COMPETITIVE AND SUSTAINABLE GROWTH (GROWTH) PROGRAMME

THE EMERGENCE OF LARGER VESSELS

Working Paper

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1 INTRODUCTION

1.1 Purpose and scope

Working Group 4 within the SPIN Thematic Network focuses on getting the message across. The overall objective is to increase users' awareness of available or emerging technology through information exchange and to help the implementation of RTD-applications. Public Relations, including a communication plan and lobbying activities will enhance transparency of the new technological possibilities, improve the acceptability of the available technology and speed up the innovation at user-level. This paper will specifically deal with the awareness of innovations concerning emerging technology and processes that will increase the optimum size of vessels in relation to waterways and infrastructures with which they interact.

The vessels considered as marginal are those due to their size, manoeuvrability, or speed are marginal in relation to clearance of infrastructure and hazards as well as availability of usable water and proximity of other vessels.

The paper will investigate some of the problems that may be faced by vessels with minimal clearance, and the use of emerging technologies that are becoming affordable and may help.

1.2 References / Consultation

Users and stakeholders such as Pilots, and Pilots associations (EMPA), EHMA, Hydrograpghic agencies and Port Authorities.
Antwerp, Rotterdam and Hamburg.
Paper of Branislav ZIGIC of VBD on Hydrodynamic aspects of navigation in restricted waterways.

2 INTRODUCTION

2.1 Acronyms, Abbreviations and Definitions

AIS	Automatic Identification System
CDGNSS	Carrier Phase Differential Global Navigation Satellite Service
DGNSS	Differential Global Navigation Satellite Service
DG TREN	DG Energy and Transport
ECDIS	Electronic Chart Display Information System
ENC	Electronic Navigation Chart
ETA	Estimated Time of Arrival
GPS	Global Positioning System
RTK	Real Time Kinematic
SWE	Shallow Water Effect
UKC	Under Keel Clearance
VTM	Vessel Traffic Management
VTMIS	Vessel Traffic Management and Information Services
VTS	Vessel Traffic Services

3 DEMAND FOR OPTIMUM USAGE

3.1 European Perspective

When one looks at the transport corridors that are served by inland waterways covering most of the Main land Europe outside Scandinavia, Iberia and Italy, it is hardly surprising that so much effort is being placed on the better utilisation of Inland Navigation.

The European Union has for some time recognised the great potential that Europe's inland waterway network has for freight and passenger transport. Europe has over 30.000 kilometres of canals and rivers that link together hundreds of key towns and areas of industrial concentration. The position of inland ports at the heart of Europe's trading routes, means they are perfectly placed to offer intermodal connections to Toad, rail and sea lines. Inland waterway transport is considered rather cheap and efficient, reliable, safe and environmental friendly particularly compared with road transport.

Freight transport by inland waterways[1] presently accounts for 7% only of total inland transport, but there is still a massive capacity that is not being used. TEN_T guidelines include an important inland navigation projects, for the complete axis of Rhine/Meuse and Danube where some infrastructure projects are needed in almost all the countries concerned. The various sections are planned to be implemented from 2011 to 2019.

An important project which is the Seine – Scheldt river link. It will connect the Parisian region and the Seine basin with the entire Benelux inland

