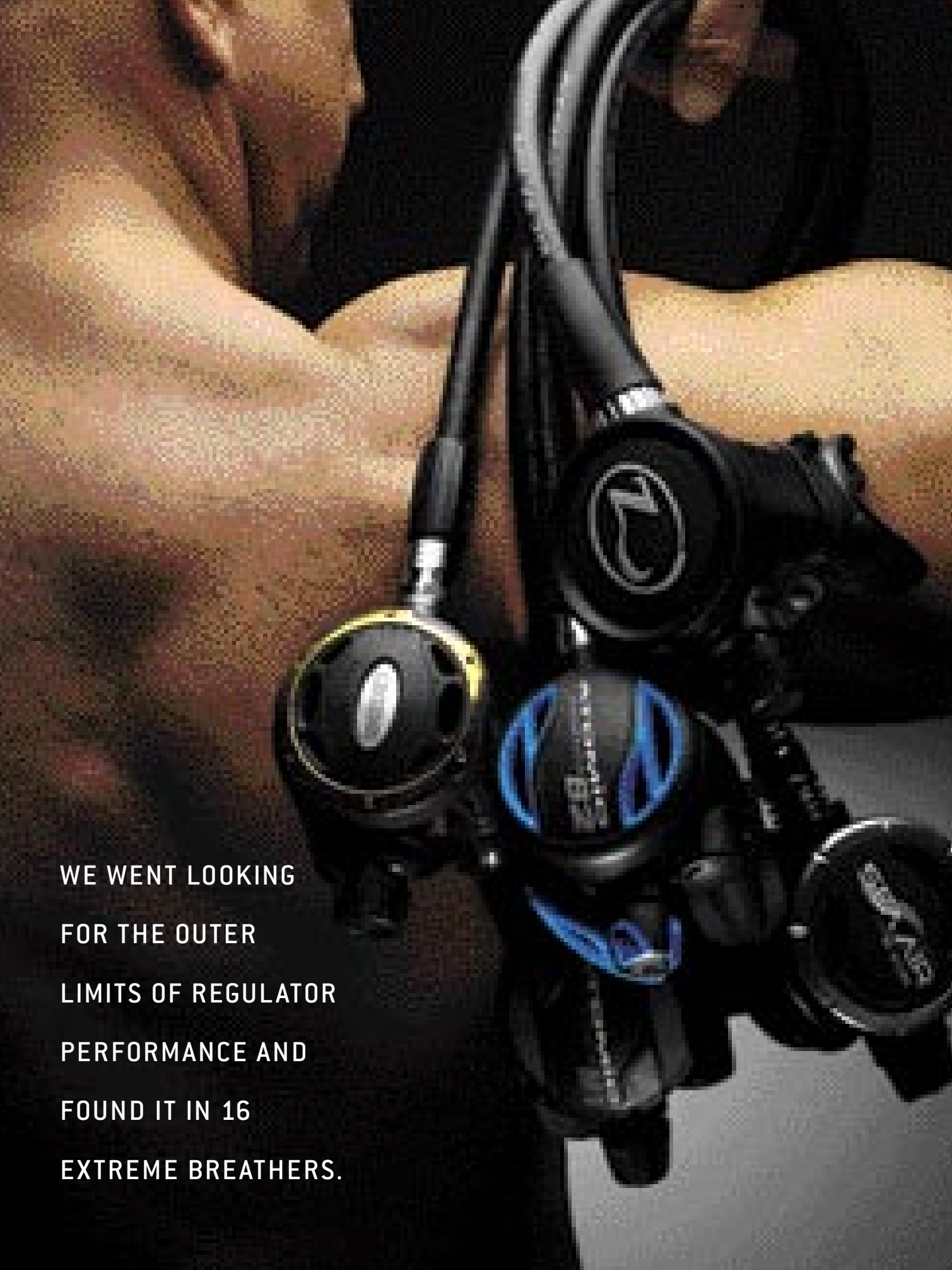

WE WENT LOOKING
FOR THE OUTER
LIMITS OF REGULATOR
PERFORMANCE AND
FOUND IT IN 16
EXTREME BREATHERS.

