

TECHNICAL INFORMATION

Raffles is in effect a small village in the form of a large and valuable single piece of floating equipment that has to be ultra safe and reliable in respect of its operational “performance”, in conditions anywhere from the extreme Arctic to extreme tropical. This while moving at speed and simultaneously being pushed up / down, sideways and back / forwards, all in hostile and corrosive environments.

It has to do this while providing a level of comfort and luxury surpassed (possibly) only by “ultra” or “mega” yachts costing Euro 10 to 12 million per single passenger and it also has to have a 100 years life, backed up by an (optional) initial 5 year guarantee, which very few yacht builders will even consider providing.

Just to further complicate matters further it must be very economical to operate and to be able to maintain itself, with minimal (to no) outside support (and a crew of only 100), even tens of thousands of miles from civilization, in the remotest areas of the world.

To make the task even harder while legally Raffles can be called (and is in practice operated as) a private yacht, it should be designed and outfitted to the strict standards of IMO for an international ocean going passenger vessel, must comply with or exceed Lloyd’s Register highest classification, and be registered in a British flag jurisdiction. All immediately recognised in the marine and insurance industries as being the highest standard(s) possible.

Then to ensure that there can never be any question as to its quality and longevity it has to use proven, long lasting equipment / materials and systems obtained only from leading European manufacturers / suppliers and with more than normal provided to absolutely ensure it can never be put out of operation.

Finally it has to be ultra manoeuvrable to allow it to operate automatically and / or safely even into small ports with restricted waters.

To FVH knowledge no ship in the world, not even one planned for, even aspires to achieve or provide all this?

Raffles does, and is a one of a kind ship!

Note: *Where Lloyd’s or LR appear this refers only to Lloyd’s Register unless otherwise notified. The other Lloyd’s that is also involved with Raffles is the Lloyd’s (of London) insurance market which is a separate entity.*

Caution:

The document following is not a technical offer or contractual description of Raffles. It is provided and intended only to inform potential owners of the ships arrangement, its general properties, attributes, features, machinery, equipment and quality.

During Lloyd’s Register final approval process, immediately before construction can start some changes, additions / deletions some will be unavoidable but these will not affect the overall delivery schedule and will only improve Raffles quality.

Similarly to ensure timely delivery and to allow construction costs to be fixed FVH / AMS may select different manufacturers / suppliers to those named.

Notwithstanding any of the above the quality of Raffles, its 100 years life, reliability / dependability and its low cost of operation will be maintained as described.

Raffles construction will be the subject of a very detailed contract specification and plans approved by Lloyd’s Register and with the construction contract itself modified from the Association of West European Shipbuilders standard contract.

1. A one of a kind ship

Raffles is a one of a kind ship and is as far as can be established the first and only passenger vessel built with a full double hull since Isambard Kingdom Brunel's "Great Eastern" was launched in 1857.

Purposely designed to have a life of 100 years, confirmed by Lloyd's Register (LR) finite analysis it uses almost twice the steel of similar size vessels and with its hull massively subdivided into over 400 WT compartments to help ensure its survival under any conceivable conditions. Raffles is also the first passenger ship to be analysed (by MARIN) for its resistance to collision with, and impact penetration by other ships <www.marin.nl>.

It will almost certainly comply with IMO resolution MSC 194(80) even though this is not mandatory until well after Raffles is delivered. It is fully MARPOL compliant and will comply with EU directive 2005/33 on Sox emissions.

Backing up its strength / survivability is its reliability, with Raffles an "all electric" ship supplied from two separate machinery spaces (or power stations), each with 4 generators. Also with 9,700KW in 4 x 360° electric driven propulsors, any one of which can propel the ship, it is highly manoeuvrable including full dynamic positioning. This combination was selected because it additionally provides high levels of back up or "get you home" capability.

No other ocean going passenger ship uses only 360° propulsors.

Being all electric allows the use of systems that both improve Raffles reliability and reduce its cost of operation / maintenance needs. Combined with the use of modern solid state electronics and systems such as ship wide wi-fi and closed loop VHF, this means Raffles crew is only about 100 compared to similar vessels that require 200 plus crew.

Even with its economy of operation and small crew Raffles remains a 7 star ship, similar to the standard of mega yachts. Reflecting this interior design is by Donald Starkey whose references include numerous mega yachts and the largest sailing ship in the world the 133m "Royal Clipper" <www.starclipper.com>. Don is now working on another one of a kind, its 157m long successor due in service in 2009.

Design / engineering / outfit and interior finish are only partial measures of a vessels quality with its "class" and "flag" of registry recognised in the international shipping industry as the other best indicators. Confirming its very high standard Raffles is "classed" by Lloyd's Register (of London) and it is registered in Isle of Man, a British Crown Dependency. With Lloyd's Register classing about 50% of the world cruise ships and mega yachts their reputation and experience is unparalleled.

Lloyd's Register will award 23 service notations to Raffles, more than any other ship in operation, which also reflects their support during Raffles development, including a first for Lloyd's Register, "future proofing" it for its 100 years life.

The Isle of Man Ship Registry is not one of convenience, as many registries are, but highly respected as being as stringent as the United Kingdom and why Raffles can also fly the Red Ensign.

Assisting in ensuring its long life, Raffles key suppliers (mostly European) are all recognised as world leaders in their field. One of them, Voith – Schneider of Germany, whose cycloidal propulsors are used, is over 160 years old and with its unique technology as used in Raffles, proven in operation for over 80 years.

What all this means is that Raffles is unique for its strength, longevity, reliability, economy, luxury and the very high standards it is built and operated to.

2. Principal facts and dimensions

	<u>Metric</u>	<u>Imperial</u>
Length, overall (approximately)	239	783
Length at water line (approx.)	211.5	693
Breadth, hull (extreme)	32.5	106.6
Hull moulded depth	11.2	36.7
Height from waterline (air draft)	42	137.6
Summer operating draft (water)	6.7	21.98
Displacement, @ about 6.7m	26,000 tons	26,000 tons
Max air draft (about)	65	196
Gross registered tonnage (about)	48,000 GRT	48,000 GRT
Owners (passengers), in 112 standard apartments and 10 penthouses (all with external balconies)	244 up to 448	
Guests of owners, in 12 x 35m ² and 42m ² cabins	up to 60	
Tankage, HFO fuel, @ 1,000kg/m ³ (main)	3,200m ³ (up to)	3,200 tons
Tankage, diesel fuel	480m ³	500 tons
Tankage water, potable	2,000m ³	2,000 tons
Tankage water, fresh	1,000m ³	1,000tons
Tankage, wastes	200m ³	180 tons
Tankage, ballast (freshwater)	3,000m ³ (up to)	3,000 tons
Power, engine(s), maximum continuous	14,400KW	19,692 hp
Power, electrical generation, maximum continuous	13,650KWe	18,200 hp
Electrical power absorbed for 10 knots (approx.)	5,000KWe	6,800 hp
Hull speed / Service speed with block coefficient 0.67	33 knots / 8 - 13 knots	
Fuel consumption, @ 13 knots (approx)	38 tons / day (inc. estimated “domestic” consumption)	
Range, @ average 8 knots calm water and average 16 tons/day consumption	about 48,000 nm	
Classification society / service notations	Lloyd’s Register (LR)	

	with 23 notations
Flag / registration	Isle of Man (British)
Ships crew	44
Hotel / service crew (initial requirement, it may increase)	47, up to 120
Hospital / medical staff (initial) complement	6, up to 30

Note: LWL, displacement / gross tonnage subject to change after measurement.

3. Lloyd's Register service notations

The design, engineering, outfit and planned method of operation are such that provisionally Lloyd's Register will award Raffles additional – service notations including:

⇒ ✕. 100. A. 1. Passenger ship. ✕ LMC

- Structural design assessment (Shipright SDA)
- Fatigue design assessment (Shipright FDA plus)
- Ice Class 1D
- Unmanned machinery space (UMS)
- Centralised control station (CCS)
- Integrated computer control (ICC)
- Propulsion and steering machinery redundancy (PSMR*)
- Machinery condition monitoring (MCM)
- Dependable systems review (DSR).
- Automation of in port operations (PORT)
- Navigation arrangements, integrated bridge system (NAV-IBS)
- Passenger and crew accommodation comfort (PCAC(VN))
- Environmental protection (EP + A, B, G, N, P, R, S)
- In water survey (IWS) subject Isle of Man Ship Registry agreement.
- Ship emergency response service (SERS).
- Machinery planned maintenance scheme (MPMS)
- Hull planned maintenance scheme (HPMS)
- Green passport

Note: As a general rule the higher the number of notations the higher the quality of the ship and the more equipment / machinery that is installed. For example the “port” notation is related to Raffles dynamic positioning. It involves installing a laser positioning system, a differential GPS, a gyro compass, an anemometer and a motion reference sensor (possibly also an acoustic, in water, measuring system). Also to be absolutely sure the system does not

fail at a critical time a 1KVA uninterrupted power supply unit (UPS). Plus of course computer and control consoles.

The system will then allow Raffles to automatically dock and undock itself taking into account winds and currents without the captain touching the controls. Or the marine equivalent to a fully automatic landing system in a commercial airliner.

4. General description

Raffles is a mono or single hull vessel similar in many ways in its above water outward appearance to a cruise ship, but much smaller than most, modern cruise only vessels, and without the ugly box stern superstructure that is common in today's cruise and residence vessels.

With only 4 decks in the hull and 4.5 in the superstructure it is relatively low profile and thanks to its about 239m overall length, at least looks to be "fast".

It is however purposely designed to operate most economically at about 8 knots, keeping its 14 to 16 knots maximum speed in reserve, for emergency use only. Fuel consumption in fact more than doubles from 8 to 13 knots.

The hull is steel and superstructures are all aluminium with the division occurring at the 6m high main (bulkhead) deck level, on and above which are located all the main public spaces and above again, 122 spacious apartments. The lowest apartment is thus about 10 meters above the water line and unusually all crew accommodation in the hull is also above or at the waterline (in most modern cruise ships crew accommodation is buried at the bottom of the ship).

Also at the main deck two open boat decks are positioned one on each side, both with 2 x 150 passenger mono hull enclosed lifeboats. Unusually for a passenger vessel these are never used as ferries, thanks to the fact that Raffles carries its own high speed ferries and water taxis in its marina.

Not using the lifeboats as ferries with such use typical of all cruise ships also means that they will last at least as long as Raffles.

The fore deck or "focsle" is unusual for such a vessel in that it is totally flush, a "whale back" (North Sea trawler style), designed to shed waves quickly without damage when operating in areas such as the route from New Zealand to Antarctica, about the only rough water Raffles will ever purposely enter.

This deck can be used for crew recreation and also whale watching with lift out railings all around.

At aft is a large open deck with sheltered hanger/garage forward, with the four decks of superstructure stepping down to it from the stack. This deck is used for storage of larger boats including a carbon composite, 38' sailboat, 6 person float plane, 2 man helicopter and various vehicles that can be unloaded with its own 100 tons extending boom crane. It also houses the 436 survivor marine evacuation system (MES) on the stern at centre.

