Oil Products Carriers "Lucy P.G." and "Asprella"

On May 19th, 2001 Frisian Shipyard Welgelegen B.V. delivered the Oil Products Carrier "Lucy P.G." to her owners Pritchard-Gordon Tankers Ltd. in the UK. The sister vessel "Asprella" was delivered on November 30th, 2001 under the new name of the yard "Volharding Frisian" by the new owners Volharding Shipyards. Both vessels are registered in the Isle of Man.
The vessels are designed to carry oil products as stated in MARPOL Annex I, with the exception of crude oil and high heat products like asphalt, and in addition the applicable products as mentioned in the IBC-Code Chapter 18.

The vessels are classed under Lloyd's Register of Shipping with notation: ✠ 100 A1, Double Hull Oil Tanker, ✠ LMC, UMS, ESP, LI, IP.
In addition the vessels are built under the regulations of Isle of Man, SOLAS, MARPOL, ILLC, OCIMF, Suez Canal, Panama Canal, USCG for foreign flag vessels and IMO rules as applicable for the ship type.
Vessels are designed for worldwide trading with special emphasis on tropical waters and with a restricted draught to allow operation in the Caribbean waters, Surinam, Venezuela, etc. Layout of the cargo systems, manoeuvrability and speed are optimised for the trade and the capacity of the local terminals. All cargo pumps and valves can be operated on deck and the deck arrangement has been designed to allow easy access to all cargo equipment.


Lucy P.G. with Mülhalm's Strom 1 alongside

Main particulars

Length o.a.	approx.	126.95 m
Length b.p.p.	"	121.40 m
Breadth moulded	"	19.60 m
Depth to main deck	"	9.35 m
Design draught	"	6.50 m
Dead-weight at design draught	"	9,990 ton
Scantling draught	"	6.80 m
Dead-weight at scantling draught	"	10,650 ton
Gross Tonnage	"	6,688 GT
Net Tonnage	"	2,869 NT
Range	"	5,000 nm

Tank capacities

Cargo - and slop tanks:		
Tanks 1 PS	approx.	653 m³
Tanks 1 SB	approx.	654 m³
Tanks 2 PS	approx.	984 m³
Tanks 2 SB	approx.	985 m³
Tanks 3 PS	approx.	1,052 m³
Tanks 3 SB	approx.	1,050 m³
Tanks 4 PS	approx.	1,048 m³
Tanks 4 SB	approx.	1,052 m³
Tanks 5 PS	approx.	1,051 m³
Tanks 5 SB	approx.	1,049 m³
Tanks 6 PS	approx.	867 m³
Tanks 6 SB	approx.	872 m³
Cargo tanks total (100%)	approx.	11,317 m³
Cargo slop tank (100%)	approx.	293 m³
Other tanks:		
Heavy fuel oil (incl. day/settl. tks)	approx.	465 m³
Gas oil (incl. day/settl. tks)	"	143 m³
Ballast water tanks	"	4,862 m³
Drinking water tanks	"	151 m³
Lubricating oil storage tank	"	23 m³
Lubricating oil sump tank (ME)	"	8 m³
Lubricating oil renovation tank	"	9 m³
Sludge tank	"	27 m³
Sewage holding tank	"	18 m³
HFO overflow tank	"	14 m³
HFO drain tank	"	2 m³
Dirty oil tank	"	15 m³
Cooling water drain tank (ME)	"	9 m³
Bilge water collecting tank	"	12 m³
Thermal oil storage/dump tank	"	21 m³

Speed
A the design draught of 6.50 m, and on even keel, the speed obtained during trials was 13.5 knots, with an output of 90% MCR of the main engine and 200 kW load on the shaft alternator.

