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Pioneer P35M1

General Description

The Pioneer P35M1 is our latest design and based closely upon the well proven parameters and components of the very successful Pioneer Mk3 series but modified to meet the exacting demands of the Indian Army as published in their Request for Proposal (RFP) of 08 October 2014.

The included systems of the Pioneer P35M1 are already well established and proven in our Pioneer Mk3 series but we have taken the opportunity to offer enhancements which considerably improve the dynamic performance and the payload and make the P35M1 an outstanding hovercraft from any perspective. The P35M1 is of modular construction which is easier to maintain, easier to transport and easier to build.

Operational redundancy of the P35M1 is outstanding in its class due to the complete duplication of all engineered power, transmission and control systems to the port and starboard sides. This means that the thrust system, the lifting system and the control systems are completely independent of each other so the port side and the starboard sides can be operated independently and regardless of the condition of the opposing side. This gives a level of redundancy which is very hard to beat in any hovercraft of this size range.

Twin thrust propellers provide steering control while travelling in the reverse direction, capability to turn on the spot and even to reverse park into a tight space. This is only possible with a twin thrust propeller layout, single propeller hovercraft do not have this level of precise control.

Performance of the P35M1 is ensured in the most arduous conditions by the combination of the lightweight yet tough composite construction and the twin General Motors V8 diesel engines which are NATO rated 'heavy duty' to provide a slow turning ultra-reliable 340 hp from each engine all day long 24/7 in the hottest of climates. That is 163% more peak power and about 194% higher MCR than the Pioneer Mk3 from an engine that has worldwide spares and service availability.

The body shell of the P35M1 is a new design driven by the requirements of the RFP and provides removable sides and removable thrust modules for easy transport and easy maintenance. A raised wheelhouse with ballistic protection can accommodate two crew and up to three observers. The majority of the P35M1 control systems are located in the crew cabin and are protected by the ballistic protection system.

The main cabin design is modular construction and can be quickly reconfigured or removed entirely for top loading of freight. Additional ballistic protection has been added to the main cabin sides to protect the soldiers when standing to fire upon the enemy. A self-contained toilet assembly is located at the starboard rear end and may be easily removed as required. The galley is at the port front corner and accommodates all crew needs with ample storage space and refrigeration space along with cooking and hot water facilities.

The 2-crew are located side by side in front of a wide visual display which seamlessly integrates the visual and surveillance systems along with the craft control systems and warning systems. The P35M1 can be operated by one crew alone, however better surveillance quality is provided by dual crew stations, each with a control wheel and easy reach to the craft control interfaces. Because the P35M1 has a 'fly-by-wire' control system the crew stations may be pre-programmed for different configurations such as captain to port and navigator to starboard, or vice versa at the change of a switch. The crew stations can be optimised for either a single control scenario (1-person) or a dual control scenario (captain and navigator). The dual control station arrangement is particularly helpful for crew training and driving sharing to relieve crew stress during long duration sorties. Configurations can literally be changed with a switch while the P35M1 is underway.

The navigation equipment and the night vision devices are fully integrated, with collision avoidance warning and capable of tracking up to 10 targets simultaneously.

The side bodies provide ample flat working deck space and are completely removable to reduce the transport width of the P35M1 to less than 3 metres. They are full 3-dimensional side bodies with intact buoyancy (certified non-flammable foam) to ensure buoyancy even in the event of suffering ballistic damage, unlike competitors who only have a top surface side body without intact buoyancy. The side bodies are easily attached or detached by 2-3 crew. The fresh water tanks are mounted in the side bodies and are easily removable for cleaning. The wide deck surfaces are easy to walk around and may have quickly detachable hand-rails fitted if required. Full walk around with safety harness attachment points is provided along the sides and around the bow for boarding parties and handling the deck equipment.

The Design and Construction of the Pioneer P35M1 is in accordance with the International Maritime Organization (IMO) requirements, the HSC Code, the British Hovercraft Safety Requirements (BHSR) and the International Convention for the Safety of Life at Sea (SOLAS), 1974.

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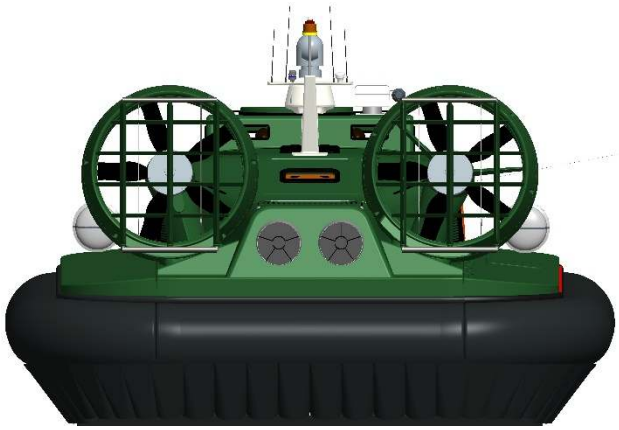

