SPUMS JOURNAL
South Pacific Underwater Medicine Society
1983: No. 4 JULY TO SEPTEMBER

CONTENTS

DISCLAIMER

All opinions expressed are given in good faith and in all cases represent the views of the writer and are not necessarily representative of the policy of SPUMS

Registered by Australia Post
Publication Number VBH 3527

PRINTED BY: UNIVERSAL COPY SERVICE,
108 QUEEN STREET, MELBOURNE 3000

OFFICE BEARERS

EDITORIAL

The recent tragic death of five divers in an explosion on a drilling rig in the Norwegian sector of the North Sea is indicative of the ever present potential for disaster in association with diving activities. Apparently the flange locking device between the bell and the deck decompression chamber failed, the resultant explosion saw the bell take off like a defeating balloon, emptying out its occupants, as it depressurised. That the disaster occurred in the North Sea is somewhat unjust, because it is there that the greatest interest in diving safety has been shown. In fact the accident patterns of other areas of Commercial Diving activities are unknown as neither the employers nor the employees deem it useful to make public accountability their policy. The sobering fact is that complete safety is impossible but the knowledge that risks are greatly reduced when the critical facts are clearly known and used to govern future behaviour encouraged the UK and Norwegian Diving Inspectorates to introduce strict controls on the health and skill standard of ALL divers operating in their spheres of control. These controls (Diving Safety Memorandum No 6/1981) are having a beneficial effect on diving around the world, for any diver with pretensions to hit the big time must now have documentation to prove his medical fitness and a valid certificate of training. No photocopies accepted!

In line with these requirements it is proposed to commence an "approved course" of training in Australia. Parts of the Draft Standard of Training and Certification of Divers appear in this issue. Readers are urged to obtain a copy of the draft standards from the Standards Association of Australia, read it critically and submit their written suggestions for improvements. There are only a few internationally approved training schools for divers and the establishment of one in Australia would be of great value to Australian divers wishing to work in Europe, and ultimately for the major companies around the world.

At a somewhat lower level in the diving "pecking order" come those professionals who undertake to train others or to oversee and supply equipment to recreational divers. The continued development of the instructor organisations in Australia will ultimately reduce the risk of untrained persons scuba diving, but only at the cost of ongoing self regulation of their members. The pull of the easy buck will always be there, here no less than overseas. It is for this reason that publicity be given to the focus of "she'll be right" laissez faire on the Barrier Reef. (The editor is aware that the instructor organisation in a position to act is in fact acting). For the problem will continue to recur unless awareness of the potential dangers of such practices is hammered home. As exemplified by people's recurring commitment to perpetual motion machines and hyperventilation before breathhold diving, there is always going to be some "smart" person who can see the benefits but who refuses to see the catches.

The Committee send greetings for the Christmas season and hopes of safe diving to all members. May all your incidents be little ones.

NOTES TO CORRESPONDENTS AND AUTHORS

Please type all correspondence, in double spacing and only on one side of the paper, and be certain to give your name and address even though they may not be for publication.

Authors are requested to be considerate of the limited facilities for the redrawing of tables, graphs or illustrations and should provide these in a presentation suitable for photo-reduction direct. Books, journals, notices or symposia etc., will be given consideration for notice in this journal.

PERSONAL VIEW
THE CLOGS-TO-CLOGS SYNDROME AMONG BARRIER REEF DIVING PROVIDERS

Douglas Walker

When the general public was first made aware of the existence of that very special breed of men the naval "Frogmen", there was an immediate and correct understanding that such activities were dangerous. However the introduction of the Cousteau-Gagnan reducing valve after World War 2 made the Aqualung a simple to use and seemingly safe alternative to the use of oxygen rebreathing units, where Oxygen Pete was only one of the dangers. Adventurous, physically hardy, youthful swimmers of many maritime nations quickly developed an interest in both breathhold and compressed air diving once this new and unexplored world was made known to them. These activities were dangerous and uncomfortable, equipment was self made or obtainable only with difficulty, and the small numbers initially involved fostered a great camaraderie. Information and advice was shared. As numbers involved increased and equipment was both improved and made readily available, many were able to enter into scuba diving without the testing phase of spearfishing off rocks which taught a proper respect for the sea. It became possible to literally "jump in at the deep end". Not all survived the problems they encountered. It was soon accepted that instruction would add to safety and increasingly fatalities were noted to occur almost solely among those who were untrained and inexperienced.

By early 1954 at least one Sydney dive shop noted that customers who bought a Porpoise scuba unit were given a book of instruction, and in the December issue of the Australian Skindiving and Spearfishing Digest the shop was offering "personal instruction" to their customers, a service anticipated by another store earlier in that year. Articles were published in which both instruction and the need for a medical assessment were noted, a theme repeated over subsequent years. In 1955 the Underwater Research Group (URG) Sydney were already involved in offering instruction to their novice scuba diver members, providing club equipment on occasion. Later the URG undertook carefully supervised experimental deep diving, both breath-hold and scuba, till warned of the dangers by the RAN.

