CONTENTS

UNDER KEEL AND OVER HEAD CLEARANCE

1. SQUAT

The relative speed through the water and the proximity of the hull to the surrounding seabed and/or any confining channel sides results in a change in the draft and trim of the vessel.

Squat is the phenomenon whereby the ship's draft increases in shallow water due to the hydrodynamic effects between the ship and the sea floor (causing an increase in draft).

Squat is the supplementary sinkage of a ship relative to the original static draft caused by the relative speed of the water passing the hull. It includes the vertical sinkage of the ship as a whole and the sailing trim.

It effectively reduces the under-keel clearance in areas where clearance may be critical.

Squat may occur even when a ship is made fast alongside if there is sufficient current present.

When navigating in channels of restricted depth, the effect of increase of draught due to squat must be taken into account. This effect increases with speed and is greater when the channel is also restricted in width.

The Barrass formulae is used to calculate squat.

SQUAT = CB / 30 x S2 ⅔ x $VK^{2.08}$ meters

Cb : Block coefficient of the vessel
Vk : Speed of ship over the ground in knots
S : Blockage factor 'S' = $\frac{As}{Ac}$

Where 'As' = The cross-sectional areas of the midships immersed ship's hull b x t (breadth x draft)

And 'Ac' = The cross-sectional area of the canal B x H (breadth of canal x depth)

Factors affecting ship squat

1.1. Speed

Squat is approximately proportional to the square value of ship speed, hence reducing the speed by half reduces the squat effect by a factor of four. In general, squat effect starts to be felt in waters where the depth/draft ratio is less than four.

1.2. Depth of Water

Squat is inversely proportional to depth of water.

1.3. The Block Co-Efficient

Squat varies directly with the block co-efficient. Thus, ships with a larger block co-efficient will squat more, other factors remaining equal.

1.4. Presence of River or Canal Banks (Width of Confined Channel)

The closer the banks are to the sides of a moving vessel, the greater will be the squat.

Presence of another ship in a river abreast of own vessel increases the squat on both vessels

1.5. Hull Form

Full hull forms such as tankers, usually with high block coefficients and low speed, when on even keel tend to trim by the bow due to squat (i.e.) Ships with a block co-efficient greater than 0.7 generally trim by the head.

Slender /fine hull forms such as container vessels, with low block coefficients and high speed, when on even keel tend to trim by the stern due to squat (i.e.) Ships with block co-efficient less than 0.7 generally trim by the stern.

Other Indications That a Ship has Entered Shallow Waters are

a. Wave making pattern changes with an increase in bow wave and a deep trough at the midship region.
b. Vessel becomes sluggish to manoeuvre.
c. Ship may start to vibrate suddenly because of entrained water effects causing resonance.
d. Rolling, pitching and heaving motions decrease due to the cushion of water beneath the vessel.
e. RPM starts fluctuating.

f. Reduction in speed.

g. Turning circle increases considerably.

h. Longer stopping distance and time.

i. Ship specific Squat Tables using applicable block co-efficient are to be prepared and displayed for both Loaded and Ballast Passages at prominent places in the Wheel House for speeds ranging over various manoeuvring and Full Sea speed.

2. INTERACTION

When one ship comes too close to another at high speed, the ship may turn towards, or be drawn towards the other ship, or both ships may sheer away from each other, or the ship may turn towards (across) the other's bows.

Similarly, when a vessel is moving through the water there is a positive pressure field created at the bow, a smaller positive field at the stern and a negative field amidships. The effects of these pressure fields can be significantly increased where the flow of water round the vessel is influenced by:

a. The boundaries of a narrow or shallow channel;

