Under Keel Clearance – Policy Paper
Guidance To Developers in Assessing Minimum Water Depth Over Devices

Purpose

The purpose of this paper is to provide guidance to developers in determining an appropriate margin of safety – to allow adequate safe under keel clearance (UKC) for mariners- and hence minimum water depth for vessels transiting over wave, tidal and similar devices and their associated structures. Additionally, it is intended that this paper assists developers in identifying suitable locations for underwater devices when considered in the context of available water depth, vessels and craft that transit the area. However, it is not intended that this paper removes the need for developers to consult with the relevant regulator and advisors on a case by case basis.

Background

Traditionally, the (minimum) under keel clearance was calculated as one of the factors required to provide safe passage for a vessel. Once known, this would allow the most viable route to be planned taking into account a vessel's size, draught and nature of cargo. Many vessel transits occur in the confined waters of ports and harbours where a minimum clearance can be defined and controlled. Many ports use whichever is the greater of a defined figure or 10% of a vessel's draught as the minimum under keel clearance.

Transits of areas of limited water depth in relation to a ship's draught and available width of navigable water are undertaken with caution, at reduced speed, with engines ready for immediate manoeuvre, watertight doors closed, bridge manning increased and in port areas, tug assistance for larger vessels. These precautions are taken because, despite the application of a minimum under keel clearance, the likelihood of grounding on immediately adjacent shallows is increased.

When calculating compliance with this requirement, the Master considers the effects of squat, heeling and other dynamic forces on the vessel. Tidal predictions will also be taken into account and transits planned to take advantage of tidal height.

Outside ports and other confined waters, the minimum under keel clearance used is at the discretion of the Master and quite often forms part of Ship Owner/Operator, Charterer or Insurer's policies/requirements.

Ensuring safe transit

In open waters, a larger minimum under keel clearance allowance will be used to account for the vessel's dynamic movement in a seaway and other external factors leading to subsequent changes in draught. Generally transits will be planned for any state of tide.

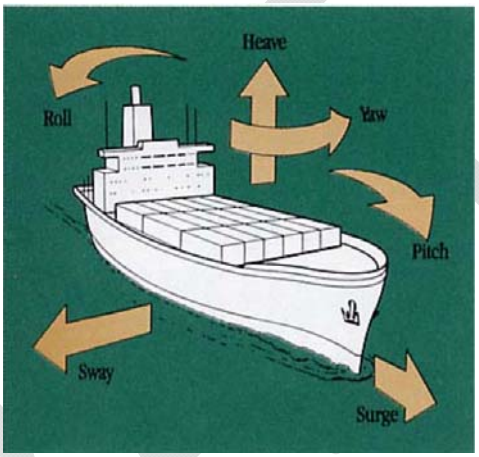

Figure 1: Vessel movements in a seaway

Available depth of water is affected by height of tide. There is a significant difference in some locations between Neap and Spring tide heights and range. Tidal heights can be affected by meteorological conditions which can on occasions mean that the actual tide height is less than the predicted height of tide.

The sea state has a significant impact with swell and sea waves causing reduced depths in the trough of a wave. Pitching and rolling along with vertical heave increases the draught of a vessel, as does the heeling of a vessel by the wind, sea and sharp rudder movements.

