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HYDROGRAPHIC SURVEYING FOR PORTS AND APPROACHES*

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SUMMARY

This paper is written essentially for Port Authorities, and the Agencies responsible to them, who do not at present have a hydrographic facility. It covers the basic reasons for setting up such an organisation and aims to give advice on the way to go about it, covering in broad outline recruitment, training and the equipment that will be required, and then looks at some of the possibilities for the future.

INTRODUCTION

The need for a Hydrographic Service in any country is firmly based on its requirement for overseas trade and the development of its national resources. Without safe, well charted and marked approaches and properly surveyed wharves no port can function properly and, as a recent United Nations report has pointed out, "in the marine environment there can be no exploitation of resources without exploration and there can be no exploration without hydrography".

Indeed a port, by virtue of the relationship it has with the vessels that use it, has a legal responsibility in this direction which, so far as the

(*) *Editor's note :* This paper, and the one by Cdr. N.N. SATHAYE which follows, are considered as complementary advisory notes appropriate both to port administrations and to countries contemplating the establishment of hydrographic services. Reprints of these papers are available by request to the International Hydrographic Bureau.

United Kingdom is concerned, was summed up by Mr. Justice LANGTON in the case of the SS *Neptune* v. Humber Conservancy Board when he listed the following obligations :

i. that the authority should have sounded and found the best navigable channel;

ii. that they should have placed seamarks—lightships, floats and buoys—in positions where they would be of the best advantage to navigation;

iii. that by night such seamarks should be provided with adequate lights so as to enable the channel to be easily found and properly kept;

iv. that the authority should have re-sounded the channel, as and when opportunity presented itself;

v. that in view of the changes in the river bed they should have kept a watch on the changes, and should alter, move or renew the seamarks in accordance with the changes ascertained;

vi. that the records should have been preserved for future reference and the guidance of subsequent officials; and

vii. that the authority should publish, as conspicuously as possible, such information as would supplement the guidance given by the seamarks.

FORMATION OF A HYDROGRAPHIC DEPARTMENT

The first question that will confront any nation recognising the need for a hydrographic ability is whether it should be fragmented or national i.e. whether it can afford a service to deal with its offshore waters and a separate service available to each port, or whether the whole should come under one heading. In the United Kingdom, as a result of the way the country has developed over the centuries, we have the former, but for a relatively small country starting from nothing it could well be that the latter is the best approach, possibly with the Hydrographic Department developing as part of one of the civil Ministries, such as the Ministry of Trade. Here again there is choice, and a number of countries attach their Hydrographic Departments to the Ministry of Defence to enable them to make use of the manpower and support facilities thus afforded. It could also develop from a port facility, expanding to cover its approaches and eventually opening out to include coastal surveying and, finally, the offshore zone.

Every country will need to assess its own position in this respect, and the best way to start will be to obtain the help of a hydrographic expert who can advise on the way to proceed, bearing in mind that country's particular needs, capability and the funds available. The only general advice here is to go for the most simple way of achieving your respective aims, since highly sophisticated equipment is usually very expensive and in remote areas difficult to maintain properly.

STAFF

Virtually all nations today have available some form of national land survey organisation which can provide horizontal and vertical control for hydrographic work. They may, and indeed probably will, need assistance in detailing the points to be fixed to provide this control, and also those points to be used as seamarks for mariners. This means that provided there is no abnormal difficulty, the emerging Hydrographic Department will need seamen trained to gather and process bathymetric data, rather than geodetic experts. The probability is therefore that it will be more realistic to take seamen in the first place and train them to become hydrographic surveyors, rather than convert land surveyors to the hydrographic role. This is not to say that a number of the skills of the land surveyor are not required by the hydrographer; they are, but to put the matter into perspective—the hydrographer will do most of his work afloat, and this is where his primary skill is required. If a sufficiently large organisation is envisaged then it could well be desirable to employ experts from both disciplines.

TRAINING

Having identified the initial staff— and it is reasonable to start with a small organisation—the next move is to train them. In the Royal Navy until the early 1960s, our officers joined the service and learned their profession from their seniors as they went along, studying the requisite text books as and when required. This system worked well at that time, but the proliferation of technical equipment and the deeper draught of merchant vessels (resulting in a requirement for far more exacting standards) have meant that it is no longer a really practical method. Furthermore it takes a long time to produce an officer who is fully conservant with all facets of his work.

The best method today is probably to arrange for your people a basic training course in an established organisation, and then to obtain the services of an experienced hydrographic surveyor to run the department in its early stages. He will then be able to build on that basic training and teach your surveyors what they need to know on their own ground. Initially, you will need one or two surveyors and three or four assistants working in the port area from a relatively small boat, which will of course need its own crew. As time goes on and they increase in number and experience, you will be able to expand; then your senior staff will be able to undertake more advanced training, until the department can stand on its own feet and you no longer need your outside expert.