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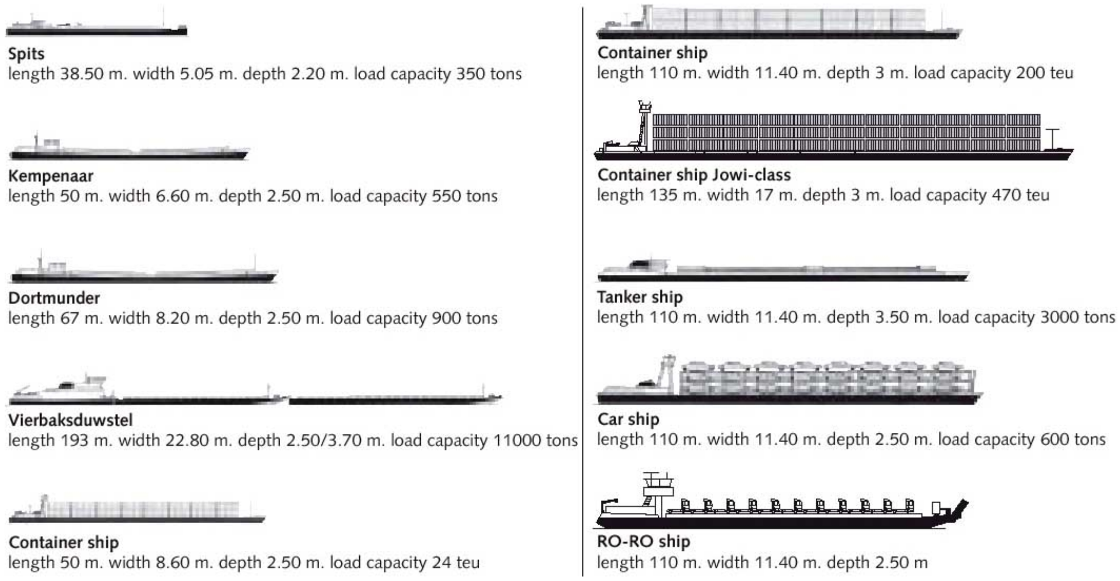
[1] Mr Edgar ThIelmann Workshop " Waterways of tomorrow" 9 December 2003 European Parliament

waterway network. It can become a vital transport route in a highly-developed economic and industrial region, connecting in particular the ports of Le Havre, Rouen, Dunkirk, Antwerp and Rotterdam. This project is considered of great importance for sustainable development of transport and modal equilibrium in an area where road and rail infrastructures are close to saturation.

It is hardly surprising that a greater emphasis has been placed on the evolution of Inland waterways to accommodate higher percentage of freight traffic than at present. Political direction within Europe is inevitably going to place a greater emphasis on the carriage of goods by inland waterways. The vision drawn up within "European Transport Policy for 2010, Time to decide" will result in the growth of the size of vessels to accommodate increased demand. Inland waterways are seen to be vital for efficient interconnection from the hinterland via to the seaway. There are more than 25,000 km of waterways that connect all major industrial areas.



Spits
length 38.50 m. width 5.05 m. depth 2.20 m. load capacity 350 tons

Kempenaar
length 50 m. width 6.60 m. depth 2.50 m. load capacity 550 tons

Dortmunder
length 67 m. width 8.20 m. depth 2.50 m. load capacity 900 tons

Vierbaksduwstel
length 193 m. width 22.80 m. depth 2.50/3.70 m. load capacity 11000 tons

Container ship
length 50 m. width 8.60 m. depth 2.50 m. load capacity 24 teu

Container ship
length 110 m. width 11.40 m. depth 3 m. load capacity 200 teu

Container ship Jowi-class
length 135 m. width 17 m. depth 3 m. load capacity 470 teu

Tanker ship
length 110 m. width 11.40 m. depth 3.50 m. load capacity 3000 tons

Car ship
length 110 m. width 11.40 m. depth 2.50 m. load capacity 600 tons

RO-RO ship
length 110 m. width 11.40 m. depth 2.50 m

More than 400 million tonnes a year are transported in barges in the European Union. The shipping fleet is made up of units of the most diverse dimensions and tonnage, adapted to the infrastructure and the freight. A suitable vessel is available for cargoes between 100 and 3,500 tonnes, and push barges are able to transport up to 16,000 tonnes of cargo in one go. Growth in freight transport causes new capacity bottlenecks

3.2 Infrastructure Capacity problems

A properly maintained waterway network will not be enough in all instances to reliably and rapidly transport freight in the anticipated future volumes future. Capacity calculations reveal that growth in freight transport will cause specific bottlenecks, because of increasing pressure on lock, bridge and berth capacity.

This will cause unsafe traffic congestion situations, as well as problems in the harmonisation of operating hours for locks and bridges between the different (waterway).

The result is that vessels size will steadily increase until they reach an optimum. This optimum size will depend on introduction of utilisation measures for a number of specific locks, bridges and berths, almost all of which are located along certain important main corridors, will make it possible to solve existing and potential bottlenecks .

The following measures are required to enable the passing of larger ships in selected areas.

- increases in bridge height
- deepening and widening of waterways;

However, the capital cost required and time taken to carry them out is considerable. Therefore any measure that can increase the optimisation of vessels with regard their interface with infrastructures such as locks and bridges, is of considerable interest. It may in some cases even reduce the requirement of major construction works.

