Good Enough for Government Work

The Navy likes US Divers regulators

Last month's *In Depth* gave a brief history of regulator testing by the U.S. Navy's Experimental Diving Unit (NEDU). The tests they performed during the late 1980s included most of the same regulators used by sport divers and so were of great interest to the dive community. However, just as regulator manufacturers were beginning to respond by designing their regs to pass or exceed the Navy standards, NEDU stopped testing.

Finally, after a seven-year hiatus, NEDU has once again started to test regulators and publish results. While the 1980s tests classified regulators into different groups according to performance, new test results use a much simpler, sink-or-swim scale. Regulators now are on the "Authorized for Navy Use (ANU)" list, or they are not. Period.

Last month's article covered two regulators that didn't make it onto the ANU list — failed miserably, in fact: Performance Diver's PDXL 700 and PDXL 1000. In Technical Report #9-94, the Navy puts three US Diver regs through the tests. If you already know or remember enough from the last issue on how NEDU conducts its tests, jump ahead one space for the results. If not, disconnect the phone and plow through the jargon below first.

Testing, Testing . . .

The tests focus on whether regulators meet an arbitrary standard of "work of breathing" (a computer-derived estimate of total respiratory effort) using a mechanical breathing simulator produced by Reimers Consultants. To make it onto the ANU list, general-use regulators must meet the standard all the way down to 198 fsw (in 33-foot increments) and back up at about 70˚F. Regulators designed for coldwater use must meet the work-of-breathing standard only down to 132 fsw at 28–31˚F. Coldwater first stages must not freeze at all, and second stages must not fail due to freezing, though minor free-flow is acceptable.

Perhaps as a result of "overwhelming evidence of acceptability" by its divers, NEDU slid the Arctic onto the ANU list by redefining the limit.

The simulated ventilatory rate (lung volume times number of breaths per minute) used in the tests is 62.5 liters. For a diver — remember, we're supposed to cruise around slowly with minimum exertion — that's really honking. An average person pumps about 6–10 liters per minute in and out of his lungs at rest, according to the U.S. Navy Diving Manual, although this can increase to 100 liters per minute "during severe work" or "during a short period of extremely forceful breathing."

To satisfy NEDU, regulators must also maintain their cracking pressure (initial inhalation resistance) within 0.5 inch of water pressure on either side of manufacturers' specifications at flow rates of 0–30 cubic feet per minute. Five samples of each regulator model are tested at 1,500 psi on the way down and at 500 psi on the way up.

Finally, there's a series of manned test dives in NEDU's Ocean Simulation Facility to 198 fsw and in open water to 130 fsw to evaluate subjective factors such as fit, function, and feel in various positions.

The USD Three

In NEDU's tests, US Divers' SEA-2 and Arctic had the highest possible bench flow rate (850 liters per minute) at initial inhalation resistances of 1.1 and 4.6 inches of water, respectively. The Micra was close behind, with 701 liters per minute at 5 inches of water.

Note that the cracking pressures measured by NEDU on the surface at its maximum bench flow rate are much higher than a recreational diver would ever be likely to experience, even at depth. For example, a regulator capable of pumping out 700 liters of air per minute at the surface, such as the Micra, should be able to channel about 100 liters per minute to a diver at 200 fsw. If a diver could suck this much air at

200 feet they would probably pass out from hyperventilation.

However, at a more typical inhalation rate, say 40 liters per minute — which is still puffing way too hard at 200 feet — the Micra would be flowing the equivalent of 280 liters per minute at the surface, or about 40% of its maximum capability. At this rate (which would empty an aluminum 80 in about 10 minutes, assuming no descent time), NEDU found inhalation cracking resistance to be about 1.2 inches of water for the SEA-2 and the Arctic and 1.6 inches for the Micra. That's about what *In Depth*'s tests have shown for modern high-performance regulators that we have reviewed. The Micra I reviewed in 1992 for *In Depth* had a measured inhalation cracking pressure of 1.4 inches at the surface.

