M.V. Rocknes

The worlds largest dynamically positioned flexible fall pipe rock dumping vessel

In answer to the increasing demand for rock dumping offshore, May 3rd 2003, saw the commissioning of the single screw flexible fall pipe (FFP) and dynamically positioned rock dumping vessel "Rocknes" after being converted from a self unloading bulk carrier at Keppel Verolme Shipyard in Botlek (near Rotterdam), The Netherlands. Weighing in at 25,000 tons deadweight, this "heavy weight" is the largest ever rock dumping vessel constructed to date in the entire world. The following article describes this modern rock dumping giant and goes into some detail regarding the design challenges which go with the conversion of a bulk carrier into such a vessel.

M.V. "Rocknes", rock dumping/bulk carrier vessel

The owners

"Rocknes" is owned by Kvitnes Shipping Company Ltd. St.Johns which is a part of the international operating Hartmann group based in Cadenberge, Germany. The owners have entered into a long term charter party agreement with Van Oord ACZ to charter their recently built (2001) bulk carrier "KVITNES" for offshore rock dumping purposes.

The charterers

"Rocknes" is contracted for a long term by van Oord ACZ. Van Oord ACZ is an international contractor, specialised in dredging, rock dumping, offshore and coastal construction. With more than 50 years of contracting experience, Van Oord ACZ has proven its technical and management capabilities on projects of all sizes from small maintenance works through to large turnkey build and install contracts.

Van Oord ACZ reputation has been built on its know-how, innovative technical solutions and versatile equipment. For over 25 years, Van Oord ACZ has held an established position in the offshore construction market and is regarded as market leader for seabed intervention. The company has always been at the forefront of rock dumping and dredging technology and has recently used its comprehensive technical skills and resources to take on, and bring to a successful conclusion, major projects such as the installation of the Malampaya Concrete Gravity Platform.

Van Oord ACZ owns and operates a large comprehensive fleet of specialised DP flexible fall pipe vessels, side rock dumping vessels, trailing suction hopper and cutter suction dredgers, construction and support vessels. For shore-end installations, shallow draft vessels are operated on either DP, anchors or spud poles.

With its DP rock dumping vessels, Van Oord ACZ excels in protecting pipelines and cables in all water depths. The flexible fall pipes are fitted with purpose-built, state of the art ROV's which ensure that the fall pipe is accurately guided along the cable or pipeline thereby ensuring the high precision required for rock dumping. These ROV's can also be used for the attachment of dedicated dredging, trenching and jetting tools. Sophisticated survey equipment is used by the crew to check that results are within specification.

Bulk carrier "Kvitnes" converted to "Rocknes"

In order to carry out offshore rock dumping, the bulk carrier "Kvitnes" had to be re-designed for her new role but, at the same time, keep her capabilities to fulfil her original role in the bulk carrier trade (albeit with some reduced cargo capacity and vessel free sailing speed, approx. respectively 3000 ton and 0.6 knots). The actual conversion was led by a special design team formed by Van Oord ACZ. This team was involved heavily in the predesign, pretendering, tendering, design engineering, coordination of conversion work at the ship yard, all ship trails and delivery tests. Due to the short time available for the complete project (planned conversion time maximum 112 days) from concept to delivery for operations, Van Oord ACZ also took responsibility for the delivery of a large number of key components for the "Rocknes". The actual conversion was carried out by the Keppel Verolme Shipyard in Botlek (near Rotterdam), The Netherlands.The total time required for the conversion was 124 days, this was 12 days more than planned but still a remarkable performance bearing in mind the unexpected problems encountered during the course of the project. Causing the latter were for example: incorrect as-built drawings, required unexpected modifications to the vessel under water in order to enhance hydromechanic performance (i.e. incur less speed loss), late delivery of some key components, human error, changes in installation instructions etc.

The design challenge

The driving forces behind the present design was to regain Van Oord ACZ's previous position in the rock dumping industry, i.e. that of being the company with the largest rock dumping capacity in one unit and also to be able to transport this large capacity in a fast manner and finally to be able to dump rock in deeper (and more distant) waters. It was thought that this would meet future client's wishes. In order to make this economically feasible a vessel must be designed with a high deadweight and a relatively high sailing speed.

The specific weight of rock for dumping varies from 1.4 to around 1.8 ton/m^3. The weight of rock in the cargo spaces leads to the demand for large buoyancy contributions from either the forehead, sides and/or aft part of the vessel. This results in large (mainly) empty spaces forward, beside and aft of the cargo holds. The holds themselves must be self-trimming and self-discharging and this leads to sloped sides, bottoms and upper parts and a centre conveyor belt system leading all along the entire length of the holds. Discharging of rock from the holds is done by way of the forehead part of the ship. It is of paramount importance that the underwater flow lines around the vessel are such that the wave-induced resistance is minimised as much as practically possible and that the wake field in the vicinity of the propellers are well predicted in order to be able to custom design the single open propeller (i.e. without a nozzle configuration) and the dynamic positioning system for maximum propulsion efficiency and station keeping ability.

Loading rock on board is done in port with the aid of shore facilities.

