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SURVEYING IN THE GIRONDE

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ABSTRACT

In 1970, when it was found that the existing sounding equipments could no longer keep up with requirements, the Port Autonome de Bordeaux started a complete renovation and modernisation of its survey arrangements, which was carried out under the sponsorship of the Ministry of Works and with the valuable collaboration of the French Lighthouse and Buoyage Service (Service des Phares et Balises).

The concept of all the tidal, telemetric, nautical and electronic equipment described in this paper for the overall sounding plan followed two main principles :

a) Of the three new sounding vessels, each should be best fitted for one of the types of waterway in the area (offshore, estuary and river), while the vessels should still be able to sound in formation together in most of the survey zones.

b) The largest vessel should be capable of real-time data transmission to the computer centre so that the fair sheet can be drawn immediately after completion of the sounding runs.

INTRODUCTION

Over the last decade, the considerable dredging projects in the waterways leading to the ports of Le Verdon, Bassens and Bordeaux have in turn required depth surveys at more frequent intervals in order to :

a) improve the safety of navigation,

b) deploy the suction dredgers with greater efficiency,

and c) plan improvement schemes for the channel and port areas.

The equipment then available being insufficient for this, a programme of renovation and modernisation of the depth survey equipment was undertaken in 1970. To meet the aims set out above, three goals had to be achieved :

a) soundings must be taken more frequently in all areas and in all seasons;

b) the accuracy of sounding must be improved;
and c) the fair sheet was to be available very soon after the survey.

This paper will review the factors leading right up to the fair sheet, namely : the area in question, the types and methods of sounding, the craft required, the radio aids and tidal telemetry networks, the shipborne equipment, and the hardware and software for the computing and plotting centres.

THE AREA

The Gironde survey area (fig. 1), totalling 825 km², can be divided into four zones, each with quite different characteristics :

a) above the Bec d'Ambès : a mainly freshwater area over 25 km of the River Garonne, giving access to the upstream ports;
b) between the Bec d'Ambès and the narrows formed by the peninsular of Verdon and the rocky coast of Royan : the estuary area 75 km long and some 11 km across at the widest point, characterised by islands and mudbanks above Pauillac, by drying banks in the central part and by shifting non-drying banks in the lower area;
c) to seaward of the line Royan - Le Verdon : the river-mouth area traversed by a 25 km deepwater natural channel terminating in a man-made pass to the ocean;
d) finally, the port areas, six in number.

TYPES AND METHODS OF SOUNDING

The three zones — river, estuary and mouth — as well as the port areas, are explored by surveys in which the scale, frequency, density of soundings and the size of the fair sheet depend closely on the survey area and the object of the survey : navigation, dredging or approach improvement works, as shown in Table 1.

Two methods of sounding are used : cross-river, where the sounding lines are perpendicular to the contours; and longitudinal, where they are parallel to the contours.

This latter method is suitable for sounding in the channels and passes, where the ratio length/width is large and where the channel sides are only slightly sloped. It gives a good distribution of soundings, does not interfere with shipping movements, and allows the survey to be completed quicker than with the transversal method, and with several ships in the channel. On the other hand, it is less accurate for the precise placing of the contours on the steeper slopes.

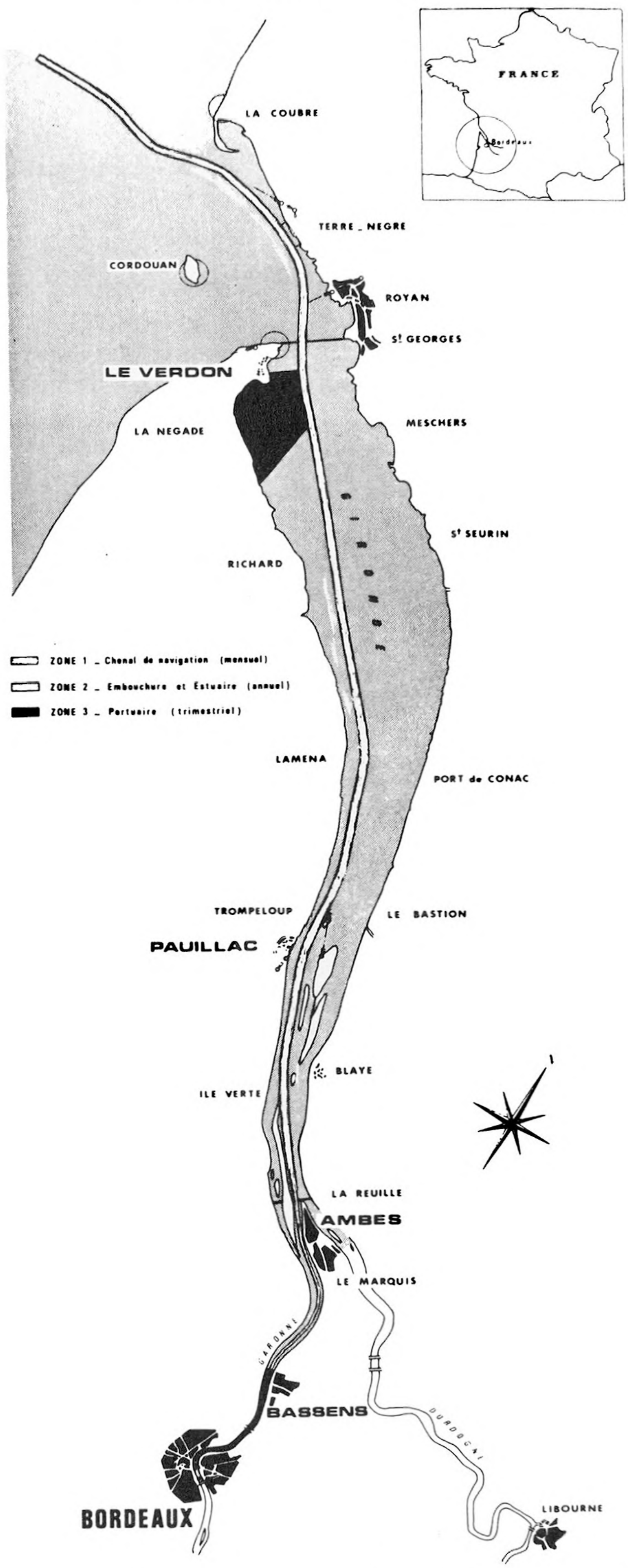


FIG. 1. — Mouth and estuary of the Gironde. Areas surveyed.

TABLE 1

Type	Zone N° (fig. 1)	Area of zones (km2)	Frequency	Scale 1/	N° of soundings per km of line	Line spacing	Ratio length/ width of the survey area
Channels and passes	1	50	monthly	10 000	75	30 to 60 m	15
Mouth, estuary and river	2	825	annual	10 000 and 20 000	50 to 100	100 to 500	3 to 10
Port areas	3	10	quarterly	500 to 5 000	approx. 200	10 to 50 m	1 to 3
Works areas		2	as required	2 000	approx. 200	10 to 50 m	1 to 3

THE VESSELS

The different types of survey area (ocean, estuary, river and port) led to the development of 3 vessels of very different characteristics but with performances sufficiently alike to be able to operate together to sound the channel between Bordeaux and Le Verdon using the longitudinal method.

Gardour (fig. 2)

This vessel entered service in April 1975 for surveys in the Gironde estuary and on the continental shelf, as well as for laying oceanographic devices and for hydrological, chemical and biological observations.

The ship was tested in small-scale model form in the Paris test tank, thanks to the aid of the Institut de Recherches de la Construction Navale. She is designed to operate up to 200 miles from shelter, i.e. up to the limit of the continental shelf, and has a length overall of 33.00 m, moulded breadth of 6.35 m and draught aft (fully laden) of 3.00 m. 2 motors of 680 HP each coupled to a variable pitch propeller give a maximum speed of 14.3 knots, while fine manœuvring is provided by a bow thruster with nozzle rotatable through 360° giving 600 kg of thrust.

Oceanographic equipment consists of a hydraulic crane, two derricks, a Zodiac Mark III inflatable, an analytical laboratory and storage for samples of water or sediment. A well housing four sounder oscillators, including one on a telescopic jack to lower it below the turbulence level, allows the vessel to operate in heavy seas. The wheelhouse/command position has an all-round view; it is air-conditioned and occupies an area of 30m^2 at foredeck level.

FIG. 2. — Survey vessel *Gardour*.

