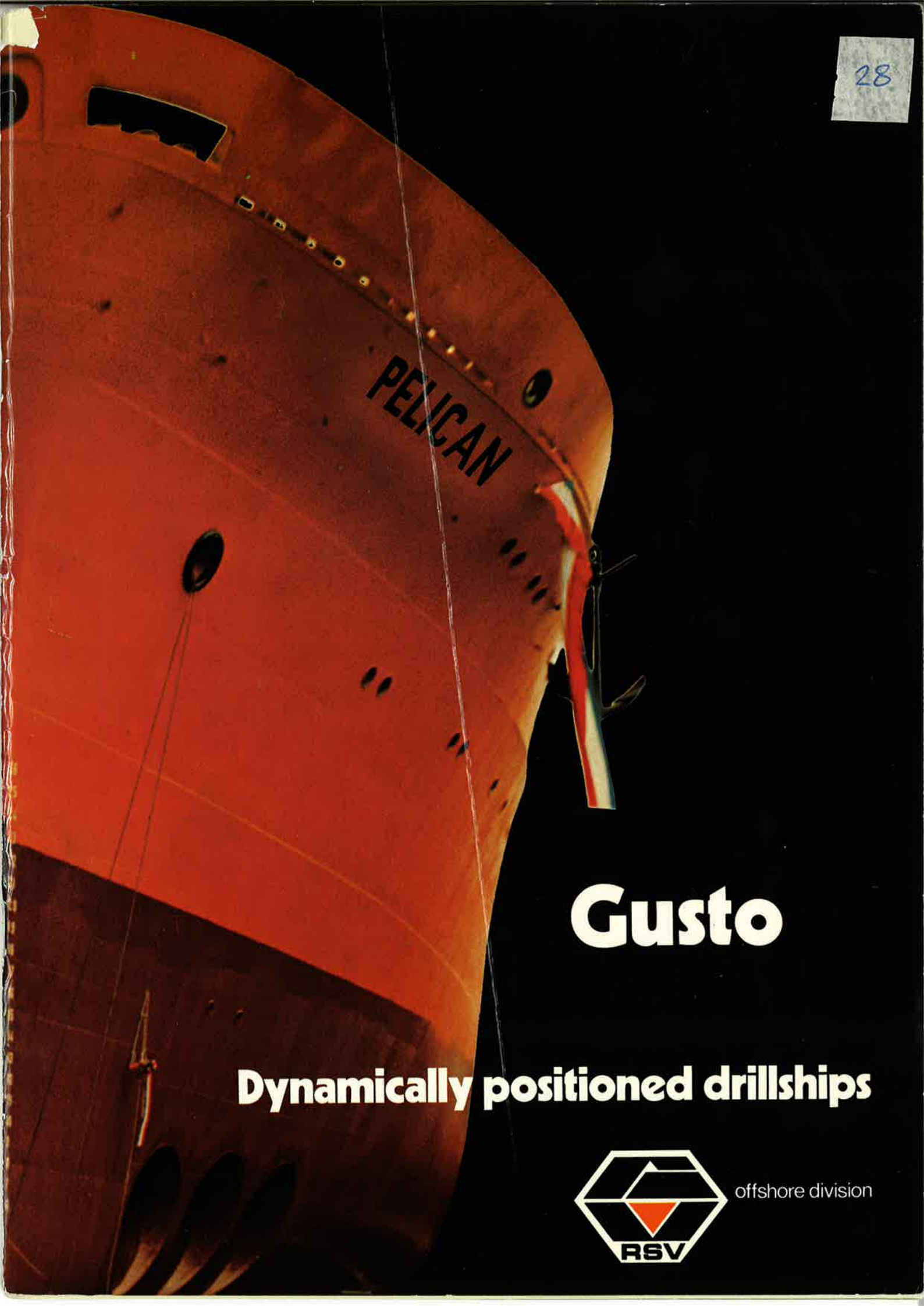

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Gusto

Dynamically positioned drillships

RSV

offshore division

Contents

Design Studio Bink The Hague
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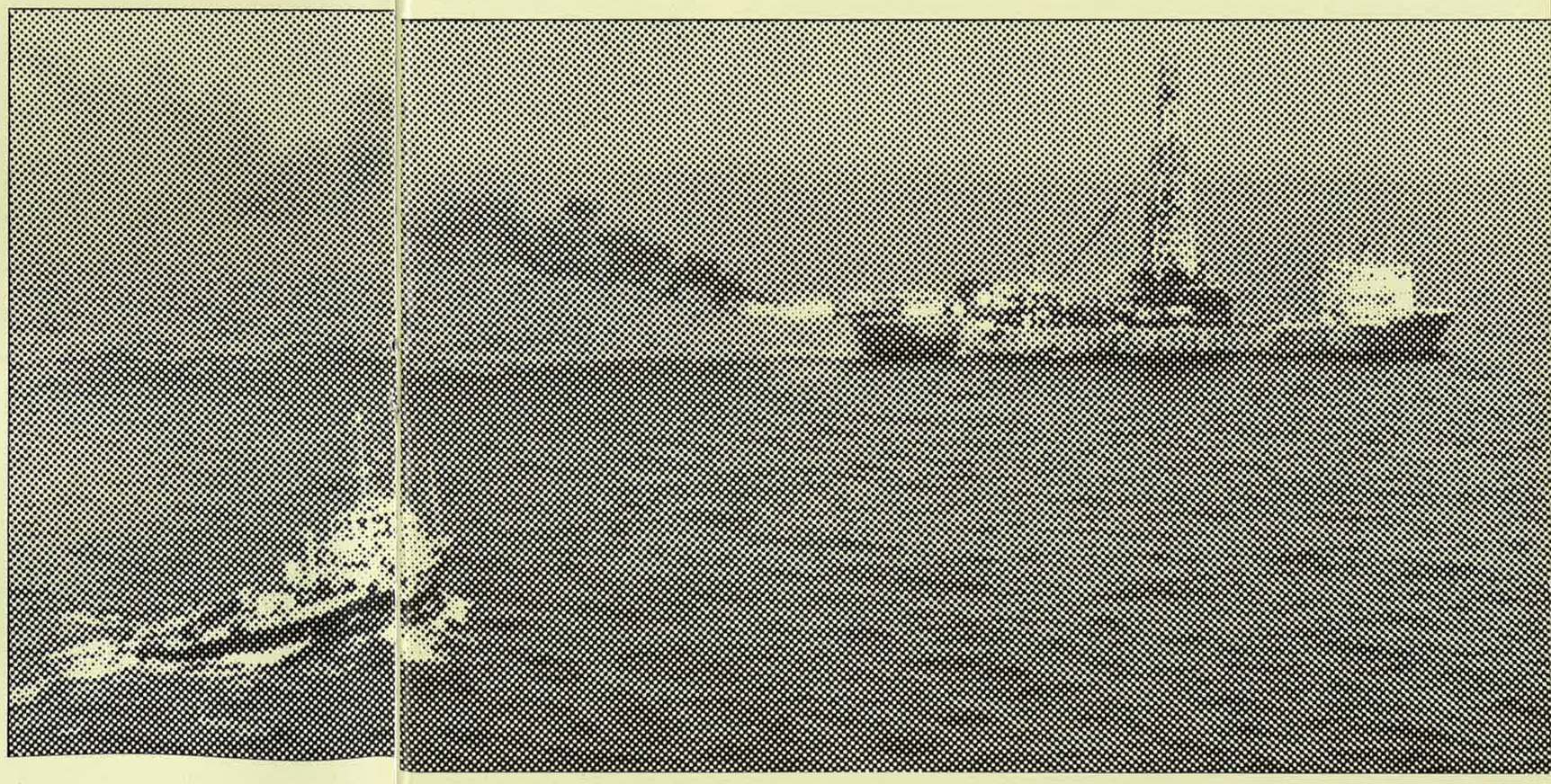
IHC Gusto B.V. have been the designer and builder of the "Pélican"-type dynamically positioned drillships which are described in this brochure.
As a result of a reorganization of the Dutch shipbuilding industries, Gusto B.V. have merged into the Rhine-Schelde-Verolme (RSV) concern in 1978.

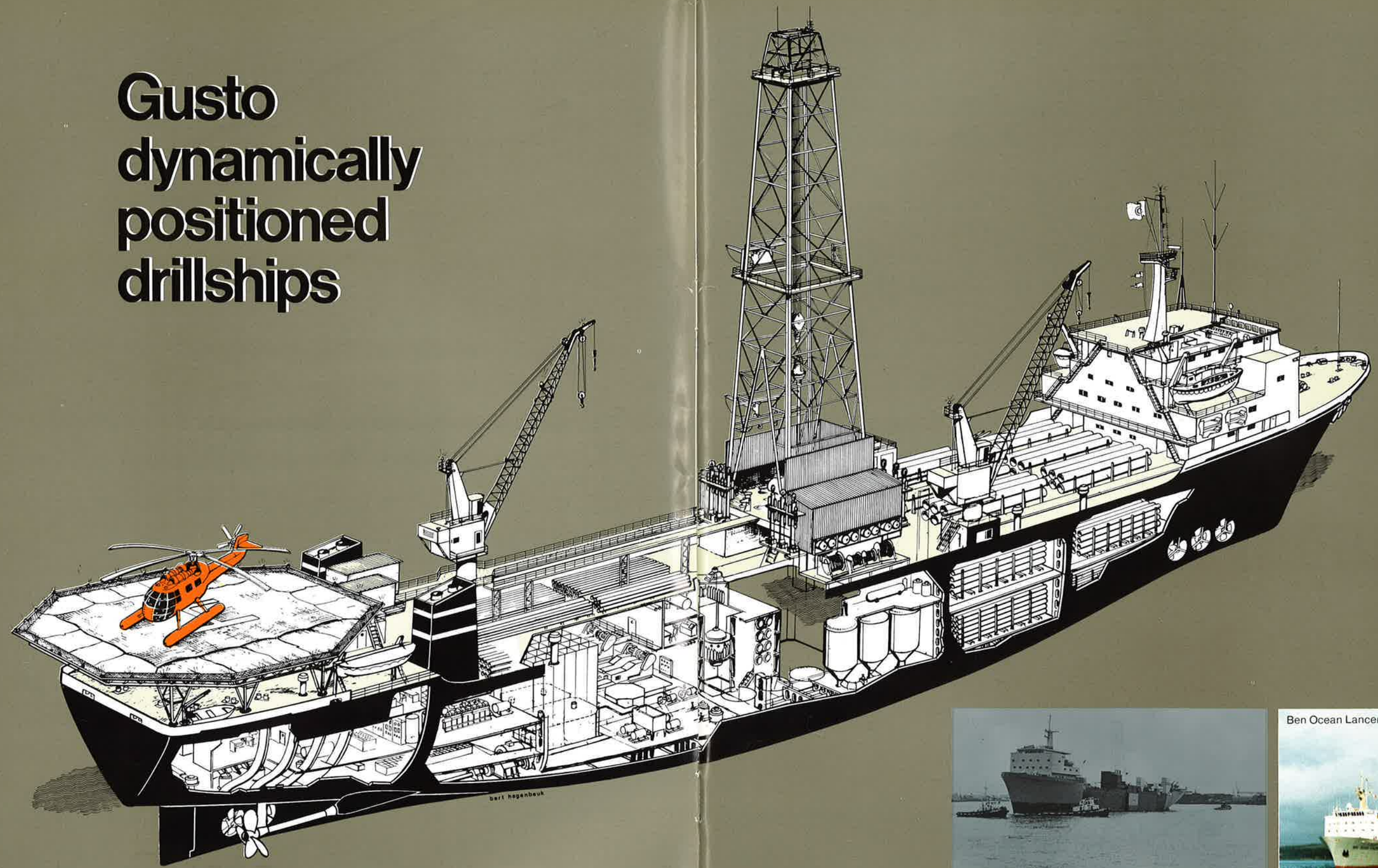
The Gusto design and engineering departments (over 100 specialists) have been concentrated in a new engineering company under the name of

RSV Gusto Engineering b.v.

All copy rights and other industrial rights of the design of all dynamically positioned drillships built by IHC Gusto have passed to RSV Gusto Engineering b.v. RSV Gusto is a member of the RSV Offshore Division.



Gusto dynamically positioned drillships




Ben Ocean Lancer


Pélican

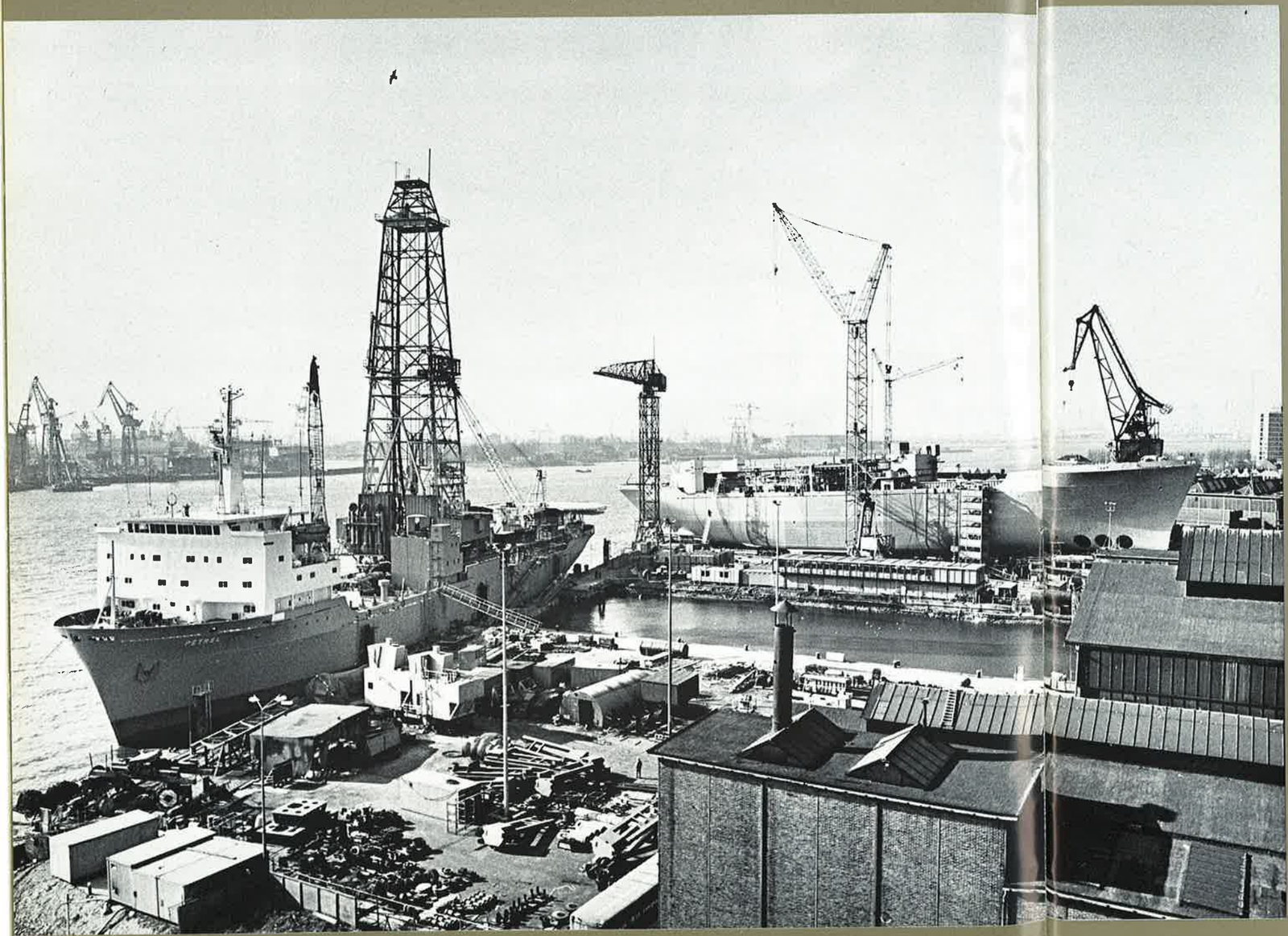

Havdrill

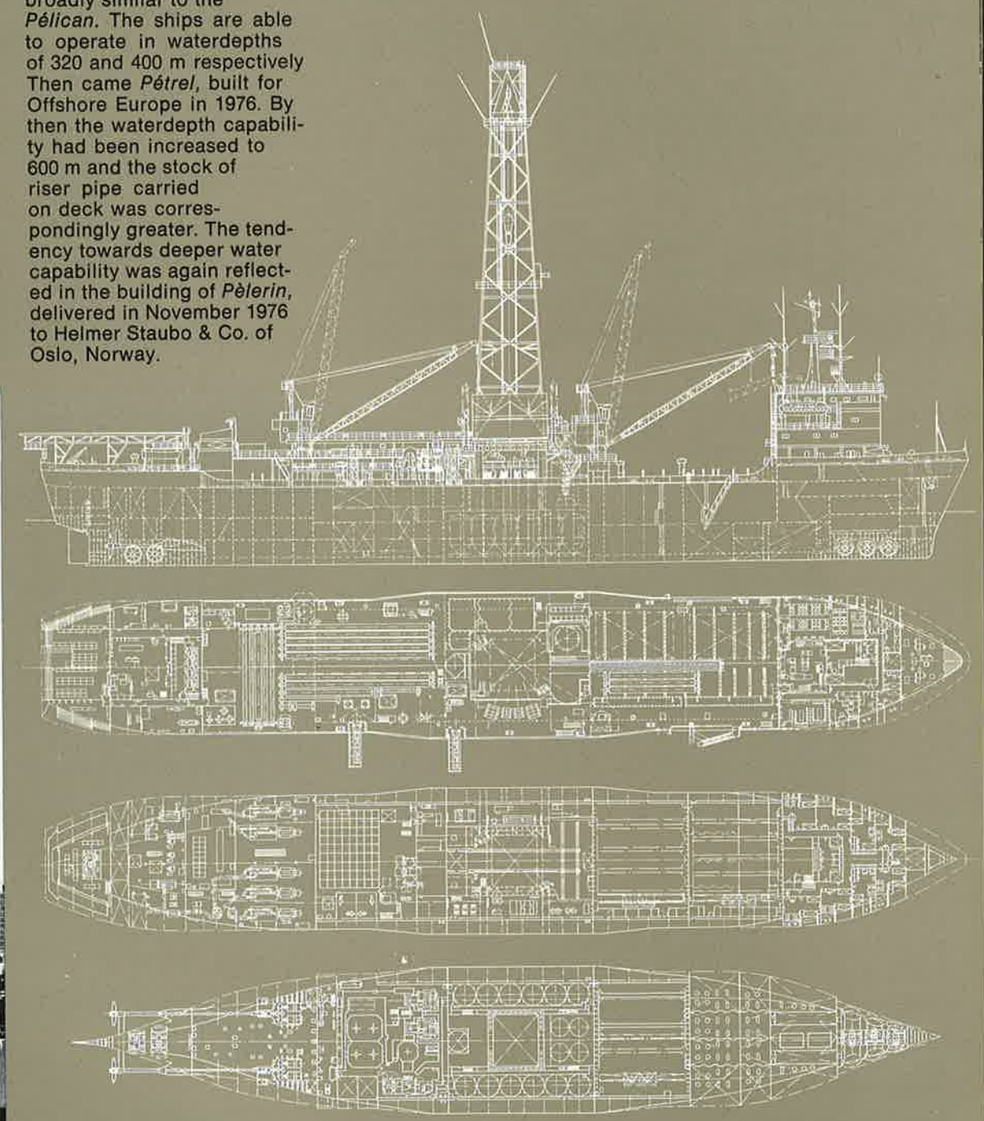

Pétrel


Pélerin

Introduction

After a long and fascinating development on land, the search for oil has over the last two decades extended to the offshore waters of the world at an increasing rate. The offshore production of hydrocarbons in 1974 represented approximately 19% of total production, which was equivalent to about 50 million barrels/day. In spite of trends towards energy conservation, the world's consumption of oil and gas is expected to keep increasing for a considerable number of years; 15 years from now more than half of all production will probably be supplied from the sea. The interest in exploring the sea is based on the enormous potential resources; of the 45,000,000 square miles of sedimentary basins all over the world, about 46% is situated offshore.
Already, numerous searches of the continental shelf have been made. Jack-up drilling units, semi-submersible units and conventional drillships have been and still are being used; however, their water-depth capacity is limited.
In 1972 the first dynamically-positioned drillship, the *Pélican*, went into service. This revolutionary piece of equipment was designed and elaborated in close co-operation between Compagnie Française des Pétroles (TOTAL), SOMASER, FORAMER and IHC Gusto. The ship is owned by Somaser, Paris.
In comparison with earlier drilling units, this type is capable of operating in deeper water under worse weather conditions in all parts of the world. It is self-supporting for a longer time, is more flexible and has a minimum of physical connections between the ship and the seabed.
In 1973 IHC Gusto delivered the *Havdrill* (now *Canmar Explorer III)*, which is broadly similar to the *Pélican*. The ships are able to operate in waterdepths of 320 and 400 m respectively Then came *Pétrel*, built for Offshore Europe in 1976. By then the waterdepth capability had been increased to 600 m and the stock of riser pipe carried on deck was correspondingly greater. The tendency towards deeper water capability was again reflected in the building of *Pèlerin*, delivered in November 1976 to Helmer Staubo & Co. of Oslo, Norway.





The *Pèlerin* has been designed on the basis of the results of studies carried out by CFP's Department of Marine Research; much use has also been made of the experiences obtained in three years of *Pélican* operations by the Drilling Department of CFP.
As designed, the *Pèlerin* can drill in 1200 m of water and for this purpose carries 600 tons of riser pipes.
Minor improvements, however, will give her the capability to drill in much deeper water. To accommodate the additional material, the width of the ship's hull was increased by 2 m.

At the end of 1976 3 more d.p. drillships of the IHC Gusto type were under construction. Experience has shown that the dynamically-positioned drillship of the IHC Gusto type is the most valuable exploration drilling unit for deep waters. Owners and operators have testified to the excellent operating capabilities of this equipment.

Design criteria

Since its entry into service in 1972 the *Pélican* has served as a model for other designs. All vessels built or under construction are the same size as the *Pélican*. This, of course, applies to its sister-ships *Havdrill* (now *Canmar Explorer III)* and *Pétrel* and, except as regards the increased beam, also for the 4 other sisterships.

Basic design requirements

☐ The ship must be capable of operating worldwide, which means that a wide variety of climatological and meteorological conditions should be anticipated. Extreme cases were considered to be Arctic (–20°C) and tropical (+35°C) regions.

☐ It was anticipated that the ship would drill in concessions in widely scattered areas of the world. Sailing time had to be limited. The minimum average sailing speed requirement was 12 knots.