Technical Details Table

Dimensions	When Hovering	Hull Survey Measure	For Transporting
Length	12,250mm	11,806 mm	11,806 mm
Width	5,878 mm	4,808 mm	2,960 mm
Height	3,230 mm	800 mm (bottom to skirt top)	2,360 mm
Control Cabin		2,107 mm long x 2,000 mm wide	
Main Cabin (@ windowsill)		2,786 mm wide x 4,005 mm long x 1,910 mm high	
Cushion height		650 mm @ front, 580 mm @ rear	
Isolated obstacle clearance		580 mm	
Wave height clearance		1.5 meters (@ a pitch of 18m or greater)	
Maximum speeds (recommended for safety with higher speeds available)	100 km/hr (54 kts) on smooth ice 63 km/hr (34 kts) on smooth water 30 km/hr (15 kts) on land or any other surface with hard obstacles		
Cruising speed	46 to 55 km/hr (25 to 30 kts) on smooth water		
Max wind speed (heavy)	37 km/hr gusting to 46 km/hr (20 kts gusting to 25 kts)		
Max wind speed (light)	46km/hr gusting to 55 km/hr (25 kts gusting to 30 kts)		
Payload (Normal) (for a water-start)	3,300 kg (includes full fuel, normal ballast, safety equipment and passengers).		
Overload Payload	Up to 3,800 kg (reduced performance & good conditions).		
Cabin	The control cabin is accessed from the main cabin by a vertical hinged door. The control cabin incorporates laminated ballistic protection glass to NIJ type 2. The main cabin is accessed by 4- gull-wing doors, each horizontally hinged and easily removable. The main cabin windows are polycarbonate glazed aluminium frames hinging inwards and upwards to facilitate the firing of weapon from.		
Climate Control	The control cabin has a 230 volt powered Dometic Air-Conditioner with reverse cycle capability. Cooling capacity is 2.5kW (8,500 Btu/hr), heating capacity is 3.0kW. The A/C system is 230V and power is provided by an inverter. Operation is unrestricted while either of the main engines are running, or if the generator set is operating or if the shore power supply is connected. It may also be operated for a short time from the house batteries alone with none of the above mentioned inputs		

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	operating. The main cabin is not air-conditioned.
Crew Seating	Seats are provided for two crew, either of which may independently operate the hovercraft alone. Alternatively the human interfaces may be quickly reconfigured so both crew can operate the hovercraft simultaneously. A bench seat is provided at the rear of the crew cabin for up to 3-observers.
Troop Seating	Troops are seated in the main cabin along bench seats at each side. The bench seats are arranged to be quickly folded up against the cabin sides to provide clear floor space for other actions. Seating is provided for up to 13 Troops @ 575mm width each. Additional seating is provided in the Control Cabin for 2-3 Observers or Troops.
Toilet	A toilet is provided at the rear of the main cabin. The toilet system is modular and may be removed or installed in different locations. Fresh water is supplied from the main supply and the black water is stored in a tank under the toilet floor to be pumped out upon return to base. All surfaces inside the toilet module are smooth and sanitary and suitable for wet cleaning.
Galley	A galley is located at the front of the main cabin. The galley has… • A 10 litre 12V/230V hot water heater • A 230V induction hot plate • A water tap with pressurised fresh water supply • A small sink draining to a well which has an automatic pump-out system. • The galley can be folded away when not required.
Food Storage	• A portable chest type Fridge/Freezer of 65 litres capacity is provided for cold storage and ice making. • Two 68 litre Ice boxes are provided. They may be used for hot or cold storage. The refrigerator and the ice boxes are secured into racks and are easily removable for cleaning or relocation.
Engines	Total installed power is 506 kW (680 hp) provided by 2 x Gale Banks 866T diesels with NATO certified heavy duty rating of 253 kW @ 2,800 rpm. Higher ratings available for short time if required.
Fuel capacity	1000 litres in the stern tank. 825 litres in the bow tank. Normal maximum fuel load is 1000 litres to allow full use of the longitudinal ballast transfer system. However the system may be operated with a maximum of 1825 litres if the crew can otherwise arrange the load positioning to compensate for longitudinal trimming requirements. All fuel including ballast fuel is useable.
Fuel Burn Rate	Approximately 115 l/hr @ max continuous Approximately 90 l/hr @ cruise of 30 knots in good conditions Approximately 50 l/hr in loiter mode (15 to 18 knots)
Endurance	Normally 11 hours or 330 nautical miles in good conditions. Optionally 20 hours or 600 nautical miles if using ballast fuel. Maximum duration is about 36 hours in loiter mode using all fuel.

