

CLASS 2 SURVEY VESSELS (BH2) OF THE 'LAPÉROUSE' TYPE

by J.M. CHIMOT (*)

INTRODUCTION

The Hydrographic and Oceanographic Service of the French Navy has launched an important programme of renewal of its ships, involving the following principal stages:

- development of overall specifications in January 1985,
- commissioning for active service of:
 - BH2 *Lapérouse* (fig. 1) — 20 April 1988
 - BH2 *Borda* (fig. 2) — 16 June 1988
 - BH2 *Laplace* — scheduled for early 1990
 - BH2 *Arago* — scheduled for 1991.

Moreover, two major items of equipment have been acquired: a hydrographic sonar for marine exploration (SEHM) and a multi-beam echosounder for shallow waters. The former, to which is linked an electronic chart display system, is fitted aboard the *Lapérouse* and the latter aboard the *Borda*.

DESIGN — OPERATIONS — PARTICULARITIES

Two versions of Class 2 (BH2) survey vessels exist:

- an auxiliary version, the BH2 A, intended for operations in metropolitan France's economic zone and possibly in tropical areas outside of the coastal zone that is only accessible to launches,
- a coastal version, the BH2 C, intended for operations in metropolitan France's economic zone and those of overseas departments and territories.

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FIG. 1. — BH2 A *Lapérouse*.



FIG. 2. — BH2 C *Borda*.

BH2 A and BH2 C vessels must be capable of the following:

- continuous bathymetric surveys, day and night;
- continuous swathe-sounding bathymetric surveys, day and night, using side-scan sonar;
- manipulation, towing and mooring of sensors and transducers at depths down to 1,500 m;
- discrete or continuous hydrological observations to depths of 2,000 m;
- use of various sensing devices from a container-laboratory;
- possibly, setting up or renewal of floating light beacons.

In addition, with the aid of two survey launches, the BH2 C is capable of executing hydrographic surveys in shallow waters. It can also be fitted with a multi-beam echosounder.

The distinctive aspect of the BH2 A is its capability for positioning and identifying obstructions in recommended channels or along regulated routes. For this purpose, it is equipped with a sonar. In addition, this vessel is designed to be fitted at a subsequent date with launches and davits, if the need for these arises. The *Lapérouse* is the only BH2 A in the programme.

GENERAL CHARACTERISTICS

Some figures

Length overall	59 m
Breadth	10.9 m
Draught	3.4 m
Displacement when fully loaded	970 t
Continuous speed fully loaded	15 knots
Endurance at 12 knots	6 000 miles
Turning circle radius at 10 knots	less than 100 m.

Construction

The management of 'Constructions navales (DCAN Lorient)' was responsible for the construction at the industrial level. Great simplicity of the elements constituting the framework and application of the specifications of Bureau VERITAS (rather than the usual standards for warships of the Navy) enabled a relatively economical construction to be achieved, the result of which is a spacious vessel, essentially made up of a simple platform whose qualities of robustness, sea-worthiness, manoeuvrability and ease of maintenance make it available for a great many uses.

The BH2 has a steel hull and very strong superstructure, as it may encounter tropical cyclones. Two decks contribute to the resistance to longitudinal stresses: these are the main deck aft — this is also the watertight deck — and the forecastle deck to the stem.

Propulsion and manoeuvring

The propulsion of the BH2 at medium and high speeds is by means of two propelling units installed in the same compartment. Each unit consists of a diesel engine, SACM (*) 175 V12 R.V.R. of 920 kW, which drives, by means of reduction gears, a propeller with controllable blades.

These vessels can be fitted, subsequently, with auxiliary propulsion machinery adapted to low speeds, since allowance was made at the construction stage for the possible future installation of electric motors acting directly on the reduction gears.

The propulsion machinery may be controlled (engine speed, propeller pitch) from the bridge.

The vessel is steered by means of a balanced rudder. A bow thruster gives the ship added manoeuvring and station keeping capabilities. An automatic pilot, which can be linked to the radio positioning systems, facilitates navigation along profiles.

Electricity

Electrical energy is produced by three diesel alternator units providing 450V-60Hz-three-phase alternating current. The nominal power of the first two, which are identical, is 250 kW, while that of the third, used when moored or as an extra source, is 120 kW.

Power is distributed through two 'force' circuits (440V-60Hz-three-phase, one for auxiliaries and equipment onboard and the other for the bow thruster, a 'lighting' circuit (115V-60Hz-three-phase), a 'scientific' circuit (220V-50Hz supplying the scientific control centre (PC), the data processing and the hydrology premises), a 'special' circuit (115V-400Hz), a 'domestic' circuit (220V-60Hz) and distributions of 28 volts CC.

Crew and accommodation

The accommodation is designed for 45 persons.

The fitting out of the four BH2 vessels differs slightly as a function of the missions and the complement of each. The average crew of a BH2 comprises 3 officers, 10 petty officers and 18 ratings. The other accommodation is occupied by the surveying team aboard and possibly by trainees or supplementary personnel.