It was not until the 1970's that public opinion reached the stage where novices acted as if seeking instruction was the reasonable thing to do, not a sign of timidity. They also ceased to regard the wearing of buoyancy aids as "sissy". A few even followed buddy diving principles! There was a developing realisation of the need to have some sort of guarantee of the worth of the instructor additional to his personal belief in his own capabilities. The growth of the several instructor organisations, with their examination of applicants before granting membership, followed this shift in public attitudes to scuba diving, a belief that with correct training one need come to no harm. Maturity had come to Scuba diving, it was no longer "sold" as a danger sport but as a means to reach the wonders of the underwater world.

The very achievement of high safety factors in modern equipment has had some inevitable disadvantages. Some no longer believe that dangers still lie in wait capable of rapidly changing a pleasant and interesting experience into a short trip with a fatal conclusion. The rapidity with which death can occur in water allows little margin of safety should misadventure occur. Here it is that training and experience is lifesaving. Naturally some are put at risk through the peer-pressure situation giving them no face-saving let out. Ray Barrett has admirably described just such a situation. "I arrived on the set to shoot an underwater scene in *The Troubleshooters* and asked 'where's the stuntman?' and they said 'You're it.' I was given some instruction by a naval frogman with a thick cockney accent. 'Nah 'ere are your tanks, sir, strap 'em on dahn right, 'ere is your dee-mand valve, and you will bite on this and breath through you mouth because you can't breath through your nose, har, har, An' remember you 'ave got to ex'ale when you come up to the surface. Ex'ale. Otherwise you'll blow yer lungs. Awright, nah get in and 'ave a go.'"

As readers will be aware, Ray Barrett survived this "lesson" and the diving. So do most others who similarly receive little or no instruction, thanks to the excellence of the equipment and the element of good luck which so often protects us from our own foolishness. But it is not an approach favoured by insurance companies, coroners, nor by the family left behind. It is not much praised, either, by other divers who catch the odium when another diver kills himself. Yet it is an approach which seems to have appeal to resort dive shop proprietors around the world, and now it has reached our shores. "Only" one fatality has been recorded so far from the day-trip-and-dive packages available to all comers to some areas of the reef, and available to more unless a fatality, or greater caution, eventuates. Hopefully the latter.

It will be tragic if the excellent safety record of present day scuba diving, for which the instructor organisations can take much credit, is to be thrown away for the sake of a short term commercial gimmick. There is surely no place for any diver, let alone a certificated instructor, taking more than one (or even one?) complete novice into open water using scuba however calm, warm and clear the water may be.

There is a saying in Lancashire which encapsulates a shrewd observation of human behaviour and seems apposite to this situation. "Clogs to clogs in three generations". This can be translated as describing how the first generation works hard, long, and often unglamourously to achieve success, the next is close enough to the founder to understand and appreciate the effort they were not required to make. This generation seeks to maintain and build on the achievements, but the third generation has no understanding of how the results were achieved or appreciation of how easily they may be lost. Often the founder generation is ridiculed for its rough simplicity, or even thought "square" and old fashioned. The family group/organisation is now ripe for disaster. Hopefully those involved in diving will realise in time that it is not merely an in-water commercial enterprise. Otherwise the insurance companies, law courts and the coroner will soon remind them.

FOR ONLY $15 I NEARLY DROWNED

A report to Project Stickybeak

My wife and I went on a day trip to a reef this Easter. The organisers of the cruise offered their customers the opportunity to make a scuba dive from the beach of the reef island as an extra experience for the payment of an additional $15. Before deciding to take up this offer I had a conversation with the crew member who was in charge of the scuba diving facilities, a person who stated that he held a master's certificate with a major diving organisation overseas.

Q. Tell me about this scuba diving. I thought you had to spend a lot of time at the bottom of swimming pools before you tried it.

A. There are two ways of doing it. Either you can, as you say, go to one of the diving schools and pay some (I thought he said $200) dollars and learn in swimming pools. It will take you a week and you will get a certificate and after that you'll know a bit about the equipment and how to use it. Or you can do it under personal supervision. You'll actually be able to see the coral. You won't know anything about scuba diving when you've finished, but it'll only cost you $15.

He then gave a brief run down of how the pressure in the oxygen tank was reduced by the use of valves and how the mouthpiece worked. He said the aim was to achieve negative buoyancy in the water so that in motion one neither rose nor sank. He said he would achieve this for us by adjusting a valve which increased or reduced the air in the vest. He said, "You can forget all about that because I'll do it. All you have to remember is four basic rules. First, keep breathing normally. If you are used to snorkelling there can be a tendency to hold your breath. Don't do that. Second, you must equalise the pressure in your ears. At depth your eardrums bow inwards. The mask has a nose piece, press in on each nostril using a finger from each hand and breath out. If you use only one hand you could interfere with the breathing apparatus. Third, you must learn some simple hand signals. (He demonstrated them). Fourth, and most important, you must keep in sight with me. I had three young men with me yesterday and they kept going off on their own. You <u>must</u> keep with me, check every 30 seconds."

