*International Hydrographic Review*, Monaco, LXIII (2), July 1986

# HYDROGRAPHIC SURVEY BAR SWEEPER FOR THE SWEDISH HYDROGRAPHIC OFFICE : HSwMS "NILS STRÖMCRONA"

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## INTRODUCTION

Improved equipment to meet increasing demands for very accurate hydrographic surveying, especially in the vicinity of fairways, was much discussed in Sweden in the late seventies and the early years of the present decade. Among the proposals was the acquisition of a small survey vessel for bar sweeping which would also be able to carry out limited sounding work. Such a vessel was duly included in the investment plans of the Hydrographic Office.

Among the tenders received, that from Nya Oskarshamns Varv was the most favourable and it was also considered the best on other grounds. This yard is part of the Swedish Special Shipyards group, in which Djupviks Varv is also included. HMS *Jacob Hägg*, which the latter yard had delivered in 1983, had given great satisfaction. A contract for the proposed new building was therefore signed in late August 1983, delivery being scheduled for October 1, 1984.

The owner already possessed experience of bar sweeping vessels, though of much smaller size. However, the proposed type of vessel represented a completely new concept, and extensive co-operation between the owner and the yard was therefore initiated.

During the designing stage, in which the Swedish Ship Testing Tank at Gothenburg was also involved, it emerged that lengthening of the vessel would be necessary if the desired speed and seakeeping qualities were to be achieved. This led to the possibility of carrying satellite boats, which in turn influenced the crew accommodation requirements, and so forth. The special manoeuvring system for the vessel was devised and discussed in depth by the owner, the yard and the Danish supplier, EMRI.

Design complications, the difficult ice situation at the time of launching, and other problems, led to delays in delivery. The new vessel was named at the shipyard on May 31, 1985 and handed over on June 28 of the same year.

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The total cost of the ship was approx. SEK27m, which was higher than the original contract sum, due, among other things, to design problems.

## THE SHIP

The basic concept behind "Ram 10" — the project name for HMS *Nils Strömcrona* — was that of a vessel suitable for special surveying using a bar sweep. Bar sweeping involves the physical determination of depths with a heavy beam, or "bar". This method gives very accurate results.

FIG. 1. — HSwMS *Nils Strömcrona.*

Bar sweeping greatly facilitates the determination of depths and widths in existing or proposed fairways, providing the basis for very accurate charting, as well as comprehensive input for the planning of dredging operations and the placing of aids to navigation, which can permit larger vessels to use the fairways. The method was not new, of course, but the equipment that had hitherto been used was far too light and sensitive for use in the open sea and endurance was poor.

The bar sweep arrangements on the *Nils Strömcrona* (working abbreviation : NSa) can be hydraulically remote controlled from the bridge. The length of the bar sweep is variable in 5 m steps, from 10 to 30 m, meaning that sweeping can be effectively performed in both narrow and open waters. To increase sensitivity and precision, a tilting sensor is fitted under each 5 m length and indicates contact with the bottom.

FIG. 2. — Surveying with booms and satellite boats.

The vessel can also be employed for hydrographic surveying by the parallel sounding method that is generally used in Sweden, whereby the two satellite boats that are carried onboard proceed on parallel course with the parent ship at a distance determined with special instruments. In shallow waters, where the ship will mainly operate, booms can be rigged from her sides. At the end of each boom there is a paravane carrying an echo transducer. Since the vessel is a catamaran, with transducers in each hull, up to six lines of soundings can be secured simultaneously. The recording of all soundings is concentrated on the parent ship, signals being transmitted from the satellite boats by telemetry.

Position can be determined by most of the systems available today. With the help of the navigational computer onboard, the ship can be steered automatically according to predetermined straight or radial courses.

Good manoeuvrability is highly important for a bar sweeping vessel. The ship has therefore been equipped with two transverse thrusters between the hulls, both fore and aft. These are hydraulically retractable. Each hull also has a conventional propeller. Manoeuvring is by joystick via a processor which co-ordinates propellers and rudders. Under normal weather conditions, it is possible to displace the ship in any direction without changing the heading. Specifications called for full control under conditions of 3 knots current and 8 m/sec wind.