3.3 Definition of Marginal Vessels

As vessels increase in size, they will eventually reach a point whereby they become marginal with respect to bottom, lock or bridge clearance, they may also be marginal in their ability to manoeuvre in and out of locks, or navigate around obstacles. There is a delicate balance between low water levels that will limit the vessels cargo carrying capacity whereas high water levels restrict the passage under low bridges.

The needs of these marginal ships has only recently evolved due to the pressure to continually increase the size or capability of vessels whilst using wherever possible existing infrastructures. These vessels are at the extreme limit of what can be safely handled. The limitations are due to their size, manoeuvrability or speed in relation the available clearance to other vessels, infrastructures, or the bottom.

In some cases though vessels may find that due to adverse weather conditions they are unable to navigate channels that they normally can. The picture shows the River Rhine unusually low in October 2003. With water levels falling to their lowest levels in over 50 years, the Rhine River in Germany is becoming increasingly dangerous to ship and passenger traffic. A number of shipping companies have been forced to suspend their operations on the world's most-densely trafficked river.

The situation was so bad that container ships navigating the Rhine could only be filled to a third of their normal capacity; otherwise they risked hitting bottom. The problems of very dry weather are not just restricted to the Rhine. Stretches of the Weser, Elbe and Oder rivers have also been closed to shipping traffic. In Holland, the ships operating as far as Strasbourg, France, and Basel, but they were only able to carry 20 percent of their normal capacity. Generally the lowest levels happen at the end of October or in November.

The navigation of vessels that are marginal, requires increased accuracy and reliability of real time traffic management and navigation information. In some cases, especially when restrained by depth of water, they will require interactive or co-operative decision support services with a vessel traffic management authority.

The largest vessels in operation on the river Rhine nowadays such as the container ship “Jowi” (picture Technomar), have an overall length of 135 m, a moulded breadth of about 16.8 m and a maximal draught of up to 4.0 m.

While the length of vessels has reached a regulatory limit there are still possibilities for enlargement of breadth (up to 22.8 m). There have already been experiments with models of ships having a breadth of 20.0 meters [2]. But extreme breadth result in problems in ensuring a good water flow to the propellers in restricted water depths. This can be compensated for by drawing water from the side rather from beneath the vessel.

Shallow waters make the navigation even more difficult because of “shallow water effect”. There are two main results of this effect, a deterioration of directional stability and squat caused by a significant decrease of pressure under the hull. Squat can increase the draft of a inland vessel by half a metre or more.

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[2] Paper by Branislav ZIGIC, VBD (Hydrodynamic aspects of navigation in restricted waterways)

4 MARGINAL INLAND NAVIGATION

4.1 Why go Marginal?

Revenues can be increased by better performance of a vessel, through a larger carrying capacity on more voyages. The optimum formulae is to be able to have vessels that are not only fully laden, but whose cargo carrying capacity in terms of volume is as large as can be safely navigated within the waterways for which it was intended. The restrictions to capacity are length, breadth and of most importance draft. Though the length and breadth in a normal vessel are fixed, the maximum draft is variable dependent on:-

- Static conditions such as:
    - Cargo
    - Fuel, water and stores

- Dynamic conditions such as:
    - Angle of Heel (dependent on loaded condition, movement of cargo or rudder angle)
    - Trim
    - Density of water (sea water giving maximum buoyancy, fresh minimum)
    - Shallow water effect (speed of water between hull and waterway bed.) May also effect Trim
    - Wave induced heave, pitch and role (large lakes and sea-ports)

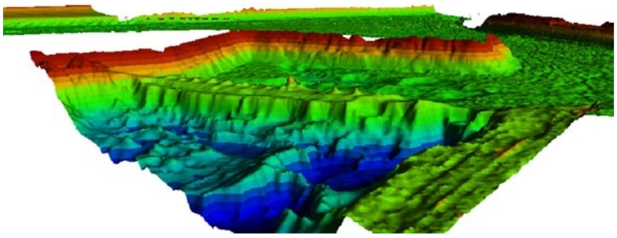
Much work has taken place by industry and institutions alike to optimise the shape of the hull and performance of steering and propulsion units. From time to time to increase capacity some infrastructures, or sections of waterways might be upgraded, but we still need to optimise performance. Therefore we now need to investigate other tools to optimise the performance of Inland Waterway Vessels within existing infrastructure.

