Multi purpose offshore installation vessel "Smit Pioneer"

In September 1999 Smit International put the Multi Purpose Offshore Installation vessel "Smit Pioneer" into service. Between October 1998 and August 1999 the former lash carrier underwent a major conversion at the Newcastle (UK) based yard of A&P Tyne. The launching of the vessel into the offshore installation market marks a new era of offshore installation vessels. Her first two jobs, the installation of flexibles and manifolds for the Kuito project in Angola and the salvage of the Egypt Air flight 990 off the American East coast, finished successfully.

Fig.1. Smit Pioneer on trials after conversion

The Smit Pioneer (former Danube Shuttle) is a sister vessel of the Smit Enterprise. Both lash carriers, built in 1984 in Italy, were acquired by Smit International at the end of 1997 after extensive feasibility studies into the requirements and the suitability of several vessel types.
While the Smit Enterprise is still being operated in her original configuration by Smit Transport & Heavy lift BV as a heavy lift transport vessel, Smit decided to convert the Smit Pioneer into an offshore installation vessel. The main target was to make the ship suitable to support and expand the activities of Smit in the contracting market, especially aiming at installation work in remote area's and deep water. Other possible tasks have also had their effect on the design.
With the Smit Pioneer, Smit International has introduced a new type of offshore installation vessel that, due to its large deck area and high payload capacity, opens up new possibilities to the offshore market.

The following tasks were, amongst others, the basis for the design:

- Installation of (FPSO) mooring systems with all types of anchors (incl. suction anchors), also in deep water (1000 m and over), including the pre-tensioning of up to 750 ton.
- Installation work of:
  - Manifolds and templates
  - Flexibles
  - Riser systems
  - Cables
  - etc.
- Trenching
- Assistance during salvages
- Heavy transports

The Smit Pioneer's main particulars are:

Length overall	156.75 m
Length between perpendiculars	140.00 m
Beam	29.00 m
Depth to working deck	7.79 m
Depth to upper deck	14.85 m
Maximum draught	5.36 m
Design draught	4.50 m
Maximum displacement	18107 ton
Maximum deadweigt	9736 ton
Working deck area	2700 m^2
Trials speed	14.5 knots
Service speed in a seaway	12.0 knots
Accommodation capacity	80 persons
Gross tonnage	11.564.

The ship is under classification with Det Norske Veritas with the following notation:
+ 1Å1, DYNPOS-AUTR, Heldk-SH, Crane, DK(+)
The ship is registered under Singapore flag.

General arrangement

Being converted from a lash carrier into an installation vessel, the original configuration of the ship is still very well visible. Most characteristic is the large working deck, which stretches over 80 % of the length. The deck is completely flush to enable skidding heavy loads and allowing maximum flexibility in project deck arrangements. The dock walls on the aft ship are removed as far as practically possible. On the aft ship a 150 ton pedestal crane is positioned. A gantry crane is running over the full length on a track on the dock walls. Forward and aft in the working deck, two large moonpools are fitted to aid ROV and installation activities. Below the working deck and in the dock walls, double bottom and wing water ballast tanks are situated. In the aft ship, the main engine room is housing the original main propulsion and generator installation, consisting of two 'father and son' installations, each driving one shaft with controllable pitch propeller. The engine control room is also located in the main engine room. Aft of the main engine room, two separate new engine rooms are housing the new azimuthing thruster installations and a new generator installation.

Situated in the lower fore ship are the ballast pump room, a new engine room for the bow thruster installation, as well as all auxiliary engine rooms, stores, workshops and recreation areas (swimming pool, gym and sauna). The accommodation for a total of 80 persons is situated on three decks. On the lower accommodation deck (the C-deck) are the galley with servery, messroom for 54 persons, the recreation room with library/meeting room and hobby rooms as well as 15 double cabins. Twenty two double cabins, of which four large ones for officers and clients can be found on the Upper deck. A helicopter arrival and departure room is also located on this deck. On the E-deck, the cabins for the Captain and Chief engineer, two double Officer cabins, three offices and a hospital including a first aid room are situated.