Biganon (fig. 3)

The launch *Biganon* was commissioned in July 1972, having been designed for hydrographic surveys in the estuary as well as in the river and in the estuary mouth under calm conditions. Her dimensions are :

Length overall	17.6 m
Beam	4.75 m
Draught	1.5 m
Speed (continuous)	12 knots.

Categorised under French rules in Class 3, she is not permitted to go outside 20 miles from land.

Her wheelhouse has a huge console containing all the necessary controls for navigation and sounding, while the air conditioned recording room houses the receivers and recording instruments and a chart table.

The third vessel

Still in the design stage, this unit will enter service soon. Her length will be 9-10 metres, maximum speed 14 knots, draught 1 m, and displacement 5 tonnes and she will be able to turn in her own length. These characteristics have been defined to meet the requirements of surveying in ports — alongside quays and pontoons and in basins — and rivers, and for tandem sounding with the *Gardour* and *Biganon*.

FIG. 3. — Survey launch *Biganon*.

ELECTRONIC POSITIONING

The estuary and mouth of the Gironde are covered by five hyperbolic TORAN systems and one SYLEDIS system (fig. 4).

TORAN chains

The principle consists in measuring at a mobile station the phase difference between the high frequency waves radiated by the fixed stations of a TORAN pair, the initial phase shift of the HF waves of which can be measured (compensation receiver-transmitter).

The phase of the LF beat signal resulting from this difference is proportional to the difference in wave travel time, therefore to the difference in distance between the mobile station and the two transmitters.

Thus, when the phase measured on board remains constant, it may be deduced that the vessel is running along a hyperbolic lane. With two pairs of fixed transmitters per TORAN chain, it is therefore possible to determine two hyperbolic coordinates which define the position of the mobile station.

If the compensation receiver of one pair is linked to a transmitter of the other pair, the TORAN chain is in mode X, and if the compensation

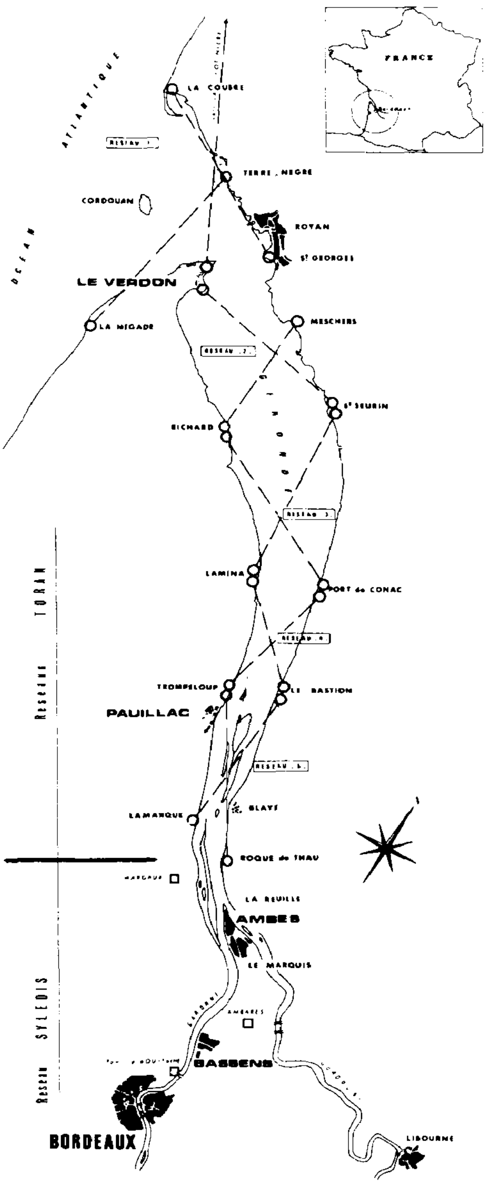


FIG. 4. — Radio positioning system network.

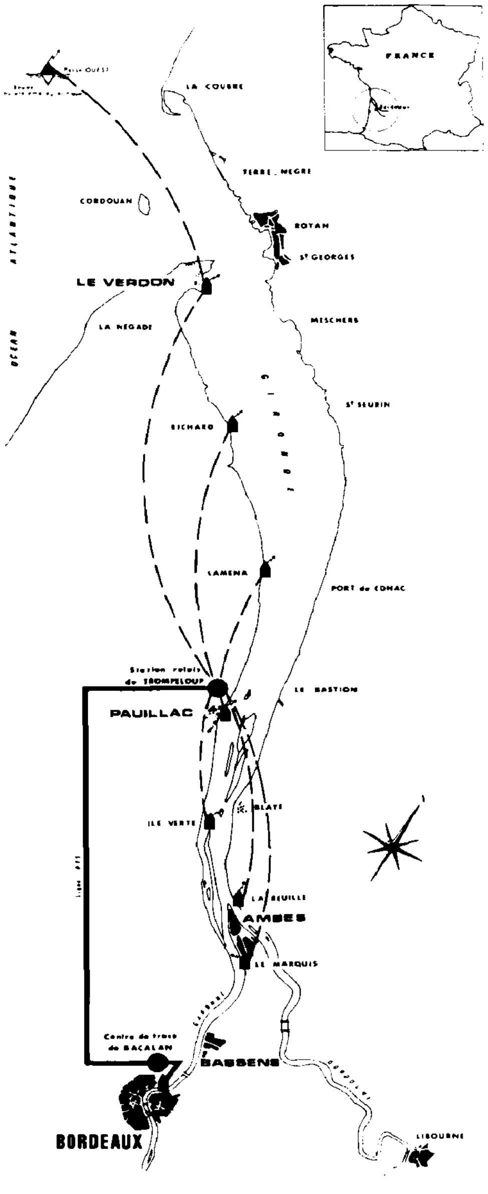


FIG. 5. — Remote-controlled tide-gauge network.

receiver of one pair is geographically separate from the two transmitters, the TORAN chain is in mode Z.

The outermost network, at the river mouth, set up in 1966, is made up of three pairs of transmitters, one in mode Z and the other two in mode X. The four networks further inland, installed in 1973 betwen Le Verdon and the junction between the Dordogne and Garonne rivers, are in mode X.

SYLEDIS network

Higher up the Dordogne, beyond this junction, the hyperbolic network is replaced by a SYLEDIS network with three transponder beacons in circular mode. Implantation of this network will be complete in 1977.

The principle consists in measuring the time intervals between the transmitting of a pulse signal by an interrogator placed on a mobile vessel and the return of this pulse signal, reflected back by transponders set up on land. Knowledge of the speed of wave travel enables these time intervals to be converted into distances. Knowing the position of the beacons, it is simple to deduce the position of the mobile vessel.

The accuracy of position-fixing is better than 10 m in all areas.

AUTOMATIC TIDE GAUGE NETWORK

The network of tide gauges (fig. 5) is intended to serve the following purposes:

— ensure safety of navigation, by:
  (a) promulgating water heights by VHF;
  (b) calculating the possibility for ships to navigate up- or down-river;
  (c) calculating the heave, pitch and roll parameters for large ships navigating through the western channel;
— draw up survey sheets automatically;
— increase knowledge of the effects of the tide in an estuary;
— improve and refine tidal predictions.

Tide stations (fig. 6)

The area of the Gironde under survey is covered by a network of 8 remote-controlled tide gauges, plus one remote-controlled tide gauge buoy. The position of each of these has been accurately defined so that the tide profile at any instant may be exactly reproduced, allowing only a very minimum number of localized tide irregularities to escape notice.

Each tide station is equipped with a tide gauge with float and with a potentiometer driven by the recording system of the tide gauge. The voltages generated by the potentiometer are converted into binary code signals and sent by radio to the centre where the survey sheets are drawn up.

The transmission sequences of the tide stations are staggered by 30 seconds to prevent simultaneous reception and recording of transmissions from several tide gauges.