He then explained that he would give me the opportunity of trying out the kit in shallow water so that I could be sure I was comfortable in it before we started. He then dealt with some administrative matters and asked me to sign a document with a liability clause "just to make it clear that you'll keep up and do as we ask you" - a description of the purport of the disclaimer of liability (which I took the trouble to read) which seems wholly inadequate.

The weather, when we were put ashore, was squally, by which I mean there was a stiff breeze, the sea was choppy, and periods of sunshine rapidly alternated with heavy rain. To be wet and in the wind was unpleasant.

Our instructor/dive leader had brand new scuba equipment with him that day he told us. In the shallow water he fitted up, or assisted to do so, those who were to dive with him. In our group there were four people beside the instructor. One young man who had been trained in the USA, two young women who were novices but who, I believe, may have dived before, and myself, a complete novice. One of the girls, the young man and I were fitted up with independent equipment. The other girl was to dive with the instructor using a spare mouthpiece on this equipment. I was fitted with weights and with the jacket to which the oxygen cylinder was attached. It seems ridiculous now, but he neither told me nor did I enquire or experiment to see how you divested yourself of this equipment. I put on the mask and he told me to swim around in the shallow water to get accustomed to it. I did so and found it all quite easy and comfortable though I detected a slight tendency to turn over on my back with the weight of the cylinder. The instructor said he would correct this by adjusting the valve of my jacket when we were in the water. I noticed the visibility in the water was very poor but thought it might improve in deeper water away from the sandy shore. Indeed, I pointed this out to him when he gave us his final admonishment to keep together, asking him not to go too fast. He replied that if anyone did get lost, that person should go to the surface and look for his bubbles, and failing that he also would surface and make contact.

We started our dive at about 11.15 am. We all kept close together, our instructor leading with the two girls, the other man and myself following. I would say visibility was 5 or 6 feet. For example, with my head more or less on the flippers of the person in front (indeed sometimes colliding) I could not see much beyond the waist of that person. I became rapidly and disconcertedly aware that keeping together was not going to be easy. Indeed I was so intent on keeping the party in view that we must have been into the coral for a couple of minutes before I even moved my eyes off the person in front sufficiently to notice that we were in coral. From time to time our instructor came to check with me, using hand signals, that I was OK. He noticed that when we dived down I was having some difficulty in getting down with the others. He made adjustment to my vest and I noticed that thereafter it was much easier to go down.

Shortly after this adjustment had been made we made a further descent and I found myself under the others actually among the coral and on the bottom on some sharpish rocks. I looked away from the others for just so long as was necessary to see where I was and to position my hands to push myself off the bottom. It could not have been more than 3 seconds. When I looked for them again they were gone. I was not unduly perturbed at first, I went as fast as I could after them in what I thought was the direction they had gone, knowing they must be very near, but to no avail. After about 30 seconds, I decided to go up to the surface and wait for the instructor to contact me as arranged.

When I reached the surface, it seemed to me I was in the middle of nowhere. I was so weighted down with lead and the scuba equipment itself that it was quite an effort to tread water. I could not, indeed, see the shore in any direction and the surface was so choppy that the idea of looking for the bubble stream was just ridiculous. However, as I was confident that the instructor would soon appear I was not much concerned. I rapidly became so, however, when what seemed to me a long time (though I doubt it was more than three minutes or so) passed without a sign of him. The point was that I am not a strong swimmer and the effort of treading water with the weight on me was rapidly exhausting me. Of course, with hindsight, my real situation was not too bad. If I had resumed surface swimming I would presumably still have been visible to him without having to exhaust myself by treading water. In my anxiety to see him the moment he surfaced, this solution did not occur to me.

After a couple of minutes or so more had elapsed, I began to pant. I could not breath quickly enough through the mouthpiece so I let it go. I swallowed a lot of water. I tried to find my mouthpiece again, for a few seconds I couldn't locate it since either by reason of the wind or the newness of the equipment it was stuck out at right angles to my mouth. That was the moment I began to panic. I began to sink again, and my efforts to tread water were becoming more frenetic, more exhausting, and my need for air more difficult to satisfy through the mouthpiece.

It was then I saw the boat we had come on. It must have been directly behind me. It seemed to be about 80 yards away. I saw the skipper on deck and shouted to him for help more than once. Each occasion led to my swallowing more water. I hoped he would come in the tender to get me or direct the instructor to where I was, assuming that he had come to the surface and could not see me. When neither of these things happened I thought I was going to drown.

At this stage my ability to tread water was failing rapidly. My head would sink below the waves frequently and trigger a desperate reaction which would push me again, but only momentarily, above them. I had altogether stopped thinking rationally. It seemed to me I had no hope of making the boat on my own but the skipper seemed to be expecting me to try. When I began to do so I was agreeably surprised how much progress I made. The combined effect of flippers and not having to support the dead weight of the equipment made all the difference. To my surprise and relief I was able to reach the anchor rope. I hung on to it for a long time before I had recovered sufficiently to move the few yards to the side of the boat where the ladder was. I did not have the strength to climb the ladder with the equipment on me so the skipper removed it from me and eventually I gained the deck. I sat on the boat for about half an hour before I felt strong enough to get into the tender and go on shore to see my wife. I felt very tired and shocked for several hours thereafter. I felt nauseous for quite a time but I did not actually vomit.