On the spacious bridge, a large survey room and a DP-room overlook the working deck.

On the bow, a helicopter deck is fitted.

The conversion program

The preliminary design and specification work for the conversion was carried out by Smit Engineering BV. An extensive model test program carried was out at Marin, to determine the required thruster power, the Dynamic positioning performance and the ship motions. After testing the major equipment was ordered, like diesel engines and generator sets, bow thrusters and azimuthing thrusters, as well as the Dynamic Positioning system and the Pedestal crane. Most of the equipment was ordered from Dutch companies. In April 1998, Smit started a tendering process in which 10 yards in Europe and the Far East were invited to offer for the conversion. In August 1998, a Letter of Intent was signed with A&P Tyne in Newcastle (UK) to carry out the conversion. Shortly after this, the detailed engineering work was started at Armstrong Technology Associates, who were working as a subcontractor to A&P Tyne.

During the conversion, which started in November 1998, approximately 1500 ton of new steel was installed, as well as 5 new thrusters, 5 new diesel engines, two new generator sets and a new switchboard, a helicopter deck, two cranes, two moonpools and a new accommodation block.

During the conversion a repair program was carried out. This involved major overhaul of the ships propulsion and generator installation, as well as the overhaul of all other major equipment. After a total conversion time of some ten months, the ship successfully finished the sea trials in September 1999, after which it immediately started her first project, working for CSO in the installation of the Kuito field Phase 1A off Angola.

Raised deck

One of the major activities was the fitting of a raised working deck over the full length and width of the vessels dock. This was necessary since the tasks of the vessel required the removal of the stern door, to enable working over the stern. After this removal the vessel only had a freeboard of 0.90 m. To meet the load line regulations the raised deck had to be fitted. The deck height of 2.50 m serves two purposes: providing the necessary freeboard to meet the regulations and create a dry working deck at the same time, and providing the necessary space under deck to fit new engine rooms. Furthermore the created void spaces under the deck have a large potential to be used as future storage space. The working deck is strengthened to carry a deck load of more then 6500 ton with a distributed load of 10 t/m^2.

By removing part of the dock walls in the aft ship, free deck edge length was created to work overboard. The remaining dock walls provide shelter and serve as a track over which the ships gantry crane can travel. To free water entering the deck in survival conditions, 16 large water freeing ports were constructed in the dock walls.

Helicopter deck

To enable the transport of personnel and equipment offshore, a helicopter deck is fitted on the bow. The deck is constructed of aluminium and is suitable to receive helicopters up to the size and weight of SuperPuma AS 332 L2 helicopters, which can carry 20 passengers. In the accommodation on the Upper deck level, a helicopter arrival and departure room is provided to allow the administration and instruction of personnel arriving and departing.

The helicopter deck is equipped with a foam/water fire monitor system.

Refit of the accommodation and the bridge

To accommodate a total amount of 80 persons on board the ship, a new accommodation block was fitted in the forward part of the dock. The new accommodation block houses 14 two-persons cabins. The existing accommodation was completely stripped, renewed and modernised, in order to upgrade the capacity, but mainly to be able to meet the noise requirements. Almost all cabins are now fitted with two berths and a pre-fabricated wet unit.

To satisfy the domestic needs for serving 80 persons, the galley area underwent a major refitting program involving re-arrangement of the galley and renewal and up-grading of all equip-

Fig.3. Smit Pioneer loaded for Kuito project

Fig.4. DP-room on the navigation bridge deck

ment, as well as the construction of a servery and a dish washing room. The laundryroom was upgraded and a changing room was arranged at the entrance to the working deck.
In order to house the DP-room, a survey room and a GMDSS- and helicopter control desk on the Bridge deck, the navigation bridge underwent a major modification. Most of the bulkheads were removed and in total five new consoles were installed. Furthermore extra windows were installed in the aft and side bulkheads to increase the visibility from all working locations onto the aft deck and the surroundings.