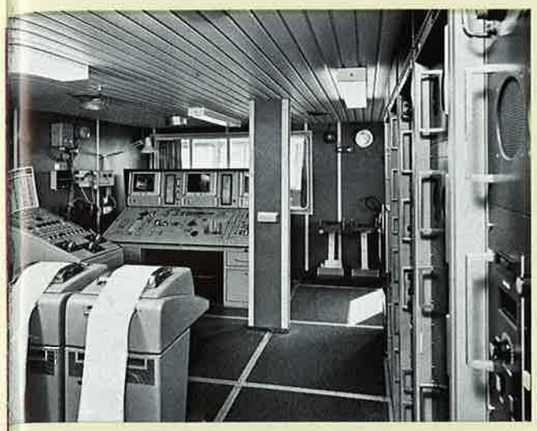
☐ For drilling in remote areas with long or uneasy supply lines, the ship should be largely independent of supplies for 2 average (3000 metre) wells or 1 deep well (4500 metre). The stock of fuel and materials required for this independency amounts to about 7500 tons.

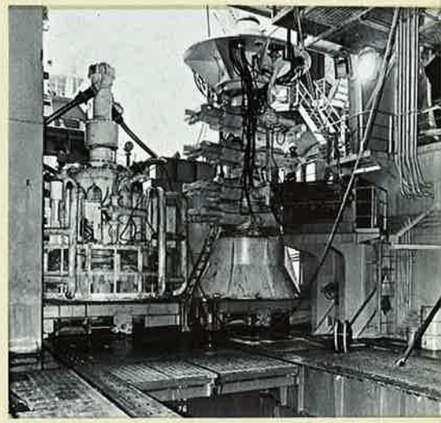
☐ The ship should be capable of working in water-depths between 50 and 300 metres. For later ships, this range was extended.

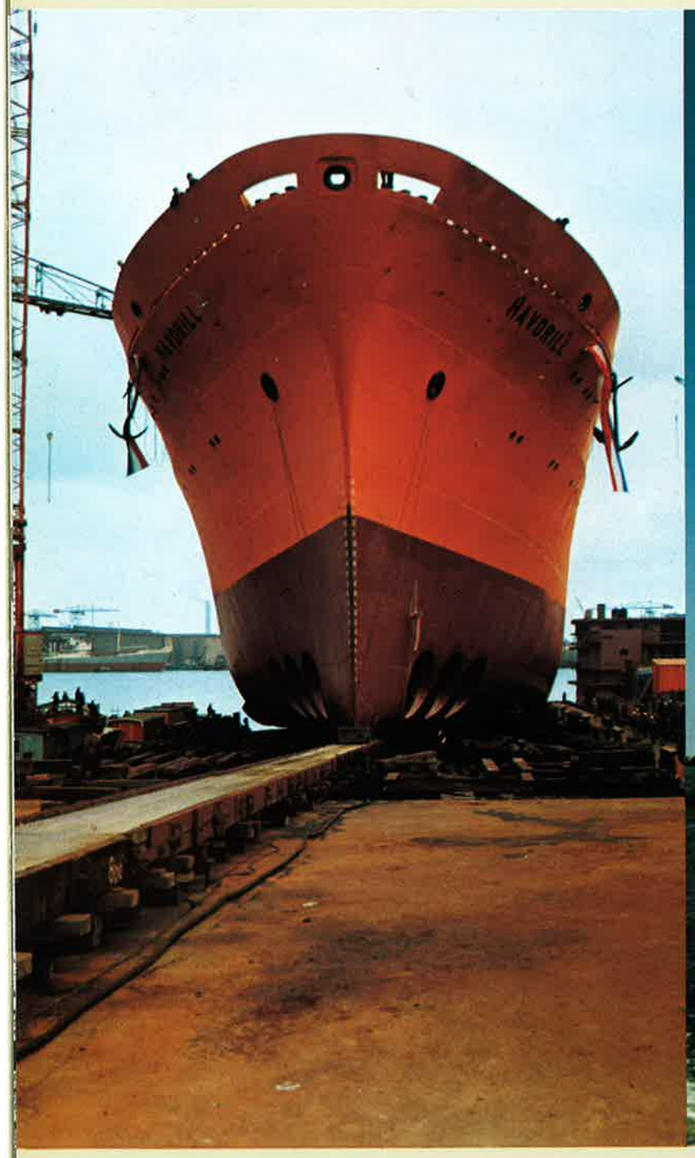
☐ The environment should, within certain limits, not prohibit drilling operations. In other words, the ship should be able to work in iceberg areas or tropical seas and above seabeds where anchoring is difficult or impossible. The following design limits were adopted for the environmental forces, in which the ship should be capable of maintaining its position:

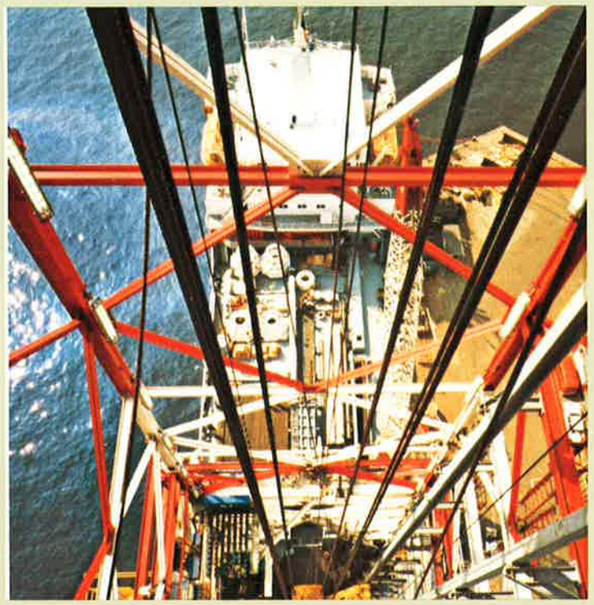
- wind speed 45 knots, gusting to 65 knots
- current velocity 2 knots
- wave height 4.9 metres (significant)
- mean wave period 12 seconds

In addition to these basic design criteria, there were many requirements with regard to the layout of the vessel. The layout should provide for easy and rapid handling of drillstring, casing pipes, riser pipes, blowout preventer and various other drilling materials and equipment.
A high degree of sophistication with respect to drilling systems was desired. Through a combination of various criteria, the conclusion was reached that a conventional anchoring system would be inappropriate for this type of vessel, and that dynamic positioning was to be adopted. Because of the novelty of this feature it probably became the most distinctive design characteristic.









Layout

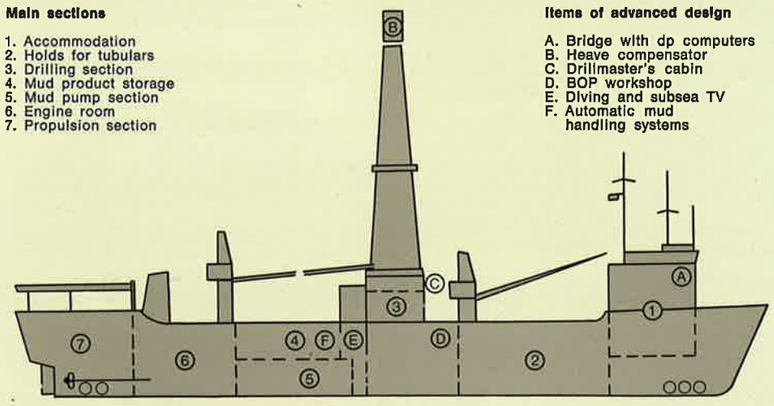
The set of basic design criteria and secondary requirements led to the design and main dimensions. The basic layout of the vessel was highly decisive for the length, in which, of course, the body lines and required deadweight played a role. In determining the beam/draught ratio, the stability of the vessel, with its highly placed equipment and important wind profile, has to be considered. The depth of the hull was determined mainly by the volumetric requirements of the underdeck stores and machinery compartments.

Main sections

1. Accommodation
2. Holds for tubulars
3. Drilling section
4. Mud product storage
5. Mud pump section
6. Engine room
7. Propulsion section

Items of advanced design

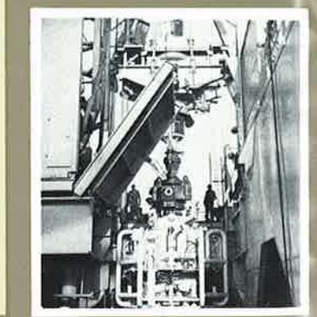
A. Bridge with dp computers
B. Heave compensator
C. Drillmaster's cabin
D. BOP workshop
E. Diving and subsea TV
F. Automatic mud handling systems

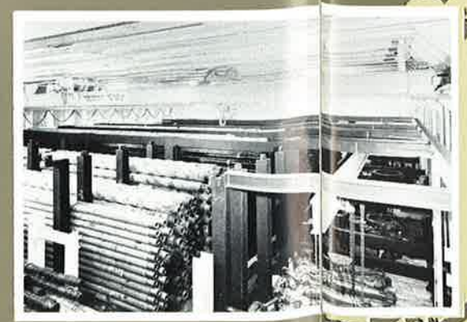


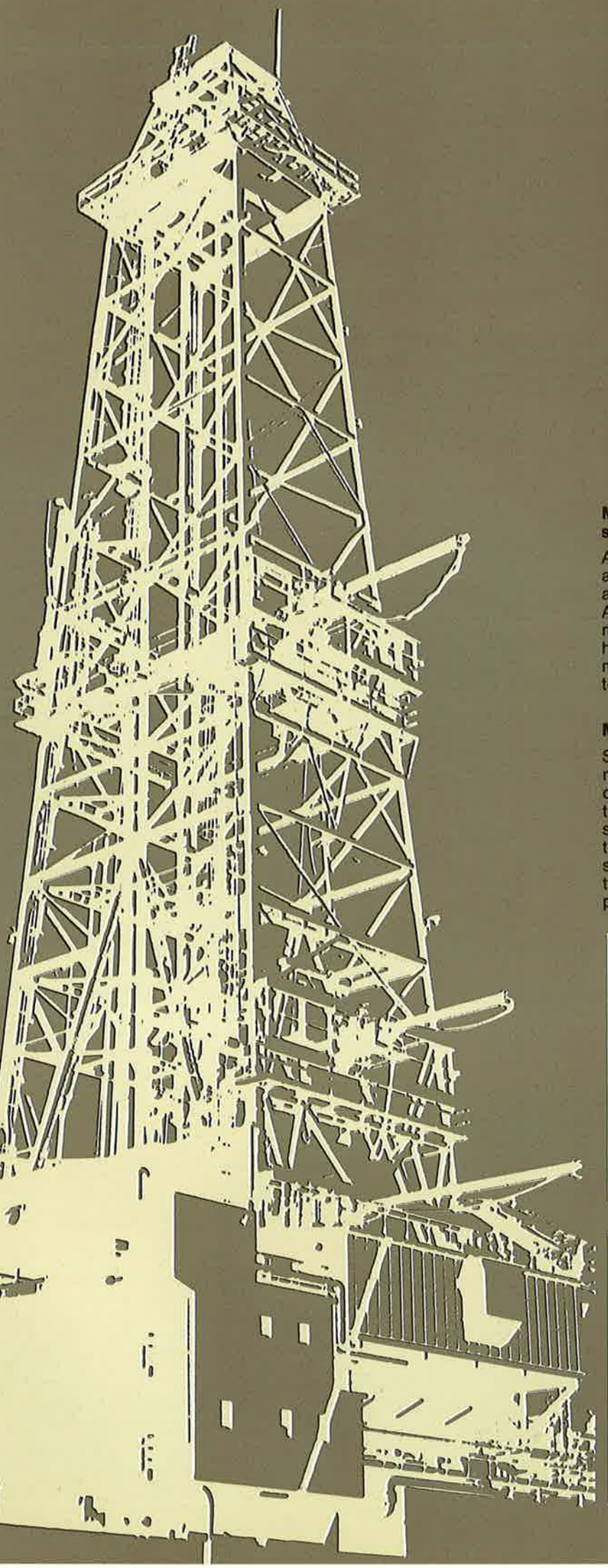
Accommodation and navigation section
The lower part of the hull and the bow incorporate various tanks and also three transverse thrusters for the positioning system. The living quarters, together with technical and navigation spaces, are distributed over 7 decks.

Pipe storage section
The main hold and two tweendeck holds are devoted to the storage and mechanical handling of drill and casing pipes. The remaining hold space is occupied by water ballast and fuel tanks.

Drilling well section
A large quantity of drilling equipment is concentrated in this section:
- the drilling well
- the diving well
- the bulk mud hoppers
- various storage and technical spaces
- the BOP handling and maintenance installation
- the drilling floor with associated equipment
- the active mud tanks
- the riser tensioning installation
- the deep diving installation
- the drilling derrick and heave compensating device
- a geological laboratory and drilling crew dayroom
- a well logging unit
- a cabin from which all drilling operations are controlled (drillmaster's cabin)

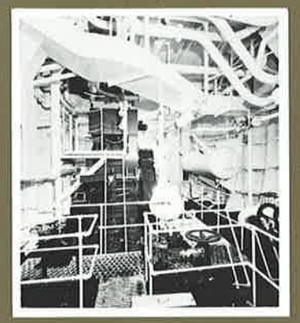






Mud product storage section
At tweendeck level is a mud additives storage, handling and extraction installation. A mud laboratory is accommodated in this area. From here the contents of the bulk mud hoppers are directed to the mixing hoppers.

Mud pump section
Situated at tank top level, the mud pump room accommodates the main mud pumps, the cementing unit, mud storage and preparation tanks, the salt storage and saturated brine preparation tank, and various centrifugal pumping units.

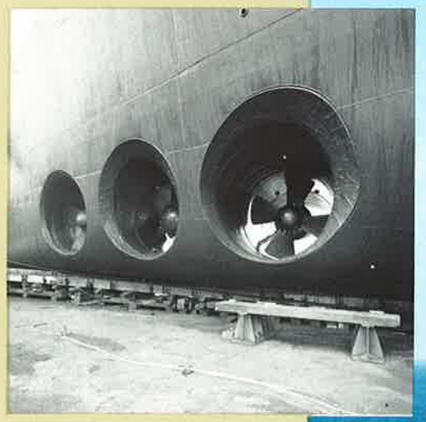


sections was constructed by longitudinal frame systems and with reinforcements for operating in ice. Bottom and wing tanks are provided for the storage of fuel oil, drilling water, drinking water and seawater ballast. Typical for the loading operation on the vessel is a fairly high amount of deck load. This, in combination with the fact that a large quantity of heavy equipment is placed on high levels, has resulted in relatively low metacentric height values, yielding a very quiet and reduced rolling behaviour of the ship.

Power and propulsion section
The lower part of the hull accommodates the two main propulsion shafts and associated driving motors, plus two transverse thrusters identical to the three situated forward, the latter being rubber mounted. The five main generators, the auxiliary generators, the switchgear, transformers, rectifiers, etc. are on the two levels situated above. Various technical spaces such as the steering gear room, and a deck suitable for a 6-ton helicopter are provided aft. The hull embodying these

Propulsion and dynamic positioning

with a D.P. system is independent of anchors or other conventional aids for remaining stationary in open water. Instead, it employs – in addition to apparatus for measuring its position with a high degree of accuracy – propellers capable of exerting thrust in controlled directions and a system for activating propellers to rectify deviations from a predetermined position.
A very specific feature of Dynamic Positioning is that the positional accuracy is essentially independent of the depth of the water and depends only on the environmental conditions and the properties of the ship and her propellers. As a rule, however, the accuracy with which it is possible to determine the actual position depends on the depth of the water.
These two properties result in the positional accuracy as a percentage of waterdepth decreasing as the waterdepth increases. This effect is amplified by the vessel's oscillations around her momentary position, which oscillations are caused by waves. These oscillations, too, are to a large extent independent of



Propulsion
The vessel is propelled by two controllable pitch propellers running at a constant speed. The main propellers also provide the required longitudinal thrust for dynamic positioning. The lateral thrust is exerted by five transverse propellers, three situated forward and two aft.

Dynamic Positioning
One of the most important features of *Pélican* and its successors is the Dynamic Positioning system. During the operation of *Pélican*, *Havdrill* and *Pétrel* it has been proven that these ships can safely work in hostile areas and can provide an answer in conditions where other types of rig fail.

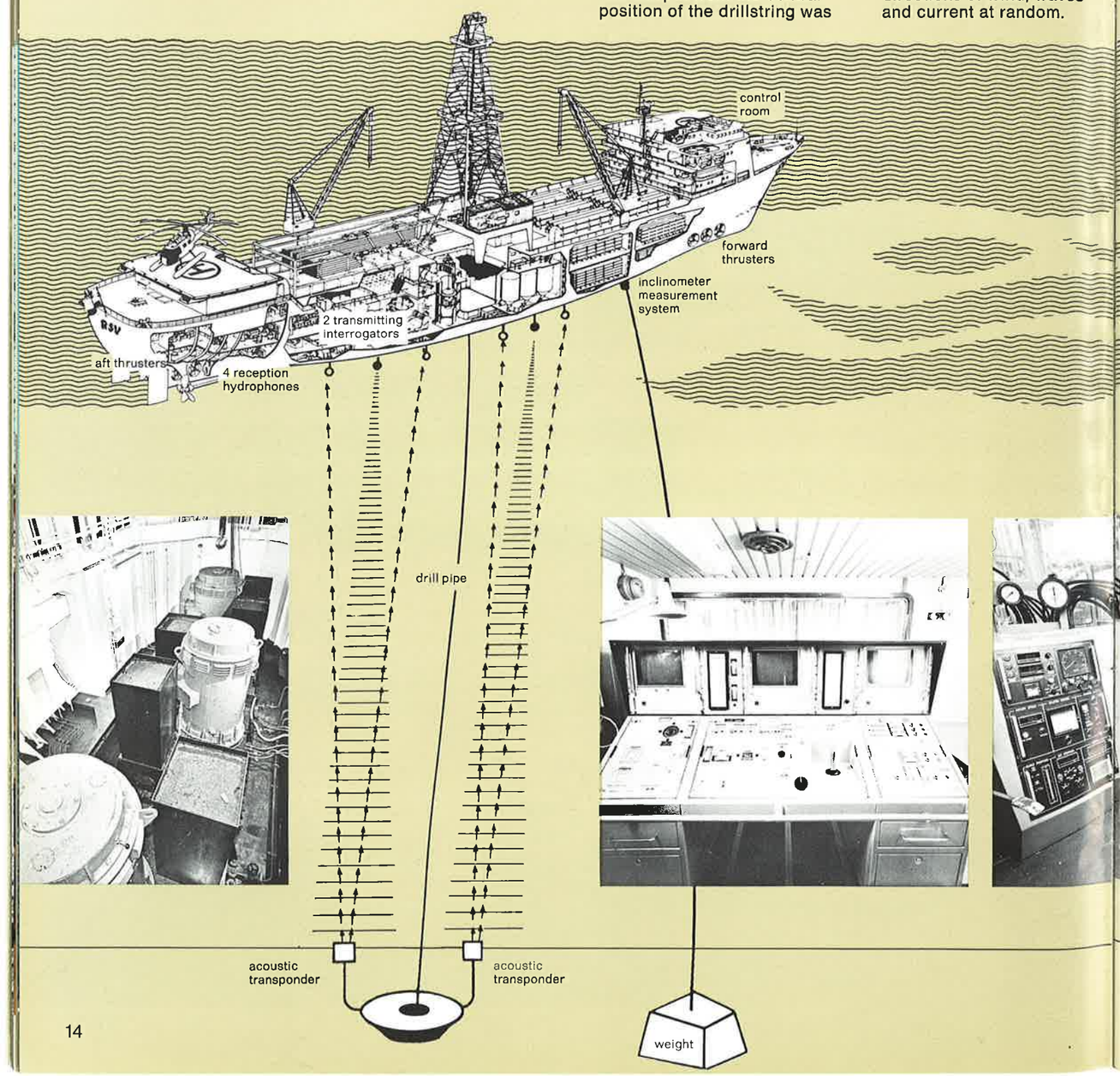
What is Dynamic Positioning?
Dynamic Positioning is the technique of maintaining the position of a vessel, barge or floating platform by means of thrust. A craft equipped

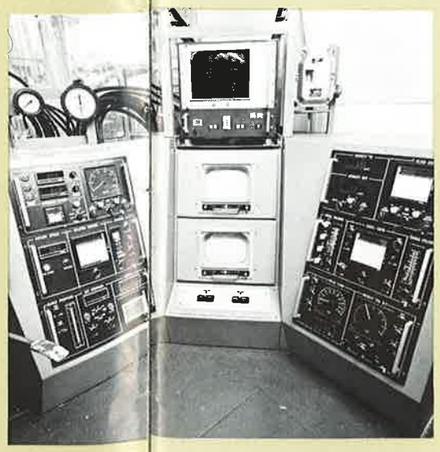
the waterdepth.
The question whether D.P. can be applied in a specific case depends, therefore, in the first place on the following specifications:
☐ what proportional or absolute accuracy is required?
☐ what waterdepths, environmental conditions and ship's properties have to be considered?

Design consideration for D.P. in the "Pélican" class
For *Pélican*, a maximum deflection of 6% of the waterdepth from the central position of the drillstring was deemed permissible.
According to the design specifications, the operational waterdepths range between 50 and 300 metres, the ship being designed to remain in position in the following environmental conditions:
- wind: 45 knots constant, gusting to 65 knots
- current: 2 knots
- waves: wave spectrum according to Bretschneider or modified Pierson Moskowitz, significant wave height 4.9 metres (16 feet), significant wave period 12 seconds
- directions of wind, waves and current at random.

This combination of data is based upon a feasibility study made during the initial stage of the design of *Pélican*. The results of simulations were sufficiently convincing to proceed along the lines of the preliminary design, and specifically to fix the longitudinal thrust at 60 tons and the transverse thrust at 45 tons at the bow and 30 tons at the stern.
For the purpose of realizing thrusts in the various directions, there were a number of possibilities from which a choice could be made.
After thorough consideration, controllable pitch propellers and transverse tunnel thrusters were found to give the best results.
Advantages of CP propellers over other types are: their natural adaptation to accurate and fast control and the fact that the driving motor is always running at the same revolutions and in the same direction. A rather unexpected property was experienced in 1974 on the *Pélican;* namely the ease of overloading the propeller. It proved possible to remain on station on only one of the two main propellers in a gale with a strength of about Beaufort 10, winds of 55 knots, a 1.5 knot current and 26-foot waves (summer storm offshore Labrador).

