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THE ROLE OF THE HYDROGRAPHIC SURVEYOR IN OFFSHORE EXPLORATION AND EXPLOITATION

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Seven years ago I had the privilege of giving the Keynote Address at Consas 78 here in Cape Town. My aim on that occasion was to turn the attention of Surveyors towards the sea and to describe the type of work likely to be required from the inshore waters of the coastal zone right out to the margin of the Continental Shelf.

Since then the 3rd Law of the Sea Conference has completed its massive ten year task and the resulting text of the Convention, comprising no less than 320 articles and eight annexures, has gone out to 155 nations for ratification.

The Republic of South Africa, together with all the other nations of Africa, has now signed this important treaty.

Although a number of other countries have yet to take appropriate action, nevertheless much of the Convention has already become customary law world-wide, including the recognition of a twelve mile limit to the territorial sea and the right of every maritime state to exploit the resources on and beneath the seabed within its Exclusive Economic Zone (EEZ) extending 200 nautical miles from the so-called 'baselines'. Article 5 of the Convention defines the baseline for measuring the breadth of the territorial sea as the low water line along the coast as marked on large-scale charts officially recognised by the coastal state. This is the first of many articles of the Convention which implicate the hydrographic surveyor, for it is he, in the great majority of maritime states, who establishes the low water line and delineates it with the appropriate symbols on nautical charts.

Articles 7-15 enlarge upon how 'straight baselines' may be developed in particular localities such as those where the coastline is deeply indented; across mouths of rivers and bays; where extensive internal waters exist; and where delineation is required between states with adjacent coast-lines. The fundamental

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starting point for all these delineations is the low water line, and when these baselines have been worked out, a hydrographic art in itself for which Peter BEAZLEY has compiled an instructive booklet for the Hydrographic Society, then Article 16 of the Convention decrees that the baselines shall be shown on charts of a scale, or scales, adequate for determining them ! Alternatively, a list of geographical co-ordinates of the change of direction points, specifying the geodetic datum, may be substituted.

Article 75 states that the outer limit lines of the 200 mile wide EEZ shall be shown on charts of adequate scale for determining them, or delineated by lists of co-ordinates, specifying the geodetic datum used. Due publicity must be given to such charts or lists.

Article 76 defines the continental shelf on which the coastal state exercises sovereign rights for the purpose of exploiting the natural resources of the seabed and the subsoil of the submarine areas that extend beyond the territorial sea throughout the natural prolongation of the land territory to the outer edge of the continental margin, or to a distance of 200 miles from the baselines where the outer edge of the continental margin does not extend to that distance.

The charts described as officially recognised by the coastal state are, in a country possessing a national Charting Authority such as South Africa, normally those published by that Authority.

For instance, in the 'New Zealand Territorial Sea and Exclusive Economic Zone Act' it is specifically stated in "Art. 31 *Official Charts*" that "for the purposes of this Act, in any proceedings in any Court the line of low water for any area depicted on the charts held in the Territorial Limits Chart Folio held by the Royal New Zealand Navy Hydrographic Office shall be sufficient evidence of the line of the low-water mark for that area". Both the Territorial Limits and the EEZ limits are shown on the charts in the special folio referred to above.

In Australia, on the other hand, where so much of the vast continental shelf area is yet to be charted, the National Mapping Authority has, for the last 15 years or so, been carrying out by contract, or using chartered vessels, simple bathymetric surveys on a scale of 1/150,000 from the 20-metre depth contour out to the 300-metre contour, without any shoaling or other examinations, in order to provide a base map of the continental shelf for resources investigations. Thus it has come about in Australia that the National Mapping Authority, in consultation with the Navy's Hydrographic Office, is preparing officially recognised maps to show the Australian Exclusive Economic Zone limits.

The task of delineating Territorial Sea and EEZ limits must clearly be carried out in co-operation with a Foreign Affairs Office or such other Government department as may be responsible for compliance with international law, whilst agreement with a national Department of Surveys is necessary in order to decide what geodetic datum is to be used in offshore areas.

A glance at the potential South African EEZ shows the enormous area over which the State may now exercise its sovereign rights to exploit the natural resources. The area would appear to extend to about a million square kilometres which equates to 83 % of the total land area of South Africa.

As an offshore industry develops over this area, navigational warnings of rig shifts, pipeline laying, etc. will be increasingly required, and these will be easily

handled by the South African Navy's Hydrographic Office. This Office has demonstrated its skill in these matters for some years past as Co-ordinator for the South Atlantic Area of the World-wide Navigational Warning System developed by the International Hydrographic Organisation, of which South Africa has long been a member.

Exploitation can, however, only follow exploration, which entails wide-ranging bathymetric, gravity and magnetic surveys together with side-scan and seismic surveys. It is no longer economical to send out an expensive vessel for offshore bathymetric surveys alone. On-board gravimeters, towed magnetometers and seabed sampling and photographic equipment should be employed concurrently by the same vessel to provide a complete geophysical survey of potential areas of exploration. A separate mission would normally be required for seismic surveys.

