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CONTRACTOR OR CLIENT: WHO PAYS FOR OVERDREDGING?

ABSTRACT

Despite significant improvements in the past thirty years in precision of the dredging process and accuracy of hydrographic survey information overdredging is still an inherent part of dredging. Both port developers and contractors alike have to deal with the allowance for dredging beyond the Client's design dredge depth. The two issues of dredging to design only and the operational capabilities of the dredge equipment and (unavoidable) overdredging need to be considered. Clear wording is required in contract documentation to deal with this aspect and in particular whether the overdredge volume is paid or included in the Contractor's rates and prices. Disputes can and do arise when dealing with overdredging caused by the lack of clarity in the contract's technical specifications and Preambles.

INTRODUCTION

Overdredging refers to the depth of dredged material removed from below a specified or required level. When designing a dredged channel, trench or berthing area the port authority needs to consider the required water depths and the navigation constraints of the vessels operating in and using the port when assessing its 'design' level. By 'design level' is meant the optimum dredge level which meets the needs of the largest vessels entering the port. This means due consideration must be given to the length, breadth and side slopes which may be needed in order to meet those needs. This in turn has an impact on the dredging Contractor and its ability to carry out the proposed dredging works.

Dredging tolerances come up at an early stage of the design process as once the port authority has decided its minimum design depth to accommodate future port users it will have to consider the likely dredge vessels to be deployed and their operating capability. The port authority will have to factor in to its environmental and resource permits not just what the design depth will be required but the likely final dredging depth following completion of the dredging works. Regulators need to know the total volume of material which is to be removed and set parameters in the extraction permits as well as any resource permit holder knowing if the volume of material is available and the total royalty amount that may need to be paid. Therefore adequate thought must be given to the factors which may influence the amount of overdredging which may ultimately result so that the permits accurately reflect the likely dredge depth which is finally achieved.

Above: A cutter at work with a floating pipeline. Because different degrees of accuracies exist for different types of dredging equipment, the Preamble of a contract with technical specification and measurement should reflect the operational limitations of the equipment selected and ultimately deployed.

ACCURATE SPECIFICATIONS

The port designer when specifying the nominal (design) level would be well advised to consider the nature of the material to be dredged and well as the vertical accuracy of the likely dredging vessels under various site conditions as well as sounding accuracy and the likely sediment deposit between the port's maintenance dredging campaigns. There is little literature available for the port designer to determine these factors other than that of PIANC and British Standards – BS 6349: Part 5 Code of Practice for dredging and land reclamation: 1991 sections 3.3 to 3.5 which deals with the horizontal and vertical accuracy of dredging equipment in various soil and rock conditions with adjustments for sea and current conditions (See BS 6349: Part 5, 1991: Tables 12 and 13).

This operational accuracy of dredging equipment is also referred to in Dredging: *A Handbook for Engineers* (Bray, Bates and Land

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1997). The port authority when selecting its overdredging tolerance also needs to be mindful of the likely type of equipment which may be selected for the dredging operation. For instance, a different degree of vertical and horizontal accuracy exists between say a grab dredger and a trailing suction hopper dredger. So the technical specification and measurement preamble should reflect the operational limitations of the equipment which may be selected and ultimately deployed on the project.

As part of this process a determination can be made of the nett and gross volumes, that is, the dredging to design level (nett) and the total dredging including overdredging (gross). When planning the execution of the dredging works the Contractor will be mindful of the gross dredging volumes as this is what needs to be dredged to achieve the design level. And it is the total gross volume to be dredged that will determine the total duration of the work as the planning of the works and any completion dates will be on the basis of gross volumes.

PAYMENT

As part of the contract documentation the port authority needs to deal not only with the issue of the likely amount of overdredging but also the volumetric measurement and payment for the work performed. The contract drafter may consider to base measurement under a contract on nett volume to be dredged: that is the quantity to be removed to design level, based on pre-dredge hydrographic surveys which establish the seabed levels before dredging. In order for contractors to achieve design levels however they will have to over-dredge; that means contractors need to remove more quantity than the nett quantity.

Whilst the dredging Contractor will be dredging gross volumes, the port authority wishes only that the works are dredged to the required design level and no further. This gives a potential area of conflict with the dredging Contractors wanting to be reimbursed for all work performed but the port authorities only wanting to pay up to the design level.

