
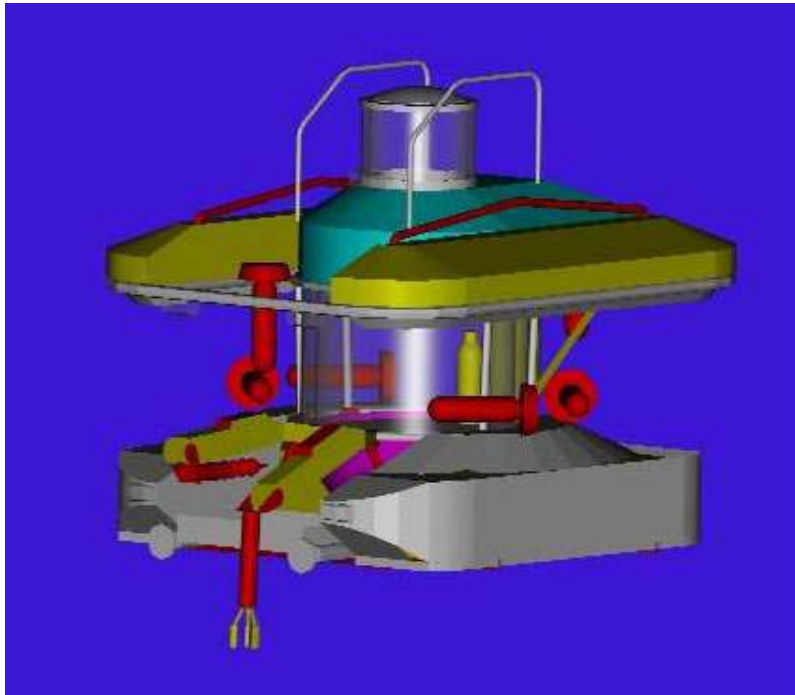


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1. GENERAL DESCRIPTION



PS2000 is an atmospheric submarine for two persons, with a manipulator device to work under water down to 200 meters.

Special tools and instruments are proposed for specific missions as:

- Video records on pipe or cable laying and mapping.
- Video records and 3D mapping of archeological survey.
- Coral fishing.

His autonomous propellers give him a 3 Knots cruise speed.

For observation with slow cruise speed, his autonomy is up to 12 hours.

The life support system

autonomy in emergency is 72 hours.

PS2000 can drop buoys and pinger beacon in order to mark out a diving area.

It is specially designed to be operated and launched from a surface boat and in order to use him in a non stop way, his batteries pack can be easily removed and changed by new charged ones.

For a normal use, bottles refilling and batteries charging are done with PS2000 along side the surface boat, so that many handlings can be avoided.

A good stability on surface, a very important floatability and a very high freeboard allow the passengers transfer directly on the dive site, with a maximum sea state of three or 4.


The design and the construction of PS2000 are carried out under the control of the French Bureau Véritas.


The Windows in Acrylic are manufactured according to the rules of ASME PVHO and have a 20 years lifetime or 20000 dives.

2. OVERALL DIMENSIONS

Length	3200 mm
Width	2500 mm
Height	2700 mm
Draught	1700 mm
Freeboard of the hatch	800 mm
Weight in Air	3500 Kg
Displacement in water	4400 liters
Drop weight	120 kg
Crew and equipment weight	200 kg
Emergency life support	72 hours
Max forward speed	3 knots
Max towing speed	5 knots
Max sea state for towing	3

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<h3>3. MISSION AND CREW</h3>		
<p>Pilot is in charge of positioning the submarine during the video operation or pipe-laying mapping, and modifies the balance of PS2000 during the sample or coral gathering operation.</p>		
<p>Co-pilot is in charge on the manipulators and sample basket, Drop beacon system and user equipment for the specific mission.</p>		
<p>A surface controller holds the communication with ultra sonic telephone and checks the positioning of the submarine with an ultra short base acoustic system interfaced with a DGPS surface navigation system.</p>		
<p>The position of the submarine is then transmitted to the submarine trough an acoustic modem so that this data can be used with the other data required by the specific mission.</p>		
<h3>4. MANIPULATORS</h3>		
		
