

Requirements for Nautilé Buoyancy replacement

Presentation of Ifremer

The French Research Institute for Exploitation of the Sea (Ifremer) is globally recognized as one of the world's leading institutes in marine science and technology. It operates with a dual focus on sustainable development and open science. Its 1,500 employees conduct research, provide expert assessments, and develop innovations to protect and restore the ocean, responsibly exploit its resources, share marine data, and offer new services to all stakeholders.

With a presence along all the French mainland and overseas coastlines, Ifremer's laboratories are located at around twenty sites across the three major oceans: the Indian, Atlantic, and Pacific. On behalf of the French State, Ifremer operates the French Oceanographic Fleet for the benefit of the national scientific community. It also designs and develops its own cutting-edge equipment and vehicles to explore and observe the ocean—from coastal zones to the open sea, and from the ocean depths to the interface with the atmosphere.

Open to the international scientific community, Ifremer's researchers, engineers, and technicians are expanding knowledge about one of the last unexplored frontiers of our planet. They help inform public policy and drive innovation for a sustainable blue economy. They are also committed to raising public awareness about maritime challenges.

Founded in 1984, Ifremer is a public industrial and commercial institution (EPIC) with an annual budget of approximately €240 million. It operates under the joint supervision of the Ministry of Higher Education, Research and Innovation (MESRI), the Ministry for the Ecological Transition (MTES), and the Ministry of Agriculture and Food Sovereignty (MAA).

Context of the call of tender

The Nautilé submersible was commissioned in 1984. Since then, it has been exploring the abyss down to 6,000 meters deep: for six to eight hours per dive, a scientist and two pilots observe the seabed and conduct experiments from the submersible's sphere. Only five countries in the world—the United States, Japan, China, Russia, and France—currently possess a submersible with such capabilities.

As part of the France 2030 investment plan, the Nautilé-2035 project responds to French state's decision to extend the service life of the Nautilé submersible, thereby preserving the ability for manned dives at a depth of 6,000 meters.

The project is focused on modernizing the submersible for a new operational service life of 10 to 15 years. This technical modernization of the Nautilé will address technological and industrial obsolescence while aiming to enhance the submersible's capabilities and performance.

The Nautilé weighs approximately 19 tons and carries around 5.2 tons of syntactic foams conditioned in one main buoyancy module and few auxiliary floats. The main module has not been replaced since the Nautilé was commissioned, and is now over 40 years old. The modernization project therefore plans to replace it and potentially some auxiliary modules.



Launch and Recovery of the submersible Nautilie (GHASS2 Cruise)

Nautilie features

The Nautilie is a manned submersible which can dive to a depth of 6,000 meters with a crew of three. It is one of the very few manned deep-sea submersibles. Three wide-angle viewports and LED lighting provide a direct view of the seabed.

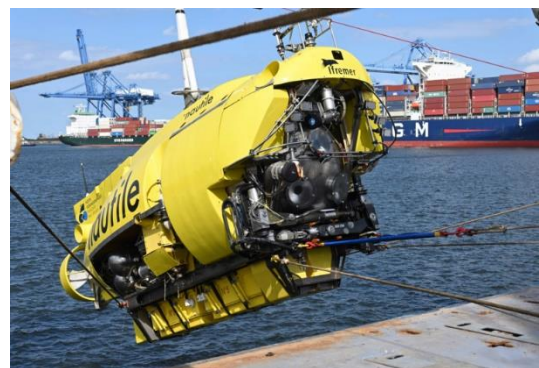
Uses:

- Surveying specific areas
- Collecting samples and using special tools
- Researching, locating, investigating and assisting in the recovery of wrecks