Receiving station

Situated in the plotting room of the Hydrographic Office, this station checks the validity of the signals received, identifies the transmitting

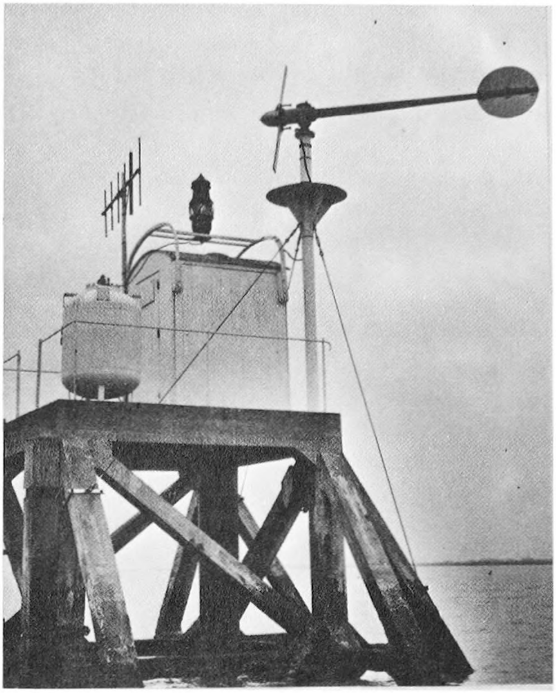


Fig. 6. — Tide-gauge station.

stations, and relates the water levels received to the low-water level of the point concerned.

Tidal heights are displayed on a cathode-ray screen, recorded on paper, and stored on 80-column punched cards for sounding data processing and tide-prediction work.

An automatic device for re-transmission of tidal heights by radio telephone to ships navigating the fairways completes this system.

Wavemeter buoy with remote-controlled tide gauge

This is a prototype developed by the Hydrographic Service of the Bordeaux Port Authority.

The support is a pillar buoy whose base is weighted with an anti-buffeting disc. The lower part of an anchor-line, in electricity-conducting nylon cable, is equipped with a swivel, a vibrating-cord pressure-sensing device, and a submerged float of 1 000 litres to maintain vertical tension on the lower part of the line and reduce alternating movement due to wave action.

A watertight door gives access to the body of the buoy containing the batteries and electronic equipment for the sensing device and the transmitter. An antenna, a flashing light and a radar reflector are fixed on top of the buoy.

On land, a receiver continuously receives the variations in frequency induced by the pressure. This analog signal is converted into continuous voltage proportional to the height of the water at any instant.

A graphic recorder linked with electronic filtering equipment enables waves and tide to be separated for graphic representation. The tidal data is coded in the same way as for the eight fixed stations in the estuary, and transmitted to the plotting centre for exploitation.

SHIPBOARD EQUIPMENT (fig. 7)

General principles

The basic principle on which the sounding system is based is the potentiality for the three vessels to survey either simultaneously or individually.

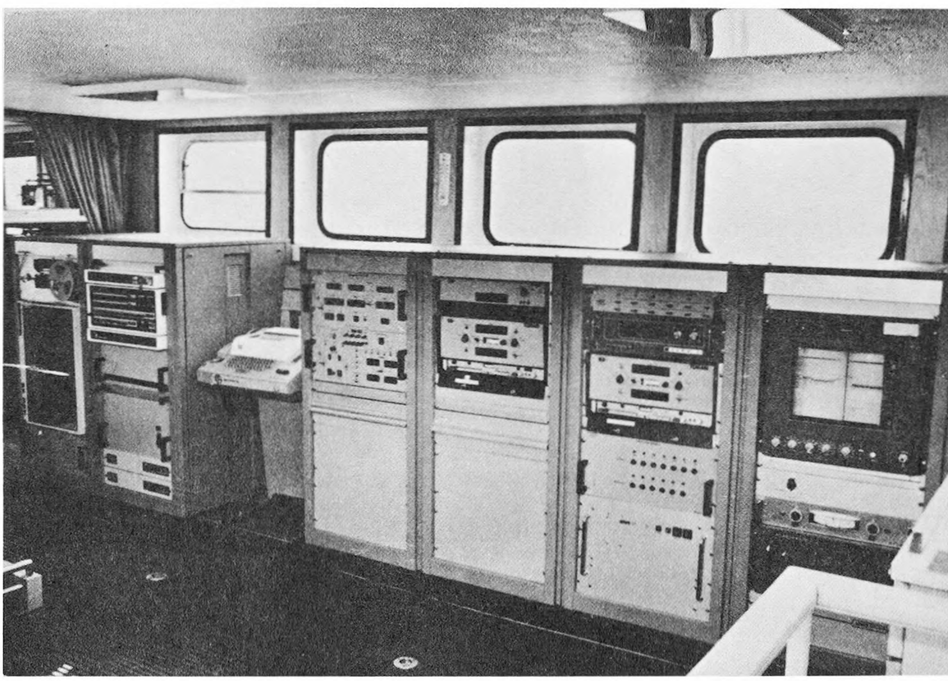


FIG. 7. — Automatic sounding equipment aboard survey vessel *Gardour*.

1. When the three sound in consort, they run along three parallel profiles. The *Gardour*, in the centre, acts as guide while the *Biganon* and the small launch are the two auxiliary or side vessels.

The first operation before sounding begins is the initial adjustment of the system (TORAN position, relative position of the two consorts from the guide, time, sounding, etc.). As soon as these operations have been carried out, the system is operational. The order to begin recording data aboard the *Gardour* and to transmit these to the computing centre via a relay station at Le Verdon can then be given to the computer, which will constitute, at a chosen rate, a data cycle of 69 characters for each point sounded. Each cycle includes the date, time, method of sounding, TORAN lattice number used, events, XY position of mother vessel, distance apart of consorts, and the soundings from the three vessels.

2. When the three vessels are sounding separately, the shipborne equipment aboard each vessel enables magnetic tape recordings to be made of all data required for processing the soundings. The *Gardour* can also re-transmit its data to the computer centre in real time.

Equipment aboard the *Gardour*

Electronic and data-processing equipment aboard the *Gardour* may be grouped into five sets of equipment governed by a computer (fig. 8):
— equipment for data collection;
— equipment for control, monitoring and visualization;
— recording equipment;
— transmitting equipment;
— navigating equipment.

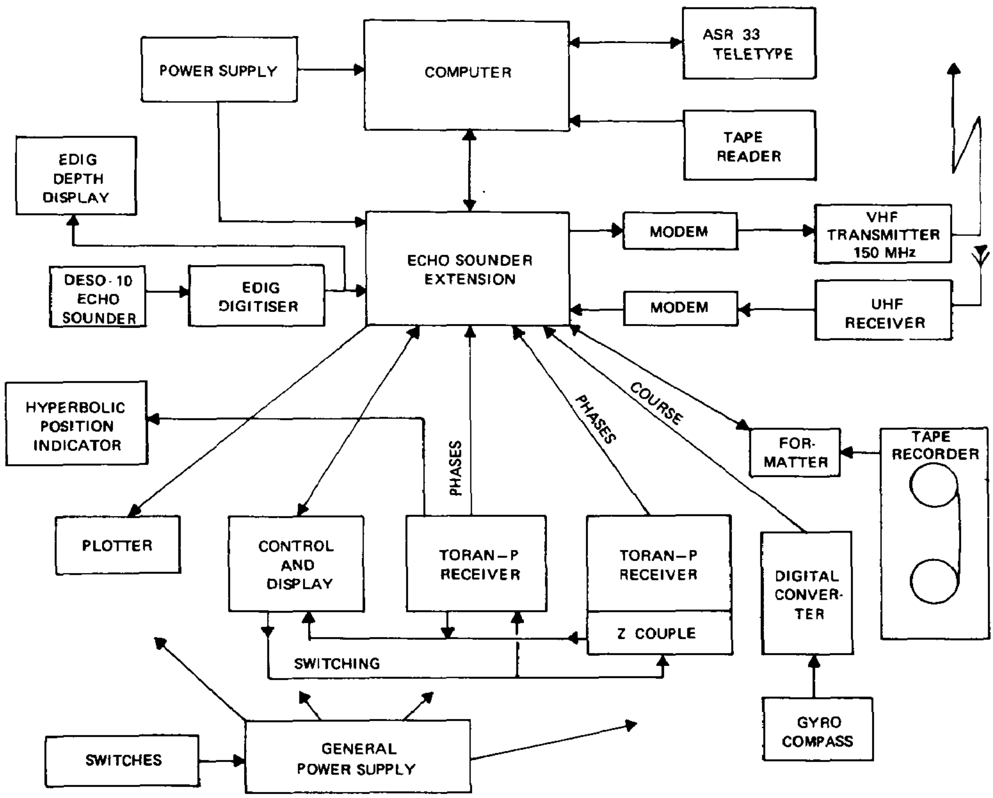


FIG. 8. — Diagram to show functioning of equipment aboard *Gardour*.

Data-collection equipment

1. Sounder

This is an Atlas Deso 10 hydrographic sounder (30 & 210 kHz) to which is linked an EDIG 10 to select soundings which will serve for the plotting of the sounding sheet. A copy of the data shown by the EDIG is displayed on the helmsman's console for safety of navigation purposes.