<p>The two manipulators and the sample basket are hydraulic actuated.</p>		
<p>The hydraulic electro pump is mounted in an external box filled with oil and pressure compensated. The Electro-hydraulic power pack is also in this box.</p>		
<p>The basket can be tipped up in order to drop a too heavy charge.</p>		
<p>The two manipulators are fixed on a special device able to drop them and their hoses if being entangled.</p>		
<h3>5. PERSONNEL COMPARTMENT</h3>		
<p>The pressure vessel is constructed by the assembly of:</p>		
<ul style="list-style-type: none"> * A hemispherical A42FP carbon steel hull (1200 mm in diameter and 8 mm in thickness). Under the hull is the drop weight system, 		
<ul style="list-style-type: none"> * A cylinder window in acrylic plastic (1200 mm in diameter, 80 mm in thickness, 800 mm in height) lying on an L flange welded to the hemispherical steel hull, 		
<ul style="list-style-type: none"> * An upper hemispherical steel hull, 1200 mm in diameter, welded to an L flange is laying on the window. 		
<p>This assembly is held unto compression by eight internal tie rods to obtain tightness of the bearing windows/flange when PS2000 is on surface.</p>		
<ul style="list-style-type: none"> * A cylindrical window diameter 600mm Thickness 40mm height 400 mm is used as conning tower. 		
<p>The hatch is constituted by a hemispherical hull (600 mm in radius) welded on a flange, 600 mm in diameter. The hatch can be opened from both outside and inside.</p>		
<p>A spring washer system opens the hatch partly and automatically in case of internal over-pressure.</p>		
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<p>An inner valve fixed on the top of the hatch enables the internal pressurization. An outer valve fixed on the top of the hatch enables also the internal pressurization.</p>		
<p>The metallic parts inside the hull are covered by fire retardant paint and thermal isolation to avoid condensation.</p>		
<h2>6. EXOSKELETON</h2>		
<p>The tubular structure is made with 50 mm OD 2.9 mm thickness carbon steel pipe.</p>		
<p>A lower ring forms the fixed point of the hull and the upper ring is used as a guide for the upper cap of the hull.</p>		
<p>A lower frame sustains all the batteries cells.</p>		
<p>On the upper frame are hung the soft ballasts, the deck and fairing. The handling points are welded on this frame.</p>		
<p>A protection against corrosion is made by marine painting.</p>		
<h2>7. DROP WEIGHT SYSTEM</h2>		
<p>One block of cast lead is attached under the cabin. This block can be released mechanically from the cabin.</p>		
<h2>8. DECK</h2>		
		
<p>The upper deck is realized in fiberglass covered with non-skid paint and fixed to the pipe frame.</p>		
<h2>9. AIR SYSTEM</h2>		
<h3>9.1. DESIGN</h3>		
<p>There are two independent networks outside the cabin. Two Pressure reducers adjusted to P+5 and P+10 allow the automatic change over from the normal bottles to the reserve bottles.</p>		
<p>Two bottles 20 liters, 200 bars, as the main system; provide enough air for blowing more than 5 times the ballasts on surface.</p>		
<p>A third bottle as reserve system provides air enough to blow the tanks when depth is 200 meters.</p>		
<p>A safety valve protects the low-pressure distribution network and the water tank.</p>		
<h3>9.2. Soft Ballasts</h3>		
<p>There are two independent ballast tanks made of AG4MC. When at surface, only half the ballasts are under</p>		
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<p>the water and so the volume above the water line is an important stability and floatability reserve.</p> <p>9.3. Water tank</p> <p>There is a 90 liters pressure tank to adjust precisely the weight of the PS2000. The level of water in this tank is set by compressed air through a blow valve or opening purge and vent valves.</p> <p>Blow and vent (3 way 3/4") and purge (1 1/2") valves are outside the personnel compartment and operated from inside the cabin.</p> <p>10. LIFE SUPPORT SYSTEM</p> <p>10.1. OXYGEN</p> <p>One external tank (20 liters, 200 bars), and an inside 5 liters bottle are connected to an inside network. On this network, there is a pressure reducer and flow meter.</p> <p>Only the 5 liters bottle inside the cabin is in operation. It is changed over easily every day.</p> <p>The other bottle gives 72 hours of emergency life support for the passenger and the pilot.</p> <p>The oxygen flow is set by an automatic injection valve and controlled by a flow meter.</p> <p>An oxy-meter checks continuously the O2 partial pressure</p> <p>A second oxy-meter checks the O2 partial pressure in back up.</p> <p>Two individual self-breathing apparatus Masks allows 45 minutes life autonomy in case of inside pollution.</p> <p>10.2. AIR SCRUBBER</p> <p>Airflow goes through a silent electric fan and a canister of soda lime for carbon dioxide removal.</p> <p>The volume of soda lime stocked in the PS2000 is sufficient for 3 days survival.</p> <p>The CO2 rate is checked continuously</p> <p>The CO2 rate is monitored manually by system back up.</p> <p>10.3. Dehumidifier system</p> <p>Airflow goes through a second canister system with silica and odor removal agent and dust filter.</p> <p>The two systems are analog and in case of failure of the first one, one can use the dehumidifier system with soda lime.</p> <p>Two high flow vents blow dry air all around the cylindrical window to prevent condensation.</p> <p>11. POWER</p> <p>11.1. BATTERIES</p> <p>Marine standard lead acid batteries are used in soft fiberglass tanks filled with oil and pressure compensated.</p> <p>Hydrogen is captured on the top of each cover of tank. Safety valves open themselves when hydrogen pressure is above 100mbar.</p> <p>A fairing protects the batteries tanks.</p> <p>The batteries tank can be easily removed and changed on the deck of the surface boat.</p> <p>There are two batteries tanks with each: Twelve Cells Twelve volts 115 Ah</p> <p>One cell is used as emergency battery and allows 72 hours autonomy (Air scrubber, Communication, internal light)</p> <p>The 23 other cells make up a 276V network</p> <p>Each battery is electrically protected. There are voltage and insulation control on each.</p>		
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11.2. 276 Vdc network