I wanted to see what the instructor would do when we all returned to the boat. He avoided my gaze and never spoke to me even though I was sitting in the cabin when he came down to get his lunch. I figured he was embarrassed. Eventually when I was still sitting in the cabin he came down and I stopped him as he walked past me. I asked to have a word with him when we got on shore. He said "What about now?". I said I didn't want to shout to make myself heard above the engines.

Shortly before we reached the shore he came asking me for the money for the diving. I considered this barefaced gall and told him publicly and angrily that I did not pay people for the privilege of near drowning and that I did not consider it had been safe to take out at least three novices or inexperienced divers in conditions of such poor visibility. He answered that he had stressed the importance of keeping up with him and that the others had no difficulty in doing so. This remark annoyed me even more partly because of its irrelevance but mainly because of its implication that I had disregarded his warnings in an irresponsible fashion and gone off on some frolic of my own. I told him that I also considered it was an unsafe practice not to show novices how to inflate their vests in an emergency such as I found myself in.

He went ashore in the first tender load and was nowhere to be seen when my wife and I followed on the second tender load. The next morning I went down to see him because I wanted a calmer conversation with him. This we had. He said he had discussed the incident with his employers and they did not consider anything unsafe had occurred. He added that he had been taking people scuba diving in like manner for some 14 months without anything untoward occurring. I particularly taxed him with why he had not come up to find me after I got lost. He said he had come up three times but been unable to find me. A fourth time he had had a signal from the skipper that I was alright. He also made what I consider to be a very revealing remark, "Don't forget I had two other people to look after down there". I told him that I considered the diving practices to which I had been subjected were dangerous. If anything were to happen to someone else such as had happened to me the outcome could be tragic and I would not want it on my conscience that I had done nothing to warn whoever there might be who could order, promote or encourage changes in these practices.

The specific dangerous practices to which I refer seem to me to be as follows:-

(1) The safety of scuba diving novices under supervision must depend upon really effective supervision. Whereas that might be possible in clear visibility it was manifestly not possible in the poor visibility conditions that prevailed that day. It is also questionable whether 3 novices can be adequately supervised at one time even in relatively good visibility.

(2) Because supervision is relied upon for safety there is no adequate instruction on what to do in an emergency. In choppy conditions such as prevailed that day it is clear that one diver on the surface is not visible to another. Divers should be clearly instructed on how to inflate their vests and told that they are in effect life vests.

(3) It would be a safety factor if there was someone in a boat on the surface, keeping a lookout while diving is going on. As it was, I believe I would have drowned if the boat had not been moored where it was and that was fortuitous, not part of the safety system for the diving.

EDITOR:
This report has been reproduced in its entirety because it highlights the dangers of the prevailing, and likely to increase, availability of such "supervised" scuba diving opportunities offered to chance visitors to the Barrier Reef. The only changes made have been the removal of identifying details. Case SC/81/2 (Provisional Report Project Stickybeak, SPUMS J. Oct-Dec 1982) documents a fatality occurring under similar circumstances.

PROJECT STICKYBEAK

This project is an ongoing investigation seeking to document all types and severities of diving related incidents. Information, all of which is treated as being CONFIDENTIAL in regards to identifying details, is utilised in reports and case reports on non-fatal cases. Such reports can be freely used by any interested person or organization to increase diving safety through better awareness of critical factors. Information may be sent (in confidence) to:

Dr D Walker
PO Box 120
Narrabeen NSW 2101

UNUSUAL INCIDENTS FROM THE PAST

Number 4, 1962

Sharks had not read his book

Terracina (Italy) - A man who wrote a book called "My Friend, the Shark", died late yesterday after a shark had attacked him.

He was Maurizio Sarra, an underwater photographer.

The attack on Sarra was one of the few recorded instances in Italy of a shark attack on a human.

He had been taking underwater pictures for years.

He was taking some pictures of a rare species of fish off the coast in the Tyrrhenian Sea when he was attacked yesterday.

Australian Skindivers Magazine. October-November 1962

LETTERS TO THE EDITOR

Dear Sir,

I have been re-reading the Stickybeak Report on the 1981 fatalities and one case (SC 81/2) has a familiar ring about it, as it brings to mind a conversation I had with a kid at a school where I teach. The boy in question is 14 years old and of sub-normal intellect (IQ <85). He went on a trip to Queensland with his older brother (20 years old) during the school holidays last year, to the Whitsunday group area. While on a boat trip they found the package deal included a scuba dive on a reef.

Scuba units were rigged for them. No BCs were provided. No one asked him if he could swim, but fortunately he swims quite well.