Discharging rock from the ship to the seabed also requires special equipment in the form of conveyor belts, both longitudinal (i.e. conveyor boom) and transverse, combined together to form an intricate conveyor belt system and (unusual for this type of rock dumping vessel) a flexible fall pipe system (unusual because this FFP system consists of buckets slotting into each other and joined by chains). Between the conveyor belt system and the FFP one finds the rock hopper which is no more than a temporary storage space for rock while being transported from vessel hold to sea bed. The flexible fall pipes are fitted with purpose-built, state of the art ROV's which ensure that the fall pipe is accurately guided along the cable or pipeline thereby ensuring the high precision required for rock dumping. These ROV's can also be used for the attachment of dedicated dredging, trenching and jetting tools.

Looking at the logistics of these systems, i.e. firstly the inner conveyor system: longitudinally and finally vertically moving/lifting rock out over the full length of the vessel's holds on to, secondly, the boom conveyor belt into the rock hopper and from there onto the transverse conveyor belt into FFP from where the rock are led to their final destination, one can appreciate the difficulty for the designer to place all these pieces of equipment in such a way that no conflicting situations occur and that high rock dumping production rates are met.

On top of this, the transverse stability of the vessel is not exactly benefited by all this sturdy heavy duty equipment placed well above the main deck level.

Another design challenge worth mentioning here is the moon pool which houses the FFP unit. Previous FFP rock dumpers have their FFP positioned outside the side of the vessel utilising the cantilever principle. Advantages of the moon pool solution is less effect of vessel motions on the rock dumping process (due to rolling of the vessel) and easier system use and access etc. (everything is well within the ship's perimeter). This moon pool is constructed in such a manner that it can be retrofitted with bottom doors if deemed necessary at a later stage in the vessel's working life. Allowance has been made in the ship's construction for such doors and their hinges, hydraulic cylinders etc. Such bottom doors are not what you would call standard rock discharging equipment for a rock dumper and the hydraulic cylinders require protection against any stray falling rock (aggressive material to say the least in such a state) and therefore steps have been taken here to separate these cylinders from contact with the rock. All these (and more) design demands finally resulted in the following vessel.

The vessel

"Rocknes" is specially designed for the transport and discharging of rock and so befit the offshore capabilities that Van Oord ACZ offers to their world wide clients which include:

- protection and stabilisation of pipelines, cables and offshore constructions
- cable and pipeline shore end installation and burial including shore pulls
- civil construction of shore approaches and landfalls
- construction of sleepers and embankments

Table 1. Main Particulars & Other Data Before and After Conversion

	Dimension	Before conversion	After conversion
Vessel name	[-]	M.V. "KVITNES"	F.F.P.V. "ROCKNES"
Type of vessel	[-]	Self-unloading Bulkcarrier	Flexible Fall Pipe Vessel and Bulkcarrier
Class:	[-]	Germanischer Lloyd	Germanischer Lloyd and Bureau Veritas
Building/conversion year	[-]	2001	2003
Shipyard	[-]	J.J. SIETAS Shipyard	KEPPEL Verolme Shipyard
Length o.a.	[m]	166.30	166.30
Breath	[m]	24.75	24.75
Depth	[m]	14.00	14.00
Draught	[m]	10.50	10.50
Deadweight	[mt]	28100	25960
Displacement	[mt]	35400	34901
Lightshipweight	[mt]	7292	9360
Speed	[kts]	14.1	13.8
Main Propulsion Power	[kW]	7300	7300
Gross Tonnage	[GT]	17357	17765
Net Tonnage	[NT]	5748	5329

- deep-sea dredging, seabed intervention and pre-sweeping
- trench dredging and backfilling
- hydraulic & geotechnical engineering
- installation of Gravity Base Structures
- installation of CALM Buoys
- installation of anchor systems
- installation of offshore wind farms

This large vessel is now being utilised in the rock dumping business. Working mainly in Northern Europe (i.e. The North Sea) and the Nordic countries, i.e. Norway and Sweden; i.e. there where the oil/gas business is. The vessel will be loading at harbours in Norway, the United Kingdom, Holland, Belgium, Germany and France.
The vessel is fitted out with a moon pool on the starboard side from where the FFP drops off to just above the sea bed where the ROV is waiting to finalise the positioning of the dumping of the rock. Furthermore, a 38m^3 hopper for the buffer containment of the rock is fitted around midships on deck and there are also special facilities for the adjustment of the length of the FFP in case of variable sea bed which will be discussed more in detail later on in this article.

Main Particulars

De main particulars of "Rocknes" are shown in Table 1.

The vessel is classed by Germanischer Lloyd and Bureau Veritas with the notation

I 3/3 E ✠ Bulk carrier and rock dumper (Deep Sea) AUT - MS
Dumping in unrestricted areas up to a depth of 1,200 m.
Dynamic Positioning Class 2 unrestricted up to with significant wave height (H_s) < 5.5 m.