The aft deck area is also a separate “safe area” place of refuge that IMO is anticipated to demand in the future.

Below the open deck in the aft part of the hull is a totally unique feature not found on any other passenger ship, a vast 48m long about 1,900m³, two level, drive in 450m² wet surface area dock / marina that at nearly 4 stories high can easily accommodate the two 15m expedition / dive boats, 12m landing craft and 16m high speed ferry that Raffles carries. It is also a recreation centre with diving store and equipment for 12 air divers, plus a multitude of water “toys” stowed here.

The about 369 meters length (12,000m²) of open, A/A1 decks, along the top of the superstructure are reserved for relaxing, centred around the 25m long 3m deep pool at midships, or in the two restaurants (one at forward formal, at aft casual) the 200m² (2,000ft²) gym / sauna and the children’s play room / area.

A single funnel or “stack” is positioned at centre near the aft end of the upper decks with the raised deck below / behind it also used for helicopter operations allowing both landings and take offs into the wind.

All of the main air conditioned public spaces formal lounge, reception, supermarket, hospital, auditorium, etc. about 5,000m², are located at the 6m high main deck level immediately below the apartments. Minor facilities such as the post office, business centre, bank and place of worship are located in the superstructure at various deck levels mainly in the 5m wide central core between apartments.

The hull is divided by full depth / width transverse WT bulkheads and cofferdams into 16 main transverse sections and with 5 almost full length, longitudinal WT bulkheads. Horizontally there are 3 deck levels, including the tank top, over the 2m high double bottom. In place of WT bulkheads Raffles has 2m wide full width / height cofferdams in 6 locations including two (2) full strength collision bulkheads / cofferdams forward.

Many of the about four hundred (400) WT hull spaces are empty / unused and the largest compartments are the two main machinery spaces or “power stations” both 6m (two decks) high and 30m long x 11.75m wide between 2m wing tanks outboard and one deck above the tank top. The control room and below it the main switch / power conversion room are WT / fire proof 5m wide, located between the two machinery spaces.

Fuel, lubricant and fresh cooling water treatment systems and storage are isolated in the 3m high spaces immediately below each main machinery space P&S.

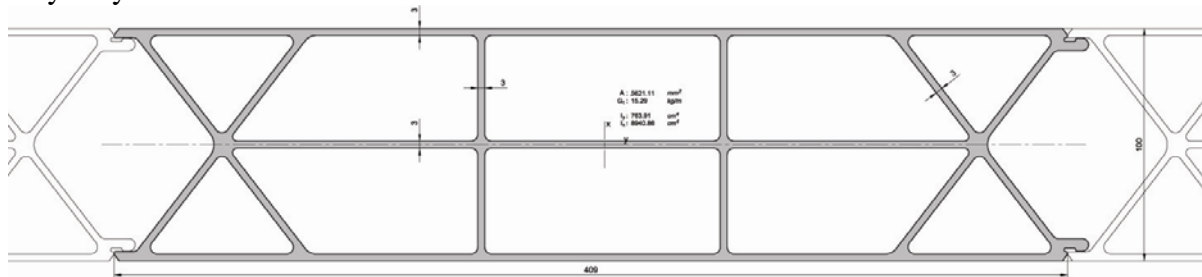
All tanks for HFO, fresh water, diesel fuel, etc. are isolated from the sea, located immediately above the double bottom (tank top) and within the wing tanks and in compliance with Marpol Annex 2 resolution MEPC 141(4) 24 March 2006. Total tankage is about 10,000 tons.

5. Apartments / accommodation / amenities and store rooms

All of the owners apartments / penthouses are located in the 4.5 levels of the mainly aluminium full width superstructure above the main deck, starting about 10m above the waterline.

Currently a total number of 122 units, with 112 “standard” or 120m² apartments and 10 penthouses of 260 to 410m² are provided with 12 units located forward at the highest “A” deck level forward. All apartments have full width teak planked private balconies and clear height deck to deckhead of 3.4 meters.

Due to Raffles superstructure design, which is based on using mainly its own design of very large extrusions, apartments can be increased / decreased in size or can be duplex or triplex with internal / private stairs or lifts installed and meaning that the total number of apartments may vary <www.alcan.com>.



Typical special aluminium extrusion from Alcan produced in Switzerland in lengths up to 25m.

All apartments face to outboard and inboard access is via two 1.5m wide passageways running forward / aft each side of a 5m wide central steel core. Cross access port to starboard is provided at a minimum of three, normally lift lobby locations and / or extreme forward and aft on each deck.

Sliding A60 fire doors are recessed into the core closing across passages and divide each deck into fire zones with typically each not more than 20m long x 13.75m but in practice less when subdivided again by the apartments double A60 walls.

The core in the superstructure is used mainly for “domestic” piping / wiring / communications systems but also provides separate long term dry storage for adjacent apartments. Plus at each level, 3 maids / concierge live full time in small ensuite mini apartments to provide 24-7 service / security / first emergency response.

A “garage” for the 6 mobile fire engines is provided in the core at each of B, C, D, E, “main” and 02 decks. Another fire engine is garaged at aft on A deck.

Apartment decks are vertically accessed by 3 main columns approximately located at forward, midships and aft. Each column is subdivided again and has two hydraulically operated passenger lifts for 8 persons and a WT / fire proof staircase in 3 separate sections. The midships stair column serving the lounge / reception area, which is also the main emergency abandon ship mustering centre and specially ventilated, is also designated a refuge with overpressure air supply to keep out fumes / smoke.

Raffles accommodation layout is analysed by BMT in Canada for its emergency evacuation routes / times <www.fleetech.com>.

Crew quarters in about forty number, 1, 2, 3 and 4 person sleeping cabins are on 02 deck below the main deck forward with common bathrooms in the core at centre. Space is provided for about 100 crew and this deck level is well above the waterline. Additional / spare crew space for about another 60 is immediately below at 03 deck on the waterline.

Spacious (about 500m²) crew recreation / messing spaces are at the main deck forward with the crew galley and ships bakery between.

About 16 officers and senior staff are housed in 1 and 2 man cabins in the superstructure with the Captain and Chief Engineer suites / offices immediately behind the navigation bridge at B deck forward. The communications centre, business centre, bank, post office, and ships offices are in the core adjacent.

The main air conditioned public spaces / amenities are located in the 6m high main deck level with boat decks outboard port and starboard through 5m high fire proof / armoured, double glazed wall / windows.

Also located at this deck port and starboard outboard forward of the reception area are 12 guest cabins 35 / 45m² each, but which are not provided with balconies.

Main deck utilisation from forward is:

- Crew mess + lounge, with galley / bakery between.
- 45 seat multi purpose auditorium.
- Doctor's office, 4 bed ICU and hospital operating theatre / dental surgery / pharmacy.
- Misc. at centre inc. golf simulator range, cigar room and high value store rooms.
- Reception with high security entrance (lock) in starboard boat deck forward.
- Main formal lounge – bar / library / games area full width between boat decks.
- Supermarket starboard aft.
- Retail outlets port aft.

At extreme aft port main deck are double WT / fire proof doors / airlock through a 6m high extension to the 2m width cofferdam leading direct into the gallery level of the marina. From the gallery wide stairs lead down to the dock side decks (with a chair lift) and a separate cargo / passenger lift serves both decks and up to the open aft deck over.

A fold down deck on the starboard side is used at anchor for viewing and diving.



Hellbergs sliding and hinged A60 fire doors, are on all the best ships <www.hellbergs.com>.

Other spaces in the superstructure core and outboard are designated for the bank, business centre, post office, ships office, on B deck, and hobby rooms, place of worship at E deck.

The two public restaurants and the attached kitchens for them are both located on the upper decks. The aft restaurant at “A” deck is casual bistro style while the forward restaurant at the

highest “A1” deck forward is formal style with its kitchen a feature at centre. There is also a small snack bar facility at the main deck lounge.

Below the main deck at mid / aft forward of machinery space are the about 2,000m³ refrigerated stores at 02 deck with refrigeration machinery at centre and the about 3,000m³ dry stores immediately below at 03 deck. Both store decks are accessed by wide stairs and a cargo lift from the main deck at aft.

At 02 deck between the refrigerated stores and crew quarters there is a transverse stores lobby with outboard to starboard a double WT shell door / lock fitted with a 2 tons extending gantry crane used for over side storing from boats / trucks.

The deck plans following shows the uppermost A1 deck at the top and at bottom 02 deck, which is the deck immediately below the main deck where crew sleeping quarters are located. The marina side decks can be seen at the left of 02 deck and the spaces between frame 50 and 80 are the upper levels of the two machinery spaces / power stations.

Owners’ apartments / penthouses are located only on the 5 decks below A1 deck.

The arrangement of apartments may change.

DECK PLANS



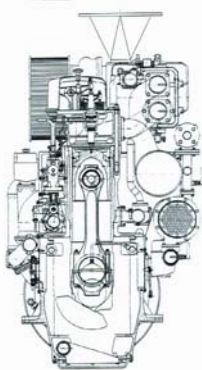
KEY

	STANDARD APARTMENT		PENTHOUSE		COLD STORES		SUPERMARKET		24/24 CONTROL ROOM
	STANDARD APARTMENT		CREW AREA		LIFTS/STAIRS		RETAIL		RESTAURANT BISTRO CAFE / BAR
	STANDARD APARTMENT		TEAK DECK		BUSINESS CENTRE/BANK POST OFFICE		AUDITORIUM		HOSPITAL

6. The electric ship

Raffles is an “all electric” ship meaning that it does not have conventional machinery arrangements, with a single or two main engines mechanically driving propellers and separate power generation for ships use.

Rather, its only power source are eight ABC Diesel 8 cylinder in line 1,000rpm diesel engines <www.abcdiesel.be> driving Convertteam alternators <www.convertteam.com> producing in total about 13,000KW of medium and low voltage electrical power for all uses, including a maximum 7,600KW used for full speed propulsion purposes.



The 8 alternator engines are from ABC Diesel, model 8DZC, @ 1,000rpm; 1,600KW. This design has been in service, since 1985 with ABC continuously building engines since licensed by Rudolph Diesel in 1899.

With Raffles stopped 3 weeks out of 4 this means that it is not carrying around expensive machinery that is under utilised but that still has to be maintained.

While an “electric” ship is more expensive initially than a conventional (propulsion) system the advantages it offers far outweigh this and in the long term the additional cost is easily recovered from fuel savings, with this further enhanced by operation on less expensive heavy fuel oil (HFO) and not diesel.

Being all electric also means that it is virtually impossible for Raffles ever to be totally stopped or unable to manoeuvre due to mechanical breakdown. With 8 generators and 4 electric propulsors, only 1 of each needs to be operational for Raffles to be able to manoeuvre and continue her voyage or “safe return to port” (see Lloyd’s Register notations PSMR). In addition Raffles has wind turbine and solar cells for the ultimate back up.