I asked about pre-dive briefing, expecting to be told about warnings re barotrauma, breathing normally, clearing ears, buddy system, etc. NONE of the list was covered! The only instruction was to stay in sight of the anchor line. I asked about supervision; there were at least ten apparent novices in the water with one dive leader. He did not remember any problems and, needless to say, thoroughly enjoyed the dive.

Such "quickie dives" are very popular in the Whitsunday area. I fear they will feature in future annual reports of fatalities.

(name supplied)

Dr CG Macfarlane,
Bass Strait Medical Services
281 Main Street,
Bairnsdale VIC 3875.

Dear Sir,

The Standards Association of Australia, Committee SF17 "Work in Compressed Air", is about to release for public comment the draft of the standard on Diver Certification of competence and fitness.

Certification of fitness currently may be made by any registered practitioner. Submissions to the Committee have demonstrated many examples of complete lack of understanding of the nature of the diving industry and its requirements. This can obviously jeopardise the life of the applicant, and perhaps others, and the Committee has found the present situation unacceptable.

There is no recognised post-graduate qualification in diving or hyperbaric medicine in Australia, and there is no suitable regulatory mechanism.

Committee SF17 has therefore suggested that Certification of fitness of commercial divers be accepted only from doctors approved by the Health and Safety Executive of the United Kingdom.

Such approval is gained by demonstrating competence in diving medicine and the usual method is proof of attendance at an approved diving medicine course, eg. the Shell-Comex Course at Marseilles in 1982. Ex-Navy diving physicians will be automatically approved.

Such a mechanism of establishing an approval panel of diving practitioners has several advantages.

1. It prevents the "grandfather" problem which so often bedevils the genesis of fledgling professional groups.

2. No new bureaucracy is required.

3. Approval by the HSE is rapid, efficient and without cost.

4. Approval will enable identification of those practitioners with a significant involvement in the commercial diving industry and improve communication between them.

5. The Health and Safety Executive encourage applications from foreign practitioners in the interests of reciprocity and communication.

Committee SF17 has called for comment on this proposed mechanism of certification. Such comment should be forwarded to me to tender to the Committee.

Geoff Macfarlane

NEW ZEALAND MEETING

4 Dodson Avenue
Milford 9 New Zealand

Dear Sir,

You will be pleased to know that in conjunction with the North Shore Medical Association dive we have held the inaugural SPUMS Meeting at the Paihia Autolodge in the Bay of islands. I gathered together sixteen diving doctors, many of whom are members of SPUMS and we had a most enjoyable weekend staying at the Paihia Autolodge and travelling on a 36 foot catamaran dive boat, the Top Cat, to first the Cavalli Islands on Saturday, and Deep Cove on Sunday.

On Saturday night we had a clinical meeting, well lubricated, in true SPUMS style. The speakers were Tony Slark, discussing local facilities available for treatment of diving accident victims; Alan Adair, hypothermia and diving accidents; Rob Stevens, diving as an antidepressant; and Simon Cotton, the diving environment. Rob Stevens discussed and showed pictures of diving at Raoul Island, while Simon Cotton showed pictures of diving with Sir Edmund Hillary in Fiji and diving in the Milford Sound. The clinical element lasted an hour and a half and was followed by our inaugural SPUMS dinner.

The first North Shore Medical Association dive was arranged by Warren Paykel and Rob Stevens two years ago and we had a day trip to the Mokahinau Islands. On that occasion there was no clinical element, but now we have introduced a clinical element we feel that asking for affiliation with SPUMS to be appropriate. Those doctors taking part were Tony Slark, Rob Stevens, Rex Brown, Robin Hardwick-Smith, John Chapman-Smith, Harold Coup, Alan Adair, Tom Marshall, Roger Peak, Julian Roberts, Simon Cotton, Warren Paykel, Ron Glennie, Bill Baber. It is our plan to make this diving weekend an annual event and would ask for the Society's blessing.

Alan Sutherland

Found in the Editor's mailbag:

WHICH ARE YOU?

Are you the *Active Member,*
The kind that would be missed,
Or are you just *contented*
Your name is on the list?
Do *you* attend the *meetings*,
And mingle with the flock,
Or do you stay at home,
And *criticise* and *knock*?
Do you take an *active part*
To help the work along,
Or are you *satisfied* to be
The kind that just belong?
Do you push the *Cause* along,
And make things really tick,
Or leave the work to *just a few*,
And talk about the "Clique"?
Think this over, Member,
You know the Right from Wrong ...
Are YOU an Active Member,
Or do you just belong?
... ANON.

SEE YOU AT THE NEXT MEETING. GOOD DIVING ONE AND ALL.

FROM DAN TO DAN AND CDC TO C OF O

Slipped inconspicuously into the pages of the most recent issue of TRIAGE, the newsletter of the National Association of Diver Medical Technicians (NADMT), is the announcement that the Diving Accident Network is now to be called the Diving Alert Network and that the Commercial Diving Centre (CDC) has gone upmarket in title and is now the College of Oceaneering (in Los Angeles). These changes signal the rapid growth in acceptance of the value of the reporting of diving-related problems (DAN) and the spurt in acceptance of the valuable role awaiting diver medical technicians. The CDC was in the forefront of designing and running courses for divers anxious to upgrade their medical skills, in the days when there was social value but little if any cash reward for their graduates. Readers of TRIAGE are now becoming aware of the promise of great things from this newsletter, the Editor (Dick Clarke) having excellent contacts among the ranks of those involved in the medical world of commercial diving: and he knows how to get them to contribute valuable articles.