Endurance, life expectation and maintenance

The BH2s can stay at sea continuously for 20 days without support and can provide 160 days of active sea time per year.

(*) Société alsacienne de constructions mécaniques.

Their theoretical life expectation is 25 years, during which time they should be able to perform with limited maintenance.

SPECIFIC INSTALLATIONS AND EQUIPMENT

Specific installations

Figures 3 to 8 show the layout of the installations. Specific items include:

- On the bridge deck, a spacious scientific control centre, situated to the rear of the wheelhouse, with which it communicates by a sliding door. Most of the measuring instruments and data acquisition systems are located in this office. Possibilities of further development have been provided for with a view to the installation of new equipment.

- On the forecastle deck, two processing rooms which accommodate offices and work stations adapted for the exploitation of automated systems. The larger of the two rooms also contains a drafting table of 2.2 m × 2 m, and the other, the infrastructure necessary for the installation of a precision AO format plotter. These two rooms can receive information in digital form from the scientific control centre.

- On the main deck, a hydrology room containing a work station adapted for the eventual setting up of a salinometer and stowage for a depth probe, sampling bottles, a side-scan sonar, a sound velocity probe, diving equipment, etc. Premises are also provided on this deck for the inflation of diving cylinders and maintenance of batteries.

- On the orlop deck, two storerooms for scientific instruments and electronic equipment, and a hold (of 80 cubic metres, with an access door of 2.4 × 2.4 m) for bulky equipment which can be taken aboard using the crane installed on the forecastle deck (2 500 daN)(*). On the orlop deck an electronic laboratory is also to be found, which receives, as appropriate, the equipment necessary for deploying the sonar and the multi-beam echosounder.

- A working area aft, situated on the main deck, at 2.6 metres above the water line, includes:

- a centre winch (of 1 500 daN) to a gipsy and a drum with clutch release mechanism, handling 1 500 m of steel cable,
- two side winches with slip rings (of 360 daN), controlled on the spot or through the scientific control centre for the simultaneous towing of two 'fish' (magnetometer and side-scan sonar),
- an inclinable gantry (of 1 500 daN) manœuvred hydraulically.

- A central work area which includes:

(*) daN = decanewton.