Being electric also has number other advantages / benefits amongst them:

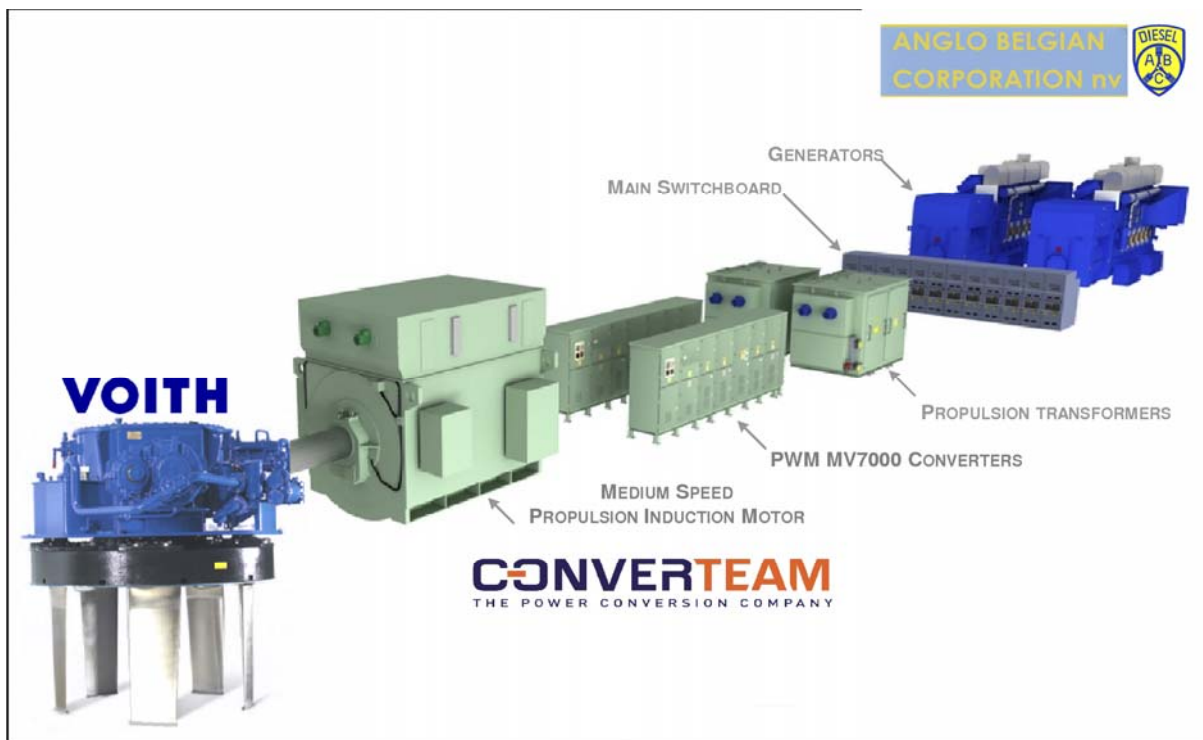
- ⇒ Reduction or elimination of most noise and vibration. Raffles is a very quiet ship.
- ⇒ Design flexibility with Raffles two power stations / machinery spaces located exactly where they have to be and propulsors positioned to maximise efficiency.
- ⇒ Ease of maintenance with it possible to provide for continuous maintenance / repair without stopping or taking Raffles out of service. In addition 95% of maintenance is by the ships engineers and carried out in situ, typically by exchange and using the ships own workshops.
- ⇒ Design growth with it being easy to add new equipment whenever, and practically anywhere in Raffles, it may be needed.
- ⇒ Economy of operation with only the power actually needed at any one time generated.

- ⇒ In the future having the option to change the motive source of power and / or fuels used.
- ⇒ Safety, with electric driven auxiliary equipment typically more reliable and easier to monitor remotely.

Because it is always occupied monitoring the operation of Raffles is a continuous task at sea or in port. This is achieved from a state of art central control room located on two levels between the main generator spaces. This additionally performs the function of an emergency centre able to also monitor most spaces and all machinery electronically and by CCTV. The control room also has full back up control of the ships steering / navigation including its own GPS, radar system, low light 360° TV positioned on the stack, as well as full off ship (satellite) communications systems. The control room is manned 24-7 even in port.

7. Main propulsion

The diesel – electric 360° propulsion system shown has the Voith – Schneider 360° propulsor on the left and the ABC diesel engines (2 only shown) on the right. The power conversion and control equipment from Converteam is between the two. Apart from the mechanical drive, the diesel engines to the alternators, and motors to propulsors all other power transmission is by electric cable.



Main propulsion is by two 3,800KW cycloidal thrusters from German company Voith – Schneider that are mounted aft and well outboard, each side of the marina wet dock. The main propulsors also provide almost instantaneous, very precise steering <www.voithturbo.com>.



The two main Voith – Schneider propulsors are model VSP 36R6 EC/300; 3,800KW, @ 60rpm, electric driven, each weighing 100 tons with 6 x 2.8m long stainless blades..

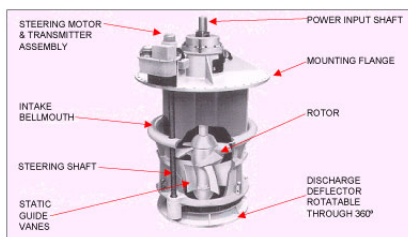
Electrically driven by a medium voltage water cooled induction motor, each of the propulsors has six 2.8m long stainless steel vertical blades that do not extend below the hull bottom line and provide both 360° thrust and steering. They can also be used to stabilise the vessels motion.

Mounted in specially designed wells that extend from the bottom shell to above the water line each propulsor, weighing about 100 tons, can be vertically lifted as a complete unit up into the marina for dry inspection / repair by ships engineers and Lloyd’s Register, with Raffles remaining afloat.

First patented in the 1800’s the cycloidal thrusters operate at only 60rpm and provide very low noise / vibration levels even at full speed. For slow speed economical operation typically only one main thruster is used where thanks to its steering function Raffles steers as easily as with two units in operation.

Integrated by Convertteam with the two bow thrusters, allowing all 4x360° propulsor units to operate in unison they provide dynamic positioning (DP) that allows Raffles to enter and position itself to ±1 meter in environmentally sensitive areas such as the Great Barrier reef, without anchoring! The PORT notation as above indicates that they also allow automatic docking manoeuvres.

The two 1,060KW 360° flush water jet bow thrusters from British company Tees “Gill Jet” as well provide propulsion and steering. Also electrically driven they are installed in two WT compartments below the hold forward <www.teesgillthrusters.com>.



The two bow thrusters are Tees Gill, jet, model T3S/50; 1,060KW, electric driven flush 360° type.

Raffles in an emergency can maintain forward movement at low speed with only one generator (in 8) in operation and one bow thruster.

The solid state power conversion / control equipment for propulsion including switchboard and power management system (PMS) is from Converteam formerly Alstom and the UK G.E. who are world leaders in this field and who supplied the same system to the QM2. Converteam also provide the 4 drive motors, bridge controls and the dynamic positioning system <www.converteam.com>.



Raffles total electrical / control and management system is from Converteam who also provided the QM2 system(s) and about 60% of electric ships in operation today.

8. Electrical systems

As an electric ship Raffles electrical systems are extensive and include:

- Medium voltage 600+ that serves only heavy users and primarily located only in the after part of the ship and low in the hull.
- Low voltage 200+ serving domestic / hotel needs and smaller machinery / equipment throughout the ship at all levels.
- DC 12/24/32 volts that is ship wide serving mainly emergency systems or where total reliability is required.
- + Miscellaneous micro systems, solar, wind, and hydro DC power sources.

To provide physical / mechanical and fire protection all main distribution systems are run in the central core for as much of their length as possible with vertical transits, deck to deck in special fire proof ducts.

For ease of maintenances / inspection most systems are run flat on metal trays or on vertical bulkheads in hangers with good separation to ensure good access and easily visible inspection, as well as to reduce fire risks.

The medium voltage systems from the switch room P&S to two main propulsor drive motor rooms are run with single continuous cables in special heavy duty metal ducts through WT compartments on either side of the marina with ducts provided with temperature measurement alarms and inert gas flooding.

Low voltage systems to apartments are run in the core, a single continuous cable from the main switchboard to multiple switch / distribution boards at each level to allow rapid isolation and cross over. Final connection from the core into each apartment's own switch / distribution board, after a digital meter, is via a flexible, armoured plug in umbilical.

Various spaces, supermarket, retail outlets, restaurants, etc. supply is similar with each space's consumption individually metered and provided with a switch / distribution board for local / isolation. A PC based system monitors long term consumption throughout the vessel.

The DC system is used for emergency lighting, fire detection systems and the special bilge/ alarm system, etc. It is provided with a combination of battery and fuel cell back up. Special

extended period stored supply, gel or matt glass battery and fuel cell based, is arranged for the hospital / operating theatre and the ships essential communication systems, plus some navigation equipment on the bridge. These systems will also be guaranteed a power supply from the solar / wind / hydro systems.

Electrical system to lifeboat davits to ensure operation even in a total power failure situation is separate again, divided both port + starboard and for the two individual boats on each deck.

Throughout Raffles automatically charged fixed and portable emergency lighting and with additional torches/ lanterns in apartments and crew quarters are significantly in excess of statutory minimum required, both in quality / quantity and capability.

The ship's closed loop VHF communication system has a separate fail safe power supply to ensure its availability in an emergency. Personal VHF radios which all crew carry are provided with individual chargers at both the users work place and sleeping quarters. Portable VHF radios / chargers in each apartment are part of the same emergency communications system.

The marina stern doors 24 volt heavy duty system has manual back up to allow the two vertical hinged doors to be opened in a total power failure with the ship dead in the water.

A 110KW, air cooled diesel driven alternator for emergency / harbour use with both electrical and hydro start is located in the stack, connected to the emergency switch board.

A special retractable vertical carbon fibre / aluminium mast with fold out vertical solar panels, battery charge system and gel battery bank is fitted.

Raffles also carries two mini-hydro generators each producing 8 amps / 12 volts about 1.5KW that can be streamed off the stern and two 6KW Darrius type wind generators, all with their own charging and battery storage systems.

Extensive use is made throughout Raffles of small solar powered extractor fans for ventilation of apartment wardrobes, service walls and small spaces in the hull / superstructure not normally entered or provided with ventilation, that might be subject to condensation.

9. Auxiliary machinery / services / systems

Being all electric and with "spare" space located throughout the vessel means that auxiliary machinery and systems can be dispersed with the added benefits of improved safety combined with generally lower installation costs.

The main auxiliary machinery / systems include:

- HFO fuel storage and treatment with two separate P&S systems installed under the main machinery spaces.
- Exhaust scrubbers with two separate systems P&S installed in stacks and aft of main machinery spaces.
- EVAC vacuum sewage plant with 3 systems installed any one of which can service all ships needs.

