



Will APA Enhance SCUBA Diving Safety?

by Marco Flagg, APA Chief Designer & Test Diver

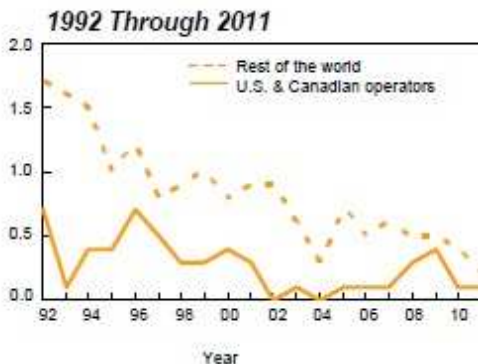


Marco Flagg test diving APA

A paper published in the Recreational Diving Fatalities Workshop Proceedings (Durham, NC 2010) concluded that 'gas supply problems' were the trigger of 41% of 965 analyzed diving fatalities [1]. The authors commented that "*Gas-supply problems resulted mainly from inappropriate gas management*". In fact, the development of APA under NOAA contracts [2] was in response to the organization's re-evaluating safety in light of gas management related accidents.

But, diving already is an equipment intensive activity. And so, I asked myself if a new type of instrument is really the answer to these safety problems. Perhaps, adjustments in training or the use of an air integrated dive computers with a low-air alert is the solution. As we developed and then refined the technology, conducted numerous test dives and observed other divers using the device, my view of the system changed. Today my view is that APA, if supported by proper instructions and used within well thought-out procedures, will indeed reduce gas management related systematic fashion. Here are my observations:

Aviation safety as a reference model for safety improvements in diving



Aviation safety has shown strong year-over-year safety gains and continues to do so even now. The fatal accident rate per million departures for commercial jet traffic has declined in the U.S. and Canada from 0.7 to 0.1 in the twenty years ending 2011. In 1959, at the beginning of the jet age, this rate was around 40 fatal accidents per million departures.

Figure 1: Fatal accidents per million departures in commercial jet traffic show dramatic safety gains even in recent history. Source: Boeing

Compared to aviation, safety gains in diving have been modest. The deaths per 100,000 members have declined somewhat for DAN and BSAC while the fatality count has been flat for years. There are many differences between aviation and diving, of course. But, a key factor in the aviation safety system is the augmentation of procedures and training by safety equipment that accounts for the high task loading a pilot may experience under adverse circumstances. This equipment guards against the errors that might be made under such circumstances. The stall warning device is a well known example, monitoring the aircraft's speed and providing a synthesized voice warning when a stall is imminent.

Diving can in some ways be more demanding than flying as divers may work in high currents, low visibility, cold, using heavy equipment and the like. The job may be physically exhausting, disorienting at times, yet demand concentration. There can also be psychological factors such as peer pressure causing a diver to push the limits. That gas management may suffer under these conditions is perhaps not surprising.

APA helps by providing an 'objective warning' of declining or low air status to the diver; one that is apparent to the diver as well as other team members. Thus, APA's safety function is to help a dive team conclude a dive in a more predictable manner, less subject to the various human factors that can cause inconsistencies in gas management.