Equipment for offshore work

The ship is equipped with two identical large size moonpools (6.1 m x 6.1 m). One is located in the forward part of the working deck. The other one is located in the aft part of the working deck. Both moonpools are fitted with flush top- and bottom hatches. The top hatches can be lifted out using the gantry crane and have the same strength as the working deck (10 t/m^2). The bottom hatches are provided with hinges and can be opened using a chain, hoisted by the gantry crane.
The forward moonpool is intended to be mostly used for ROV deployment, while the aft moonpool will mainly be used for construction activities. On the ships first project the aft moonpool was used to install flexibles, using a vertical launching system.
To allow quick passing of objects through the waterline, both moonpools are fitted with an aeration system.
To protect flexibles and cables when installed vertically through either one of the moonpools, a large diameter ring shaped pipe (baptised moonpool plug) can be lowered into the moonpool and fixed in the bottom, thus increasing the radius of the moonpool's lower edge.
Probably the most important equipment on board the Smit Pioneer is the offshore pedestal crane, manufactured and delivered by Kenz Cranes B.V., Zaandam. The crane is positioned on the aft ship on starboard side and has an offshore rating of 150 ton. Inshore the crane can lift 250 ton. The maximum reach of the crane is 35 m, which makes it possible to cover the aft part of the working deck and the aft moonpool. The forward part of the deck is covered by the gantry crane (also manufactured and delivered by Kenz), equipped with two trolleys of 25 ton lifting capacity each. The gantry crane has been designed to be used offshore, and also serves to lift the moonpool hatches. The clear height of the gantry is 11 m above the deck to allow the use of large diameter flexible installation reels or the positioning of other high cargo (suction anchors etc).
The pedestal crane is fitted with a passive and active heave compensation system. The wire capacity makes it possible to lift weights to a depth of 1200 m. Preparations have been made in the crane to serve even larger depths, working with an external winch mounted on the deck.

A major advantage of the ship is that it can lift 250 ton weights at the maximum allowable reach without the need for counter ballasting, which makes it possible to work with extremely short cycle times when lowering heavy equipment to the seabed.
To allow the working with wires, anchors and chains, the ship has been fitted with a 350 ton SWL stern roller, pop-up towing pins and chain stoppers (fork type) delivered by Karmoy.
To assist with the installation of mooring systems or other work which involves handling of chain, wire and ropes, the ship has been prepared to be fitted with a high capacity A&R/anchor handling winch, which will be fitted in the near future.
Distributed along the dock walls on both sides, electric power connections (1200 kW total), fresh water- and seawater connections and working air connections are provided to supply deck equipment with the necessary services.

Dynamic positioning installation and machinery

To provide the required position keeping capabilities, the ship has been fitted with a newly installed dynamic positioning system which meets the IMO requirements for a Class 2 system. This means that the redundancy of the system is such that any single failure will not result in the failure of more than one thruster. By installing enough thrusters forward (three new bow thrusters) and aft (two new azimuthing thrusters) it has been assured that the failure of one thruster will not result in a loss of position.

The DP installation controlling the thrusters consists of a Kongsberg SDP 21 system with a dual operator station located on the bridge. The system is equipped with the following reference systems:

- 1 x HIPAP acoustic reference system
- 2 x Differential Global Positioning Systems (DGPS)
- 1 x Taut wire

The HIPAP system allows the use of Long baseline, Short baseline and Super short base line transponder systems, as well as the tracking of multiple underwater units like ROV's, trenchers etc.
Looking at the general arrangement, the most striking feature of the ship is the bowthruster dome, in which the three bow thrusters are fitted. This unusual arrangement is the result of the ships relatively shallow draught (4.5 m design draught) in relation to the thruster diameter (2.50 m) and the ships existing internal arrangement. During the design process it became apparent that due to the shallow draught it was not feasible to fit the three thrusters in the confines of the hull without jeopardising the proper functioning. By calculations and model tests it was established that the thrusters would start ventilating in a very early stage, thus reducing their effectivity to a large extent. The internal arrangement of the foreship also made it very difficult to fit the thrusters and the engines in the conventional location in the hull, without having to remove the existing auxiliary engineroom.
Modern applications like retractable or folding azimuthing thrusters have been studied, but proved not to be the best solution for this conversion due to their sizing and price or delivery time. The solution has been sought in the