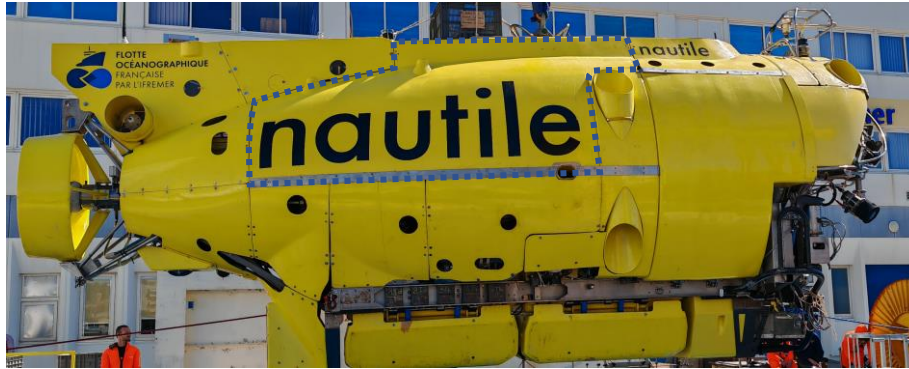
The Nautilie is a versatile vehicle which can be deployed quickly in difficult environments thanks to its capacity for providing a direct view of its surroundings and the absence of any physical link to the support vessel. A dive can last up to eight hours, of which six can be spent working at the sea floor.

Technical and Operational Features¹ :

- Max depth: 6,000 m
- Weight: 19 tons
- Length: 8 m
- Beam: 3.8 m
- Height: 2.70 m
- Speed: 1.7 knots
- Range: 10km
- Crew: 3 (1 pilot, 1 navigator, 1 passenger)
- Endurance (at the seabed): 6 hours



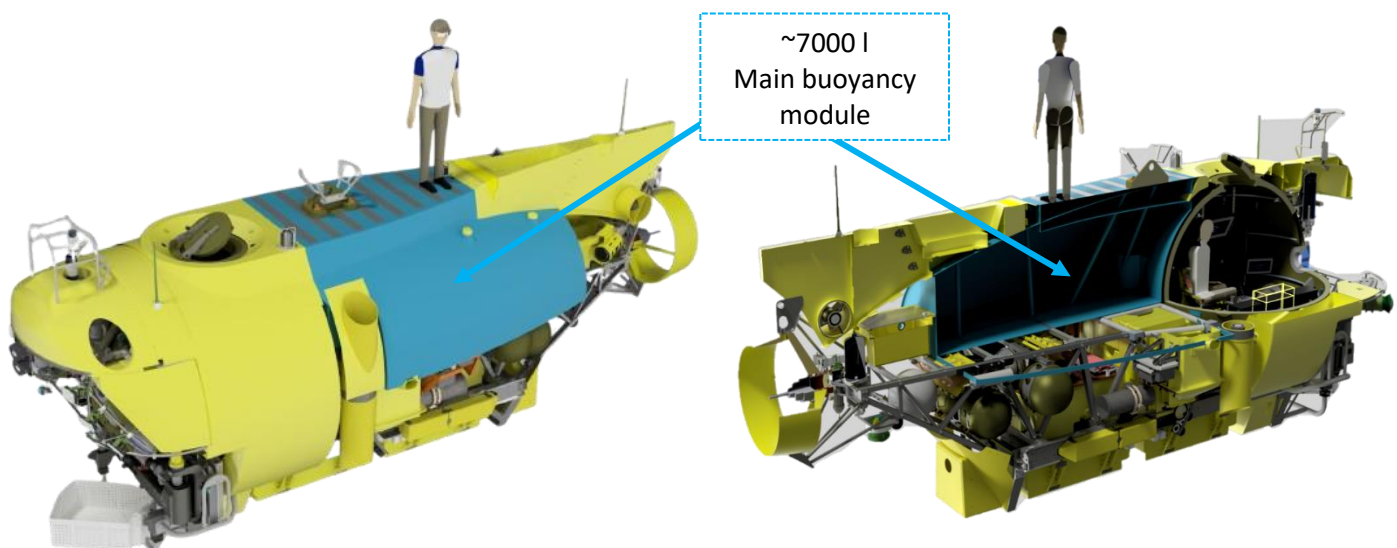
¹ For more information : <https://www.flotteoceanographique.fr/en/Facilities/Vessels-Deep-water-submersible-vehicles-and-Mobile-equipments/Deep-water-submersible-vehicles/Nautilie>