SPUMS SCIENTIFIC MEETING 1983

SEA SNAKE ENVENOMATION

Chris Acott

On my first dive in the central Queensland area I noticed a very large sea snake swimming between my legs. Unfortunately I had not been warned about the sea snake population in the area.

SEA SNAKES

Physiology

Sea snakes are recognised by their flattened paddle-like tails. They grow to variable lengths, some can be more than 2 metres long.

They are mainly fish eaters, and are usually bottom feeders. However, the Pelarmis platurus is pelagic (ie. a surface feeder). They are preyed upon by sea eagles, sharks (especially the Tiger shark) and even by seals.

Lacking the ability to regulate their own body temperature, they are often found sunning themselves on the surface. This will only elevate their body temperature slightly. They cannot breed or survive in water below 20°C, hence their distribution in tropical and sub-tropical waters.

They can excrete only hypotonic or isotonic urine as their kidneys lack the ability to concentrate it. Their skin is impermeable to salt. A salt gland is located at the base of the tongue. It secretes salt into the mouth which is washed away.

They have one lung which extends backwards into the abdominal cavity. This lung is divided into 3 sections. The 2 front parts are rich in blood vessels, while the posterior section is not functional as a gas exchanger but as an air storage organ. They are capable of diving to depths of 100 metres. Their maximal submergence (voluntary) time is 2 hours. However they usually dive to 20-40 metres and stay submerged for 60-90 minutes. Anaerobic metabolism is only used in emergency situations. Upon surfacing the operculum covering the nostrils opens and allows the reptile to breathe. They usually take only one breath at the surface and then dive again.

Sea snakes have a breathing tachycardia and not an apnoeic diving bradycardia. The sea snake is normally bradycardic. An increase in the pulse rate is seen as the animal surfaces. The breathing tachycardia increases the perfusion of the lung during ventilation. This tachycardia has been noted to begin 15 seconds before the animal surfaces and starts to breathe. It is not semantics to talk of a breathing tachycardia or an apnoeic diving bradycardia. A diving bradycardia husbands oxygen for the vital organs.

The sea snake's skin is also unique. It has a respiratory function. Not only is a third of the snake's oxygen requirement taken up during a dive via the skin, but carbon dioxide and nitrogen are eliminated. Most of the CO_2 produced during a dive is eliminated via the skin and not during expiration at the surface.

The cardiovascular system is also very interesting. They only have one ventricle which is incompletely divided. During a dive there is an increase in the pulmonary vascular resistance. This increases their right to left shunt. Hence blood is shunted away from the pulmonary bed to the skin. This decreases nitrogen uptake and increases nitrogen excretion. In this way they avoid decompression sickness.

Evolution

The evolution of the sea snakes is interesting and still clouded in uncertainty. The Elapidae, the most significant group of land snakes, have given rise to marine forms on two different occasions. These are the Laticaudiae (sea kraits) and the Hydrophilae (true sea snakes). Both are venomous to man.

The sea kraits lay their eggs on the shore, and also rest in crevices amongst rocks on land. Their nostrils are placed laterally and they have broad overlapping ventral (belly) scales which allow land movement.

The Hydrophilae, however, are purely aquatic. They lay their eggs at sea. They have central nostrils covered by an operculum. They have poor land locomotion because they lack the ventral scales.

There are other aquatic snakes, however these occur in fresh or brackish water, are not fully marine and are generally not venomous.

The strong evolutionary links between the Tiger snake and the Hydrophilae are important especially when considering which antivenom to use. This is discussed later. Tiger snakes are nearly always found near water, be it rivers, lakes or dams. Their front fangs are medium sized in comparison to their head size, which is very similar to the Hydrophilae.

Distribution

Distribution of the Hydrophilae (true sea snakes) is generally confined to tropical and sub-tropical regions of the Indian and Pacific areas. The most widely spread of all the species is the Pelarmis platurus (yellow bellied sea snake).

Local distribution of a particular species around any reef is patchy, and is probably due to seasonal shifts which determine winds, currents and food supplies.

Normally sea snakes inhabit sea water, usually around estuaries, especially in the rainy season. However they can live in fresh water and captured ones have been kept alive in tap water. Some species of Enhydrina schistosa have been found in fresh water lakes of Cambodia, while other species have been found in fresh water in the Philippines.

Attacks on man

Statistics of attacks and their subsequent fatal or non fatal outcome are difficult to obtain. There are probably thousands of attacks each year, usually against fishermen in South East Asia. Superstition there forbids anyone talking about attacks. Both Reid (in Malaya) and Barme (in Vietnam) found that once bitten, the victim disappeared and it was impossible to learn from his companions what became of him. Apparently it is believed that the King of Snakes and the Genie of the Sea rule the sea snakes. Anybody who talked about attacks or the victims was liable for reprisals from one of the king's other subjects.

