

Pressure testing of new Alvin Personnel Sphere successful

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The human-occupied submersible Alvin reached a major milestone in its upgrade project on June 22 when its new titanium personnel sphere successfully completed pressure testing, reports the Woods Hole Oceanographic Institution (WHOI), the vehicle's operator.

The sphere, which holds a pilot and two scientists, is designed to descend to 6500 meters (21,000 feet or 4 miles) – depths that generate nearly 10,000 pounds per square inch (psi) of pressure on the sphere. The tests validate the sphere design and fabrication and ensure it meets the requirements of the agencies that will ultimately accept the sphere—the American Bureau of Shipping (ABS) and the U.S. Navy. It is the final step in the sphere construction project.

"The project team is delighted that the personnel sphere has successfully concluded its hydrostatic testing," said Susan Humphris, a WHOI senior scientist and the principal investigator on the upgrade project. "We look forward to receiving the sphere, integrating it into the submersible Alvin and resuming scientific research early next year."

The testing took place the Northrop Grumman hydrostatic test chamber in Annapolis, MD, and was overseen by a team comprising engineers from WHOI, Navy, ABS, and Southwest Research Institute (SwRI), the company that managed the design and construction of the titanium sphere as a subcontractor to WHOI.

During the testing, gauges were affixed to the interior and exterior of the

sphere to measure strain and "creep," the minute change in the metal from prolonged stress. The sphere was filled with water and placed in a test tank of water. The tank was then pressurized in a series of test dives to progressively greater depths over four days. The team monitored 240 channels of data streaming from strain sensors to ensure the sphere stayed in the safe range of strain and creep. The sphere ultimately was tested to 8000 meters—nearly 12,000 psi—to comply with engineering standards for human occupied submersibles and meet a factor of safety 24 percent deeper than the maximum operating depth of 6500 meters.

Sufficient data were collected and analyzed to support certification for human occupied operations to 6500 meters.

Construction of the personnel sphere is one of the biggest technical challenges in the Alvin upgrade project, which is funded by the National Science Foundation (NSF) and WHOI. The sphere needs to be nearly flawless—free of any deformities that could weaken its structure and potentially cause it to crumple under pressure—and as perfectly spherical as possible.

"As the project sponsor, I am very pleased to see this state-of-the-art personnel sphere can withstand the pressure at its planned operating depth of 6500 meters," said Brian Midson, the NSF program manager for the Alvin upgrade project. "This is a critical milestone toward resuming ocean science missions with Alvin in the near future."

The new sphere is capable of descending 2000 meters deeper than the previous sphere. With greater depth comes greater pressure; therefore, the new sphere is three inches thick, rather than two. The sphere's interior diameter is 4.6 inches wider than Alvin's previous sphere, increasing the interior volume by 18 percent, from 144 to 171 cubic feet, and allowing for greater ergonomics. With five viewports, it also has improved field of view for the pilots to drive the sub and use the

manipulator arms and for the scientists to help guide the pilot and make better observations of the seafloor.

To build it, engineers needed more than 34,000 pounds of titanium, about the weight of a large school bus. Two huge, barrel-shaped titanium ingots were fabricated by a mill in Morgantown, Pennsylvania, and reshaped into two giant hemispheres in Cudahy, Wisconsin. These were then shipped to Los Angeles, where workers joined the two hemispheres using a special welding technique. They also cut inserts for the hatch, electrical and fiber-optic connections, and viewports.

With testing complete, the 11,000-pound sphere will be delivered to WHOI on Thursday. Upgrades are underway on Alvin's titanium frame as well as to the research vessel Atlantis, the support ship for Alvin. Over the next several months, engineers at WHOI will reassemble the submersible and should begin dock trials in November. Alvin is scheduled to begin certification sea trials in December.

Alvin is owned by the U.S. Navy and is operated by WHOI through the U.S. National Deep Submergence Facility. The Facility provides marine scientists with access to the deep ocean with Alvin, as well as the remotely operated vehicle Jason and the autonomous underwater vehicle Sentry.

"As owner of Alvin and its supporting vessel Atlantis, the Office of Naval Research is pleased with this milestone accomplishment in the development of the new Alvin personnel sphere," said Tim Schnoor, manager of ocean research facilities at ONR. "We look forward to the completion of the Alvin upgrade program and reinstatement of certification for manned operations in support of national deep submergence science objectives."

Provided by Woods Hole Oceanographic Institution

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