A Major Upgrade for the U.S. Deep Submergence Vehicle *Alvin*

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OVERVIEW

Over the past four decades, the human-occupied submersible *Alvin* has conducted over 4600 dives providing routine and reliable access to the deep seafloor to conduct observational, sampling, and mapping studies. Now, preparations are underway to conduct a major upgrade of *Alvin*. The upgrade will be completed in two stages.

During Stage 1, a new 6500 meter-rated titanium personnel sphere currently under construction will be integrated into *Alvin's* modified frame. The sphere is 6.4" larger in diameter than *Alvin's* current sphere, and has five viewports: two 5" side viewports and three 7" forward viewports. These provide larger fields of view for scientists and complete overlap with the pilot's field of view—a major improvement over the current viewport configuration. In addition, the improved vehicle will have fiber optic penetrators, improved ergonomics, a new command and control system, improved lighting and imaging, increased science payload and data logging capabilities, and better interfaces with science instrumentation. Because some of *Alvin's* systems will be re-used (e.g., variable ballast, hydraulic, and mercury trim systems), the vehicle will initially continue to be rated to 4500 meters.

During Stage 2—to occur at a later time—the changes necessary to increase working time and extend the depth rating of the submersible to 6500 meters will be accomplished. The increased energy necessary to provide longer duration dives will require a different battery type—most likely a lithium-based chemistry. However, this technology is not yet sufficiently mature and affordable enough to be installed in *Alvin*.

The Stage 1 upgrade will begin in early 2011 when *Alvin* will be removed from service and disassembled. Sea trials and certification dives of the upgraded vehicle are expected in spring 2012, followed by a science shakedown cruise with broad community participation.

The Upgrade Plan for the HOV *Alvin*

4500 m *Alvin* Upgrade

Stage 1

- New personnel sphere
- New syntactic foam
- New command and control system
- New data and power pressure housings
- New illumination system
- Upgrade to HD cameras
- Increased science payload
- New internal video infrastructure
- Upgrade to shipboard video duplicating system
- Upgrade to shipboard science video processing station

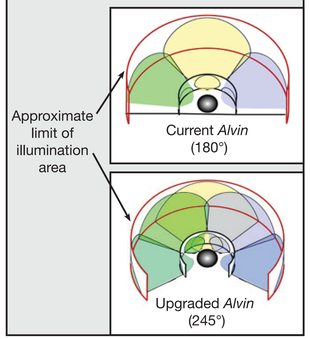
6500 m *Alvin* Upgrade

Stage 2

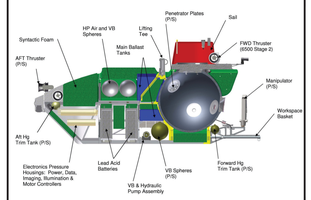
- New Li-ion batteries
- Increased horsepower thrusters and motors
- Upgrade of remaining components to 6500 m (e.g., variable ballast and HP air spheres)
- New ultra-high resolution digital still camera
- Addition of photomosaicing cameras

Comparison of Old and New Personnel Sphere

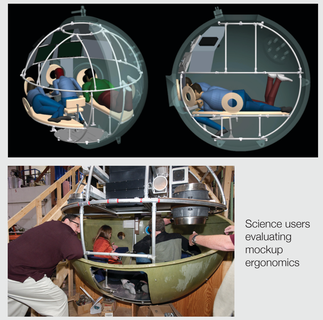
Comparison of Fields of View



Major Components of Upgraded *Alvin*



Interior Ergonomics



Science users evaluating mockup ergonomics

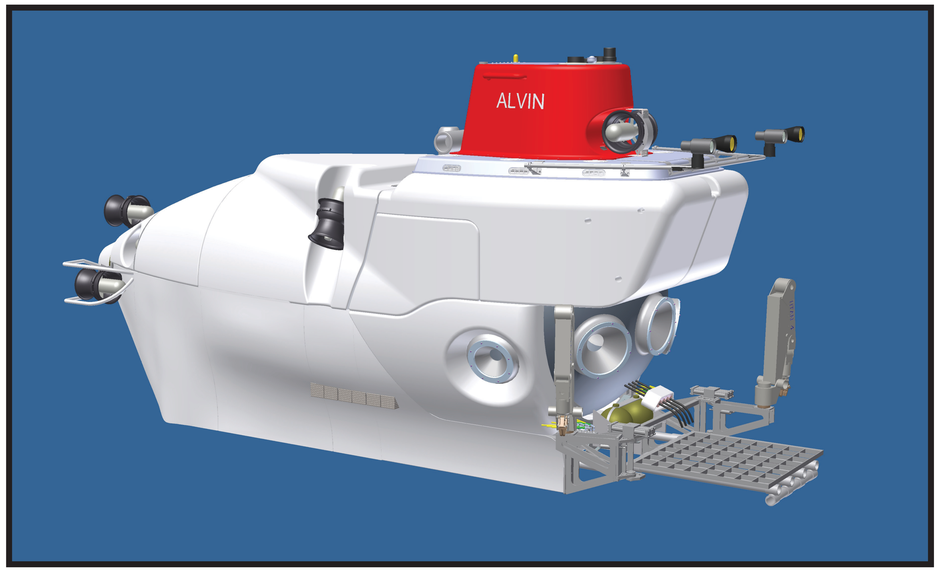
Meeting the Desired Science Capabilities

