JAPAN P&I CLUB　第 32 号 2014 年 7 月　Vol.32　July 2014

# P&I Loss Prevention Bulletin

The Japan Ship Owners Mutual Protection & Indemnity Association
Loss Prevention and Ship Inspection Department

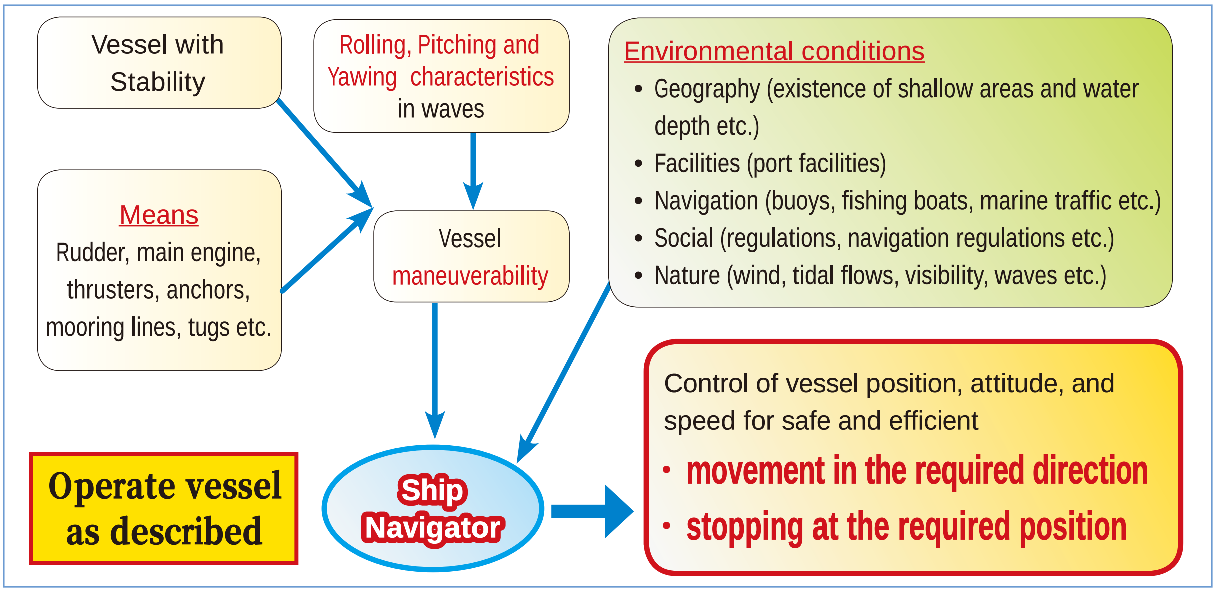
## Preventing Damage to Harbour Facilities and Ship Handling in Harbours

## PART 2

## INDEX

## 5. What is Vessel Handling?

Vessel handling is based on the basic knowledge that a vessel floats in the water and returns to its original position after a list. It is maneuvered with the assistance of the rudder, main engine(s) and other auxiliary equipment, using knowledge of the rolling, pitching and yawing characteristics of the vessel in waves. In handling the vessel it is necessary to consider the effects of environmental conditions while controlling the position of the vessel, its attitude, and its speed, to move the vessel in the designed direction in a safe and efficient manner, and to stop at the intended position (*Theory and Practice of Ship Handling*, Kinzo Inoue, Honorary Professor, Kobe University).




### 5-1 Investigation of Environmental Conditions (harbour conditions)

Harbour conditions must be investigated each time a port is entered, not just the first time. For liner services, conditions must also be investigated and verified at appropriate intervals as well.

Such investigation requires the collection of as much data as possible and verifying it with the local agent. Recently it has been possible to find information out via the Internet. However, many vessels do not have an Internet connection, and it is therefore desirable that a shore team collects the relevant data and provides it to the vessel. A table of the points to be investigated is shown on Attachment (1).