We will see more, larger, vessels, decrease of acceptable margins and stretching of limits resulting in a higher demand of vessel handling capabilities of skippers. The skipper will be at the same time will have to work in closer corporation with the Traffic management operators and lock keepers to guaranty safety, efficiency, fairway workability and port accessibility

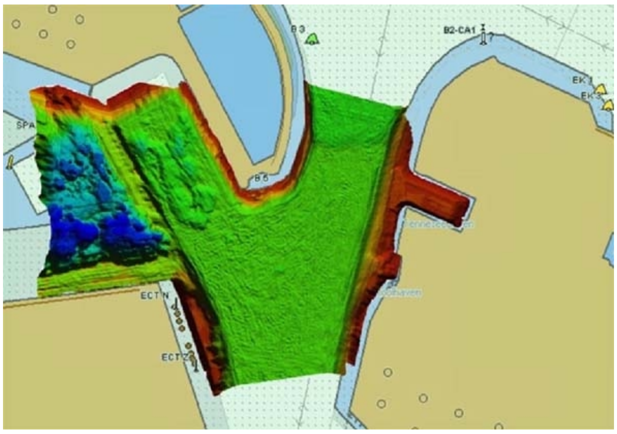
Solutions that have been tried successfully for large vessels in Australia and Netherlands and include the use of real time bathometric information for updating real time high density charts and under keel clearance applications for dynamic path prediction and management and measurement of squat using co-operative decision support between the vessel and traffic / lock authority for optimum speed and rudder control.

4.1.1 Real Time Bathometric Information and update of charts.

As the clearance between the hull and the bottom decreases, the steerage and propulsion performance suffers, though innovative propulsion and steerage systems can help to reduce this reduction in performance, real time or near real-time 3D bathometric depth information will allow the vessel to be loaded to its optimum draft considering the depth of water and amount of available water that is required for manoeuvring. The 3D image gives a cross section profile of the waterway. To obtain and update bathometric information in areas that are liable to bottom movement 3D multibeam sonar (SOund NAvigation and Ranging) offer the most effective solution. Side scanning sonar was used for this kind of work, but it often distorted the image and contained insufficient information about the true 3-D shape of the underwater profile. Modern high-resolution multibeam sonar offers an opportunity to cover a relatively large area while resolving the true three-dimensional (3-D)shape of an object or underwater profile with centimeter-level resolution.



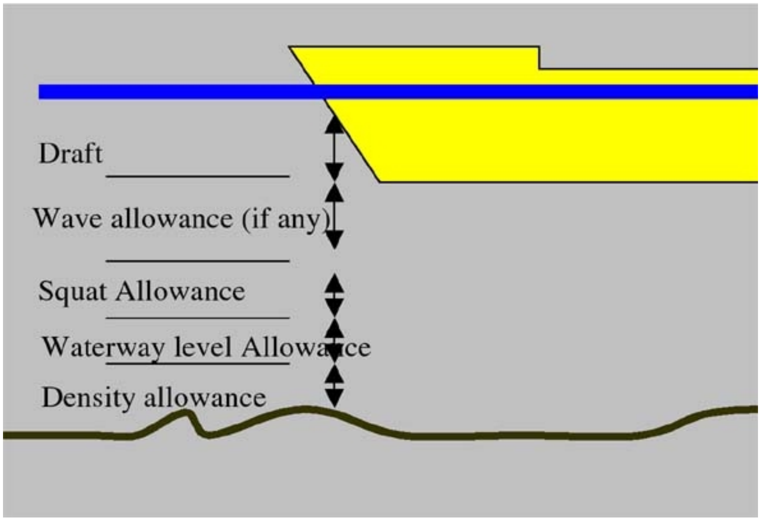
Sonar transmits sound energy and analyses the return signal (echo) that has bounced off the bottom or other objects. Multibeam sonar systems provide fan shaped coverage of the seafloor and the output data is in the form of depths rather than images. Instead of continuously recording the strength of the return echo, the multibeam system measures and records the time for the acoustic signal to travel from the transmitter (transducer) to the seafloor (or object) and back to the receiver. Multibeam sonar's are generally attached to a vessel, rather than being towed. Therefore, the coverage area on the seafloor is dependent on the depth of the water, typically two to four times the water depth. Unlike side scan sonar requing speeds of 5 knots or less to insure 100 percent bottom coverage, the steering and focusing techniques, of a multibeam sonar enables several simultaneous adjacent parallel beams to be generated allowing100 % coverage at very high tow speeds with extraordinary resolution and image clarity.