SCUBALAB SPECIAL REPORT

# MUSCLE REGS

BY JOHN BRUMM
PHOTOGRAPHY BY JOSEPH BYRD

**AS TIM "THE TOOL MAN" TAYLOR USED TO SAY** on the sitcom *Home Improvement*, life for many Americans is about the pursuit of "more horsepower." Cars that cage fire-breathing V8s under their hoods, stereos capable of cranking 1,000 watts of ear-splitting power, and, yes, regulators able to keep on breathing far, far beyond the normal bounds of recreational diving.

All this extra power may not be needed, and perhaps will never be used. But for high-performance aficionados, just knowing your reg can go well beyond the traditional performance limits is pretty cool stuff. So as an experiment, we decided to forgo our usual comparative review process and examine the outer limits of regulator performance. We invited all major manufacturers to submit their best breathers, and of the 24 models submitted, 16 met or exceeded our "muscle reg" threshold.

Now before we proceed, let's be absolutely clear: We are not suggesting that any reg not on this list is unsafe or deficient. In fact, our tests clearly show that virtually all major-brand regulators on the market today have more than enough horsepower to handle anything you can throw at them within the bounds of recreational diving. And most are capable of doing more, in that they can meet the somewhat stringent breathing requirements of the European conformance standard EN250, the dive industry's benchmark test standard. Among EN250-qualifying regs, many can meet the even more stringent U.S. Navy tests for regulator breathing performance. All these tests demand breathing performance in excess of what most divers will ever need.

This special report looks at the regs that can take it one step further. Indeed, our "muscle reg" threshold (75 RMV at 198 feet) borders on the limits of human breathing ability. Simply put, the average recreational diver probably can't breathe this hard at this depth—but it's nice to know that your reg could hack it, even if you couldn't.

We conducted this test by hooking the regs to a ANSTI breathing simulator, then pulling out all the stops to see how much they could take before hitting the wall. This is akin to know-

ing how fast your car is on the quarter-mile track—it's just one benchmark of performance. If you're shopping for a reg, we urge you to consider all areas of performance as covered in our previous regulator reviews (see: Editor's Note, p. 75).

That said, the high-end performance of these regs is a laudable engineering feat, made all the more impressive by the fact that these muscle regs all work just as well on easy shallow dives, too. And our test divers rated them all from Good to Excellent in real-world diving categories. To continue the car analogy, these aren't souped-up dragsters designed only for top-end speed. These regs are like more like family sedans that tear up the quarter-mile, too.

## MAKING THE CUT

**WE BEGAN THE SEARCH FOR THE OUTER LIMITS** of reg performance using our standard breathing machine tests (see chart, p. 101) as a baseline. These tests measure breathing resistance at specific breathing rates or respiratory minute volumes (RMVs), and at specific depths. Test A is the breathing rate/depth combination that most closely represents recreational diving (37.5 RMV @ 132 fsw). We then switched to Test B, an aggressive breathing rate loosely representing two divers breathing off the same first-stage reg, as in an air-sharing situation (75 RMV @ 132 fsw). From there it was on to Test C, the EN250 test (62.5 RMV @ 165 fsw), before moving to Test D, the U.S. Navy tests (62.5 RMV @ 198 fsw). But instead of stopping there like we normally do, this time we kept going.

Maintaining a depth of 198 feet, we kicked up the breathing rate to 75 RMV and used that as our muscle reg qualifying point. If the reg could achieve the 75 RMV @ 198 fsw qualifier, we noted it, then began to slowly dial up the breathing rate, higher and higher, to see just how much strain the reg could withstand before exceeding test parameters for an acceptable work of breathing. Tests were run with a relatively low supply pressure (725 to 760 psi). In other words, we couldn't have made it any more difficult for these regs to perform short of strapping them to an anchor and dropping them to the bottom of the Mariana Trench.