#### 5-1-1 Investigation of Geographical Conditions and Conditions Associated with Harbour Facilities

The primary points to be investigated in relation to geographical conditions and conditions associated with harbour facilities are as follows.

- Maximum permissible draft (for each passage, channel, and pier)
- Maximum acceptable vessel type (e.g. hull shape, DWT, length overall, breadth, molded depth)
- Turning basin
- Tugs available Y/N
- Local pilot available Y/N
- Loading facilities:
- For bulkers etc. which use shore loaders, the maximum air draft of the loader. For PCCs, the pier height and space available to lower car ramps. For tankers, the diameter of the loading arm and the type of reducers on the vessel.

The following reference material is available when an overall prior investigation is conducted to acquire this information.

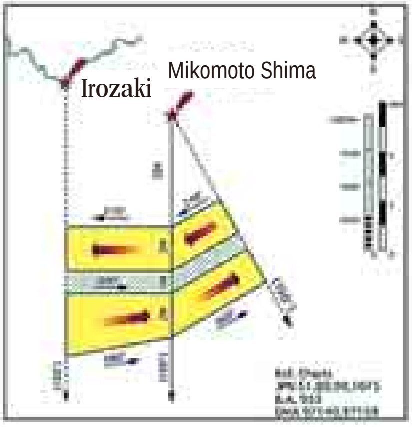
- Port Guide Online (IHS: Information Handling Services)
- Guide of Port Entry (Shipping Guide)
- Dry Cargo Data base (Global Port)
- Ports of the World (Port world)
- Japanese Harbours (The Ports and Harbours Association of Japan)
- Charts, sailing directions, passage pilots, BA Admiralty publications etc.

## 5-1-2 Investigation of the Navigation Environment (e.g. buoys, fishing vessels, fishing reefs, shipping movements)

An investigation of the navigation environment covers the following.

- Fishing facilities and areas of fishing activities not noted in Notice to Mariners.
  In particular, information on recent fishing operations and fishing reefs along the Chinese Coastal area should be acquired from the local agent.
- Information on recommended separate traffic lane around the Japanese coast.
- National defense exercise areas.


Notice to Mariners
(copyright : Japan Coast Guard)




Recommended separate traffic line
(copyright : Japan Captains' Association)

## 5-1-3 Investigation of the Social Environment (local regulations and navigation restrictions)

It is also important to investigate the local regulations for each harbour (e.g. notifications and harbour regulations).

- Pilot available Y/N
- Various notifications required before entering port (e.g. ETA, VTS and passage notifications under Maritime Traffic Safety Act of Japan).
- Notifications and speed restrictions of coastal nations.
- Harbour entry and exit restrictions (e.g. harbour entry at night, times zones for passage).
- Restrictions on use of fuel oil (e.g. regions in which use of low sulfur fuels is required).
- Is there a security-related prior notification system, and are crew visas required Y/N.
- Prior notification system (e.g. Panama and Suez canals)

## 5-1-4 Investigation of the Natural Environment (e.g. wind, tides, visibility, wave direction)

- Tide tables and current information
- Information from sailing directions, passage pilots, BA Admiralty publications
- Weather information

Tidal information via Internet (example)

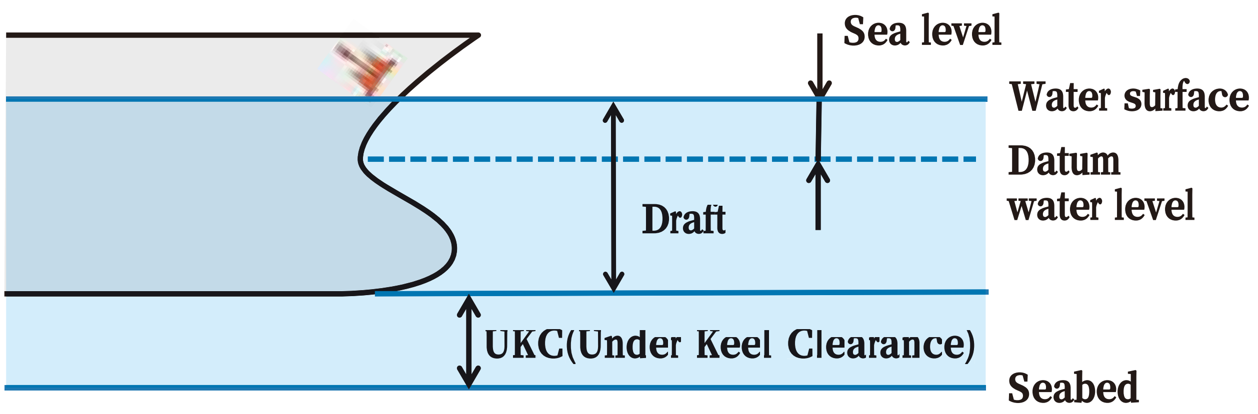
# 6. Example of Investigation of Geographical Conditions