Multibeam sonar's are ideal systems for mapping large areas rapidly, with essentially 100 percent bottom coverage. Multibeam signal backscatter information can be used to generate side-scan data for imaging bottom features and targets in a wide variety of water depths. The coverage area of these systems is a function of water depth and number and pattern of beams. Most systems provide coverage ranging from two to approximately seven times the water depth. The benefits to using multibeam sonar include increased bottom coverage, higher resolution of bottom features, and more coverage in difficult survey areas (ie, under vessels, barges, and piers) and improved detection of changes to bottom conditions.

The 3D bathometric depth information can be integrated in real or near real time to Inland ECDIS chart update depositaries within traffic centres along the waterway. The traffic centres then can broadcast to vessels the corrected charts or give updates to vessels in way of suitable memory hardware. For marginal applications the Electronic Navigation Chart S57 ENC standard alone is not sufficient, therefore it is necessary to produce, maintain and disseminate "high density S57 ENC", base on multi beam side scan surveys. Providing standards can be put in place, this can mean near real-time update of the bottom profile of a specific area through a wireless uplink, directly updating the on board electronic chart. Whether this would be possible through RIS needs to be investigated.

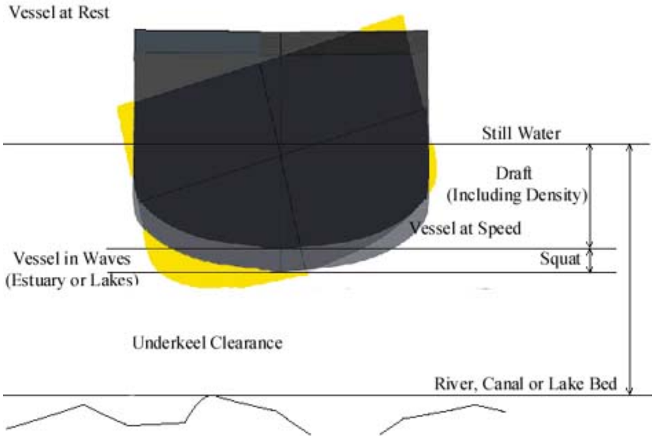
4.1.2 Underkeel Clearance



UKC requirements are generally calculated to cover a broad range of environmental conditions and vessel parameters. If the requirements are too conservative, ships carry less cargo than they could, and the operation is not as economic as it might be. At the other extreme, inadequate criteria could jeopardise safety.

It is essential that underkeel clearance requirements include all allowances required for the voyage in question. This may for some vessels include the effect of wind and atmospheric pressure changes on water levels, particularly in tidal areas, but also the dynamic motions of vessels of varying size and stability characteristics.

4.1.2.1 Squat Allowance



Squat is a combination of bodily sinkage and change in trim of a vessel while sailing. The major factors affecting squat are ship form and initial trim, vessel speed through the water, vessel acceleration and deceleration, depth/draft ratio, channel width and depth of river /canal, abrupt depth changes, changes in fluid density, passing and overtaking vessels.

In normal navigation a vessel will expect, in shallow water to suffer increased immersion of approximately 10-15% of its draft due to squat. As a vessel in shallow water increases its speed, the water is forces under the hull at a speed faster than the vessel, this results in low pressure that literally sucks down the vessel, thus increasing the draft.

4.1.2.2 UKC Wave Response Allowance

In channels, estuaries and lakes subject to wave action, vessels can experience heave, roll and pitch motions which combine to produce vertical displacements of the hull. The magnitude of these dynamic and irregular displacements at each point of the vessel's transit depends on many factors, including:

- Wave frequency and direction;
- Vessels dimensions, hull shape and stability data;
- Vessels speed;
- Vessels depth/draft ratio.

4.1.2.3 Changes in Water Level

Within estuaries and tidal rivers, in addition to the change in water level due to predicted astronomical, water levels are also affected by meteorological changes in wind speed and direction and in barometric pressure. These changes in water level represent the difference between measured and predicted water levels and are known as the tidal residuals. In particular circumstances this difference can be substantial (of the order of ± 40 cm, or greater).