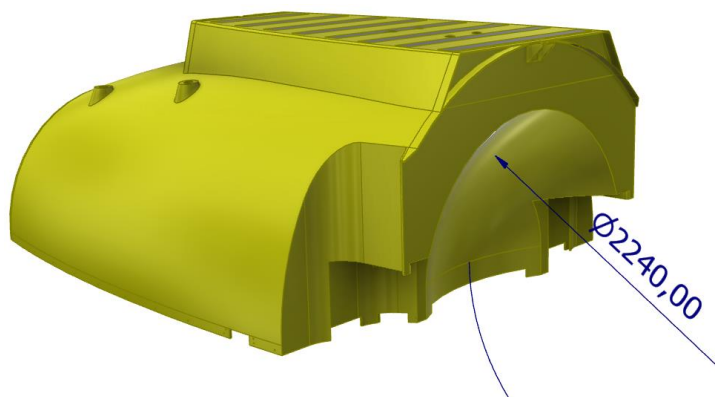
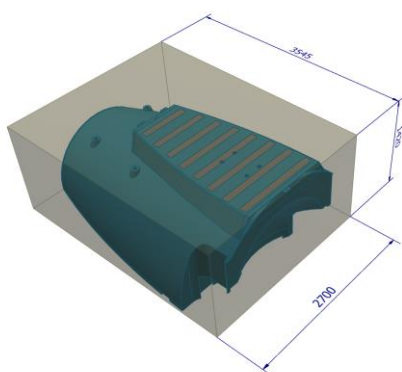
Technical requirement

The supplier will provide buoyancy modules for the Nautile. Buoyancy modules are made of syntactic foam blocks, manufactured to the required shape and wrapped inside a glass reinforced plastic (GRP) coating.

The volume of the main buoyancy module is approximately 7000 L (see below the blue part on the CAD view) and the additional total volume of other buoyancy modules is approximately 2000 L.



The final shape of buoyancy modules will depend on developments of the submersible, integrated as part of the modernization project. At this stage of the project, the current design (see main dimensions below) will be the reference in the call for tenders.



The syntactic foam to be used for the buoyancy modules will comply with the following requirements:

- Maximum operational pressure P_s : 625 bar;
- Operational service life: 1000 hydrostatic pressure cycles to P_s ;
- Hydrostatic crush pressure after 1000 hydrostatic pressure cycles to 750 bar: no individual result less than 812.5 bar and average result greater than or equal to 850 MPa;
- Water Absorption after 1000 hydrostatic pressure cycles to 750 bar: no individual result greater than 2%;
- Average density at atmospheric pressure before the first pressure exposition: $\leq 590 \text{ kg/m}^3$.

The supplier selection process will involve a series of hyperbaric chamber tests on samples that will be carried out by Ifremer. If necessary, the approval protocol will be presented during the negotiation phase.

The supplier will submit one or more technical solutions for the assembly of standard blocks into buoyancy modules.

The solutions selected will be subject to a series of tests in a hyperbaric chamber on one or more models provided by the supplier according to an Ifremer specification.

Process and schedule

- March 2026: contracting with several qualified suppliers;
- Syntactic foam approval phase (tests on samples): duration to be defined (Ifremer);
- Selection of the final supplier (Ifremer);
- Manufacturing of models (supplier);
- Qualification phase of assembly process with tests on models (Ifremer or supplier);
- Manufacturing of standard syntactic foam blocks (supplier);
- Selection of standard syntactic foam blocks for inspection and batch validation (Ifremer);
- Acceptance of the batch (tests on selected standard syntactic foam blocks) (Ifremer);
- Release of manufacturing drawings (Ifremer);
- Manufacturing, assembling and coating of the buoyancy modules (supplier);
- FAT and delivery to Ifremer.