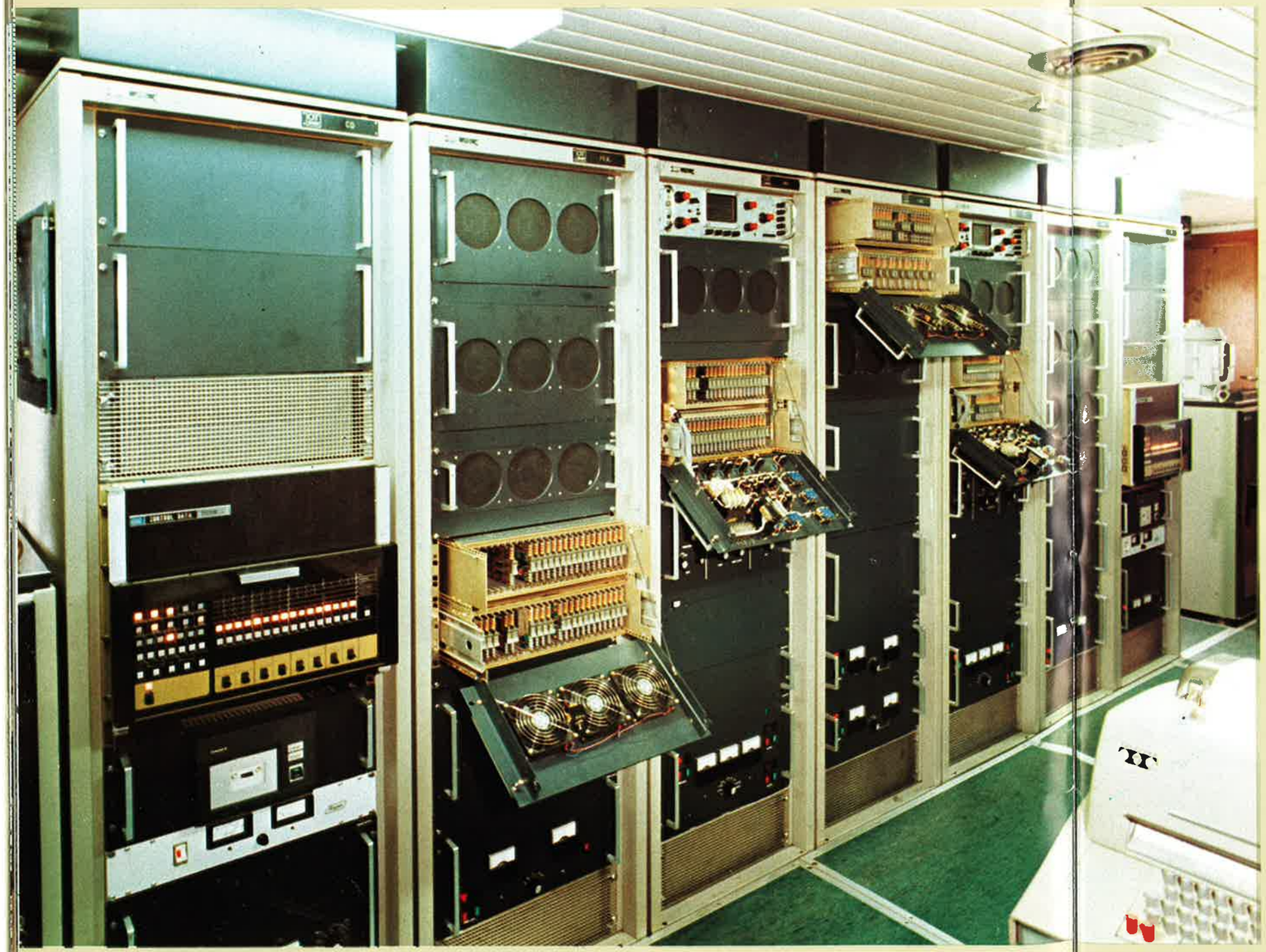
Position measurement systems
In the case of a drillship, the positional requirements will generally be that the centre of the rotary table is directly above the centre of the well head on the seabed, and that the heading of the vessel be such that its motions, i.e. rolling, heaving and pitching, are minimal. Thus, the longitudinal and transverse displacements of the centre of the rotary table must be measured as well as the heading of the vessel.
The source of the heading data is the vessel's normal gyro-compass. Two systems were chosen for determining the linear displacements:
☐ an acoustic position reference system
and
☐ a taut wire inclinometer as a back-up system.
Both indicate the position of the vessel with respect to fixed points on the seabed, these being an acoustic beacon and a taut wire dead weight respectively. The accuracy of the systems as a percentage of the waterdepth is largely independent





of this depth. The taut wire inclinometer features a biaxial pendulum in an oil-filled bottle.
The pendulum remains vertical, while the bottle follows the inclination of a taut wire between the ship and a dead weight resting on the seabed. The two measured angles (in longitudinal and transverse directions), together with the vertical distance between pendulum and seabed, serve for calculating the horizontal displacement of the inclinometer bottle. Although the taut wire inclinometer has certain drawbacks, such as current influence on measurements, problems in Arctic areas and mechanical implications, it has proved possible to employ it for positional measurement at sea and for dynamic positioning purposes.

☐ All later ships possess an additional riser angle sensor; in its working principle, this sensor is essentially the same as the taut wire.
The basic position measurement system on board the *Pélican* is a short baseline, passive acoustic system. A beacon on the seabed is activated by interrogation from the ship and transmits a 25 kc pulse lasting 2 msec. This pulse is picked up by a number of hydrophones installed on board. The differences in time of arrival are proportional to the distance between the hydrophone and the beacon, thus enabling the angles under which the hydrophone array "sees" the beacon to be calculated. These angles, together with the vertical distance between hydrophone array and beacon, yield the horizontal distances between the centre of the hydrophone array and the beacon. In contrast to the taut wire inclinometer, these angle measurements are not performed in relation to the vertical, but in relation to the plane of the hydrophone array. Therefore they must be corrected for any inclination of the hydrophone plane resulting from roll, pitch, heel or trim of the vessel, this correction being made by gyroscopic means. The mean accuracy of the acoustic position measurement is better than 1% of the waterdepth. An important advantage of the acoustic system lies in the fact that it is not only suitable for measurements during dynamic positioning, but can also be used in the approach or re-approach phases, as the vessel will be able to "see" the beacon at a horizontal distance which may be several times the waterdepth. In this case, however, the accuracy is less.
A minimum of three hydrophones are required in a system of this type, and these are arranged to form a triangle. On the *Pélican*, a fourth hydrophone was installed to provide continuity in the event of failure of one of the others. Redundancy is among the principal features of the D.P. system. Therefore the seabed beacon and interrogator are also duplicated. The beacons can be interrogated by signals of different frequencies, i.e. 7 and 9 kc.
On the *Havdrill*, the first sistership of *Pélican*, an active acoustic system was installed featuring a beacon that produces 10 signals per second. In the 5 later ships, one or other of these principles was applied. There is no decisive advantage or disadvantage in either system.

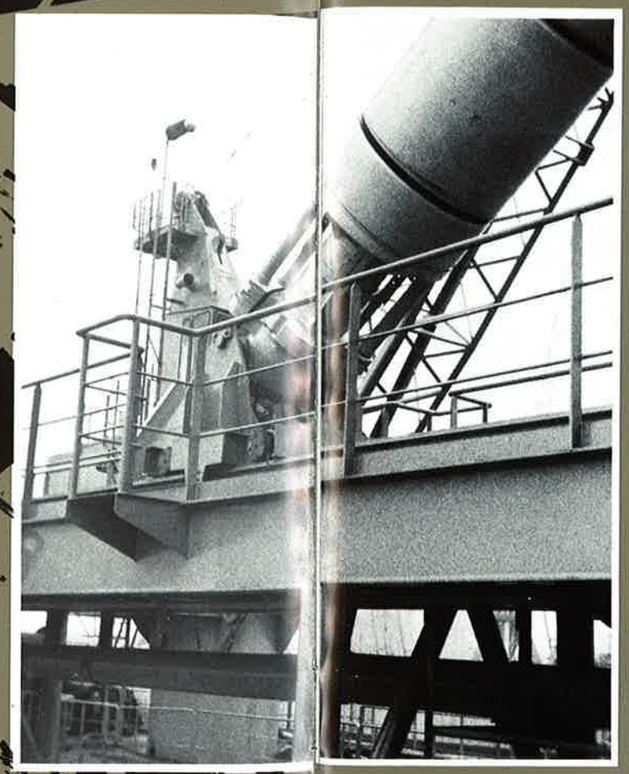


In *Pétrel* and *Pèlerin*, the position measurement systems have been extended with a doppler sonar for experimental purposes. This may be an important aid for deep water applications.

Control system hardware and software
The use of digital computers for drillship D.P. systems has more or less become standard, since they offer, apart from flexibility, the best possibilities for extensive reliability checks, periphery control and man-machine interfacing.
The possibility exists to install an analog computer also as a back-up.
As in the case of position measurement equipment, the principle of redundancy has been applied to the control system hardware. If the operating computer fails or shows programme interruptions, it is automatically switched off-line and the stand-by computer takes over. The computer carries out all checks and calculations at cycles of between 0.5 and 1.0 seconds. During each cycle, position information from the various measurement systems is read, compared and validated. Control forces are calculated and distributed over the thrusters through the thruster allocation logic. Command signals and visualizations are updated. On request, or at long intervals, the status of the system is printed on the teletypes. In addition to automatic dynamic positioning, the installation embodies facilities for semi-automatic or manual positioning.
Adjustment of the position reference points is also carried out from the console. This adjustment is particularly important during re-entry of the drillstring into the well head. Accordingly, a second, smaller control panel with displays is situated in the drillmaster's cabin. At his request, the control of some functions can be transferred from the wheelhouse console to the smaller unit.

Drilling and special equipment

Derrick and drilling floor
A heavy sub-structure supports:
☐ a derrick of special design which is matched to the hull construction, the racking system and the heave compensating device.
☐ the drawworks with electric drive
☐ a complement of equipment of the heaviest capability independent rotary, crown block, travelling block, swivel, etc.
☐ the hook, power tong and tong adjustment pedestal which constitute a functional part of the racking system.

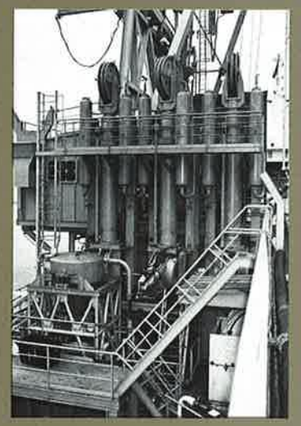


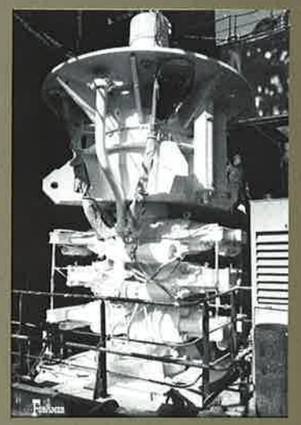
☐ the racking system machinery and structures
☐ the riser tensioner system
☐ the drillmaster's cabin
☐ various manifolds and implements
The strength of the substructure is adequate for the static and dynamic stresses exerted by the drilling equipment, drill pipes, casing pipes, riser pipes, etc.
Dynamic conditions considered for the strength calculation are as follows:
wind 100 knots
list 3 degrees
roll amplitude 10 degrees/10 seconds
pitch amplitude 4 degrees/10 seconds
heave 3.65 metre/8 seconds

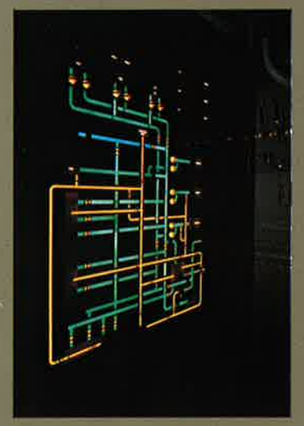
Riser handling
For transport of riser pipes stored on aft deck, a platform levelled with the drillfloor, is installed. The marine riser is pulled into the derrick by the hook, while a truck-mounted carriage supports the bottom end of the riser.

Drillmaster's cabin and instruments
An enclosed cabin favourably located on the drillfloor enables the drillmaster to control activities on the drillfloor as well as other activities which are not directly visible. The cabin accommodates the necessary controls for:
☐ drilling equipment and DC motors
☐ drilling measurement and manifolds
☐ riser tensioners and heave compensator
☐ BOP and well control valves
☐ ship behaviour and dynamic positioning
☐ underwater television
The measuring instruments incorporate a continuous rate of penetration indicator. The main data are recorded.

Riser tensioning equipment
The wires supporting the riser pipes are connected to Gusto-designed swell compen sators, which are attached to the drilling substructure. The tension is regulated by a hydro-pneumatic system. A control console is located in the drillmaster's cabin. The main operating panel is located close to the drilling well.

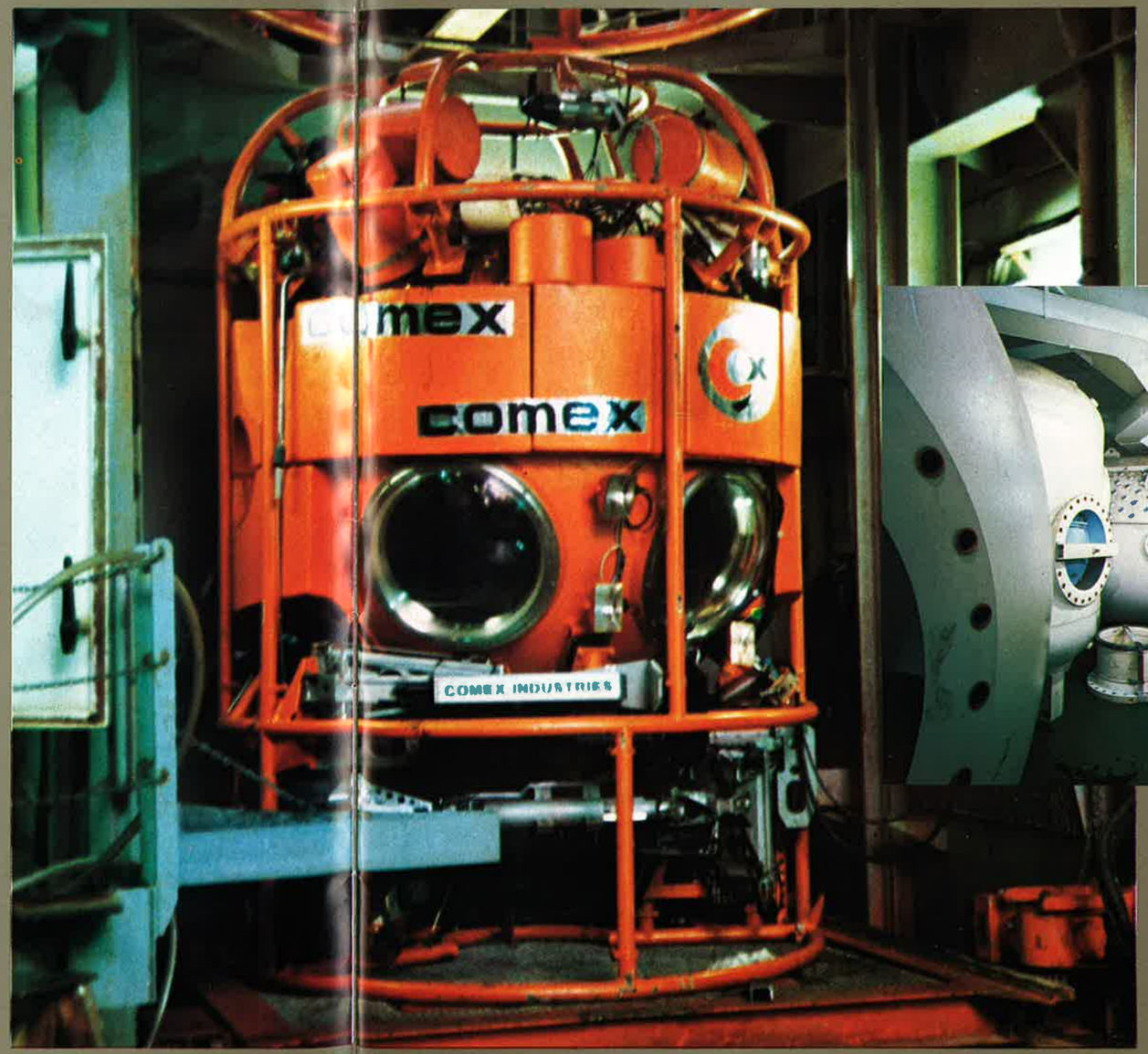


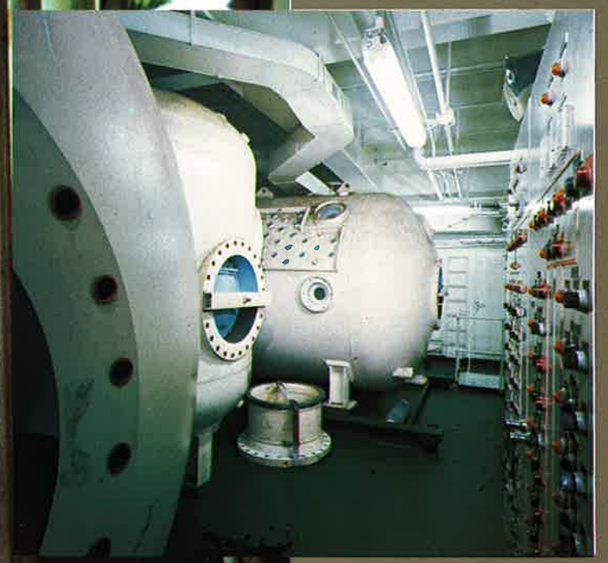




Mud pumps and tanks
Triplex pumps, a complete cementing unit and two centrifugal mud transfer units are located in the mud pump room. Three circulating mud tanks are situated on the main deck. They are equipped with mud processing machinery; double deck shale shakers, two sets of cyclone desanders, one battery of cyclone desilters, degasser, mixers, etc.
Three additional centrifugal pumps feed the cyclone-type separators.
Four storage and two mixing tanks are built into the mud pump room.

BOP controls
The BOP controls are of the electro-hydraulic multiplex type. The pumps and manifolds are located at the rear of the forward superstructure. The main control panel and the two remote control panels are situated on the drilling floor and in the tool pusher's or site manager's office respectively.

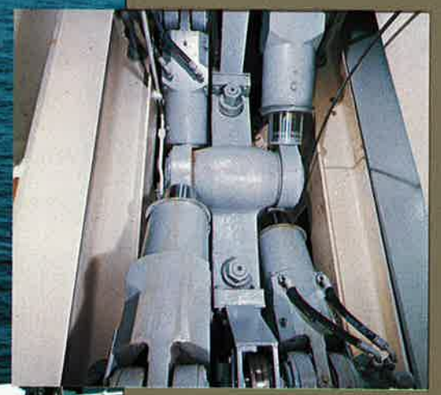




Deep diving installation
The installation allows for:
☐ long saturation diving by six men down to 300 m with two decompression chambers
☐ observation diving with hydraulically-operated manipulators down to 1,200 m.

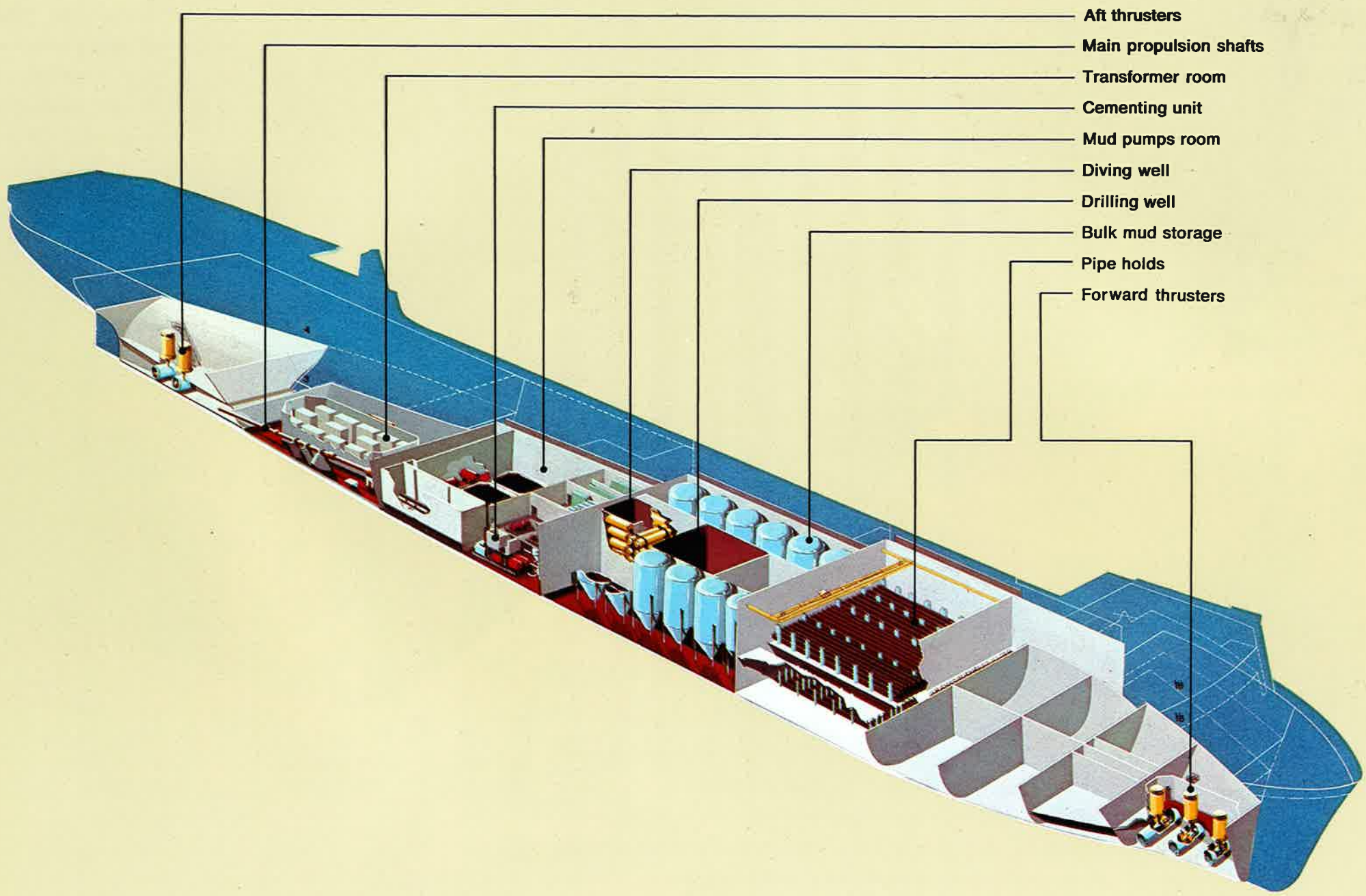
Heave compensating device
This is of RSV Gusto design, producing the heave compensation by vertical adjustment of the derrick crown block.