Within Inland waterways the water level is liable to change due to seasonal effects, that not only effect the flow rate and depth, but also change the profile of the bed due to movement of large amounts of silt.

4.1.2.4 Changes in Water Density

Changes in water density have the same effect as a change in water level in terms of draft and the resulting underkeel clearance. It is important to identify where these changes occur and by how much the density has changed. Changes in density may be caused by the salinity level in tidal rivers, estuaries and sea ports and by suspension of organic matter in inland rivers canals and lakes.

4.1.2.5 Underkeel Clearance Management in Inland waterways.

Management of underkeel clearance involves complex calculations based on a range of static and dynamic factors (including channel depth, environmental conditions and vessel characteristics). Though historically, clearance was managed by prescribing maximum allowable draughts, which included large safety margins based on experience and judgement, this was before the introduction of marginal vessels. Now with the advent of ore accurate information, it is possible to navigate marginal vessels with much reduced safety margins.

However the calculation of underkeel clearance required for effective directional stability and for safety of the vessel, particularly where there is a “hard bottom”, also depends on the amount of increase in draft resulting in “shallow water effect” due to squat. The manoeuvrability of a vessel also effected by interaction with other vessels and the bank (or infrastructure) of the waterway. Here the increased speed of water between the two hulls, or the hull and the bank/infrastructure (Bank effect) again causes a reduction in pressure on the side of the other vessel or bank/ infrastructure causing the performance of the rudder to decrease substantially, whilst also "sucking" the vessel towards the area of low pressure.

Fortunately, there are not many hull shapes in use in inland navigation, and therefore modelling the hydrodynamic performance of them in marginal situations is a realistic aim. With accurate models, and by monitoring by traffic / lock management centres of the directional stability of vessels in areas where they are marginal, it is possible to build up a database of profiles of draft / trim, hull shape, waterway / infrastructure, squat versus speed and resultant directional stability.

4.1.2.6 Path Prediction tools

For many vessels a satisfactory prediction of movement for a period 90 to 120 seconds ahead can be achieved by knowing its accurate position, velocity and rate of turn. This is a proven application already in use in sea port VTS Centres today.[3] For marginal vessels, however, further modelling is required, which includes the ship's hydrodynamics, use of actual draught, trim; and for very long vessels, flexure, the prediction of squat, shallow water effect and interaction, coupled with a three dimensional model of the waterway. This also calls for real time hydrological and meteorological data, with water movement being measured at various levels and not just on the surface.

This does not mean that we have to re-calculate a vessels hydrodynamic performance, each time it encounters a marginal situation, but we can use stored data of other similar profiles to predict the likely squat, and with that estimated squat, and taking account of other allowances mentioned before, predict the resultant velocity of a vessel in real time. Due to the need for local knowledge such as recent bathometric profile to determine best route/approach, density and previous vessel encounters, for the application to be effective the path prediction needs to be performed, certainly in the short and medium term by traffic management operators resulting in a requirement for electronic exchange of data between vessel and infrastructure.

4.2 Co-operative decision support

As we have seen it is neither practicable or at present possible for a marginal vessel to sense, manage, compute and thereafter use the information in a decision support process by themselves. Because of the number of infrastructures distributed all over Europe, and the number of vessels that eventually may find themselves in marginal situations, it is important to ensure integrity and accuracy and content of information is the same form and to all vessels and infrastructures. Co-operative decision support will be required whereby the vessel and the infrastructure traffic manger exchange information:-

1) Infrastructure / traffic management authority will manage and provide to vessels:

    - Information on shifting bottoms and differences in water level caused by seasonal effects, and how bathometric surveys using 3D multibeam sonar.
    - Dynamic update of ENC's based on real time or recent bathometric information on onboard adaptive ECDIS
    - Dynamic Under Keel Clearance based on real-time and or predicted water level, current, water density, wave energy and measured squat information

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[3] Rotterdam Pilots (Source European Maritime Pilots Association)

- Real time squat and 3D velocity measurement (when navigating in vicinity of infrastructures such as locks, docks, bridges, cuts or berths)
- Radio-navigation CDGNSS (RTK) corrections.