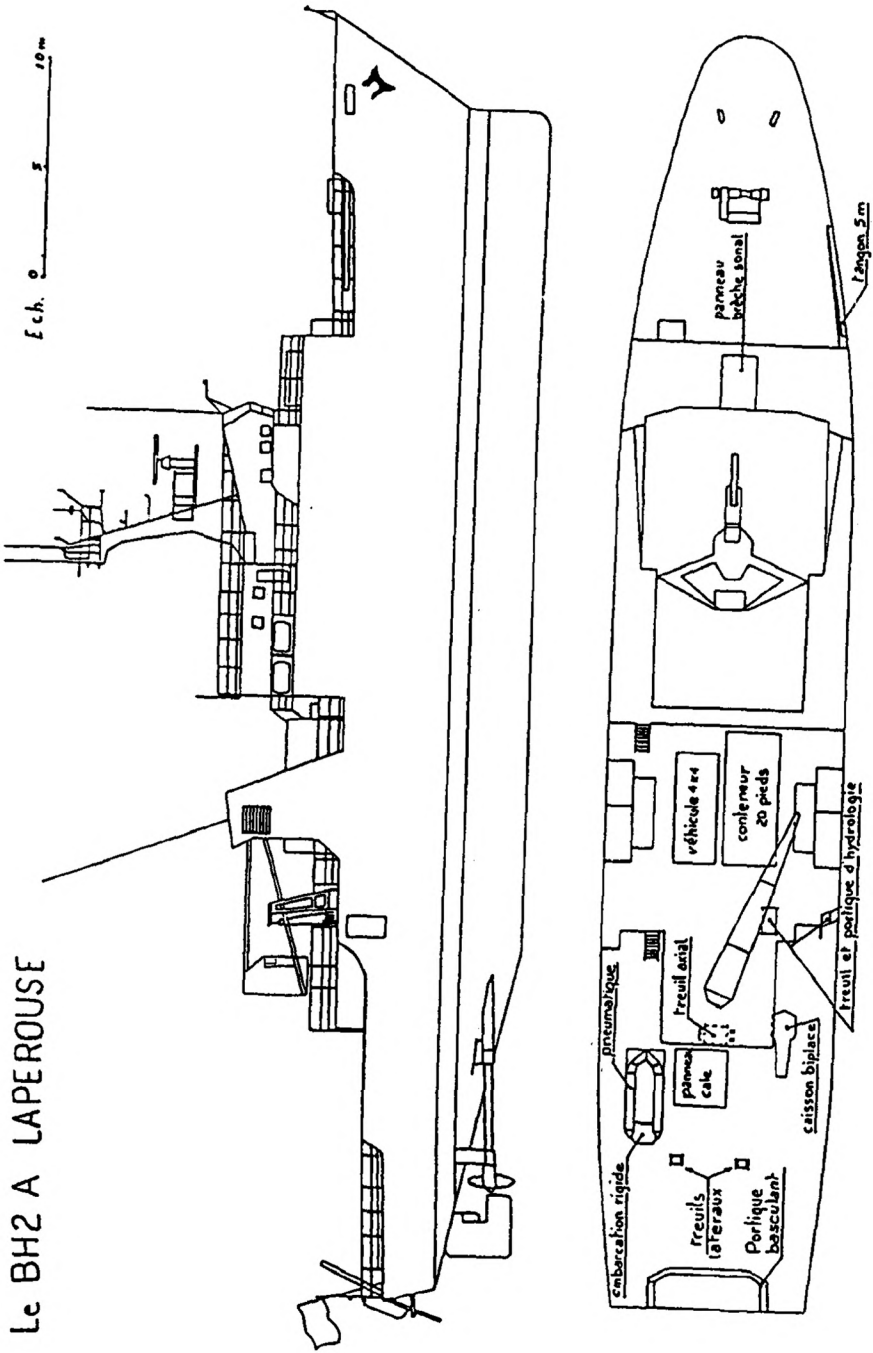


FIG. 3.

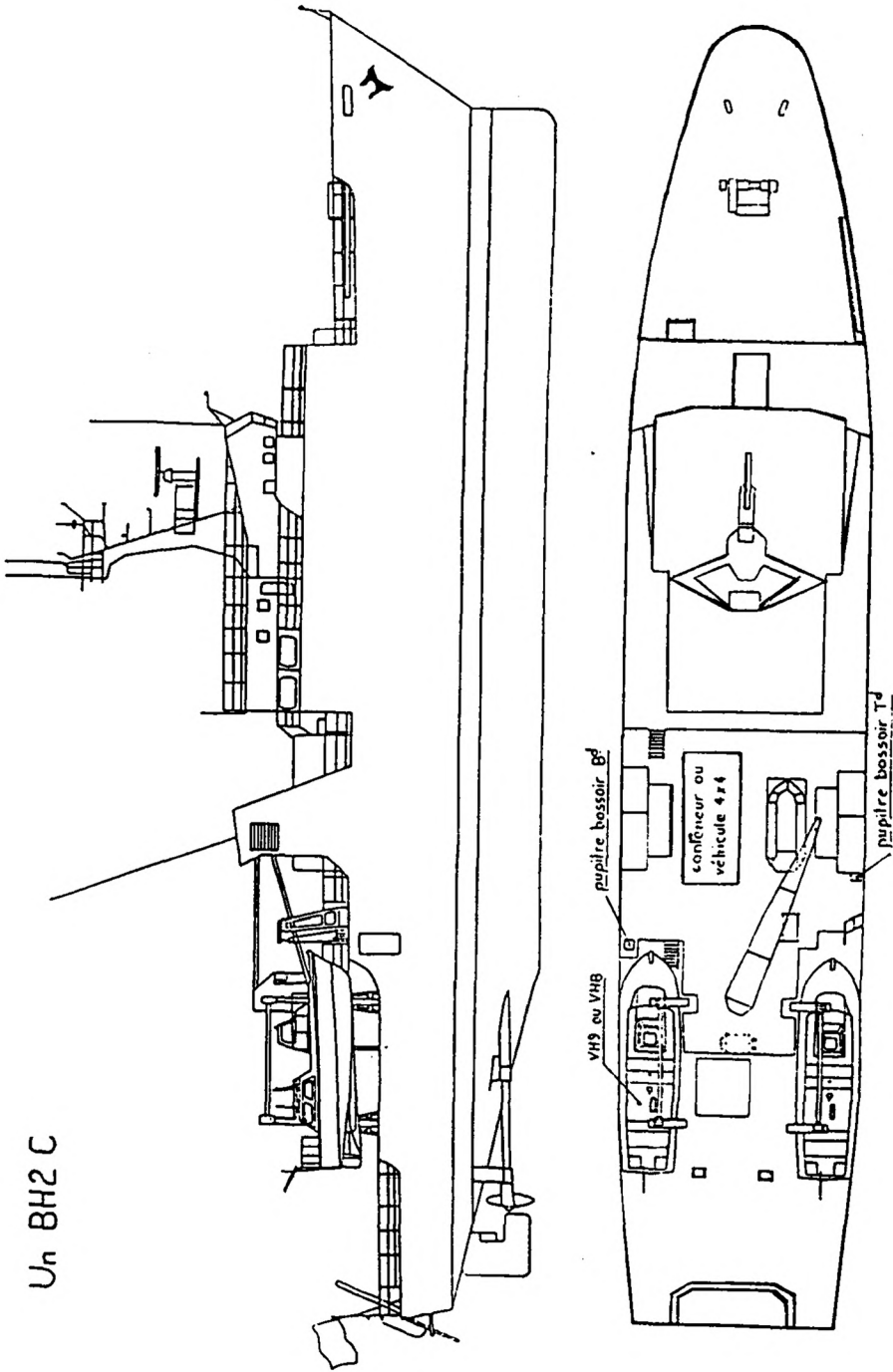


FIG. 4.