The 276 Voltage network is confined in an external electrical tank.

The charging of the batteries is done through this electrical tank, without slipping the submersible.

This external pressure tank contains the electronics needed for the control and protection of the AC Asynchronous motors of the thrusters.

11.3. 24 /12VDC distribution

Converters 276/24V and 276/12V supply the 24 and 12 V networks

Emergency battery provides 72 hours autonomy (Air scrubber, Communication, internal light)

12. PROPULSION

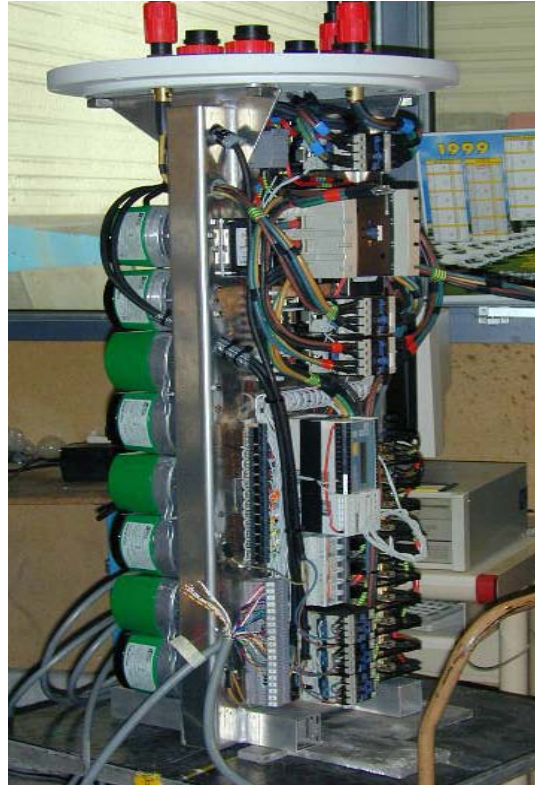
The thrusters are made of an AC motor working in a dry tank. The water tightness is created by a rotating gland seal on the shaft. A second gasket protects the electric motor from a default of the rotating seal

The power on shaft is 1500 W with 200 VAC motors, supply through servo drive.

Fairing of the propeller increases the efficiency and protects them from entanglement.

The position of thrusters are as follow:

4 at 45 ° from the axe of the submarine so that a lateral motion is possible
2 in vertical position fore and aft so that change trim is possible.



13. EXTERNAL LIGHTS

Four external and pressure resistant lights 250 W, 220 VAC allows dive by night and intensification of natural colors.

A fifth light is used in the cabin and can be used in every direction.

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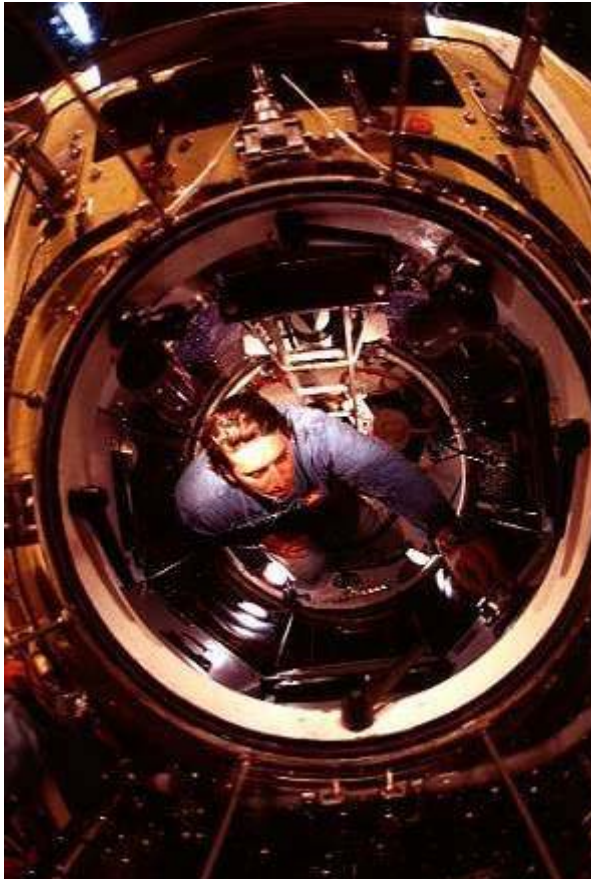
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14. MANOEUVRING

