NEEMO 16
Mission Days 10 & 11 – Status Report
Aquarius Reef Base, Key Largo, FL
June 20-21, 2012

Deco Day

Mission Day 11 was decompression day, or "deco" as we call it. The crew spent the day inside the habitat completing surveys and data sheets, and conducting two final outreach events. Finally, they commenced decompression itself – the final but critical step required to prepare them to safely return to the surface on Friday. Going through the 17 hour decompression protocol is required because once your body is "saturated" with nitrogen from the increased pressure of living under the sea, it simply is not possible to return to the surface at will. The inability for crewmembers to return to the surface without this 17 hour decompression procedure is another reason that this extreme environment is an excellent spaceflight analog.

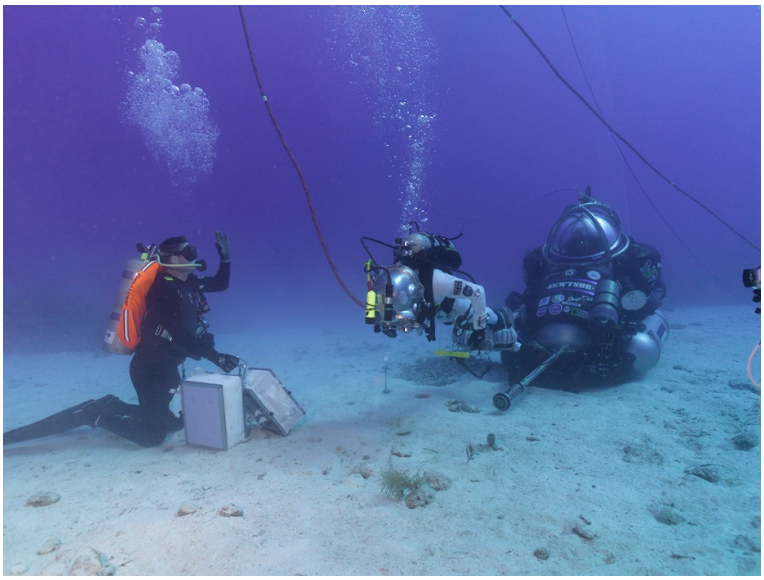
N16 Dive Team "Profile"

The NEEMO 16 Mission wouldn't be successful without the work of the "NEEMO Dive Team". This team is comprised of members from NASA and ARB who provide three critical roles during an EVA: In-Water Test Director (TD), Working Diver, and Imagery Diver. Any divers in the water at NEEMO, including these three roles, always have a "dive buddy" for safety. Each buddy pair plans their dives together and works to support each other while finishing the tasks on their checklist. Each morning the dive buddy pairs board boats and head out towards Aquarius. Once moored above the habitat, pairs of divers take turns diving from these topside support boats to assist the mission and aquanauts.

The In-Water Test Director pair focuses on "moment by moment" observations of the test, especially all the moving elements such as submarines and Aquanauts who might have umbilical tangles. This pair utilizes special masks that allow them to talk underwater through a hardline connection to the Aquanauts, submersibles, Aquarius crewmembers, and the Mobile Mission Control Center back on land, ensuring there are "eyes on the scene" that can quickly inform everyone and take preventative action prior to any undesired situations developing. This team also provides in-water observation of test objectives and any test/simulation issues that might confound the test results. They help direct the action underwater, and ensure that everything is done safely and follows the rules of the test.

Test Directors Andrew Abercromby and John Mularski discuss the test plan prior to their dive.

Test Director David Coan preparing for dive.