- Reverse osmosis fresh water makers with 3 systems installed any one of which can provide all the daily fresh water needed (also used for ballast).
- Two back up 16 tons per day fresh water evaporators.
- Chilled water air conditioning systems with multiple VRF systems to allow for wide ranging loads.
- 2,000m³, about 600 tons, of deep freeze / refrigerated storage with four separate machinery systems.
- The hi-fog system with at least 12 pump / accumulator units to provide minimum 300% redundancy.
- Oily bilge water treatment + storage with two separate systems.
- Two vertical electric 75KW anchor windlasses installed in two separate WT compartments

With most of these systems located outside the main machinery spaces, either at or near the tank top or in the core and as close to users as possible to reduce piping and delivery needs.

In the main machinery spaces generally auxiliary machinery / systems are limited to those directly serving the main generators or propulsion, however some such as compressed air for engine starting are also used to provide “working” air through out the vessel.

The only significant non electric systems onboard are the local, but still electrically driven hydraulics for the lifts and the 100 ton aft crane, with all operating using non flammable type hydraulic oil.

Electronic systems including most navigation and communications are located mainly in a specially protected space(s) aft of the navigation bridge or in the post office / bank adjacent, and in the control room.

Various surveillance systems are based / monitored mainly in the control room but with remotes at the bridge, Captains cabin and the reception area.

Within individual apartments auxiliary systems include for hot water heating, FW pressure and air conditioning with only umbilical connections into the main systems run in the core, for low voltage electricity supply, fresh water and vacuum sewage suction.

Piping systems, with associated pumps, generally run in the hull and mainly via the central core with branch connections to spaces served at each deck.

10. Dependability / redundancy and back up

That Raffles carries no cargo and operates at a constant draft, ballasting only with fresh water, is a very slow speed vessel and does nothing in a hurry or under time pressures means also that a very high level of dependability redundancy / back up can be built in.

Plus it means that the equipments / machinery needed can generally be smaller, standard off the shelf items, long proven in service on such as coastal vessels, offshore supply boats, warships, mega yachts, etc.

Taking advantage of this, allied with the “spare” space available, a concerted effort has been made to simplify all auxiliary systems and provide a level of dependability / redundancy / back up not found in any other vessel.

Another inherent advantage of this policy is obtaining more economical operation while making repair / maintenance tasks much easier and faster.

Throughout the vessel what this typically means is that where on most vessels one item of machinery is the norm, on Raffles there are two, three or four. Normally they will be sized at 60 to 90% of total capacity which means that when demand / loads are low, only sufficient machinery to provide the required capacity is in operation.

Naturally it also means equipment of a small physical size allowing repair by exchange using the vessels fully equipped work shops.

The total excess capacity installed also means that in an emergency this can be available.

The dependability / redundancy provided by this policy is one reason why Raffles can obtain Lloyd’s Register notation DSR and will fully comply with SOLAS safe return to port requirements when these are introduced.

11. Safety, fire fighting, lifesaving

With its full double hull, heavy construction to ice class and massive internal subdivision and very limited internal access below the waterline Raffles is inherently safe, especially when compared to any other vessel afloat.

In addition it carries lifesaving, fire prevention / detection and safety equipment that is in some cases 500% more than required by international and Isle of Man law.



The four Schat – Harding 150 survivors enclosed lifeboats and davits are located port and starboard on two boat decks at the main deck.

The emphasis on safety reflects that Raffles will operate for long periods in remote areas of the world where external assistance from coastguard, fire brigade or ambulance services is non existent, or will be a very long time arriving.

For lifesaving / evacuation of Raffles about 400 occupants it has three + two separate systems:

- 4 x 150 passenger enclosed lifeboats. <www.schat-harding.com>
- 1 x 436 survivors marine evacuation system with 4 fully reversible liferafts. <www.rfdbeaufort.com>
- 8 x 100 survivor MARIN – ARK fully reversible liferafts. <www.rfdbeaufort.com>

- + 1 x stern slide launched tug / lifeboat, aluminium RIB type with 1,500 nautical mile (towing) range.
- + 4 x special survival stores stainless capsules.
- 200% lifebelts (inflatable and solid type) + rings + quick launch naval type MOB spar buoys.
- 1 x UAV with real time TV for search purposes.
- 1 x 2 person SAR helicopter.

It is also provided with a place of refuge in anticipation of this becoming a requirement for all passenger carrying ships.

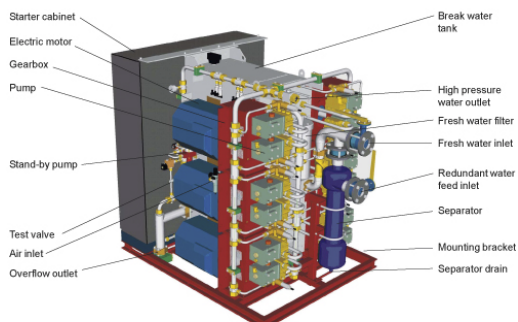


RFD 436 survivors, in 4 fully reversible liferafts, MES.

The unique tug – lifeboat, launched over the stern, is specially designed and outfitted to tow the four main boats + rafts out of a sinking in Antarctica to the nearest continent, while also unique to Raffles the four float free survival capsules will allow 400 survivors to live ashore in Antarctica for 2 weeks.

In addition most of Raffles about 20 recreational boats have a dual purpose, and with larger units equipped to act as rescue or lifeboats in an emergency they almost triple the officially required lifesaving capacity. The 15m expedition / dive boats, able to carry 100 in an emergency, are fully equipped with radar, satnav / coms and can also be used as tugs.

The main ship wide fire detection / suppression system is based around a Marioff hi-fog – water mist system that protects 95% of occupied spaces plus others such as main machinery. The pump / accumulator units at the heart of hi-fog system are nearly six times in number the recommended level and provide coverage about equal to that installed on the QM2!



There are at least nine of these hi-fog pump / accumulator units, with one located on each apartment deck.

The critical machinery spaces are protected by the same hi-fog system, but in the two main machinery spaces there are three additional / overlapping systems including foam, inert gas flooding and rapid drenching using water from the swimming pool. Some WT spaces such as the HFO fuel treatment and crew's galley, not normally occupied or that can be shut down / evacuated quickly are protected by high expansion full foam flooding.

Apart from its very rapid suppression of fire an advantage of hi-fog <www.marioff.com> is that it does not destroy the contents of a space and also does not cause flooding that can lead to instability.

On a personal level in each apartment, in addition to being fitted with combined smoke / heat detectors there are additional CO₂ detectors in bedrooms and each permanent occupant is provided with a personal 15 minute air breathing device <www.draeger.com>, VHF radio, chargeable torch and whistle. All the crew and crew quarters have similar equipments / arrangements. Portable extinguishers, well in excess of rules are provided at about 120 fire (hose reel) points throughout Raffles and in each apartment / crew quarters.



Dräger 15 minutes fire escape hoods are provided for all owners and crew.

Large wheeled high expansion foam film generators are located at the aft open deck and in the marina for fighting fires on vehicle / boats.

Each apartment is a totally enclosed A60 fire zone meaning that a fire can start and is contained without any damage to surrounding apartments and structure for at least 60 minutes.

A unique feature is a CCTV monitoring the electric cooking surfaces in the kitchen activated by either a heat / infra red or smoke or rate of temperature rise sensor. The CCTV is switched on automatically and monitored in the control room while local fire extinguishers are automatically activated and the cooking surface is retracted down into a fire proof cabinet.

Pneumatic or electric operated sliding action A60 fire doors are fully recessed into the core at typically 20 meters intervals along passage ways in the superstructure. The number installed is in excess of SOLAS and designed to isolate any fire quickly. Doors can be remote or locally manually operated. Doors air supply is also from 24 volt system so fail safe.

Similar doors to SOLAS are provided at the main deck and in the hull. Hinged closing A60 doors may be used in some locations where they cannot be recessed.

Similar doors may be used in the crew galley and spaces such as the hospital laboratory.

Throughout the vessel a conventional pressurised fire main system with about 120 hose reel stations means that no occupied space is more than 30m/100ft from a fire point, fire hose.

Backing up these systems is a CCTV network including thermal cameras that means the control room can visually detect most problems and a ship wide wi-fi, VHF and back up sound powered phone, communications system that means crew are always on call to respond quickly.

A unique feature on Raffles is that at least one maid / concierge is always on duty 24-7 at each apartment level and is trained to act as a first responder to fire and medical emergencies. Equipped with a mobile fire engine / emergency wagon garaged on each accommodation level, including the main deck and crew quarters, they can reach any part of the accommodation in a minute.

The “fire engine” has special equipment for fighting all types of fires, thermal location, saving lives, and first aid. Other fire engines can be moved between decks by the lifts as needed and Raffles crew will include a fire fighting team trained by the UK Royal Navy.

Raffles has another safety feature that is totally unique in any passenger vessel. In memory of that vessel this is named the “Derbyshire” system and is based around a 24 volt pump / level switch unit installed in all WT compartments below / at the water line plus other such as the fore peak. These units are so sensitive that they sound an alarm when only 1cm of water enters a compartment and if more they automatically start pumping it out. Tied in to a dedicated PC in the control and bridge they provide an early warning system of any water entering the hull, when the one of the ships three (3) separate main evacuation pumping systems can be activated as back up.

The aft open deck in anticipation of SOLAS mandate is a designated “safe area” / “place of refuge” equipped with:

- Toilet / bathroom facilities.
- Emergency water & food.
- Medical treatment facilities
- Weather shelter.
- Lighting, heating and ventilation
- Emergency thermal clothing / blankets.
- Stand alone power supply

12. Navigation / communications and computerisation

With final outfit not decided until shortly before delivery, the navigation and communications equipment on Raffles is state of the art but also purposely designed to allow safe operation with a small crew.

Onboard, a ship wide wi-fi, VHF (closed loop) and fibre optic telephone system combined with cell phones and pagers means that all crew are “online” at all times. With most officers also equipped with portable PC’s or PDA’s wasted movement around the ship is almost eliminated (also allowing most crew to work a normal 8 hour day).

All critical communications cabling is run in metal ducts within the core and for essential systems between the bridge and control room, two separate (alternative) routes are used.

For navigation Raffles has all the mandated / statutory systems but generally above minimum standard and in duplicate or triplicate to provide back up / redundancy.

It also has dedicated back up systems such as the aft mounted GPS, radar, 360° low light tv and sat com that allow the control room to take over and manoeuvre / navigate the ship in an emergency.

Two additional non standard radars are fitted one designed to look forward and down for unusual / dangerous wave patterns, the other aft and down against small boat pirate attack from astern.

Communications are mostly satellite based with individual stand alone systems provided for encrypted communications to the HSBC, and with a specially stabilised antenna for tele-medicine between the hospital and University College Hospital (HarleySt.on15) in London. The hospital system has its own fail-safe fuel cell based power supply. Other systems service only internet traffic while yet another is dedicated to telephone traffic that allows direct dialling from an apartment to anywhere in the world. All television and radio reception is of course satellite based.

For safe navigation into remote and or uncharted areas Raffles has three sonar systems one of which is naval standard, one retractable forward looking, which combined with Raffles ability to stop almost instantly is very useful when entering shallow waters or rivers and when anchoring.