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Hull construction	Infusion moulded using Vinyl-ester resin, non-woven E-glass fabrics and Corecell® foam core. Under-hull Urethane landing pads for abrasion protection.
Skirt type	Pressurised bag tapered from front to back with larger sections at the front for improved wave clearance. All fingers are separate and detachable.
Thrust system	2 x IFA propellers featuring 5x wide blades x 1400mm dia. Capable to go from full forward to full reverse <6 seconds while running at maximum rotational speed.
Thrust transmission	Combination of toothed belts and shafts. An automatic clutch is incorporated for smooth engine starting and stopping and to allow engine idle without the prop turning for safety of bystanders.
Lift System	Two sets (port set and starboard set) of co-axial fans direct coupled to hydraulic motors. Under each set is a non-return valve to prevent backflow when either set is operating alone. Each set alone capable of providing adequate lift.
Lift Transmission	Port side and starboard sides are not connected and can operate independently. One each side there is one hydrostatic pump for the fan drive and a smaller tandem mounted pump to power the radiator cooling fans and other accessories. Each fan set has two hydrostatic motors, one up and one down for direct dive of the co-axial fans. The lift fans speed is automatically controlled to a constant pre-set speed.
Steering	By 3 - power assisted rudders fitted behind each of the thrust ducts (Total of 6-rudders). Steering assistance at low speed and in the reverse direction is managed by changing the propeller pitch to give differential or reverse thrust from the propellers and steering in reverse motion. This allows the P35M1 to pivot on the spot and steer while going backwards to provide exceptional control capability, particularly when manoeuvring with crosswinds in tight places.
Dynamic Pitch & Roll Control	Dynamic control by 4 - power assisted elevators fitted behind each thrust duct (total of 8-elevators).
Static [weight shift] Pitch & Roll Control	By transferring fuel load between the front and rear ballast tanks. Note there are limits to this system depending on the fuel load available to shift.
Controls Interface	• Engine speed and propeller pitch is provided by a pair of levers mounted between the crew seats. The PLC system seamlessly matches the propeller pitch and the engine speed for simple control and maximum economy. • Pitch & Roll is provided by a 2-axis joystick mounted between the crew seats. • Steering is controlled by two helm wheels and a selector switch to change control between sides.
Electrical System 24 volt and 230 volt	Nominal 24-volt system. Battery charging by 2 x 150-amp alternators (300A total). One fitted to each engine. A 250W solar system is provided for battery maintenance in remote locations. There are three sets of batteries… • One set of AGM batteries in the rear for engine starting. • One set of Lithium Ion batteries for operating accessories. • One set of AGM batteries for emergency communications.

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	Battery management and inverted power is controlled by a Victron Quattro 48/5000/70-100/100 which can accept power from • The engine driven alternators. • The generator set. • From the shore power connection. • From the Solar system. The Victron Quattro 48/5000/70-100/100 provides the correct charge rate and maintenance currents according to the state of the batteries. The Victron Quattro 48/5000/70-100/100 system also provides full sine wave inversion 230 Volts power for the air-conditioning, galley and other services. All circuits are identified and wired in compliance with maritime codes.
Controls	Machinery monitoring and control is byJ1939 compliant CANBus networks. Navigation and power distribution is by a NMEA 2000® compliant CANBus network.
Pumping	Two double acting manual bilge pumps with manifold to each compartment, strum boxes and non-return valves. One electric pump 7570 l/h (2000 gph) in the For'd Compartment. One electric pump 7570 l/h (2000 gph) in the Main Cabin. One electric pump 7570 l/h (2000 gph) in the Engine Room. One electric pump 7570 l/h (2000 gph) in the Rear Compartment.
Fire Protection	Engine room lined with refractory fibre fire barrier faced with aluminised foil. 30 minute fire rating with low temperature rise to the bulkheads and a facing surface which is attractive and easily cleaned.
Fire Fighting	Fixed HFC-227ea type fire extinguisher to the engine room with temperature sensor and monitoring at the dashboard. Control of extinguisher and engine room vents is from inside the cabin space.
Navigation & Communications Options (Standard)	Standard equipment includes… • Magnetic Compass, 70 mm • VHF transceiver and matching antenna (NMEA2000 compliant) • SIMRAD GPS with co-ordinate display to radio and navigation system. • SIMRAD Chart Plotter (Including World maps) • SIMRAD X-Band Digital radar overlay on the chart plotter. • Man Overboard System distress signal broadcasting position. • AIRMAR PB150 weather station with wind velocity, temperature, air-pressure, apparent and true wind direction indication.
Other Electronic Equipment (Available at extra cost)	Optionally Fitted and fully Integrated extra equipment may include… • DGPS Compass • Gyrocompass, auto start and auto stabilised fibre optic type. • Loudhailer with Siren and Flashing Light. • Fog Horn. • S-Band surveillance radar with Auto Plotting Aid (ARPA) integrated with digital maps for area of operation. • Night Navigator with all around panoramic vision able to

	track up to 10 targets simultaneously and incorporating collision avoidance mode, target range finding. Incorporates gimbal mounted 3-axis gyro-stabilised IR camera, Low Light camera and Laser Range Finder. • Controls position display incorporating 3-units 17 in monitors with all 360 degree all around vision and all navigation systems integrated along with engineering systems displays and warnings. • Multi-point internal vision system with cameras mounted in the main cabin, engine room and reversing view. • Security system with or without mobile phone link. • Remote control spotlight, 150W Xenon bulb with 6M candlepower and 1 Nm range. • Binoculars 7 x 50 marine type • Black signal beacon • Anchor signalling balls • Semaphore flags • Signalling lantern • Barometer, hygrometer, W&D thermometer • High power driving lights • Generator set, portable gasoline powered 5kVA, or • Generator set, installed diesel powered 4.9kVA. • Other equipment may be available by customer request

Technical Details, Descriptions

Classification

Classification is available by any of the following societies by negotiation with the buyer.