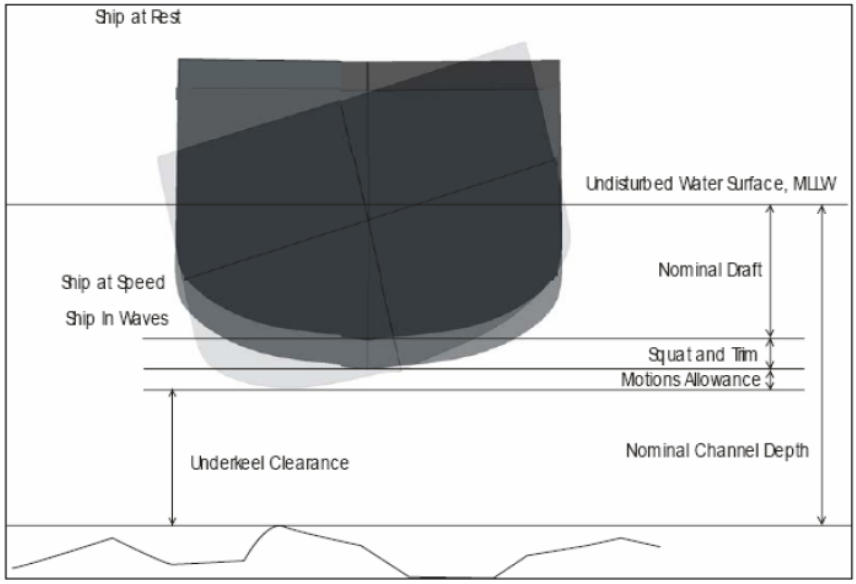

Figure 2: Effects of vessel dynamic movements on under keel clearance

Vessels create significant pressure variations around them as they pass through the body of water. These pressure variations are causal factors in vessel squat, bank effect, and interaction between vessels. The impact on these pressure variations on wave, tidal and similar devices is unknown and therefore advice from individual manufacturers should be sought.

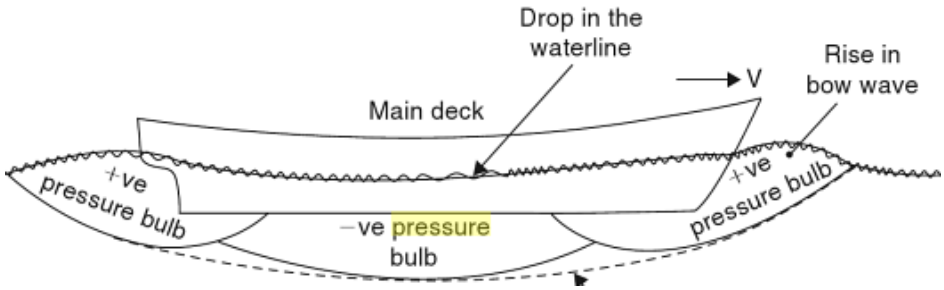

Figure 3: Vessel pressure variations (reproduced from Derret "Ship Stability for Masters and Mates")

Guidance for determining safe depth of water over wave, tidal and similar devices

Where there is no safe and reasonable deviation for marine traffic using the area, under keel clearance (UKC) over tidal turbines or other man made under water obstructions must allow for the safe transit of vessels at all states of tide.

This transit must be safe; this means that it must protect the vessel, its crew and cargo along with the wave, tidal turbine or other under water structures associated with them.

Two key factors need to be considered in determining UKC:

(i) The height of the device including its vertical safety margin. Two aspects to be considered; the position of the sea bed in relation to chart datum (CD) and the minimum vertical safety margin (M required above the device to ensure vessel transits do not damage and/or are detrimental to the device (e.g. the effects of interaction between a vessel and the device).

(ii) The draught of vessels transiting above the device. In Figure 4 the draught (Dd) is the maximum dynamic draught of the vessel and includes suitable allowances for the factors discussed under the heading 'Ensuring safe transit'.

When considered collectively, these two factors should ensure that there is no increase in likelihood of a vessel grounding (or in this case, striking an underwater device).