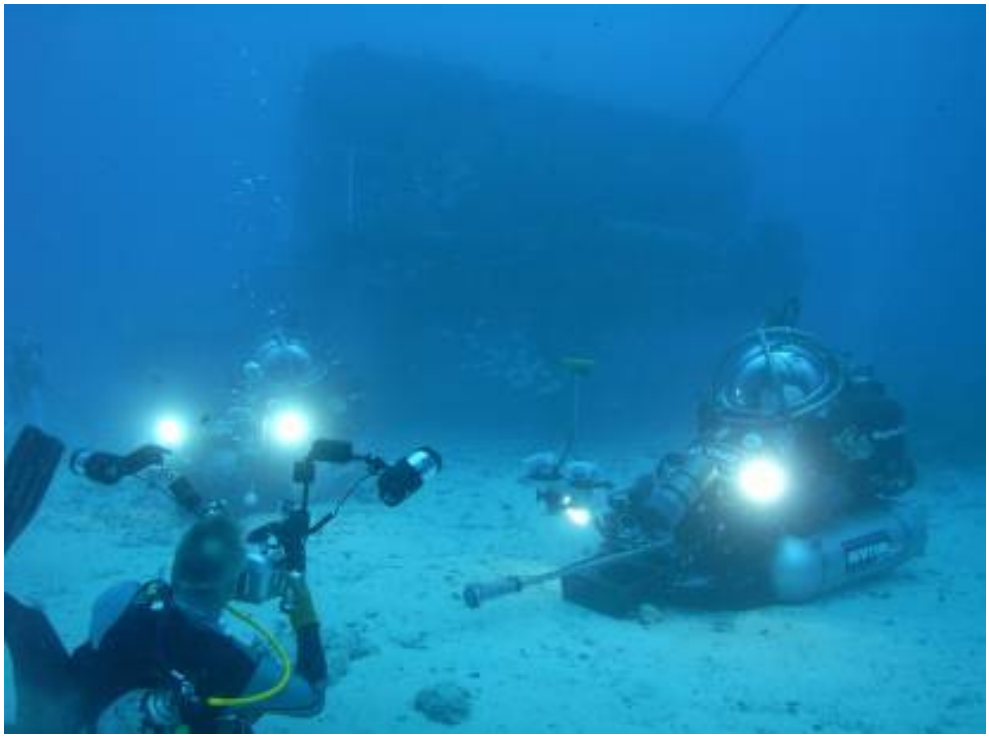


Test Director Andrew Abercromby monitoring the EVA operations.

The Working Diver pair has a very different task. These divers spend their time moving about the test circuit in a wide variety of jobs such as staging the Aquanaut's tools and equipment, the test articles, configuring hardware, repairing things that break, taking items to and from the habitat, and providing simulation assistance to the Aquanaut to reduce any issues with hardware "weigh-out" since many items cannot be made perfectly neutral in the water. Working Divers also tend the Aquanaut's life support umbilicals and the submarine communications umbilicals, managing them for snags or tangles and keeping them held up out of the way so they do not interfere with the Aquanauts' tasks. With two Aquanauts and two submarines in the test circuit, these divers have a very important role to play.

Working Divers re-staging equipment and managing umbilicals for the submersible and Aquanaut.

The Imagery Diver pair takes pictures and videos of the Aquanauts as they perform tasks. This imagery records the actions for analysis by engineers, and shows people not directly involved with the test what kind of mission NASA is planning for the future. This dive buddy pair really brings the test to the rest of the world, generating interest and enthusiasm for spaceflight and exploration.



Imagery Diver Mark Widick documenting the test.

Finally, all three types of dive pairs observe the Aquanauts throughout the test to see firsthand how the conceptual methods and tools for the NEA EVA are working. This experience is a huge benefit to the NASA engineers who conduct the mission planning and EVA hardware development as they can immediately see ways in which the test, mission concept or hardware can be improved. These direct observations are included with Aquanaut feedback questionnaires, post EVA debriefs, and go into the post-mission report to capture the lessons learned. They also help refine tasks and techniques to quickly improve the whole system.