Contrary to public opinion, there have probably been two deaths in Australia from sea snake envenomation. My reference here is Prof H Heatwole, who has made an extensive study of Australian sea snakes.

Generally sea snakes from non-reef habitats are aggressive and responsible for many human deaths. These attacks occur against fishermen who handle the snakes that have been caught in their nets.

In contrast the species from the Australian reefs are relatively inoffensive and only very rarely attack when provoked. Catching, restraining or striking them may convert curious behaviour into an aggressive attack. Stay clear when they are feeding, or if you see them swimming in pairs, as this usually indicates that they may be mating. Treat them with respect and handle them gently if you have to. Commonsense often prevents trauma, both to you and to the snake.

The Bite

The bite is usually painless. Victims hardly realize that they have been bitten. At the most they may feel a sting. There is no local swelling, ecchymosis or abnormal bleeding. My patient noticed a slight sting. However, rarely, some victims may develop some hypaesthesia, then localized anaesthesia and numbness spreading to adjacent areas.

Defensive bites rarely release venom. Large amounts of venom may be milked from the snake shortly afterwards. In the envenomating bite most venom appears to be released at the first bite, very little on the second, and none on the third. However, the Astrotia stokesii (Stoke's sea snake) can inject large amounts of venom in each of 7 successive attacks. After their venom stores have been depleted it take 7 days for them to be replenished.

Sea snakes can open their jaws wide enough to inflict a good bite. Their fangs are fixed, usually of small size and are hidden in folds of mucous membrane. The fangs are fragile and often break off and remain in the wound. The fangs are not usually long enough to penetrate the average wet suit, except for Astrotia stokesii and Aipyrsus laevii.

Clinical Course

This can be very variable as these two cases from Queensland show.

On the Australia day holiday weekend 1983, a 19 year old youth noticed a stinging sensation on his left foot. He looked down and saw a sea snake wrapped around his ankle. From his description it was probably an Emydocephalus annulatus. There were no signs of envenomation when the first aid pressure bandage was removed.

In 1981 Dr H Mercer, a paediatrician at the Royal Brisbane Hospital, published a report in the Medical Journal of Australia of an incident in October 1979. A 2 year old girl started screaming while playing in the water at the beach of the central Queensland resort of Yeppoon which is 40 km from Rockhampton. Her mother noticed a snake wrapped around her daughter's left ankle. The snake then swam off towards two teenage boys, who later killed it and brought it to the Yeppoon hospital. Using her hands as a tourniquet around the child's calf the mother rushed her to the nearest ambulance station. At this stage the child was quite settled and was claiming that a snake had bitten her. The mother released her grip when she reached the ambulance station and within 30 seconds the child became drowsy and developed ptosis. While being rushed to Yeppoon hospital she began vomiting and respiratory distress became obvious. On arrival at Yeppoon hospital, 20 minutes after being bitten and 4 minutes after the onset of symptoms, the patient was unconscious, cyanosed and had tonic movements of her limbs. She required intubation 40 minutes after being bitten. There were multiple fang marks and serrated edge lacerations on her foot. The snake was identified as Astrotia stokesii. The child survived.

Reid pioneered the study of sea snake envenomation while working in Malaya in the 1950s and 1960s. Nearly all his work was with victims of the Enhydrina schistosa. He documented 101 cases and found that 68% of victims were not envenomated. This has subsequently been substantiated by other workers. Fifty per cent of the envenomated patients died, while the remaining victims took up to 2 months to recover. All fatalities were due to respiratory failure, renal failure and hyperkalaemia. Even after the antivenom was available patients still died, all from hyperkalaemia. The antivenom used was against the venom of Enhydrina schistosa. Reid found that the antivenom could be used up to 2 days following envenomation with a successful outcome.

Haemodialysis has also been successfully used in the management of envenomated victims. Sitprija et al in Thailand reported, "*The treatment with dialysis are comparable to those victims who received the specific antivenom. Haemodialysis appears to be a lifesaving procedure for sea snake poisoning and constitutes an alternative treatment, especially in hospitals where sea snake antivenom is not available. Venoms from all the Hydrophilae are not dialysable, their molecular weight being greater than 9,000, so one assumes that the hyperkalaemia was the main factor causing the muscular weakness and respiratory failure.*" Reading the reports showed the response was quite dramatic.

Reid developed a "2 hour rule". This differentiated envenomated cases into "serious" (or potentially fatal) and "non serious cases". This 2 hour rule still applies, however, it can only be applied to victims who have had no first aid measures, such as a pressure bandage and immobilization, performed. Once the measures have been discontinued, the 2 hour rule comes into effect. Serious envenomation was indicated by:- myalgic pains, especially in the neck muscles, trismus, prosis, opthalmoplegia, red-black urine (myoglobinuria), leucocytosis >20,000. It is interesting to note there is no mention of joint pain. The development of myoglobinuria was an important index of the expected morbidity. For each day of myoglobinuria there would be one week of illness.