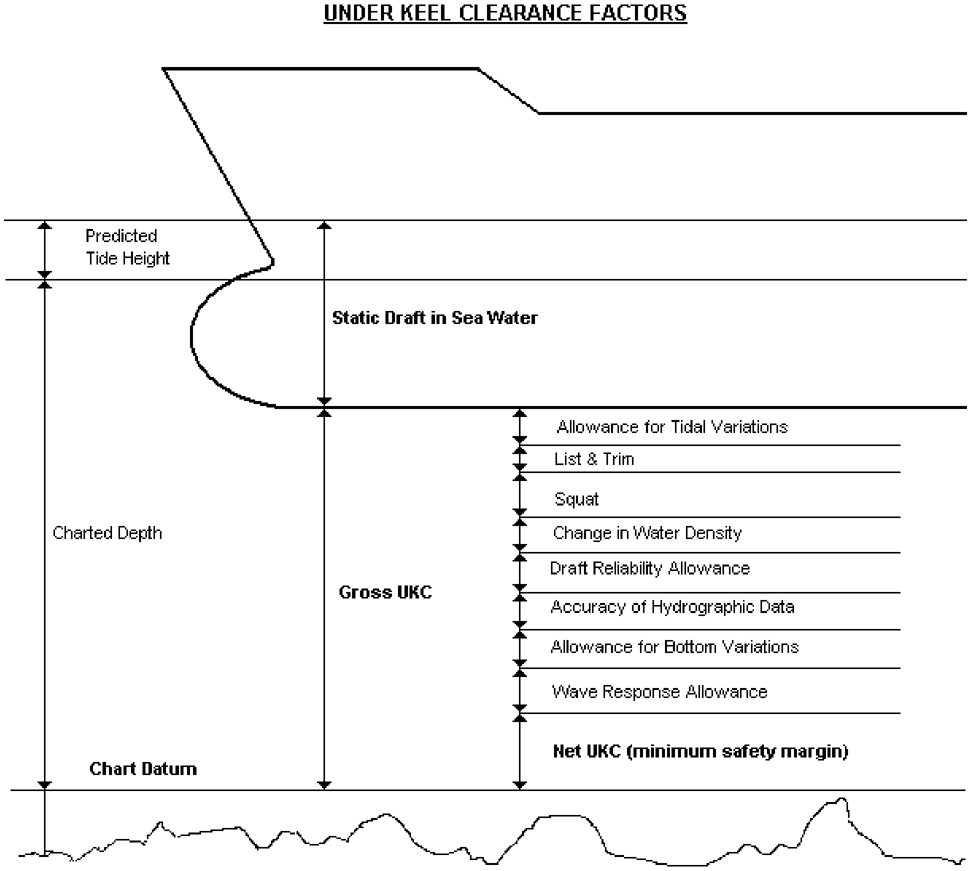
b. Sudden local constrictions such as shoals;

c. The presence of another vessel;

d. An increase in vessel speed

These hydrodynamic effects are collectively known as 'interaction'. They can and do lead to collisions or contact. Interaction is accentuated by shallow water when a large hydrodynamic effect can render a ship almost impossible to control.

3. UNDER KEEL CLEARANCE



3.1. Preamble

Note: The Company's policy relating to under keel clearance must be included as part of the Master/Pilot interchange in the form of a written under keel calculation. The policy must provide a minimum allowed under keel clearance for both coastal, river navigation, while alongside and guidance on the action to be taken in shallow water to ensure the minimum clearance is maintained.

Under keel clearance can be affected by several factors and the under-keel calculations should include, but not necessarily be limited to;

- The predicted height of the tide;
- Changes in the predicted tidal height, which are caused by wind speed and direction and high or low barometric pressure;
- Nature and stability of the bottom – i.e. sand waves, siltation etc.;
- Accuracy of hydrographic data, (References to reliability is often included on charts);

- Change of water density and the increase in draught due to fresh water allowance;
- The vessel's size and handling characteristics and increase in draught due to heel;
- Wave response allowance, which is the vertical displacement of the hull due to heave, roll and pitch motions;
- The reliability of draft observations and calculations, including estimates of hogging and sagging;
- Reduced depths over pipelines and other obstructions.

Once the available under keel clearance has been calculated taking into account all the applicable factors, including those above, it can then be determined whether any speed reduction is required to counter the effects of squat.

Squat information relevant to the vessel for both loaded and ballast passages should be readily available on the bridge.