2) Vessel will provide management authority with:

  - Hull class (length, breadth and underwater profile)
  - Static Draft, and Trim
  - Real time steerage and propulsion information.

The last component that is required is an accurate navigation service that will enable 3D measurement of vessel that includes vertical measurement for squat tendency and horizontal velocity. This is not an absolute 3D position, but a measurement relative to the infrastructure.

4.2.1.1 Equality of information

The information used for decision support for marginal applications is of a dynamic nature and often once a "mission" has started it has to be completed, and can not be interrupted. This requires co-operative systems and services to enable interactive decision support for command of a vessel between the vessel and the management authority. In a scenario where a number of vessels will be sharing the same water, all vessels should be considered as marginal whilst the operation is under way. The information on which decisions will be made will also need to have an acceptable level of equality to ensure that the accuracy, reliability and integrity of radio navigation and other associated status information is within acceptable tolerance and is "of equal kind".

4.2.2 Navigation information

When we consider marginal applications the vessel is at the extreme limits of the waterway usability so we need to measure with the accuracy required both the vertical and horizontal movement of the vessel, an accuracy is required of a few centimetres. This is achievable by using Carrier Wave Differential Global Navigation Satellite Service, or CDGNSS. The process is also known as Real Time Kinematic (RTK).

A lot of experience has been gained on large vessels in Rotterdam, there to enable marginal seagoing vessels to safely use the waterways, here multi sensor arrays are used to measure the vessels three-dimensional velocity and / or attitude (heel/trim & bending /distortion). The multi sensor arrays range from a minimum of two sensors placed on the beam extremities of

the vessel, giving accurate positioning as well as course / helm measurement, to four or six sensors placed both port and starboard, in the forepart, aft part and sometime also in the mid-ship section of a vessel. These multiple sensors are the able to measure the heel and trim of a vessel and thus bottom clearance below the sensors. This information is crucial to dynamic path prediction and under-keel clearance. However, for most inland navigation applications only one or possibly two sensors will normally be needed. Two for measuring changes in trim due to squat.

The sensor-derived information needs to be broadcast to the Vessel Traffic management authority for co-operative decision support between the authority and the vessel. The technology required for computing and display the navigation sensor derived information as well as other supplied by the Vessel Traffic Management service, has already been developed for the application in Rotterdam. However, in the future adaptive ECDIS would have to be developed for receiving and displaying real time information.

4.2.2.1 The Rotterdam experience

When within range of RTK service the system can achieve an accuracy of within 2 to 5 centimetres! Both vertically and horizontally. This makes the system capable of reliable and extremely accurate docking and approach mode.

In Rotterdam they use a combined GPS/GLONASS correction transmission with an update rate of 5Hz. Two separate receivers are used and so it is possible for the system to calculate the Heading (accuracy 0,3 degrees) and Rate of Turn (accuracy 0,3 degrees/min). The hardware of the JAVAD GPS/GLONASS receiver has been updated specially by AD-Navigation in Norway due to some difficulties caused by obstructions and other radio signals. The range of coverage from each station is about 14km. Using three base stations, they are able to cover, including overlap, 35 Kilometres. The system is RTCM compliant and gives a horizontal accuracy of 3cm, and vertical accuracy smaller than 5cm.

Experience from pilots who have used the system say that it has proved to be highly accurate. Under favourable conditions the RTK signal gave a position to within an accuracy of 1-2 centimetres where the rate of turn is better than 0.1 degree/minute, the heading is equal to the gyro and speed and transverse speed are better than 1-2 centimetres/second. The RTK signal for the docking mode has given accuracies measured to 1 centimetre, equal to that of the laser docking system. However, the sighting of the RTK stations were perfect for the locations were this accuracy was measured.

The experience of space based services was that they were not found to have sufficient vertical accuracy.

4.2.2.2 Availability of Terrestrial Carrier Phase services for Inland Navigation.

RTK is a high precision carrier phase based positioning systems exist today using GPS dual frequency signals. The term Real Time Kinematic (RTK) is often used to describe carrier-based positioning systems that employ static reference station(s) and moving receiver(s). Service infrastructures for carrier phase reference observations have been installed in several countries, but it is unclear how successful these are in real time applications. There are several applications that would potentially benefit from a robust service providing centimetric accuracy. The future introduction of satellite transmissions on three frequencies and also the future GALILEO constellation will give a processing advantages offering the potential of better performance and reliability. Many member state already have RTK networks, the services are available using a variety of communications including VHF, HF, GSM. All are RTCM SC 104 compliant. For a fuller appreciation of RTK coverage please consult the working paper “Radionavigation & Localisation innovations for inland waterways”.