- Indian Register of Shipping, Provisional Rules & Regulations for the Construction & Classification of Air Cushion Vehicles.
- Australian Maritime Safety Authority, National Standard for Commercial Vessels. NSCV class 1D or class 1C.
- Lloyd's Register Group Limited (LR)
- Korean Register of Shipping

In all cases the build construction does not change but there can be minor changes in the equipment requirements. Consultation between the builders and the owners is required before construction commences so plans can be submitted and approved by the classifying society prior to construction commencing.

Hull and Superstructure

The hull is infusion moulded from Vinyl ester resin and non-woven E-glass fibreglass reinforcements and Corecell® cores for increased panel stiffness. This method of construction is lightweight while retaining excellent strength and stiffness. Thermal and sound isolation properties are excellent for this construction system. All laminating is conducted within a controlled environment with active quality control procedures to ensure the highest quality. Minor laminate damage is in-field repairable with a simple kit carried onboard.

Four lifting 'Chain Plates' are mounted through the deck and internally strengthened. A towing eye is fitted to the stern. There are 8x cleats mounted to the deck (separate to lifting eyes) provide more than ample attachment points for mooring, towing and lifting. The underneath of the hull is protected by replaceable moulded Poly-Urethane landing pads.

Control Cabin

The control cabin is accessed by a door from the main cabin and a short stairwell. The cockpit internal surfaces are gelcoat finished for easy cleaning and maintenance and all soft furnished surfaces are covered in a grey non-reflecting vinyl. The floor is gelcoat finish with an overlay of rubberised cork to provide an attractive and easily maintained and non-skid surface.

There are two crew seats, both are pedestal mounted with adjustment for height, fore and aft, reclining and swivel. The crew seats are covered with vinyl. A bench seat is provided at the rear of the cockpit for up to three observers and is upholstered with a vinyl covered rubber cushion. One observer seat space may be used for the machine gun operator to stand on.

A reverse cycle air-conditioner is fitted to the control cabin to provide cooling or heating. The air-conditioner can operate in the following modes…

1. With either or both main engines running the A/C can operate continuously.
2. With the main engines at rest but with the generator set running and connected to the hovercraft power system the A/C can operate continuously.
3. With no generators and no engines running but with the shore power connected the A/C can operate continuously.
4. With no engines running, no generator running and no shore power the A/C can operate for up to 15 minutes powered by the inverter via the house batteries.

There are six ballistic resisting composite glass windshields which are direct glazed to the composite structure. Each windshield is fitted with a wiping and washing system which is operated from the control station and incorporates a selective delay.

The roof of the control cabin has a hatch with machine gun mounting ring bearing.

Dual Controls in Control Cabin

The P35M1 has two control stations, each with a steering wheel. A change-over switch is used to select command from either side. A centre console is mounted between the seats and has controls such as engine, propeller, trim, ballast and other often used inputs mounted centrally in easy reach of either crew seat. This provides for different operating scenarios…

1. Single crew operating craft systems and navigating. Spare seat empty.
2. Pilot on one side and co-pilot or navigator on the other side with the displays in 'extended' mode. Sides are interchangeable by means of the command selector switch and pre-programmed display options on the screens. This may suit right handed or left handed operators.
3. Instructor at one position and Student at the other position with the displays in 'duplicate' mode. This arrangement will be invaluable for crew training. Alternatively it makes for easy changes to reduce crew fatigue during long hauls.

The visibility angle for each crew member is 121 degrees to the offside and 142 degrees to the near side. Offside is opposite to the side they are seated at.

For convenience the communication equipment is mounted to the bridge console towards the

starboard side.

P35M1 Control Cabin Layout – 2 crew plus observers

Main Cabin

The main cabin is accessible through four (4) gull wing doors which are hinged parallel to the centreline. The doors are supported by gas springs which hold them in either the open or the closed positions. The doors are removable by dis-engaging the spring loaded hinge pins. The centre portion of the main cabin is also removable leaving the main cabin open for top loading of goods. Each removable part of the main cabin (4-doors and 1-centre piece) is easily handled by two people.

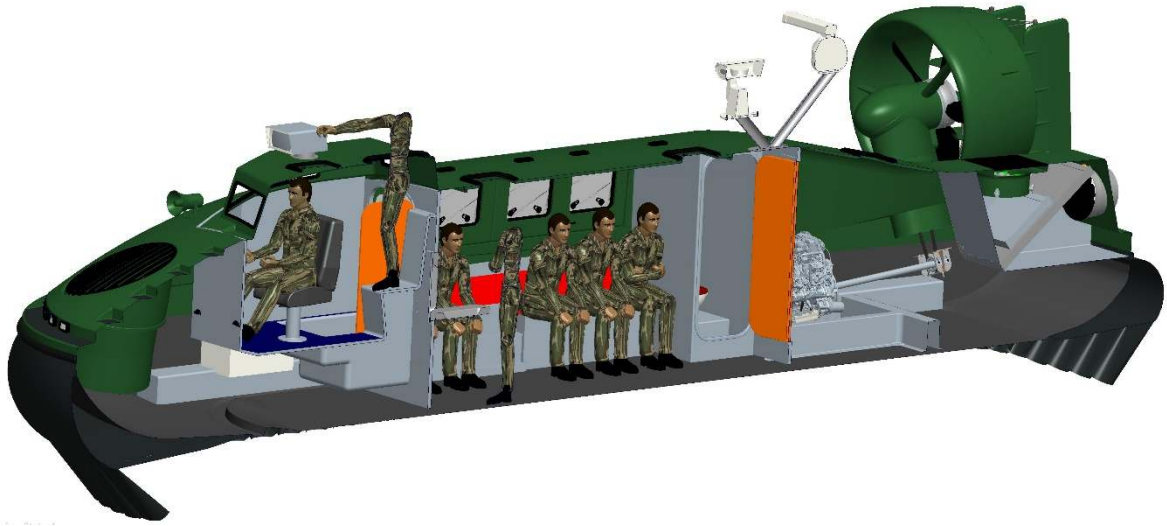
The floor of the main cabin is flat without interruption from any structural ribs or any other things that can obstruct a payload. The surface of the floor is gelcoat finish with a non-skid surface applied. A drain is fitted into the floor to facilitate washout when the hovercraft is hardstanding. A bilge pump is fitted to drain the main cabin when the hovercraft is floating. General finished surfaces in the main cabin are of gelcoat or paint and may be washed down.