A few important points in investigations of geographical conditions are explained below.

## 6-1 Maximum Permissible Draft and Under Keel Clearance (UKC)

Maximum permissible draft and Under Keel Clearance (UKC) are important information in making decisions on safe entry of the vessel to harbour.

As shown below, UKC is a value indicating the margin between the sea bottom and the bottom of the hull. For example, if the water depth and draft are the same (UKC = 0), there is a possibility that the vessel may run aground, and entry to harbour is therefore unsafe.




### 6-1-1 Datum Sea Level

Harbours directly connected to the ocean have difference in sea level due to the tide. The water depth noted on charts etc. is therefore the datum sea level. This datum sea level is the lowest tide level for that location, i.e. the lowest possible water level.

In Japan, **the Chart Datum Level (CDL)** is the datum sea level. **In rare cases, negative tide levels (i.e. below the CDL) are possible.**

In some countries, **the Lowest Astronomical Tide (i.e. no negative tides occur)** is employed as the datum sea level, and the International Hydrographic Organization (IHO) suggests using the Lowest Astronomical Tide as the datum sea level, or notes the difference with the datum sea level in tide tables.

### 6-1-2 Relationship Between Maximum Permissible Draft and Under Keel Clearance

The relationship between maximum permissible draft and Under Keel Clearance is as shown by the following calculation.

**Maximum permissible draft < Channel draft + sea level - UKC**

The maximum permissible draft must consider **errors and a safety** factor together with the variables in the calculation. It is also necessary to investigate the maximum permissible draft for each harbour (or each berth) to determine problems.

## 6-1-3 UKC

Most harbours set guidelines for UKC, and many harbours throughout the world manage UKC together with data on weather and sea conditions to ensure a margin for navigation. In Japan, many harbours employ fixed UKC which is a proportion of the draft, or a set value in meters.

The European Maritime Pilots' Association and the Japanese harbour technical criteria employ the following guidelines.

- Navigation within harbours: 10% of maximum draft of vessel
- Navigation outside harbours: 15% of maximum draft of vessel
- Ocean navigation: 20% of maximum draft of vessel

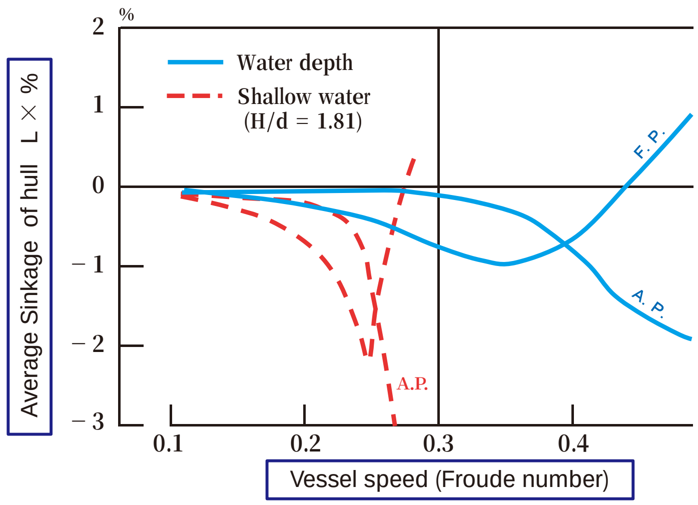
## 6-1-4 Points to be Considered for Maximum Draft

The following points must be considered for maximum draft.