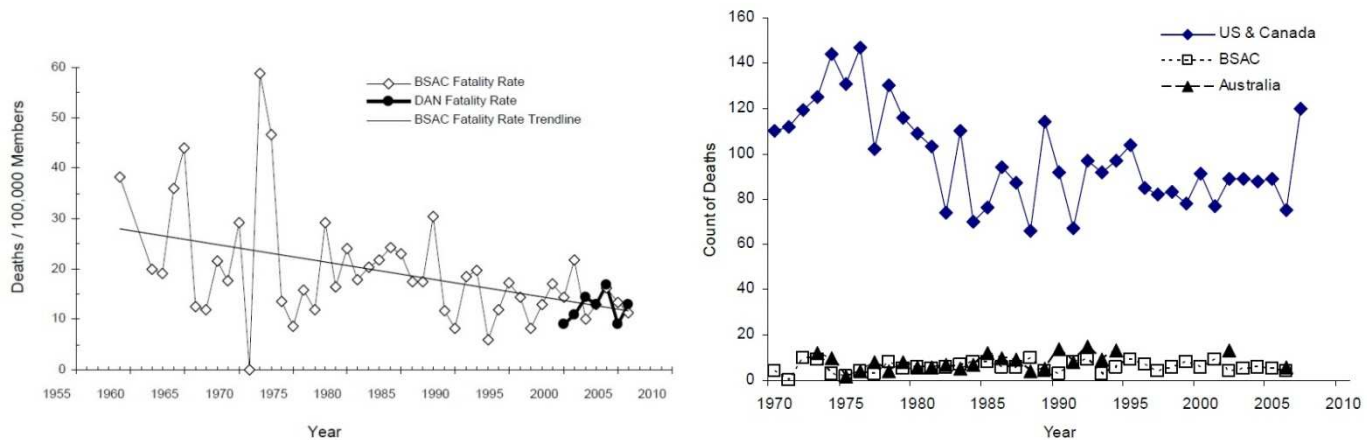


Figure 2: Improvements in dive safety have been modest. Dive fatalities per 100,000 members registered by DAN and BSAC have declines slowly in recent years (left) while total deaths have held steady (right). Source: DAN Diving Report 2008

Continuous Awareness of Gas Reserve Status

Driving down a highway, it's easy to lose track of your speed. You mean to go 65mph, but then look at your speedometer and realize it's closer to 80mph. Thus, your speed awareness is really only sporadic and significant discrepancies between your perception of the situation and the reality can quickly kick in. The situation in diving can be similar. And, because conditions are very complex with air consumption depending on depth, temperature, exertion level and more, and task loading or distractions can be high, it is easy to lose track of your air reserve.

When we designed APA, our concept was at first to issue alerts only when gas pressure reached the warning threshold. But, as we conducted test and evaluation dives, we found that this concept of 'active warning' would not be sufficient because it still leaves the diver with only sporadic air status awareness. There are circumstances when even the brightest and loudest practical alert signal may be missed. And, as any other wireless technology, APA's transmissions can be interrupted.

These insights led us to the concept of 'continuous awareness', where a diver is nearly always aware of air status in the background of their mind even while concentrating on a demanding task for example. This might be compared to body position awareness, which is always there but requires little mind share.

APA sets up this awareness by producing a tone sweep and blink every 16 seconds when gas reserves are still in the OK region. Fully head's up in its operation, the diver gets accustomed to these periodic status updates. And so, if there is a change in the rhythm, be that due to the persistent low air alerts kicking in or the 'no telemetry available' buzz or indeed a complete cessation of signals or their perception for whatever reason, the diver notices.

Summary

Out of air situations and unfortunately accidents continue to occur with some regularity. Any one technology including APA will not solve the problem entirely. The aviation industry's recognition that safety is the result of the combination of good training and procedures, augmented by objective and effective warning systems that take the human factors limitations of pilot into account is a good role model. It is one that has yielded ongoing improvements in safety in that industry and should similarly benefit diving.

Accidents are the results of a chain of events, and APA can provide an opportunity to break that chain and forestall gas management related incidents and accidents. The key to actual, measurable gains in safety however will lie in the development of proper procedures for its use within the context of your organization's standards and training. I.e., procedures that use APA in conjunction with SPG check procedures and that make use of its 'continuous gas status awareness' principle to recognize both low gas reserve and 'no information available' conditions earlier. Procedures that then break the accident chain by prompting appropriate responses.

[1]: Annual Fatality Rates and Associated Risk Factors for Recreational Scuba Diving, Denoble et. al., DAN Recreational Diving Fatalities Workshop Proceedings, 2010

[2]: NOAA SBIR Contract WC133R-09-CN-0109. Phase-1 and Phase-2 contract awards. Any opinions, findings, conclusions or recommendations in this paper are those of the author and do not necessarily reflect the views of the Department of Commerce.