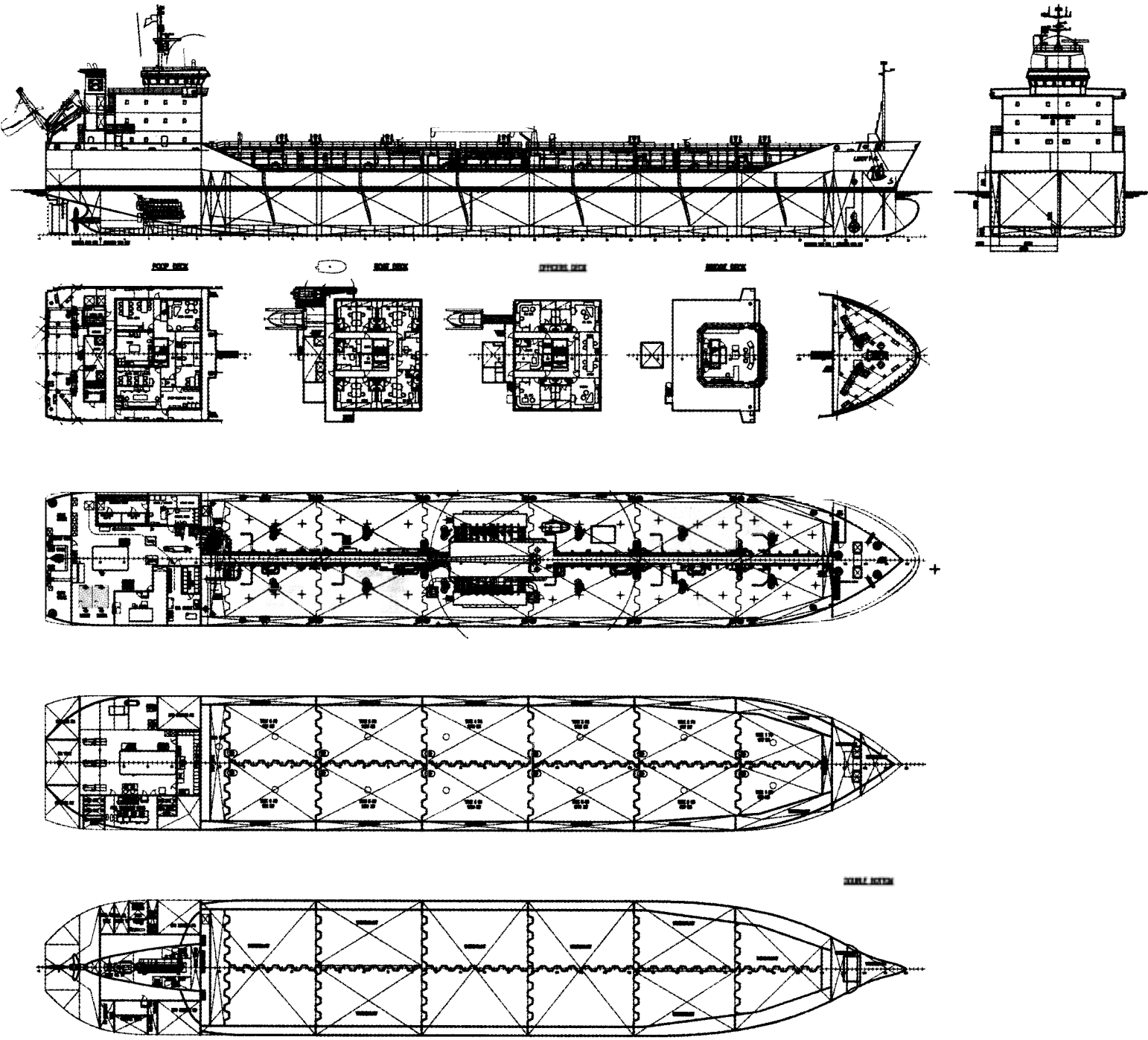
Design of the vessels

The design of the tankers was made based upon a set of design constraints as laid down by the Owners.

Design constraints:

- Operationally restricted draught of only 6.50m.
- Deadweight of nearly 10,000 tons at 6.50 m draught.
- Cargo capacity of 60,000 barrels.
- Ten to twelve cargo tanks of almost the same capacity.
- Speed of 13 knots at 90% MCR and including 200 kW shaft alternator load.
- Ballast capacity minimum 40% of deadweight.
- Length if possible close to approx. 120 m over all.

Design results:
The final design reached after several iterations resulted in vessel with main particulars as shown above. In particular the body plan came out with some specific elements due mainly to the limited draught and the wish to restrict the length.



1) Centre of buoyancy aft of 1/2 L (most tankers forward).
2) High block coefficient of 0.855.
3) Very full and short aftbody as the result of 1) and 2).

The first design of the lines plan showed a more or less conventional aftbody with a water flow mainly along the waterlines. After the first modeltests at HSVA it showed that the upper region of the wakefield was not acceptable and propeller induced vibrations could be expected in full scale. It was decided to change the lines to a moderate pram-type with a water flow mainly dominated by the buttocks.