Stage 1

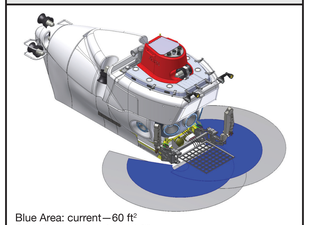
	BASIC VEHICLE UPGRADE	Command and Control Enhancements; New Power and Data Pressure Housings	New 6500 m Syntactic Foam	Illumination Enhancements	Internal Video Infrastructure	Upgrade of Cameras to HD; Upgrade of Shipboard Data Duplication System	Ramped and Strobed LED Lights; External Still Image Capability	Upgrade of Shipboard Science Processing Station	Stage 1 *Alvin*
Larger personnel sphere with improved interior ergonomics	●	●	●	●	●	●	●	●	●
Increased Field of View for pilot's and observers	●	●	●	●	●	●	●	●	●
Improved illumination	●	●	●	◐	◐	◐	●	●	●
Improved imaging systems	●	●	●	●	●	◐	◐	◐	◐
Improved data collection, logging, and interface capability	●	●	●	●	●	●	●	●	●
Improved interior electronics	●	●	●	●	●	●	●	●	●
Automatic position keeping	●	◐	◐	◐	◐	◐	◐	◐	◐
Increased thruster horsepower and better maneuverability	●	◐	◐	◐	◐	◐	◐	◐	◐
Enhanced mid-water research capability	●	◐	◐	◐	◐	◐	◐	◐	◐
Increased science payloads	●	●	◐	◐	◐	◐	◐	◐	◐
Increased battery capacity	●	●	●	●	●	●	●	●	●
Increased on-bottom time	●	●	●	●	●	●	●	●	●
Increased hydraulic plant capacity (improved manipulator performance)	●	●	●	●	●	●	●	●	●
Increased operating Depth to 6500 meters	●	●	●	●	●	●	●	●	●

Stage 2

	Stage 1 *Alvin*	Still Image Mosaic Processing Tools	Ultra-High Resolution Still Camera; Mosaic Cameras	Addition of Software Tools for HD Editing	Variable Ballast Sphere Replacement	Li-ion Batteries	New Motors, Thrusters and Lateral Thruster	Upgrade of Remaining 4500m Components	Stage 2 *Alvin*
Larger personnel sphere with improved interior ergonomics	●	●	●	●	●	●	●	●	●
Increased Field of View for pilots and observers	●	●	●	●	●	●	●	●	●
Improved illumination	●	●	●	●	●	●	●	●	●
Improved imaging systems	◐	◐	●	●	●	●	●	●	●
Improved data collection, logging, and interface capability	●	●	●	●	●	●	●	●	●
Improved interior electronics	●	●	●	●	●	●	●	●	●
Automatic position keeping	◐	◐	◐	◐	◐	◐	●	●	●
Increased thruster horsepower and better maneuverability	◐	◐	◐	◐	◐	◐	●	●	●
Enhanced mid-water research capability	◐	◐	◐	◐	◐	◐	●	●	●
Increased science payloads	◐	◐	◐	◐	◐	●	●	●	●
Increased battery capacity	●	●	●	●	●	●	●	●	●
Increased on-bottom time	●	●	●	●	●	●	●	●	●
Increased hydraulic plant capacity (improved manipulator performance)	●	●	●	●	●	◐	●	●	●
Increased operating Depth to 6500 meters	●	●	●	●	●	●	●	●	●

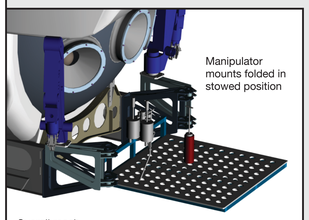


Work Space



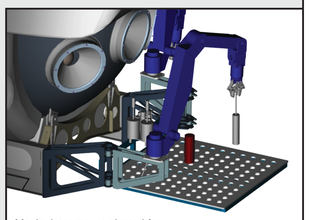
Blue Area: current—60 ft²
Gray Area: updated—114 ft²

Manipulator Mount Design



Manipulator mounts folded in stowed position

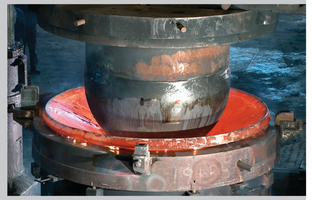
Overall reach increased from 93" to 118"



Manipulator mount pivoted for maximum workspace coverage

Personnel Sphere Construction

Ti Ingots

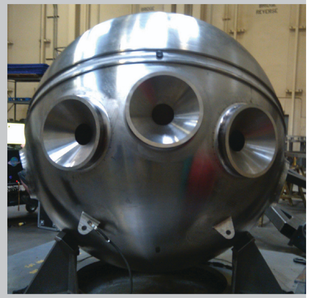


June 2008

August 2008

August 2009

April 2010



November 2010

Images courtesy of the Southwest Research Institute and WHOI Advanced Imaging & Visualization Laboratory

VISIT A LIFE-SIZED MOCKUP OF THE PERSONNEL SPHERE — MOSCONE WEST, BOOTH 755