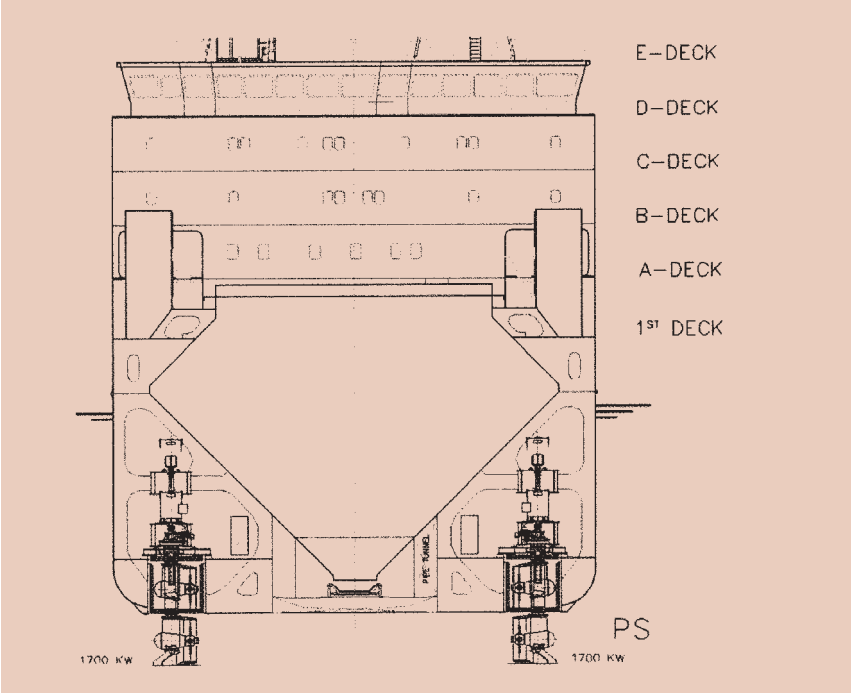
eral, Germanischer Lloyd has classed the ship as a bulk carrier and B.V. has classed the rock dumping equipment on board. There are no classification rules for rock dumpers but Van Oord ACZ, together with B.V. found agreement upon construction materials, construct details and fabrication details etc. for the rock dumping equipment on board.
This means that the vessel can be active as a rock dumper but, in times of work shortage therein, she may be plying once more in the bulk trade sector. In this way the ship should be well utilised in the coming years.

Internal subdivision

Originally the "Kvitnes" was a fairly standard (self discharging, internal conveyor belt + conveyor boom system) bulk carrier design with an internal subdivision (from forehead to aft) consisting of forecastle, 7 holds, engine room aft and accommodations with bridge also aft. On the forecastle deck is situated the boom conveyor belt cargo discharging system which may be swung over to either port or starboard to unload the cargo on to the quay side.
Resulting from the conversion, a different subdivision (mainly effecting hold, deck and engine room configuration) has been introduced in the design. From forehead to aft the internal subdivision of "Rocknes" is as follows (see General Arrangement Plan):
- The vessel has a forecastle deck which, besides the usual anchor and mooring gear, still accommodates the boom conveyor belt discharging system which now also can discharge the cargo from forehead to the rock hopper (read cargo buffer) just abaft of midships.
- Abaft of the forecastle, there are four cargo holds (two of which are not effected by the conversion) each closed with hatches situated on the upper deck. The hatch coaming of cargo hold #1 has been shortened by 1 frame space and cargo hold #4 has been enlarged by 9 frame spaces to gain as much cargo capacity as possible.
- What was previously hold #5 of "Kvitnes" has now been converted so as to accommodate electrical switch board rooms and a number of dedicated workshops for the rock dumping process. In order to realise this, the former hold space has been fitted out with four different decks.
- Built (on starboard side) into former cargo hold #5 (and partly in the wing tank) is a moon pool (L=7.00 m and B=5.60 m}. This moon pool accommodates the free fall pipe for the discharging and dumping of rock.
- On deck, above former cargo hold #5, a hopper (capacity 38 m^3) is situated with a cargo capacity throughput of just up to 2000 tons/hour. This hopper is fed with cargo via the boom conveyor belt system and the port side transverse conveyor belt. The hopper, in turn, discharges the cargo to the FFP via three conveyor belts.
- Also situated within former cargo hold #5 are Fresh Water and MDO (deep) tanks for respectively main engine and auxiliary engines. Also a HYPAP space has been created in front of the moon pool.
- Abaft of the moon pool etc., former cargo holds #6 and #7 have remained unchanged apart from the longitudinal steel construction from the moon pool
- Behind cargo hold #7 is situated the engine room with main engine/shaft generator, auxiliary generators etc.) (virtually unchanged with the exception of the placement of enlarged sewage unit, enlarged fresh water maker, extra AC compressors for the new accommodation and extra electrical switch boards to enable the connection of the new four auxiliary power sources to the complete ship's electrical systems).

In gen- ***Moonpool from above***

Model tests of moonpool



Cross section of a hold

• Between the fore peak bulkhead and the forward engine room bulkhead all cargo and working spaces are fitted with wing tanks and double bottom tanks. These spaces include a number of watertight bulkheads.