Fig.5. Overview of workingdeck with cranes

construction of a dome under the keel, in which the thrusters are built. The thrusters are manufactured by Lips and are of the Low-noise, resiliently mounted type with controllable pitch propellers with low noise blade design. These thrusters were specifically selected to reduce the noise in the accommodation, which is located directly above the thrusters.

Fig.6. Bow thruster dome.

Each thruster is driven by a resiliently mounted Caterpillar 3616B DITA diesel engine (1566 kW at 1800 rpm) through a Centalink floating shaft. Each thruster generates a thrust of approximately 20 ton.
The diesel engines and the thrusters are located in a new bow thruster engine room, formed by joining two former HFO tanks and the existing bow thruster room together. The existing bow thruster was removed in the process.

List of major equipment suppliers

Croon Electrotechniek	Auxiliary Switchboard and distribution boxes
Van Duijvendijk en Overbeek	Working- and starting aircompressors
Econosto	Valves
Geveke motoren	Diesel engines for bowthrusters
	Generator sets
Hatenboer	Freshwater installation
International paint	Paint
Intersona	Noise and vibration consultancy
Kenz Cranes	Pedestal Offshore crane,
	Gantry crane
Kongsberg	Dynamic positioning system
Lips	Azimuthing thrusters
	Bow thrusters
Praxis	Alarm and monitoring system
Wärtsilä NSD	Diesel engines for azimuthing thrusters.

Both model test and full scale results have proven that the application of the bow thruster dome arrangement prevents the ventilation of the thrusters below significant wave heights of 5 m. Furthermore, the total arrangement proves to be efficient and contributes considerably to the extremely low noise levels experienced in the accommodation during DP operations. The effect on resistance has been minimised by carefully shaping the dome. The resulting design is a trade-off between minimum resistance, mimimum transverse area, and constructive requirements. Looking at the manoeuvring capabilities and the speed of the vessel, the bow thruster dome does not have an adverse effect. A photo of the bow thruster dome is given in figure 6.
In the photo it can be seen that a lot of attention has been given to a careful shaping of the tunnel edges, in order to reduce the flow losses.
In the aft ship, two new azimuthing thrusters are fitted. The thrusters are fitted with propellers of the controllable pitch type in nozzles and have been manufactured by Lips. Each thruster is driven by a Wärtsilä 8L26 diesel engine providing 2600 kW at 1000 rpm. The thrusters deliver a bollard pull of 40 ton each.
The diesel engines and thrusters are built into new engine rooms formed by converting two ballast tanks into engine rooms. The azimuthing thrusters are installed with a 5 degrees longitudinal inclination, to allow the diesel engine to be lowered, easing the installation of air inlets and exhausts, but also reducing the thruster-hull interaction when giving astern thrust. The thrusters are also placed under a 5 degree transverse angle, in order to reduce thruster-hull and thruster-thruster interaction.
Apart from during DP operations, the Azimuthing thrusters can also be used to assist the main propellers during transit. By doing so, the transit speed can be increased from an economic speed of 8.5 knots to 12 knots.