The ship has dynamic positioning, i.e. with the help of the computer she can be automatically manoeuvred to a predetermined position and kept in that position.

Whereas the bar sweeping craft used previously were more in the nature of tools, manned only when in use, the new ship is much larger and has a permanent crew of five officers and six ratings.

The principal characteristics are as follows:

| | |
|---|---|
| length o.a. | 30 m |
| beam | 10 m |
| moulded depth | 3.4 m |
| speed | 12 knots. |

The vessel is classified with Det norske Veritas with the notations + 1A1 EO R90 (non-tropical waters, 1/11-1/9) 1 dk LFL Alloy, and fulfils the Swedish National Administration of Shipping & Navigation requirements for unrestricted coastal navigation, domestic voyages, with monitoring for unmanned machinery spaces. The hull is of aluminium alloy and fully welded.

The main machinery comprises four Scania DSI14 diesels rated at 433 bhp each, placed two in each hull and driving two KaMeWa-Seffle controllable-pitch propellers via Valmet reduction gears. The main engines also drive the hydraulic pump sets. The transverse thrusters, which are of Hydroland 520 TS type, are hydraulically driven.

The auxiliary machinery consists of two 142 hp Scania diesels each driving a Hitsinger type GAS 8-05 generator rated at 118 kVA.

The twin electro-hydraulic steering gears are of EMRI make, electrically synchronised, but also capable of individual manoeuvring. The control system is of analog type for high precision and fast reaction.

All machinery is monitored from the wheelhouse, the engine rooms being unmanned when under way.

The hydraulic deck machinery comprises a winch for the bar sweep and two combined windlass/mooring winches. There is also an Effer electric crane for handling the satellite boats. This has a capacity of 14 mt and a maximum outreach of 7 m.

Lifesaving equipment includes three inflatable rafts, two for 20 persons and one for 12 persons. A 4 m workboat can also be carried onboard.

The wheelhouse is arranged as a 'cockpit', with all duty personnel seated. The main conning position offers an unrestricted view of all parts of the deck which are of importance during surveying operations. In certain cases there is supplementary closed-circuit television. A great deal of effort has been devoted to the ergonometrically correct design of the bridge. The windows are fitted with defrosters, hot-water washing and electrically heated glass.

Navigational equipment comprises:

- Two Racal-Decca radars, 3 cm, types 1070 and 370 — the latter with colour PPI and daylight viewing
- Navstar type 601
- Anschütz Standard 12 gyrocompass
- Magnetic compass
- Atlas echosounder with repeaters
- Racal-Decca doppler log
- EMRI autopilot
- Tyfon fog signal with automatic control.

FIG. 3. — The manoeuvring bridge.

Considering the amount of equipment she carries, the ship may definitely be regarded as 'compact'. While the catamaran configuration means that hull spaces are confined, the twin-hull design was essential to achieve the stability required for bar sweeping in a vessel small enough to be able to work in narrow waters.