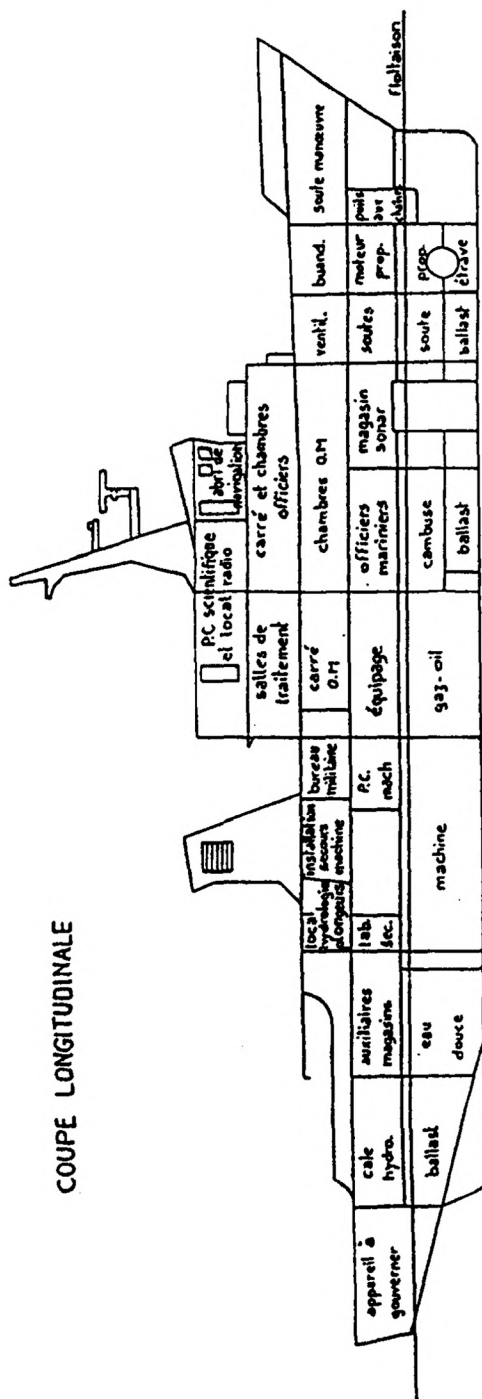


FIG. 5. — Fore-alt section.

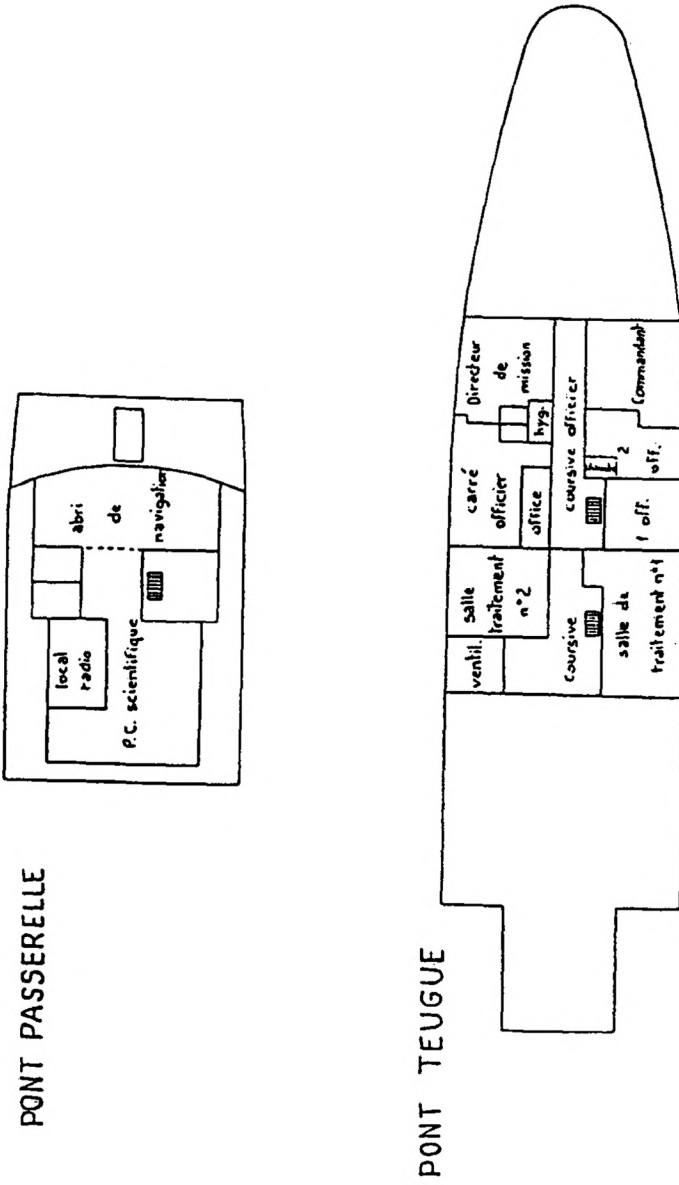


FIG. 6. — Bridge deck. Forecandle deck.