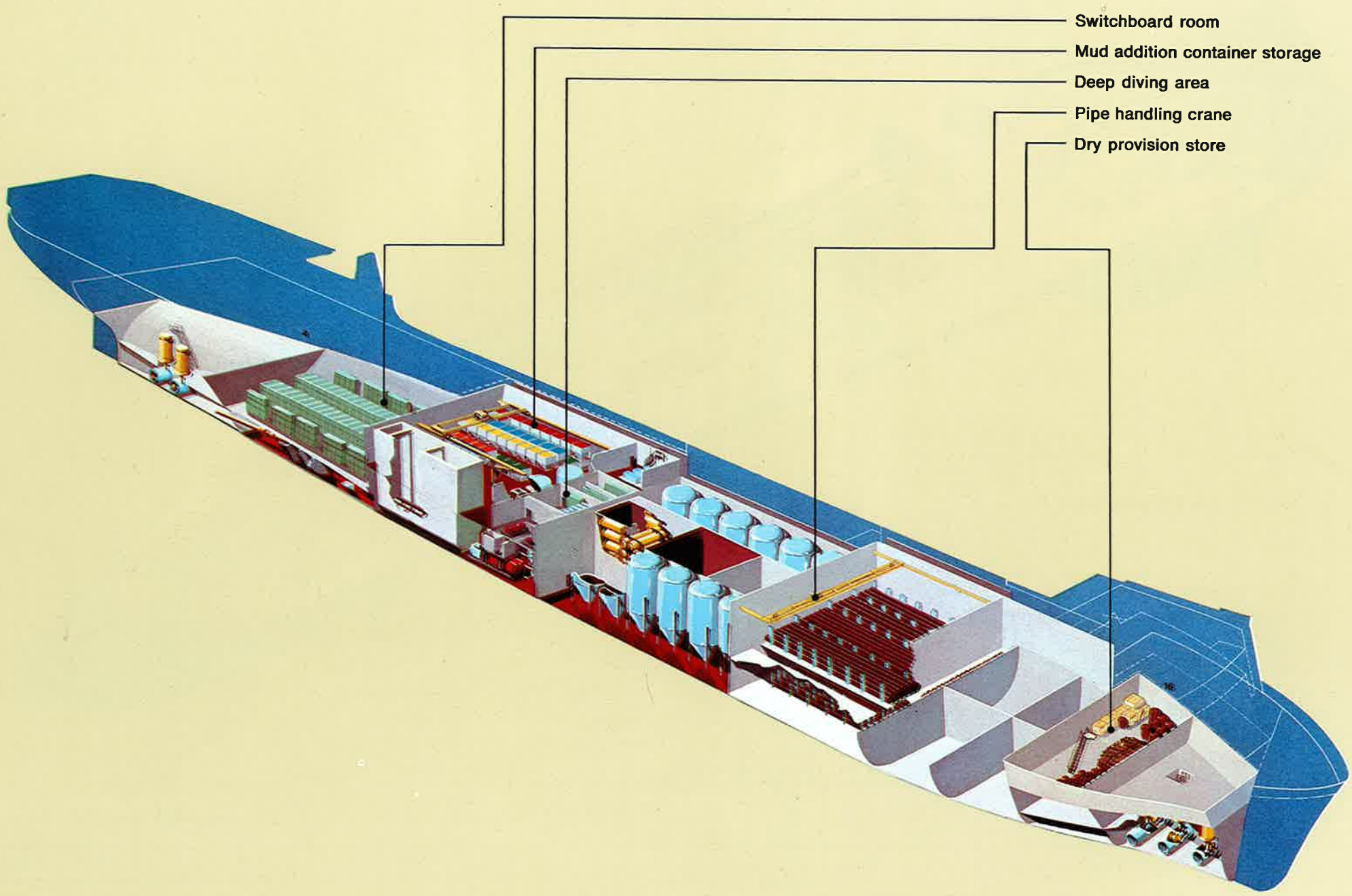
The hydraulic jacking system is controlled by a patented Gusto Unicode device, developed jointly by IFP and Gusto.
The system is controlled from a panel in the drill-master's cabin.

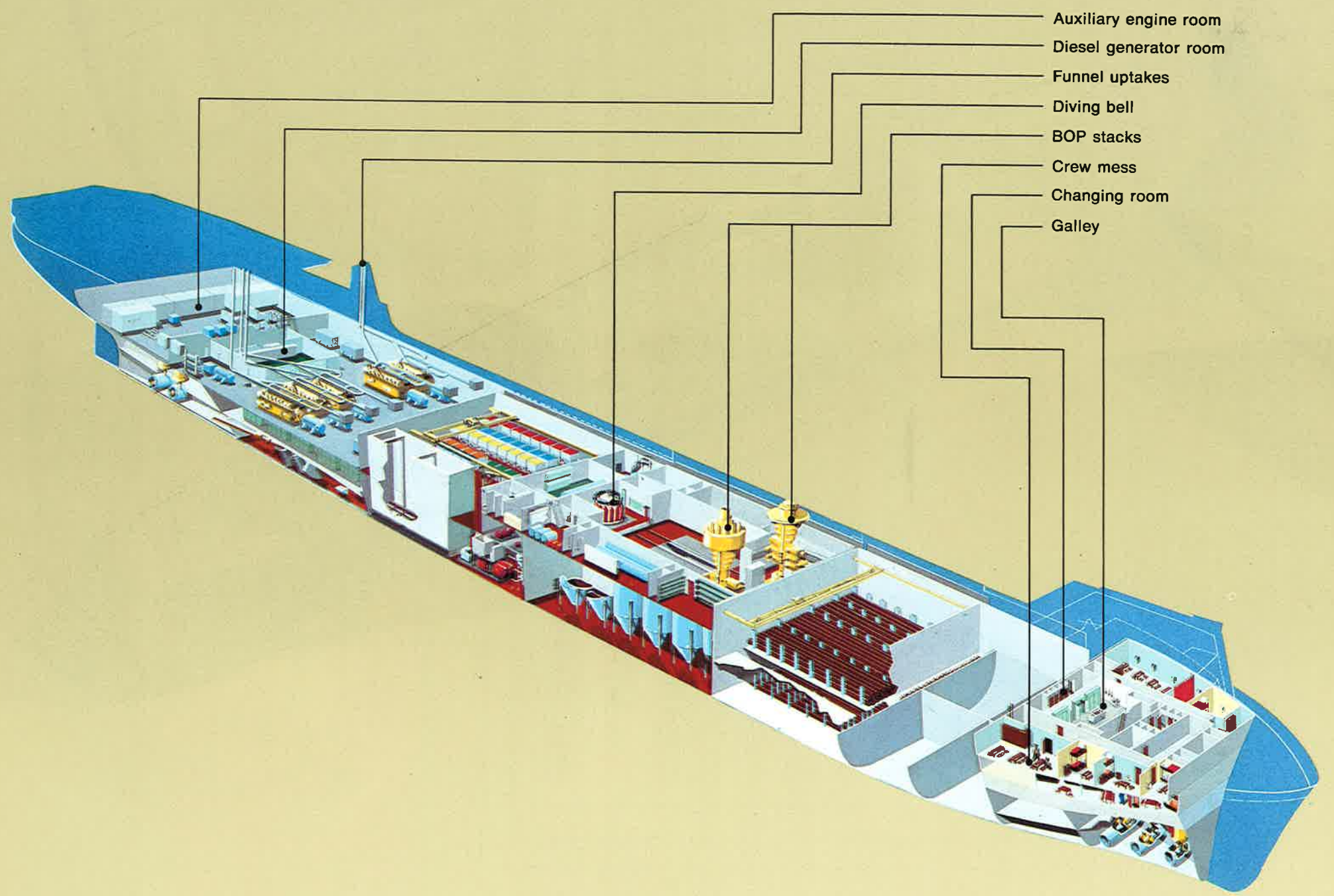


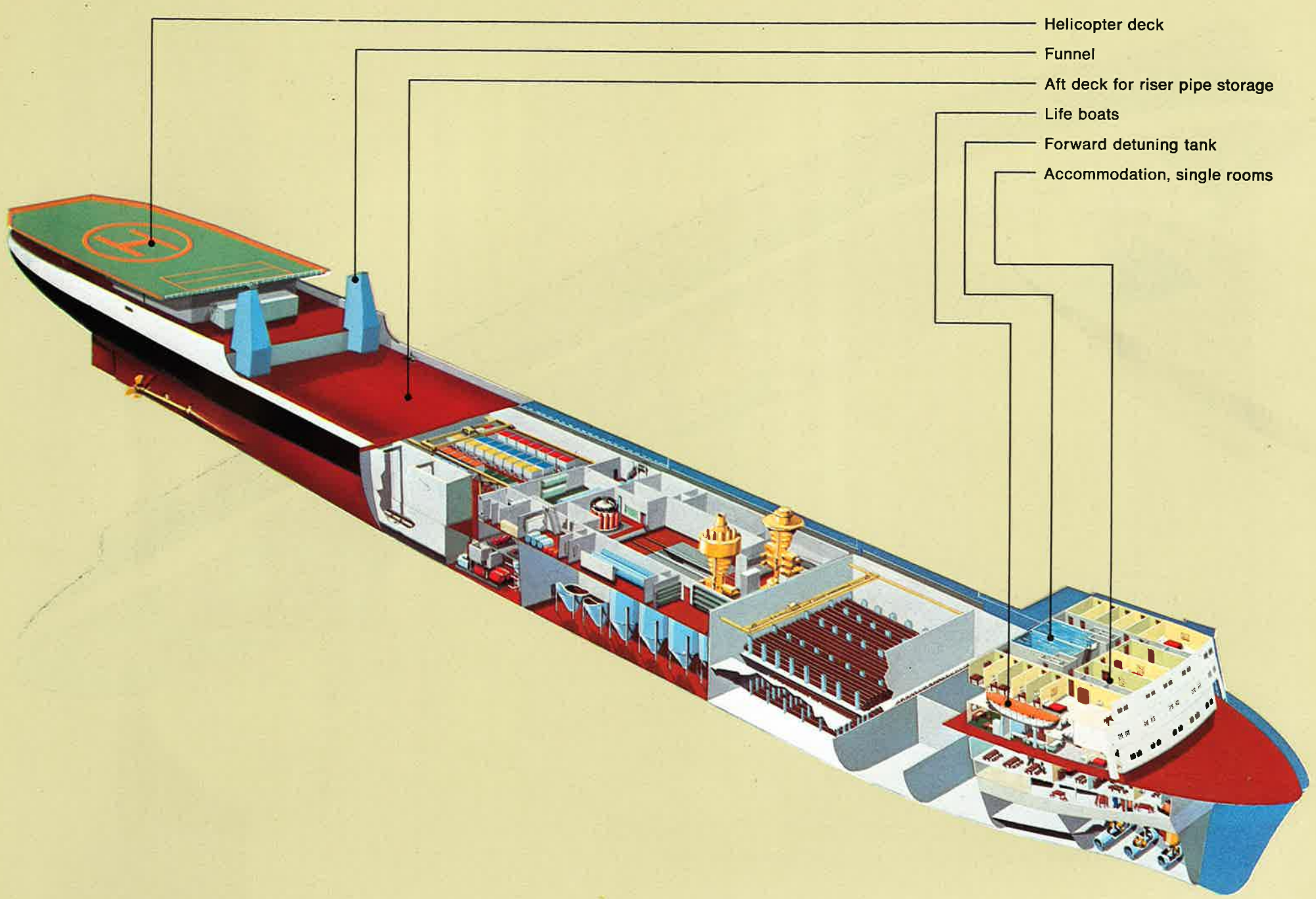
Well testing devices
The rig is equipped with a conventional well logging unit.
Cores can be analysed in the geological laboratory on the port side of the BOP workshop. Various well monitoring and recording instruments are accommodated in this room. The production potentials of a formation containing oil or gas can be tested with a production testing installation on the well test deck, on the portside behind the derrick. During testing, the oil or gas is flared through a burner extending from under the helideck.

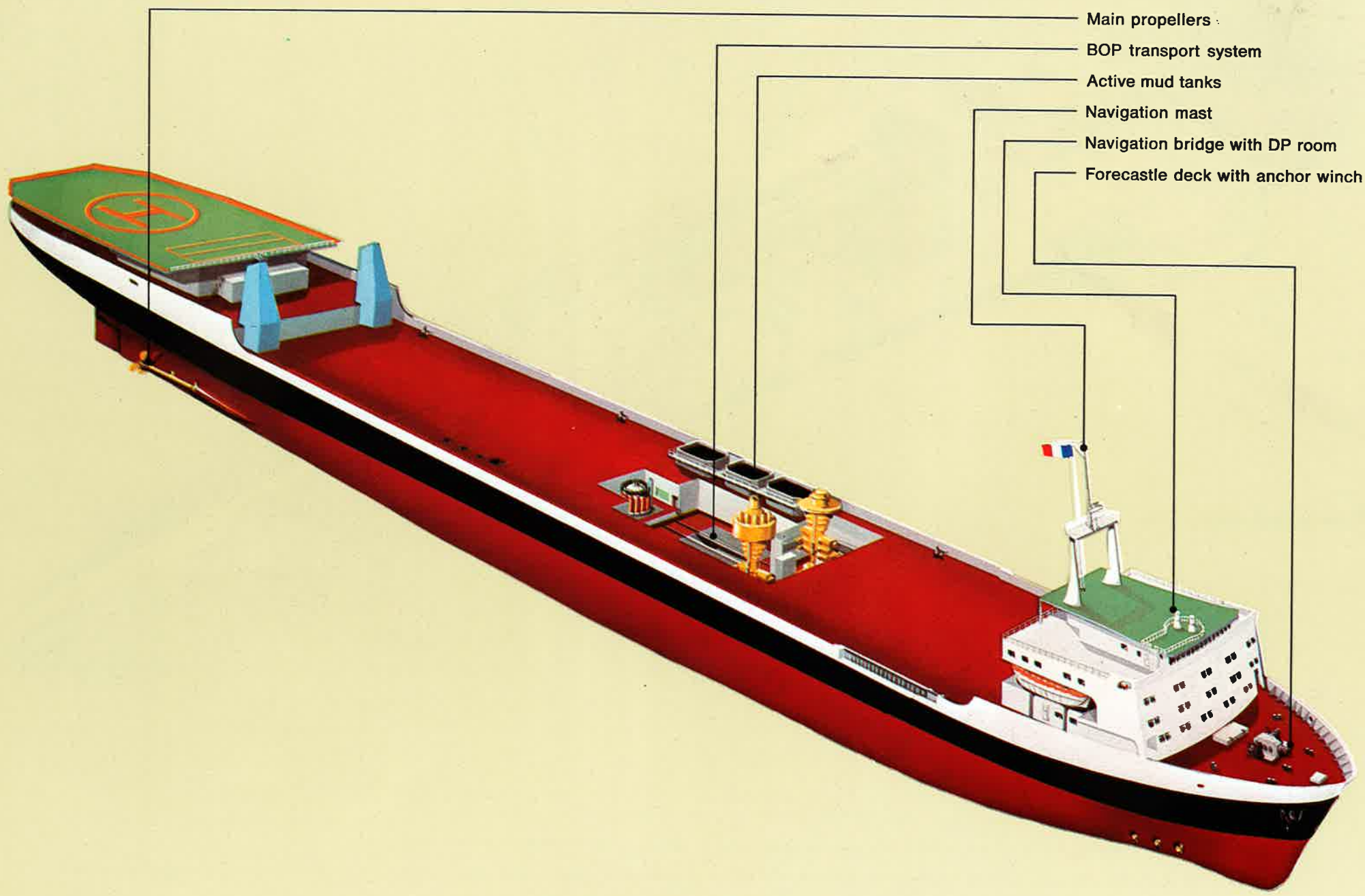
Progressive cutaway illustration Pélican

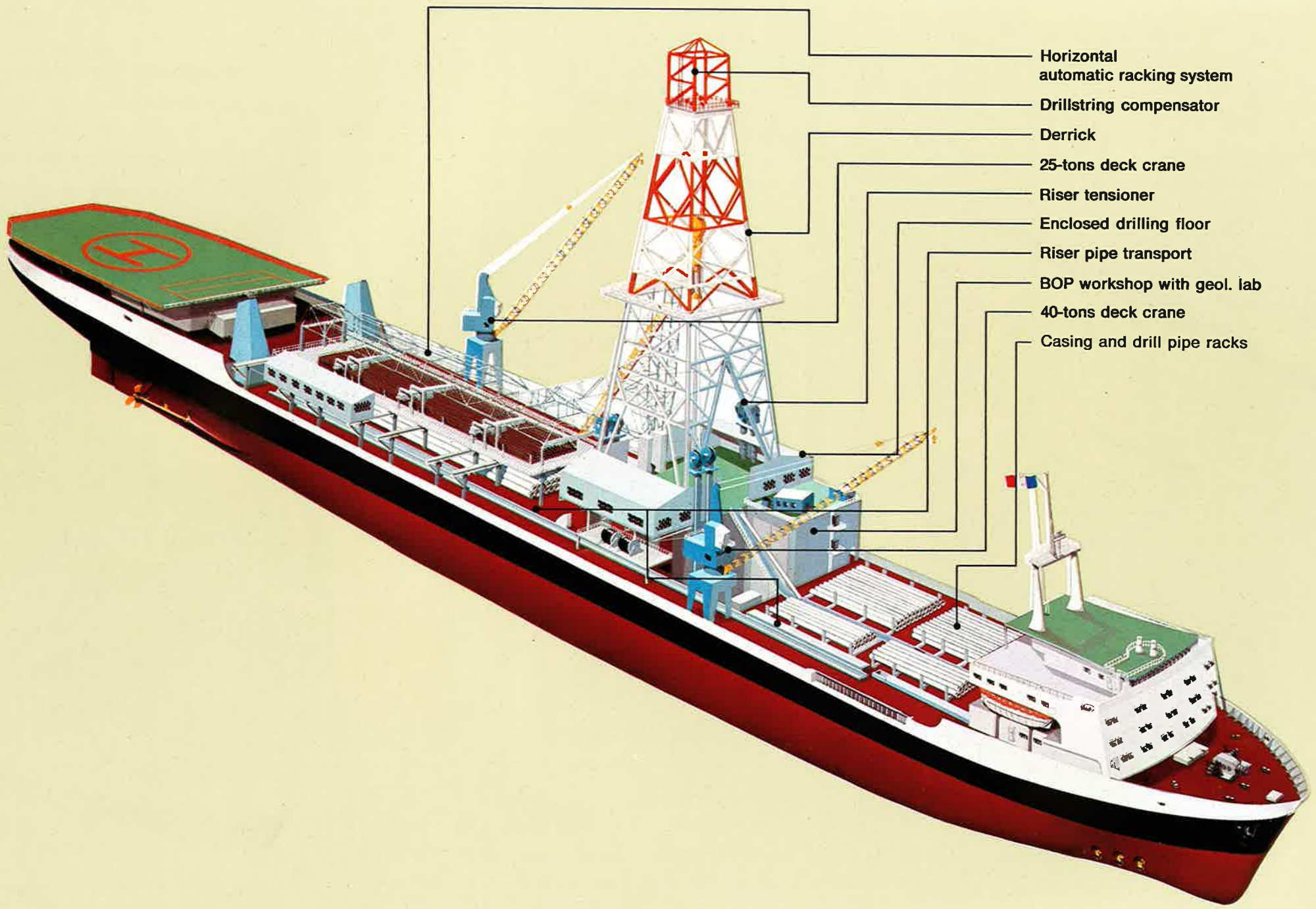

Aft thrusters
Main propulsion shafts
Transformer room
Cementing unit
Mud pumps room
Diving well
Drilling well
Bulk mud storage
Pipe holds
Forward thrusters


Switchboard room
Mud addition container storage
Deep diving area
Pipe handling crane
Dry provision store


Auxiliary engine room
Diesel generator room
Funnel uptakes
Diving bell
BOP stacks
Crew mess
Changing room
Galley

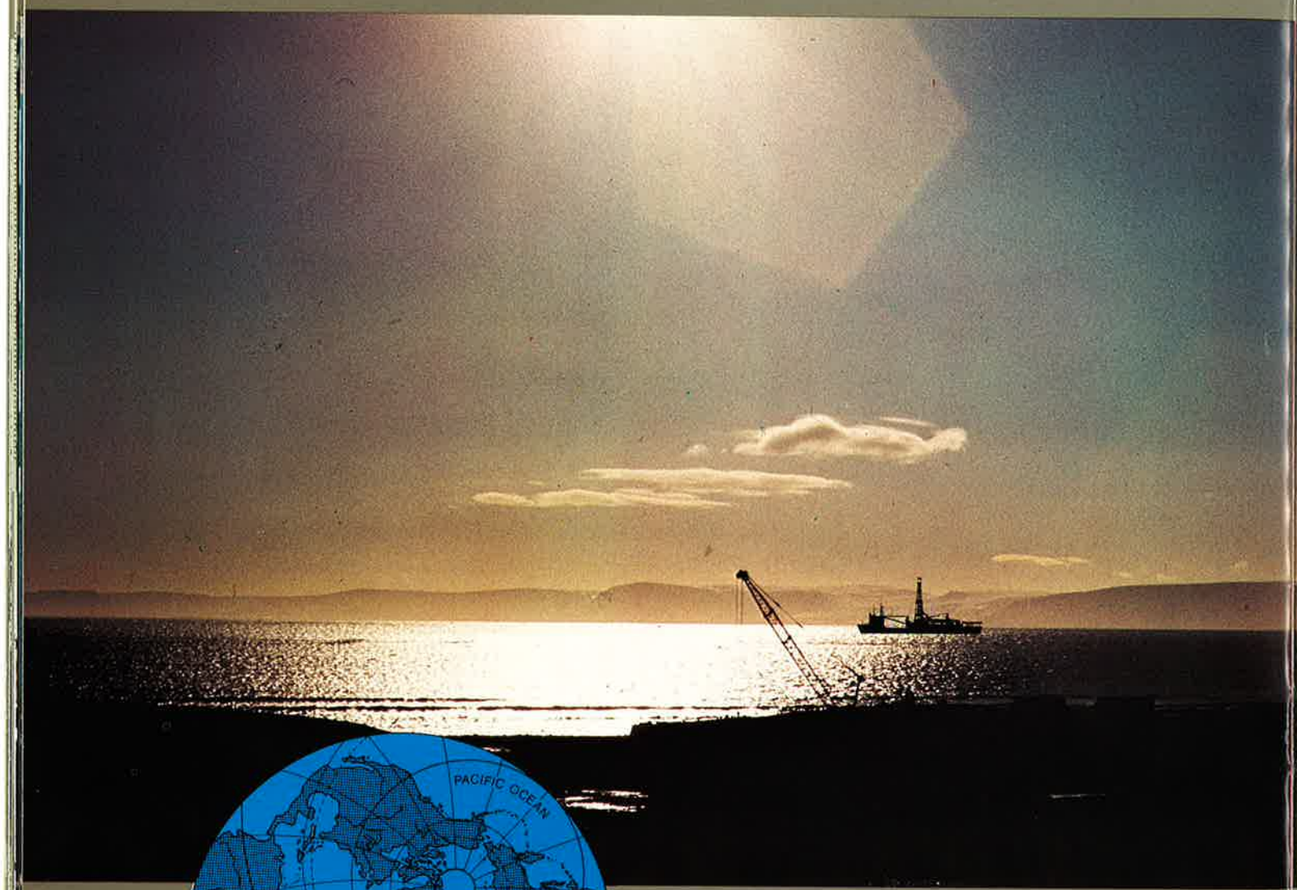

Helicopter deck
Funnel
Aft deck for riser pipe storage
Life boats
Forward detuning tank
Accommodation, single rooms

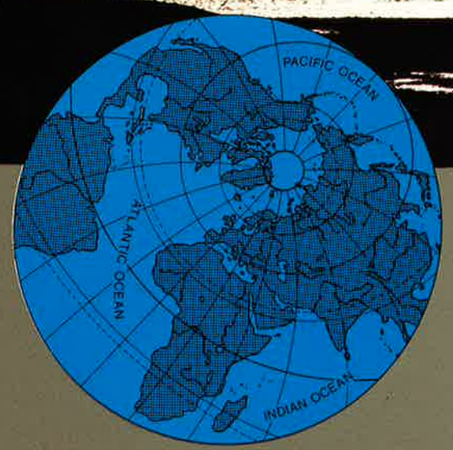

Main propellers
BOP transport system
Active mud tanks
Navigation mast
Navigation bridge with DP room
Forecastle deck with anchor winch


Horizontal
automatic racking system
Drillstring compensator
Derrick
25-tons deck crane
Riser tensioner
Enclosed drilling floor
Riser pipe transport
BOP workshop with geol. lab
40-tons deck crane
Casing and drill pipe racks

Operating experience with dynamically positioned drillships

Five dynamically-positioned drilling vessels have now been in operation for several years, performing offshore petroleum exploration tasks on a worldwide basis.
Among them are the sister-ships *Pélican* and *Havdrill* (now *Canmar Explorer III*), on which the drilling management is provided by FORAMER S.A. of Sèvres, France.
These units have together accumulated a great deal of experience in widely scattered areas, ranging from Labrador to Angola.
A very large number of data covering the floater behaviour and the resulting operational efficiencies have been gathered and analysed. These include environmental conditions; their influence on the unit motions and the positioning over the drilling well; the consequences for the actual activity; the various operational procedures; economic factors and the resulting ability to predict and prepare future tasks.
On the basis of this information it has also been possible to improve the design of future *Pélican*-type units capable of drilling in much greater waterdepths and to extend the same concept to larger ships and other types of floating unit.
The existing dynamically-positioned vessels have now fully proved the reliability of anchorless drilling units by safely and efficiently completing their assignments, among which the successful *Pélican* campaign offshore Labrador during the summer of 1973 was the most significant demonstration to the entire petroleum exploration industry.