5 SUGGESTED STANDARDS FOR MARGINAL OPERATIONS

1) Adopt a single published industry standard as the basis for calculation of underkeel clearance throughout Europe.

2) Applying a quality assurance approach to:-
   - the recording of factors affecting underkeel clearance, and the making of the calculations based on those factors;
   - aligning roles and responsibilities with the persons best placed to manage particular aspects of the management of underkeel clearance, that is, the skipper and the traffic manager.

5.1 Roles and responsibilities

The following roles and responsibilities are only suggestions to stimulate discussion for setting technical and policy standards that are achievable and acceptable throughout the European inland navigation network of waterways.

5.1.1 The Skipper

The skipper is generally responsible for the safety of the vessel. With respect to the management of underkeel clearance, he is responsible for:

- providing particulars about the vessel and relevant ETA/ETD and draft information to the traffic manager; and
- Providing static information regarding vessel particulars to the traffic manager.

This information could be provided autonomously via AIS.

5.1.2 The Vessel

The vessel systems will need to be update the traffic manager system autonomously with information at an agreed appropriate interval for.

- RTK position;
- velocity (course and speed);
- vertical and horizontal acceleration (Forward and Aft)

5.1.3 Traffic management authority

The traffic management authority is responsible providing to the vessel information to ensure optimal propulsion and steerage performance whilst keeping squat to a minimum:

- obtaining necessary input data from the vessel skipper (vessel specific data)
- obtaining information about channel depth, waves and tides;
- input data for making the detailed path prediction calculations throughout the transit;
- determining whether transit is possible under prevailing conditions;
- for interaction with infrastructure such as locks, produce and inform the vessel

skipper of transit plan;
- for transit of shallow areas of waterway such as in dry seasons, produce and inform the vessel skipper of transit plan (probably by way of adaptive ECDIS)
- monitoring the transit against the plan (making any changes as may be necessary) and record any departures from the plan;
- continually update skipper with recommended speed or direction information so to maintain a safe transit.

5.1.4 Local infrastructure Management or River information service (LRIS)

The systems employed by the infrastructure management authority will need to autonomously:

- provide vessel with adaptive ECDIS with real or near time bathometric information;
- record key phases of the transit to update path prediction database on vessel behaviour patterns;
- Provide RTK radio-navigation service.

5.1.5 Waterway Authority

Generally responsible for ensuring that waterway is safe for navigation. This includes ensuring that information about channel depth and environmental conditions is made available, the waterway authority is responsible for:

- Providing bathometric information of the profile of the waterway for route planning to the traffic management authority;
- Provide water level information about channel depth to the traffic management authority; and
- Making available environmental information about wave and tide conditions (if required).

6 CONCLUSIONS AND RECOMMENDATIONS

Carry out RTD using vessel models in tanks to:-

- Find minimal clearances of both bottom and side of vessels to manoeuvre vessels safely.
- Realise hydrodynamic models that can be used in calculating Dynamic Underkeel Clearance for differing trim and heel attitudes of vessel - representing all vessel hull shapes anticipated for use in marginal applications.

Carry out RTD for tools, services and trials for dynamic under keel clearance applications such as dynamic path prediction and “interactive” or “co-operative decision support”.

If not already existing, establish harmonised guidelines throughout Europe for determination of under keel clearance including squat calculations and other critical information.

Establish harmonised Guidelines throughout European inland waterways for:-

- Survey using multi-scan sonar after during exceptionally conditions of low water levels and during periods of exceptionally high rainfall or snow melt.

- Collation and dissemination of waterway depth contour information to vessels for update of (interactive) Inland ECDIS.

Establish guidelines for roles and responsibilities for provision of information for waterway authority, Infrastructure / traffic management authorities and vessels.

For sub metre vertical and horizontal position or relative position accuracy, promote the need for European wide Real Time Kinematic (RTK) services and standards for promulgation of differential corrections serving such as those within the EUPOS project enabling RTK communication component and navigation receivers to be standardised.