• In each of the wing tanks (SB and PS) of hold #6, one retractable azimuthing thruster (1700 kW) has been placed for unrestricted DP-2 purposes.

• Behind the engine room is situated the aft peak compartment which is designated as fresh water tank space. This SB tank however has been reduced considerably in height (by the lowering of the local deck by 1.20 m) over part of the vessel's breadth in that area in order to accommodate a new auxiliary engine room (4 x 1825 kW), placed on starboard side) that was necessary to produce the extra electrical power required for the vessel in her new role as rock dumping vessel. The air intake ducts and exhaust pipes for these four auxiliary engines are also situated on the starboard side just aft of the accommodations.

Table 2. Cargo Hold Capacity

Hold Name	Cargo [mt]
No. 1	3060
No. 2	4060
No. 3	4328
No. 4	4542
No. 5	-
No. 6	4550
No. 7	4550
Total	25090

• Also above the aft peak fresh water tank is situated the steering gear room.

• Above the engine room sprouts a four layer accommodation deckhouse on top of which the navigation bridge is placed.

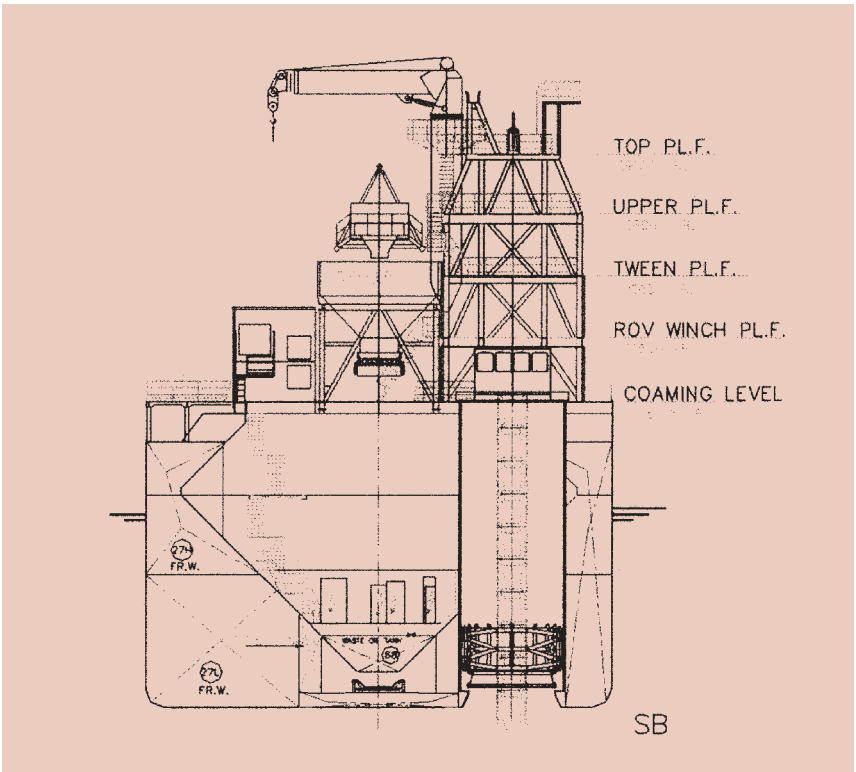
• Behind/below the accommodation deckhouse, the aft deck holds the usual anchor and mooring gear.

The cargo hold measures at main deck level L= 14.70 m and B= 14.00m. The transverse cross section of the hold is designed in such a way so as to accommodate the long central conveyor belt (which is used to discharge the cargo) travelling along the complete length along the bottom of the hold. The hold's sides, top and bottom are furthermore sloped in order to make the hold self trimming (and avoid shifting of cargo at sea) and thereby facilitate the discharging of the cargo. This causes large loss of hold volume and also results in a high vertical centre of gravity of the cargo. The capacities of the different holds are given in Table 2.

The moon pool has a constant waterline cross section which measures at main deck level (L=7.00 m and B=5.60 m). The FFP is drawn off the starboard deck, fed through the moon pool and finally held suspended in position at the required length to suit the rock dumping depth.

The spaces underneath the holds are utilised for ballast tanks and in some cases fresh water or fuel tanks. Aside the conveyor belt centre tunnel throughout the length of the cargo holds a section is used as a piping tunnel on PS and as cable duct on SB side.

In the engine room, situated on the upper tweendeck port side and starboard, fuel oil settling tanks and fuel oil day tanks are positioned while space is centrally allocated for the switchboard room in the ECR and workshop spaces abaft. On the lower tweendeck the auxiliary systems like the fresh water maker, the sewage unit, the AC compressors and several coolers are installed on PS, while on SB side the fuel treatment installations are situated. The space below the tweendeck aft of the engine room has been designated as a void tank Space on SB side and as Fresh Water Tank on PS.



Cross section moon pool

Table 3. Total Tank Capacity	
Tank Contents	Capacity [m^3]
Heavy Fuel Oil	1123
Marine Diesel Oil	592
Lub. Oil	56
Fresh Water	535
Ballast Water	15940
Total	**18246**

The tankcapacities of the vessel (100%) are shown in Table 3.
In the forecastle, space has been dedicated to switchboard rooms, hydraulic power pack room and working spaces such as boatswain stores and paint stores.