One joystick controls easily the four Horizontal thrusters.
A switch makes possible the lateral motion.
An other joystick controls easily the two Vertical thrusters.
An offset between fore and aft allows a correction of the trim.

15. MONITORING & COMMAND

Pilot and copilot control:



One Command pack for the electro-hydraulic manipulator.

One Command box for the thrusters.

The blowing, venting 3-way valve and filling valve of the water tank are operated by mean of a mechanical system through the hull.

The two blowing, venting 3-Way valves of the soft ballasts are operated by mean of a mechanical system through the hull.

One-stop valves to put the emergency oxygen network in service.

Two regulating and flow meters valves on the normal and emergency O2 system.

The pilot monitors:

276 VDC and 24/12 VDC voltages

Current input to each thrusters

Earth default alarms on each circuit

Course (Magnetic compass)

Course (Fluxgate compass)

Depth under the hull and submersion

Internal pressure

O2 partial pressure

CO2 rate

temperature and humidity

Roll and pitch situation

Time

The pilot communicates by mean of VHF radio when at surface and with an ultra sonic telephone when underwater (25 W 27 KHz & 8.7Khz).

Navigation Sonar

Pinger or transponder for ultra short base acoustic positioning system.

Acoustic Modem for transmission of the position from the surface controller.

Pressure of 2 HP air and Pressure reduced air

Pressure of emergency oxygen circuit.

One droppable buoy with rope for handling from the surface.

Two droppable beacons to mark out a site dive.


One flasher

16. SAFETY EQUIPEMENTS

All the components inside the cabin are fire resistant type. In addition, one fire extinguisher (water with nitrogen gas) is available.

If the atmosphere of the cabin becomes polluted, individual masks are available for 45 Minutes autonomy.

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<p>When submerged, an acoustic beacon is automatically put in service, so an acoustic positioning of the PS2000 is always possible by a device called ping pointer. This system is the back up system of the normal navigation system (Ultra short base + DGPS + Acoustic Modem).</p> <p>The pilot can releases a buoy with 400 Meters rope and a flasher and radar beacon to show his position to the surface controller. Then on this line, a sling with a special hook can be sent to handle the submarine from the surface.</p> <p>The soft ballasts can be filled up with external bottles.</p> <p>Water, food and hygienic bags are available for 72 hours.</p> <p>Lifting points are clearly indicated when hauling up the PS2000 with a tender boat.</p>		
<p>17. OPERATING PROCEDURE</p>		
<p>The PS2000 is towed at 5 knots towards the diving place.</p>		
		
<p>The depth must not exceed 200 meters</p> <p>The passengers boards on the diving place</p> <p>Closing the hatch</p> <p>Life support system in service</p> <p>Fill the air ballast</p> <p>Fill the water tank until the conning tower just begins to submerge</p> <p>Use the thrusters to begin the dive</p> <p>Contact with the surface controller every 10 minutes with the ultra sonic telephone.</p> <p>Underwater exploration</p> <p>Position given every 10 seconds by the navigation system.</p> <p>Request surfacing permission</p> <p>Blow the water tank</p> <p>Blow the air ballast when nearly on the surface</p> <p>Equalize the pressure in the cabin</p> <p>Open the hatch and boarding new passengers for new mission</p> <p>A complete operating instructions will be supply with the PS2000</p>		
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18. MAINTENANCE



Periodic check of the batteries and rotating gland seal are the main maintenance operation.

Charging batteries can be made with PS2000 alongside the boat.

Every month check the general tightness, the level of the oil in the fiberglass tank and the quality of the solution batteries.

A yearly visit of the system is done under control of a classification society.

Every 5 years, a complete disassembly of the PS2000 is done for a complete inspection and tests.

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