The two issues of dredging tolerance (dredging to design only), operational capabilities of the vessels to be deployed and (unavoidable) overdredging can become intertwined so it is therefore vital to clearly identify the dredging tolerance and what volume is subject to re-measurement. This can then be properly described in the technical specification and any payment preamble.

With major advances in vessel development and operational positioning with increasing

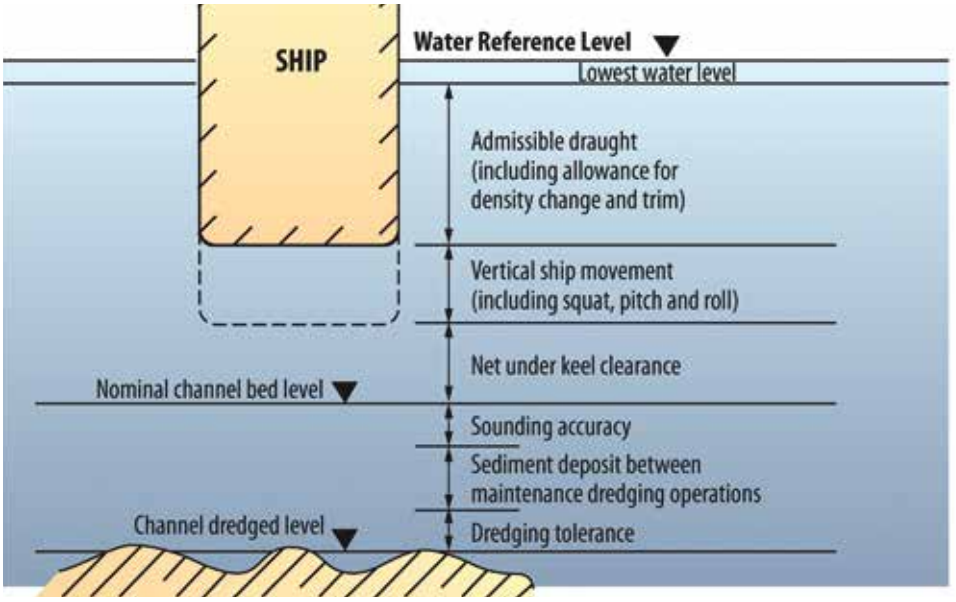

Figure 1. Components of depth (after Bray, Bates & Land, 1997).

Figure 2. Dredging accuracy is a combination of dredge operator skill combined with a constant flow of real-time information.

Figure 3. In recent year modern vessels such as the cutter suction dredger (left) and the backhoe (right) have undergone great advancement in horizontal and vertical dredging accuracy.

use of GPS and vessel automation coupled with increasing use of high resolution single and multi-beam echo-sounders there have been significant improvements in accuracy of the dredging process. Likewise the quality and accuracy of hydrographic survey information, sounding work and data processing has also increased so real-time feedback on the precision of the dredging process by the dredge master has improved to an extent unimaginable over thirty years ago.
The dredge operator now has real-time information on the depth and volumes of material removed and can thus minimise the amount of overdredging whilst still achieving the required levels of productivity (Figure 2).

One could then think that dredging tolerances could ultimately be done away with so that the design depth is the same as the dredging tolerance (zero deviation). Not so. The simple fact is that as the dredging operation taking place is unseen, many factors still remain – such as the type and properties of soil/rock, prevailing wave and tidal climate, type of equipment chosen and the experience of the dredge operator – which make the need for a dredging tolerance a reality.

So if the port designer has followed the guidelines, based on the correct selection of likely equipment, then an optimum for both horizontal and vertical tolerances will have been determined and listed in the technical specification (Figure 3). The horizontal tolerance will need to take into consideration not just the limitation and accuracy of the dredge equipment's own positioning system but should build in a safe margin when the dredge equipment is required to work near adjacent structures such as quay walls, jetties to avoid these being undermined and destabilised with potentially catastrophic consequences. Rectification works may be determined by the Client, but generally consist of back-filling the overdredge area in an approved and timely manner using selected material.