Where there is doubt that sufficient clearance can be maintained during any part of the voyage, the Master must:

- Inform the Company at the earliest opportunity;
- If within port limits, obtain the latest sounding information, including the nature of the bottom, directly from the local authorities or terminal well before arrival. Should this not be available, the Master should request guidance from the Company;
- If alongside, vacate the berth if in any doubt about the risk of grounding. It should be recognised that occasionally smaller vessels 'take the ground' – i.e. sit on the bottom - at some ports. This may even be to the extent that the berth dries out completely. In such circumstances, considerable reliance is placed on previous experience, as often there is no other information available to ensure that the berth is safe. In such circumstances, documentary evidence should be sought to demonstrate that the operator is aware that the vessel takes the ground at these particular ports and that the situation has been fully assessed, including the effects of stress and stability and the nature and level of the bottom. Adequate procedures should be in place for maintaining services such as firefighting and engine cooling water.

The wheelhouse poster should be permanently displayed in the wheelhouse. It should be of such a size to ensure ease of use. (IMO Res. A.601 (15))

3.2. Static Draft or Hydrostatic Draft

This is the draft determined by the weight of the ship and the distribution of weights within the ship when stopped in calm water at the time under consideration. The hydrostatic draft depends upon the density of the water in which the ship is floating. As salinity increases draft decreases.

3.3. Dynamic Draft

This is the draft of the ship when moving through the water. The dynamic draft is dependent upon a number of factors, the most valid being the ships relative speed through the water and the proximity of the hull to the surrounding seabed and/or any confining channel sides. The motion of the ship causes an increase in the draft called squat. Length and breadth of the hull also have a direct effect on this and may be taken into consideration at some ports.

Dynamic draft = Static draft + Squat

4. COMPANY'S UKC POLICY

Minimum UKC requirements are referenced to the vessels corrected maximum draft. Corrected maximum draft is determined by applying following correction factors to the vessels maximum static draft:

- Increase in draft due to list.
- Squat
- Change of density

4.1. UKC at Berth Terminals and SBM / CBM

Ships Extreme Beam UKC (minimum to be maintained at all times)

- Up to 20.0m 0.3m
- Over 20.0m 1.5% of ships beam

e.g. a vessel with a 10m beam will maintain a Net UKC of 0.3m, and a vessel with a beam of 31m will maintain a Net UKC of 0.465m (31 x 1.5%).

4.2. Approaching Port / Harbour / Inland Waterways / Rivers / Channels / Canals or When Navigation Waters are Restricted.

- 10% of draft

4.3. Open Water/Coastal Passage / Malacca / Singapore Strait

- Minimum UKC is 3.5 meters

4.4. Ocean Passage

- Minimum UKC is 50m

4.5. Transiting Canals (Panama, Suez, Kiel)

- as per local navigation rules, but never exceed maximum allowable draft

4.6. Safe Draft Declarations

Where the relevant Port Authority manages channel navigation and terminal limitations based upon a declared “safe draft”, rather than indicating depth and required UKC, the Port Authority declared safe draft may be followed where there is clear precedent of similar sized vessels safely navigating the channel in numerous transits under similar conditions and where the passage is conducted under Port Authority Pilotage.

It is applicable at ports in the United States Gulf of Mexico Region:

- Corpus Christi
- Freeport
- Houston Area
- Port Arthur/Sabine River,
- Lake Charles
- South West Pass/Mississippi ports
- Mobile
- Tampa

4.7. Safe Arrival/Departure Drafts and Water Density

In regions where draft limitations do exist, density variances will have an impact on vessels draft and therefore under keel clearance. All deck officers should have a thorough knowledge of the impact that changes in salinity have on a vessels draft (dock water allowance/fresh water allowance).

Following to be considered when calculating safe arrival and departure drafts of vessels in order to meet company’s UKC requirements and prevailing port requirements:

- Confirm the prevailing density of water and any draft restrictions for each port call from, for example vessel agents, port/terminal authorities or port/terminal hand book.