### ① Vessel's Sinkage While Underway

When a vessel begins moving the distribution of water pressure around it changes, and the hull lowers slightly in the water. When navigating in harbours, therefore, the amount of this sinkage of the vessel in the water must be added to the draft while at berth. This amount becomes greater as the water becomes shallower, and as speed increases, as shown in the following graph.

Vessel's sinkage in water at bow and stern while underway (as per Maritime Technology Research Report)




Froude number $= V / \sqrt{L \times g}$

V : Vessel speed (m/sec)

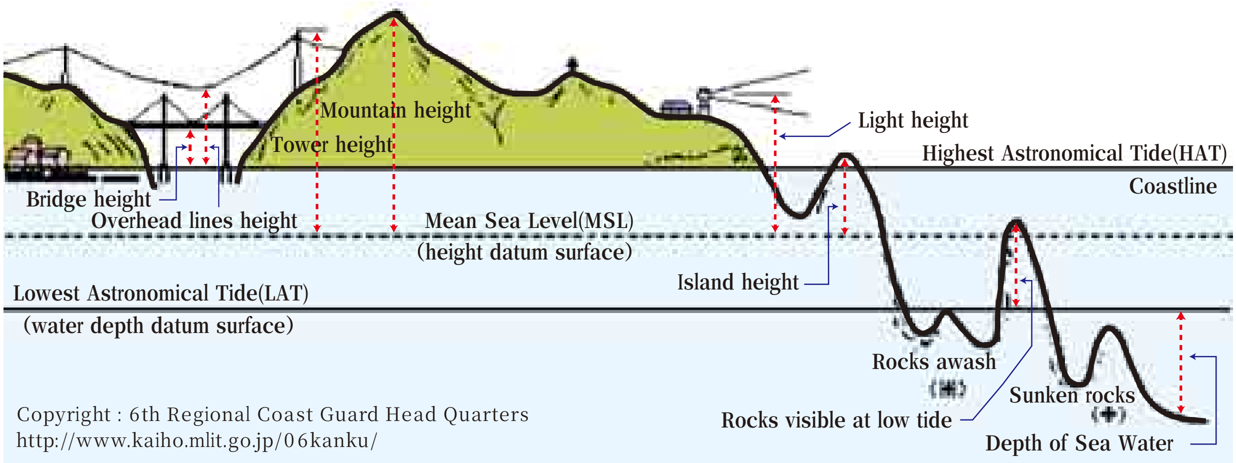
L : Vessel length (m)

g : Acceleration of gravity (m/sec$^2$)

Large vessels are operated at low speed (S/B speed) in harbours, and it is therefore appropriate to estimate the sinkage of the vessel as 0.1 – 0.2% of the length of the vessel. It is also necessary to consider sinkage of the vessel due to rolling, pitching and yawing of the vessel with wind and waves, and swell.

## ② Water Depth and Tide level

As described above, the water depth noted on charts and navigation guides is a value at the datum sea level. The datum level for water depth and coastal height is as shown below.




On charts, **the allowable limit for error in water depth** at the international depth datum is as follows.

| | |
|---|---|
| **Water depth to 20m** | **: Up to 0.3m** |
| **Water depth to 100m** | **: Up to 1.0m** |
| **Water depth to 100m or more** | **: 10% of water depth** |

The actual water depth is the depth on the chart, plus or minus the tide level. The tide level is obtained from the tide table. Since this tide level is a predicted value which can be calculated from a fixed datum, it must be considered that the actual tide level may differ. If the diurnal inequality and abnormal weather conditions etc. are ignored, **the accuracy of the tide table is within 0.3m of the actual value.**

## ③ Example Calculation to Decide Whether or Not to Enter Harbour

The following introduces a calculation used, in conjunction with the UKC, tide level, and water depth error, in deciding whether or not to enter harbour. For example, the value for maximum permissible draft received from the agent is evaluated with this calculation and the decision as to whether or not it is possible to enter harbour.