The breathing rates these muscle regs were able to achieve in these extreme conditions ranged from 75 RMV, considered an extremely heavy work rate regardless of depth, to just over 90 RMV, which is three to four times the breathing rate of a typical recreational diver. Considering 90 RMV is a breathing rate few if any divers could maintain for more than a few seconds at shallow depths, much less at close to 200 feet, this represents some serious gas delivery horsepower.

# 16 MUSCLE REGS

IN ALPHABETICAL ORDER BY MANUFACTURER

## APEKS ATX50

**A MEMBER OF** Apeks' line of British-made regs, the ATX50 has a balanced diaphragm first stage with an environmentally dry-sealed system and a low-pressure port turret. Its second stage is equipped with a heat exchanger for cold water diving as well as a breathing resistance adjustment knob and a venturi control lever.

The reg enjoys a well-earned reputation for performance, cranking out **Very Good** to **Excellent** breathing performance in our standard reg tests. When we raised the bar in the muscle test, the reg kept on cranking, reaching a breathing rate of 78.5. The ATX50 is a proven performer in the water as well. Test divers report it's dry and comfortable in all positions and has a very efficient purge.

## APEKS ATX100

**THE ATX100 HAS A** balanced diaphragm first stage and a compact second stage. Of the three Apeks muscle models listed here, this reg delivered the best breathing machine performance. It turned in a perfect score on ScubaLab's standard test regimen, then edged out its cousins in the muscle test, reaching the highest breathing rate of the Apeks family, 81.6 RMV.

In the realm of real-world diving, this 2003 Testers' Choice reg breathes extremely easy and dry in all positions and it clears easily using either the responsive purge button or the blowing method. It also has an efficient dive/pre-dive switch that's easy to operate even when wearing gloves. It comes with a Comfo-Bite mouthpiece, which most test divers found comfortable and secure.

## APEKS ATX200

**THE FLAGSHIP OF THE** Apeks line, the ATX200 has a slightly different balanced diaphragm first stage than the ATX100. According to Apeks, it's been designed to improve gas flow and reduce size and weight. It also has angled high- and low-pressure ports to make it easier to route hoses, as well as an additional micro adjustment that allows the reg to be easily tuned. The first stage is dry-sealed for cold-water diving.

The reg delivered **Very Good** to **Excellent** breathing machine performance on the standard tests and achieved a breathing rate of just over 79 RMV in the muscle test. In the water, the ATX200 proved itself to be a great breather, dry in all positions, with a second stage that features a very efficient purge.

## AQUA LUNG LEGEND & LEGEND LX

**THE LEGEND AND LEGEND LX** represent Aqua Lung's top-line regs. They use an "overbalanced" diaphragm first stage. According to the company, the medium pressure in the hose actually increases at a rate faster than in traditional balanced regs. This compensates for the increased density of gas at greater depths, which allows for consistently easy breathing. Based on our tests, the system works. The two regs delivered **Excellent** simulator performance, racking up perfect work of breathing scores in the standard ScubaLab breathing tests. When pushed to the extreme, they were both able to achieve breathing rates of more than 80 RMV.

In-water tests showed these regs, both 2002 Testers' Choices, to be very good breathers and dry in all positions. The flexible purge cover is efficient, and Comfo-Bite mouthpieces keep the second stages securely in the mouth. The regs are fitted with environmental dry kits, and their two high-pressure ports and four low-pressure ports are angled for optimal hose routing. Both regs' second stages are equipped with effective venturi control switches. The LX also has a breathing resistance adjustment knob.

## AQUA LUNG TITAN LX

**THE TITAN LX,** a 2002 Testers' Choice, is the ranking member of Aqua Lung's line of Titan regs. This workhorse reg is inexpensive, compact and delivers excellent simulator performance along with solid performance in real-world diving conditions.