- Many port authorities publish data on the expected range of water densities within their area of jurisdiction. Masters should confirm applicable density for the day/date in question from above means.
- Use made of latest charts and publications to confirm the local conditions that could impact drafts.
- In instances where conflicting / ambiguous information is noted or a doubt exists in available information (e.g. density of water), the Master should seek clarification from the company for conclusively determining accuracy of the details.
- Master-Pilot information exchange includes draft and density information as well as minimum expected under keel clearance during passage and alongside the berth.
- Visual verification of arrival/departure draft with pilot, where feasible.
- Confirming drafts visually prior departing and where feasible prior arrival each port call.
- Effective use is made of the remote draft gauging equipment to confirm prevailing draft.
- Effective use is made of the vessel's loading computer to verify draft.

Masters to note that Panama Canal Gatun Lake TFW density is less than 1.000 tons/m3. Large vessels transiting from sea water into fresh water can experience an alteration of trim of 7.5 to 10 cm by the head.

5. UKC CALCULATIONS

5.1. Deepest Navigational Draft

		Unit (Meters/Feet)	Remark
1	Maximum draft		
2	Increase Draft Due List		
3	Intended Transit Speed		Knots
4	Anticipated Squat		
5	FW/DW Allowance		
6	Corrected Maximum Draft		1+2+4+5
	1+2+4+5		

5.2. Anticipated Controlling Depth

7	Minimum Charted Depth		
8	Height of Tide		
9	Other factors from latest information		(Swell, rolling etc may reduce depth)
10	Controlling Depth		7+8+/-9

5.3. Anticipated Under Keel Clearance

6	Corrected Maximum Draft		
10	Controlling Depth		
11	Under Keel Clearance		10 - 6

UKC should be calculated for arrival, departure, shifting berth and for transiting the depth less than thrice the draft of the vessel.

The Master should discuss intended transit speed with pilot for calculating UKC and the form to be signed by master and pilot.

The Master should endeavour and obtain the latest sounding information, including the nature of the bottom well before arrival for the port passage. Anecdotal information provided by third Parties relating to UKC must not be relied upon. Acceptable sources include port authorities, pilots or terminals. Every effort should be made to obtain such information in writing. This information shall be verified again before actually making the transit into or out of the port especially when the UKC is a concern. Following information is to be obtained from agent before arrival port and it may be combined with any other pre-arrival information required by master:

a. Maximum allowable draft by port authority
b. Depth of the berth, nature of bottom & water density
c. Depth of the Channel/River, nature of bottom and water density
d. Any other pertinent information
e. Number of tugs will assist during mooring/unmooring operation

Should this not be available, the master should request guidance from the company.

If in doubt that sufficient under keel clearance cannot be maintained during any part of the voyage or when alongside, the master must:

a. Inform the Ship Manager at the earliest opportunity;
b. If alongside, vacate the berth if in any doubt about the risk of grounding.

Some charter party require vessel to lie safely aground (NAABSA clause) in some ports (NAABSA PORTS). This may even be to the extent that the berth dries out completely.

Master shall inform Company well in advance if visiting these ports.

Company is aware of ports where the vessel takes the ground and shall assess the situation including the effects of stress and stability and the nature and level of the bottom and provide necessary guidance to master.

In such circumstances, considerable reliance is placed on previous experience, as often there is no other information available to ensure that the berth is safe.

A risk assessment shall be prepared which shall also include adequate procedures for maintaining services such as firefighting and engine cooling water.

Entries shall be made in deck log book if vessels take the ground.

Where under-keel clearance is less than three meters, the master should take the following actions;

a. Reduce speed whenever in need or doubt
b. Reduce speed when crossing known underwater obstructions such as pipelines, foul ground, cables or tunnels
c. When under pilotage, discuss speed and squat with pilot and agree on a maximum safe speed for the transit. (Kindly note Pilot is engaged only in the capacity of an adviser. If the master believes that a slower speed should be used than that recommended by the pilot, then the master’s view shall prevail).
d. If excessive vibration is experienced while transiting shallow waters, then the vessel’s speed should be immediately reduced to minimize squat and increase the UKC.
e. Vessel’s list increases the vessel’s effective draft. The ship should be up-right before proceeding through the restricted area.
f. The heeling effect produced by the rudder when making a turn must be considered and the speed of the ship adjusted when approaching turns to minimize rudder induced list.