A simulation was made with CFD programs to evaluate the wake pattern in the propeller disc area of the new aftbody lines. This was found satisfactory especially if you consider the full aftbody. We decided to reduce the propeller diameter slightly to increase the tip clearance in order to limit the pressure pulses on the hull. At the same time the skew of the propeller was increased to approximately 35° to soften the passage of the propeller blades at the "twelve-o'clock" position.

As a result of the new lines plan the space in the aftship was increased, offering a lot of useful deck space in the engine room. In the lower area of the engine room the main engine, gear and shafting are placed in a "gondola". The pram-type aftbody has also caused the bottom of the aft two cargo tanks to be partly inclined upwards in aft direction with as result that the lowest point in the tanks and the position of the deepwell pumps has moved forward almost to the forward bulkhead.

The design called for a "one-compartment-damage" according MARPOL Annex I but it showed that with the required tank configuration and subdivision it was possible to obtain a two-compartment-damage result. The vessel will be able to be converted into a MARPOL Annex II vessel with some changes in the safety equipment and piping to comply with the requirements for the carriage of chemicals.

In an early stage of design noise and vibration calculations were made and the results used in optimising the design and construction. One of the most prominent changes was the introduction of flexible supports under the main engine. Some cabins gave a calculation

Main Control Desk on Bridge

result that was just to high to ignore it and the decision for flexible supports was justified during trials. The noise levels measured in the cabins of the accommodation are very low (maximum 52 dB(A)) but without flexible chocks this would have been approximately 10 dB higher and thus above the allowed maximum level of 60 dB(A). Overall the vessel is very comfortable concerning vibration and noise levels.

Construction and conservation

The vessel is constructed according the regulations of LRS. Mainly longitudinal framing is adopted with transverse framing in fore and aft ship.

The main deck is kept almost clear of constructions to ease the operation in the many ports in the Caribbean where a lot of manual operations of valves and start and stop of pumps are required. As a result of course the cargo tanks have construction under the main deck causing more complicated tank washing and tank coating procedures.

Walking over the spacious and clean main deck shows the benefits of this choice and also during construction it is of course productive not to have to climb over webs and frames on deck.

Conservation of cargo tanks

The twelve cargo tanks and the slop tank are coated with a two-component epoxy phenolic tank lining from International Paints. This coating is typically suitable for the storage of aviation fuel, unleaded gasoline, aromatic solvents and salt solutions.

All surfaces in the tanks are abrasive blast cleaned to Sa 21/2 (ISO 8501-1:1988) after construction and with all piping fitted. Heating coils were protected during blasting and painting to prevent a paint film on the heating surface. Painting was done in three layers of 90 microns dry film thickness each with intermediate stripe coatings in corners, edges and difficult to reach spots.

Conservation of vessel and other tanks

Jotun supplied the coating system for the vessel, except for the cargo tanks. The coating of the outside hull is based on Jotamastic high built epoxy covered above water with polyurethane topcoat and below water with TBT-free anti-fouling.

Ballast tanks are provided with two layers of balloxy light colour after grinding to ST 2/3.

Machinery

Each vessel is provided with a low-NO_x main engine, driving a controllable pitch propeller through a reduction gearbox. A PTO/PTI arrangement allows the shaft alternator to produce electricity at sea or to drive the propeller in motor-mode as a "bring-me home" device.

The main engine is a MaK type 8M32C with an output of 3,840 kW at 600 rpm. This four-stroke engine is running on HFO 380 cSt/50°C or MDO and is able to run at constant speed or combinator mode.

For electricity generation three diesel-driven alternators are provided of 460 kVA each running at ISO-F-DMA fuel. In addition one shaft alternator of 940 kVA and one emergency diesel-driven alternator of 130 kVA are installed. All alternators are running at 1,500 rpm and suitable for 3x415 Volts/50 Hz.

The gearbox together with the CP propeller is supplied by Scana Volda and incorporates a primary PTO/PTI shaft and a built-in clutch allowing the main engine to run the shaft alternator with disconnected propeller. A four-bladed controllable pitch high-skew propeller is provided with a diameter of 3,600 mm and running at 176 rpm. The hub is made of stainless steel and the blades of Ni-Al-Bronze.

On the main gearbox PTO shaft a separate two-speed gear is provided with manual changeover. This gear allows the shaft alternator, running as a 750 kW synchronous motor, to drive the propeller in "take-me-home" mode at reduced rpm. The motor is than supplied by the three generators running all in parallel. Starting of the electric motor is performed in asynchronous mode controlled by a starting transformer switching over to synchronous mode at full rpm.