Earning perfect scores on the breathing machine in standard simulator tests, the reg was then able to jump to 75 RMV in the muscle test. In the water, the Titan LX is a good breather in all positions and offers an efficient purge. Its dive/pre-dive switch is easy to use and well-marked. The reg comes with a choice of a Comfo-Bite or a standard mouthpiece to suit individual tastes.

## DEFINING OUR TERMS

**RMV.** Or Respiratory Minute Volume. This is basically the amount of gas that can be ventilated through the lungs in one minute.

37.5 RMV represents how a physically fit recreational diver might breathe while swimming a long distance (for comparison, a relaxed diver making a drift dive will be breathing at about 22 RMV or less). A diver could theoretically maintain 37.5 RMV for only about five minutes without becoming significantly winded.

62.5 RMV is considered a standard "heavy work" breathing rate, what commercial divers might be breathing when active on a project. A recreational diver in excellent condition would be able to maintain this rate for only a couple of minutes.

75 RMV is considered an "extremely heavy work" breathing rate. A diver in excellent condition can breathe at 75 RMV for only about a minute, even at shallow depths. This rate can also provide a pretty good indication of a regulator's ability to support two divers breathing off the same first stage in an air-sharing situation.

**WORK OF BREATHING.** Also referred to as External Work of Breathing or EXT WOB. This is the sum of the inhalation and exhalation effort expressed on the breathing simulator in joules per liter, or j/l, as captured on a "breathing loop," a graphic representation of a regulator's total inhalation and exhalation performance.

**TEST PARAMETERS.** Following internationally accepted test standards, a regulator's work of breathing is measured in joules per liter (j/l) for each complete inhale/exhale cycle, during which the highest inhalation or exhalation pressure experienced by the "diver" should never exceed 25 millibars or a total WOB of 3 j/l. If a reg does exceed these parameters, it doesn't mean that it stops delivering air—only that the breathing resistance at some point in the cycle is higher than what is considered acceptable.

## ATOMIC AQUATICS T2

**THE T2 HIT THE MARKET** in May, easily earned a 2005 Testers' Choice in our June review of new regulators, and has had divers talking ever since. Both first and second stages are built with solid billet titanium components, creating a corrosion-free breathing system that weighs less than two pounds. The reg comes with an all-titanium version of Atomic's Comfort Swivel on its second stage, and uses the company's patented Automatic Flow Control, a depth-activated venturi control that automatically balances breathing performance and stability as depths increase.

In standard breathing simulator tests the T2 delivered a perfect score without breaking a sweat. In the muscle test the reg was able to attain a breathing rate of just under 91 RMV. In ocean tests the reg was rated excellent in all ergo categories but bubble interference, where it earned a very good.

## ATOMIC AQUATICS T1X

**REPLACED BY THE T2,** the T1x (a 2002 Tes-

## SO WHAT MAKES THESE REGS DIFFERENT?

**THE 16 MODELS THAT** met or exceeded our muscle reg threshold are a diverse lot. They range in price from $375 to $1,596. Seven have balanced piston first stages, nine have balanced diaphragm first stages. All but one have balanced second stages. All but one have some kind of user adjustment, and all but three of these user adjustments include breathing resistance knobs on their second stages.

So what's the secret to their extreme capabilities? Is it in the first stage? The second stage? Parts or materials or maybe machining? We put these questions to manufacturers. The answer: All of the above. The devil, they say, is in the details.

Unfortunately, that's about all they were willing to say, although it's understandable that they wouldn't be eager to share their secrets. But we couldn't help but notice these regs have a few things in common.

**ACCESS TO BREATHING MACHINES DURING THE DESIGN PROCESS.** The manufacturers of these muscle regs either own, or have access to, an ANSTI breathing simulator. This ability to test design modifications takes the guesswork out of engineering breathing performance.