Electrical installation

To satisfy the increased power requirements, two new Caterpillar 3512B DITA generator sets (1200 kW at 1500 rpm) are installed in the new port side azimuthing thruster room. The two generators feed a newly installed 380 V/50 Hz auxiliary switchboard. At high power demand (i.e during installation works), the new switchboard operates independent from the existing main switchboard.
When working with the Pedestal crane in Heave Compensation mode, an air cooled two step ballast resistor consumes the reverse power from the crane.
In low power demand (ship in transit), the new auxiliary switchboard can be connected to the main switchboard. In that mode it is possible to feed either one from the other, allowing either the new generators or the shaft generators on the main propulsion installation to be switched off.
A new Praxis alarm and monitoring is installed for monitoring of the new thruster installations and generator installation. Workstations are fitted in the engine control room and on the bridge. Operator stations are fitted in all engine rooms, engineers cabins and in the mess-room.

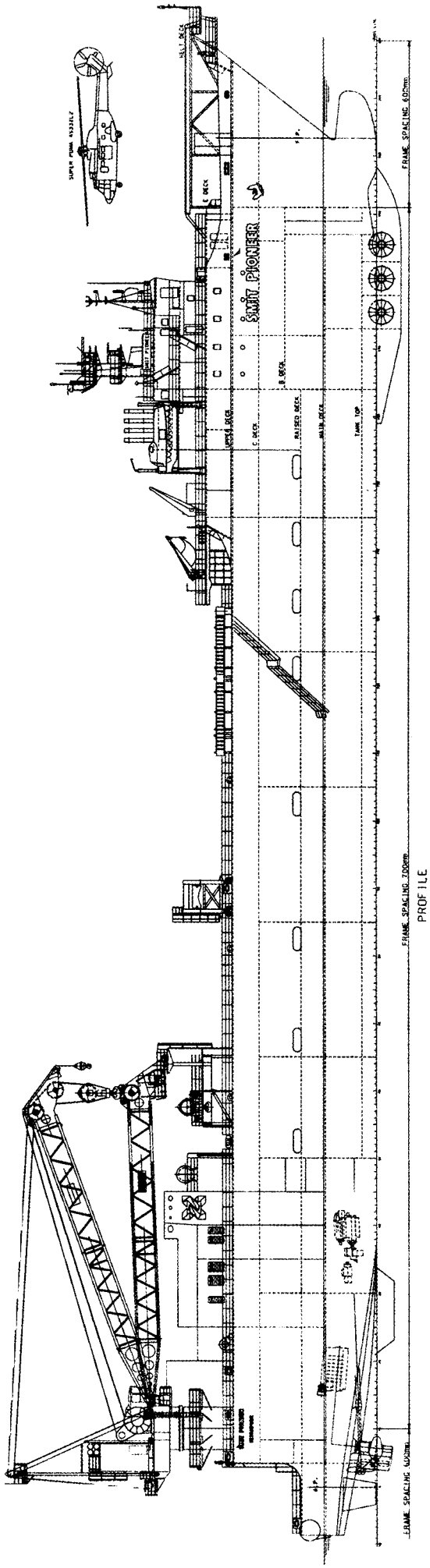
Noise reductions

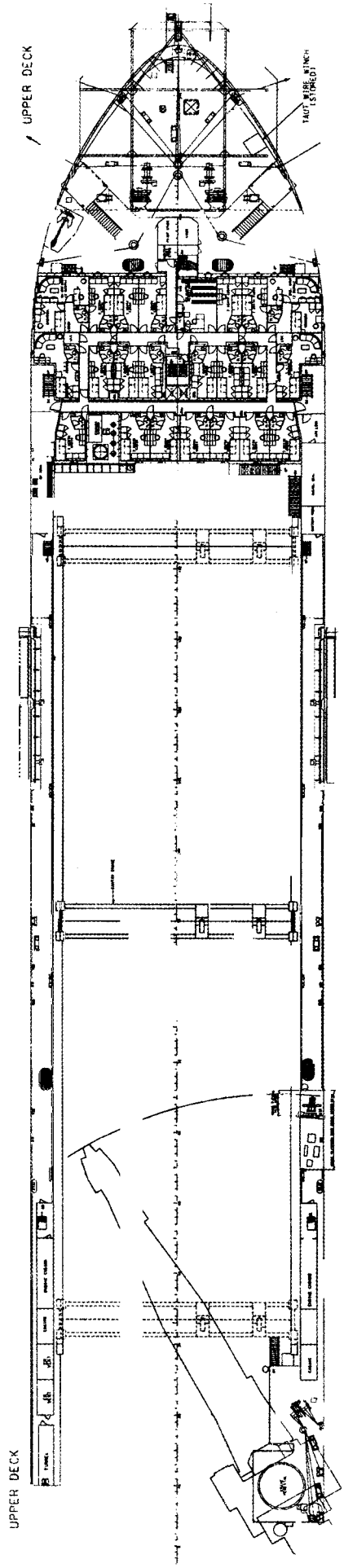
