary parts or other objects
- intake openings of blowers or exhaust fans for pneumatic conveyors.

Enclosure of intermediate lengths of belt conveyors is not always necessary but may be needed to protect the material being conveyed from the weather or from being stripped off by wind. Horizontal conveyors at floor level should be protected by metal grating or otherwise guarded. Stopping devices should be provided at all work stations at power-driven conveyors. Trip wires should be provided along the side of the conveyor where walkways are alongside them. These should operate stop switches fitted at intervals of not more than 50 m. The controls of any system of two or more conveyors operated together should ensure that no conveyor can feed onto a stationary conveyor. Conveyor systems started remotely should have audible or visual warning systems to warn workers that the system is about to start. Workers should be able to communicate with the control room. Closed-circuit video systems may be helpful. Conveyor systems that can be started remotely or from more than one position should be fitted with lock-off switches in appropriate locations to protect persons cleaning or working on the system. Provision should be made for the safe cleaning of conveyors and for clearing obstructions. Where appropriate, guards should be interlocked. A suitable time delay should be incorporated if the machinery has a significant overrun before stopping. Walkways adjacent to open conveyors should be at least 1 m wide. Suitably fenced bridges should be provided where it is necessary for workers to cross over conveyors. Sheet or screen guards to catch any falling material should be provided at places where conveyors pass over workplaces or walkways. Where the tops of hoppers feeding conveyors are less than 900 mm above the floor, the openings should be fenced. The sides of conveyors moving solid objects should be at least 100 mm high, or half the height of the objects if greater. Enclosed conveyors that convey flammable materials should be suitably explosion protected. This may be done by making the enclosure sufficiently strong to withstand and contain any explosion inside it, or by providing appropriate explosion relief venting to a safe place, preferably in the open air. The enclosure should include facilities to enable any fire in it to be tackled."

STAGES OF A RISK ASSESSMENT – DISSECTING THE TASK

"Risk assessment techniques are fundamentally the same for large or small ports or harbours, although the execution and detail will vary considerably. For a large port or harbour, the task is large and, if done to a sufficient level of detail, complex. It is thus much better to insert a structure through the whole assessment from the beginning and carve the work needed into manageable packages. In a port or harbour risk assessment, the following five stages are appropriate:

- **Stage 1** Data Gathering and System Assessment
- **Stage 2** Hazard Identification (HAZID Meeting)
- **Stage 3** Risk Analysis
- **Stage 4** Assessment of existing risk management strategies, development of new measures; Assessment of Control Adequacy Rating
- **Stage 5** Managing and Treating the Risk via the Port and Harbour Safety Management System.

In order to make the process work practically, consultation with port or harbour stakeholders needs to be undertaken in the beginning, but also needs to occur at critical stages through the process as shown in AS/NZ 4360. The risk assessment needs to evolve with a number of structured meetings and the most important of these is the HAZID meeting (HAZard IDentification Meeting)."

Undertaking the Risk Assessment

Stage 1 - Data Gathering and system assessment

"As well as assessing the current risk control measures in place, this stage allows any external members of the risk assessment team to undergo a familiarization process and be placed in the necessary position to identify relevant hazards from their experience of port or harbour risk assessment. It comprises a review of any historical incident data and/or database, pilotage, the vessel traffic management that is in place, as well as any procedures or requirements managing navigation. This naturally entails meetings involving management and operational personnel (harbourmaster, marine officers, pilots, tugs, line handlers, etc.) within the port or harbour as well as regular users. Regular users should contribute to the process at an early stage, because they often hold detached but important information about the hazards in any particular port or harbour. It is useful at this stage to consider the port or harbour layout as a gameboard. First the components of the gameboard can be determined, such as channels, cross currents, environmental conditions, berth orientations/locations, navigation aids (leads and lead sensitivity, marks and buoyage). Then the way in which the game is played on the gameboard can be assessed. Information to take into account will include, but not be limited to:

- Vessel sizes and types using the port or harbour
- Nature of leisure activities
- Passenger movements
- Traffic density and types of traffic involved at busiest times or at key locations for crossing
- The tidal regime, wave height and periodicity

- Non tidal oceanography (long period waves; surging, etc.)
- Navigational channel width, depth and route/heading needed for each transit
- Hydrographic information and sea bed morphology
- Weather limitations
- Types of berths/securing and fendering arrangements
- Types of cargoes being handled (Oil products; IMDG; chemicals in bulk; gasses etc.)
- Disposition of navigational aids
- Communication or radar blackspots
- Pilotage system and pilotage criteria; training systems and competence assurance systems in place
- Status of operating manuals and limitations on movements
- Available incident and accident data.

The quality of the record of incident data will vary widely depending on the history of the port or harbour. At this stage, plotting incident data by location, even from anecdotal sources, simply as stars on a chart always reveals something about the key hazards of a port or harbour. Many harbour management systems have been developed partly as a result of lessons learned from incidents and accidents. Other requirements are normally based on the perceived threat to safety by key individuals in the management chain, as opposed to hazard identification involving those at the sharp end of operations. Neither of the two approaches to safety management will identify the full spectrum of actual risks that reside in a harbour and cannot compete with the holistic response to safety management that can arise out of a well-planned risk assessment. Consultation with regular users and organizations having interest in the port or harbour is an important task to undertake at this stage in order to identify the parameters of their involvement in the port and harbour. As users and organizations subsequently develop their own structure of safety management systems not only within individual organizations, but also between organizations, robust links between and across the risk areas identified will be created."

Stage 2 - Hazard Identification Process

"The process of hazard identification is likely to begin soon after Stage 1 has commenced and a preliminary list should become available almost as a direct output from this stage. Hazard identification is, in many ways, the most critical of the steps involved in the risk assessment process. An overlooked hazard is more likely to introduce error into the overall risk assessment of a port or harbour, than an inaccurate assessment of frequency or consequence. In many cases, errors made in assessing consequence and frequency can cancel each other out over the full spectrum of incidents, whereas the omission of a hazard results in an underestimation of the overall risk profile. Moreover, important risk control may not be introduced to properly manage the risk, resulting in an accident waiting to happen. The facilitator of a HAZID meeting is key to the successful delivery of the hazard information and the role is often combined with that of the chairman. There are few areas where the assessment can truly benefit from a specialist, but this is one of them. An experienced HAZID chairman can make a real difference in the delivery of information from participants. All ports and harbours intending to undertake their own risk assessments are strongly recommended to consider, as a minimum, using a specialist to facilitate their HAZID. All stakeholders should participate in the HAZID at some stage in its agenda. It is vital to involve regular harbour users at this stage. The aim of the exercise is to identify all hazards; even those managed by existing risk control measures. Within this stage, one or more structured meetings (HAZID meetings) with those having experience of vessel movements and berthing in the location should be held. It is strongly advisable to have some form of independent attendance at the HAZID meeting, which could be expertise drawn from a neighboring council or port company. This approach recognizes that the people best placed to identify hazards are often personnel working within the port or harbour, but that a "new pair of eyes" also notices items of significance that are accepted as normal in the system. The benefits provided by those outside pair of eyes are very important to the success of the risk assessment. It is perhaps obvious that risk assessments undertaken totally in-house do not generally address all the issues, some of which will be related to problems that the organization with responsibility has hesitation in addressing. The HAZID process should be conducted on an Incident Category basis, across each area of the port or harbour. It should systematically consider vessel types, operations and interfaces appropriate to each area. The approach will be to undertake a general Hazard Identification on a geographical basis, followed by a number of smaller meetings concentrating on specific areas and assessment of specific operations. Hazards should be identified initially on a generic basis and then added to in order to consider scenarios specific to different areas of the port or harbour."