Accommodation

The accommodation for crew and officers is arranged above main deck in a deckhouse placed aft above the engine room, as per general arrangement plan (see GAP).
Accommodation is arranged for a total complement of 50 persons (this was 20 pers. prior to conversion). The extra 30 persons needed in the rock dumping mode are sub-divided into the following groups/activities:

- Project planning
- Project control
- Project execution
- Project maintenance

The vessel accommodations as such therefore consist of the following :
Bridge deck:
- Wheel house with communications room on PS
- Rock Dumping Process Room
- Post Processing Room SB aft
- Client Office and Superintendent Office on PS

Officers' C-deck:
- 1 Captain's cabin with separate sleeping room and private bathroom annex
- 1 Chief Engineer's cabin with separate sleeping room and private bathroom annex
- 9 single berth cabins with combined private bathroom
- 6 double berths cabins with combined private bathroom

Officers' B-deck:
- 7 single berth cabins with combined private bathroom
- 4 double berths cabins with combined private bathroom
- 4 Offices
- 1 12 persons Meeting room

Crew's A-deck:
- 4 single berth cabins with private bathroom
- 2 Offices
- 1 Cargo Control Room
- 1 Bonded Stores locker

Crew's Maindeck:
- 2 double berths cabins with private bathroom
- 1 five persons cabin with private bathrooms
- 1 Changing room
- 1 First Aid Room
- 1 Officer's Messroom for 12 persons
- 1 Crew's Messroom for 23 persons
- 1 Rec. Room with Internet Café
- 1 Galley
- 1 Provision store room with refrigerated stores incorporated
- Several store rooms abaft

Discharging installation

There are two systems available for discharging the cargo:
- In bulk carrier mode: 'dry' discharging using the internal conveyor belt system and the boom conveyor belt system
- In rock dumping mode: 'wet' discharging via the 'dry' discharging components augmented by transverse conveyor belt system, rock hopper, transverse conveyor belt system, the moon pool with therein the FFP and the ROV at the lower end of the FFP. This is described in more detail further on in the text.

'Dry' discharging (the usual way to discharge this bulkcarrier)
"Rocknes"'s fully automated conveyor unloading system, which can be controlled from the Cargo Control Room or the bridge is designed for an average capacity of 2,000 ton/hr. The conveyor boom is hoisted to approx. 18 degrees and swung either over to port side or starboard depending on the preferred discharge location. The boom conveyor's 100° maximum slewing angle is controlled by hydraulic motors with gear wheel and slewing ring with internal cogs. The boom is luffed by hydraulic cylinders. The boom conveyor is a heavy structure, especially when loaded, and therefore needs a strong foundation. When offloading, the entire discharge system as well as the ship's mains derive their power from the auxiliary generator power situated in the main engine room. When not in use the boom conveyor is rested in two craddles, one at frame 160 and one midships and sea fastened.

The rock discharging
The rock discharging installation may be subdivided into the following systems:

The conveyor belt system
At the heart of the discharging system are the large conveyor belt units. These belts have a maximum discharging capacity of 3000 ton of rock per hour and this is limited only by the capacity of the rock hopper and not by the conveyor belt system.
The steel construction of the conveyor belt system are - for the case that contact is made with the rock material - covered as protection against wear with a rubber layer. Depending on the position in the installation, the rubber layers may have a thickness of 25 or 12 mm. The belt material (width= 2000 mm) is also of the hard wearing type and is made of rubber with a thickness of 25 mm
Maximum angular elevation of single belt conveyor system is 10 degrees. In the forehead part of the vessel, between forecastle deck and tanktop, the rock material is clamped between two conveyor belts and is thereby able to pass over the vertical distance between hold centre line conveyor system to large boom conveyor system of around 23 m.

Midship tower construction with winches and a deck crane
The midship tower construction is situated around and above the moon pool and provides the support for 9 winches and a 21 ton deck crane. These winches are utilised for transportation, placing and securing of the FFP and for moving the Catcher Frame and the Umbilical Guidance Frame. The bucket winch has a maximum tension of 90 Tons and a maximum wire speed of 15 m/s. Required kW amounts to approx. 250kW for all these winches together.
Furthermore, any changes in the elevation of the sea floor, obstacles etc. may be compensated either by use of the telescopic capability of a section of the lower end of the FFP or by adjusting the vertical length of the FPP with the aid of the winches.
The 21 ton SWL (maximum outreach deck crane is 23 m) is used for general purpose hoisting and lowering work in the vicinity of the moon pool as well as for equipment maintenance etc. All this makes "Rocknes"'s rock dumping installation more powerful than that of other large rock dumping installations in today's market.
Winches and deck crane are placed in such a way that easy access is given for maintenance and repair thereof.

