ORIGINAL ARTICLES

SCUBA DIVING FATALITIES IN AUSTRALIA AND NEW ZEALAND

PART 3. THE EQUIPMENT FACTOR

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Background

In a previous report[1] it was determined that amongst recreational Australian and New Zealand diving fatalities during the 1980s, equipment faults contributed in 35% of the cases and equipment misuse in 35%. There was some overlap between these, with some divers having faulty equipment and also misusing that or other equipment.

In the Australian and New Zealand (ANZ) series we only documented the factors which materially contributed to the divers death. Errors in technique, which indirectly involved equipment (such as exhaustion of the air supply, failure to ditch weights and some problems with buoyancy) are errors of judgement and recorded in an earlier presentation.[1]

Under the equipment "fault" category were included problems that have developed which could not have been reasonably attributed to any action of the diver during that dive. It was not considered an equipment fault if the diver injudiciously chose the wrong equipment. This was included under the "misuse" category.

In many cases the information about equipment problems was imparted by the victim to his companions, whereas in other cases it was observed by the companions.

Equipment testing was carried out by the Water Police, Police Divers and Navy Diving units. Their reports included bench testing of the diving equipment used by the deceased, comparison with the national standards for compressed air equipment, and were often supplemented by in-water trials where an experienced diver of similar stature employed the equipment in a simulation of the fatal dive profile. Only if the abnormality was obvious and of practical relevance to the incident, was it counted as a contributor to the fatality. Gas analyses were routinely carried out at government laboratories.

One hundred consecutive deaths, which complied with strict requirements as regards data acquisition, were assessed. The figures therefore represent both actual numbers and percentages of the total. The equipment problems are detailed below.

Regulator problems (15%)

In 14 cases there was a significant fault in the regulator and in one instance it was misused. The faults were as follows:

Catastrophic failure	2
Increased resistance to breathing	4
Salt water inhalation	8

There is little doubt that the regulators of the 1980s cause much less resistance to breathing that those of previous decades, but they were still a significant contributor to 15% of the diving fatalities. In none of the cases was the regulator reported to be in a neglected state before the dive.

Although the most obvious regulator problem was with the sudden catastrophic failure, the commonest problem was the regulator producing, for a variety of reasons, a large degree of salt water during inhalation. This malfunction, together with the increased resistance to breathing noted in the other cases, was more likely to develop with increased respiration such as during exertion. The associated panic, removal of the regulator and the need to surface rapidly, were frequent observations preceding the death

Fins (13%)

In 13 cases there was an absence or loss of one or both fins. In 3 there was definite misuse, in that fins were not worn or were excessive in boot size, and were therefore lost. In another 10 cases one or both fins were lost. Whether this was cause or effect of the accident is not known.

The loss of one or both fins (13%) was a difficult problem to evaluate, as a cause or an effect of the accident. The frequency of the observation in this series was surprising and did cause concern to us. Presumably very active leg movements, such as during panic and swimming in strong currents, would be more likely to displace fins.

Fins must be retained if a current has to be negotiated. Fins are are also necessary if the diver is negatively buoyant and trying to remain on the surface. Divers over-weighted "to get down" are especially vulnerable to this dependency on fins to ascend or remain on the surface.

Buoyancy compensator (12%)

In 8 cases there was a malfunction of the buoyancy compensator (BC). In 6, two of which were also included in the previous eight, there was a misuse of the BC. The misuse involved such actions as gross over-inflation, producing the Poseidon missile type ascent, or mistaking an emergency CO_2 cord for the dump valve cord. In 2% the feed hoses were not connected to the BC. The faults included failures in the performance of the equipment, especially with the inflator mechanisms.

The buoyancy problems related to technique were described in part one of this report.[1] These greatly exceeded the frequency with which the BC malfunctioned or was misused. It is evident that the BC is a major contributor to diving accidents, as technique problems with the BC were present in 52% and malfunction or misuse in 12%, even allowing for some overlap.

The problems with buoyancy compensators highlighted the observation that using safety equipment can itself cause problems.[2-4] Unfortunately it is not known, for comparison, how many divers have been saved by the use of this safety apparatus. These figures, cannot therefore, be used to denigrate the use of the BC, but could be used to encourage more robust equipment and better training in buoyancy control.

