

Getting 'the Ball' Rolling

ALVIN'S NEW PERSONNEL SPHERE (A.K.A. 'THE BALL') IS ONE-OF-A-KIND



Tom Kleindinst/WHOI

Alvin's upgrade began with a larger, stronger personnel sphere to give occupants more room and visibility and eventually allow the sub to dive to 6,500 meters. Only a handful of deep-diving spheres exists in the world. None had been forged in the U.S. since 1973. Alvin project manager Kurt Uetz helped supervise the sphere manufacture and describes its cross-country journey.

- 1 The process began in 2008 with three ingots from TIMET, a mill in Pennsylvania, two at 17,000 pounds each and one at 7,000 pounds.
- 2 The two larger ingots were sent to Milwaukee for forging. The Ladish Company beat the ingots into disks about 140 inches across and 4 inches thick. They heated them up and pressed them down, heated them up, pressed them down. Then they built a massive round mold and pressed each heated disk into the mold to make two hemispheres.
- 3 The hemispheres went to Bodycote in Los Angeles for annealing. They were heated in an oven, in a specific atmosphere of oxygen and other elements, and quenched in water within 60 seconds of coming out of the oven. Annealing captures the metal's material properties to give it what they call 'material toughness' so it can be machined, yet be strong enough to absorb the stress of going to ocean depths at 10,000 pounds per square inch.
- 4 From there, the two hemispheres went to Stadco in Anaheim, where they were machined to their current thickness of 2.81 inches. The greatest out-of-roundness is about 30 one-thousandths of an inch. Then they used an electron-beam weld to weld the two hemispheres together without any filler metal. It was done in extreme vacuum, greater than the vacuum of space, to reduce any air that could affect the weld. Then they machined openings for the windows, the hatch, and two parts on the back called penetrator plates. With the smaller ingot they made fluted inserts for the holes. Those were also electron-beam welded into place.
- 5 When you weld, the metal close to the weld expands and then shrinks. That leaves stress in the metal. So the sphere was shipped to Aerobrazed Engineered Technologies in Ohio, where it was heated slowly in a vacuum oven and then cooled to relieve the stress from all the welding.
- 6 Then it went back to Anaheim for more machining and some minor welds.
- 7 From there it went to San Antonio, where the primary contractor for the sphere, Southwest Research Institute, installed the hatch and windows. The windows are made of a high-grade optical acrylic.
- 8 Next, the sphere went to Northrop Grumman in Annapolis for hydrostatic tests. For the pressure test, both the chamber and the sphere are filled with water, because if the sphere is empty and it fails, it implodes, and you could get shrapnel flying about. The test is performed in stages of increasing depths and held there for specified amounts of time. The sphere was tested to 8,000 meters, nearly 12,000 psi, which is about 24 percent deeper than Alvin's eventual maximum operating depth of 6,500 meters. It passed all the tests.
- 9 The sphere was delivered to WHOI in June, 2012, and we began assembling it into the vehicle. ▲



Advanced Imaging & Visualization Laboratory, WHOI



Robert Brown/courtesy of Southwest Research Institute



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“We took 41,000 pounds of titanium and built an 11,000-pound sphere, and left shavings all over the U.S.”
—Kurt Uetz