2. Pitch and roll stabiliser

When pitching and rolling are so pronounced that they may render soundings inaccurate, a device consisting principally of a pendulum will eliminate doubtful ones.

3. Anti-heave device

Heave must be eliminated as soon as it reaches an amplitude of 15 cm.

A first solution consists in subjecting the echo-sounder to voltages proportional to the degree of heave, which will correct the voltage signal given out by the sounder; however, it has not yet become technologically possible, for non-military use, to market these devices at prices acceptable for port surveys. Therefore, the French Lighthouse Service has carried out research into the analytical aspect of the phenomenon, based on the following principle:

The "noise signal" introduced by the heave of the ship is considered as a random function. Appropriate analysis of the measurements enables, first of all, an estimation to be made of the spectral density. The signal represents the difference between a reference value and the true value of the sounding. With the aid of a filter adapted to the spectral properties of the signal and the noise, it is possible to minimize the effect of the noise on the signal.

4. Radio positioning

The receiving station aboard the mother ship consists of two TORAN P receivers which can be switched manually or automatically to the five networks.

Use of two TORAN receivers is necessary when switching automatically from one network to another, as automatic switching of TORAN networks is not instantaneous; there is a time lag, referred to as 'locking', of 10 to 30 seconds during which the hyperbolic phases are not exploitable. Use of a second receiver eliminates this problem. In fact, the first receiver (R1) supplies the position on the Ri network where the ship actually is, and the second receiver (R2) gives, at the same moment, the ship's position in the Ri + 1 network towards which the ship is making. When the imaginary line separating the two networks is reached, the computer will no longer retain the R1 phases, but those of R2. This is the 'exchange' or 'switching' of networks. In order that further switching may take place to the following network (Ri + 2), the R1 receiver must, beforehand, be automatically commuted from Ri to Ri + 2 before the ship reaches the next line (see fig. 9).

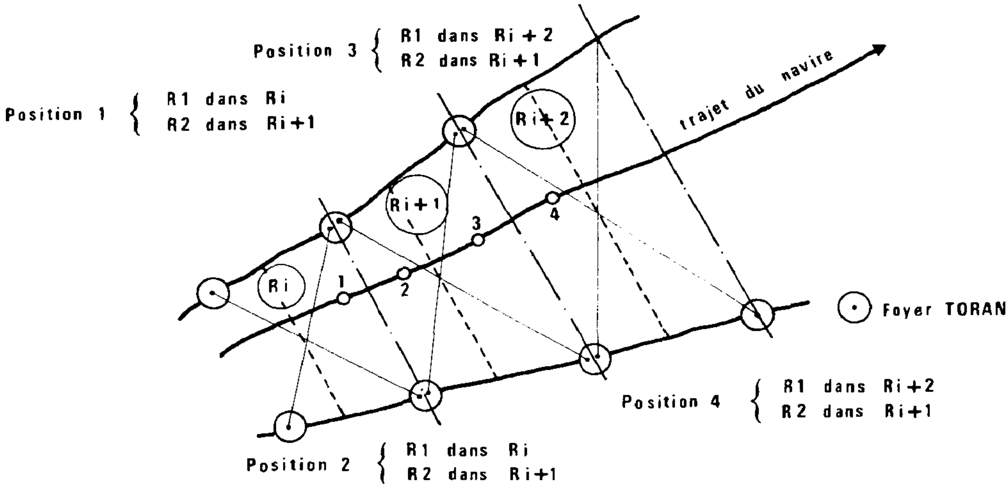


FIG. 9. — Automatic network switching.
—— . —— Line separating two networks.
- - - - - - - - - Line of switching between networks.

Controls, monitoring and visualization

Control and visualization unit (fig. 10)

To enable the user to check the system 'at a glance', or to feed data simply into each input cycle, the principal controls and information recorded are grouped together in this unit.

One of the important features of this control unit concerns the positioning of the consorts. Their theoretical positions compared with that of the mother ship are displayed. With this information, together with the actual positions transmitted by the consorts themselves, the computer determines the variation in the positions of the consorts. The differences from the theoretical positions are transmitted to the consorts for display on a 2-needle indicator.

Recording, positioning and transmitting equipment

This includes :
— one 1 600 BPI magnetic tape unit;
— one ASR 33 teleprinter for computer read-out;
— one fast punched-tape reader for programme loading;
— one plotting table for plotting the sounding profile;
— two UHF receivers and one VHF transmitter for liaison between the launches and with the computer centre.

Data-processing equipment

The 'heart' of the system is a Campanule mini-computer by CROUZET, which at present has a memory of 4 K words, extendable to 8 K words.

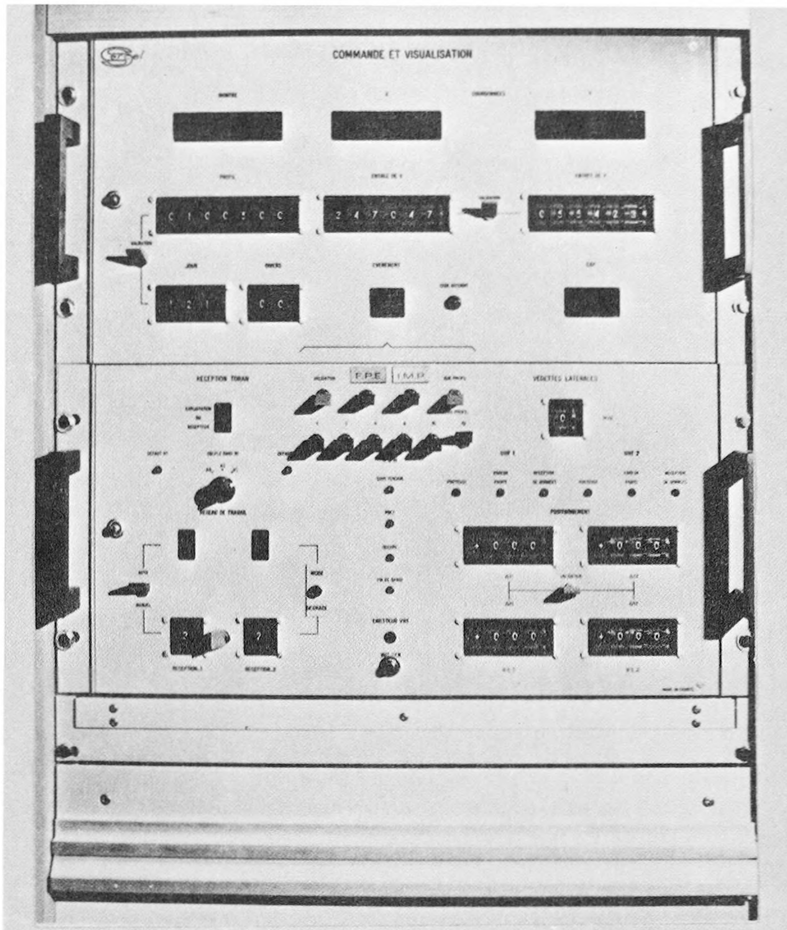


FIG. 10. — Control and monitoring unit.

Its essential task is data acquisition and processing, either for monitoring purposes, for modification or for re-distribution to the output peripherals.

Besides its role of system control, it carries out a certain number of operations concerning the cycle and its preparation:

— automatic switching of TORAN receivers;
— automatic determining of lattice numbers;
— positioning of consorts;
— converting of hyperbolic coordinates into XY values;
— acquisition of TORAN positions;
— maintenance of TORAN phases.

As sounding begins, it enables the TORAN to be set at a known position as the point of departure, either in Lambert XY, or by taking two angles on three landmarks.

If the TORAN receiver in use breaks down, the computer replaces it by determining the XY position of the ship from the TORAN phases of the second receiver linked to the adjoining network. If both receivers break down, it will extrapolate the new positions of the ship on the basis of the former known positions for a duration of 30 seconds, a delay which will enable the operator to take the necessary action to record an 'event' causing a break in the logical sounding process.

It monitors the transmission of data to the consorts and to the computing centre.

It enables connection in conversational mode, by programmed or manual interrupt, between the control unit and the teleprinter and the data acquisition equipment, the input and output of which it governs.