**A ROCK-SOLID FIRST STAGE.** Muscle regs tend to have really solid first stages, built upon generation after generation of successful designs. Past ScubaLab tests have shown that a weak second stage powered by a solid first stage will rise to the occasion. But put a well-performing second stage on a poorly performing first stage, and you'll get a poorly performing reg. Of course, these muscle regs have solid first and second stages, or they simply couldn't do what they can do.

**THE ABILITY TO BALANCE SHALLOW AND DEEP WATER PERFORMANCE.** Having a reg that goes to the extremes is great, but all of the muscle reg manufacturers agree: You can't ignore the primary function, which is to deliver gas efficiently at standard recreational diving depths.

**REPEATABLE PERFORMANCE.** One manufacturer claimed that it is relatively easy for a good engineer to make one super-performing reg. The challenge is to make a thousand of them and have them all perform the same. Repeatability requires quality parts and tight manufacturing tolerances.

ters' Choice) is no longer in production for the U.S. market but was still available at the time of our test. It aced all of the standard breathing simulator tests, then handled a breathing rate of just under 85 RMV in the muscle test. It was also a test diver favorite in the water, earning an excellent rating for ease of breathing. It also scored well for dryness, clearing and overall comfort.

## ATOMIC AQUATICS Z2

**THE Z2 ONLY RECENTLY** hit dive stores, but already it is developing a reputation as a superb breather. When subjected to ScubaLab's standard simulator test protocols, the Z2 delivered perfect simulator scores. When pressed to the limit, it was able to achieve one of the best breathing rates of this group, just over 87 RMV. This superior performance carries into the water as well, where test divers found the reg a very easy and dry breather in all positions with an excellent purge.

The Z2 has a new high-flow second stage casing similar to what's on the new T2. Like all Atomic regs, the Z2 also uses Atomic's patented Automatic Flow Control and comes with a great dual composite mouthpiece. The first stage is available with either seven fixed low-pressure ports of five low-pressure ports on swivel.

## ATOMIC AQUATICS Z1

**THE Z1** (so-named for the zirconium/nickel coating on the brass valve body of the second stage) is the least expensive model in Atomic's line, yet it features all of Atomic's design innovations and can stand up with the priciest of them when it comes to performance. Earning perfect simulator scores under normal test conditions, this budget reg, which received a Testers' Choice in 2002, achieved a maximum breathing rate of over 81 RMV at 198 feet.

In the water, the Z1 offers very good breathing performance in all positions. It also breathes dry and clears easily due to a very powerful purge. With a compact balanced piston first stage offering seven low-pressure ports and a lightweight second stage, this regulator is efficient and comfortable and has been a consistent favorite among test divers, although its standard mouthpiece tends to be a bit too small for many divers' tastes.

## ATOMIC AQUATICS B2

**ATOMIC'S B2 FEATURES** a balanced piston first stage with a low-pressure port swivel turret to simplify hose routing. The second stage is built with titanium components and features Atomic's Comfort Swivel, which we consider the best second stage swivel around. This 2003 Testers' Choice breathed effortlessly on the simulator, delivering perfect scores on ScubaLab's standard tests. When pushed to its limits, the reg was able to achieve a breathing rate of just a tad over 75 RMV.

Take the B2 into the water and it breathes

easily in all positions and is dry as a bone. It is equipped with a resistance knob and Atomic's Automatic Flow Control instead of a dive/pre-dive switch. According to Atomic, this depth-activated venturi control automatically balances performance and stability as depth increases. Its dual compound mouthpiece was a favorite among test divers, along with the second-stage swivel.

## ATOMIC AQUATICS M1

**THE M1 IS MANUFACTURED** with Monel internal parts. Monel is high-grade stainless-steel known for its strength, corrosion resistance and oxygen compatibility. Like its Atomic brethren, the reg is equipped with Atomic's Automatic Flow Control, a depth-activated venturi control that automatically balances performance and stability as depth increases. Also like its brethren, this reg turned in **Excellent** performance on the breathing simulator, earning perfect work of breathing scores when subjected to our standard reg tests. In the muscle test, it reached a breathing rate of just over 81 RMV.