VHF, HF and SSB radio systems to IMO – SOLAS and Isle of Man Government requirements are fitted but in addition Raffles has its own local VHF and cellphone system mounted on a carbon fibre retractable mast that when raised to about 70 meters allows Raffles to keep in touch with owners and crew when ashore, on islands or away in small boats.

For long range navigation / survey in uncharted areas and such as Antarctica, Raffles float plane and helicopter can be used well ahead of the vessel. Similarly the expedition boats are also fitted out for survey duty with echo sounders, GPS and satcoms.

All of Raffles operation is continuously monitored by various computer systems that allow engineers, accountants and the Captain to obtain up to date information on the ships operations / status at any time. It includes monitoring such as onboard sales in the supermarket to allow restoring, and an internal security system that restricts access to certain spaces as well as checks crew and owners on and off the ship.

13. The marina and aft deck

Raffles marina is unique with no other commercial passenger ship known to have one.

The design is based on the British Royal Navy's 16,000 tons landing platform ship(s) dock, HMS Albion + Bulwark.



HMS Albion's stern well / dock is similar to Raffles, but larger?

Albion's dock is designed to allow smaller landing craft carrying Challenger battle tanks to drive in and out at anchor and also for large hover landing craft. It does not have the side / gallery decks that Raffles has.

Raffles dock serves the same purpose but instead of being full width its wet dock is only 13m (40ft) wide and extending about 35m forward from the stern entrance doors, with the marina space in total about 48m long and full width. The entrance itself is an about 11m high clear opening, entered between two raked (largely cosmetic) extensions to the hull, port and starboard.

With a water depth of 1.5m to 2m in the wet dock it allows both its 15m expedition boats the 16m large fast water jet ferry landing craft and amphibious vehicles to enter and also to be stored here (dry) for long ocean passages.

The marina is separated from the rest of the vessel by a 2m wide full width / depth cofferdam forward that extends above the main / bhd deck to the strength deck effectively isolates the marina. It is surrounded by the 2m wide wing tanks up to the main deck (gallery deck) and with a double hull construction across the transom up to the open deck. Construction under the dock and side decks is mainly single hull compartments but all small, with very heavy transverse / longitudinal subdivision in this area.

There is a very heavy duty central skeg 5m wide at its forward end that extends aft to near the main thrusters and is effectively a double bottom in this area.

In the double transom are two WT vertical hinged doors (also double / sandwich construction) that close over a 4m high lower WT flap that hinges down to aft, but only after the two doors are opened. The flap alone can be closed quickly leaving the doors open in event of bad weather. The doors / flap in the transom when closed and manually secured become a part of the double hull structure but are fabricated from aluminium and stainless steel. Normal door operation is by 24 volt hydraulics (with local back-up power supply) but final WT closure is by hand operated / secured devices, with the door monitored by CCTV in the control room and navigation bridge.

The two P&S hull extensions or horns aft of the transom cofferdam provide additional protection.

The marina is on two levels with 7.75m wide side teak planked lower / side decks all around the wet dock and a set back, 6m wide U shaped teak planked "gallery" deck at 3m over. At forward the gallery deck is 8m wide and the height over the gallery is 6m, less deep transverse web frames at 10m centres.

The dock itself has a backal wood lining and is evacuated by special high capacity pumps located P&S at aft that also service the separate bilge system in this aft section of the vessel between the two cofferdams. These pumps can also provide back up to the fire main.

Flooding the dock can be by the same pumps in reverse or manually operated valve inlets in the flap. (The dock is also used as an emergency overflow “tank” when loading HFO at the main deck fuelling point over).

The marina is both a recreation centre and a work place with a 2 ton gantry crane with 20m span running down the centre from forward to aft and used for repairing boats, loading stores, lifting small boats into the dock for use and to load small vehicles to the boats.

An open cage type lift, rack and cog driven, operates from the port marina side deck up through the gallery deck and on up to the open aft deck in a WT casing over. It is used for stores but also provides personal, particularly wheel chair access.

The marina can also be used as an alternative entry point for ships boats when at anchor and rough seas prohibit the use of the semi submersible pontoon / companionway at the midships entry point.

A fold down viewing platform at the gallery deck level forward starboard also provides through ventilation at anchor.

A special feature of Raffles, a 9m long all aluminium fully enclosed tug / lifeboat RIB is housed in a “garage” entered at the port side aft marina gallery level. It is launched via an inclined ramp down the port transom with a WT door over and the boat garage itself WT, accessed by a door from the marina gallery.

A stern anchor, HHP type on a wire is mounted at the gallery deck level starboard on transom aft. Winch is electric housed inboard at the marina side deck. Anchor deploys over the starboard transom via a pop-up roller guide.

Complementing the marina boat operations two boat booms are fitted port and starboard outboard of the aft open deck on which boats not in use or overnight can be secured by a single tensioned line while streamed alongside.

The large about 18,000m² aft open working / recreation deck immediately over the marina is also not standard on a cruise or residence vessel and as noted in 11 serves as a “safe area” outside the main vertical zone.

At this deck are stowed larger boats, aircraft, and vehicles with the forward, about 600m² area partially enclosed as a hanger / garage, serviced by tracked gantry cranes. This area also has light and heavy workshop facilities forward starboard.

A 100 tons at 3m extending boom electro-hydraulic crane mounted on transverse rails is used to lift large boats, float plane, vehicles, etc. into the water or to boats. It is also used to lift vehicles to alongside in port and for heavy storing.

Boats and planes are stored on special racks / cradles.

At extreme aft centre is the 436 survivor mass evacuation system (MES) as a back up to the lifeboats. Outboard P&S are another eight 100 survivor fully reversible life rafts. Also P&S on quick release racks are four large (2,000 litres) stainless steel survival capsules fitted with automatic floatation collars.

The aft deck is teak planked with mooring bollards on bronze / stainless steel pedestals through the deck arranged for Mediterranean mooring, with 10 ton vertical electric capstans adjacent.

14. Boats, aircrafts, vehicles and toys

Much of the equipment carried on Raffles has a dual purpose with many items contributing both to providing for its owners recreation and to ensure the long life or safety of the vessel.

An example is the two Spyfish ROV <www.spyfish.com>. These can be deployed from Raffles itself or on its 15m expedition / dive / survey boats and provide those people who can't dive with real time underwater viewing on a large screen of very high quality.



Providing non divers access to an underwater world, Spyfish also allows regular survey of the hull, in water.

Deployed from onboard they are also used to survey the hull on a regular basis to monitor fouling or damage.

The submarine can also be used to transport surveyors for under water hull inspections.

Deployed from the survey boats they can also be used to ensure that Raffles planned anchorages in the many locations that may be less than well charted, are safe.

The ships boats themselves are mainly for recreation or transport as ferries. However most of the larger boats are also outfitted as back up lifeboats and the 15m exploration boats even have radar, echo sounders, full satcom's, etc.



Purely for recreation the 38ft Stompcraft, carbon fibre composite sail boat is competition class sleeping six for extended sailing even across the Atlantic in company with Raffles.
<www.stompcraft.com>

The marina doors and the 100 ton crane at aft are specially designed that in an emergency, with the ship dead in the water with no mains power, they can still be operated and boats can still be safely launched.

Most smaller boats are RIB type and range in size from 4 person, water taxis up to 20 passenger 35 knot triple water jet ferry.



For diving, high speed water taxis, or just messing about.

The Murphy Moose float plane carried is a replica of the famed De-Havilland Beaver and is intended for use mainly as an air ambulance for emergency evacuation. It can also be used as an air taxi or simply for recreational flying. It is strong enough with its bush plane antecedents to be launched by the 100 ton crane and take off in a seaway. It is also used for survey and SAR duty <www.murphyair.com>.



A true bush plane, the Murphy Moose main use is as an air ambulance.

Raffles two man helicopter is carried mainly for SAR duty but can also be used for recreation and surveying.



The two man gas turbine helicopter is as easy to fly as a car, with no tail rotor.



For real exploration hop aboard U Boat Worx of Holland. 3 – 4 persons submarine for dives up to 40 meters under the sea.

The two man autogyros fitted with floats are intended mainly for recreation but also are used in SAR and survey roles.



Two autogyros mainly for fun but also rescue / survey duty.

A 1.5km range UAV with real time video is also carried for SAR duties.



At sea the electric powered micro drone is always ready for instant take off, programmed to automatically search in a 600 meters wide zigzag pattern to 1.5km astern of the ship with its colour, tilt controlled video camera.

The landing craft can carry a 4WD to shore as well as all the other miscellaneous vehicles carried. Most of the vehicles carried are electric or hybrids and range from bicycles to an 8 seat aluminium mini bus. Stored in the wet dock the landing craft is loaded by the 100 ton crane. A removable bladder fuel tank that can be loaded into its well also allows its use in emergency as a tanker for escorting lifeboats out of Antarctica or to sustain survivors onshore.



The landing craft takes vehicles of Land Rover size to shore from an anchored Raffles.

An unusual feature of Raffles is that its four 150 survivor enclosed lifeboats do not ever need to be used as ferries because it carries its own water taxis and fast ferries. This means that with good care and maintenance like Raffles they will also have a 100 years life.

Two other features of Raffles related to its boat operations are that it has boat booms P&S of the aft deck to which boats afloat can be safely secured temporarily or overnight when at anchor, with low light CCTV coverage of the area.

Also that its single landing pontoon for use at anchor is a special aluminium semi-submersible design with the ships short companion way landing on it via an air pad. Combined, the two mean that motion when unloading / loading passengers from boats is very much reduced.

Raffles alternative embarkation point if rough water blows up is into the marina at aft.

The water toys on Raffles are too numerous to detail and range from body boards to divers scooters through jet skis to ski boats as well as the obvious windsurfers and kayaks. Most are stowed around the marina and / or in the larger boats.

15. Lloyd's Register

Lloyd's Register is an industrial and provident society and an exempt charity registered in England and Wales, registered number 29592R. Registered office: 71 Fenchurch Street, London, EC3M 4BS, UK. A member of the Lloyd's Register Group.

High levels of technical excellence are required to help ensure that Raffles is built to the exacting standards of safety and comfort that is guaranteed to apartment owners. So, when it came to classification, Lloyd's Register was Raffles naval architects and builders first and only choice.

As a classification society, Lloyd's Register is an essential link in the overall safety chain of the marine industry. Developed as a result of extensive research and experience in the maritime industry, it's all encompassing Rules and Regulations set international standards used by most governments for the design, construction and ongoing maintenance of ships.

Lloyd's Register has always been at the forefront of cruise ship innovation and it has been instrumental in the development of increasingly large cruise vessels over the last 40 years. The world's major cruise operators all benefit from its experience and 50% of the cruise / mega yacht fleet is classed by Lloyd's Register, ranging in size from 500 to over 150,000 gt (gross tonnage).

Lloyd's Register has been supporting the Raffles project for a number of years and they say they are delighted that they will remain intimately involved until final delivery of the ship to apartment owners.