The Remote Controlled Underwater Vehicle (ROV)

There can only be talk of efficient rock dumping when the position of the lower end of the FFP can be exactly positioned just above the required point to be buried/covered/filled etc. This requirement has been fulfilled by the placement of an ROV at the lower end of the FPP. This ROV (see Photo) is connected to the vessel by means of three umbilicals/hoisting wires (three working and each others standby) and can position the lower end of the FPP by way of four built in thrusters (75 kW/each). These thrusters are fixed with regard to the di-

ROV

rection of available thrust. Three combined umbilical/steel wires support the ROV and have a rock dumping process control and monitor function. Each umbilical is constantly electronically checked regarding ability and status for data transmission/receival; ROV control and process monitoring functions are constantly thereby carried out via a reliable umbilical connection line.

The main particulars of the ROV are as follows:
Make: The Engineering Business Ltd. (UK).
Dimensions: Diameter 3.80 m, Height 4.00 m.
Propulsion: Four thrusters of 75 kW.
Fixture to vessel: Suspended by three lift lines/umbilicals on three ROV winches of 37 kW each.
Frames: ROV provided with Catcher Frame and Umbilical Guidance Frame.
Control System: Integrated control system covering lift winches, ROV and splitter head.
The ROV is provided with the following survey equipment:
Navigation and processing computer systems, HIPAP, bathymetric systems, SEABAT 8125, multibeam and mechanical scanning profilers, scanning sonar, underwater cameras and lights. Other systems can be installed optionally.

The Flexible Fall Pipe (FFP)

The FFP system is situated on SB in either vessel transport mode (on deck just afront of the rock hopper installation) or in suspended condition (rock dumping mode) in the moon pool. The FFP consists of open tapered buckets (top diameter 1100 mm, and height 2250mm) and these are kept in one line by way of two chains running through open rings along the bucket's top perimeter; the chains are furthermore connected to every fifth bucket via slings. The total FPP length is 1300 m. which bears in mind a vertical angular FPP displacement due to sea and weather conditions of around 10 degrees. This coincides with the "Rocknes" working in a significant wave height of around 5.5 m. The Flexible Fall Pipe Launching/Recovering speed is 15 mtr/min

Ballasting

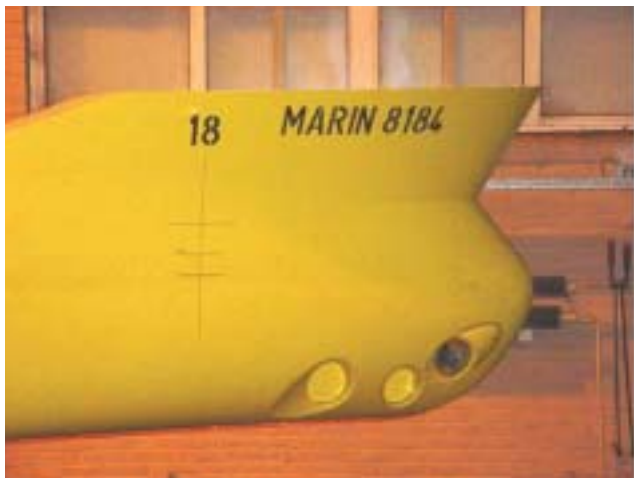
The vessel is equipped with ample ballast tanks (total ballast capacity 15,940 ton) and may be ballasted to almost any favourable condition when required. If necessary, the trim of the vessel can be adjusted by ballasting of the fore peak or the ballast wing tanks or d.b.tanks. To this effect, two electrically driven suction, ballast, fire fighting, general purpose pumps are situated in the engineroom of 900 m^3/h each with a pressure head of approx. 1,5 bar. The ability to ballast the vessel may be very important for DP purposes, i.e. thus optimise the forces required for DP.

Dynamic Positioning System

The vessel is equipped with Unrestricted Dynamic Positioning Capabilities as far as Classification Rules are concerned. This has been realised by the fitting of:

- Three tunnel thrusters in the bow section (2

Bow thrusters units



Model 'Rocknes' bow

x 1,200 kW + 1 x 1,480 kW)
• Two retractable azimuthing thrusters midships, just abaft of the moon pool on starboard and on port side (2 x 1,700 kW)
• One tunnel stern thruster, in the aft part of the engine room just below the propeller shaft (1 x 1,000 kW)
All told the six thrusters have a total power of 8280 kW as may be seen in Table 4. The DP system is manufactured by Kongsberg Simrad (SDP 21).
Before they arrived at this thruster configuration, a large number of different thruster configurations (5) were investigated regarding ERN number, power demand and first costs. Table 5 shows a number of such different thruster configurations and also mentions the main findings therein. During this investigation close contact was held with MARIN in The Netherlands. Resulting DP capabilities were determined via MARIN model tests and calculations.