Working areas

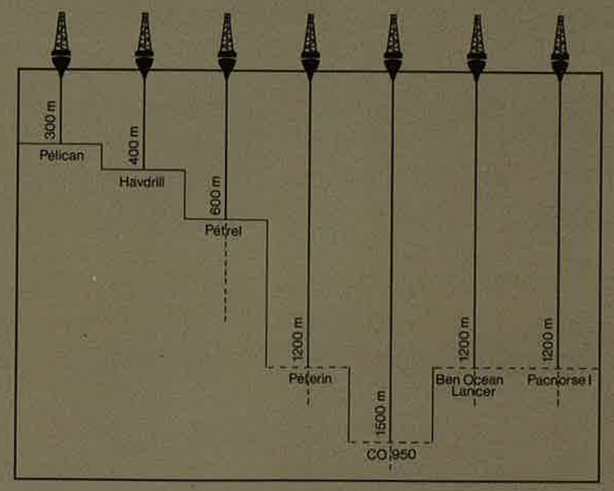
The two vessels have worked in the North Sea, the Celtic Sea, the Mediterranean, offshore Angola, Morocco and Labrador in the Atlantic Ocean.
38 per cent of the total time has been spent offshore Labrador, where the units had to cope with tight ice packs, drifting icebergs, freezing temperatures and Force 12 storms during the four-month summer-fall campaigns. At one time *Pélican* was surrounded by up to 19 icebergs within a 12-mile range (July 28, 1974), some of them well over 10 million tons.
On the other hand, one 22-metre (72 ft) wave was recorded on October 9, 1975, whilst wind gusts reached 80 knots (148 km/h).
In Angola, long swells were experienced. In the Mediterranean and Adriatic, whirling winds proved trying for the dynamic positioning system. The vessels' Ice classifications enable them to operate in more difficult conditions than have been experienced so far. On the other hand they can operate in the warmest areas of the world.

Transit

A 13-knot sailing speed had been specified on typical long transits for *Pélican*, assuming a maximum speed of between 13 and 14 knots. During trials the speed was actually slightly over 14 knots for *Pélican* and *Havdrill*.
Both vessels have now covered about 45,000 miles at transit speed. In October 1973, *Pélican* sailed from St. John, Newfoundland, to Luanda, Angola, at an average of 13.1 knots.
Within a six-month period she sailed from Marseilles to Labrador, worked 85 days in the area, then sailed to Angola, where a 3,900-metre well was completed, and then started a well offshore Tunisia.

Self-sufficiency

The variable load capacity of *Pélican* is of the order of 7,700 tons. The fuel storage capacity is sufficient for about 150 day's operation in dynamic positioning situation.
The materials supply is adequate for the completion of one deep well (4,500 metres) or of two of 3,000 metres.
The food storage, including deep freeze, gives 100-day self-sufficiency. Thus, the need for standard size supply boats is limited to emergency requirements, except in special conditions such as ice watching, iceberg-towing, safety. Besides, no significant shore bases are necessary for the oil company or the contractor.
The result is that long-term planning of a given operation is not necessary, in contrast to the position with other units. Thus, maximum assignment flexibility is achieved, enabling the oil company to use the unit at its best level of efficiency at all times.



Waterdepth

The nominal waterdepth capability of the two existing units was deliberately limited to 300-400 m.

In fact, most operations have taken place in the 150 - 250 metre waterdepth range.

But both units operated in waterdepths exceeding 300 metres offshore Eastern Canada in 1974 and 1975 (the recovery of the *Havdrill* stack involved the deepest diving job undertaken, namely 320 metres, during June 1975). On the other hand, both units have also drilled oil- and gas-producing wells in much shallower waterdepths: 65 metres in the Mediterranean and 55 metres in the Adriatic during the winter season (wind gusts up to 135 km/h offshore Tunisia in early 1975).

The latter fact has also extended the assignment flexibility for the oil companies during the winter and spring seasons.

The new units are capable of working in much deeper water without major design changes. The nominal capability of *Pélerin* today is 1,200 metres.

Positioning flexibility

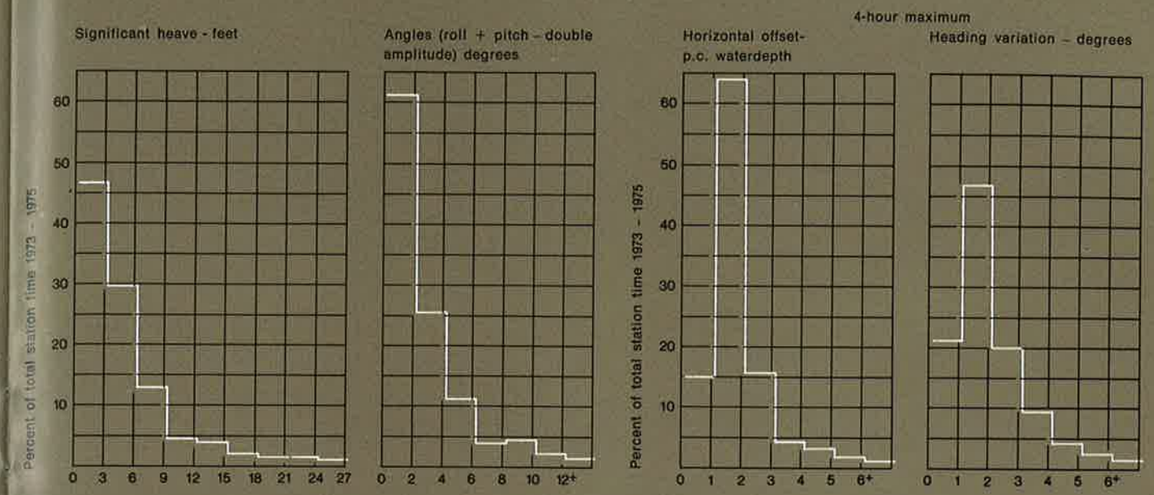
The dynamic positioning system, combined with the absence of any guide lines, reduces the physical connections between the seabed and the ship to the drill pipes and riser pipes only. Therefore, the ability to move the unit into the most favourable heading is available at all times. Significant heading changes have taken place up to 5 or 6 times during a single day. A more average figure is in the range of 1 to 2 per day (*Pélican* offshore Labrador). Such heading modifications are manually controlled. Statistically, the vessels have been kept within 15° of the incoming swell direction for about 75 per cent of the time. This limited the angular motions (roll) of the ship, and also reduced the power demand by the dynamic positioning system. The ability to render the vessel free of any connection with the seabed at short notice is also essential in many circumstances:

- ☐ occurence of storm, drifting icebergs, etc. . . .
- ☐ failure of the dynamic positioning system
- ☐ special procedures

As an example of the last-named, we can mention the ISIS 1 well, offshore Tunisia.

The supply boat carrying various equipment had sunk in a storm in December 1973. When ISIS 1 was completed as an oil producer, the wellhead protection cap was still missing.

Pélican then moved to drill ISIS 2. While a casing cementing was setting, *Pélican* was disconnected, moved to ISIS 1, where a new cap was installed, moved back to ISIS 2 and reconnected, all within 11 hours and at a much lower cost than any other solution. In case of a really serious emergency, an automatic sequence can fully free the ships in less than a minute, including, if necessary, the activation of the BOP shear rams to cut the drill pipes. All those procedures are based on the re-entry and reconnection procedures, exclusive of any guide lines.



Ship behaviour

Many thousands of data have been collected and statistically processed, covering the environmental conditions and the resulting behaviour of the floating units.

They have provided a comprehensive picture of the true transfer functions governing the ship's heave factors in relation to the various sea energy spectra. The other factors relating to the dynamic positioning capability of the ship have been analysed from actual situations, thus giving a very reliable insight into a theoretically intricate problem.

We have reproduced the histograms of the following characteristics offshore Labrador during 1973, 1974 and 1975 as the most revealing of the available data (total station-keeping: 554 days).

- ☐ wind speed (sustained)
- ☐ wave height (significant)
- ☐ heave (significant)
- ☐ total angular motion (roll + pitch, double amplitude; maximum)

We outline the main facts:

wind
The design wind speed for the dynamic positioning (45 knots) has been exceeded during 2.1 per cent of the time. The design 1 minute gust (60 knots) has been exceeded during about 1 per cent; maximum 80 knots.

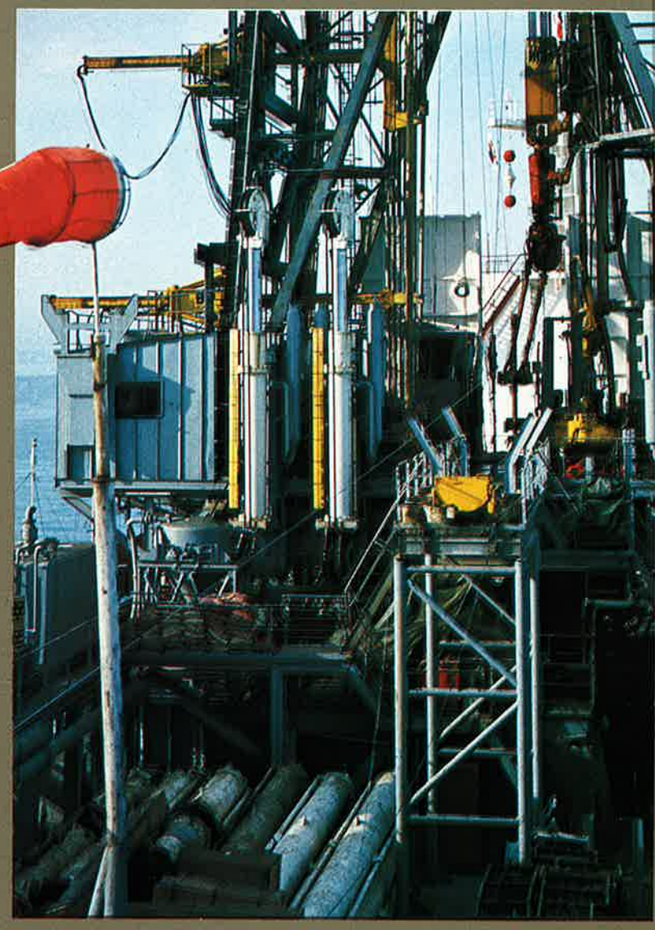
waves
The design wave spectrum (4.90 metres – 12 seconds) has been exceeded during about 6 per cent of the time.

heave
A 3-metre significant heave has been exceeded during 8 per cent of the time, thus preventing the progress of the work during about the same length of time (waiting on weather). The overall percentage of idle time due to weather (waiting on weather) since the two vessels were put in operation, has been cumulatively 6.5 per cent.

angles
A 10-degree (double amplitude) total has been exceeded during 1.6 per cent of the time. This is a very low figure for a ship-shape floater. It is due in part to the extensive care given to the ship dynamics, but mainly to the fact that the ship generally heads into the incoming waves.

In no case whatever has an excessive angular motion limited the progress of work aboard *Pélican*. The main limiting factor has always been the heave motion.

This factor holds good in the other areas where the ship has operated until now.



Dynamic positioning

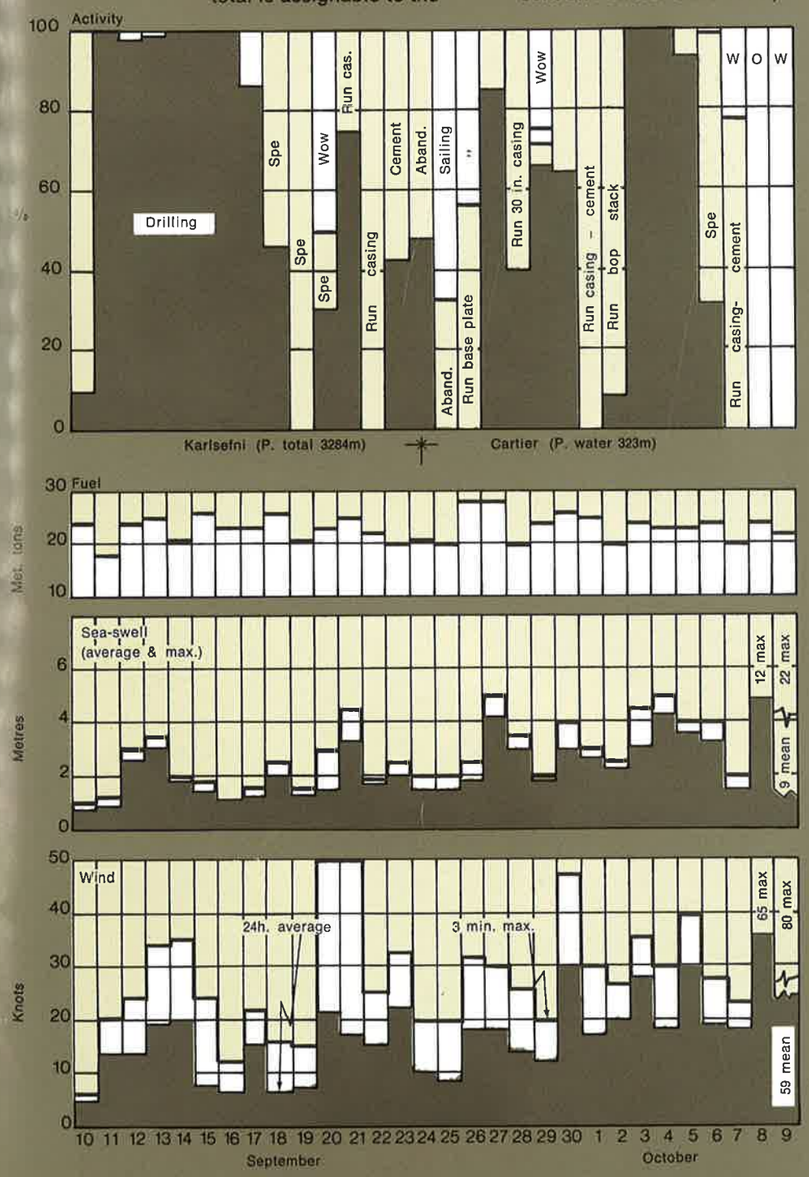
The two charts (figure) display the accuracy of the *Pélican's* dynamic positioning system offshore Labrador (1973 and 1974 combined)
☐ waterdepth per cent of the maximum (6 hours periods) offset.
☐ maximum heading variation.

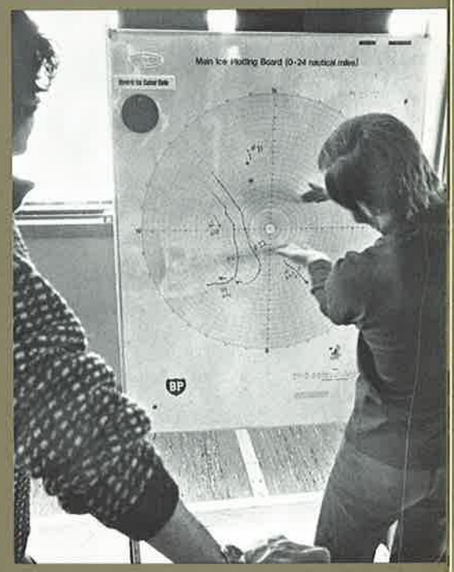
The offset incorporates the intrinsic accuracy of the acoustic telemetry (roughly 1 per cent of waterdepth) and the random ship horizontal motions, including the orbital motion.

The maximum allowable offset is 6 per cent of the waterdepth before disconnecting ("red alarm"). An intermediary "yellow warning alarm" is activated when the offset exceeds 4 per cent of the waterdepth.

Briefly, the maximum offset has not exceeded 3 per cent during 93 per cent of the time offshore Labrador. In fact, the yellow alarm has been activated on a very limited number of occasions and all disconnections have been prescheduled (excessive weather or iceberg). The absolute offset of *Havdrill* has been of the same order while operating in somewhat deeper water.
The assigned heading variation has been kept within 4° during 94 per cent of the time.

On October 17, 1974 *Pélican* was subject to 60 - 65 knot sustained winds (gusts up to 72 knots) and 10 - 12 metre waves (maximum recorded: 19 metres with no significant current). The riser had been disconnected. The ship drifted slowly astern out of the 6 per cent range while using one of the two main 3.000 hp propellers. The other propeller had been sheared off and lost due to fouling a submerged ice growler at the beginning of the campaign.
Replacement of the propeller was carried out afterwards in Europe.
The average fuel consumption during the entire period offshore Labrador has been slightly below 20 metric tons per day; 50 per cent of the total is assignable to the propellers and a further share (roughly 6 per cent) to the power auxiliaries. The daily consumption has ranged between 15 and 27 metric tons, largely depending on the environmental conditions but also on the drilling gear demands.
In milder areas it has on average not exceeded 17 - 18 metric tons per day.
The overall lost time due to dynamic positioning failure has been of the order of 1.5 per cent, including the consequential operations.
The direct lost time is less than 0.5 per cent (0.2 per cent on *Pélican* since 1973.)





Re-entry and reconnection

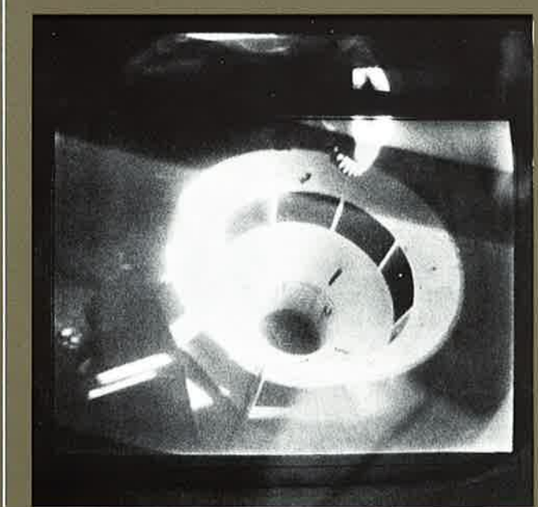
Re-entry and reconnection are regarded as separate operations. We refer to a re-entry when a drilling bit or a casing is introduced in the well by means of a loosely attached re-entry funnel which is disconnected and brought back on the vessel after the re-entry has been achieved. This occurs during the preliminary drilling operations on a given well, before any BOP stack and riser is in use.

A reconnection consists of relocating the BOP stack or the lower riser stab assembly and actuating the corresponding connector.

It takes place when the 20 3/4 in. or 13 5/8 in. stacks are connected to the base plate, or when the riser has been disconnected for any reason. To date, about 225 operations comprising 120 re-entries and 105 reconnections have been achieved.

Normally, a re-entry should not be made while the vessel's heave exceeds 1.20 - 1.50 metres, typically corresponding to a 3-metre, 7-second significant wave.

Some have been performed with up to 1.8 - 2.2 m, with a limited number of mishaps. For reconnection, heave is limited to 80 cm to 1 metre.
Most of the re-entries and reconnections have been controlled by underwater television. The driller, with the T.V. receiver before him, modifies the dynamic positioning-assigned location in order to align the mobile pendulum and the fixed equipment before achieving the operation. The guiding devices are based on a 0.6 m maximum offset. In fact, the ship positioning accuracy is generally much smaller.
The recovery of an abandoned BOP stack, offshore Labrador, in July 1973, involved the reconnection of a 20 3/4'' connector.
No guiding funnel was available as the stack was wire line guided. The positioning clearance was of the order of a few inches. The reconnection was achieved at the first attempt within a fraction of an hour.
The success of all the re-entry operations is mainly due to the perfect accuracy of the C.I.T.-Alcatel dynamic positioning system.