Past and present in-water tests have shown the M1, a 2002 Testers' Choice, to be a real easy breather in all positions. The reg has a very efficient purge system and minimal bubble interference. Test divers liked the mouthpiece and low-pressure port turret on the balanced piston first stage that simplifies hose routing.

## POSEIDON XSTREAM DEEP 90

**THE XSTREAM DEEP 90** merges two former Poseidon regs; its first stage comes from the former Xstream Dive 90, and the second stage comes from the Xstream Deep technical reg. When put to standard breathing simulator tests, this new combo delivered **Very Good** to **Excellent** performance in most RMV/depth categories. When pushed to its limits, the reg just squeaked by the muscle reg qualifying line with a breathing rate of 75 RMV at 198 feet.

The reg is a smooth breather in real-world diving conditions, especially when diving heads-down where test divers found virtually no increase in breathing resistance. The second stage is light in the mouth and uses a side-exhaust design that tends to reduce bubble interference. The reg clears relatively easily using the blowing method; however, the purge button is considered by some test divers to be too explosive.

## XS SCUBA SEAAIR TRI-METAL

**WHEN IT COMES TO** performance this 2005 Testers' Choice winner is nothing if not consistent. So-named because of its stainless-steel, titanium and brass components, this inexpensive balanced piston reg delivered **Very Good** to **Excellent** performance on the breathing simulator when subjected to ScubaLab's standard test protocols. When pushed to extremes, it was able to maintain a breathing rate of over 91 RMV at 198 feet.

The reg also proved its worth in real-world diving conditions. It was rated very good by test divers in all categories except adjustments, where it earned a good (the adjustment knob is a bit sticky). Test divers found the reg to be a sweet breather in all positions and dry as a bone. The Tri-Metal's balanced piston first stage features an low-pressure port turret for easy hose routing.

## ZEAGLE FLATHEAD VI & FLATHEAD XP

**ZEAGLE'S FLAGSHIP** Flathead VI/ZX (a 2004 Testers' Choice) has an environmentally dry-sealed first stage and a new side-ducted cover on its second stage that improves flow efficiency and helps resist free-flowing when swimming into a strong current. The Flathead XP is the same reg but without the environmental kit. Both regs are proven performers, capable of turning in perfect breathing simulator scores under normal testing, and muscle rates of just under 80 RMV at 198 feet.

In real-world diving, both regs proved to be very easy breathers in all positions. They also breathe dry, even after clearing, thanks to a very efficient purge system. Test divers found the resistance adjustment knob and the dive/pre-dive lever effective and easy to use. They also tended to like the larger-than-normal mouthpiece. SD

**GET MORE** > For more information on high-performance regs, turn to In Depth, pages 100-101, section 5.

## EDITOR'S NOTE

**FOR THE RECORD:** This is not a traditional ScubaLab review. We have made no attempt to rate or rank these regulators based on this narrow, specialized test. If you're shopping for a reg, please look at the full range of performance as measured in our annual reviews of new regulators (including the one we published in our June 2005 issue), all available free online at www.scubadiving.com.

Also for the record: Having a reg that can go to the extremes doesn't mean that you should. If you're planning dives to extreme depths, please seek appropriate training first.

# 5


MUSCLE REGS, P. 70

## CHARTING THE OUTER LIMITS OF REG PERFORMANCE

First, a quick refresher course on our terms:

### RMV.

Stands for Respiratory Minute Volume. This is basically the amount of gas that is ventilated through the lungs in one minute.

### WORK OF BREATHING.

Also referred to as External Work of Breathing, or EXT WOB. This is the sum of the inhalation and exhalation measured by the breathing simulator in joules per liter, or j/l.