Main Cabin Windows (PortLights)

Each door has two inward opening portlights (pressure sealing windows) with a clear opening of 393mm x 500mm when opened. There are a total of 8 portlights (4 doors x 2 per door).

The portlights are aluminium framed and glazed with polycarbonate for safety. The portlights may be locked in the partially open position to aid ventilation but at the same time provide security. When they are in the fully open position they may be latched upwards providing unhindered clear opening for firing of weapons through.

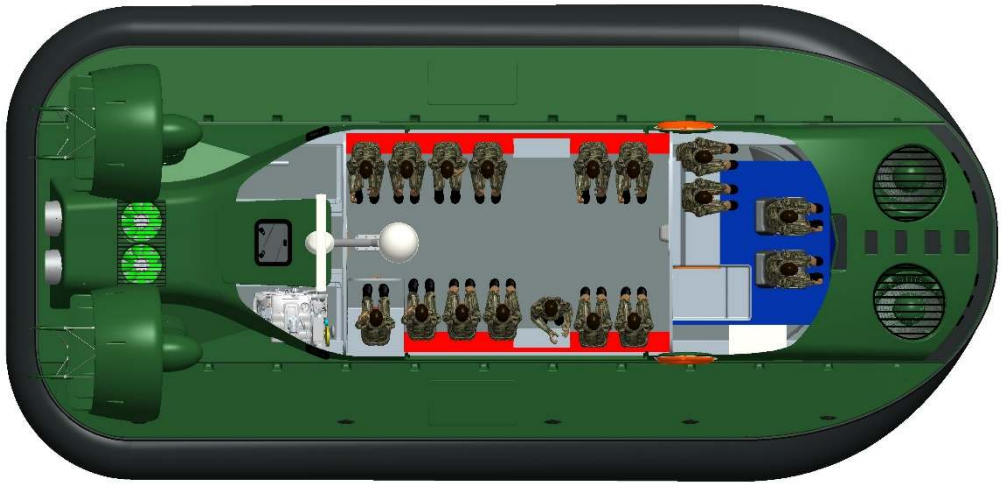
In addition to the portlights mounted in the doors, there are an additional two outward opening deck hatches mounted into the centre portion of the main cabin. These provide ventilation while standing or underway and an additional escape route in emergencies.



P35M1 Long-Section

Main Cabin Seating

The main cabin is fitted with longitudinal folding bench type seating, normally providing space for up to 13 Troops. Overload capability is available if using the toilet and stairs spaces and seated on the floor in the centre of the main cabin. The rear cushions are fixed to the cabin sides and the base is hinged so it can be quickly folded up against the cabin wall to provide clear floor space. The seat cushions are high density foam rubber with vinyl covers.



P35M1 – Main Cabin Seating Layout (incl Toilet)

Main Cabin Galley

A small galley is fitted to the front port side of the main cabin. This may be optionally located at the rear port side. The galley has the following features…

1. 1 unit stainless steel sink and bench assembly.
2. 1 unit fresh water tap over the sink. The fresh water supply to the tap is from a small electric pressure pump which draws supply from the two outboard mounted fresh water tanks in the side bodies. The side body tanks are food grade moulded plastic, each of 120 litres (total of 240 litres) and may be removed easily for cleaning. Filling can be effected on

or off the craft.

3. 1 unit Electric 10 litre hot water heater mounted on the bulkhead above the sink. This will operate on 12 Volts (via a 24 to 12 converter) and 230 Volts via a 24VDC to 230AC inverter, switching automatically as power is available.
4. 1 unit smooth top electric hotplate induction type operating on 230 volts.
5. 1 unit Portable Fridge/Freezer of 80 litres internal capacity. This will operate on 24 volts or 230 volts as is available. It is mounted securely but may be easily removed for cleaning or use off-craft.
6. 2 units Icebox, each of 68 litres capacity. These may be used as cool storage or warm storage. If used for cool storage they may be topped up with ice from the portable Fridge/Freezer. The ice boxes are securely fastened but may easily be removed for cleaning or off-craft use.