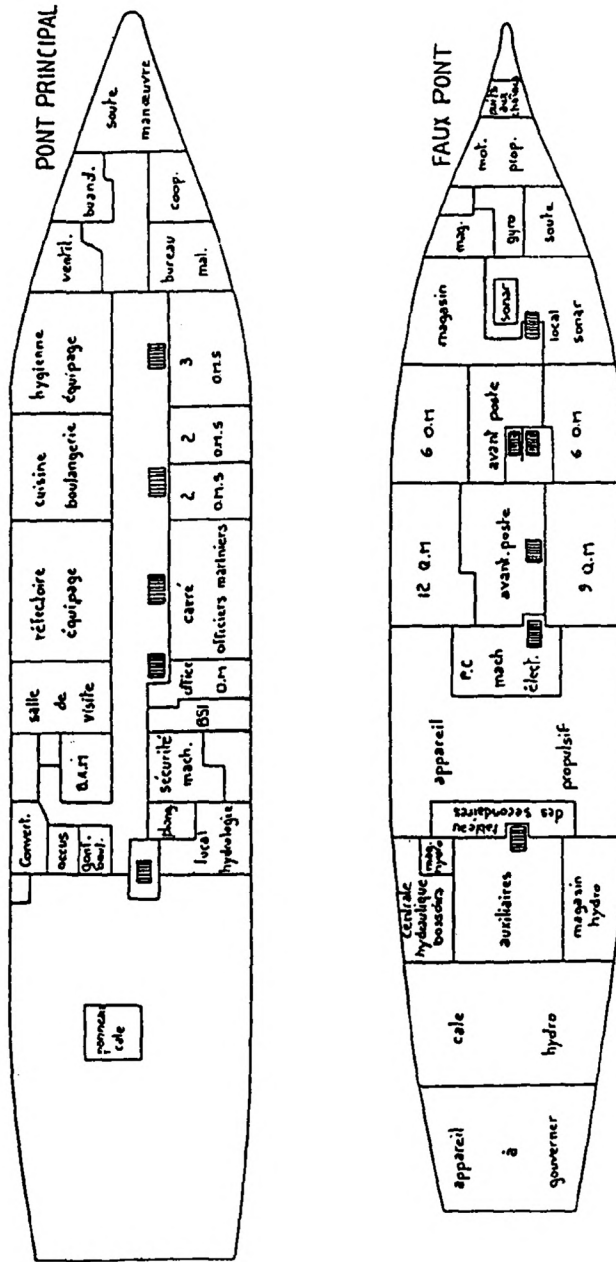


FIG. 7. — Main deck. Orlop deck.