The vessel is fitted with a flaprudder and a rotary vane steering gear. During trials the vessel showed an astonishing manoeuvrability with for instance a turning circle from full speed within the vessels own length.

A bowthruster of the CPP type is fitted forward provided with an electric motor of 400 kW output. The bowthruster is normally powered directly from the shaft alternator and started by means of field excitation. Alternatively the bowthruster can be powered from the diesel-driven alternators running in parallel.

Engine room auxiliaries

The engine room is as far as possible built up with pre-fabricated modules.

The engine room installations includes:

- Purifier-module with HFO (2), MDO and LO purifiers.
- HFO booster-module for the main engine
- Box type coolers for main and auxiliary engines
- Bilge-, ballast-, fire-fighting-, cooling- and lubricating oil pumps
- Thermal oil boilers (2), exhaust gas boiler and pump-module
- Inert gas generator, combustion type, of 1,875 m^3/h capacity complete with deck seal, vacuum breaker, blowers and fuel pumps
- Fresh water evaporator, 10 m^3/day, connected to HT cooling water system of the main engine
- Sewage treatment plant with integrated vacuum unit
- Starting air compressors (2) and working air compressor
- Foam unit for deck fire-fighting system

Ballast system

A remote controlled ballast system is provided, controlled from the CCR at a dedicated mimic panel. Remote level indication was not required since ballast tanks are used only full or empty.

Ballast piping is made of GRE and is provided with hydraulic operated butterfly valves. The overboard valves are proportionally adjustable. A separate hydraulic system with

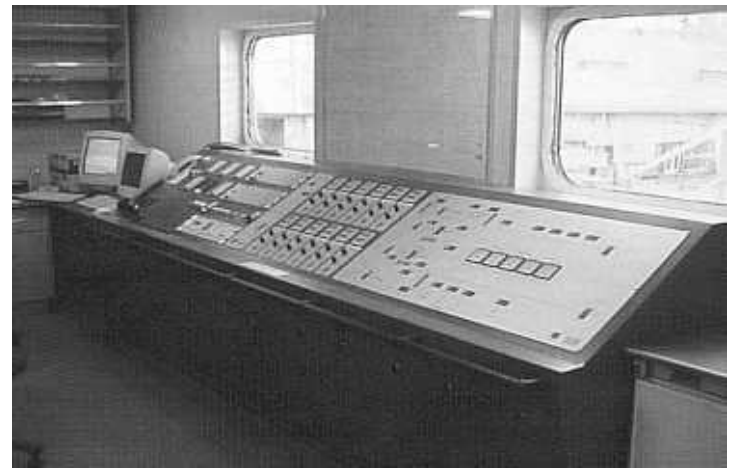
pump unit and piping is installed to power the ballast valves operating system.
The two ballast pumps are situated in the ballast pump room between engine room and slop tank. The pumps are driving directly by Eex electric motors, which is allowed for oil tankers. Next to that an ejector is placed for stripping the ballast tanks.
The mandatory oil-discharge-monitoring-equipment (ODME) is also placed in the ballast pump room with the main control panel in the CCR.

Cargo systems

The vessels have twelve cargo tanks and a total of eight cargo segregations each with an individual crossover at the manifold (6xDN 200 and 2xDN 150).
Each pair of tanks is connected with a DN 150 discharge line to a common DN 200 line to the manifold. In addition two tanks have a separate DN 150 line to the manifold. The six main crossovers are interconnected with a DN 200 common line with double separation through butterfly valves and sliding blanks.
All PS and SB tanks are provided with a bulkhead valve between them to allow back-up service from the pump in the adjacent tank. Four tanks have double separation bulkhead valves to allow for different cargoes on PS and SB side. All cargo valves are manually operated on deck.