During the design and the conversion of the ship major attention has been given to achieve low noise levels in the accommodation and working areas of the ship. Given the existing situation, everything possible has been done to avoid problems with noise and vibrations. By careful selection of equipment and extensive noise predictions involving noise and vibration measurements before the conversion, the noise levels have been reduced to an extremely low level.
Apart from the selection of the low noise bow thruster installation, the reduction measures have consisted of the complete stripping of the existing accommodation, application of a floating floor with natural frequency selected to avoid resonance problems, application of new bulkheads and lining and noise insulation of bulkheads and ceilings.
Special attention has been paid in the design process and during the conversion to avoid resonance frequencies of bulkheads and panels, removal of all unnecessary steel partition bulkheads and pillars where possible and in securing minimum air gaps between bulkheads to avoid resonance of the air column. Special attention was also paid to a good supervision during the re-fitting, to avoid noise leaks and rattles.
Table below gives the achieved noise levels in relation to the IMO noise level requirements.

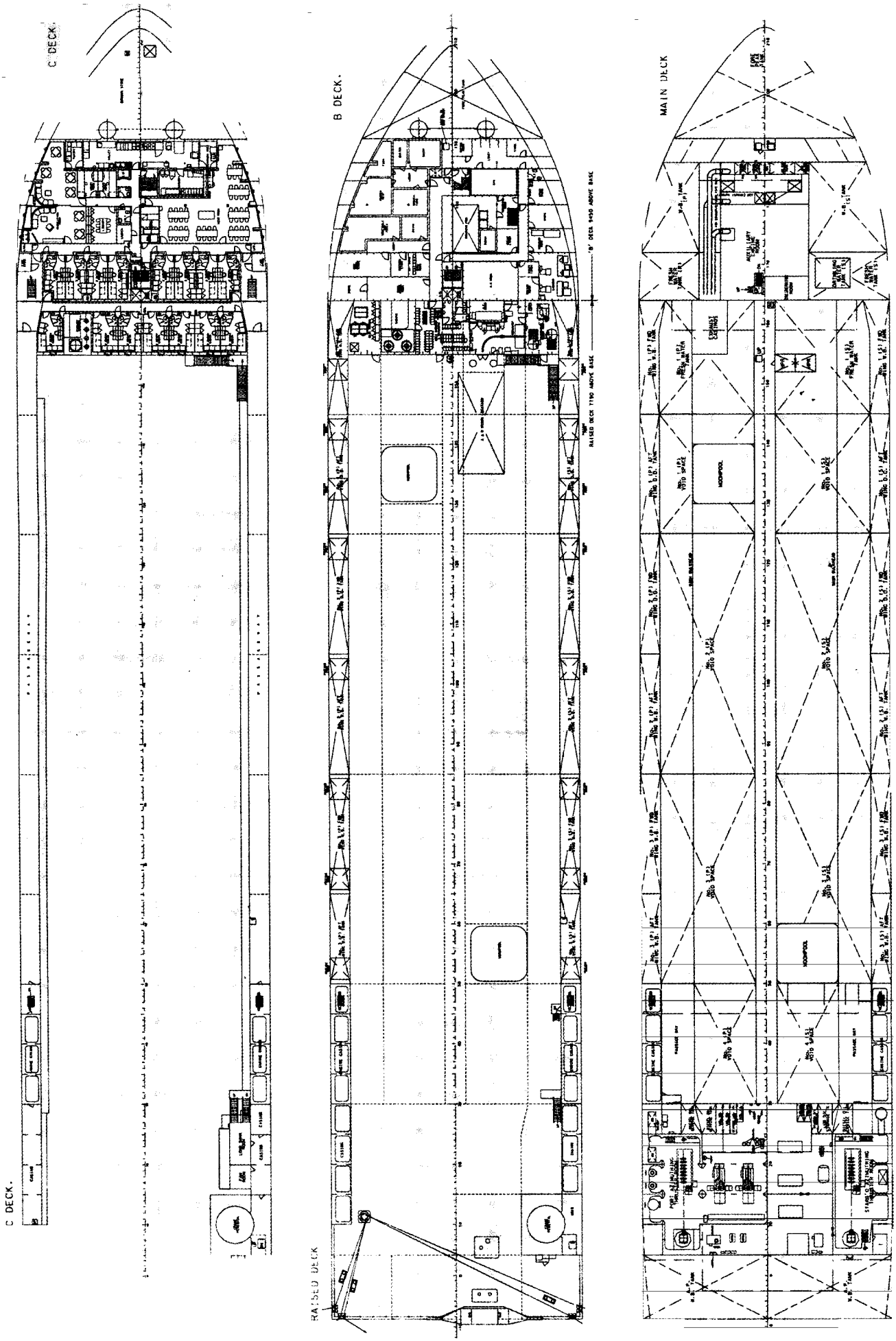
Ir. M.N. Oele is Project Manager Smit Pioneer conversion