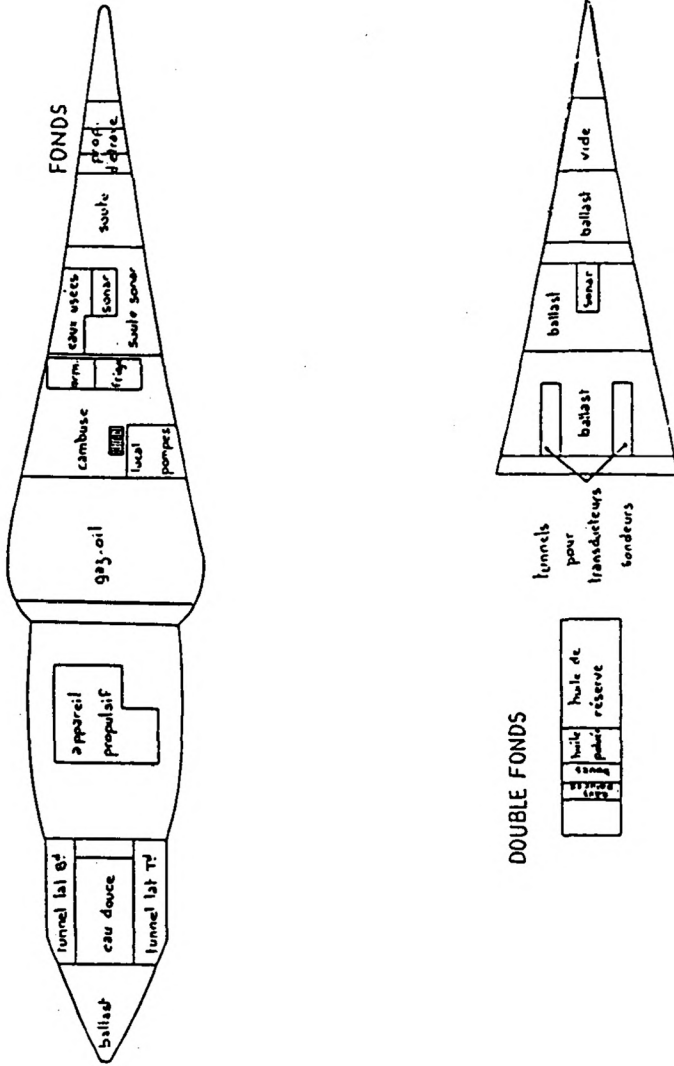


FIG. 8. — Lower deck. Double bottom.

- on the forecastle deck: an electric side winch with slip rings, handling 4 000 metres of cable (speed from 0 to 60 m/min., $F = 1\ 000\ daN$) which permits the carrying out, using a side gantry, of hydrological measurements, discrete or with a depth probe,
 - on the main deck, a folding platform, situated near the hydrology room, which enables the hydrology cable to be supervised and sampling bottles to be deployed or retrieved.
- On the BH2 Cs only, two sets of gravity davits, arranged symmetrically on the main deck, for launching the two survey launches.
 - On the BH2 A, an infrastructure intended for carrying a two-man re-compression chamber.

A place on the forecastle deck between the two funnels is available for carrying a 20-foot container intended for special measuring operations; this can be linked by telephone with the scientific control centre and receive information in digital form.

To be noted, finally, is the fact that the masts have been designed so that connection can be made with radio positioning antennas, even at sea, in good conditions of security.

Small craft

The boats carried by the vessel include one in light alloy (4.3 m) and an inflatable one with rigid bottom (6 persons), each with outboard engines.

The BH2 C has, in addition, two survey launches of 8.3 m or 9 m.

Special equipment

The BH2s carry the following specific equipment (apart from the equipment on the launches):

Navigation

- magnetic compass (Noroit type);
- gyroscopic compass with heading relay (CGM-4) and various route guides;
- electromagnetic log (LMN-4-BEN);
- track automatic pilot (BEN EPS 50);
- anemometer;
- radio direction finder (CRM 4215);
- Omega receiver (M 6);
- radar (type Decca 1226).

Radio position fixing

The infrastructure is provided for the following receivers:

- Trident (III, III A or IV by Thomson CSF);
- Syledis (SR 3 or STR 4 by Sercel);
- Toran (P 10 by Sercel);
- Loran (LRX 22P by MLR Electronique);
- Transit (JMR) — only for BH2s operating overseas;
- GPS (TR5S by Sercel);
- Rana (CK03 by MLR Electronique).

These (SHOM) receivers are in fact installed according to the type of survey.

Sounders and under-water detection

- an Atlas Deso 20 — 100 kHz navigation sounder;
- an Atlas Deso 20 — 66 and 210 kHz shallow-water sounder;
- an Atlas Heco 10 heave compensator for the shallow-water sounder;
- a Raytheon 12 & 34 kHz deep-water sounder;
- infrastructure for a side-scan sonar (EG&G 260 with 272 TD fish);
- infrastructure for a magnetometer (Barringer M-123);
- for the BH2 A, a sonar for marine hydrographic exploration;
- the BH2 C can be fitted with a shallow-water multi-beam echo sounder.

A description of these last two major items of equipment will be given further on.

Oceanography

- a Sippican bathythermograph, with a data acquisition unit (MK 9).

In addition, the following (SHOM) equipment is carried (according to the type of survey):

- a sound velocity probe (Suber SLS 12);
- one or more submersible tide gauges (Suber SLS 13 or 23);
- one or more shallow-water current meters (Suber SLS 11 or 21);
- a bathysonde.

Data acquisition and processing

More or less elaborate configurations of the following systems (SHOM equipment) can be carried (according to the type of survey) :

- digital data acquisition unit with submerged sensors (tide gauges, current meters);
- real-time (on-line) data acquisition system (HYDRAC)(*);
- off-line post-processing system (HYTRAI)(*);
- on the BH2 A, display-acquisition-processing system linked to the sonar;
- on a BH2 C fitted with a multi-beam echosounder, the off-line post-processing system.

Internal communications

- several networks of intercom and telephones.

(*) These systems have been described in various papers (refs. [1], [3] & [4]).

THE MARINE HYDROGRAPHIC EXPLORATION SONAR (SEHM)

This sonar, fitted aboard the BH2 A *Lapérouse*, is a DUBM 21 C sonar from Thomson-Sintra ASM, designed on the basis of a mine-searching sonar and incorporating a number of specific supplementary devices required for hydrographic searches. It is completed by a system of display-acquisition-processing developed by SHOM.