P35M1 - Galley

Main Cabin Toilet

The toilet is normally located in the rear starboard side of the main cabin. It is a modular 'boxed' unit which may optionally be fitted into any corner of the main cabin. The toilet is provided with hand wash and flushing water from the fresh water storage tanks. The black water is contained within a tank under the floor of the toilet module and needs to be pumped out at a suitable base location. The toilet module is a 'closed cell' and vented to a negative pressure area to avoid smell penetrating the main cabin.

Armour Protection

The control cabin has NIJ type 3 ballistic protection around all vertical surfaces. Below the deck level the NIJ type 3 ballistic protection is fitted external to the control cabin walls. Above deck level the NIJ type 3 ballistic protection if fitted inside the cabin top walls. All windows in the control cabin are NIJ type 2 composite material.

Additionally ballistic protection additional to the RFP requirements is fitted to the following areas…

1. NIJ type 2 is fitted inside the cockpit roof providing protection from shrapnel exploding from above.
2. NIJ type 3 equivalent is fitted around the lift fan ducts in the area near the fans and the hydraulic motors. This is to provide some protection to the critical lift system components and reduce the chances of damage from cross fire.
3. NIJ type 2 ballistic protection is fitted to the main cabin sides from floor level to deck level. Cross fire in this area would need to pass through the side bodies and the intact buoyancy before contacting the NIJ 2 material so a level of protection similar to NIJ type 3 material is

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affected here for additional protection of the troops.

4. NIJ type 2 ballistic protection is fitted to the engine room sides from floor level to deck level in the area of the engines and the primary transmission. This is to provide some protection to the engines to reduce the chances of damage from ballistic cross fire.

Engines

Power is provided by two units of Gale Banks 866T Diesel engines. These engines are based upon the GM 6.6 litre V8 turbocharged and intercooled common rail diesel engine and are modified and heavy duty rated by Gale Banks for hovercraft continuous duty use. They have been tested and certified to produce 340 hp each according to stringent NATO test procedures. At this rating the expected life is in excess of 4,000 TBO. Higher power ratings can be provided for shorter duration or lower TBO's but this is not necessary as this engine has ample power at the 350 hp heavy duty rating.

Fuel consumption of both engines together will vary between 50 l/hr and 125 l/hr according to operating speed and conditions.

Hover and forward motion may be achieved on one engine alone for reduced speed 'get you home' capability.

All controls, transmission, fuel, cooling, exhaust, power generation and auxiliary systems are independent port and starboard for good redundancy.

Exhaust Systems

The engines exhausts are ducted through quiet mufflers and eject to the rear via the radiator cooling air discharge ducting. This arrangement keeps the exhaust gasses enclosed in the radiator exhaust air-stream until it is well clear of the craft bodywork, thereby reducing the craft cleaning requirements. All exhaust pipe work is manufactured from Stainless Steel and is elastically suspended on rubber mounts and with a 'bellows' joint to compensate for movement. Heat rejection to the engine room and surrounding surfaces is limited by the ceramic refractory insulation covering all exposed hot surfaces. The ceramic refractory is contained within silicone glass fabric cover to protect it from adverse environmental contaminants.

Propellers

There are two in-flight pitch adjustable ducted propellers of 1400mm diameter X 5 blades. The propeller blades are precision moulded from Carbon-Fibre and Epoxy resin and are post-cured at high temperature to obtain consistent high tensile strength. The propellers provide full in-flight pitch control and reversing capability. The pitching mechanism is powered from the hydraulic system and is controlled by the operator for optimum angle relationship to the engine speed and for the best performance and economy. The propellers are capable to go from full forward pitch to full reverse pitch at full power without reduction of rotational speed. Optionally available is an automatic pitch control system which integrates the engine speed control with the propeller pitch

and provides the best combination for performance, best economy and improved slow speed manoeuvring. This system relieves the crew from worry about control of propellers and engines separately.

Propulsion Transmission System

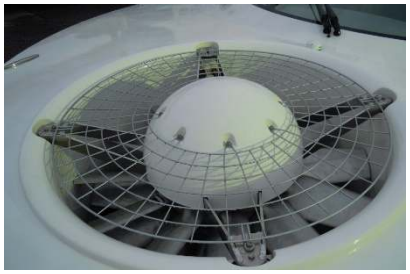
An automatic clutch is fitted to the rear of each engine. The clutch automatically engages on increasing engine RPM and dis-engage when the engine RPM drops below a set point. This disconnects the high inertia parts of the transmission system at slow engine speeds to avoid shock loads during the engine starting and stopping procedures.

The automatic clutch improves safety by stopping the rotation of the propellers when the engines may be idling and when personnel are working in the near vicinity of the propellers.

Power for the propellers is transmitted from the rear of engine mounted auto-clutch, through a cardan shaft which has constant velocity joints on each end, into a toothed pulley and via a carbon fibre belt to the pulley mounted at the front of the propeller shaft. The transmission system is simple and rigidly supported with oil-bath tapered roller bearings. All transmission components are power rated well above the maximum available engine output.

Lift Fans

There are two sets of fans for providing the lift air requirements, one set mounted at the port bow and the other set mounted at the starboard bow. Each set of lift fans has a pair of co-axially rotating fans in the same duct. Each fan is mounted directly to a hydraulic motor which provides power and support for the fan. That is two pairs, or a total of four fans and four motors. The co-axial arrangement provides a fan system characteristic which favourably matches the hovercraft lift air requirements and provides an efficient use of the power available for lift.