Noise levels

SPACE	DECK	IMO Noise level Requirement dB(A)	Noise levels measured on trials at 50 % Bow thruster power dB(A)
Gymnasium	B-deck		76
Cabins	C-deck	60	48-49
Mess room	C-deck	65	63
Cabins	D-deck	60	48-56
Cabins	E-deck	60	48-56
Wheelhouse	Bridge deck	65	54-57


SWIFT PIONEER
PROFILE


UPPER DECK
UPPER DECK


C DECK.
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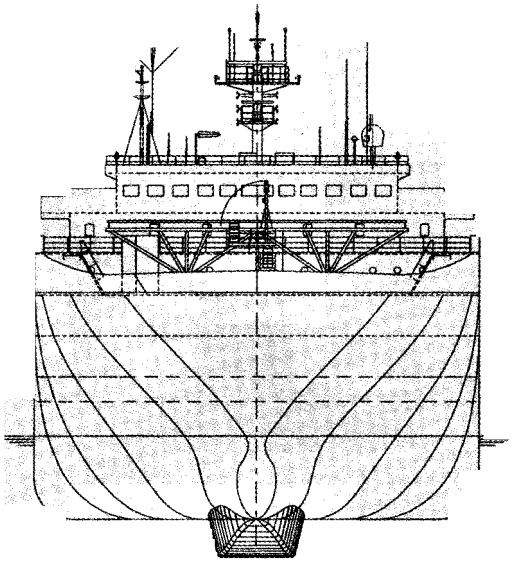
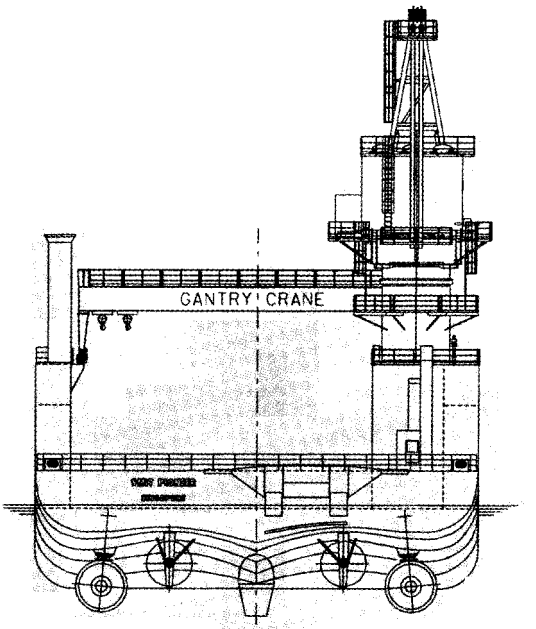
RAISED DECK
MAIN DECK