General characteristics

This hull-mounted sonar is intended for exploration at depths from 10 to 60 metres; it enables objects of at least 1 square metre in size to be detected, investigated and classified by analysis of the shape of the acoustic shadow.

For its exploration function, this sonar should be capable of operating normally in seas up to state 3 and at vessel speeds of at least 8 knots.

For its investigation and classification functions, it should be capable of operating at vessel speeds of 6 knots at least.

This sonar may also be used, if required, with reduced performance, to explore depths between 60 and 100 metres and in seas up to state 4.

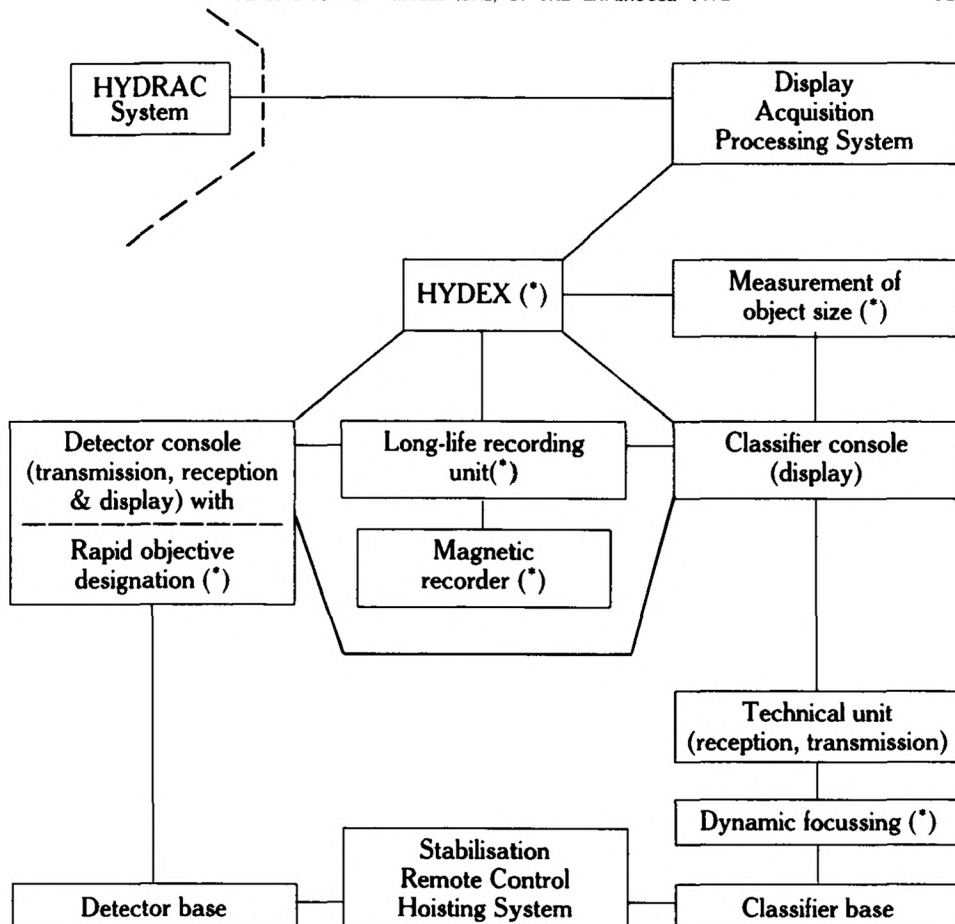
It is equipped with devices which enable real-time (on-line) exploitation, on-screen measuring of the size of dangers detected, and the recording of data required for subsequent (off-line) exploitation.

Description

A synoptic diagram (fig. 9) shows the equipment, which is composed of:

- a sub-system of 'stabilisation-remote control-hoisting' equipment by ECAN (*) of Ruelle, fitted in a well, situated about one third of the way along the vessel (pivot point). This system allows for hoisting, stabilisation when rolling (up to 15°) and pitching (up to 5°), and direction holding independently on a relative bearing ($\pm 175^\circ$) and on site (from -5° to 40°) of the bases of the classifier and the detector. It is completed by a system for closing the well;
- a sub-system of detection equipment consisting of an active sonar for manual or automatic scanning (sector of 30° over 400-600 or 900 m), functioning at 100 kHz. This sonar is made up of transmitting or receiving arrays (32 columns of 6 transducers, processed into 20 pre-set tracks); a console performing the electronic functions of transmitter, receiver and display; a device for rapid checking and singling out enables the operator to designate echoes for analysis in

(*) Etablissement des constructions et armes navales.



(*) Option specific to DUBM 21 C.