The work-of-breathing values for both the SEA-2 and Micra were within the performance goal standard. This performance plus their "compelling evidence of acceptability by Navy divers" in the manned testing earned them a place on the ANU list. At 500 psi, they were still within the work-of-breathing limit at 165 fsw, though at 198 fsw both of them drifted over the limit. They did, however, stay within the work-of-breathing limit at 198 fsw when the breathing rate was reduced to 40 liters per minute.

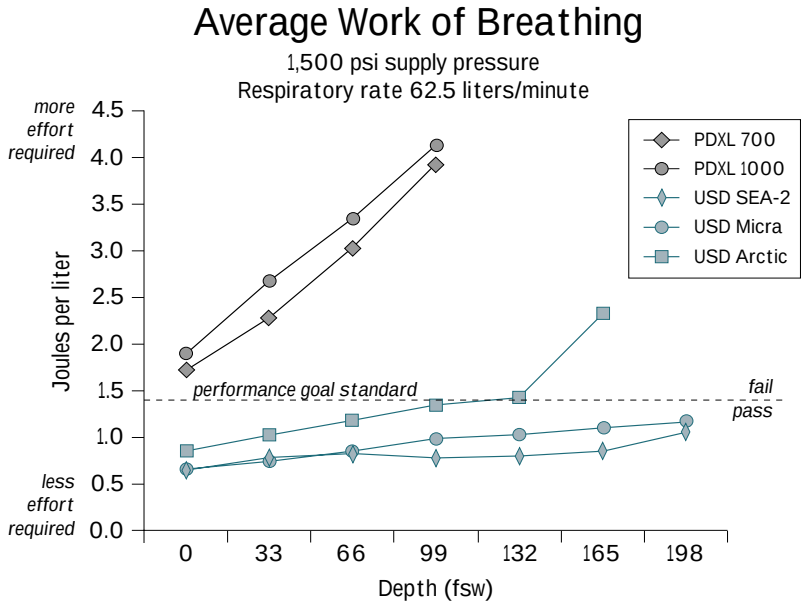
The Arctic, however, did not meet the performance goal. With a supply pressure of 1,500 psi, its work of breathing exceeded the standard for coldwater regulators at 132 fsw. With a supply pressure of 500 psi, the Arctic also failed the work-of-breathing test at 99 fsw and below. However, NEDU's divers liked the feel of the Arctic, and perhaps as a result of this "overwhelming evidence of acceptability," NEDU did some fancy statistical footwork and managed to slide the Arctic onto the ANU list by redefining the limit in somewhat softer terms ("Although 1.44 J/L is higher than the performance goal standard of 1.37 J/L, there is no significant difference in the two values"). This is a sleazy trick that any decent statistician would shun. Acceptance criteria are arbitrarily fixed values, not Gaussian distributions. But, hey, it's their list, and they can do what they want to with it.

The Bottom Line

USD has a couple of winners in the SEA-2 and the Micra, the latter of which we reviewed very favorably (*In Depth*, Sept. 1992). The Arctic squeaked in the back door, and NEDU's apparent willingness to bend its own rules to justify what it wanted to do in the first place is, unfortunately, only human. The Arctic is probably a fine piece of gear, but we can't say, because we haven't tested it. We welcome volunteers who like to dive in frigid water. The performance goals set by NEDU are designed for hard-workin', heavy-breathin' Navy guys, and the rest of us shouldn't be put in situations where we're going to burn more than 60 liters of air per minute anyway.

The new NEDU standards, even if still a little fuzzy around the edges, are tougher than the old ones. They will undoubtedly become the standard for the sport-diving industry, and regulator manufacturers are sure to try to meet them. The likely outcome will be even easier-breathing (and, we hope, equally stable) regulators on the market.

Delmar Mesa



Test results for the three US Diver regulators are in blue. For comparison, the results from two Performance Divers regulators also tested by the Navy are in black.