The conditions for the calculation are first established. The maximum values for each item are used here.

- Maximum draft of vessel : Draft at departure (or expected draft at arrival) + amount of sinkage of vessel (0.2% of Lpp)
- Safety factor for water depth on chart : 0.6m (water depth error + tide level error)
- UKC : 10 – 20% of maximum draft (depending on sailing area), 15% in following calculation

Reference example (finding minimum required water depth)

The calculation example after all conditions have been determined is as follows.

Lpp = 200m　　draft　= 12m

**Maximum draft:** 12m + 0.4m (200m × 0.2%: Sinkage of vessel) = 12.40 m

**UKC :** 15% of maximum draft, navigation outside harbour (12.40m × 15%) = 1.86 m

**Errors of water depth on chart and tide level :** = 0.60m

**Total　14.86m**

In other words, provide (**water depth on the chart + tide level**) for the transit area (including navigation outside the harbour) is equal to or greater than the above, it is possible to enter harbour using the tide level. The point of primary importance is as follows.

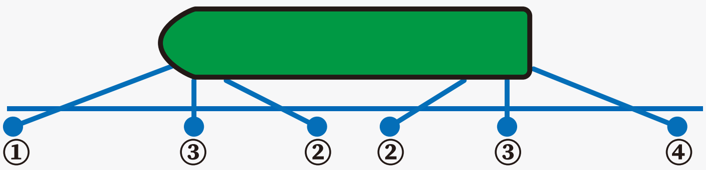
**Do not simply evaluate by applying the UKC ratio to the harbour entry and exit draft, but also include the vessel's sinkage while underway, and the error in depth measurements on charts, to determine on the side of safety.**

## 6-2 Maximum Size of Acceptable Vessel at Pier

### 6-2-1 Design Criteria for Harbour Facilities

Technical criteria for harbour facilities according to Japanese ministerial ordinances are as follows. Verify that sufficient pier length is available based on the length of the vessel. The same considerations apply in other countries.

- Water depth = Maximum draft + water depth margin (UKC: 10%)
- Pier length = LOA + 1.0 to 1.7 × breadth (B)
  Coefficient of 1.0: Angle between mooring lines and pier of 45°
  Coefficient of 1.7: Angle between mooring lines and pier of 30°




① **Head Line**
② **Spring Line**
③ **Breast Line**
④ **Stern Line**

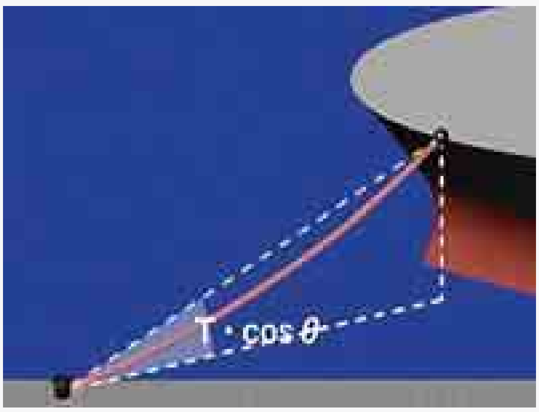
### 6-2-2 Mooring Forces for Vessel

Mooring forces for each mooring line can be found with the following equation.