Rock loading and dumping process operation/handling

The rock loading and dumping process is controlled and monitored in different places/spaces. The loading process is checked in the cargo control room and the rock dumping in the Dump Process Room on the bridge. Visual control is gained via a number of camera's and monitor screens etc.
The rock dumping console has an operation mimic showing all cargo discharge valves of each cargo hold and the conveyor belt controls. Besides this, there are the necessary LCD-screens, metres, pointers, signal lamps etc.
The rock dumping instrumentation include, amongst others:
- a depth and monitoring system;
- a discharge recorder,
- a system to regulate, monitor and show the position of the FFP;
- regulation of the rock dumping speed;

There is also an unloading console in the wheelhouse where the operator has a good view on the unloading equipment

Table 4. Main Engine and Thruster Power Data

Unit description	Number [-]	Thruster name [-]	Power/per unit [kW/unit]	Propulsion Power Total Power [kW]	DP Power Total Power [kW]	Total Power [kW]
Main Engine	1	T7	7300	7300		7300
Bow Thruster	2	T1 & T2	1200		2400	2400
Bow Thruster	1	T3	1480		1480	1480
Midship Thruster[1]	2	T4 & T5	1800		3600	3600
Stern Thruster	1	T6	1000		1000	1000
			Total Power [kW]	7300	8480	15780
	% Total installed power			46,3	53,7	100,0

[1]Retractable Thruster

Engine installation

"Rocknes" has in the engineroom one MAK main diesel engine , type 8M43, rated at 7300 kW m.c.r. at 500 rpm. This main engine drives via an integrated coupling in the reduction gearbox (make ADVANCE G.m.b.H.), type GVE 950 x 3,29, a controllable pitch propeller (make: four bladed WÄRTSILÄ Propulsion Netherlands, type 4C13). A shaft generator is driven via a PTO, make STN-ATLAS, type SE 500 S4 V1 (2250 kVA - 1800 rpm).

Auxiliary installation

"Rocknes" has 3 + 4 auxiliary generators and an emergency generator. The original gen. sets are placed in the engineroom and the four new gen. sets are placed in the New engine Room at SB aft.
The three original auxiliary generator engines (air started) make CATERPILLAR, type 3508 DI-TA-SCAC with an output of 682 kW at 1200 rpm. These auxiliary diesel engines drive a STN generator with an output of 800 kVA and a frequency/speed of 60 Hz/ 1200 rpm with a voltage of 440 VAC/3 Phase. The cosine phi factor of this generator is equal to 0,8.
The four new auxiliary generator engines (air started) make CATERPILLAR, type 3516B DI-TA with an output of 1901 kW at 1800 rpm. These auxiliary diesel engines drive a LEROY-SOMER generator with an output of 2281 kVA and a frequency/speed of 60 Hz/ 1800 rpm with a voltage of 690 VAC/3 Phase. The cosine phi factor of this generator is equal to 0,8.

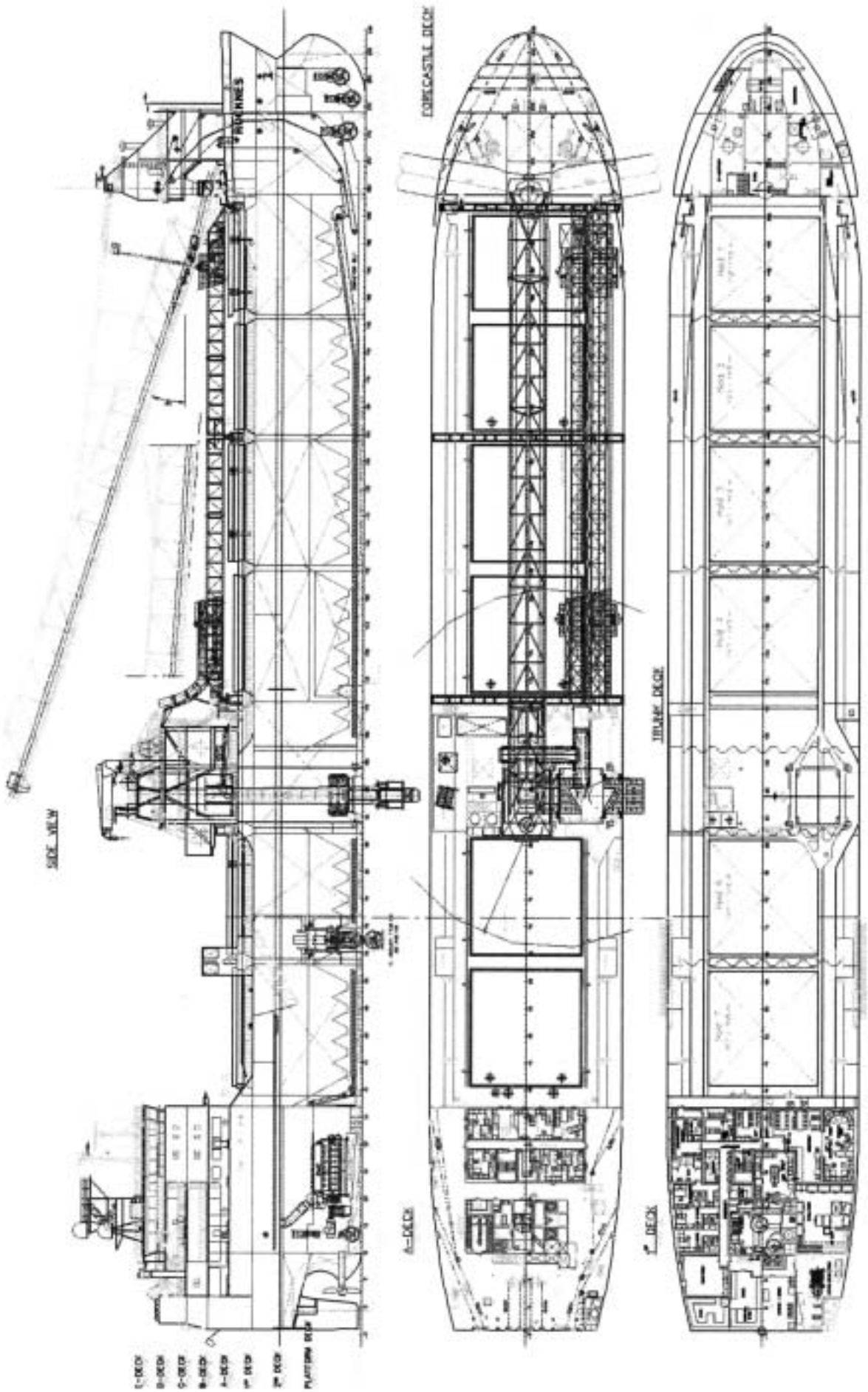
The emergency generating set is a CATERPILLAR diesel engine,type 3508 DI-TA SCAC with an engine output of 682kW (at 45°C). This auxiliary engine drives an STN-ATLAS generator with an output of 800 kVA with a frequency/speed of 60 Hz/ 1200 rpm and a voltage of 440 VAC/3 Phase (Cos phi = 0,8).