When the port authority only needs a thinner layer of material to be removed then control of the amount of overdredging by the dredge operator is not easy: the depth of material as well as type and variability of material will impact on the volume which may be overdredged. This ratio of dredging to design and amount of possible overdredging needs to be considered when the contract drafter decides whether the overdredging is to be paid or not as the Contractor will have a significant adjustment to its unit rate if any (unpaid) volume has to be absorbed into the paid volume.

ACCURACY

As indicated in the publication, *Construction and Survey Accuracies for the Execution of Dredging and Stone Dumping Works* (IADC / Port of Rotterdam/VBKO, 2001), construction accuracy achieved during a project will not only depend on the selected dredge type and its inherent excavation accuracy, but also on:

- Accuracies of the support hydrographic and positioning (two dimensional reference) systems used;
- Level of quality control used to continuously monitor data quality; and
- Experience level of the crew.

The total construction accuracy is therefore dependent upon reference accuracies, steering (operator) accuracy, and excavation point accuracy (IADC 2001). The reference accuracy relates to errors in determining vessel position relative to fixed reference (coordinate) system. Steering accuracy concerns those errors introduced manually by the operator (dredge or pipe operator, and so on.). Excavation point accuracy is related to the dredge type selected (e.g., shape and adjustability of suction mouth, cutterhead/ suction mouth geometry, use of a level cut bucket as opposed to conventional bucket and so on) (Figure 4).

The required accuracy (and respective dredging costs) between general navigation dredging and environmental dredging should also be considered. Environmental dredging refers to the removal of contaminated sediments. Environmental dredging generally

requires greater precision in dredging as only the contaminated sediments are to be removed as the costs of disposal of such material is huge when compared to general navigational dredging (Figure 5).

In the mid-1990s with the construction of the Ketelmeer environmental depot in the Netherlands for the storage of contaminated material, a detailed study was done into the accuracy of the dredge process (Figure 6). The study found that the inaccuracies became greater in the order of: reference inaccuracies, excavation mouth inaccuracies, and then total construction inaccuracies. During the Ketelmeer dredging there was no factor for steering accuracy as it was performed by stationary cutter suction dredgers but one can assume that steering accuracy will follow reference inaccuracies in its influence on total accuracy.

When dealing with new port construction the accuracy of any side slopes which have been dredged for marine structures can become an issue for any follow-on contractors if for instance a piled jetty is to be built on the dredged slope as the box-cut profile and loose nature of the material forming the dredged slope may cause problems when the follow-on contractor comes to drive the piles. If this is the case the port designer would be well advised to specify a more accurate slope tolerance which would require the dredge equipment to dredge a series of many shallow cuts on the slope profile. If this degree of accuracy is required, this will have significant cost implications in terms of lower productivity of the dredge equipment. Consequently, such requirements need to be clearly addressed in both the technical specification and preamble. A failure to specify such stringent requirements will likely result in a claim from the piling contractor who may be faced with difficulties in those operations.

PREAMBLE

Whilst some deliberation by the designer is usually given to the design depth and maximum dredge depth which may be achieved, experience has shown that whether the specified tolerance is paid or not is often an afterthought with little consideration given to clarity in the Preamble of the Bill of Quantities. The Preamble of a Bill of Quantities is usually a summary of the work

Figure 4. Dredging accuracy remains a challenge to maintain throughout the dredging process – shape and adjustability of suction mouth, cutterhead /suction mouth geometry all have an influence on dredging accuracy.

Figure 5. Because of the presence of contaminated sediments, environmental dredgers are tasked with having even greater accuracy than other types of dredging.

Figure 6. At the construction of the Ketelmeer contaminated sediment depot in the Netherlands for the storage of contaminated material, a study found that inaccuracies in dredging become greater in the order of reference, excavation mouth and then total construction inaccuracies.

Figure 7. CESMM4 published by The Institution of Civil Engineers in the UK.

requested divided into sections that explain the project, materials needed, unit prices, provisional sums, methods and principles of measurement. In cases in which excavation is included in the project, the way the volume is to be measured is usually outlined in the preamble.

The purpose of a Bill of Quantities is to define the work requested for a project. The aims of a Bill of Quantities are to provide such information of the quantities of work as to enable tenders to be prepared efficiently and accurately. Where a contract has been entered into, the Preamble and Bill of Quantities provide guidance in the methods of measurement and the valuation of work and therefore determine the quantities of work which will be reimbursed. Hence a proper definition of the overdredging allowance is vital.