### TEST PARAMETERS.

Following internationally accepted test standards, a regulator's work of breathing is measured in joules per liter (j/l) for each complete inhale/exhale cycle, during which the highest inhalation or exhalation pressure experienced by the diver should never exceed 25 millibars or a total EXT WOB of 3 j/l. Note: If a reg does exceed these parameters, it doesn't mean that it stops delivering air—only that the breathing resistance at some point in the cycle is higher than what is considered acceptable.

## SIMULATOR TESTS DEFINED

### TEST A (37.5 RMV @ 132 FSW).

This is the breathing rate/depth combination that most closely represents recreational diving. A breathing rate of 37.5 RMV represents how a physically fit recreational diver might breathe while swimming a long distance. A typical diver could theoretically maintain 37.5 RMV for only about five minutes without becoming significantly winded. For comparison, a relaxed diver making a drift dive will be breathing at about 22 RMV or less.

| MANUFACTURER/ Product/Contact | PRICE | MADE IN | WARRANTY | 1st STAGE | PORTS | 2nd STAGE | 2nd STAGE ADJUSTMENTS | FACTORY-READY NITROX CAPABLE | SIMULATOR TESTS: STANDARD TESTS: A (37.5 RMV @ 132 fsw) | B (75 RMV @ 132 fsw) | C (62.5 RMV @ 165 fsw) | D (62.5 RMV @ 198 fsw) | SIMULATOR TESTS: MUSCLE PT.: Maximum RMV @ 198 fsw within test parameters ** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **APEKS** ATX50 www.aqualung.com | $547 | UK | Ltd. Lifetime | Over-balanced diaphragm | 2 HP 4 LP | Balanced | Resistance Knob Venturi Control Lever | Up to 40% | 5 | 4 | 4 | 4 | 78.5 |
| **APEKS** ATX100 www.aqualung.com | $675 | UK | Ltd. Lifetime | Over-balanced diaphragm | 2 HP 4 LP | Balanced | Resistance Knob Venturi Control Lever | Up to 40% | 5 | 5 | 5 | 5 | 81.6 |
| **APEKS** ATX200 www.aqualung.com | $695 | UK | Ltd. Lifetime | Over-balanced diaphragm | 2 HP 4 LP | Balanced | Resistance Knob Venturi Control Lever | Up to 40% | 5 | 4 | 4 | 4 | 79.2 |
| **AQUA LUNG** Legend www.aqualung.com | $495 | France | Ltd. Lifetime | Over-balanced diaphragm | 2 HP 4 LP | Balanced | Venturi Control Lever | Up to 40% | 5 | 5 | 5 | 5 | 80.1 |
| **AQUA LUNG** Legend LX www.aqualung.com | $595 | France | Ltd. Lifetime | Over-balanced diaphragm | 2 HP 4 LP | Balanced | Resistance Knob Venturi Control Lever | Up to 40% | 5 | 5 | 5 | 5 | 81.4 |
| **AQUA LUNG** Titan LX www.aqualung.com | $375 | France | Ltd. Lifetime | Balanced diaphragm | 1 HP 4 LP | Balanced | Venturi Control Lever | Up to 40% | 5 | 5 | 5 | 5 | 75.0 |
| **ATOMIC AQUATICS** T2 www.atomicaquatics.com | $1,395 | USA | Ltd. Lifetime | Balanced piston | 2 HP 5 LP | Balanced | Resistance Knob | Up to 40% | 5 | 5 | 5 | 5 | 90.8 |
| **ATOMIC AQUATICS** T1x* www.atomicaquatics.com | $1,596 | USA | Ltd. Lifetime | Balanced piston | 2 HP 5 LP | Balanced | Resistance Knob | Up to 40% | 5 | 5 | 5 | 5 | 84.8 |
| **ATOMIC AQUATICS** Z2 www.atomicaquatics.com | $429 | USA | Ltd. Lifetime | Balanced piston | 7 HP 5 LP | Balanced | Resistance Knob | Up to 40% | 5 | 5 | 5 | 5 | 87.2 |
| **ATOMIC AQUATICS** Z1 www.atomicaquatics.com | $379 | USA | Ltd. Lifetime | Balanced piston | 2 HP 7 LP | Balanced | Resistance Knob | Up to 40% | 5 | 5 | 5 | 5 | 81.5 |
| **ATOMIC AQUATICS** B2 www.atomicaquatics.com | $699 | USA | Ltd. Lifetime | Balanced piston | 2 HP 4 LP | Balanced | Resistance Knob | Up to 40% | 5 | 5 | 5 | 5 | 75.3 |
| **ATOMIC AQUATICS** M1 www.atomicaquatics.com | $699 | USA | Ltd. Lifetime | Balanced piston | 2 HP 5 LP | Balanced | Resistance Knob | Up to 80% | 5 | 5 | 5 | 5 | 81.1 |
| **POSEIDON** Xstream Deep 90 www.poseidon.se | $835 | Sweden | 2 yr. | Balanced diaphragm | 2 HP 5 LP | Unbalanced | None | Up to 40% | 5 | 3 | 4 | 4 | 75.0 |
| **XS SCUBA** SeaAir Tri-Metal www.xsscuba.com | $375 | USA | Ltd. Lifetime | Balanced diaphragm | 2 HP 5 LP | Balanced | Resistance Knob | Up to 40% | 5 | 4 | 4 | 4 | 91.3 |
| **ZEAGLE** Flathead VI www.zeagle.com | $598 | USA | Lifetime* | Balanced diaphragm | 2 HP 4 LP | Balanced | Resistance Knob Dive/pre-dive | Up to 40% | 5 | 5 | 5 | 5 | 79.1 |
| **ZEAGLE** Flathead XP www.zeagle.com | $549 | USA | Lifetime* | Balanced diaphragm | 2 HP 4 LP | Balanced | Resistance Knob Dive/pre-dive | Up to 40% | 5 | 5 | 5 | 5 | 79.1 |