Other than periodic inspection of the corrosion protection, the lift fans will not normally require servicing unless they are accidentally damaged. In the event of suffering damage the fans can easily be accessed and changed over.

Lift Fan Transmission

Each lift fan is driven and supported by a hydraulic motor. The hydraulic motor is mounted in a frame which is elastomerically mounted to the hovercraft hull, thereby reducing transmitted noise and vibrations. Each side of the hovercraft hydraulic motor set is provided by high pressure oil from the pumps mounted on the engine of the same side. There is no cross connection between port and starboard to compromise the operation of one side if the other side suffers damage during enemy action. All hydraulic components, reservoirs, coolers, filters and controls are isolated between port and starboard sides.

The hydraulic pumps mounted on the engines are variable displacement piston pumps and are automatically controlled to keep the lift fans running at a pre-set speed while the main engine speed changes. This is a system was pioneered by AirLift to provide early lift off capability when the engines are running at only a 'fast idle' while controlling the fans speed so as to not over-supply the lift system and waste power when the engines are running faster. The pilot may easily

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vary that lift fans speed according to the requirements of the hovercraft load and surface terrain. By providing just enough lift power to meet the conditions and avoiding over-supply, the overall hovercraft efficiency is enhanced and the operation is extended.

Should one side be accidentally damaged the other side may have its rating increased so the hovercraft can operate on one lift system alone and thereby have redundancy in the lift system which would be difficult to provide by any other means.

All aspects of the hydraulic design (pressure, speeds, cooling and filtration) are conservative and suitable for long life salt water tropical (+44ºC) and dirty conditions.

Skirt

The skirt is a fully pressurised tapered bag and finger system. The bag pressure is higher than the cushion pressure and is regulated by control orifices in the bag inner membrane. This system is well proven to be the most stable and dynamically efficient skirt system available for amphibious hovercraft today. More stable than the open loop and finger variety commonly used on other hovercraft.

The skirt bag is manufactured from Hypalon coated polyester fabric. The skirt fingers are manufactured from Natural Rubber coated Nylon fabric and have high abrasion resistant properties.

Controls

The controls are simple and easily managed.

- Turning is controlled by a 'steering wheel' type helm, similar to boats.
- Pitch (fore and aft trim) and Roll (sideways trim) easily accomplished by a small joystick mounted on the console between the operator's seats.
- The speed of the engines is combined with the control logic of the propeller pitch. Input from the commander is by twin levers mounted on the control console. Operation is very simple and intuitive.
- The fuel ballast system is logically controlled by switches on the dashboard with automatic over-ride from the PLC to protect against inadvertent starving of the engines..

Instrumentation and Indicators

Control Systems and Monitoring Systems

The monitoring and control of all machinery (engine and hydraulic) is accomplished by Parker IQAN controllers operating on J1939 compliant CANBus networks.

System Displayable Information…

Hydraulic System

Item	Range	Operating
Main Loop Pressure	0 – 300 Bar (0 – 4300 PSI)	210 Bar
Charge Pressure	0 – 5 Bar (0 - 44 PSI)	1.5 Bar
Main Loop Temperature	0 °C to 120 °C (32F to 250F)	60°C
Hydraulic Oil Tank	Contents – 0% to 100%	
Critical Warnings	Low Charge Pressure. Low Oil Level. High Oil temperature.	

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Engines

	Range	Operating
Engine Speed	0 – 4000 RPM	700 - 3600
Oil Pressure	0 – 500 kPa (0-100 PSI)	350 kPa
Coolant Temperature	48°C-116°C (120F-240F)	85°C-90°C
Manifold Boost	0 – 6 Bar (0 - 87 PSI)	0 - 2.5 Bar
Engine Load	0% to 105%	
Fuel Consumption	0 – 999 l/hr	48 – 125 l/hr
Critical Warnings	Low Oil Pressure High Coolant Temp Engine Over-speed ECU Fault Any steering system sensor fault or auto changeover due to a fault condition.	

Other Systems

Item	Display
Fuel Tank Front	Contents – 0% to 100%
Fuel Tank Rear	Contents – 0% to 100%
Power Management (indicated separately for each battery bank).	Battery Volts - Starting Battery Volts - House Battery Battery Volts - Emergency Services Energy Remaining – House Battery Charging monitor on all batteries Port Engine Alternator Input Status Stb'd Engine Alternator Input Status Generator Input Status Shore Power Input Status
Front Space Bilge Pump	On/Off (with fault warning)
Cabin Bilge Pump	On/Off (with fault warning)
Engine Room Bilge Pump	On/Off (with fault warning)
Rear Space Bilge Pump	On/Off (with fault warning)
Fresh Water Pump	On/Off (with fault warning)
Galley Sump Pump	On/Off (with fault warning)
Fuel Transfer Pump	Running (with fault warning)
Air-Con	Off – Heating - Cooling Set Temperature Ambient Temperature Fault Codes
Fixed Generator set (if fitted)	All run indicators, loads and warnings
Toilet	Black water tank level indicator
Critical Warnings (flashing warning on screen and	Fire Alarms