Since its introduction in 1976, the United Kingdom's Civil Engineering Standard Method of Measurement (CESMM) has proved to be extremely resilient in meeting the needs of those engaged in preparing contracts based on traditional 'measure & value' principles. CESMM4 may be used with any conditions of contract for civil engineering work that includes measurement (Figure 7).

The fourth edition of CESMM4, published in 2012, supersedes the third edition published in 1991 and retains essentially the same principles as when the document was first published. This is a great tribute to the authors of that first edition that they were able to produce a methodology that has proved so resilient to the changing practices and procedures within the construction industry.

Dredging is dealt with under 'Class E: Earthworks'. Class E: Earthworks states "*Items for excavation shall be deemed to include upholding sides of the excavation, additional excavation to provide working space and removal of dead services*". It is a moot point whether a overdredging allowance is 'working space' and it would seems to stretch the point for a dredging tolerance to be deemed a form of working space. CESMM4 goes on to say "*The location and limits of excavation by dredging shall be stated in the item descriptions where its extent would otherwise be uncertain*". Therefore when using CESMM4 it is important to state the limits of any overdredging and give certainty to whether it is paid or not.

In Australia the Australian Standard Method of Measurement of Civil Engineering Works and Associated Building Works, first published in 1971 with a Second edition in 1982 under Section 7: Dredging under sub-clause 7.4 (d), states "*Where dredging is to be measured by soundings, the method of taking soundings shall be stated, e.g. by echo sounding, plate sounding, jetting, lead line, staff. The quantities of dredged material shall be calculated by taking the cubic content of voids formed, i.e. measured in-situ, such quantities being computed by comparing the sounds and levels taken before and after dredging*". So it is clear that in using the Australian Standard Method of Measurement all quantities are paid including the overdredged quantity.

When drafting a contract it is important to outline all work to be completed and how it is to be measured on a periodic and final basis once all the work is completed in accordance with the contract drawings. This allows managers to perform periodic evaluations on the tasks completed and to ensure that these tasks match what was delineated in the Bill of Quantities.

Work must be itemised in the Bill of Quantities as reflected in the Preamble. The itemised list creates the estimated cost of the project and allows contractors to tender on the work on an identical basis. The Bill of Quantities Preamble for a Re-Measured Works Contract may simply refer to measurement by in- and out-survey which would lead tenderers reviewing the contract documentation to reasonably infer that ALL quantities are paid quantities including those quantities below or outside the dredging tolerance. It should be part of a Contractor's tender checklist to confirm whether overdredging is paid or not and to what extent the Contractor has to absorb overdredging into the unit rates (that is the unit rate under the contract which is applied to the nett quantity).

Clear wording is needed in the Bill of Quantities Preamble to establish what the definition of the paid volume is. It is within this area with poor drafting of both technical specification and preamble that disputes can and often do arise. The mix-up is usually between the tolerance in the technical specification and how the measurement Preamble has been drafted. If it is the Employer's intention that overdredging quantities are to be strictly minimised (for instance to keep within resource consent provisions), then the consequence in terms of non-payment for overdredging beyond the design depth and any overdredging allowance should clearly be spelt out.

This may be different, however, in a maintenance a dredging campaign where the port owner is seeking to maximise the amount of material to be removed. In such a case it may be appropriate that all measured quantities are paid with no restriction placed on the overdredging allowance in terms of paid or unpaid volume measurement.

A typical dredge tolerance specification would be as follows: Maximum permitted tolerances to achieve design depth in accordance with the dimensions provided on the drawings for the different dredge areas will be as follows:

HORIZONTAL

Toe lines adjacent to any structures:
-0.0 m / +1.0 m
All other areas: -0.0 m / +3.0 m

VERTICAL
Toe lines adjacent to any structures,
to a distance of 5 m off the toe line:
+0.0 m/ -0.25 m
All other areas including slopes:
+0.0 m/ -0.50 m

A dredge tolerance clause in a Bill of Quantities Preamble would state:
"The re-measurable prices shall be based on the quantities and volumes determined by Contractor from the dimensions, levels and elevations as specified on the Drawings together with the allowance for over-dredging to the tolerances stated in the technical specification. The Employer shall not compensate Contractor for any volumes dredged by Contractor beyond the dredge tolerance".