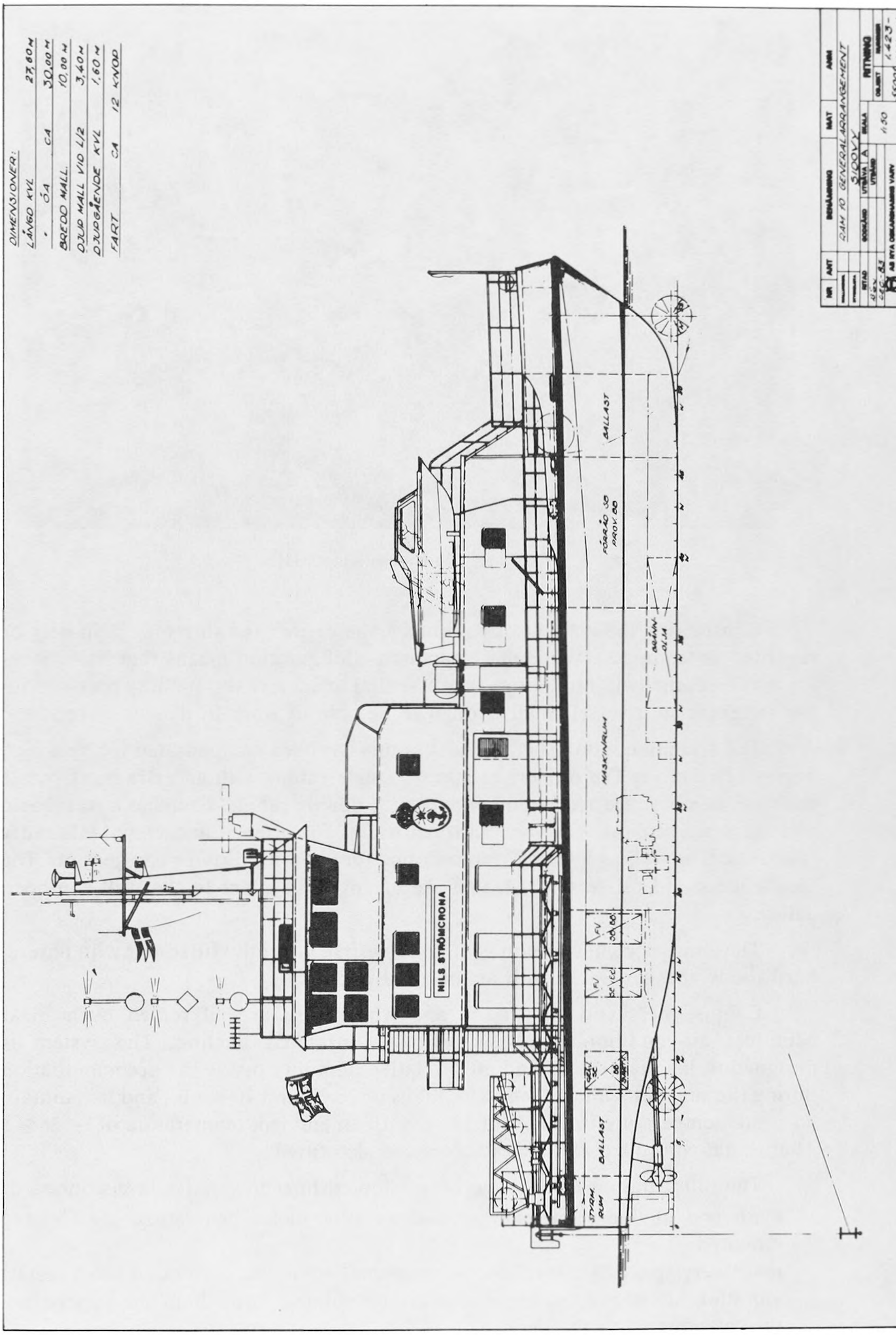
The accommodation is cramped, but this has been compensated for by a high degree of comfort. The officers each have single cabins with an extra bunk, while the crew members are accommodated in three double cabins. Each has a washbasin and there are separate shower and toilet rooms for officers and crew. A laundry is provided, as well as a duty entrance lobby for use with dirty or wet gear on. The crew's mess and officers' wardroom are arranged adjacent to the well-equipped galley.

The entire accommodation is of good design, tastefully fitted-out with natural hardwoods and decorated with art of good quality.

Cabins, mess and wardroom, and wheelhouse are all served by a Fläkt Miniduct air-conditioning system with pre-insulated ducting. The system is designed to maintain 22 °C and 50 % relative humidity inside the accommodation during the summer with ambient conditions of 28 °C and 70 % r.h.; and to maintain an inside temperature in winter of 18 °C with an ambient temperature of – 28 °C. Thermostat-controlled electric radiators are also fitted.

The following measures have been adopted to reduce noise levels onboard:

- main and auxiliary engines, as well as other noise generators, are flexibly mounted;
- machinery spaces are insulated with mineral wool and perforated sheet metal;
- vibration absorbing arrangments are incorporated throughout the superstructure attachment to the deck.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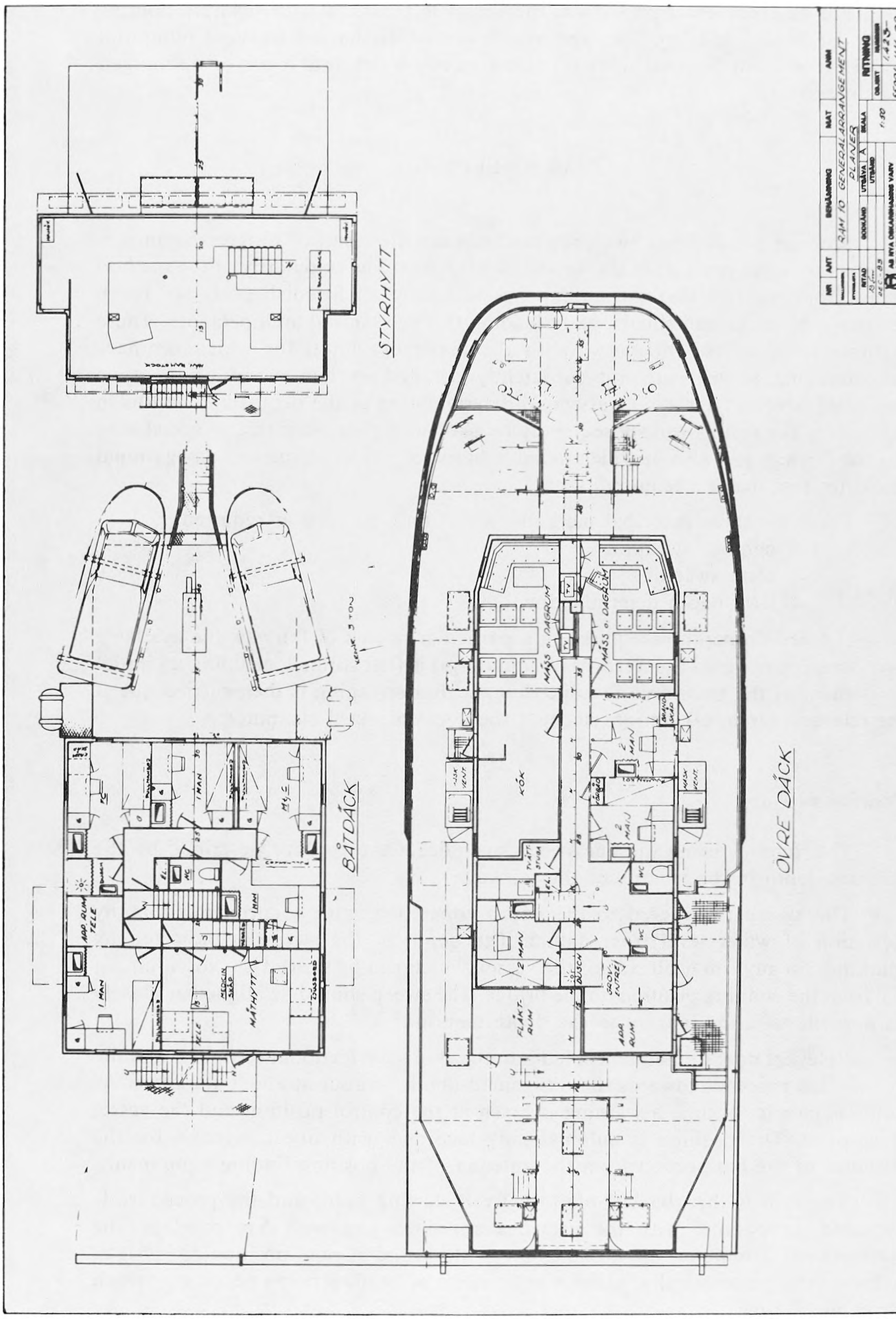


FIG. 4. — General arrangement of the HSwMS *Nils Strömcrona*.

For environmental protection, the vessel is provided with separate holding tanks for 'black' and 'grey' sewage, which can be discharged to shore pump-out facilities; and with a special tank for retaining oily water until it can be discharged for processing.

## BAR SWEEPING

Modern Swedish bar sweeping methods are the result of progressive improvements over the years since the Second World War. The popularity of the method stems from the fact that the approaches to nearly all Swedish ports are much restricted by rocks and shoals, often leading through coastal archipelagoes. There is pressure to utilise the fairways to the maximum limit, for which ordinary echosounding surveys are not sufficiently detailed. A bar sweep of the type described here can achieve a very good determination of the depths and widths in a fairway. The results can subsequently be used to decide what size of vessel may use the fairway and also provide a reliable basis for any dredging and navigational markings that may be required.