Efficiency

It has already been noted that the angular motions have had a negligible influence, if any, on the progress of the work. Thus the table shown in the figure outlines the maximum allowable significant heave relating to various types of operation:

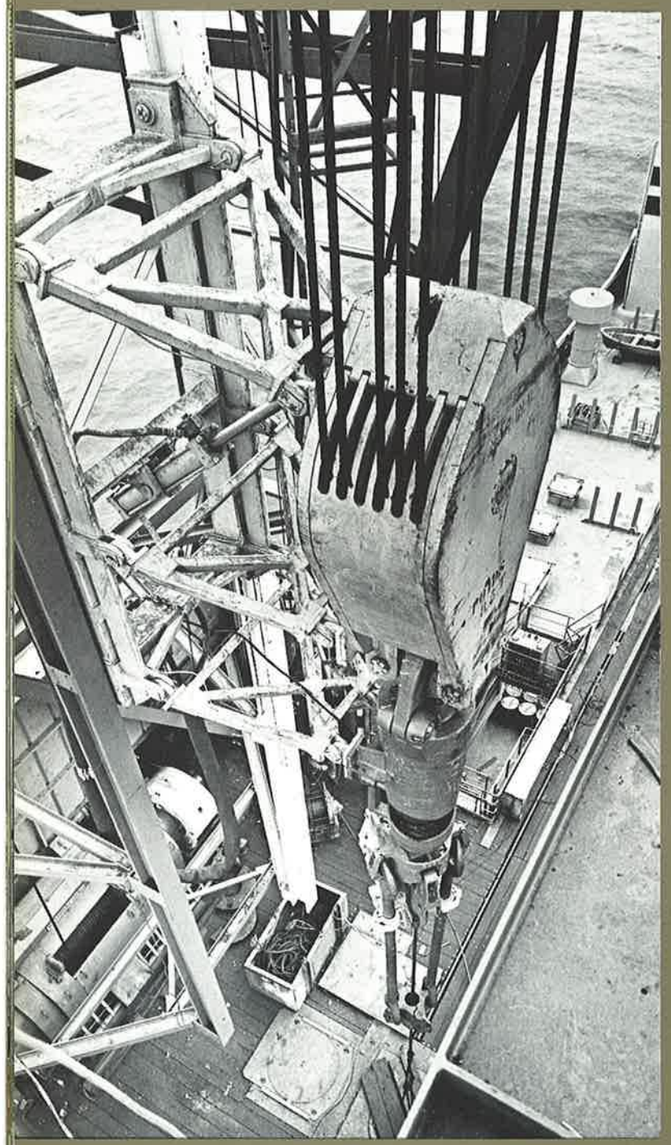
- drilling (with 4. 5 metre stroke heave compensator)
- tripping the drill pipes and collars
- casing, logging, re-entry
- BOP handling and connecting, diving
- disconnection

The corresponding typical sea conditions have been indicated.
Our past experience has provided knowledge of the ship's availability, percentagewise, in various sea and weather conditions. We have not taken into account the time required to adjust various systems like the dynamic positioning or the electro-hydraulic BOP controls during the earliest operations of *Pélican*. Some results are summarized in the table.
By analysing the actual data and reports, we have developed an accurate and reliable method of computing the ship efficiency in a given area, provided sufficient probable environmental conditions and some operational data are made available.

OPERATING LIMITS (PELICAN, HAVDRILL)

Operation	Heave (Significant)	Sea conditions
Drilling	2.50 m	5 m – 8.5 sec
Tripping	3.00 m	6 m – 9 sec
Casing, logging	1.50 m	3.50 m – 7.5 sec
BOP handling, diving, reconnection	1.00 m	2.50 m – 7 sec
Riser disconnection	4.50 m	8 m – 10 sec

Due to the ability to select the best heading and to the fact that the ship is kept exactly above the well, the drilling efficiency is definitely better than with any conventionally moored, ship-shaped unit. Together with the transit speed, speedy positioning and reduced overheads, this results in a competitive overall cost, even for operations which could be caried out by less sophisticated units. This statement has been significantly demonstrated by the 3,900 metre well drilled by *Pélican* offshore Angola in late 1973.



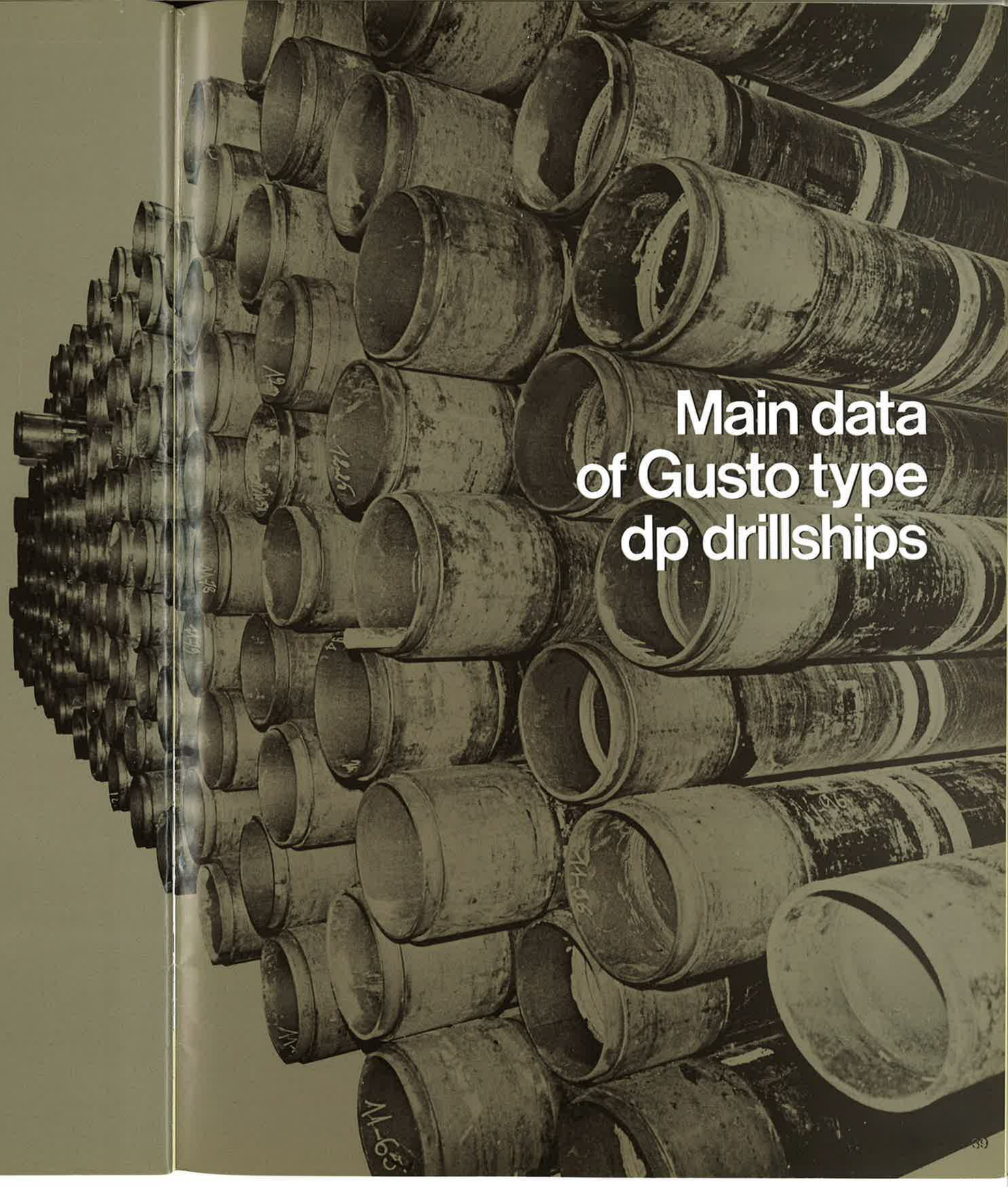
The speedy positioning ability is proved by the minimal time lost between consecutive jobs. This is the total time between the completion of the previous well and the commencement of actual drilling on the sea bed at a new location; 3 miles: 2h45; 120 miles: 15 hours.

Actual and future developments

The adequacy of the ship design, as far as functional layout and dynamic balance are concerned, has been satisfactorily demonstrated. Therefore, the new developments are bound to extend the waterdepth capability. The ultimate depth now being considered by various oil companies is of the order of 2,500 to 3,000 metres, corresponding to some 40 million sq. km of additional offshore sedimentary basins to be explored.

Conclusion

The operational success of dynamically-positioned vessels is now generally regarded as fully demonstrated. The initial psychological reluctance to rely on an anchorless rig support to complete drilling ventures has been overcome during the last years (very largely due to the efficient *Pélican* campaign offshore Labrador in the summer and fall of 1973, carried out by CFP.)
The dynamic positioning of drilling units – and of other kinds of offshore industrial units – is now accepted as the prime solution to the problem of extending the waterdepth capability beyond the traditional anchor-moored unit range. This single development has dramatically pushed forward the frontiers of offshore exploration and production to vast and promising deep-water and/or hazardous areas. In fact, much more than the dynamic positioning itself was involved in realizing the actual achievements; this has also been fulfilled.
Still more has to be done before much deeper operations can be safely and efficiently carried out, but the challenge is worth taking up.



Main data of Gusto type dp drillships

Pélican

Classification

The *Pelican*, delivered in 1972 to Somaser, Paris, has been built by Gusto to the requirements of Bureau Veritas for Class ✠ 1.A1. – ICE B – AUT – Drilling vessel.
The propulsion machinery meets the Society's requirements for Automatic Class. All international regulations and recommandations applying to this category of vessel have been complied with.

Principal particulars

Dimensions:

Length overall	149.32 m
Breadth	21.35 m
Depth to main deck	12.50 m
Max. draught	7.32 m
Size of moon pool	7.20 x 8.20 m

Deadweight:

Deadweight	approx. 7,700 tons

Capacities:

Fuel	approx. 3,000 tons
Drilling water	approx. 790 tons
Fresh water	approx. 190 tons
Potable water	approx. 190 tons
Ballast water	approx. 1,600 tons

Speed:

Maximum speed	14 knots (7.15 m draught)
Average service speed	12,5 knots (7.15 m draught)

Propulsion:

Twin screw, total	6,000 hp

Accommodation:

89 berths in single, twin and 4 berth cabins; 2 berths in hospital. Cabins, messroom and recreation room are all airconditioned.

Operating capacity:

Waterdepth	320 m
Drilling depth	15,000 ft

Capacities sufficient for 3 months of operation.

Dynamic positioning

Automatic position control system
Manufacturer: C. I. T.-Alcatel.
Main positioning system based on a dual acoustic measurement system, with back-up systems consisting of 2 tautwires and a dual riser angle system.
2 digital computers and 1 analog computer calculate the ship's position and operate 5 thrusters and 2 main propellers to keep the ship in position above the wellhead.
System accuracy 6% of waterdepth with maintenance of heading within 2 degr. under the following environmental conditions:

Wind:

Constant wind speed	45 knots
Gust during 1 minute up to	65 knots

Waves:

Significant height	4.9 m
Significant period	12 sec.

Current:

Velocity	2 knots

Operating waterdepth	50 - 320 m

Drilling equipment specifications

Derrick sub-structure:

Size 22.6 x 12.0 m, height above main deck 7.35 m, height above cellar deck 10.70 m.

Derrick and derrick equipment:

Pyramid 147′ Dynamic derrick base: 44′ 4″ x 36′.
Hook load: 1,330,000 lbs gross nominal capacity.
Gusto Unicode crown block heave compensator: hook stroke 15′.
National travelling block type 660 H 500 and swivel;
BJ Dynaplex hook.
National 1625 DE drawworks 1600/2400 hp and National C-375 rotary table.
A horizontal pipe handling system is installed on aft deck.
Pipe set back for 174 stands of 5″ O.D. drill pipe, 8 stands of 8″ O.D. and 3 stands of 9½″ O.D. drill collars.

BOP and riser system:

Dual stack BOP system including Cameron marine risers 24″ and 16″ for 320 m.
Cameron BOP stacks fitted with Koomey electro-hydraulic and Matra multiplex and acoustic (back-up) controls.
Gusto riser tensioners: 3 pairs with 6 support lines.
Max. plunger stroke 3.00 m allowing approx. 12.0 m wire line travel.

Max. line tension each 68,000 lbs.

Mud pumps, mud tanks and accessories:

2 National 12-P-160 triplex mud pumps.
3 Active mud tanks, total capacity 130 m³ mud.
2 Reserve mud tanks, total capacity 125 m³ mud.
2 Mixing tanks, total capacity 25 m³
2 Swaco super screen shale shakers.
1 Swaco vacuum degasser.
1 Picenco desander.
1 Picenco desilter.
2 Mission transfer pumps.
1 Possum Belly transfer pump.

Cementing installation:

One twin compact Dowel Schlumberger R-708-J cementing unit consisting of:
2 triplex pumps, one for 5,000 psi; one for 10,000 psi.

Schlumberger well logging unit

Drillmaster's cabin:

An enclosed and conditioned drillmaster's cabin equipped with desk for:
Drilling control including BOP control.
Display for dynamic positioning and d.p. control.
Synoptic panel for mud flow control.
Controls and indicating boxes for mud system.
Auto- and alarm panel "UNICODE".

Power plant and electric equipment

Main generators:

5 SACM diesel engines, each 3,400 hp at 1200 rpm.
5 Synchron compound generators Jeumont Schneider, three-phase, 3,000 kVA, 5,500 V/60 Hz.

Auxiliary generator:

1 SACM diesel engine, 950 hp.
1 Alternator, 750 kVA, 440 V.

Emergency generator:

1 diesel engine, 110 hp.
1 Alternator, 120 kVA, 440 V.

Electrical installations:

9 Jeumont Schneider AC motors, 1,700 hp, 5,500 V. for main propulsion and thrusters.
3 Transformers 3,000 kVA, 5,500 V/440 V, three phase, 60 cycles.
7 Jeumont Thyristor converters for energy supply to DC motors.
7 Jeumont DC motors, each 800 hp, for drawworks, rotary table, and slush pumps.
2 Jeumont DC motors, each 400 hp, for cementing unit.

Fresh water evaporators:

2 ATLAS fresh water evaporators, capacity of each: 30 t/24 hours.

Fuel consumption:

Steaming	28-30 tons/day
Drilling	20-22 tons/day

Main propellers and thrusters

Variable pitch propellers manufactured by Kamewa:
2 Propulsion propellers, each 3,000 hp; diameter 4 m.
5 Transverse thrusters: 3 forward and 2 aft, each 1,500 hp; propeller diameter 2.40 m.
Pitch setting time: 100% minus to 100% plus: 8-10 sec.

Storage

Riser storage:

On main deck storage for risers is available, total max. weight 340 tons.

Drill pipe and casing storage:

Storage of casing in tweendeck hold 1.
Storage of drill pipe and casing in hold 2 and 3.
Total capacity for one hole with a depth of 15,000′ or two holes with a depth of 10,000′.
Total capacity more than 1,000 tons of tubular goods.

Dry mud, baryte and cement:

12 Silos, each 43 m³ (5 for baryte, 5 for cement and 2 for bentonite).
4 Surge tanks of approx. 2 m³ each.
1 Salt tank of 190 m³.
120 Containers of 2 m³ each for storage of dry mud and chemicals.

Handling and transportation

2 Deck cranes, one 40-ton crane located in front of drill floor and one 25-ton crane forward of poop; auxiliary hoists 3 tons.
3 Overhead travelling cranes in pipe storage holds with a capacity of 2.5 tons each.
1 Overhead travelling crane in container storage, capacity 4 tons.
1 BOP hydraulic handling tackle of 60 tons.
2 BOP carriages from moon pool to BOP house, capacity 100 tons.

Diving equipment

1 Diving bell for saturation diving to 300 m for operations of 30 minutes for 3 divers.
2 Decompression chambers are installed on board.

Sub-sea and surface TV equipment

Sub-sea cameras:

Axial re-entry camera for funnel guide. Control camera for tool and positioning control.
Electronic unit with multiplex camera for axial guide to be run through drillstring.

Surface cameras:

1 Camera in derrick above monkey board.
2 Cameras in moon pool area.

Helicopter deck

Helicopter deck with a diameter of 83 ft, constructed for S-61N type helicopter.

Lifesaving and fire fighting equipment

Lifesaving equipment:

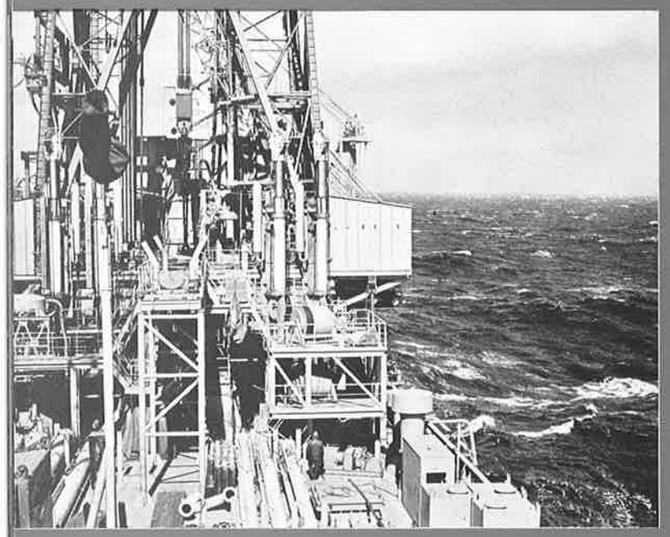
2 Lifeboats, each for 50 persons, located adjacent to forward accommodation.
4 Inflatable rafts, various locations.

Fire fighting equipment:

CO_2 distribution network for engine room, auxiliary room and boiler room.
1 Powder station, capacity 750 kg, for mud tanks on and below deck.
Foam stations on both sides of active mud tanks on deck each 200 l.
Foam and powder station at helicopter deck, cap. 400 l.

Havdrill

Now Canmar Explorer III



Classification

The *Havdrill*, delivered in 1973 to Nordic Offshore Drilling, Oslo, has been built by Gusto to the requirements of Det Norske Veritas for Class ✠ 1.A1. – ICE B – drilling vessel – EO. The propulsion machinery meets the Society's requirements for Class EO. The vessel also complies with the rules and regulations of the Norwegian Ministry of Industry and the Norwegian Maritime Directorate.

Since 1976 the *Havdrill* is owned by Canadian Marine Drilling and is renamed *Canmar Explorer III*.

Principal particulars

Dimensions:

Length overall	149.32 m
Breadth	21.35 m
Depth to main deck	12.50 m
Max. draught	7.32 m
Size of moon pool	7.20 x 8.20 m

Deadweight:

Deadweight	approx. 7,700 tons

Capacities:

Fuel	approx. 3,100 tons
Drilling water	approx. 400 tons
Fresh water	approx. 260 tons
Potable water	approx. 274 tons
Ballast water	approx. 1,700 tons

Speed:

Maximum speed	14 knots (7.15 m draught)
Average service speed	12.5 knots (7.15 m draught)

Propulsion:

Twin screw, total	7,000 hp

Accommodation:

92 berths in single, twin and 4 berths cabins; 2 berths in hospital. Cabins, messroom and recreation room are all airconditioned.

Operating capacity:

Waterdepth	400 m
Drilling depth	15,000 ft

Capacities sufficient for 3 months of operation.

Dynamic positioning

Automatic position control system
Manufacturer: Honeywell.
Main positioning system based on a dual acoustic measurement system, with back-up systems consisting of 1 tautwire and a dual riser angle system.
2 digital computers calculate the ship's position and operate 5 thrusters and 2 main propellers to keep the ship in position above the wellhead.
System accuracy 6% of waterdepth with maintenance of heading within 2 degr. under the following environmental conditions:

Wind:

Constant wind speed	45 knots
Gust during 1 minute up to	65 knots

Waves:

Significant height	4.9 m
Significant period	12 sec.

Current:

Velocity	2 knots
Operating waterdepth	50 - 400 m

Drilling equipment specifications

Derrick sub-structure:

Size 22.6 x 12.0 m, height above main deck 7.35 m, height above cellar deck 10.70 m.

Derrick and derrick equipment:

Pyramid 160' Dynamic derrick base: 44' 4" x 36'.
Hook load: 1,330,000 lbs gross nominal capacity.
Gusto Unicode crown block heave compensator: hook stroke 15'.
National travelling block type 660 H 500 and swivel;
BJ Dynaplex hook.
National 1625 DE drawworks 1600/2400 hp and National C-495 rotary table.
B.J. type "V" Pipe handling system. Pipe set back for 174 stands of 5" O. D. drill pipe, 8 stands of 8" O.D. and 3 stands of 9½" O.D. drill collars.

BOP and riser system:

Dual stack BOP system including Cameron marine risers 24" and 16" for 400 m.
Cameron BOP stacks fitted with Koomey hydraulic and Electronic controls.
Gusto riser tensioners: 3 pairs with 6 support lines.
Max. stroke 3.80 m allowing approx. 12.0 m wire line travel.
Max. line tension each 69,000 lbs.

Mud pumps, mud tanks and accessories:

2 National 12-P-160 triplex mud pumps.
3 Active mud tanks, total capacity 130 m³ mud.
2 Reserve mud tanks, total capacity 125 m³ mud.
2 Mixing tanks, total capacity 25 m³.
2 Swaco super screen shale shakers.
1 Swaco vacuum degasser.
2 Picenco desanders.
1 Picenco desilter.
2 Mission transfer pumps.

Cementing installation:

One twin compact Dowell Schlumberger R-708-J cementing unit consisting of:
2 triplex pumps, one for 5,500 psi; one for 10,000 psi.

Schlumberger well logging unit:

Drillmaster's cabin:

An enclosed and conditioned drillmaster's cabin equipped with desk for:
Drilling control including BOP control.
Display for dynamic positioning and d.p. control.
Synoptic panel for mud flow control.
Controls and indicating boxes for mud system.
Auto- and alarm panel "UNICODE".

Power plant and electric equipment

Main generators:

5 SACM diesel engines, each 3,400 hp at 1200 rpm.
5 Synchron compound generators, three-phase, 3,000 kVA, 6,000 V.

Auxiliary generator:

1 SACM diesel engine, 950 hp.
1 Alternator, 750 kVA, 440 V.

Emergency generator:

1 Scania diesel engine, 200 hp.
1 Alternator, 150 kVA, 440 V.

Electrical installations:

9 AEG AC motors, 1,750 hp, 6,000 V, for main propulsion and thrusters.
3 Transformers 3,000 kVA, 6,000 V/440 V, three phase, 60 cycles.
7 AEG Thyristor converters for energy supply to DC motors.
7 AEG DC motors, each 800 hp, for drawworks, rotary table and slush pumps.
2 AEG DC motors, each 400 hp, for cementing unit.