A unique way of achieving a reconnaissance survey of extensive areas of EEZ has recently been described by Dr. Tony LAUGHTON, Director of the U.K. Institute of Oceanographic Sciences. His Institute, in collaboration with the United States Geological Survey, employed the massive British built long-range side scan sonar known as 'Gloria'. Towed from a chartered vessel, 'Gloria' provided data for a sonar mosaic of 250,000 square miles of the United States Pacific EEZ in 1984.

A great number of formerly unknown features were discovered in this survey, including ridges where hydrothermal vents have been revealed typical of fast spreading centres associated with poly-metallic sulphates. Several hundred new seamounts were discovered which may be coated with cobalt-rich manganese crusts. Such discoveries are truly amazing in an area already much explored in recent years by oceanographic research vessels from the Scripps Oceanographic Institute. A 14 million dollar contract has now been won by the Institute of Oceanographic Sciences (U.K.) to continue the survey of the greater part of the U.S. Exclusive Economic Zone. Perhaps this survey shows how much is still to be learnt about national Exclusive Economic Zones even off the coasts of highly developed industrial states.

At the Second International Hydrographic Technical Conference at Plymouth last September there was much discussion on what hydrographic or cartographic work could be, or could not be, let out to contract. Some of the world's leading hydrographic offices are under pressure from their Governments to have at least some of their work carried out by contractors for economic reasons.

The general concensus during extensive discussion at the Conference seemed to be that hydrographic surveys could well be carried out by well qualified contractors, and even the compilation and printing of charts, but that the data bank, that is the national repository of hydrographic data, should remain firmly in the hands of the Government Hydrographic Authority.

It was further generally agreed at this Conference that it would be quite wrong to put out all survey and chart production work to contract. It would always be necessary to retain an efficient and well found national corps of hydrographic surveyors and cartographers, so that the skills and technical know-how remain with those whose duty it will be to prepare the specifications for the contracts and to supervise the entire operation from the survey work at sea to the proof reading of the chart compilation.

Preparing specifications for survey contracts requires skill and great attention to detail. Two very useful booklets have recently been published by the Royal Institution of Chartered Surveyors (U.K.). One gives guidelines for the preparation of hydrographic survey specifications, the other for surveys in support of dredging operations. Both booklets provide a series of check lists covering every aspect of the contract from the broad scope of the work to the detailed accuracy expected, together with details of how the data should be finally rendered. These checklists are proving to be of the greatest assistance to both the commissioner and the contractor when drawing up specifications for a contract acceptable to both sides.

It may be instructive to quote from the Introduction to the hydrographic booklet where HASKINS and ROBERTS state : "the scope and precision of the survey measurements, and the variety of options to be considered in arriving at an economic specification for the task in hand, continue to increase year by year. In addition to this, the growth of hydro-carbon and mineral exploration development and production from deep water has added a new dimension to the work of the hydrographic surveyor".

Co-ordination of all sea surveying work is necessary for a number of reasons and so one must consider which government departments and non-governmental agencies are likely to be involved. In some Member States of the International Hydrographic Organisation a national committee, convened at regular intervals, reviews the current hydrographic requirements to ensure that these are met as far as possible with the resources available, and that, if a survey is to be made on behalf of one agency or department, the maximum benefit accrues to all interested parties. For instance, it is frustrating to find that a bathymetric survey made for navigation purposes has failed to include certain oceanographic observations in the same area which would have been of benefit to current fisheries research.

I know little of the South African marine scene, but a study of the table presented at a former Hydrographic Symposium here by the South African Hydrographer, Captain WAGENFELD, entitled 'Data Users and Data Types' enables me to list a number of authorities who are likely to have an interest in sea surveying programmes. These would seem to include the State President's Office, the Office of Surveys and Mapping, the Department of Transport Affairs, the South African Railways, the Shipowners Association, the National Research Institute for Oceanography, the Department of Agriculture and Fisheries, the Council of Scientific and Industrial Research, the Department of Mines and Energy Affairs, and the Southern Oil Exploration Organization, and, of course, the Hydrographic Office of the South African Navy. Some kind of co-ordination among these bodies on a regular basis concerning the general progress of hydrography in South African waters would seem to be necessary if the fullest benefit is to be obtained from expanding exploration within the Executive Economic Zone.

What type of surveys are we likely to encounter during the development of a successful offshore industry ? They might be listed as follows : First, there is the reconnaissance survey to which I have already referred in which bathymetry, gravity and magnetic data are collected, the vessel being fixed with a long range radio wave system giving location accuracies of $\pm$ 50 – 100 metres. Then might follow, or precede, a regional seismic survey with somewhat similar positional accuracies, followed by a more detailed seismic survey, after which the exploration rigs must be sited with geodetic accuracy down to $\pm$ 10 – 15 metres. Successful

exploration drilling will result in a requirement for the precise placing of a production platform with an accuracy of ± 5 – 10 metres, to which sub-sea hardware such as pipelines must be tied in very precisely on large scale surveys, based on stations on the platform itself, or on a network of seabed acoustic beacons.