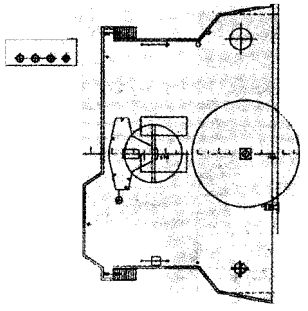


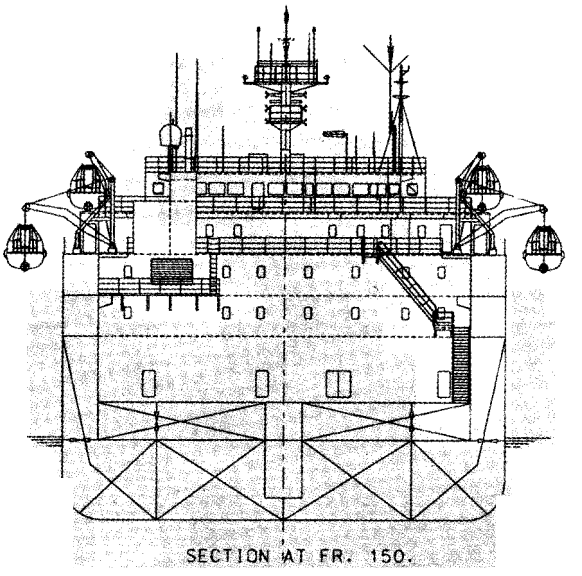
FRONT VIEW.



AFT VIEW.

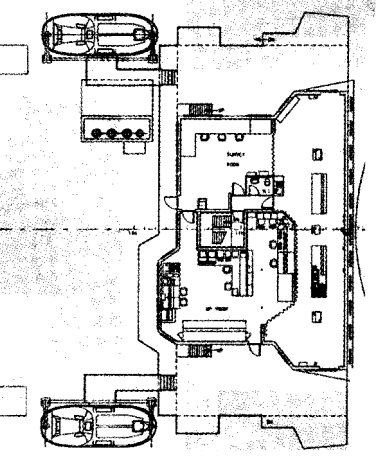
WHEELHOUSE TOP



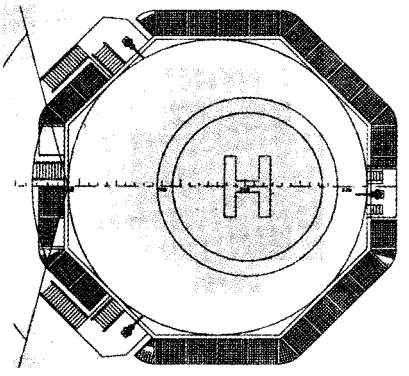


SECTION AT FR. 150.

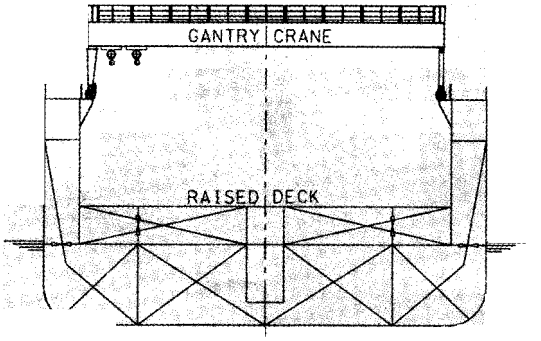
NAV. BRIDGE DECK



HELIDECK



LOOKING FORWARD



TYPICAL SECTION