Fresh water evaporators:

2 ATLAS fresh water evaporators, capacity of each: 30 t/24 hours.

Fuel consumption:

Steaming	28-30 tons/day
Drilling	20-22 tons/day

Main propellers and thrusters

Variable pitch propellers manufactured by Lips:
2 Propulsion propellers, each 3,500 hp; diameter 4 m.
5 Transverse thrusters: 3 forward and 2 aft, each 1,750 hp; propeller diameter 2.36 m.
Pitch setting time: 100% minus to 100% plus: 8-10 sec.

Storage

Riser storage:

On main deck storage for risers is available, total weight 340 tons.

Drill pipe and casing storage:

Storage of casing in tweendeck hold 1.
Storage of drill pipe and casing in hold 2 and 3.
Total capacity for one hole with a depth of 15,000' or two holes with a depth of 10,000'.
Total capacity more than 1,000 tons of tubular goods.

Dry mud, baryte and cement:

12 Silos, each 43 m³ (5 for baryte, 5 for cement and 2 for bentonite).
4 Surge tanks of approx. 2 m³ each.
1 Salt tank of 190 m³.
120 Containers of 2 m³ each for storage of dry mud and chemicals.

Handling and transportation

2 Gusto deck cranes, one 40-ton crane located in front of drill floor and one 25-ton crane forward of poop; auxiliary hoists 3 tons.
3 Overhead travelling cranes in pipe storage holds with a capacity of 2.5 tons each.
1 Overhead travelling crane in container storage, capacity 4 tons.
1 BOP hydraulic handling tackle of 60 tons.
2 BOP carriages from moon pool to BOP house, capacity 100 tons.

Diving equipment

1 Diving bell for saturation diving at atmospheric pressure to 300 m for operations of 30 minutes for 3 divers.
2 Decompression chambers are installed on board.

Sub-sea and surface TV equipment

Sub-sea cameras:

Axial re-entry camera for funnel guide. Control camera for tool and positicning control.

Surface cameras:

1 Camera in derrick above monkey board.
2 Cameras in moon pool area.

Helicopter deck

Helicopter deck with a diameter of 83 ft, constructed for S-61N type helicopter.

Lifesaving and fire fighting equipment

Lifesaving equipment:

2 Lifeboats of enclosed type, each for 50 persons, located adjacent to forward accommodation.
2 Lifeboats, open, for 25 persons each, located on poop deck.
4 Inflatable rafts, various locations.

Fire fighting equipment:

CO_2 distribution network for engine room, auxiliary room and boiler room.
1 Powder station, capacity 750 kg, for mud tanks on and below deck.
Foam stations on both sides of active mud tanks on deck each 200 l.
Foam and powder station at helicopter deck, cap. 400 l.

Pétrel

Classification

The *Pétrel*, delivered in 1976 to Offshore Europe, Antwerp, has been built by Gusto to the requirements of Det Norske Veritas for Class ✠ 1.A1. – ICE B – Drilling vessel – EO – (notation EO only includes sailing with main propulsion).
The vessel also conforms to the rules and regulations of the Norwegian Ministry of Industry and the Norwegian Maritime Directorate.

Principal particulars

Dimensions:

Length overall	149.42 m
Breadth	21.35 m
Depth to main deck	12.50 m
Max. draught	7.50 m
Size of moon pool	7.20 x 8.20 m

Deadweight:

Deadweight	approx. 7,200 tons

Capacities:

Fuel	approx. 2,700 tons
Drilling water	approx. 100 tons
Fresh water	approx. 405 tons
Potable water	approx. 280 tons
Ballast water	approx. 950 tons

Speed:

Maximum speed	14 knots (7.15 m draught)
Average service speed	12.5 knots (7.15 m draught)

Propulsion:

Twin screw, total	7,000 hp

Accommodation:

91 berths in single, twin and 4 berth cabins; 2 berths in hospital. Cabins, messroom and recreation room are all airconditioned.

Operating capacity:

Waterdepth	600 - 1000 m
Drilling depth	15,000 ft

Capacities sufficient for 3 months of operation.

Dynamic positioning

Automatic position control system
Manufacturer: C. I. T.-Alcatel.
Main positioning system based on a dual acoustic measurement system, with back-up systems consisting of 2 tautwires and a dual riser angle system.
2 digital computers calculate the ship's position and operate 5 thrusters and 2 main propellers to keep the ship in position above the wellhead.
System accuracy 6% of waterdepth with maintenance of heading within 2 degr. under the following environmental conditions:

Wind:

Constant wind speed	45 knots
Gust during 1 minute up to	65 knots

Waves:

Significant height	4.9 m
Significant period	12 sec.

Current:

Velocity	2 knots
Operating water-depth	50 - 600 - 1000 m

Drilling equipment specifications

Derrick sub-structure:

Size 22.6 x 12.0 m, height above main deck 7.35 m, height above cellar deck 10.70 m.

Derrick and derrick equipment:

Pyramid 160′ Dynamic derrick base: 44′ 4″ x 36′.
Hook load: 1,330,000 lbs gross nominal capacity.
National crown block type 760.
National travelling block type 600 H500 and Vetco heave compensator;
BJ Dynaplex hook and swivel.
National 1625 DE drawworks and National C-495 rotary table.
B.J. type "V" Pipe handling system.
Pipe set back for 182 stands of 5″ O.D. drill pipe and 10 stands of drill collars.

BOP and riser system:

Single stack BOP system including Cameron marine risers 18⅝″ and 16⅝″ for 600 m.
Cameron 16¾″ BOP stack fitted with Koomey hydraulic and Matra Electronic multiplex controls.
Also provided with Matra Teltac acoustic back-up system.
Gusto riser tensioners: 3 pairs with 6 support lines.
Max. stroke 3.00 m allowing approx. 12.0 m wire line travel.
Max. line tension each 80,000 lbs.

Mud pumps, mud tanks and accessories:

2 National 12-P-160 triplex mud pumps.
1 National 8-P-80 triplex booster pump.
3 Active mud tanks, total capacity 133 m³ mud.
2 Reserve mud tanks, total capacity 125 m³ mud.
2 Mixing tanks, total capacity 25 m³.
2 Swaco super screen shale shakers.
1 Swaco vacuum degasser and 1 vertical degasser.
1 Picenco desander.
1 Picenco desilter.
2 Mission transfer pumps.
1 Possum Belly transfer pump.

Cementing installation:

One twin compact R-708-J cementing unit consisting of:
2 triplex pumps, one for 5,500 psi; one for 10,000 psi.

Schlumberger well logging unit

Drillmaster's cabin:

An enclosed and conditioned drillmaster's cabin equipped with desk for:
Drilling control including BOP control.
Display for dynamic positioning and d.p. control.
Synoptic panel for mud flow control.
Controls and indicating boxes for mud system.

Power plant and electric equipment

Main generators:

5 SACM diesel engines, each 3,400 hp at 1200 rpm.
5 Synchron compound generators, three-phase, 3,000 kVA, 6,000 V.

Auxiliary generator:

1 SACM diesel engine, 950 hp at 1200 rpm.
1 Alternator, 750 kVA, 440 V.

Emergency generator:

1 Scania diesel engine, 230 hp at 1800 rpm.
1 Alternator, 150 kVA, 440 V.

Electrical installations:

9 AEG AC motors, 1,750 hp, 6,000 V, for main propulsion and thrusters.
3 Transformers 3,000 kVA, 6,000 V/440 V, three phase, 60 cycles.
8 AEG Thyristor convertors for energy supply to DC motors.
8 AEG DC motors, each 800 hp, for drawworks, rotary table and mud pumps.
2 AEG DC motors, each 400 hp, for cementing unit.

Fresh water evaporators:

2 ATLAS fresh water evaporators, capacity of each: 30 t/24 hours.

Fuel consumption:

Steaming	28-30 tons/day
Drilling	20-22 tons/day

Main propellers and thrusters

Variable pitch propellers manufactured by Lips:
2 Propulsion propellers, each 3,500 hp, diameter 4 m.
5 Transverse thrusters: 3 forward and 2 aft, each 1,750 hp; propeller diameter 2.36 m.
Pitch setting time: 100% minus to 100% plus: 8-10 sec.

Storage

Riser storage:

On-deck storage for risers with and without buoyancy, total weight 340 tons.

Drill pipe and casing storage:

Storage of casing in tweendeck hold 1.
Storage of drill pipe and casing in tweendeck and hold 2.
Total capacity for one hole with a depth of 15,000′ or two holes with a depth of 10,000′.
Total capacity 1,570 tons of tubular goods.

Dry mud, baryte and cement:

12 Silos, each 43 m³ (5 for baryte, 5 for cement and 2 for bentonite).
4 Surge tanks of approx. 2 m³ each.
1 Salt tank of 80 m³.
120 Containers of 2 m³ each for storage of dry mud and chemicals.

Handling and transportation

2 Bucyrus-Erie deck cranes, one 40-ton crane located in front of drill floor and one 25-ton crane forward of poop; auxiliary hoists 3 tons.
3 Overhead travelling cranes in pipe storage holds with a capacity of 2.5 tons each.
1 Overhead travelling crane in container storage, capacity 4 tons.
1 BOP hydraulic handling tackle of 100 tons.
2 BOP carriages from moon pool to BOP house, capacity 200 tons.

Diving equipment

1 Diving bell for observation at atmospheric pressure to 600 m or for operations of 30 minutes for 3 divers at a depth up to 300 m.
2 Decompression chambers are installed on board.

Sub-sea and surface TV equipment

Sub-sea cameras:

Axial re-entry camera for funnel guide. Control camera for tool and positioning control.
Electronic unit with multiplex camera for axial guide to be run through drillstring.

Surface cameras:

1 Camera in derrick above monkey board.
2 Cameras in moon pool area.

Helicopter deck

Helicopter deck with a diameter of 83 ft, constructed for S-61N type helicopter.

Lifesaving and fire fighting equipment

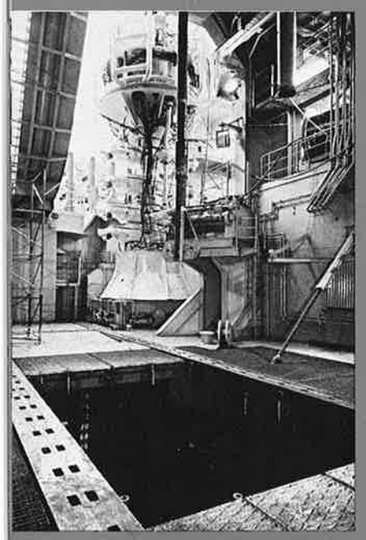
Lifesaving equipment:

2 Lifeboats of enclosed type, each for 50 persons, located adjacent to forward accommodation.
2 Lifeboats, open, for 25 persons each, located on poop deck.
4 Inflatable rafts, various locations.

Fire fighting equipment:

CO_2 distribution network for engine room, auxiliary room and boiler room.
1 Powder station, capacity 750 kg, for mud tanks on and below deck.
Foam stations on both sides of active mud tanks on deck each 200 l.
Foam and powder station at helicopter deck, cap. 400 l.

Pèlerin



Classification

The *Pèlerin*, delivered to Helmer Staubo & Co., Oslo in 1976, was built by Gusto to the requirements of Det Norske Veritas for Class ✠ IAI "deep sea drilling vessel" and Ice Class B. The propulsion machinery meets the society's requirements for Class EO. The vessel also conforms to the rules and regulations of the Norwegian Maritime Directorate and the Norwegian Ministry of Industry.

Principal particulars

Dimensions:

Length overall	148.70 m
Breadth	23.45 m
Depth to main deck	12.45 m
Max. draught	7.50 m
Size of moon pool	7.20 m x 8.20 m

Deadweight:
Loading capacity approx. 8,000 tons

Capacities:

Fuel	approx. 3,200 tons
Drilling water	approx. 100 tons
Fresh water	approx. 505 tons
Potable water	approx. 190 tons
Ballast	approx. 800 tons

Speed:

Maximum speed	14 knots (7.15 m draught)
Commercial speed	13 knots (7.15 m draught)

Propulsion:
Twin screw 2 x 3,500 hp

Accommodation:
101 berths in single, twin and 4-berth cabins (incl. 4 in hospital). Cabins, messroom and recreation room are all airconditioned.

Operating capacity:

Waterdepth	1,200 m +
Drilling depth	20,000 ft.

Capacities sufficient for 3 months' operation without supplies.
Temperatures —20 to + 35 °C

Dynamic positioning system

Manufacturer: C. I. T. - Alcatel.
Main positioning system based on dual acoustic position reference system, with back-up systems consisting of dual taut wire and dual riser angle systems.
2 digital and 1 analog computers calculate ship's position and operate 5 thrusters and 2 main propellers in order to keep the ship in position above the wellhead.
System accuracy 6% of waterdepth under the following environmental conditions:

Wind:	
Constant wind speed	45 knots
Gusting up to	65 knots
Waves:	
Significant height	4.9 m
Significant period	12 sec.
Current:	
Velocity	2 knots
Operating waterdepths	50 - 1,200 metres +

Drilling equipment specifications

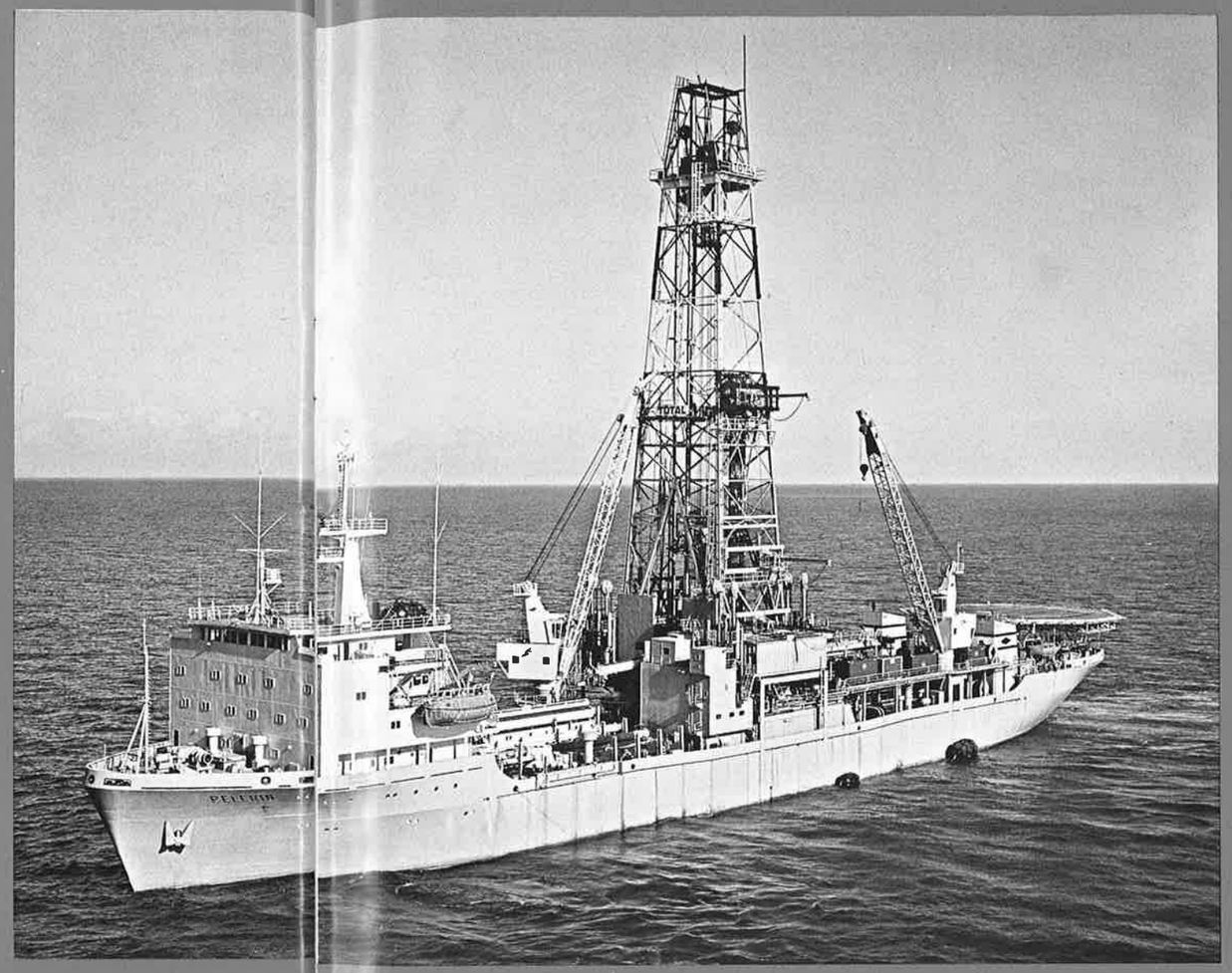
Derrick sub-structure:
Size: 22.6 x 12 m; height above main deck: 7.70 m.
Pipe setback area for 178 stands of drill pipes and 14 stands of drill collars.

Derrick and derrick equipment:
Pyramid derrick: height 160'; base 44'4" x 36'; 1,330,000 lbs gross nominal capacity.
Gusto Unicode crown block heave compensator.
National travelling block and swivel, BJ Dynaplex hook: capacity of gear 500 tons.
National 1625 DE drawworks and National C495 rotary table.
BJ automatic pipe racking system.

BOP and riser system:
Gusto riser tensioners: 5 pairs with 10 support lines.
Max. stroke 3.75 m, allowing approx. 15 m wire line travel.
Max. line tension 80,000 lbs.
Single stack BOP system including:
Cameron marine riser 18⅝" 1,000 m
Cameron 16¾" BOP stack fitted with Koomey hydraulic and Matra electronic multiplex controls.
Also provided with Matra Teltac acoustic back-up system.

Mud pumps, mud tanks and accessories:
2 National 12-P-160 triplex mud pumps.
1 National 8-P-80 triplex booster pump.

4 Active mud tanks, total capacity 190 m³.
4 Spare mud tanks, total capacity 274 m³.
2 Preparation tanks, total capacity 25 m³.
2 Swaco super screen shale shakers.
1 Swaco vacuum degasser and 1 vertical degasser.
2 Pioneer desanders.
1 Pioneer desilter.
2 Mission transfer pumps.
1 Possum Bellytank with transfer pump.



Dowell cementing unit including:
1 Triplex pump 5,000 psi.
1 Triplex pump 10,000 psi.
Schlumberger well logging unit.

Power plant and electric equipment

Main generators:
5 SACM diesel engines, 3,400 hp each.
5 Synchron compound generators, three-phase, 3,000 KVA, 6,000 V.

Auxiliary generator:
1 SACM diesel motor 950 hp
1 Alternator, 750 KVA 440 V.

Emergency generator:
1 Scania diesel motor 230 hp
1 Alternator, 150 KVA 440 V.

Electrical installations:
9 AEG AC motors 1,750 hp 6,000 V., for main propulsion and thrusters.
3 Transformers 3,000 KVA 6000 V. /440 V., three-phase, 60 cycles.
8 AEG Thyristor converters for energy supply to DC motors.
8 AEG DC motors, each 800 hp, for drawworks, rotary table, slush pumps and booster pump.
2 AEG DC motors, each 400 hp, for cementing unit.

Fresh water evaporators
2 ATLAS fresh water evaporators, capacity 30 t/24 hours.

Fuel consumption:

During steaming	28-30 ton/day
During drilling	20-22 ton/day

Main propellers and thrusters

Variable pitch propellers manufactured by Lips:
2 Propulsion propellers, 3,500 hp each, diameter 4 m.
5 Transverse thrusters: 3 forward and 2 aft, 1,750 hp each, with a propeller diameter of 2.36 m.
Pitch setting time 100% minus to 100% plus: 8-10 sec.

Storage

Riser storage:
On-deck storage for 1,200 m of riser with buoyancy.

Drillpipe and casing storage:
Storage of casing in tweendeck hatch 1; of drill pipe and casing in tweendeck and hold hatch 2.
Total capacity 1,570 tons of tubular goods.

Dry mud, baryte and cement:
12 Silos, 43 m³ each (5 for baryte, 5 for cement and 2 for bentonite).
4 Silos, 22 m³ each for cement and chemicals.
1 Salt tank of 78 m³.
120 Containers of 2 m³ each for storage of dry mud and chemicals.

Handling and transportation

2 Gusto deck cranes, one (capacity 40 tons) located in front of drilling floor, and the other capacity 25 tons) forward of the poop; auxiliary hoists 3 tons.
3 Overhead travelling cranes in pipe storage holds, capacity 2.5 tons.
1 Overhead travelling crane in container storage, capacity 4 tons.
1 BOP hydraulic handling tackle, 100 tons.
2 BOP carriages from moon pool to BOP house, capacity 200 tons.

Diving equipment

1 Observation bell with 2 hydraulically-operated manipulators constructed for 1,200-metre waterdepth.
2 Decompression chambers are installed on board.

Sub-sea and surface TV equipment

All TV equipment supplied by Thomson-CSF, France.

Sub-sea cameras:
Various cameras intended for observation bell mounting and reentry, including multiplex cameras to be run through drillstring.

Surface cameras:
1 Camera in derrick above monkey board.
2 Cameras in moon pool area.

Helicopter deck

Helicopter deck with a diameter of 83 ft. constructed for type S-61 N helicopters.

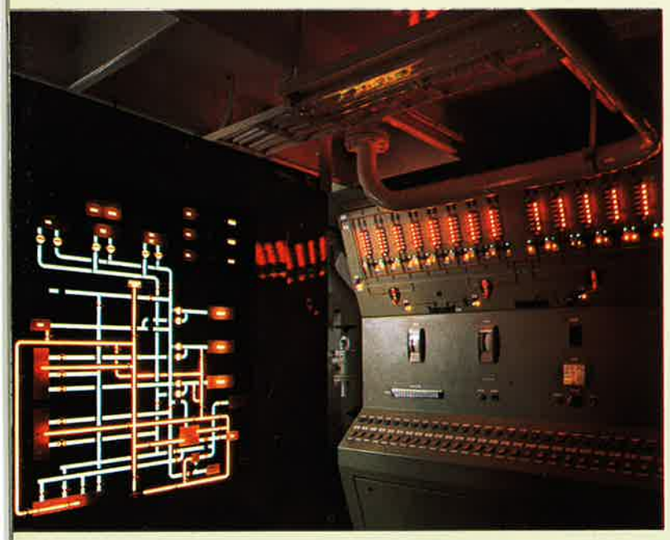
Lifesaving and firefighting equipment

Lifesaving equipment:
2 Lifeboats of enclosed type, each for 50 persons, located adjacent to forward accommodation.
2 Lifeboats, open, 1 for 25 persons and 1 for 34 persons, located on poop-deck.
8 Inflatable rafts, various locations.