θ : Angle between horizontal at mooring point and feed point for mooring line on vessel
T : Tension on mooring line
T × Cos θ :Horizontal component of tension on mooring line

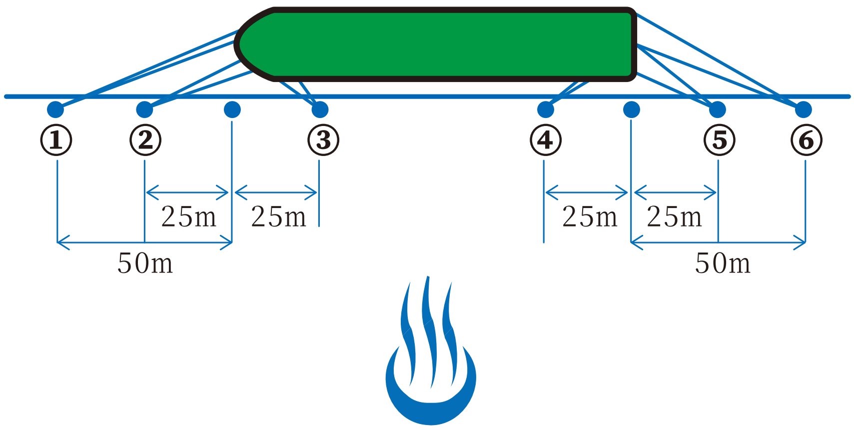
The angle between the mooring line and face line of the pier is φ. The mooring force along the axis in fore-and-aft line of the vessel (Tx), and the mooring force in the transverse direction (Ty), are found with the following equation.

$$Tx = T \cdot \cos\theta \cdot \cos\phi$$
$$Ty = T \cdot \cos\theta \cdot \sin\phi$$



**The resultant mooring force is the sum of the mooring forces from each mooring line acting along the fore-and-aft and transverse axes of the vessel, and is determined by the takeup capacity of the mooring winches and the number of mooring lines.**

The mooring forces for a car carrier of 200m LOA (projected area from side: 5,500$m^2$) are calculated below as an example. The calculation assumes that the wind is acting perpendicular to the pier.
As shown below, 12 mooring lines are used. Winches are able to apply a force of 25 tonnes per mooring line. Mooring lines enter the vessel 15m above the pier.




The total of mooring forces in the transverse direction is 63.6 tonnes.

Mooring Force on Transverse Direction

| Mooring Lines | | No. | Angle | | Mooring Force(ton) | |
|---|---|---|---|---|---|---|
| | | | θ ° | φ ° | per Line | Total |
| ① | Head Line | 2 | 17 | 20 | 8.2 | 16.4 |
| ② | Head Line | 2 | 32 | 14 | 5.1 | 10.2 |
| ③ | Fore Spring | 2 | 32 | 7 | 2.6 | 5.2 |
| ④ | Aft. Spring | 2 | 32 | 7 | 2.6 | 5.2 |
| ⑤ | Stern Line | 2 | 32 | 14 | 5.1 | 10.2 |
| ⑥ | Stern Line | 2 | 17 | 20 | 8.2 | 16.4 |
| Total | | 12 | | | | 63.6 |

Lines pull of Mooring winch : 25.0 tons

Theoretically, the vessel can be moored at the pier under wind forces of 63.6 tonnes in the transverse direction. Using the Hughes equation to convert this to wind speed gives a wind speed of 12.4m/sec.

Wind pressure (Ra): 63.6 tonnes

$$Ra = \frac{1}{2} \times \rho \times CRa \times Va^2 \times (A\cos^2\theta + B\sin^2\theta)/1000 \text{ (ton)}$$

Projected area from side: 5,500$m^2$, θ : Relative wind angle (transverse direction: 90°)

**Wind speed: 12.4m/sec**

**In other words, if the wind is considered, the vessel will begin to move away from the pier at a wind speed of 10m/sec.**

## 6-2-3 Strength of Mooring Bitts

It is also necessary to verify that the mooring bitts on the pier are able to withstand mooring of the vessel. Strength of mooring bitts in accordance with Japanese harbour technical design standards are as follows.