There are three principal methods, which may be used as required:

- contour sweeping
- clear sweeping
- least-depth determination.

If a certain depth is required in a particular stretch of fairway, the available hydrographic material (i.e. records of soundings) is first studied, enabling an initial assessment of the maximum feasible draught. Bar sweeping is then carried out at the relevant depth, taking into account the necessary keel clearance.

### Contour sweeping

This implies using the bar sweep to indicate the contour described by the relevant depth in the vicinity of the fairway.

The sweep is lowered to the depth concerned, with a correction for any deviation of water level from datum. The depth of the sweep is indicated by markings on guys on each side of the vessel, which can be viewed on closed-circuit TV from the conning position on the bridge. The sweep should be aligned as closely as possible with the tangent to the depth contour.

Relevant operational data is fed into the ship's navigational computer and the vessel then proceeds towards the designated depth contour at about 1.5 knots. As soon as contact occurs, a warning is given at the control position and the vessel is stopped. The position is automatically recorded, with due correction for the distance of the bar section from the antenna of the position-finding equipment.

The ship is then backed-off to a fresh starting point and the procedure is repeated, in parallel with the previous approach and with 5 m overlap. The navigational computer, in conjunction with the dynamic positioning system, achieves this automatically, without any change of heading being necessary, which saves much time.

**Clear sweeping**

If the objective is simply to confirm that a given depth of water exists throughout a wide area, such as a harbour or a broad reach of a fairway, the sweep is moved back and forth on successive parallel courses with a certain degree of overlap. If contact with an obstruction occurs, least-depth determination is carried out as described below, or other measures are taken, such as inspection by diver or dredging.

**Least-depth determination**

Isolated shallows which may be a hazard to shipping often occur in the open sea or in fairways. In our experience, echosounding is inadequate for determining that a required least depth exists in a given area. Highly localized depth variations of 1 m or more are not unusual. Bar sweeping is therefore always carried out in the vicinity of fairways and shipping routes.

The sweep is lowered to a depth 0.5 m greater than the minimum sounding and passed over the indicated position of the shoal. If contact occurs this is recorded and the sweep is raised 0.1 m and a further pass is made over the same place, the process being repeated until the sweep goes clear. Filed records comprise:

— last recorded contact
— first clear sweep.

The final setting of the sweep is given as the least depth over the shoal to provide a margin of security.

As a further safety measure, three or four sweeps are carried out on each side of the shoal to ensure that there are no other peaks in the neighbourhood.

Water level data is obtained continuously, during both bar sweeping and echosounding, from an automatic tide gauge set up by the survey vessels. The radio signals may be fed directly into the survey vessel's computer and/or converted into audible information given by a synthetic voice.

TV scanners have been fitted experimentally to the bar sweep. Hitherto, however, the visibility has been too poor. Tests are continuing with more sensitive scanners.

## SUMMARY

Experience gained so far with the *Nils Strömcrona* has been very satisfactory. Operationally, speed and precision have been surprisingly good. The fully automatic steering system in conjunction with the ship's computer mean the vessel can maintain position and heading in the reference system with decimeter accuracy.

The hydraulic steering gear has, however, suffered certain teething troubles which have resulted in downtime. The high pressure (285Pa) means that strict

cleanliness must be maintained in the oil system. Stray particles in the oil have caused damage to packings and other sensitive components. The source of the problems has been identified and measures taken which are expected to prevent a recurrence of these difficulties.

A catamaran of this size is a novelty in the Swedish hydrographic survey fleet, exhibiting characteristics not encountered in monohulls. In this vessel the special characteristics of the catamaran, particularly stability and good manoeuvrability, have been deployed where they are used to best advantage, i.e. in bar sweeping operations.

Space in the hulls of the vessel is very limited. The machinery spaces are of minimal dimension, which calls for very careful planning during construction, so that essential equipment can be serviced without excessive difficulty. The shipyard has been largely successful in solving these problems and, in the light of operational experience to date, we consider that our hydrographic survey fleet has been augmented by a most useful unit.