The Report of the United Nations Group of Experts on Hydrographic Surveying and Nautical Charting, which I have already quoted, lists the

major training programmes available throughout the world. In the United Kingdom, at the Royal Naval Hydrographic School, we accept trainees from foreign and Commonwealth countries as well as our own people. We train surveyors on our Officers' courses, and assistants on the Surveying Recorders' courses. In the latter case our people follow three main courses, separated by periods of sea experience. The first is aimed at teaching students to record data for the surveyor and to look after his instruments; the second goes a little further and he learns to begin to collect data for himself; and in the last he learns to use the main surveying instruments, theodolite and electromagnetic distance-measuring equipment and to take soundings in a boat on his own. This in fact brings him more or less into line with the surveyor who, having completed his normal naval training, and being qualified to take charge of a watch in a ship at sea, has had about six months' experience in one of our ships and then done the Basic Officers' course. This teaches the use of the various instruments and provides the training to enable him to take charge of a small survey on his own, under the direction of a qualified officer. Then, after $2\frac{1}{2}$ to $3\frac{1}{2}$ years at sea engaged in hydrographic work, he returns to the school to do a six-month course in which he learns the technical aspects of his profession. This sort of training—courses sandwiched between periods of sea experience—we find gives us the best results, since it enables a man to consolidate his classroom training with practical work under the direction of a fully qualified and experienced hydrographic surveyor.

EQUIPMENT

The equipment you will require will depend on the stage you have reached in your development. Initially, for harbour work, provided you have reasonable shelter and your direct approach area does not extend too far offshore, you will be able to use a relatively small boat with a shallow-water echo-sounder and fix the position of your soundings by visual means, or else by using a short-range electronic system. The boat could be 7 to 10 m long, but it will need to be readily manœuvrable and have a good working area from which the echo-sounder and fixing system can be operated. If it is intended to use visual fixing a good all-round view is vital.

There are a vast number of different methods of controlling the position of your soundings, both visual and electronic, ranging from horizontal sextant angles through transits and tachymetric distance measurement to highly sophisticated electromagnetic distance measuring devices and lasers, and various combinations of all of them; the results can be plotted by hand or computer in the boat at the time of observation, or plotted afterwards in the comfort of a shore office. In general, it is better to retain control of the survey in the boat as the work progresses, plotting as you go, so that you can ensure that no gaps are left in the work, but this is by no means essential. The normal practice is to correct your soundings for the height of the tide, and plot them in their correct position as soon as possible after the day's work has been completed, in order that the examination of shoals and dangers can be carried out as

the survey progresses. In this way you will be able to ensure that your work is complete as you go along.

For years it was accepted that dangers on the seabed rose from a broadish base, and that, in general, the likelihood was that the gradient would not exceed 60°. It was thus possible to survey an area with the distance between lines of soundings such that no danger was likely to rise above a certain depth. This resulted in work being done on a larger scale than necessary, and even so there could be no guarantee that no dangers between lines of soundings had been missed. Today there are various methods of dealing with this problem. The original, and even now the surest method is wire sweeping over dangers, rocks or wrecks to obtain the least depth, and putting a clearance sweep down a marked channel to ensure that nothing is shoaler than a given depth. The next method, and one which is well suited to a small organisation (as indeed it is to a large one) is sidescan sonar. There are a number of firms producing different forms of this equipment today, and most can be operated from a small boat. They consist of a recorder and a "fish" towed astern on an electric cable. The transducer in the "fish" sends out sound signals on each side, and the returning echoes are depicted on a paper trace on the recorder. From it, with experience, the texture of the seabed can be identified and objects standing above the general level will show up, so that shoals, coral pinnacles, wrecks, etc. between the lines of soundings can be fixed. It is not yet possible to produce a truly accurate depth from this equipment, but a fair indication can be obtained and further investigation can then be carried out either by echo-sounder or wire sweeping.

FUTURE DEVELOPMENTS

The United States National Ocean Survey have been doing work on photobathymetry, that is to say, obtaining the depth of water from aerial photographs. This requires the right sea-transparency conditions and proper offshore vertical control, and, given these two, can produce good results in relatively shallow water—say down to about 18 feet. It is ideal for filling in coastal areas round coral reefs where proper delineation by boat would be a long and tedious task. It does, however, require the use of an aircraft and skilled photogrammetric staff working on dedicated machines. If this equipment is available, then the method is considerably cheaper than working in the conventional way, and might be practical for a country that was planning a contract for land mapping from aerial photography where the results could be processed as part of the contract. But this method will always be subject to restrictions on depth penetration.

The Australian Hydrographic Department is developing a system of laser counding from aircraft, which it believes will provide the hydrographic surveyor with the most productive sounding system ever devised for use in coastal waters. It is hoped that it will provide soundings on a 10 m grid covering a path 268 m wide beneath the aircraft, and penetrate to a depth of 30 m in clear water with calm weather conditions. This

system is not yet fully operational, and again is a highly technical and expensive way of sounding, but like photobathymetry is likely to prove cheaper in the long run than conventional boatwork. This again would appear to be something that might be considered in the future as a contract project, but it is unlikely to become a tool in common use in small organisations.

For work in ports, there are various forms of multitransducer echo-sounding equipments available for specially constructed vessels. These either take the form of transducers at intervals along the length of the vessel, which then propels itself sideways while surveying, or mounted on booms which can be turned out from the vessel's sides. The path which is totally covered by the cones of the echo-sounders is of the order of 50 m wide.

CONCLUSION

In this paper I have looked quickly at the requirement for a hydrographic organisation, which is of fundamental importance to any maritime state with overseas trade and ports to import and export its goods, and also vital for the proper exploration and exploitation of its natural offshore resources. I have discussed the formation of such an organisation and in broad outline the training of staff and the equipment needed. Finally, I would like to stress very strongly that, in hydrographic surveying (as in many other fields), the best way to progress is slowly—building your organisation on sound advice, starting your own people with a tried training scheme which is within their capabilities, and gaining experience with relatively simple methods before moving on (if it is absolutely necessary) to more sophisticated techniques. Above all do not try to go too fast, and avoid temptations to introduce unnecessarily complicated, expensive and hard-to-maintain equipment.