Fire fighting equipment:
CO_2 distribution network for engine room, auxiliary room and boiler room.
1 Powder station, capacity 750 kg, operable for mud tanks on and below deck.
Foam stations on both sides of deck mud tanks.
Foam and powder station at helicopter deck.

CO 950

Under construction



Classification

The CO 950 is being built by Gusto to the requirements of Det Norske Veritas for Class ✠ 1.A1. drilling vessel and Ice Class 1B. The propulsion machinery meets the Society's requirements for Class EO.

Principal particulars

Dimensions:

Length overall	148.70 m
Breadth	23.00 m
Depth to main deck	12.50 m
Max. draught	7.30 m
Size of moon pool	7.20 x 8.20 m

Deadweight:

Deadweight	approx. 8,100 tons

Capacities:

Fuel	approx. 2,200 tons
Drilling water	approx. 475 tons
Fresh water	approx. 405 tons
Potable water	approx. 190 tons
Ballast water	approx. 1,000 tons

Speed:

Maximum speed	14 knots (7.15 m draught)
Average service speed	12.5 knots (7.15 m draught)

Propulsion:
Twin screw, total 7,000 hp

Accommodation:
96 berths in single, twin and 4-berth cabins and 4 berths in hospital. Cabins, messroom and recreation room are all airconditioned.

Operating capacity:
Waterdepth 1,500 m, possible extension to 3,000 m.
Drilling depth 15,000 ft
Capacities sufficient for 3 months of operation.

Dynamic positioning

Automatic position control system
Manufacturer: C. I. T.-Alcatel.
Main positioning system based on a dual acoustic position reference system, with back-up systems consisting of 1 tautwire and a dual riser angle system.
2 digital computers calculate the ship's position and operate 5 thrusters and 2 main propellers to keep the ship in position above the wellhead.
System accuracy 6% of waterdepth with maintainance of heading within 2 degrees under the following environmental conditions:

Wind:

Constant wind speed	45 knots
Gust during 1 minute up to	65 knots

Waves:

Significant height	4.9 m
Significant period	12 sec.

Current:

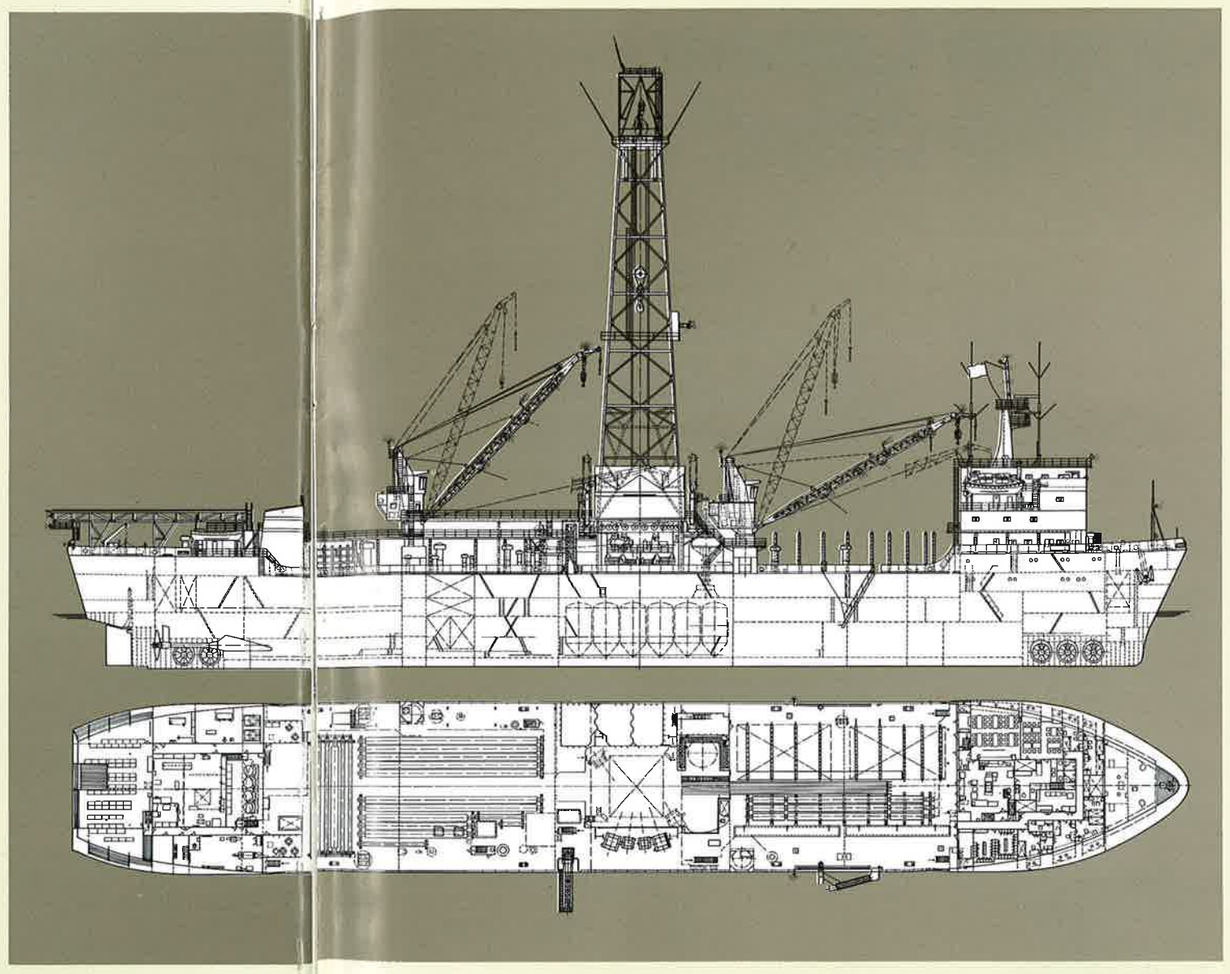
Velocity	2 knots

Operating water-depth 50 - 1,500 m+

Drilling equipment specifications

Derrick sub-structure:
Size 22.6 x 12.0 m, height above main deck 7.35 m, height above cellar deck 10.55 m.

Derrick and derrick equipment:
Pyramid 160′ Dynamic derrick base: 44′ 4″ x 36″.
Hook load: 1,330,000 lbs gross nominal capacity.
Gusto Unicode crown block heave compensator: hook stroke 15′.



National travelling block type 600 H 500 and swivel;
BJ 5500 hook.
National 1625 DE drawworks and National C-495 rotary table.
B.J. type "V" Pipe handling system. Pipe set back for 178 stands of 5″ O.D. drill pipe and 10 stands of drill collars.

BOP and riser system:
Single stack BOP system including Cameron marine risers 18⅝″ and 16⅝″ for 1,500 m.
Cameron 16¾″ BOP stack fitted with Koomey hydraulic and Matra Electronic multiplex controls.
Also provided with Matra Teltac acoustic back-up system.
Gusto riser tensioners: 5 pairs with 10 support lines.
Max. stroke 3.80 m allowing approx. 15.25 m wire line travel.
Max. line tension each 80,000 lbs.

Mud pumps, mud tanks and accessories:
2 National 12-P-160 triplex single-acting mud pumps.
1 National 8-P-80 triplex booster pump.
3 Active mud tanks, total capacity 190 m³ mud.
4 Reserve mud tanks, total capacity 275 m³ mud.
2 Mixing tanks, total capacity 25 m³
2 Swaco super screen shale shakers.
1 Swaco vacuum degasser and 1 vertical degasser.
2 Picenco desanders.
1 Picenco desilter.
2 Mission transfer pumps.
1 Possum Belly transfer pump.

Cementing installation:
One twin compact R-714 Dowel Schlumberger cementing unit consisting of:
2 triplex pumps, one for 5,500 psi; one for 10,000 psi.

Schlumberger well logging unit.

Drillmaster's cabin:
An enclosed and air-conditioned drillmaster's cabin equipped with desks for:
Drilling control including BOP control.
Display for dynamic positioning and d.p. control.
Synoptic panel for mud flow control.
Controls and indicating boxes for mud system.
Auto- and alarm panel "UNICODE".

Power plant and electric equipment

Main generators:
5 SACM diesel engines, each 3,400 hp at 1200 rpm.
5 Synchron compound generators, three-phase, 3,000 kVA, 6,000 V.

Auxiliary generator:
1 SACM diesel engine, 950 hp.
1 Alternator, 750 kVA, 440 V.

Emergency generator:
1 Scania diesel engine, 200 hp.
1 Alternator, 150 kVA, 440 V.

Electrical installations:
9 AEG AC motors, 1,750 hp, 6,000 V, for main propulsion and thrusters.
3 Transformers 3,000 kVA, 6,000 V/440 V, three phase, 60 cycles.
8 AEG Thyristor converters for energy supply to DC motors.
8 AEG DC motors, each 800 hp, for drawworks, rotary table, slush pumps and booster pump.
2 AEG DC motors, each 400 hp, for cementing unit.

Fresh water evaporators:
2 ATLAS fresh water evaporators, capacity of each: 30 t/24 hours.

Fuel consumption:

Steaming	28-30 tons/day
Drilling	20-22 tons/day

Main propellers and thrusters

Variable pitch propellers manufactured by Lips:
2 Propulsion propellers, each 3,500 hp, diameter 4 m.
5 Transverse thrusters: 3 forward and 2 aft, each 1,750 hp; propeller diameter 2.36 m.
Pitch setting time: 100% minus to 100% plus: 8-10 sec.

Storage

Riser storage:
On-deck storage for risers with and without buoyancy, total weight 910 tons.

Drill pipe and casing storage:
Storage of casing in tweendeck hold 1.
Storage of drill pipe and casing in tweendeck and hold 2 and 3.
Total capacity for one hole with a depth of 15,000′ or two holes with a depth of 10,000′.
Total capacity 1,570 tons of tubular goods.

Dry mud, baryte and cement:
12 silos, each 46 m³ (5 for baryte, 5 for cement and 2 for bentonite).
4 Surge tanks of approx. 2 m³ each.
1 Salt tank of 80 m³.
120 Containers of 2 m³ each for storage of dry mud and chemicals.

Handling and transportation

2 Gusto deck cranes, one 25-ton crane located in front of drill floor and one 40-ton crane forward of poop; auxiliary hoists 3 tons.
3 Overhead travelling cranes in pipe storage holds with a capacity of 2.5 tons each.
1 Overhead travelling crane in container storage, capacity 4 tons.
1 BOP hydraulic handling tackle of 100 tons.
2 BOP carriages from moon pool to BOP house, capacity 200 tons.

Diving equipment

1 Diving bell for observations at atmospheric pressure.
For great depth a submarine vehicle with manipulators can be installed.

Sub-sea and surface TV equipment

Sub-sea cameras:
Axial re-entry camera for funnel guide. Control camera for tool and positioning control.
Electronic unit with multiplex camera for axial guide to be run through drillstring.

Surface cameras:
1 Camera in derrick above monkey board.
2 Cameras in moon pool area.

Helicopter deck

Helicopter deck with a diameter of 83 ft, constructed for S-61N type helicopter.

Lifesaving and fire fighting equipment

Lifesaving equipment:
2 Lifeboats of enclosed type, each for 50 persons, located adjacent to forward accommodation.
2 Lifeboats, open, 1 for 25 persons and 1 for 34 persons, located on poop deck.
4 Inflatable rafts, various locations.

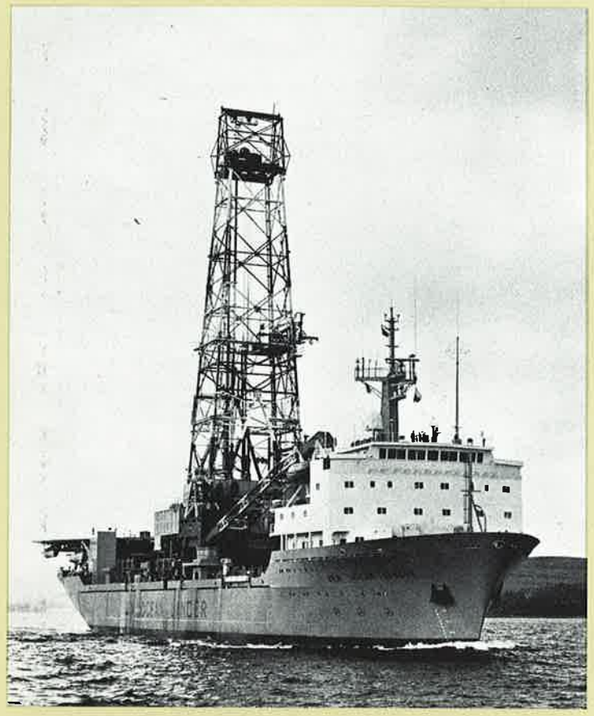
Fire fighting equipment:
CO_2 distribution network for engine room, auxiliary room and boiler room.
1 Powder station, capacity 750 kg, for mud tanks on and below deck.
Foam stations on both sides of active mud tanks on deck, each 200 l.
Foam and powder station at helicopter deck, cap. 400 l.

Sewage plant.

2 Red-fox units are installed.

Ben Ocean Lancer

Built under licence by Scott Lithgow UK



Classification

The Ben Ocean Lancer, delivered in 1977, to Ben Odeco Ltd. Great Britain, was built to the requirements of Lloyd's Register Class ✠ 100, A1. Ice class 2, L.M.C., U.M.S. The vessel also conforms to the rules and regulations of D.T.I. and N.M.D.

Principal particulars

Dimensions:

Length overall	153,64 m
Breadth	23.45 m
Depth to main deck	12.45 m
Max. draught	8,03 m
Size of moon pool	7.20 x 8.20 m

Deadweight:
Loading capacity approx. 9193 tons

Capacities:

Fuel	3147 tons
Drilling water	395 tons
Fresh water	454 tons
Potable water	246 tons
Ballast water	2150 tons

Speed:
Average service speed 12.8 knots

Propulsion:
Twin screw, total 6,000 hp

Accommodation:
99 berths in single, twin and 4-berth cabins. 4 berths in hospital.
Cabins, messroom and recreation room all airconditioned.

Operating capacity:

Waterdepth	up to 1,000 m
Drilling depth	20,000 ft

Capacities sufficient for 3 months operation.

Dynamic positioning system

Manufacturer - Honeywell.
Main positioning system based on dual acoustic position reference system with back-up systems consisting of one taut wire, one riser angle and a dual ball joint angle system.
2 digital computers calculate the ships position and operate 2 main variable pitch propellers, each of 3000 hp, and 5 variable pitch thrusters, each of 1,750 hp. to keep the ship in position above the well-head.
System accuracy 6% of waterdepth with maintenance of heading within 2 degrees under the following environmental conditions:

Wind:

Constant speed	45 knots
Gusting up to	65 knots

Waves:

Significant height	4.9 m
Significant period	12 sec.

Current:

Velocity	2 knots

Operating waterdepth 50-1000 mts.

Drilling equipment

Derrick sub-structure:
Size: 22.60 x 12.00 m, height above maindeck 7.35 m.
Height above cellardeck 10,55 m.

Derrick and Derrick equipment
Pyramid 160'. 0" Dynamic derrick, base 44' 4" x 36' 0".
Hook load 1,000,000 lbs static.
Pyramid crown block assembly.
Travelling block. Gardner Denver model 65T660.
Brown Brothers Heave Compensator (compensating load max. 500,000 lbs).
B.J. Dynaplex Hook and National P 650 swivel.
Gardner Denver model 3000 E drawworks.
Oilwell "A" 49½" Rotary table.
B.J. type "V" Pipe handling system.
Pipe setback for 198 stands drill-pipe and 10 stands drill collar.
Total weight 235 tons.

BOP and riser system:
Single stack BOP system with Cameron marine riser 18⅝". Cameron 16¾" BOP stack fitted with hydraulic and electronic multiplex controls. Also provided with acoustic back-up system.
Brown Brothers riser tensioners – 6 sets coupled hydraulically in pairs.
Maximum stroke 12' 0" allowing 45' 0" of wire line travel – maximum line tension 100,000 lbs each.

Mud pump, mud tanks, cementing unit
2 Gardner Denver PZ 11 mud pumps.
1 Halliburton twin HT-40 cementing and fracturing unit.
4 Active tanks total capacity 154 m³
3 Storage tanks total capacity 198 m³
1 Mixing tank total capacity 26 m³

Drillmaster's cabin
An enclosed air conditioned cabin equipped with desks for controls and instrumentation of:
drawworks, elevators rotary table mud pumps, mud synoptic panel. Riser tensioners, Heave Compensator, BOP controls, Dynamic positioning, fire alarm – gas detection alarm.

Storage

Dry mud, baryte and cement:
12 Silos, 43 m³ each (4 baryte, 6 cement, 2 bentonite).
4 Surge tanks 2 m³.
1 Salt tank, 260 m³ used for drilling water.
207 Containers each 1 m³ for dry mud and chemicals.

Tubulars
On main deck storage for risers with and without buoancy total weight 555 tons.
In nos 1 and 2 hold storage for casing.
In nos 3 hold storage for drill pipes.
Total for drill pipe and casing - 1,326 tons.

Handling & Transportation

2 Clarke chapman Deck cranes - one of 40 tons and one of 25 tons.
4 Overhead travelling cranes in holds.
3 BOP carriages – each 200 tons load.

Diving equipment
1 Diving bell for observation. Diving at atmospheric pressure.
2 Decompression chambers.

Pacnorse I

Built under licence by Scott Lithgow UK

Classification

The Pacnorse I, delivered in 1979, to Pacnorse, Bermuda, was built to the requirements of Det Norske Veritas Class ✠ 1, A1. Drilling vessel and Ice Class B.
The propulsion machinery meets the society's requirements for Class E.O.

Principal particulars

Dimensions:

Length overall	153,64 m
Breadth	23.45 m
Depth to main deck	12.45 m
Max. draught	8.03 m
Size of moon pool	7.20 x 8.20 m

Deadweight:
Loading capacity approx. 8837 tons

Capacities:

Fuel	2087 tons
Diesel oil	594 tons
Fresh water	500 tons
Potable water	246 tons
Drilling/Ballast water	3743 tons

Speed:
Average service speed 12,8 knots.

Propulsion:
Twin screw, total 7,000 hp

Accommodation:
99 berths in single and twin berth cabins. 4 berths in hospital.
Cabins, messroom and recreation room all airconditioned.

Operating capacity:

Waterdepth	up to 1,500 m
Drilling depth	20,000 ft

Capacities sufficient for 3 months operation.

Dynamic positioning system

Manufacturer – Honeywell.
Main positioning system based on dual accoustic position reference system with back-up systems consisting of one taut wire, one riser angle and a dual riser angle system.
2 digital computers calculate the ships position and operate 2 main variable pitch propellers, each of 3450 hp, and 5 variable pitch thrusters, each of 1,750 hp to keep the ship in position above the well-head.

System accuracy 6% of waterdepth with maintenance of heading within 2 degrees under the following environmental conditions:

Wind:

Constant speed	45 knots
Gusting up to	65 knots

Waves:

Significant height	4.9 m
Significant period	12 sec.

Current:

Velocity	2 knots

Operating waterdepth 50-1500 mts.

Drilling equipment

Derrick sub-structure
Size: 22.60 x 12.00 m, height above main deck 7.35 m. Height above cellardeck 10,55 m.

Derrick and Derrick equipment
Pyramid 160' 0" Dynamic derrick, base 44' 4" x 36' 0".
Hook load: 1,000,000 lbs static.
Pyramid crown block assembly.
Continental Emsco model RA-60-6/650 tons travelling block and swivel, model L-B-650 with 650 tons capacity.
Brown Bros duplex Heave Compensator (compensating load max. 500,000 lbs stroke 20')
B.J.No. 33502 type 550, dynaplex – 500 tons capacity.
Continental Emsco C-3 Drawworks.
Continental Emsco T 4950 Rotary Table with 49½" opening.
B.J. type "V" Pipe handling system.
Piepe set back for 198 stands of 5" drillpipe and 10 stands drill-collars.

BOP and riser system:
Single stack BOP system with Rucker marine riser 18⅝" for 1500 m.
Vetco 16¾" BOP stack with well-head connectors and riser connectors of Vetco type H-4 and fitted with Koomey electro hydraulic multiplex controls. Also provided with Koomey acoustic back-up system.
Brown Brothers riser tensioners - 12 sets coupled hydraulically in pairs.
Maximum stroke 12 ft allowing 45 ft of wire line travel – maximum line tension 80,000 lbs each.

Mud pumps, mud tanks, cementing unit
2 Oilwell A-1700 PT triplex single acting mud pumps.
1 Halliburton twin HT-400 cementing and fracturing unit with 2 triplex pumps for 10,000 psi.
4 Active tanks total capacity 154 m³
4 Storage tanks total capacity 275 m³
1 Mixing tank total capacity 36 m³

Drillmaster's cabin
An enclosed and air-conditioned drillmasters cabin equipped with desks for:
Drilling control and BOP control.
Display for dynamic positioning and dp-control.
Synoptic panel for mud flow control C.A.T. 100 system.
Heave compensator and riser tensioner controls.

Storage

Dry mud, baryte and cement:
12 silos, 43 m³ each (4 baryte, 6 cement, 2 bentonite).
4 Surge tanks 2 m³ each.
207 containers, each 1 m³, for storage of dry mud and chemicals.

Tubulars
On main deck storage for risers with and without buoyancy total weight 515 tons.
In nos 1 and 2 hold storage for casing-pipe.
In nos 3 hold storage for drill pipes.
Total storage for drill pipe and casing - 1,350 tons.

Handling & Transportation

2 Clarke Chapman Deck cranes – one of 40 tons and one of 25 tons.
4 Overhead travelling cranes in holds
2 BOP carriages – each with a capacity of 200 tons load and 1 ancillary transporter carriage for wellhead equipment – approx 20/22 tons capacity.

Diving equipment
1 Diving bell for observations at atmospheric pressure, fitted with single hydraulically operated manipulators.
Subsea Television Equipment and combined Acoustic Television system for wellhead re-entry.

Yard No's 15 - 16 - 17

Construction under licence
by Rauma Repola Oy, Finland

VO Sudoimport, Moscow, USSR has ordered in March 1979 three dynamically positioned drillships of the "GUSTO" design.

The d.p. drillships are intended for operation in Arctic areas and shall be built to the requirements of the USSR Register under class notation: K.M.⊛ , UL, [1] F, A2 Drillship, Super Ice Class.

The adaption of the design to meet the specific requirements shall be carried out by RSV Gusto Engineering in close coöperation with Rauma Repola and Sudoimport.

The three ships are scheduled for delivery in the beginning of 1981, the end of 1981 and mid 1982.

RSV

Offshore Division

RSV Gusto Engineering b.v.

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