Equipment aboard the launch *Biganon*

The equipment aboard the launch *Biganon* is less extensive than that aboard the *Gardour*. It consists of:

— an Atlas Deso 10 depth sounder;
— a TORAN radio-positioning receiver;
— a SYLEDIS radio-positioning receiver, for sounding in the Garonne river;
— a control and monitoring unit;
— a magnetic recorder and printer;
— a plotting table to plot the sounding profiles;
— a unit for transmitting information and data to and from the *Gardour* when sounding in formation;
— a position indicator, showing lateral and longitudinal position with respect to the *Gardour*.

COMPUTING AND PLOTTING CENTRES (fig. 11)

The UNIDATA 7730 computer used in calculations for plotting, for dredging volumes and for records is run by the computer division of the Bordeaux Port Authority. Its characteristics and conception make it multi-programmable.

The plotting centre, situated several kilometres away from the computing centre, is equipped with a MITRA 15-35 terminal, a control unit for the UNIDATA 7730, a card-reader, and a BENSON 222 plotter measuring 1.20 m × 0.80 m with a precision of 1/20th mm.

The operating principle of this data-processing equipment from the cartographic viewpoint can be defined in three stages:

— acquisition
— processing
— plotting.

Data obtained from the *Gardour* via the Le Verdon relay station and the Post Office line are decoded then checked and analyzed by the computer before being recorded on magnetic tape or disc. Thus, as soon as a sounding operation is completed, the plotting data for the survey sheet is available.

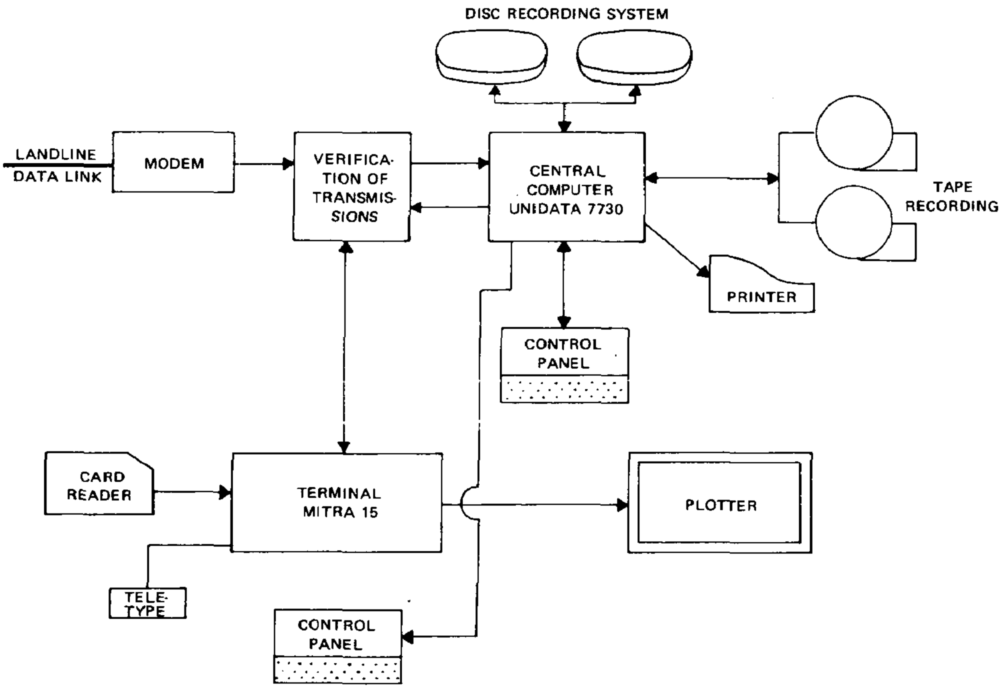


FIG. 11. — Line diagram of equipment at computing and plotting centres.

During the whole of this acquisition stage, the progress of the sounding operations and transmissions is displayed on the control unit of the Bacalan terminal. Liaison between the terminal and the ship is possible by radio telephone.

At the end of the data-acquisition stage, i.e. as soon as sounding has ended, the control unit operator at the plotting centre can start the data processing stage, which, based on the amount of sounding done, may take from 10 to 20 minutes.

The final stage, which is the plotting, consists solely in transmitting to the MITRA 15 the plotting instructions for the fair sheet.

PROGRAMMES

Data acquisition

The HYDRONAV programme consists of:

— the initial adjustment of the radio navigation system as sounding begins;

— the programme itself, which runs in one-second cycles and which includes acquisition of data, calculation of position, recording, transmitting and monitoring.

The simplified flow diagram (fig. 12) illustrates the principle on which this programme functions.

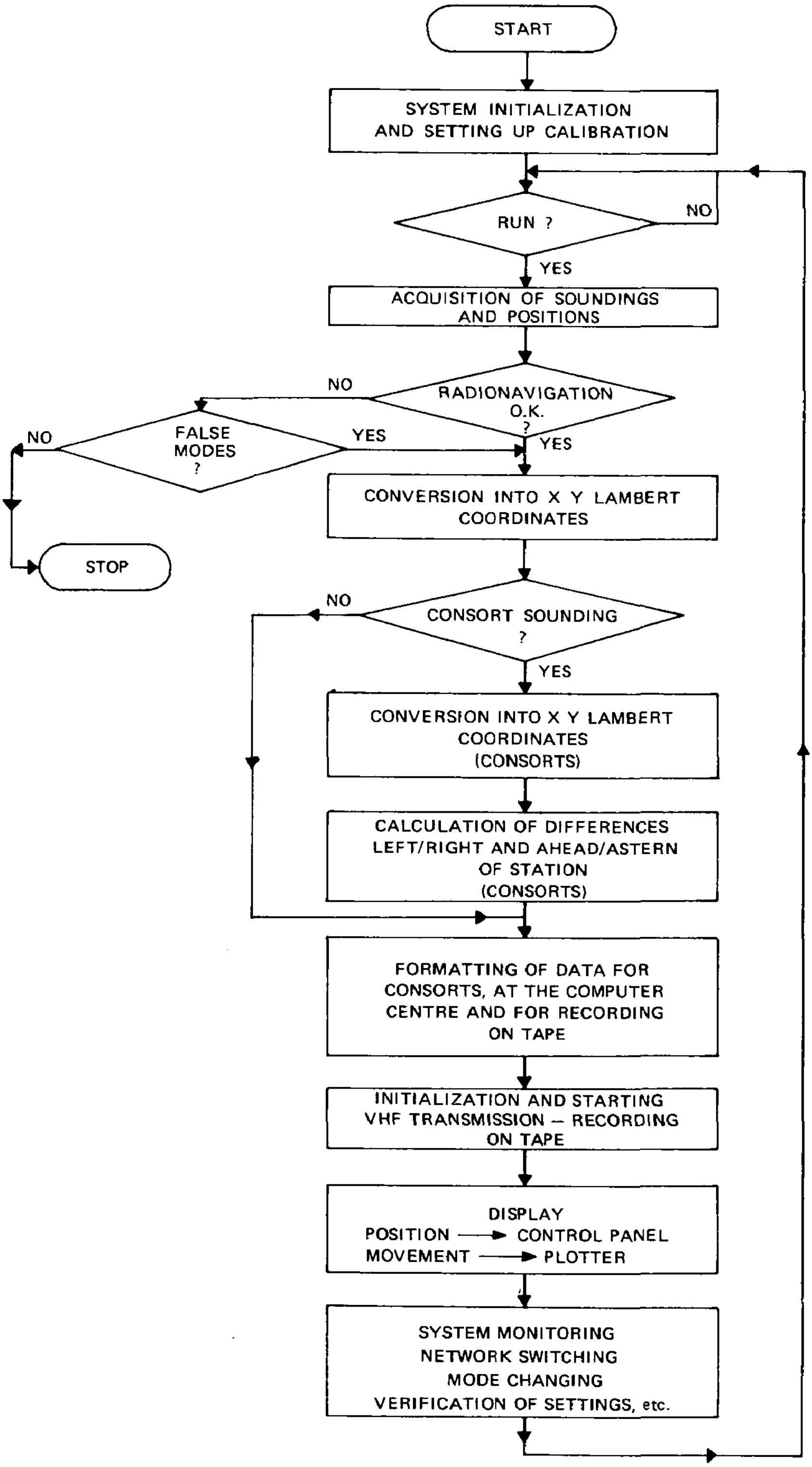


FIG. 12. — HYDRONAV, simplified flow diagram.

Acquisition

The DRACQ programme processes the data transmitted from the vessel *Gardour* via the Le Verdon relay station and the telecommunications network.