Each cargo tank has the following independent systems:

- Electric driven centrifugal three-stage deep-well cargo pump with local start/stop and individual frequency controlled speed control
- Radar level measuring with local and remote reading
- MMC secondary gauging connection with pipe down to the tank bottom
- De-aeration pipe with flame arrestor (8") with cover and two P/V valves (1x4" and 1x5") with connection through sliding blanks to the main vapour return line
- Temperature measurement at three different levels
- Separate drop line DN 200 to the bottom of the tank
- Stripping connection on the pump
- Two fixed tank washing machines
- Two hatches for fitting portable tank washing machines
- 2x50% thermal oil heating coils near the tank bottom
- High and high/high level alarms
- Inert gas supply connection with butterfly valve and sliding blank valve
- Circular entrance hatch with PTFE sealings and ullage port
- Inclined stainless steel ladder



Cargo Control Room

Cargo piping and valves are of stainless steel AISI 316L quality.
The cargo pumps are of Svanehøj make and are driven by Eex type electric motors with individual speed control. The capacity of the twelve cargo pumps is approx. 250 m^3/h at 92 mlc. The slop pump has a capacity of 80 m^3/h at 70 mlc. The speed control is arranged in the CCR where speed is set on the control panels of each frequency control unit. Also the dry running protection of the pumps is set in these control panels. Starting of the pumps can only be arranged on deck near each pump. Emergency stops are provided along the cargo deck and in the control room.
The cargo pumps are provided with a foot valve to allow for stripping. The cargo lines and pump are stripped with air or inert gas pressure inserted in the crossover, back through the cargo line, down through the pump, up the stripping line and finally back to the crossover but on the outside of the main valve and than ashore. Alternatively the stripped liquid can be pressed to the cargo slop tank through a main drain line. The drain line also serves the manifold drip trays.
Ventilation of the cargo tanks is arranged through two fans of 10,000 m^3/hour each situated on deck near the manifold and supplying compressed air into a common line below the manifold and connected to the six main crossovers through removable spool pieces. The air enters the tanks through the drop lines near the tank bottom.
The cargo control room (CCR) is fitted with all controls of the cargo system and the ballast control panel. Next to that the loading computer, the inert gas control panel and the oil-discharge-monitoring panel are in the same room. The control room has two large windows overseeing the cargo deck and a separate office corner for all cargo related administration work.
At the front of the deckhouse a large panel with flashing lights for high and high/high level alarms is fitted to indicate alarms to the staff working on deck during cargo operations.
The manifold is arranged with the following crossovers and connections:

- Cargo crossovers (6xDN200 and 2xDN150)
- Common lines PS and SB between the 6xDN200 crossovers
- Slop crossover DN80
- HFO crossover
- MDO crossover
- Vapour return crossover
- Connections PS and SB to the ballast system
- Shore connection flange on the inert gas main line
- Ventilation common line with connections to each DN 200 crossover
- Pressure measuring at cargo and vapour crossovers

The piping running along the cargo deck is mounted as far as possible under the catwalk running from poop to forecastle deck. The catwalk is positioned very high above the deck with all cabling and piping as high as possible to allow passing under when moving from PS to SB side for cargo operations. The result is a very clean deck and very easy to access pumps, valves and start/stop buttons.

Heating systems

The vessel is provided with a thermal oil heating installation for the heating of:

- Accommodation systems: accommodation air-conditioning, potable water
- Engine room systems: HFO tanks, purifier

View in Galley of Asprella

heaters, HFO systems
Cargo systems: cargo and slop tanks, tank washing heater

The basic system is split into two subsystems:

1) A system working at 180/140°C for the engine room and accommodation systems. This system is mainly supplied from a 600 kW exhaust gas economiser.
2) A system working at 220/180°C for the cargo systems. This system is supplied from the two 1,500 kW oil-fired boilers.

Both systems are interconnected to allow for heating of system 1) when the main engine is not running.
The cargo tanks are heated by means of double-loop stainless steel coils providing a maximum cargo temperature of 65°C in all tanks.
The maximum capacity of the heating installation is based on washing of two cargo tanks simultaneously with hot water of approx. 80°C.
The thermal oil piping on deck is built up with pre-insulated pipes manufactured with rock wool primary insulation and polyurethane foam as secondary insulation. Insulation is contained in a PVC cover which gives an absolute watertight construction.

Accommodation

Accommodation is built up with a B-15 panelling system for walls and ceilings with integrated doors and lighting. The insulation of floors and walls is according SOLAS and MCA.
Accommodation is provided for fourteen persons all in very spacious single cabins with private bathrooms. The four senior officer's cabins are each provided with a separate bedroom.
In addition following spaces are provided:

- Crew's mess-dayroom
- Officer's messroom
- Officer's dayroom
- Captain's office
- Chief engineer's office
- Galley, very spacious with all modern equipment and lined with stainless steel walls and ceiling
- Laundry with separate drying room
- Dry provision store, cool store and refrigerated store
- Engine room change room
- Safety equipment/deck change room
- Cargo control room with cargo office
- Wheelhouse with main desk, chart table, radio station and separate toilet
- Air-conditioning room
- Workshop with lathe, drilling machine, grinder and AC-unit.