Tension Applied to Mooring Bitts
(technical criteria for harbour facilities) (units: tonf)

| Vessel type (GT) | Curved bitts | Straight bitts |
|---|---|---|
| 500 - 1,000 | 15 | 25 |
| 1,000 - 2,000 | 15 | 35 |
| 2,000 - 3,000 | 25 | 35 |
| 3,000 - 5,000 | 25 | 50 |
| 5,000 - 10,000 | 35 (25) | 70 |
| 10,000 - 15,000 | 50 (25) | 100 |
| 15,000 - 20,000 | 50 (35) | 100 |
| 20,000 - 50,000 | 70 (35) | 150 |
| 50,000 - 100,000 | 100 (50) | 200 |

Figures in brackets are for angle mooring bitts incorporating springs between the mooring facilities, and for which a maximum of one mooring line are applied. The straight mooring bitts are storm bitts installed at least the vessel width from the face line of the pier.

## 6-2-4 Fenders

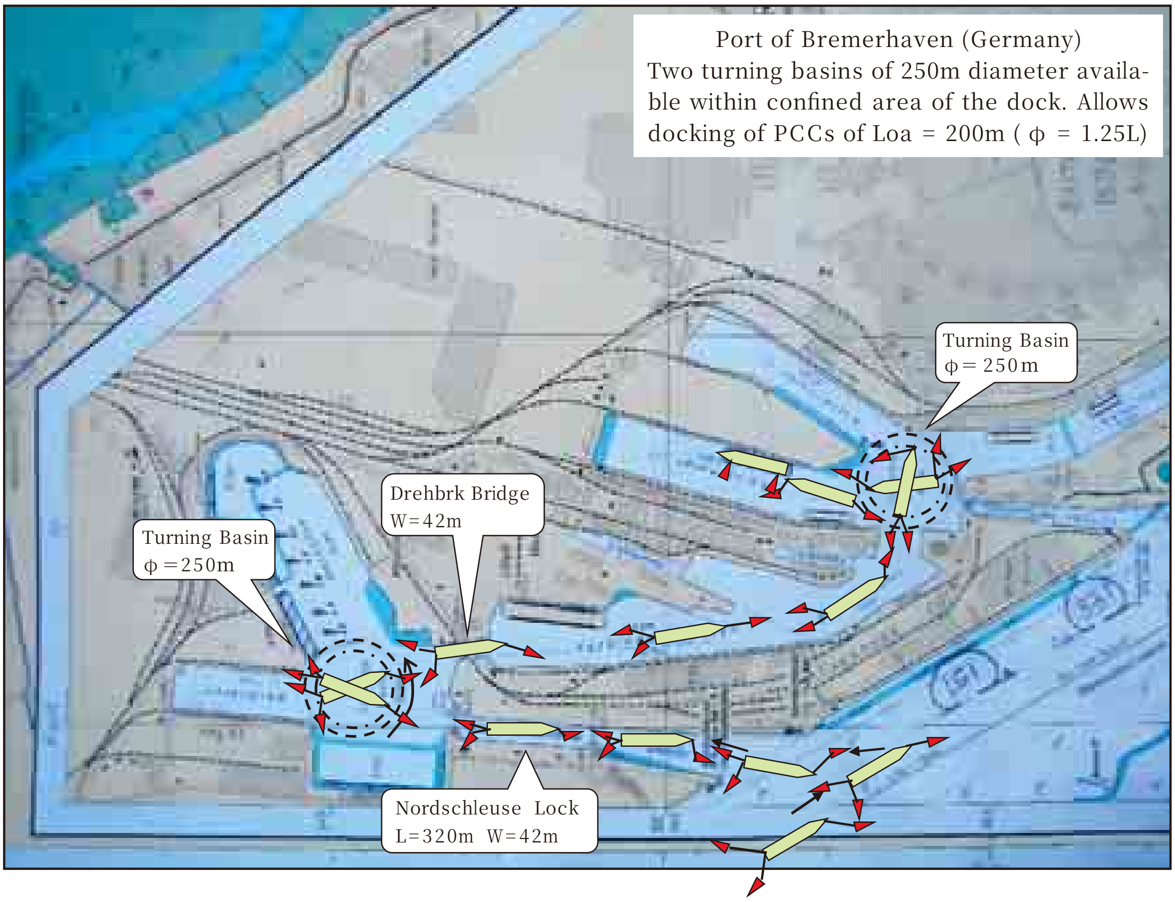
Fenders are also an important item of equipment for safe mooring of the vessel. Particularly when a swell enters the harbour, insufficient fenders may result in damage to the pier and to the hull of the vessel. If damaged fenders are discovered after entering harbour, they should be photographed to guard against claims later on.