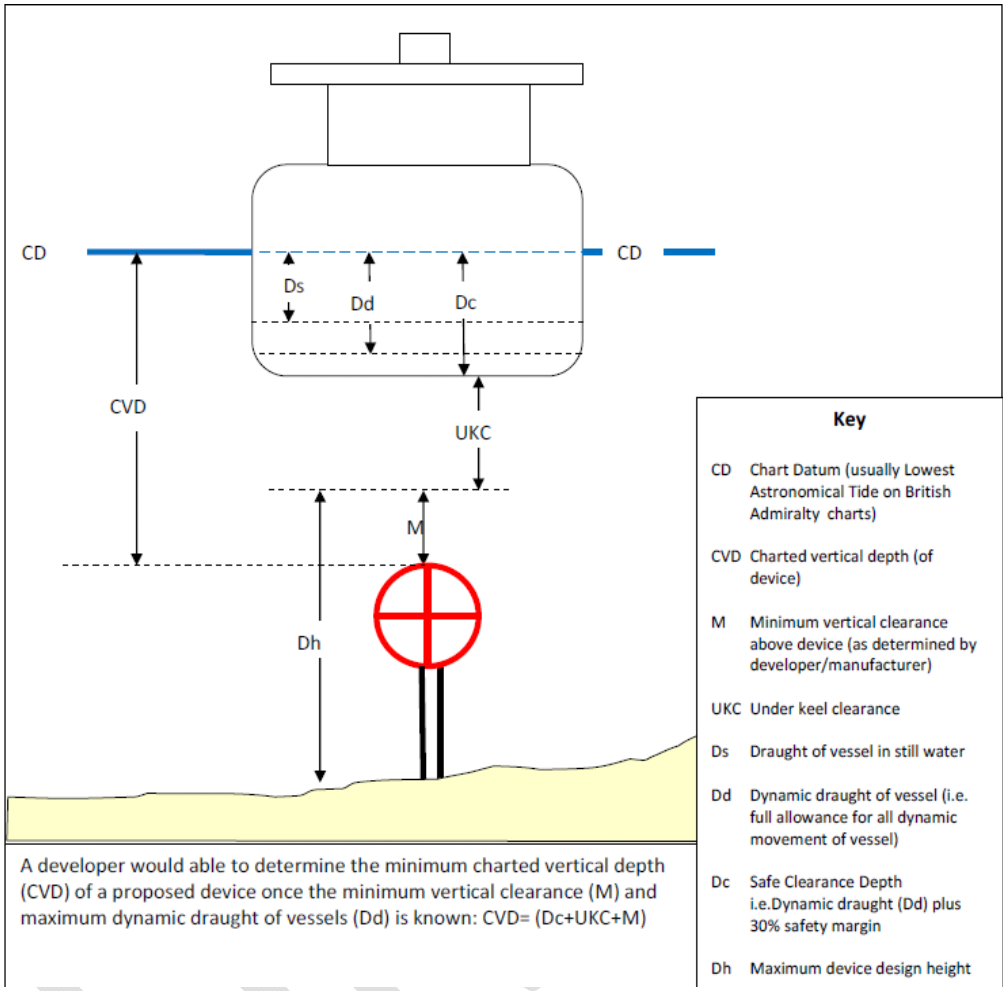

Figure 4: Illustrative view of a vessel passing over an underwater wave, tidal or similar device with the key heights and measurements

Each location will be unique and must be considered for the characteristics of sea, weather and swell. Traffic using the area must be thoroughly understood and the generic characteristic of vessels whether small, medium or large and their behavior in expected sea states should be documented.

Based on this analysis, the maximum worst case dynamic draft can be calculated along with the least depth of available water.

OREI operators have no control over the transit time of vessels and therefore will not know what the tide state is during transit. To take account of this, their calculations should be based from chart datum and consider the worst case scenario transit at Low water (which for calculation purposes can be considered as the charted depth).

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Assessment Criteria

In assessing minimum clearance depth over devices, using figure 4 as the source data, the developer needs to establish a figure for Charted Vertical Depth (CVD) i.e. the minimum depth of water over the device, the following process should be adopted.

Establish, from traffic survey the deepest draft of observed traffic (Ds), this will require modeling to assess impacts of all external dynamic influences giving a calculated figure for dynamic draught (Dd).

A 30% factor of safety for UKC should then be applied to the dynamic draught, giving an overall safe clearance depth (Dc) to be used in calculation,

Charted Depth reduced by safe clearance depth (Dc) gives a maximum height above seabed available from which turbine design height (Dh) including any design clearance requirements (M) can be established.

This simple formula will give a minimum depth over the device against a calculated worst case scenario.

Conclusion

Taking account of the issues identified within this paper, it is clear that there is no standard figure that can be used to establish the safe clearance over underwater devices. Rather, developers will need to demonstrate an evidence based, ‘case by case’ approach which will include dynamic draught modeling to ascertain the safe water depth taking into consideration the guidance contained in this document.