Depth gauges, contents gauges and miscellaneous equipment problems reported in the Diving Incident Monitoring Study

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Abstract
Problems with depth and contents gauges reported to the Diving Incident Monitoring Survey are reviewed. The development of these gauges and their safe and unsafe use are discussed. A method of diving safely without a contents gauge, used by the Royal Navy for decades in the past, is explained. Attention is drawn to the fact that running out of air was the most common cause of death in divers in the 1990s. This is usually due to diver error (not checking the contents gauge frequently) but can be due to faulty contents gauges. Another common diver error leading to death is failure to drop the weight belt. Depth and contents gauges are known to go out of calibration and dive computers to be faulty, so regular testing of both sorts of gauges should be carried out. Some personal experiences are used to illustrate the message that diving safety involves preparation and attention to detail.

It is now accepted that depth and contents gauges are essential parts of a diver's equipment. This was not always so. Reports in early diving magazines make it clear that scuba divers often did not have contents or depth gauges in the early years of scuba diving, the 1940s and early 1950s. In those far-off times depth was usually estimated, not measured, and many divers terminated their dives when breathing became difficult or even impossible, necessitating a 'free ascent'. As people became less reliant on home-made gear, contents gauges became popular. They are essential for safe diving using a single tank.

is looked after properly, and rinsed through with fresh water after use, a capillary gauge rarely malfunctions. When using a dive computer, a Bourdon tube depth gauge in the regulator console can be used as the back up.

Human factors that contributed to contents and depth gauge problems were lack of calibration and servicing, combined with the diver's failure to check the gauge before and during the dive. Design factors that contributed included gauges having red lettering, sometimes against another colour background, providing poor colour contrast.

Air integrated gauges are advocated by some divers. In the mid 1980s, I bought an early model air integrated gauge, which showed the remaining air pressure numerically and as a steadily emptying cylinder icon. It also showed how long the air would last at the current breathing rate, the depth in metres and temperature (°C). It took about 10 years for the battery to die, by which time the manufacturer had gone out of business and the battery was not replaceable!

Most dive computers possess reliable depth gauges (this being essential for accurate function of the decompression model on the chip), but errors have been reported.[2]

The DIMS results show that depth and contents gauges are essential for safe diving. They must be easy to read. Accuracy determines their safety, but are they accurate when they leave the dive shop? There are no legal requirements for recalibration or servicing of depth or contents gauges. Although there is an Australian/New Zealand Standard for gauges, it does not cover gauges of the accuracy of those used for recompression chambers, nor submersible gauges used by recreational or professional divers. The current Standards for diving and working under pressure usually refer to pressure measuring devices rather than gauges, as there are many substitutes for the Bourdon tube gauge.

Miscellaneous equipment problems

The DIMS reports include some unusual incidents leading to harm (Table 2). These include damage to the diver from exit ladders, surface signalling devices, light sources, shot and other lines, and the backwash from a dive scooter. Five divers had problems with the exit ladder, resulting in injury to four, including lacerated or crushed fingers and a lacerated scalp. Contributing factors were unfamiliar diving conditions, poor dive planning and rough seas. The lesson is that entry and exit from the water needs to be carefully planned. The range of equipment problems contributing to fatalities in Project Stickybeak is also shown in Table 2.

Eight incidents with surface signalling devices were reported to DIMS. Whistles, often supplied with buoyancy compensators, were not heard over the noise of the boat's engine. Whistles driven by cylinder contents are useless if the diver is out of air. Some divers were unable to inflate their 'Safety Sausage' because they were out of air.[3] Some inflatable devices were not seen because of rough water, or flopped over in windy conditions. The original Safety Sausage, being a deep red colour, was poorly visible in some water/light conditions, even from a relatively short distance.

TABLE 2
MISCELLANEOUS DIVING EQUIPMENT PROBLEMS CAUSING MORBIDITY IN THE DIVING INCIDENT MONITORING STUDY OR FATALITY IN PROJECT STICKYBEAK

DIMS	
1 Air cylinder:	Slipping out of BCD
2 Snorkel:	Non-functioning flap valve
3 Diving computer:	Not activated before the dive
	Battery became flat during dive
4 Depth gauge:	Inaccurate
5 Dive tables:	Misreading
6 Exit ladder:	Sea conditions made it difficult to use
Project Stickybeak	
1 Air cylinder:	Rusted inside
2 Fins:	Dislodged during the dive
	Too loose
	Diver forgot to put fins on
3 J-valve:	Incorrect position before the dive
	Diver did not know how to activate
4 Trophy bag:	Weight belt became snagged on it during release
5 Multiple gas:	Confusion, causing the incorrect gas mixture to be used

Here, I must declare my interest in the Safety Sausage. I became the Australian distributor for the original, invented in the 1980s by Bob Begg, a dive retailer in Dunedin, New Zealand.[3] The Safety Sausage suffered from two major disadvantages, it was cheap and it implied that diving could be dangerous. The first meant that dive shops had little incentive to sell it, and few dive shops were willing to be honest with budding divers and admit that divers could become separated from the boat that they were diving from.

Air from the cylinder via a regulator held inside the Safety Sausage with the open end underwater is an easy way to inflate one, or it can be inflated by blowing into it at the surface. The tension in the tube is increased, and the tube stiffened, by the lower end of the inflated tube being held deeper underwater. Later inflatable tubes, from different makers, were made of thicker, more durable materials, but, when inflated, usually less than a metre of the tube showed above the surface, compared with the two metres of an inflated Safety Sausage, so were less easy to see.

Four divers reported problems with their light source, including flooding, flat batteries, and the lamp snagging on other equipment or rocks during the dive. Contributing factors were poor design (unable to test the light before entering the water), lack of a battery charge indicator, lack of pre-sales testing and inattention on the diver's part. Shot lines and surface safety lines caused two incidents. In both cases the diver became entangled due to inattention, but no morbidity resulted.

Personal experiences

At an earlier SPUMS meeting, I observed a SPUMS member prepared to commit suicide if he fell off the edge of the boat. Dressed in a wet suit without its jacket, he was wearing his normal heavy weight belt whilst sitting on the gunwale of the dive boat without his scuba gear or fins on. Had he fallen backwards, his only hope of survival would have been immediate release of his weight belt. Unfortunately, few divers drop their weight belts before they die underwater.[1,4]

During the 1987 SPUMS ASM at Mana Island, Fiji, I maintained contact with the dive boat with a Safety Sausage for about 45 minutes after one dive when my buddy and I missed a short stern safety line in a strong current. As a safety measure, the captain had hung a spare cylinder and regulator below the boat. Unfortunately, the dive boat was short of a line, so one end of the 'Jesus' line was used to hang the cylinder under the boat, which shortened the surface safety line by some three metres. We were swept towards the open ocean, while the dive boat, which did not have a tender that day, had to wait for all other divers before coming to collect us. Although the dive boat had two decks and a sun deck above the wheelhouse, we could see the top of it only when we were on the crest of a wave. Without the Safety Sausage we would have been invisible. The boat could follow our progress toward the breaking surf on the reef because I had inflated my Safety Sausage.

Another personal experience, long before the establishment of the DIMS database, was starting a dive and getting a mixture of air and salt water on my second breath. For some reason, the diaphragm of the expiratory valve had flipped out of place and was sucked inwards with each inspiration, letting water into the regulator.

References

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