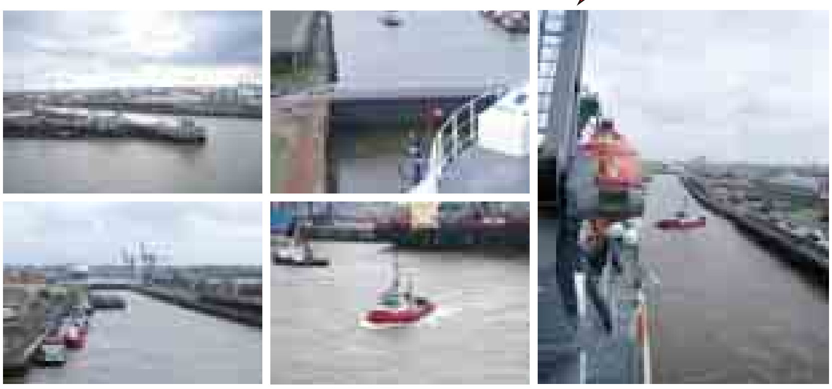
## 6-2-5 Turning Basins

When entering and leaving most harbours, the vessel will use its own power, or auxiliary facilities such as tugs or bow thrusters, for turning. The Japanese harbour design criteria guidelines specify as standard a circle of **a diameter three times the length of the vessel when turning under its own power, and twice the length when turning with the assistance of tugs.**

It is desirable that the turning area be directly off the pier, and that this area is free from the effects of external forces. In practice, due to the effects of the pier and terrain, many harbours have turning areas in locations subject to effects off the pier, and to tidal flows.

Many harbours do not provide sufficient area as shown in the following diagram. In such cases, it is neccesary to investigate the relevant points sufficiently in advance (verifing the number of tugs required, and determining the procedure for turning the vessel., etc.)



Nordscheleus Lock at the Port of Bremerhaven (width : 42m, length 320m and tugs)

## 6-2-6 Tugs

Tugs are an important means of assistance when maneuvering while entering and leaving harbour. Verifying the number and power of tugs is an important part of the investigation of harbour conditions.

### ① Power and Number of Tugs

The assistance of tugs is most necessary when the vessel is to be pushed sideways to the pier. The total power of the required tugs in this case does not exceed the power required for braking or turning. The following points must be considered when determining the power required for tugs.

- Size and loading condition of the vessel
- Conditions of main engines, rudders, and anchors of the vessel
- Weather and sea conditions (wind direction, wind force, direction and speed of tidal flow, waves)
- Water depth in the area (consider effects of shallow water)
- Area available for maneuvering
- Availability of thrusters
- Method of approaching and leaving the pier (mooring toward the direction of arrival and departure)

Guidelines are commonly set for the number of tugs required at each harbour. Use this information for reference.

When no guidelines have been set, use the following equation to determine the necessary power in conjunction with the deadweight of the vessel.

Equation: Total required horsepower = $7.4 \times (DWT)^{0.6}$
Conditions: 10m/sec offshore wind, maximum speed approaching pier 15cm/sec

Deadweight and power requirements

- Up to 50,000DWT : Approximately 3,000HP × 2 tugs
- 50,000 – 100,000DWT : Approximately 3,000HP × 3 tugs
- Over 100,000DWT : Approximately 3,000HP × 3 - 4 tugs
- VLCCs : Approximately 3,000HP × 5 - 6 tugs

Tugs have approximately 100HP/tonne, however this varies with the propilsion device used.

It is possible to reduce the number of tugs if they are fitted with thrusters. While bow thrusters operate only in the tranverse direction, tugs have a significant difference in that they allow towing and pushing at an angle. It is important to increase the number of tugs used when entering or leaving harbour without hesitation in bad weather and sea conditions.