Its design support and plan approval teams scrutinise the design / engineering and specification of the ship to ensure that it meets the current and anticipated requirements of the Rules and Regulations, as well as International Maritime Organization (IMO) and other legislation. It will then ensure that the vessel is built to the highest standards by having two surveyors present in the shipyard throughout the entire construction process, plus other specialists visiting as needed.

As well as helping to 'future-proof' Raffles, in this way Lloyd's Register will provide ongoing advice on methods for enhancing its dependability and maintainability in service. In addition, it will carry out a special fatigue analysis taking into account Raffles' intended operation, and to recommend structural adjustments to help increase the lifetime of the hull. Furthermore, drawing on its extensive knowledge of cruise ships and large yachts, Lloyd's Register will be providing valuable input into the builders general outfitting of Raffles.

Lloyd's Register will act on behalf of the Isle of Man Government in statutory matters as well as if required advising Raffles owners / trustees on technical / operational matters both during construction then in sea going operation.

Once built and in service, Lloyd's Register provides unrivalled passenger safety surveys through its worldwide surveyor network, which will support the owners anywhere in the world Raffles may be.



Typically Raffles will go through a special survey by Lloyd's each 5 to 10 years.

Lloyd's Register will be happy to advise individual apartment owners on the design, engineering, safety and operational aspects of Raffles should they have any questions.

The Lloyd's Register Group assumes no responsibility and shall not be liable to any person for any loss, damage or expense caused by reliance on the information or advice in this document or howsoever provided, unless that person has signed a contract with the relevant Lloyd's Register Group entity for the provision of this information or advice and in that case any responsibility or liability is exclusively on the terms and conditions set out in that contract.

16. Raffles low operating costs

An unseen "feature" of Raffles is its low cost of operation, but which in practice is as important as the physical features detailed above.

Achieving as low operating costs as possible, consistent with ensuring a very high quality operation and a higher level of safety than standard, was from the start a paramount objective of Raffles design and engineering development.

Selecting diesel – electric propulsion systems based on multiple (8) generators does add to Raffles initial cost but this is more than compensated for by the fuel saved. With 8 x 1,766KW engine driven alternators, only as many as are needed to provide for the current electrical load are "on line" at anyone time. This means in addition to no fuel being wasted, that maintenance and repairs costs are also directly reduced. Not so obvious is that maintenance and repair can be carried out on a continuous basis. On Raffles this in turns means within normal 8 to 5 working hours for its engineers, with no overtime necessary. Simultaneously the number of engineers / electricians that need to be carried can be less than on other similar vessels.

In practice even 1,766KW of electrical power may on occasion be too much so Raffles also has a system to switch from steam heating its stored fuel, to electric heating, to soak up the excess power.

With fuel the major cost of operation then crew costs are typically the next highest. On Raffles the crew numbers 105 with 44 designated as "ships" crew and 47 considered as

“hotel” or “domestic crew”. This is about half that of similar size residential ships and achieved without any reduction in service levels simply by making sure that the crew can work efficiently and have everything they need to make their job easier. Again this involves additional capital cost, such as for the ship-wide wi-fi, closed loop VHF systems and related communications equipment, but the fact of the reduced crew needed again justifies this investment.

Overall maintenance costs, typically the next biggest item, are reduced by the decision to install multiple units in auxiliary systems, with in total higher capacity than needed. This also contributes to lower power consumption due to that only the capacity actually needed being on line. Additionally it means that 90% of maintenance can be by exchange in situ, and because physically smaller units are used, that 99% of maintenance can be carried out by the crew in their own well equipped workshops.

The unique feature (and ships structure) that allows the two main propulsors, each 100 tons, to be totally withdrawn vertically up into the marina, with Raffles still afloat, for inspection by Lloyd’s Register and / or repair – maintenance, means Raffles does not have to be dry docked for 2 to 5 days at regular intervals for this routine inspection. But of course building in this capability and providing a 100 ton crane does add to Raffles capital cost.

Throughout Raffles there are many such examples of the “future thinking” that has gone into her operation for the next 100 years and that contribute to substantially reducing her operating costs.

Lloyd’s Register, who will supervise Raffles construction full time with 2 surveyors on site, plus others visiting have also contributed to this process, informally during engineering development, then formally via their unique “future proofing” of Raffles. This process is ongoing until Raffles is delivered, with additionally some of the leading experts in the world also involved.

An indication of what this effort means is that a similar size residence vessel is projecting charging its lessees €1,400 per m²/year contribution to its operating costs, versus the about €625 per m²/year that is planned Raffles owners will need to contribute.

17. Caution

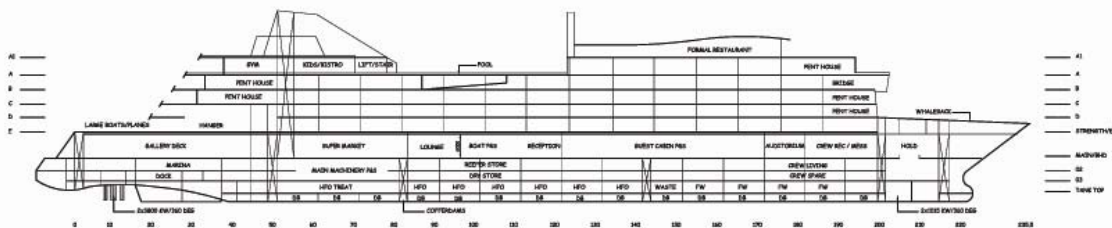
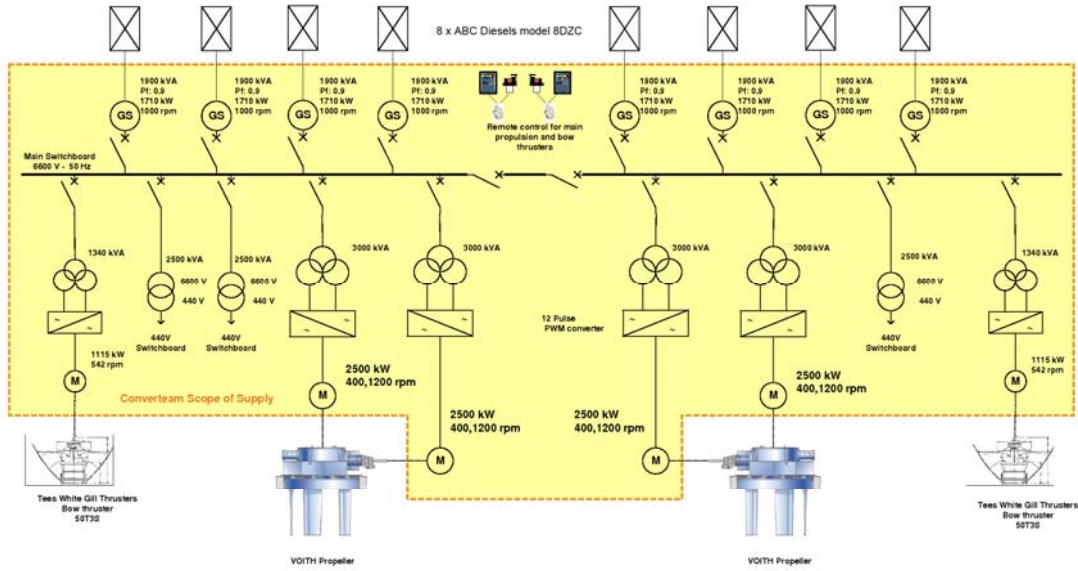
This document is not a technical offer or contractual description of Raffles. It is provided and intended only to inform potential owners of the ships arrangement, its general properties, attributes, features, equipment and quality.

During Lloyd’s Register final approval process, immediately before construction can start some changes, additions / deletions will be unavoidable but these will not affect the overall delivery schedule and will only improve Raffles quality.

Similarly to ensure timely delivery and to allow construction costs to be fixed FVH / AMS may select different manufacturers / suppliers to those named above and in the equipment list following.

Notwithstanding any of the above the quality of Raffles, its 100 years life, reliability / dependability and its low cost of operation will be maintained as described.

Raffles construction will be the subject of a very detailed contract specification and plans approved by Lloyd's Register and with the construction contract itself modified from the Association of West European Shipbuilders standard contract



VOLVO TEAMS AND OUTFITTING RAFFLES APARTMENTS / SUITES

Introduction

The cabin accommodation of modern cruise ships is typically obtained / assembled from pre engineered and fully outfitted / furnished cabin modules deliver to the shipyard that simply require plugging in to the ships electrical, water, sewage systems.

Even the QM2 was assembled in this way with it is believed the cabins actually made in Scandinavia for delivery to the ship in France.

Custom and mega yacht accommodation is typically carried out by specialist outfitting subcontractors with the Italians followed by the Dutch having a worldwide reputation for this sort of high quality work. Hundreds of people may be employed working in all parts of the yacht.

On Raffles your apartment is outfitted using a third method that is termed the Volvo system.

This is based on Volvos practice of a team producing a car from start to finish and not using a production line where bits are added as a car moves down the line.

What this means for the individual apartment owner is that your apartment, with it starting out as a bare aluminium box, through to putting a bag of freshly ground coffee in your refrigerator is carried out by a single team of people that will be identified personally to you. They are responsible for everything in your apartment and thanks to the way in which they are organised and methods used are uniquely responsive to your every need or desire.

The description below of how they do their job and the other factors that influence this, such as Raffles Green Passport, was first prepared for construction insurance underwriters and Lloyd's Register whose concerns included risks (particularly fire) and costs. As such it may contain technical terms you are not familiar with. However any questions you may have on the process can be answered.

General / organisation

Raffles aluminium superstructure modules in outward appearance are similar to a block of apartments, however made of metal and with dimensions up to 150 meters long x 13,7m wide and up to 5 stories high. In practice 3 modules per side will probably be fabricated each with about 22 apartments.

They are built on land and later loaded onto the hull at which time the apartments they contain apart from loose items are substantially completed.

Access to the individual apartment for outfitting is via a scaffolding wall along one side of the module that has inclined stairs and construction type lifts serving each floor. There is also a construction type tower crane serving all apartments.

The scaffold wall is also used to run piping / wiring for the temporary hi-fog system to each deck level with the pump / accumulator unit mounted on the roof of the module.

It is almost 100% certain that each of 112 standard 120m² apartments and 10 suites or penthouses in (all) the modules will be unique in terms of its design, layout, furnishings, outfit, and finishes.

Internal divisions, arrangements may also be different ranging from open plan, to 2 bedroom units in the standard sizes and up to 5 bedrooms in the 410m² penthouses.

It is also possible that the size of “standard” apartments can vary and that some may be on two levels. Some penthouses can be enlarged, to about 600m², simply by adding an adjacent standard apartment.

As noted two storey or duplex apartments / penthouses are also a possibility, connected by stairs or private lifts.

The superstructure (modules) has been purpose designed to accommodate these various arrangements by the use as main fire divisions of longitudinally adjustable 500mm wide steel framed double (2 x) A60 service walls once the basic module is completed. All apartment layout changes only involve cold work including if required cutting holes in decks for stairs / lifts in duplex apartments.

The wide range of variations possible mean that virtually nothing used in outfitting and furnishing apartments / penthouses can be standardized and that probably 80 to 90% of outfitting will be custom made items / systems.