Figure 8 shows design levels (nett payment line) and overdredging in channel bottom and channel slope. The contractor must make an assessment of how much overdredging will be done and include an allowance for this overdredging in the unit price: that is the unit rate under the contract which is applied to the nett quantity.

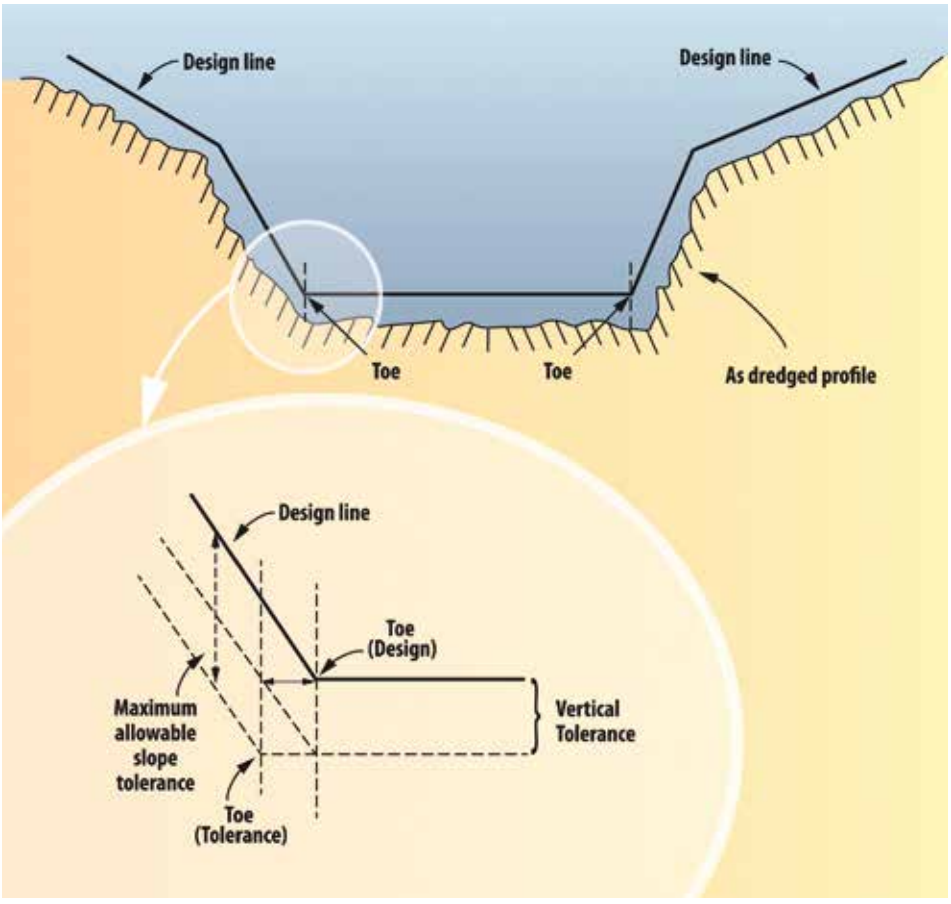

Figure 8. A dredge profile with design level and tolerances.

CONCLUSIONS

Summarising the above considerations, it is recommended that proper consideration should be given by the contract drafter for how the dredging tolerance and overdredging allowance is managed in the dredging contract. The contract drafter should consider whether overdredging is paid as a measured quantity to the overdredge allowance or to be absorbed in an allowance in the Contractor's unit rates and prices. There is no industry standard or guideline in this respect. Each dredging project should consider the merits of a paid or unpaid dredging tolerance.
Contract drafters should bear in mind that reducing the overdredge allowance tends to slow production rates and increase the time and cost to complete the dredging project.

A well-defined overdredging provision in both the technical specification and Bill of Quantity Preamble clause will take speculation out of the tasks of the Contractor when considering how the measurement preamble is to be interpreted. This will result in less chance of misinterpretation of how the overdredging allowance is to be applied by the Client.
The administration of an overdredging allowance in terms of paid quantities is relatively straightforward if the contract is appropriately drafted. Prior to going to tender Contractors are advised to check how the specific dredging contract deals with the overdredging allowance in terms of the definition in both the technical specification and measurement preamble.

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