It verifies the transversal and longitudinal parities of the data blocks received to eliminate any incorrect blocks.

It monitors the state of 'event' blocks (in sounding profiles, soundings out of line, momentary break in profile, erroneous profile, break in sounding, end of sounding) coded aboard ship and included in the 69-character blocks transmitted. Every first block containing a new 'event' is edited in the control unit, which enables the ship's position to be known at the moment of each new 'event'.

It records the blocks on magnetic tape, following the same procedure as that of the control unit, retaining, however, all the blocks on profiles.

It monitors the transmissions.

Plotting of sounding sheets (fig. 13)

The DALI programme (automatic scribing of isobaths) was designed for the purpose of obtaining the most accurate and the quickest possible drawing of isobaths and spot soundings at their exact geographic position, using a small computer (60 K octets), which is not generally the case in most cartographic scribing programmes based on scattered points. This

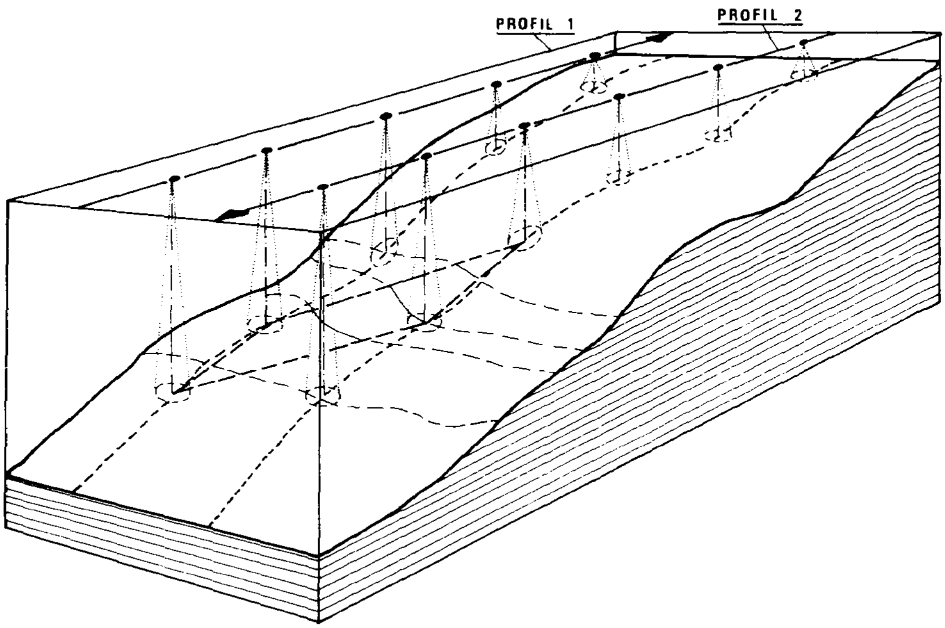


FIG. 13. – Sectional view of a sounding area.

programme is available to all French port authorities and may be marketed abroad under licence from the French Lighthouse and Buoyage Service. A DALI users' club has been formed to collate all enquiries leading to improvement of the programme.

An AWE 76 study report (on automatic plotting of sounding sheets using the DALI programme) by the Lighthouse and Buoyage Service describes in detail the full range of possibilities of the programme. It is, therefore, only necessary here to recall the basic principles.

The fundamental theory is that the area of the sea floor between four sounded points is correlated with a hyperbolic paraboloid passing through the four segments joining the four points. The isobath portions are defined by the intersection of horizontal planes with this paraboloid.

This theory necessarily implies that the four corners of the quadrilateral are taken two by two on two adjoining sounding profiles, largely parallel and similar in length, and that the number of corners is the same on all the profiles of the area sounded. These apexes are selected from the points sounded according to the criteria for selection of soundings applied by the hydrographer when sounding manually.

Calculation of cubic volumes and drawing of curves showing isovariation of the bottom

For the requirements of port surveys, it is necessary to be able to:

- calculate the cubic volume of material within a quadrilateral, between the bottom and a horizontal plane;
- plot a chart showing equal variation of the bottom between successive sounding operations, so that any changes may be analyzed;
- store data relative to successive sounding operations, for subsequent exploitation when planning improvement schemes.

Extensions of the programme now being studied concern:

- calculation of sediment volumes washed away or deposited between successive surveys;
- calculation of positive or negative volumes contained between the surface representing the bottom of a fairway or channel and the theoretical surface of the bottom of this fairway represented by successive prisms;
- search for maxima and minima significant for navigation purposes.

Drawing of field sheets

So that the fair sheet may become a document that can be used for navigation purposes, it is necessary to represent it on a field sheet containing all background information useful to navigators (lights, buoys, leading lines, wrecks, landmarks, kilometre points, scales, etc.). All the drawing of these symbols and the light characteristics has been programmed and stored in the programme's library. The banks of the Gironde and the

Atlantic coast of the estuary have been digitised and stored on cards with the positions of the symbols and the lettering to be reproduced.

The BALRIV programme makes it possible to represent any area, at any given scale, within a rectangle defined by the Lambert coordinates of its four corners (see Plot N° 10).

A special programme enables the background information to be updated (buoy movements, changes in light characteristics, modifications to shorelines consequent on new harbour works, etc.).

PLOTS

The print-outs reproduced here, though they do not seek to provide a complete sample, give an idea of the capabilities of the system and of the DALI programme.

General sounding

Every year, the 825 kilometres making up the Gironde mouth and estuary are sounded. The area to be surveyed is divided into preliminary sounding zones, an example of which is shown in Plot N° 1.

The lines of soundings reproduced correspond to the profiles followed by the ship. The hydrographer has increased the density of sounding profiles in areas in which he knew the configuration to be rugged. Each sounding reproduced corresponds to the least depth in the immediate area.

The exploratory surveys which enable field sheets to be drawn up are stored yearly on magnetic tape. Plots N° 2 and N° 10 are examples of print-outs of bottom relief based on stored data, isobaths and background information.

Monthly sounding operations

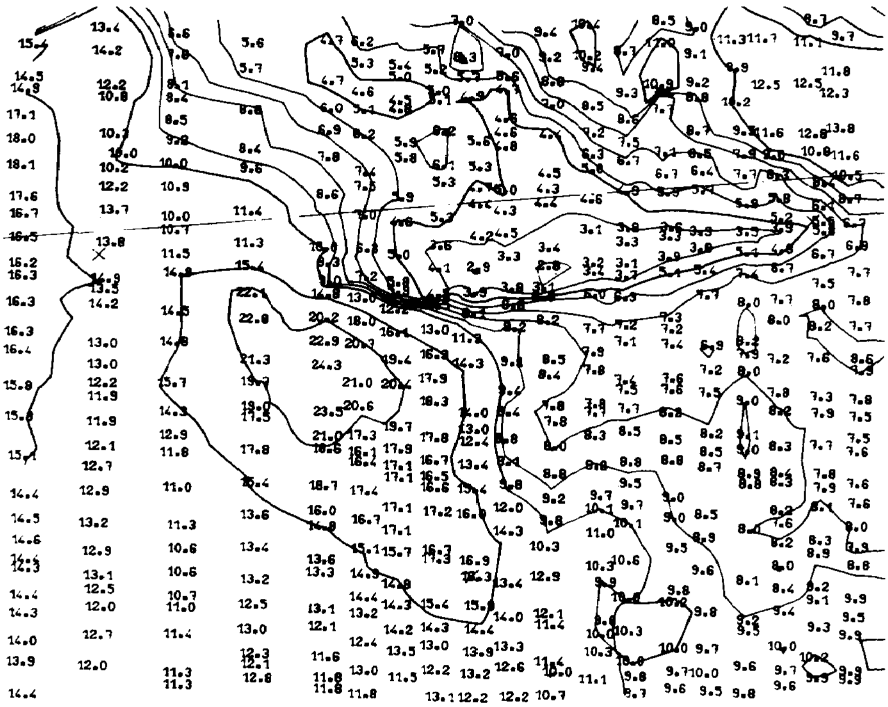
These concern the channel from Bordeaux to the sea, a distance of 140 kilometres.

Plot N° 3 is an extract from a survey using cross-river profiles. The same area sounded by means of longitudinal profiles is portrayed in Plot N° 4.