Accommodation is arranged according the requirements of the Isle of Man authorities (MCA) with special attention for fire protection and insulation.
The accommodation is provided with an AC-system suitable for tropical conditions and fitted amongst others with three AC-compressors of 50% capacity each.

Safety and lifesaving equipment

All safety equipment complies with SOLAS and the requirements of The Isle of Man (MCA).
Following safety equipment is provided:

- Free-fall lifeboat with ramp and recovery frame
- Rescue boat with davit
- Liferafts, life belts, line throwing equipment
- Mandatory personal lifesaving equipment
- Additional high speed workboat situated under the manifold crane
- Foam (AFFF) fire-fighting system with monitors on cargo deck
- Mandatory portable fire-fighting equipment
- Main seawater fire-fighting piping system with couplings all over
- CO_2 fire-fighting system in the engine room, fuel treatment and SBR
- Fire detection system in engine room and accommodation
- Additional fire detectors in all cabins (Owners requirement)
- Portable gas detectors for oxygen and hydrocarbons detection in air and in inert gas
- Fixed gas detection system for ballast tanks in the cargo area and the ballast pump room
- Inert gas generator with connecting piping to all cargo and slop tanks
- "Save-all" around the cargo deck of 250 mm high with closable drains overboard or into the slop tank to control deck spills

Deck equipment

- Hose handling crane (3 ton at 15 m) at the cargo manifold
- Two windlasses with mooring drums forward
- One mooring winch and one mooring/stern anchor winch aft
- Two anchors forward with chains and one anchor aft with steel wire

Crane and winches are all of the self-contained electric-hydraulic type.

Electric installations

The electric installation complies with the regulations of IMO, LRS, MCA and IEC. The automation of all engine room systems complies with LRS UMS notation. Power is supplied at 3x415 Volts/50 Hz, 3x230 Volts/50 Hz and 24 Volts DC.
The main switchboards, automation panels and main control desk are placed in a sound-insulated and air-conditioned switchboard room overseeing the engine room through two large windows.
The installation comprises the following main switchboards:

- Main switchboard placed in the ECR with alternator and synchronising panels, outgoing groups 415 Volts and 230 Volts, PTI panels, bowthruster panel, outgoing groups to frequency controllers of the cargo pumps, shore connection panel and main equipment starter panels.
- Emergency switchboard placed in the emergency generator room on poop deck.
- Twelve frequency control panels for the cargo pumps placed in a separate air-conditioned frequency control room in the engine room.

Auxiliary electric systems fitted:

- Lighting and emergency lighting
- Navigation lighting system
- Engine room automation system
- "Dead man" alarm system engine room
- Watch keeping alarm system for the wheelhouse
- Search lights and floodlights
- Transformers 415/230 Volts
- Auto transformer PTO/PTI alternator/motor
- Automatic fire detection system
- Automatic telephone installation
- Sound powered telephone system
- Talk-back system for mooring operations
- Central aerial system AM/FM and TV
- Emergency telegraph for main engine
- Control desks in SBR, CCR, wheelhouse and on bridge wings
- Window wipers on wheelhouse windows
- General alarm and fire alarm systems
- Public address system

All cabling is fitted on steel cable trays and fastened with PVC or stainless steel straps. The cabling on the cargo deck is running just below the removable gratings of the catwalk.

Nautical equipment

The complete communication and navigation equipment package is supplied and installed by Radio Holland and consists of:

- (1) Arpa radar Kelvin Hughes, Nucleus 2 5000, X-band, 6 ft scanner
- (1) Arpa radar Kelvin Hughes, Nucleus 2 5000, S-band, 12 ft scanner
- (1) Dual Interswitch unit, Kelvin Hughes, type HRC-A9
- (1) Radiotelephony installation, S.P. Radio type HT-4500
- (2) Inmarsat-C installations, S.P. Radio, type H-2095C
- (2) GMDSS VHF radio's, S.P. Radio, type RT-4822
- (3) Portable VHF, Jotron, type Tron-VHF
- (4) Portable radio's, Motorola, type GP-900
- (1) Gyro compass, Anschütz, type Standard-20
- (1) Autopilot, Anschütz, type Pilotstar-D
- (1) Course recording system, Anschütz
- (1) Rate of Turn indicator, Anschütz
- (1) Magnetic compass, Kelvin Hughes Observator, type Pilot MK-3
- (1) Repeater compass, I.T. Holland, type 6MC
- (1) Inmarsat-M installation, Nera, type Worldphone Mini-M
- (1) Document fax, Toshiba, type TF-471
- (1) VHF radio, S.P. radio, type RT-2048 (in cargo control room)
- (1) Echosounder, Furuno, type FE-700, with PC LOGdata software
- (1) Digital depth display, Furuno, type FE-720
- (1) Doppler speed log, Furuno, type DS-70
- (2) GPS navigators, Leica, type APN Mk-10
- (1) Weather fax, Furuno, type FAX-207
- (1) Navtex receiver, ICS, type NAV-5
- (1) Epirb, Jotron, type Tron-40S
- (2) Radar transponders, Jotron, type Tronsart

Closing remarks

Both vessels are at present operating to full satisfaction under charter agreements with Shell Trading. Both the owner and the charterer are very satisfied with the quality the yard delivered and it has to be noted that the owner's representative Campbell Maritime contributed strongly to this result.

Makerslist of "Lucy P.G." and "Asprella"

Design and engineering	Vuyk Engineering, Rotterdam
Model testing	HSVA, Germany
Steel and steel preparation	Metalix, Kinderdijk
Main engine	MaK, Germany
Main gearbox and PTO/PTI gearbox	Scana Volda, Norway
Flexible coupling main engine	Vulcan, Germany
C.P. propeller	Scana Volda, Norway
Propeller shaft seals	IHC-Lagersmit, Kinderdijk
Bowthruster	Lips, Drunen
Generator diesels	Cummins, Dordrecht
Alternators	A. Van Kaick / Bakker Sliedrecht
Assembly generator sets	De Ruyter, Sliedrecht
Flap type rudder	Bot, Groningen
Steering gear	Rolls-Royce Tenfjord, Norway
Windlasses, mooring winches, anchors, chains	SEC, Groningen
Free-fall lifeboat, rescue boat, davits	Hatecke, Germany
Inert Gas Generator	Smit Gas Systems, Nijmegen
Thermal oil boilers, exhaust gas boiler	Aalborg/Wiesloch, Denmark
Cargo deepwell pumps	Svanehøj, Denmark
Design and installation of piping systems	MSN, Westerbroek,
Electric installation including design	Eekels, Hoogezand
Frequency controllers for cargo pump drive	Eekels, Hoogezand
Ventilation, air-conditioning and heating	Novenco, Bergschenhoek
Tankwashing machines	Scanjet, Denmark
Tank radar level measuring system	Auxitrol, France
Paint supply cargo tanks	International Paint, Rhoon
Paint supply (ex cargo tanks)	Jotun, Spijkenisse
Paint applicator cargo tanks	Mühlhan, Rotterdam
Paint applicator (ex cargo tanks)	Welsec, Harlingen
Sewage treatment plant	Hamworthy, Rotterdam
Pressure-vacuum relieve valves cargo tanks	Pres-va, Denmark
Cargo hose handling davit	Acta, Denmark
Cargo loading computer and software	SARC, Bussum
Cargo system valves	Bac, Spain
Centrifugal pumps in general	Azcue, Spain
Oil discharge monitoring equipment	Jowa, Ridderkerk
Engine room monitoring and alarm system	IPH, Denmark
Fuel oil and lubricating oil purifiers	Westfalia, Germany
Starting air compressors	Deno, Krimpen a/d Lek
Working air compressor	Ingersoll-Rand, Zoeterwoude
Breathing air compressor	Deno, Krimpen a/d Lek
Provision cooling installation	Fridina, Groningen
Galley equipment	Electrolux, Alphen a/d Rijn
Navigation and communication equipment	Radio Holland, Delfzijl
Potable water evaporator	Aquamar, Spain
Box-type coolers	NRF, Mill
Workshop equipment	Thofex, Rotterdam
Welding equipment	Unitor, Rotterdam
Foam fire fighting equipment on cargo deck	Ajax, Amsterdam
CO_2 fire fighting equipment	Ajax, Amsterdam
Safety and life saving equipment	Datema, Delfzijl
Cargo tank access hatches	Winel, Assen
Portable gas detection equipment	BMI, Hardinxveld-Giessendam
Hydraulic control ballast valves	Besi, Germany