FIG. 9. — Synoptic diagram of hydrographic sweep sonar.

the classifier, or to send the relevant information (azimuth-distance) to the display-acquisition-processing system;

- a sub-system of classification equipment consisting of an active sonar for manual sweeping (sector of 10° over 200 or 300 m), functioning at 420 kHz. This sonar is made up of transmitter and receiver arrays (100 columns of 6 basic ceramics processed into 80 pre-set tracks), a unit carrying out dynamic focussing between 50 and 300 m, a technical unit performing the electronic functions of transmitter and receiver, a display console allowing the operator to classify the echo by analysing the shadow, if necessary using a magnifying lens (10° over 25 m), to proceed with measurement of the horizontal and vertical dimensions of objects, and to send the relevant information to the display-information-processing system;
- a device for recording the video signal of the images displayed on the

detection and classification consoles;

- an interface unit (HYDEX) through which all information passes in digital form;
- a display-acquisition-processing system, an electronic chart display system adapted to the sonar and intended to perform the following functions:
 - acquisition and computerized storage of all data from the sonars (state of the sonars, azimuth-distance of the echoes singled out on the detector or the classifier, results of measurement of the size of objects),
 - acquisition and storage of time-position-water depth data established by the real-time HYDRAC system, together with characteristics of the tracks to be followed,
 - display on a colour graphic screen of such information (vessel position, areas insonified by the sonars, echoes singled out) overlaid on a chart background,
 - possibility of introducing, for storage, comments on the progress of the operations or information on the nature of the echoes singled out and of the sea bed,
 - possibility of consulting the data base used to create the background chart displayed,
 - printing out of information and comments on a fast printer and plotting of the track and the echoes singled out on a flat plotter.

Performance

The system is still in the trial stages and procedures and principles for use have in any case not yet been fixed. However, in winter, south of Brittany, and in the following favourable conditions:

- sea state 2 — wind 20 knots
- sand bottom at 30 m depth
- vessel speed: 4 knots,

the distances at which contact was made with cylindrical targets with a size of 1 square metre were about 600 m for the detector and about 280 m for the classifier. A resolution of 15 m at over 400 m was observed for the detector and 1 m at over 200 m for the classifier.

THE SHALLOW-WATER MULTI-BEAM ECHOSOUNDER

The Lennermor multi-beam echosounder which has been fitted aboard the BH2 C *Borda* has been developed, under contract to SHOM, by Thomson-Sintra ASM.

General characteristics

This equipment is intended for depth measurements on the continental shelf, i.e. in shallow water (range equal to 250 m). It should be possible to use it normally in seas up to state 4 and at vessel speeds of up to 15 knots.

The working frequency is 100 kHz and it must provide insonification of a swath whose width is 2.4 times the depth. It simultaneously measures 20 slant ranges perpendicular to the ship's centre line. Its angular resolution is 5°; its accuracy must be to less than 0.5 % of the depth with a minimum of 30 cm.

All the raw data are recorded on magnetic media for post-processing (SHOM development), the system providing real-time provisional tracing of the depth contours.

In other respects, possibilities for extension and for further development and study have been provided for. Thus, for instance, it is possible to record all received signals after high-speed sampling by the calculator.

Description

Certain particularities of this sounder will be pointed out:

- It uses the cross-beam technique. The transmitting transducer beam is narrow in the along-track direction of the vessel and wider in the athwartship (transverse) direction so that the whole area is insonified. It transmits a single beam (5° × 140°).
- The receiving transducer has a radiation pattern that is wide in the along-track direction but narrow in the athwartship direction. It enables 20 directional beam paths to be formed transversely to the vessel (5° × 30°).
- The transducer array is fixed rigidly to the hull by means of a retractable system.
- The transmitting beam is electronically stabilised for pitch ($\pm 10^\circ$) whilst the 20 receiver beams are stabilised for roll ($\pm 20^\circ$).
- Digital technologies have been widely used, thus introducing great flexibility:
 - software allowing for real-time testing of each function and simple maintenance of these,
 - techniques and methods of real-time and post-processing can be perfected more easily and improved without replacement of material,
 - interfaces and sub-systems, specifically those intended for visual control, will be able to be developed as required.
- In addition, the sounder is interfaced with the HYDRAC system which supplies it with real-time data on time, heading, speed, position, predicted tide and the precise instants of start and end of the profile. Moreover, it receives from the heave compensator (Atlas Heco 10) data

on roll, pitch and heave.

- So as to enable storage of a very large amount of data, notably if one wishes to record after high-speed sampling the signals received from the 20 beams, a digital optical disk unit has been interfaced with the system.

Performance

The sounder has just been received and is currently undergoing initial trials, so it has not yet been admitted into active service. It is only after these trials and a thorough assessment have been made that details of its performance will be available.

However, it can already be reported that it has on several occasions permitted observations to be made at slant ranges of over 500 m.

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- [3] L'automatisation «temps réel» des levés hydrographiques au SHOM, by J.M. CHIMOT and Y. LE BARON. *Navigation*, No. 126, April 1984.
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(Translated from French)