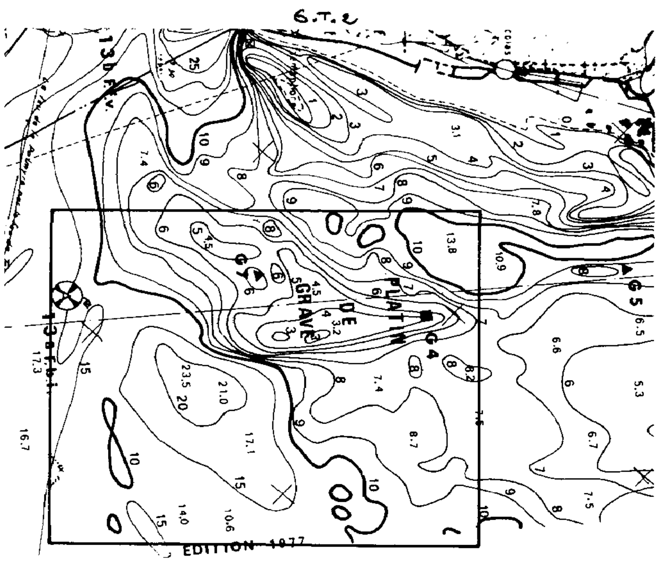
It is reassuring to note that, whatever the direction in which profiles are run, the position of isobaths remains unchanged from one operation to the next, except where bottom changes have occurred.

Print-outs showing retrieved soundings and outlines of isovariation curves

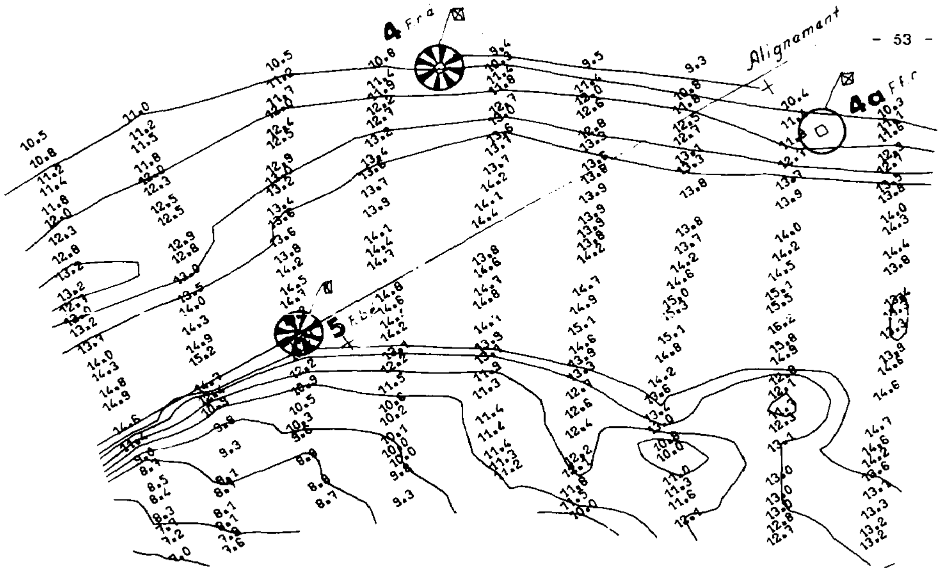
Since these are working 'tools' for those responsible for port improvements and constructions, it was necessary to be able to make comparisons



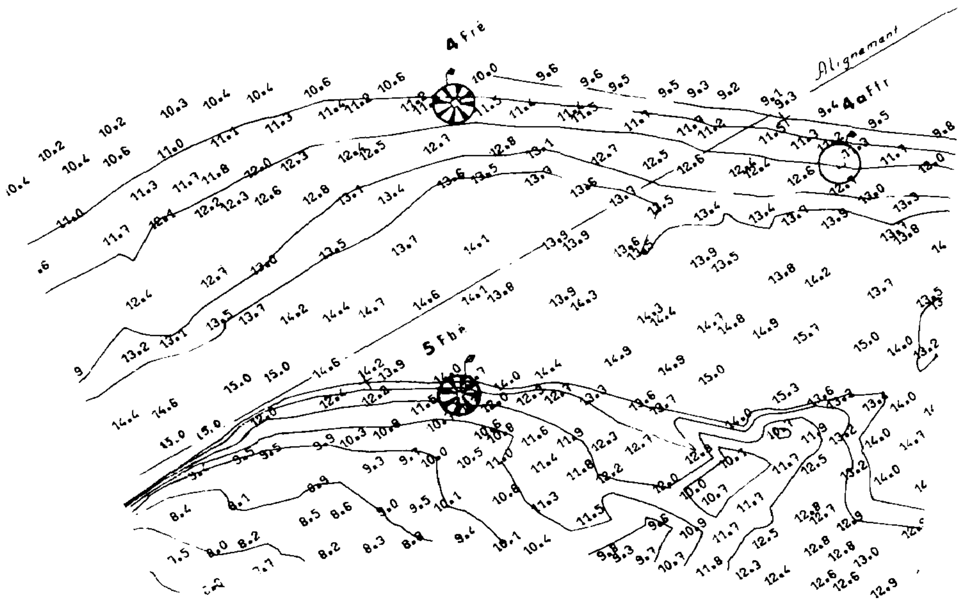
PLOT N° 1. — Preliminary survey — fair sheet.
Scale 1/20 000. Isobaths represented : 3 to 10, then 10 to 20 metres.



PLOT N° 2. — Extract from a chart at 1/40 000 drawn up from fair sheets.
The rectangular area outlined was from the fair sheet at Plot N° 1.



Plot N° 3. — A survey of 8 July 1975 in cross-river profiles.



Plot N° 4. — A survey of 8 June 1976 in longitudinal profiles.

between the state of the bottom as surveyed at different times for studies relating to port improvements and dredging.

Plate 1 gives a sample of what can be done with retrieved data from the DALI programme. The Cussac channel was sounded on 20 January 1976 then on 3 March 1976 (Plots N° 5 and N° 6). These two sheets were stored on magnetic tape, each record being in the form of a grid, at the intersections of which are recorded the soundings from successive surveys.