5.4. Local Requirements for UKC

The Master to load vessel as per declared transit or port draft whichever is less but shall maintain minimum UKC as per company policy for the entire transit.

When the ship's draft is close to the maximum draft for the port or berth, the ship must be maintained upright and as close to even keel as is possible.

If in doubt Master should vacate the berth and contact the office to seek guidance.

Where a government, port authority, or pilot association establishes mandatory or recommended minimum UKC greater than company's policy, such requirements of local authorities take precedence over this policy and the master must ensure that, as a minimum, such UKC is maintained.

In case the port allows vessel to enter or leave at a draft which is safe as per customary practice of port but the draft does not satisfy company UKC policy, Master shall inform Ship Manager and seek clearance for the same.

The Ship Manager may permit lesser UKC on a case to case basis provided:

a. A thorough risk assessment is undertaken by master involving all senior officers and bridge team
b. Vessel proceeds at minimum speed during transit to reduce squat effect
c. Additional officer is on bridge for soundings and position monitoring
d. Vessel berths at discharge ports only at time of high water
e. Vessel un berths at load ports only at time of high water
f. Vessel commences cargo well before low water at discharge ports
g. Vessel is upright
h. Vessel is on even keel
i. The concept "pumping over the tide", that is, pumping out as much ballast as possible before the low water avoiding grounding the ship is to be used at loading berths. At discharge berths, the taking of ballast will be delayed until sufficient cargo has been discharged to avoid grounding the ship.
j. Following additional control measures are implemented by company in consultation with charterers/terminal which may include:
k. Rescheduling vessel transit so as to obtain maximum height of tide
l. Employing tugs for assistance
m. Lightering
n. Amending cargo quantities
o. Adjusting cargo onboard to bring vessel to even keel

p. Vacating berth if required.

The importance of determining the correct times for a required minimum water depth during a tide cannot be overemphasized; therefore, the calculations made by the Navigating Officer will be verified as correct independently by the Master.

6. OVERHEAD CLEARANCE

The overhead clearance is the difference between the highest point of the ship and the lowest point of any bridge, cable or other overhead obstruction.[1]

The recommended minimum overhead clearance for bridge or power cable is 3.0m.[2]

Power lines may need more overhead clearance due to the risk of electrical discharge between the ship and the power line for which local requirement is to be complied.[3]

The overhead clearance in pilotage waters needs to be discussed with the pilot during Master / Pilot information exchange.[4]

Allowance should be made for tidal height and swell. In case of bridges with a maximum clearance in the centreline only, allowance should be made for the ship's steering performance, and drift angle

Below is a summary of factors, which can affect the overhead clearance:

a. Ship's air draft, as measured from the baseline (keel)

b. Ship (baseline) draft

c. Effect of trim

d. Movements in sea and swell

e. Tidal prediction

The effects of squat should not be taken into account when calculating the overhead clearance.

6.1. Overhead Clearance and Risk Assessment.

If the Master, for operational reasons without breaching the minimum overhead clearance as required by port/channel/river passage authorities[5], wishes to reduce the overhead

[1] W 08 / 2024
[2] W 08 / 2024
[3] W 08 / 2024
[4] W 08 / 2024
[5] W 08 / 2024

clearance[6], a risk assessment should be conducted. The Master is reminded that if he finds himself in a position of doubt, he should contact Marine Superintendent or DPA.
The results of the risk assessment must be included in the Passage Plan.

When making a risk assessment deciding on a safe overhead clearance, at least these factors should be considered:

a. Clearance according to chart or authorities
b. Air draft of own ship
c. Tidal height
d. Width of the overhead clearance
e. Steering performance and leeway
f. Ship's movement in sea and swell
g. Reliability of all data used in calculation
h. Power Line: Voltage – the risk of electrical discharge
i. Power Line: In rare occasions: Lower clearance due to heavy ice build-up on the cables.

Insure this is brought to all Navigation officers' attention and overhead clearance placed in the passage plans.

[6] W 08 / 2024