Propeller installation

"Rocknes" has one fixed pitch propeller (four bladed). This system is designed for a free sailing speed at around 13.8 knots.

Table 5. Thruster Configurations Investigated

Configuration Number [-]	Unit description	Number [-]	Power/per unit [kW/unit]	Thruster Power Total Power [kW]	Thruster Power Total Power [kW]	ERN Number	Costs
1	Azimuth thrusters	4	1200	4800		Too High	High
	Bow thruster	1	original	1000			
	Stern Thruster	1	original	1000	6800		
2	Azimuth thrusters	4	1500	6000		Acceptable	Even Higher
	Bow thruster	1	original	1000			
	Stern Thruster	1	original	1000	8000		
3	Azimuth thrusters PS	2	1500	3000		Better	Lower costs
	Azimuth thrusters SB	1	1200	1200			
	Bow thruster	1	modified	1333			
	Stern Thruster	1	modified	1222	6755		
4	Azimuth thrusters PS	1	1500	1500		Better, but less than present vessels	Costs lower than before
	Azimuth thrusters SB	1	1200	1200			
	Bow thruster	1	modified	1333			
	Extra Bow thruster	1	1200	1200			
	Stern Thruster	1	modified	1222	6455		
5	Azimuth thrusters PS	1	1500	1500		Best	Higher costs
	Azimuth thrusters SB	1	1200	1200			
	Bow thruster	1	modified	1333			
	Extra Bow thruster	1	1200	1200			
	Extra Bow thruster	1	1500	1500			
	Stern Thruster	1	modified	1222	7955		


SIDE VIEW
ENGINES
FORECASTLE DECK
A-DECK
UPPER DECK
1st DECK

Other equipment

Rudder steering machine

The single rudder is rectangular with a streamlined cross section. It is of the free hanging type and has an area of 24 m^2. An automatic continuous grease lubricating system is provided for the rudderstock bearings. The rudder arrangement permits a maximum rudder angle of 45° from centre each side.

The steering gear is of the electric-hydraulic type make NMF, type 2Z-SL 320/45gr-K. The hydraulic system of the steering gear is fed by two electrically driven hydraulic pumps. In normal operation mode, both pumps are in operation.

Cranes for moving equipment stores etc.

Cleverly installed for maintenance service on deck and rock dumping equipment, a deck crane has been fitted on top of the tower construction The maximum capacity of this deck crane is 21 ton at 23 m.

Further hydrodynamic design considerations

"Rocknes" has an average service speed of 13,8 knots, which for her large displacement, (block coefficient approx. 0.78) proposed a formidable design challenge for the shipyard. In close co-operation with MARIN, the vessel was fitted out with a spoiler on tunnel thruster T1 and scallops on tunnel thrusters T1 and T3.

Around the protruding azimuth thrusters T4 and T5 streamlined boxes were fitted.

During the sea trials, "Rocknes"'s speed was noted as 13.8 knots at 8.5 m vessel draft. This was 0.3 knots slower than required in the vessel's conversion agreement with the Owners.

Also the behaviour of water in the moon pool (i.e. vessel workability etc.) was subject of research carried out by MARIN.

Where is "Rocknes" now?

"Rocknes" is now in the southern part of the North Sea There she is engaged in survey and rock dumping work. The vessel has been booked for several offshore works until late 2003. The prospect for 2004 looks good. Van Oord ACZ seems to have taken the right approach to the market.

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