A possible exception to this is the vacuum toilet bowl / WC where only a limited number of models are available from EVAC. (However it is possible to customize these units by adding hand made mahogany covers / seats and by hand painting).

The uncertainty and diversity indicated by the above means that the task of outfitting apartments / suites will be difficult and combined with the need to reduce the fire risks, requires application of new methods / innovative thinking to complete it to the very high quality demanded.

The process cannot be, as on conventional cruise ships, a production line, box by standard box!!!

As experienced in building super yacht the process will be further complicated by the possible involvement of the individual apartment owners, typically a husband and wife team, who may have conflicting ideas, and also may not be experienced.

There is also a time element involved in that the process cannot start on the individual apartment until the owners decide on what they want. Conflicting with this, Raffles / the total vessel, has a fixed completion date within which all the individual apartments have to be completed!!!

Taking time into consideration individual apartment owners will be provided a window within which they have to finalize their requirements **or** to select one of the standard designs on offer (which can still be semi customized).

With the delivery of aluminium and the construction methods used meaning apartment outfit

probably cannot start before month 6 to 8 of the 26 month schedule, this 20 months is the maximum window allowable but in practice may be less.

The “tools” used to decide with the owners the individual apartment design / outfit include:

- “Hard” paper plans, with multiple suggested layouts provided to owners.
- A 3D computer model(s) (optional to owners a walk through version).
- Various colours artist renditions from the 3D model.
- Physical scale models, @ 1:20. Aka grown ups dolls houses.
- A computerized catalogue of items / designs, etc. available.
- A show room (in the yard) of materials and applicable / appropriate products made from them, such as beaten silver wash basins
- A hard file of the final selection of finishes, equipment, etc. (agreed to by the owners) unique to that apartment.

Owners can opt to live in Vietnam and be involved in the design and outfit of their apartment during its planning and construction. As part of the package to facilitate this they are provided with an English speaking design assistant / PA / interpreter who will also act as a liaison with the Volvo team (below). There is also at least one full time on site, female expatriate design advisor to whom the assistants report and an onsite interior designer from DSD who will develop the 3D / CAD, models and also help to supervise the interior outfit of the whole vessel.

To ensure cost control a central full time estimating / costing / accounting team will only monitor the apartments outfitting activity.

To keep fire risks under control a flammability audit of each apartment is carried out based on the selected finish / contents that is continuously updated as outfitting proceeds by the PA and this information fed into Lloyd’s global assessment / Green Passport record.

To coordinate the outfitting activity with the rest of the shipbuilding process there is a dedicated project manager only for the superstructures / apartments who will develop his own plans and schedules (inc. as below an individual production schedule **per apartment**).

To carry out the physical work of outfitting and furnishing individual apartments AMS employs the “Volvo” method. This involves a multi discipline “team” that will have total responsibility for completing an (one) apartment, from a bare space to hand over after testing.

The Volvo team

For large spaces and the 10 penthouses the Volvo Team can number 30 plus, but for standard 120m² apartments the basic Volvo team will comprise 14 people:

- | | |
|---|---|
| - Team leader / foreman | 1 |
| - PA / communicator / accounts clerk / flammable / Green Passport auditor | 1 |
| - Carpenter | 2 |
| - Carpenters assistant | 1 |

- Electrician	1
- Plumber	1
- Fitter / metal worker / welder	1
- Plasterer	1
- General hands / riggers	4
- Cleaner / fire watcher / gofer	1
	14

The basic team will be augmented at various times, and as necessary by specialist personnel seconded from a central yard “pool”, (but still under the Volvo team leaders control / responsibility) that will include carpenters, plumbers, electricians, plasterers, glaziers, painters, etc.

Separately to all the above staff, “detailers” whose only task is to spot omissions, mistakes, less than perfect work will continuously monitor the Volvo Teams (and others) work. They will correct it or will point it out to the relevant team / subcontractor. A record will be kept, updated on a daily basis by the PMT / QC.

As apartments are outfitted in stages, with each stage approved by the individual owners, the typical Volvo team may be working on more than one apartment at a time with each apartment / team responsibility clearly identified to allow inspectors / project managers full control.

Based on the overall time available and 122 apartments it is likely that as many as 12 basic Volvo teams will be deployed, plus others involved at the main deck and in crew quarters, or 200 to 250 people all together.

Each team will install its own lockable (temporary) access door in the apartment and will control all entry. Only fire marshals, inspectors and managers can enter without the prior approval of the team leader.

It is important to note that Lloyd’s construction surveyors’ involvement in apartment outfitting is not in any way concerned with interior design / quality. Their main role involves structural integrity, fire proofing / suppression and confirming the (allowed) flammability of each apartment.

The high value outfitting process

Each apartment begins as a bare taped out area on the aluminium deck with only the inside corridor “wall” and outside balcony “wall” in place. The position of doors / windows in these walls may not at this time have been decided.

As soon as the apartment size (longitudinal span) is confirmed the 500mm wide 2 x A60 transverse service wall position(s) will be fixed and marked. The door / window openings may then be cut (cold with circular saws).

Internal apartment subdivisions are marked out next after which decisions can be made on materials required / to be ordered (type and quantity) for floors, divisions, ceiling systems, etc. and then an individual apartment production schedule is prepared in draft form.

The next step, based on owners input to the interior designer's proposal in turn based on 3D, CAD models, artist's renditions, etc., is construction of a physical model at a scale of 1:20 or about 60 x 75cm and 14cm high.

(Owners will pay for additional models after the first if requesting changes).

With the physical model approved by owners the design / layout of the piping, wiring ducting systems fitted in the service wall(s) and partitions can be finalized.

With internal divisions position fixed, material estimates for flooring, ceilings, linings can be finalized and the per apartment production schedule confirmed.

The first **physical** act is installation of the main A60 steel framed service wall ideally with piping, wiring ducting ready installed offship or installed in situ by the Volvo team.

With the service walls installed and either final windows or temporary perspex / plastic sheet substitutes in place the Volvo team install their own lockable main door (and the apartment can then be air conditioned / dehumidified by a portable unit supplied from a temporary power source).

The second physical act is to position and install the temporary fire protection / hi-fog system nozzles together with temporary smoke, and smoke / rate of temp rise fire detectors set to also activate an external audible fire alarm that can also connect to the wi-fi system, then the hi-fog system.

The position of the hi-fog nozzles will take into account the planned internal subdivision in the apartment and because of this the number can vary from 5 (at 30m² each coverage) up to 15 nozzles per apartment.

Subject to the method(s) used to surface it, the service walls will then be closed up, rough finished ready to accept final linings / finishes.

The sequence of work after this will depend upon the design(ers) and Volvo team leader decisions but typically installation will be:

- Internal dividing walls erected, unfinished, together with piping + wiring.
- Wall to corridor insulated, rough lined / unfinished.
- Wall to balcony insulated, rough lined / unfinished (final windows / doors installed).
- Ceiling systems, insulated, rough finished.
- Floor systems, internal, completed to wood layer with temporary protective surface over.
- Deck system balcony, completed to wood layer with protective (WP) surface over.

and with wiring and piping, and ducting connections via ceilings, partition walls, and under deck completed up to the outlet fixtures locations in this process.

At this point it is likely that work in the apartment will stop and the Volvo team move on to the next apartment. This hiatus will allow owners and interior designers to "walk the

ground”, to finalise their plans / make any changes **and owners to approve the work to date** (as the first stage).

Provisionally all floors are “floating” comprising 15mm thick mahogany or bamboo / mahogany plywood over high density rock wool (which may include a steel layer), over pound lead sheet with flooring butted up against wall linings that continue down to the aluminium deck to provide fire protection. The final (top) floor finish materials can be:

- Mahogany planking.
- Marble.
- Granite.
- Slate.
- Tiles.
- Wool carpet.
- Bronze.
- Leather.
- Etc., etc.

Ceilings will be a combination of sculptured / suspended cape board^T or rockwool based and these secured direct to the aluminium deck head extrusion, which is specially designed for this.

Final linings / finishes on walls are infinitely variable and typically only installed after all piping, wiring ducting, terminations, power outlets, switches, pipe connections, grills, etc. have been trial fitted and before the final floor finishes are installed. Provisionally natural silk is the most common wall finish in the form of hand made and hand painted “paper”.

During this period the bulk of the work will be carried out by the Volvo team but with assistance by specialists from the pool.

Concurrently with the work above the team will liaise with the interior designer / master cabinet maker on their progress, with loose furniture manufacture (offship), equipment and fittings delivery with the warehouse so that the production schedule can be updated and work on built in items required, such as kitchen cupboards, bathroom furniture, etc. can commence, typically offship.

Built in furniture can also be manufactured by the Volvo team actually in the apartment or in the onshore / adjacent workshops run by a European master cabinet maker.

All fittings / equipment / materials / furniture for one apartment will be stored in one high security fire protected location, separate from all other apartments and only accessed by the Volvo team / warehouse staff / the owner.

Items will be drawn from the store only with a counter signature from the central store man (who will also inform the team leader when items are delivered / placed ready for use in the store).

A checklist of all items of work to be carried out is hung in each apartment giving its location and status, updated by the Volvo team clerk and also reported electronically to central project control. A full set of hard plans is provided and remains in each apartment at all times.

It is probable that the scale hard model will also be positioned in the apartment for ready reference after rough linings are installed.

After all linings, floorings, ceilings (inc. finishes) and built in items including air conditioning, are completed the apartment will again be secured, waiting later installation of loose and soft furnishings / equipment (which might be after sea trials). During this period the apartment is dehumidified by a portable unit and monitored by the Volvo team cleaner / firewatcher and the per deck fire marshals.

The permanent windows if installed by this time will be protected by clear plastic or paper sheets and all doors will be lockable.

The A/C external units are temporarily disconnected and stored in the apartment.

All toilets are secured shut by a special lockable clamp device.

As soon as the service walls are installed and a door in place each apartment will be connected to a temporary telephone system and or a WI FI system will cover the whole superstructures.

The Volvo team PA / communicators will have a portable computer and printer to communicate with the project office etc. They will also have a digital camera to provide daily updates over Internet on work completed to owners.

The PA will also maintain a detailed record of tasks, man-hours utilized, materials consumed / wasted and will also record waste material removed from the apartment by cleaners.

The flammable material in each apartment will be calculated on a daily basis by the PA and provided to Lloyd's surveyors for their global assessment / Green Passport purposes.

Each apartment will be connected to a temporary power system via a meter to track electricity used in outfitting it.

Each Volvo team will be independent with its own tools / equipment which move with it. Equipment will include such as fire fighting and vacuum cleaners, cold lights, etc. detailed in the list following.

Summary outfitting / the Volvo method

As noted Raffles is a 7 star ship and its outfitting to this standard **and** to satisfy the interior designer Donald Starkey is absolutely critical.

The method of outfitting described inc. the Volvo teams is designed to achieve this.

The methods used also contribute significantly to Raffles safe construction particularly its protection against fire at a late stage of the high value construction process.