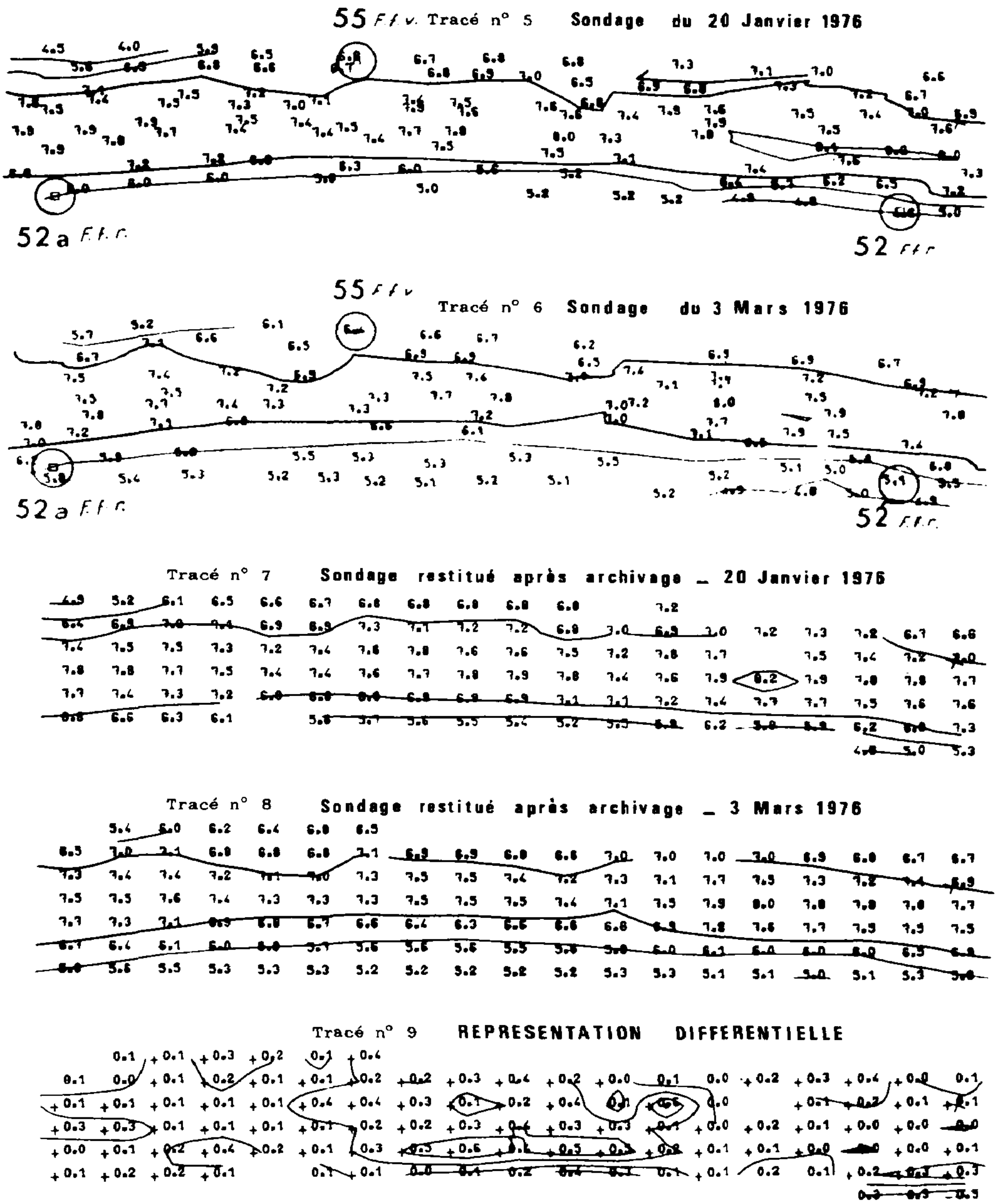
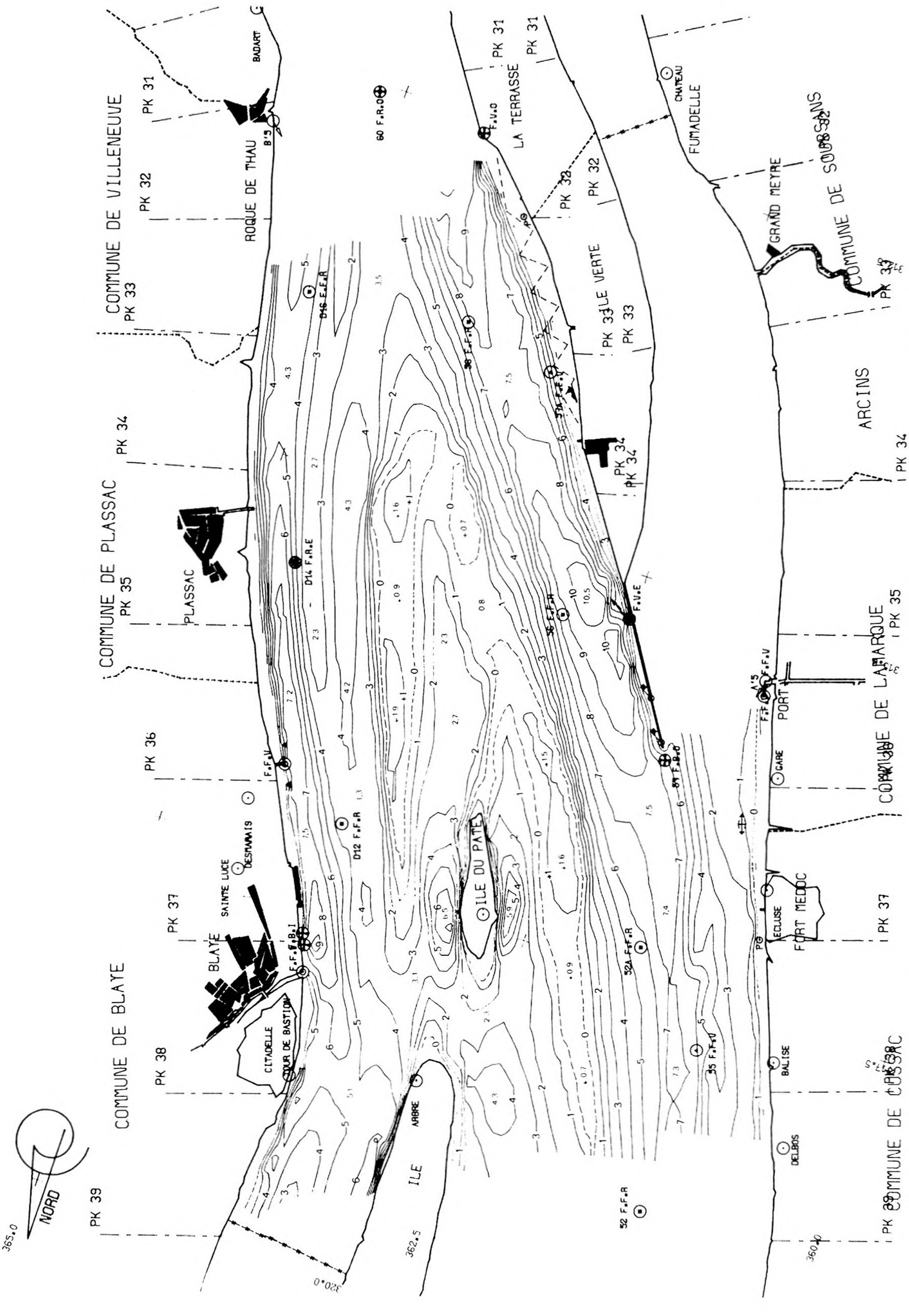


PLATE 1. — Extracts from a survey of the Cussac channel. Original scale : 1/10 000.



Plot N° 10. — Field sheet of part of the Gironde, with isobaths reproduced from stored data.

The retrieved data print-outs (Plots N° 7 and N° 8) enable verification to be made of the exactitude with which data is retrieved, the only difference being the smoothing.

It is a simple matter, using data thus stored, to compare soundings taken at different times. The differential plot (Plot N° 9) between two sounding operations (20 Jan 1976 and 3 March 1976, in this case) shows isovariation curves and values for decreased depths (+ sign) and for increased depths (no sign) at the grid intersections.

Drawing of field sheets

Plot N° 10 is an example of what can be portrayed. The expert eye will pick out on this field sheet imperfections which we have not overlooked ourselves, and which are being corrected. On the same sheet, we have represented isobaths taken from stored data.

DEVELOPMENT AND FUTURE

The experience gained in the Gironde estuary has enabled other French ports to develop the collection of sounding data by automatic methods. Dunkirk, Bayonne and Kourou (French Guiana) were the first to do so.

The Port of Bayonne is a good example of successful development of the system. A small launch only 9 metres in length records data on punched tape. This tape is sent to the Port of Bordeaux, where, thanks to the computer facilities available, the plotting of sounding sheets is undertaken.

For those ports which do not wish to take on the processing of data but wish to have fair sheets available rapidly and access to all the many possibilities offered by the DALI programme, the solution lies in transmitting data by landline to the Bordeaux plotting centre which, after processing, re-transmits the plotting instructions to each port for reproduction of the fair sheets by plotter.

CONCLUSION

The success of this operation is due to the good relations existing between men of varying professions who have been capable of intelligently sharing their knowledge and pooling their expertise.

In the team there were represented hydrographers, data-processing experts, mariners, electronics experts, draughtsmen, technicians and engineers, working either for private companies, for the Lighthouse and Buoyage Authority, or for the Bordeaux Port Authority.

Electronics and data-processing experts took part in hydrographic operations in order to have a clearer appreciation of the needs of the hydrographer.

Hydrographers attended courses in factories with data-processing and electronic equipment comparable to that in the Gironde surveying system.

At the present time, all sounding of the estuary and mouth of the Gironde is carried out by automatic processes.

The sounding results are given monthly to the river users (Gironde pilots, Captain of the Port, dredging service) so that exploitable depths can be defined and areas where dredging is required pinpointed.

Thus safety of navigation is increased and strengthened, and dredging work is better directed to give optimum results.

(Translated from the French)

I have been actively engaged in the underwater world practically the whole of my professional life. One thing I learned very early in my career is that the sea is a cruel and inhospitable master full of surprises, showing contempt for all those entering the environment ill-prepared.

It amazes me that in the last few years we have been exposed to so many "instant experts" in the area of underwater science and technology, people who have never got their hands dirty, let alone their feet wet. I am a great believer in getting your feet wet, to learn first-hand the rigours of the marine environment. I have a general rule of thumb : if a job takes one day to do on shore, it will take four days on a surface ship and eight days on a submarine. This kind of thing cannot be taught in the universities, you must be exposed to it.

Extracted from a speech by Mr. Kenneth R. HAIGH, retiring Chairman of Council of the Society for Underwater Technology, at the Annual General Meeting, 2 December 1976, London.