* No longer manufactured for the U.S. market, but available at the time of initial testing. ** See explanation of test parameters on page 100.

### STANDARD TEST SCORES

Tests A, B, C and D are the standard ScubaLab breathing machine tests and are scored on a 2 to 5 scale that represents the EXT WOB expressed in j/l as follows:

**5 = EXCELLENT**
The regulator can achieve the breathing rate/depth category with a EXT WOB of 1.05 j/l or less.

**4 = VERY GOOD**
The regulator can achieve the breathing rate/depth category with a EXT WOB of 1.06 to 1.55 j/l.

**3 = GOOD**
The regulator can achieve the breathing rate/depth category with a EXT WOB of from 1.56 to 2.25 j/l.

**2 = FAIR**
Any regulator that can achieve the breathing rate/depth category with a EXT WOB of 2.26 to 3.0 j/l which is the EN 250 limit.

### TEST B (75 RMV @ 132 FEET).

For a single diver, this is an "extremely heavy work" breathing rate. A diver in excellent condition can breathe at 75 RMV for only about a minute, even at shallow depths. This rate also tests a regulator's ability to support two divers breathing off the same first stage in an air-sharing situation.

### TEST C (62.5 RMV @ 165 FEET).

This is the EN250 test. In addition to going beyond the traditional depth limit of recreational diving, this test uses an RMV of 62.5—a standard "heavy work" breathing rate similar to what commercial divers might be breathing when active on a project. A recreational diver in excellent condition would be able to maintain this rate for only a couple of minutes.

### TEST D (62.5 RMV @ 198 FEET).

This is the U.S. Navy's basic regulator test, representing a standard "heavy work" breathing rate similar to what commercial divers might be breathing when active on a project and conducted well beyond traditional recreational diving depth limits.

### MUSCLE POINT.

This is not a standard ScubaLab breathing machine test and is used in this special report only to gauge the outer limits of regulator performance. We set a threshold of 75 RMV @ 198 fsw. If a reg could meet that standard within the 25 millibar or 3 j/l parameters, we gradually increased the RMV to see where each reg fell out.