Volvo team equipment

Note: In addition to the equipment listed below the Volvo team can obtain large(r) tools if needed, from a central pool.

Carpenters tool set / box.	1
Electricians tool set / box.	1
Plumbers tool set / box.	1
Tiler / plasterer tool set / box.	1
Laptop computer / printer	1/1
Skype portable wi-fi phone	1
Portable bench / tool storage / vise.	1
Wandering power leads / terminals / meter.	3
Compact neon floodlight stands.	3
Wandering lights with CFL “bulbs”	2
Portable ventilation fan / ducting.	2
Temporary lockable apartment door.	1 per apartment
Temporary Perspex / plastic apartment windows.	set per apartment
Portable A/C unit / dehumidifier	2/1
Keyhole saw.	1
Circular saw.	1
Hand drill cordless.	2
Hand drill.	1
Power screw driver, cordless.	2
Router.	1
Masks.	3
Portable work stand / bench / vise	2
Portable sander / polisher.	1
Portable compressor 50 liter / 400 liter min.	1
Hand held power riveter.	1
Hand held power stapler.	2
Hot glue gun.	1
Belt sander.	1
Aluminium scaffolding / ladder / planks.	3
Beam laser level.	1
Ultra sonic distance measure.	1
Folding aluminium step / ladder / bench.	2

Aluminium jacking poles.	6
Electronic bulkdeck levels.	2
Hydraulic hand jacks, 2 tons.	4
Foam / gas water extinguishers.	2/2
Fire blankets	2
Wet / dry shop vacuum.	1
Rubbish bin, fire proof.	1
Portable smoke / rate of temp-rise detectors / alarms.	set per apartment
Fresh water hose on reel.	1
Bolt cutter.	1
Rechargeable LED flashlight.	2
Thermometer, hanging.	1
Chain blocks.	2
Comealongs.	3
Rope block and tackle.	2
Misc. ropes / shackles / belts.	set
Tape measures / rules.	Set
Ironing board / steam iron	1
Cellular phone.	1
Digital still camera.	1
Notice board.	1
Mobile plans stand.	1
Portable drawing board.	1
Misc. signs.	set
2 drawer portable file cabinet.	1
First aid kit.	1
Electric kettle / jug.	1
Portable refrigerator.	1
Misc. / glass / mugs / utensils.	set
Misc. work clothes, belts, shoe covers, etc.	set

The Volvo team will be provided with steel portable trunks, lockable with 4 handles in which to store their equipment at night and / or to transport between apartments.

PRELIMINARY MANUFACTURERS / SUPPLIERS LIST

Note: MTM may mean, made (to measure) in Vietnam or may mean made under license in Vietnam.

This list is divided into 3 sections.

Country (of origin) may not show actual country of manufacture

A. Main or high value or critical systems, machinery, equipment and materials.

	<u>Manufacturer</u>	<u>Country</u>
1) Aluminium, large extrusions and other material plates / shapes	Alusisse / Alcan Norske Hydro	Switzerland Norway
2) Steel shipbuilding plates / shapes (country)		China Brazil Romania South Africa
3) Main generator engines + auxiliary supporting systems	ABC Diesel Wärtsilä MAN	Belgium Finland Germany
4) Main propulsors inc. gears	Voith – Schneider	Germany
5) Bow thrusters	Tees Gill Jet	UK
6) Power conversion inc. alternators, transformers, converters, medium voltage switchboard large (induction) motors and power management system (PMS)	Converteam	UK / France
7) Low voltage distribution system inc. switchboard and commercial electrical fittings	EMS Wiska	Singapore Germany
8) Dynamic positioning	Converteam	UK
9) Shafts / couplings	Centaflex Voith - Schneider	Germany
10) Fire protection, water mist (hi-fog)	Marioff	Finland
11) Steam boilers for HFO system	MTM Aalborg	Vietnam Denmark / Vietnam
12) Anchor windlass / mooring winches /	Brusselles	Belgium

	<u>Manufacturer</u>	<u>Country</u>
capstans	China (Hatlapa)	China
13) Freshwater RO generators	Aqualyng	Norway
14) Evaporators	Hamworthy	UK/Germany
15) Lifeboats / davits	UMOE-Schat-Harding	Norway
16) Diesel engine for emergency genset	MAN Bukh	Germany Denmark
17) Marina / machinery space cranes	Fuchs Demag	Germany Germany
18) MOB / small deck cranes	Fuchs Demag	Germany Germany
19) Vacuum sewage toilets / treatment plant	Evac	Sweden
20) Air conditioning, chilled, water + air cooled crew accommodation, hospital, passenger cabins (not inc. apartments)	Webasto REE	France/Australia Vietnam
21) MES and inflatable life rafts	RFD	UK
22) Refrigeration systems	Yantai Sabroe Noske – Kaiser	Vietnam Denmark New Zealand
23) MOB boats / diesel engine / jet	MTM–Bukh–Doen DSB–Bukh– Doen Zebec–Bukh–Doen	Denmark/Australia Germany Korea
24) RIB / tug boat	MTM – BVKH	Vietnam / Denmark
25) HF oil separators	Alfa Laval Westfalia Nelson RWO	Sweden Germany UK Germany
26) Lube oil separators	Alpha Laval West Falia ABC Diesel Wärtsilä	Sweden Germany Belgium Finland
27) Titanium plate heat exchangers	SWEP Alpha Laval	Germany Sweden

	<u>Manufacturer</u>	<u>Country</u>
28) Oily bilge water separators	Turboco RWO Nelson	Germany Germany
29) FW hydrophores	Grundfoss Megator Sihi Allweiler MTM	Denmark UK Germany Vietnam
30) Air compressors / receivers	Atlas – Copco / ABC Diesel / Wärtsilä	Sweden / Belgium / Finland
31) Low voltage electric cables	Vietnam Draka	
32) Medium voltage electric cables	Converteam Draka	UK / France
33) Alarm detection / monitoring	Consilium	Sweden
34) Lifts, hydraulic	Schindler Demag Thyssen	Switzerland Germany Germany
35) Wind generators	Quietrevolution Turby	UK Holland

B. Small machinery, systems, equipment and finishes

	<u>Manufacture</u>	<u>Country</u>
1) Linings / partitioning systems	Paroc Cape Dampa MTM Glenn	Australia UK Denmark Vietnam Australia
2) Deck coverings	MTM Paroc Cape Glenn	Vietnam Australia UK Australia
3) Sound insulation	Merford Paroc Dampa MTM	Holland Australia Denmark Vietnam

	<u>Manufacture</u>	<u>Country</u>
4) Deckheads	MTM Paroc Dampa Cape Glenn	Vietnam Australia Denmark UK Australia
5) Hatches / manholes cast	Hercules	UK / Vietnam
6) Hull vents stainless	Winel	Holland / Vietnam
7) Exterior doors WT	MTM	Vietnam
8) Interior door WT	MTM	Vietnam
9) Bridge windows	Winel Van-Wingerden MTM	Holland Holland Vietnam
10) Clear view screens / wipers	Kent Wynn	UK UK
11) Navigation lights	Aqual Signal Den Haan	Holland Holland
12) Electrical / light fixtures (non apt)	Aqual Signal Karl Dose Wiska Mastervolt	Holland Germany Germany Holland
13) Searchlights	Francis Wiska Astralux	UK Germany Germany
14) Fog horn	Klaxon Zoellner	Germany Germany
15) Anchor chain / anchors	China MTM	China Vietnam
16) Valves, various	MTM Danfoss Glynwed	Vietnam Denmark UK
17) Filters, various	MTM Boll & Kirch Alpha Laval	Vietnam Germany Sweden

	<u>Manufacture</u>	<u>Country</u>
18) Piping synthetic	Glynwed Ameron Viconex	UK Singapore Vietnam
19) Pumps general / special	Grundfoss Megator Hamworthy Desmi Iron Azcure Sihi	Denmark UK UK Denmark Denmark Italy Finland
20) Fans	Noske – Kaiser Witt & Sohn MTM	New Zealand Germany Vietnam
21) Hydraulic power packs	Kobelt. Mannesman-Roth	Canada Germany
22) Galley / kitchen / laundry equipments	MTM Electrolux Metos Siemens Miele	Vietnam Sweden Finland Germany Germany
23) Hospital equipments	Philips Siemens	Holland Germany
24) Life jackets / buoys	Zebec Dunlop RFD	Korea Malaysia UK
25) Apartment air conditioning	LG REE China	Korea Vietnam China
26) Instant water heaters	Rinai Exalto Ariston	Vietnam Holland Italy
27) Lift, cargo, rack + pinion	Demag	Germany
28) Paint systems	International	UK / Vietnam
29) Communications / navigation – electronic systems	Kelvin Hughes Konsberg	UK Norway
30) Nox exhaust scrubbing systems	MES Krystallon	Canada UK

	<u>Manufacture</u>	<u>Country</u>
31) Lightning protection	Thien Phuoc Seratck	Vietnam Singapore

C. Other boats, aircraft and recreation equipment

	<u>Manufacturer</u>	<u>Country</u>
1) 15m expedition boats	Vripack	Holland/Vietnam
2) 6 person float plane	Murphy	Canada
3) 38ft composite sailboat	Stompcraft	Vietnam
4) 2 persons helicopter	Aerospatiale	France
5) 3 – 4 man submarine	U Boat Worx	Holland
6) Autogiro	Mike	UK
7) Landing craft aluminium / composite, diesel - jet	MTM–Bukh–Doen	Vietnam Denmark Australia
8) 16 passenger 30 knot ferry, aluminium / composite, diesel – jet	MTM–Bukh–Doen	Vietnam Denmark Australia
9) Small RIB water taxis / ski boats, composite and aluminium	Castoldia Zebec MTM	Italy Korea Vietnam
10) Jet skis	Bombardier	Canada
11) Diving centre (air) 12 diver	Siebe-Gorman	UK
12) 100 tons boat crane	Krupp / Marinized	Germany
13) 14ft Catamaran sailboat	Corsair	Vietnam
14) ROV's	Spyfish	UK
15) Electric bus	Modec	UK
16) Electric bikes	Thong Nhat	Vietnam
17) Hybrid scooters	Peugeot	France
18) Mini moke	MTM/2nd hand	UK/Australia

	<u>Manufacturer</u>	<u>Country</u>
19) Golf buggy		UK
20) Mountain bikes	Thong Nhat	Vietnam
21) Dune buggy	VW/2nd hand	Germany
22) Sailing dingys	Optimist	UK / Vietnam
23) Single / double sculls	MTM	Vietnam
24) 14ft fishing punt aluminium	MTM	Vietnam
25) Kayaks, strip plank	MTM	Vietnam
26) Windsurfers	Mistral	France
27) Water skis		Australia
28) High power binoculars	Zeiz	Germany
29) Celestial telescope	Celestron	Germany
30) Air boat / air cooled engine	MTM VW	Vietnam Germany
31) LPG car / pick up	Smart	Germany
32) Amphibious vehicle, cargo	Alvis / 2 nd hand	UK
33) Golf simulator	?	?