Whilst existing radio wave navigational systems and satellite positioning receivers will probably give sufficient accuracy for reconnaissance and broadbrush seismic surveys, it will be necessary, as offshore oil or gas fields develop, for the contractors or the companies concerned to set up at least two radio location systems having the capability of greater accuracy, with the provision of perhaps up to six or more transmitters sited to cover the field of operation, and an onboard computer system to monitor redundancy of data.

It is essential that, from the earliest stages of exploration and exploitation, a single horizontal and vertical datum be used, however many commercial companies are involved. The failure to have such uniform control from the outset has led to many subsequent problems in the North Sea. A Committee composed of suitable representatives from the Ordnance Survey, the Hydrographic Department and a user's consortium now meets regularly in U.K. to review the geodetic control being exercised within the British North Sea oil or gas field areas.

Copies of all hydrographic surveys, be they carried out by a national agency, commercial company or a contractor, should be supplied for inclusion in the national data bank. It is the accepted principle in a number of industrial countries that a production company does not receive its lease from the Government until the surveys have been copied to the national data bank, albeit that the surveys may be considered 'Commercial in Confidence' if the Company so wishes.

For centuries, hydrographic surveying has referred to the taking of depth soundings in order to chart the safe channels and the sub-surface dangers with reference to visible landmarks and the current state of the tide so that vessels might navigate the coastal waters in safety.

Since World War II, the discovery of valuable natural resources beneath the seabed and man's increasing ability to harvest them in ever deeper water has expanded dramatically the task of the sea surveyor. Technological developments in radio and satellite location systems has enabled the hydrographer to work far out of sight of land whilst still relating his work to land based geodetic control. At the same time, seaborne gravimeters, towed magnetometers, core-samplers, deep-sea photography, multi-sensor profiles and side-scan sonars have increased the hydrographer's armoury for mapping the seafloor far beyond the echo-sounder which was virtually his sole investigating weapon in pre World War II days.

Here, I myself am about to sail into deeper waters, albeit they abound with dangers. What sort of man do we require to meet the requirements imposed on the modern day hydrographic surveyor ?

Pure bathymetric surveys are still required as we move out into deeper water where we are finding that the few existing old leadline surveys are far from adequate for towing out oil platforms, some of which have draughts of 90 metres or more. The techniques of bathymetric surveys are developing with real-time onboard plotters and digitised echo-sounding inputs to fully automated systems. The operation of such systems is becoming easier, now that surveyors have been

acquainted with computers since their schooldays. But in the off-shore industry more complex skills are required by the surveyor, not only must he fix with great accuracy structures erected upon, or anchored above, the ocean floor, but he must take part as a vital member of a complex navigation team involved in towing a platform, worth many millions of rand, into its exact grounding or anchored position; or precisely laying a pipeline from a laybarge, controlled by kedge anchors, along a pre-surveyed route; or directing a submerged remotely operated vehicle (ROV) along a pipeline during a statutory examination; or towing a side-scan sonar to monitor the changes in seabed 200 metres either side of a pipeline during the normal annual inspection in areas where bottom currents prevail.

It must be realized that the surveyor in charge of locating a platform will be responsible for interpreting and assessing the value of positioning data from two or possibly three different radio-wave or satellite systems, whilst moving into a larger scale seabed acoustic system. His continuing advice to the tow master, taking account of the tidal streams he has previously measured, the wind conditions, and the pre-planned positions of up to six massive anchors in the case of a semi-submersible platform, is vital and uniquely available from a surveyor with the practised seaman's eye, engaged as he is in a major seamanship operation. And it must be remembered that we are here striving for an accuracy of ± 10 meters in a position up to 200 nautical miles off-shore.

Pipeline inspections using an ROV call for similar close co-operation between the master of the mother vessel operating the ROV and the embarked surveyor. With the ROV at the extremity of its umbilical cord moving along the pipeline ahead of the vessel there is no margin of positioning error or room for misunderstanding. A tangle between the mother ship and her ROV can be very expensive.

I am not saying that a hydrographic surveyor trained in the traditional methods is the only man who can tackle the complex survey work involved in the offshore industry, or that a land surveyor can not become equally competent. What I can say, however, is that I strongly support the guidance given in the 'Standards of Competence for Hydrographic Surveyors', published by the FIG-IHO International Advisory Board, when it is stated that hydrographic surveyors must possess both education and experience to effectively carry out their work, and that an aggregate period of at least two years' sea experience is necessary to reach the minimum level of competence required to take charge of offshore work.

Diplomas in Hydrographic Surveying obtainable now in several countries, must be considered as a major step forward in providing sea surveyors for traditional bathymetric work in the off-shore industry. But until such graduates have obtained sufficient superintended sea experience they will not replace the surveyor who has been deeply involved in ship handling and seamanship from the commencement of his training.

"Hydrographic Surveying remains, essentially, a maritime occupation", so runs the introduction to the Diploma Course Book at the Plymouth Polytechnic in U.K., and many years of experience in the North Sea and elsewhere underline that concise statement. Ignore it at your peril.

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