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audible buzzer in control cabin)	Engine Room High Air Temperature Front Compartment Bilge Alarm Engine Room Bilge Alarm Rear Compartment Bilge Alarm Low Fuel Level Alarm (rear tank)
Normal Warnings (indicated values overlay normal indicators)	High Air Temperature Engine Room Open circuit faults (current too low). Short circuit fault (current too high) Screen Wash Tank Low Level
Other Information (normal indicators viewable on screen)	Engine Room Inlet Air Temperature Engine Room Outlet Air Temperature Cabin Air Temperature Engine Room Air Temperature Rudder Angle indication Elevator Angle indication (Port & Stb'd) Propellers Pitch position (Port & Stb'd)

Electrical System

System voltage is nominally 24 volts DC. Battery charging is by two 150-amp alternators, one mounted to each engine. All electrical cable is marine type tinned copper multi-strand cable with V90°C (or better) low halogen insulation. Connectors are Deutsch environmentally sealed connectors with nickel plated contacts suitable for pressure washing and engine room service. Every wire in the loom is identified by a printed number which matches the comprehensive electrical schematic and layout drawings provided with each craft

Batteries

There are three banks of batteries…

- A 24 volt AGM battery bank for engine starting.
- A 24 volt Li-Ion battery bank for house battery and general services.
- A 12 volt AGM battery bank for emergency services and basic navigation aids.
- All batteries are connected through remotely operated battery switches according to class rules. The house battery bank may be paralleled with the starting batteries for emergency use.

Protection

Circuit breakers, fuses and all electrical components are installed according to class rules. All terminations in exposed areas are crimped and covered with heat shrinking and hot-melt insulation for corrosion protection. Exposed cable runs are protected in conduits. Signal circuits are separated from power circuits and additionally shielded to protect against electro-magnetic interference.

Navigation Lighting

All navigation lights comply with IMO recommendations. In addition a flashing orange beacon is mounted atop the thrust cabin according to the British CAA requirements for hovercraft.

A red night vision map light is provided at the navigation station. Main cabin lighting is provided by strip lighting. Entrance and steps are illuminated by LED lights. Beside the cabin doors are 12V x 10A power outlets suitable for connecting a spotlight or other auxiliary devices.

A remotely controlled spot light is mounted to the roof.

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Fuel System

Fuel Type is normally commercial grade Diesel (DF-2). The engines can also operate at reduced power on Jet-A and JP-8.

All fuel piping (apart from short flexible elements near the engine) is stainless steel. A safety shut off valve is mounted near each tank and may be operated from outside the engine room. Comprehensive Racor fuel/water separators and filters are fitted for reliable supply of the fuel to each engine.

Fuel Ballast System

The fuel transfer (ballast) system helps to provide longitudinal trim of the P35M1 to improve operational efficiency.

The fuel system provides combined fuel storage for normal operations and additional tank space for extra fuel to be used as ballast. The extra fuel may be moved fore and aft for weight transfer to assist with the longitudinal trimming of the hovercraft (static pitch control).

There are two fuel tanks in the ballast system. The rear tank is 1000 litres and the front tank is 825 litres. The rear tank has a reserve section to maintain 175 litres in reserve after all fuel available for ballast is transferred to the front tank.

The maximum fuel load is normally 1000 litres but this can be 'pressed-up' to 1825 litres for exceptionally long duration in special circumstances. When the front and rear tanks are full there is no capability to transfer fuel ballast so independent movement of the cargo might be required for longitudinal trimming.

To prevent inadvertent fuel starvation of the engines by poor fuel ballast management, a warning is provided to the crew when the rear tank reaches 50 litres remaining. If the warning is ignored and the contents drop to 25 litres or less then the fuel ballast transfer pump automatically switches on and transfers fuel from the front to the rear until the contents in the rear tank is approximately 80 to 100 litres. This cycle will repeat so long as the crew ignore the warnings and fuel is available in the front tank.

Fire Safety

The engine room is lined with ceramic fibre refractory material to provide a 30 minute fire barrier with minimal heat rise at the bulkheads according to class rules. This material is mechanically mounted and has an aluminised facing to provide an attractive and easily cleaned surface.

A fire detection heat sensor is mounted in the engine room and connected to an alarm at the control position. The engine room is fitted with a fixed HFC-227ea chemical smothering system that can be activated from the cabin. The engine room vents may be closed and the fire extinguisher operated from a control panel at the rear of the cabin area. Additional portable extinguishers are mounted inside the cabin. The exhaust system is lagged and shielded to reduce heat radiation and increase safety. Fuel pipes are stainless steel.

Lifting

There are four lifting attachment points protruding from the deck upper surface enabling connection with cranes and other lifting tackle. Included in the standard equipment is a 4-leg lifting harness to provide a single hook point lift. Optionally available are spreader bars. The lifting attachments are certified with a factor of safety of 4.

NB: The above specifications pertaining to performance are based on a properly trimmed and maintained craft with a competent operator. These specifications are subject to change as improvements are made and should only be used as a guide unless specifically annexed to a build contract and signed by all parties to that contract. Specifications may also be varied from time to time by agreement between the parties involved.