Scuba cylinder (9%)

In each of these cases there was no actual fault in the equipment, but it was either inappropriately chosen or was misused in some other way. The following analysis was made:

Cylinder too small (28-42 cu ft)	3
Low air fills	3
Valve not turned on	2
Removed inappropriately	1

The scuba cylinder contributed to a low-on-air situation in each of these cases, by the victim using either a cylinder smaller than normal or a cylinder with less than customary air pressure. Most of the 9 divers had contents gauges.

In the case of the small cylinder, not only was there less air supply than that available to the other divers, but when the low-on-air situation developed the actual amount of reserve air was much less than usual. In some of the cylinders, holding only 28 cu ft, there was only a few breaths of air available once the low-on-air situation was reached at depth.

Harness (6%)

In 4 cases there was a contributing fault (not permitting release or not retaining equipment) and in 3 there was misuse in the wearing of the harness, such as wearing it over the weight belt. The result was an entrapment which either contributed to the accident or prevented rescue.

Mask (5%)

In 2 cases there was a fault in the equipment and in 3 there was misuse.

Problems with masks contribute to panic. One mask was designed to inflate a space around the ear (as the diver had a chronic tympanic perforation), but was unable to be cleared of water. Others broke or leaked to an unacceptable degree.

Protective suit (5%)

In 4 cases the suit was considered to be so tight as to have caused problems for the diver, either in restricting respiration or in causing panic, and there was one instance of the carotid sinus syndrome.

Lines (4%)

In 3 cases there was clearly misuse, and in one there was a fault. The result was entanglement.

J Valve (2%) **and Contents gauge** (2%)

These were rare contributors, but problems were encountered both from faults in performance and explosive “blow-outs”.

Absence of equipment (6%)

In some other instances, not counted above as equipment misuse or failure, there were situations in which equipment should have been worn and if it had, may have helped to prevent the fatality. The following is certainly an underestimate, as negative data was not recorded as reliably as positive:

Absent equipment	**%**
Buoyancy compensator	2
Snorkel	2
Compass	1
Wet suit	1

Other equipment

Problems with weights and weight belts were also represented in our earlier report[1], showing the difficulties due to human judgement such as overweighting (45%), failure to ditch weights (40%) and the belt being fouled or unreleasable (6%).

It was impossible to determine the incidence of problems with snorkels. These were not at all well documented in the case reports, even though there was some indirect evidence of these as 8% died while snorkelling on the surface. It was not possible to determine whether these could be attributed to the snorkel design or misuse, or even whether this was a major contributor.

There were many other instances in which equipment was not used but could have been considered of possible value to the diver, but in which one would be hesitant to label as contributing to the death.

Discussion

The analysis of some equipment problems due to incorrect technique, was referred to in the first report.[1] Thus the problems with air supply have been previously recorded. The misuse of weight belts and many of the problems with buoyancy that were clearly errors of judgement, have also been recorded in that paper.

It is important to realise the difference between these figures and those given in the United States by the NUADC[5,6] and Australia by Project Sticky Beak.[7] In this ANZ series only when equipment fault or misuse actively contributed to the death was it recorded. Problems with diving equipment are reviewed elsewhere.[8,9] There are many other problems that are experienced in the field that are not evident in this series. An example is the diving computer, which was not commonly used during most of the period under discussion, but which has contributed to many problems since.

The reassurances given by the diving industry, regarding the reliability and sophistication of our current equipment, are possibly not correct. In many instances the misuse of equipment could be, at least partly, the responsibility of the equipment designers and at other times purely the responsibility of the diver himself.

When the equipment problems and misuse are combined with the fatalities related to equipment related techniques[1] (out of air situations, overweighting, buoyancy control, etc.), it is evident that more attention should be given to diving training and to training in the use of diving equipment.

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WHAT PRICE TASMANIAN SCALLOPS?

A report of morbidity and mortality associated with the scallop diving season in Tasmania 1990.

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Introduction

The D'Entrecasteaux Channel is a narrow strip of water lying between Tasmania's southeast coastline and Bruny Island. It is a natural breeding ground for many forms of fish life, especially the famous Tasmanian scallop. Prior to 1969 the channel was heavily harvested for scallops by commercial fishermen using dredges. Divers could also collect scallops, but as it was dangerous to dive close to the dredging operations so this was only performed to a limited degree. In 1969 the area was closed because of the enormous damage to the sea bottom caused by dredging, which removes the top layer of sand and all weed and marine life. After a period of recuperation, the channel was reopened in 1982 and for three years was heavily dredged, before it was again closed to scallop fishing in 1985.