One Person's Hazard is Another's Cause

"Structuring the output of a HAZID needs a consistent approach. Hazards, causes and consequences can become confused and causes or consequences can also easily be stated as hazards. It is therefore essential that an organization is able to identify hazards effectively and where a need for training is identified, this should be conducted at Stage 1 of the process. It is also vital to identify hazards at an appropriate level of detail. An example of a hazard scenario is as follows: Developing a hazard list in this generic way, in the first instance, enables the assessment to focus on one hazard for a wide topic. This ensures manageability of the risk assessment and provides a hazard list which reflects the diversity of activities in a port or harbour. For any marine risk assessment in general, it is better to consider hazards generically, rank them (to identify those that pose highest risk) and then to revisit the risk assessment in areas of high risk and consider more detailed hazards in those areas. This not only targets resources, but also targets later risk management attention. It is important to note here that there are a number of possible consequences (or a range of outcomes) associated with this hazard."

Stage 3 - Risk Analysis

"The potential for different organizations to produce different hazard and causal output from a HAZID meeting is obvious from the hazard example in paragraph 3.1.2.1. It is also a recognizable feature of marine incident investigation that there is often little in causation terms to differentiate between incidents resulting in a minor outcome to those in which a serious loss occurred. Because of this, for port and harbour risk assessment (and general marine use) the "most likely", "worst credible" approach was developed. The most likely outcome rating is obvious, but the worst credible scoring should be differentiated from the worst possible spectrum of outcomes. The frequency of incidents associated with the most likely outcome is often higher than that associated with the worst credible case. There can, however, be cases when frequency is low (rare), where because of the logarithmic scales used in a risk matrix, both outcomes are within the same frequency band. Where both “most likely” and “worst credible” scores end up in the same frequency band, risk control can only be recommended as it is a symptom that there is little to differentiate between a minor or a major event, should the hazard be realized. Although a “most likely” and “worst credible” approach needs more data to score the hazards, the process can be assisted by using a spreadsheet or software to provide a ranking of hazards in order of risk. Assessing the risk in this way also helps a judgmental risk assessment as the “most likely” and “worst credible” scores provide a cross check of risk data for each hazard. The assessment of frequency and consequence should tend towards the historical evidence of incidents at a port or harbour, rather than completely unaided expert judgement. The risk scoring must also be the subject of a meeting involving a cross section of the same participants that were involved in the hazard identification exercise. To populate a risk assessment, the most likely outcome of hazard realization is assessed first against each of the consequence categories:

- Consequence to People
- Consequence to Property
- Consequence to Environment
- Consequence to Harbour Stakeholders.

Then the associated common frequency is added for the most likely case. The procedure is then repeated for the worst credible outcome. The risk matrix is then used, either manually or electronically, to identify the position of any risk within the matrix. Using this four-consequence approach to the risk assessment not only allows hazards to be assessed in relation to their impact on safety, but also on their impact on other areas vital to the continuing health of the port or harbour. Hazards providing high scores in a number of these measures will be obvious candidates for risk reduction in the next stage.

Stage 4 - Assessment of Existing Risk Management Strategies, Development of New Measures, Assessment of Control Adequacy Rating

The risk assessment process will output a prioritized list of hazards ranked by risk. The hazard identification process will also have identified causes. Comparison of areas targeted by existing risk control with the risk profile will identify where additional risk management strategies can be considered, not only in areas where there may be gaps in existing risk management systems, but also where existing risk control measures may need radical overhaul, because of the hazard potential posed. Alternatively, there may be areas identified where the existing risk management system in place may benefit from a relaxation, allowing resources to be redirected into areas of greater risk. Risk Control options are identified by reference to the key causes of highly ranked hazards. Common causes are often linked to a number of hazards. Using the causes as the reference material for a brainstorming exercise is recommended. Addressing causes of hazards in the risk control options results in solutions that address the underlying problems identified. The brainstorming and identification of risk control options should be the subject of a further structured meeting involving key participants, with appropriate knowledge of the regulatory system available to the harbour and the organization managing the port facility. When risk management options are complex, such as new radar sites or leads, and the risk benefit is unclear, cost benefit analysis techniques can be used to provide powerful information to support recommendations.

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