Now, someone might ask "Why does the Dive Team have to dive from the surface if the Aquanauts can live in the Aquarius habitat? Can't the Dive Team live down there too?" The reality is it's simply not practical to build a habitat large enough to house all the Aquanauts and the Dive Team. So, the Dive Team lives on the surface and goes down each day. This means that the critical jobs the Dive Team does would not be possible without the use of "Self Contained Underwater Breathing Apparatus" or SCUBA equipment. These devices utilize portable tanks of compressed breathing gas, regulators, and inflatable vests to allow the diver to work underwater. The SCUBA divers utilize a special diving gas called "Nitrox" which has a higher proportion of oxygen in it than normal atmosphere. This increase in oxygen reduces the amount of time the diver needs to spend on the surface between dives, making the dive team as efficient as possible while offshore. To get the maximum amount of time practical in the water, the many members of the dive team actually use "twin tank" assemblies which double the

amount of gas available on a single dive. Although the tanks start off pressurized to about 3000 psi, each assembly is usually consumed on a single dive, so each diver usually has two twin assemblies per day and uses both of them. This means that at the end of the day when the team returns to the shore, all the tanks need to be refilled before being used again the next day, so a Nitrox filling station is required to have enough gas available to quickly turn the team's gear around. Each diver is responsible for seeing that their tanks are filled and properly analyzed for oxygen content, then reloading them on the boat that evening so as not to delay the next morning's departure.

Full nitrox tanks staged for operations.

That gets us to the final piece of the puzzle. Moving the divers and their tanks back and forth from shore to the Aquarius dive site takes boats and the expertise to operate a Nitrox dive team from a boat. The Nitrox filling station also takes expertise to operate. This means that the "Dive Team" also includes the boat, safety standby divers, the boat operators, equipment technicians, and the Nitrox filling station operators. In the end, this all means that the Dive Team is a complex team made up of many parts, all of which work together to enable the successful execution of NEEMO 16.

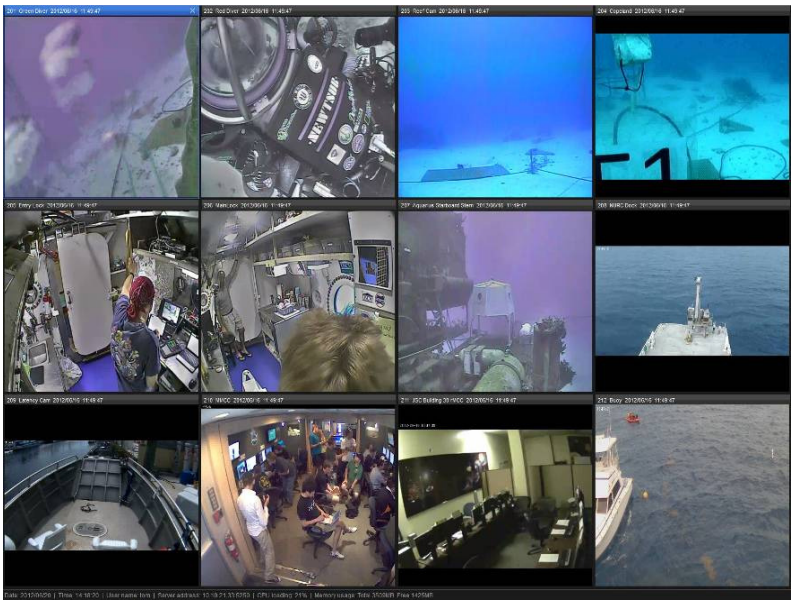
KSC Communication Team Assets and Support

The Kennedy Space Center (KSC) communication support team provides the necessary communication systems and ground logistics support for the mission. Logistics support includes two Mobile Mission Control Center (MMCC) trailers, two vessels for support out to the Aquarius Life Support Buoy (LSB), generators, and additional hardware to host a team of 30-40 NASA engineers working topside for the mission duration.

KSC-supplied MMCC trailers and support ships.

The communications setup includes a wireless network to connect the Liberty Star and other surface vessels to the Aquarius LSB, which is the lifeline of Aquarius, and provide those secure communications including voice, video and data back to the MMCC, KSC and Building 30 MCC at JSC.

This mission utilizes KSC built communication delay technologies that allow the crew to experience any duration (in our case, 50 seconds each way) communication latency during their science and EVA operations. This includes delay in voice, texting and video, allowing the crew to give feedback about which communication devices and technologies would be most advantageous to pursue further development.



Snapshot of camera views provided by KSC communications team.

The NEEMO Mission Management and Topside Support Team

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