In serious cases death would usually occur between 12-24 hours but it could occur as early as 8 hours or as late as 48 hours.

Reading the case histories shows how respiratory and ventilator care has advanced in the past 20 years.

SNAKE VENOMS

All snake venoms contain a diverse array of toxic substances which are only now being elucidated. They are all proteins. Short chained toxins consist of 60-62 amino acid residues. Medium length toxins consist of 66 amino acid residues. Long chain toxins consist of 71-74 amino acid residues. They are characterized by potent specific toxins which act on the victim usually at sites distant from the actual bite.

Broadly the venoms can contain:-

1. Neurotoxins
2. Myotoxins
3. Cardiotoxins. The role of cardiotoxins in envenomation by Australian snakes remains unresolved. Kellaway noted that the venoms of the Copperhead Red Bellied Black snake has a weak cardiotoxic action. The cardiotoxic properties irreversibly reduce the resting membrane potential. There is an increase in the QT interval. Some of the venoms cause the release of histamine SRS or indirectly cause their release by forming lysolecithin which in turn damages the cells causing the release of these substances.
4. Haematologically active components.
   a. Coagulation disturbances are caused either by the formation of autoprothrombin, formation of thrombin, or the formation of fibrin. Most Australian snakes cause the conversion of prothrombin to thrombin.
   b. Haemolysins. Some of the venoms have a strong haemolytic action (black snake) while some are weakly haemolytic (brown snakes). The action is either a direct one on the red blood cells or an indirect one converting lecithin to lysolecithin which then causes haemolysis.
5. Other enzymes that cause local damage, anticoagulation, the release of kinins, local tissue damage and necroses.

<u>Sea Snake Venoms</u>

Sea snake venoms are interesting. Fish and mice are susceptible, but the reef eel is not. Broadly they have either neurotoxic properties, or myolytic properties, or a combination of both. Usually one particular property dominates the clinical picture, from the neurotoxic properties of the Astrotia stokesii to the myolytic activity of the Enhydrina schistosia.

The lethal activity of 23 species sea snake venoms have been reported. There are probably about 50 different species of Hydrophilae. Nearly all the venoms act on neuromuscular transmission, the majority being post-synaptic. According to Professor Heatwole the following are the main species seen in Australian waters, Pelamis platurus, Astrotia stokesii, Emydocephalus annulatus, Aipyrsus laevis, Aipyrsus dudoisii. The venoms of Astrotia stokesii, Aipyrsus laevis and Pelamis platurus are all neurotoxic, while the venom of the Aipyrsus dubosii has not been studied extensively. Emydocephalus annulatus is not considered dangerous to man. Enhydrina schistosia venom has been extensively studied in different regions. It is possible that geographical variations in venom composition may occur. The Australian distribution of Enhydrina schistosia is uncertain. It is found from the Gulf of Iran through the waters of the Far East to as far south as Rockhampton.

Neurotoxins

These act at two sites.

1. Presynaptic. Typically cause a progressive-neuromuscular paralysis. This paralysis is preceded by a latent period. During this period spontaneous transmitter release is increased, as evidenced by an increase in miniature endplate potentials. At the time of paralysis there is a marked reduction in the number of vesicles due to hydrolytic phospholipase activity with a wide variation in the size and shape of the remaining vesicles. There is also damage to the mitochondria and other intracellular organelles storing calcium, thereby increasing the amount of free ionized calcium which decrease the amount available for synaptic transmission.

2. Post-synaptic. These toxins bind to and inhibit the function of the acetyl choline receptors. The rest of the molecule probably blocks many other receptor by its sheer size. No ultrastructural changes are produced.

Myolytic properties

Reid pioneered the work on sea snake venoms, particularly the venom of the Enhydrina schistosia. He found this caused muscle destruction, sometimes extensively, with the release of myoglobin causing myoglobinanaemia and myoglobinuria, which can lead to acute tubular necrosis.

ANTIVENOMS

Workers in 1967 found in vitro cross neutralization between the majority of land snake venoms and Enhydrina schistosia antivenom. Further work by Baxter and Gallichio demonstrated, in vitro, that Tiger snake antivenom was more effective than Enhydrina schistosia antivenom in the neutralization of the 9 species of sea snake venoms they tested. However, they found that it was not as effective in neutralizing the venoms from Enhydrina schistosia, Laticaudata semifasciata and Hydrophis major. One would not encounter these frequently in Australian waters. Baxter and Gallichio suggested where these species and Lapemis hardwickii are encountered Enhydrina schistosia antivenom is the antivenom of choice, while in other areas of the Pacific Tiger snake antivenom is preferable. However in vitro neutralization is more efficient than in vivo, and clinically the pattern seen is not always the one which is reflected by the in vitro results.

TREATMENT

First Aid

First aid measures are as for any other snake envenomation. Apply a pressure bandage and immobilize.

One wonders whether a wet suit would provide adequate pressure to prevent venom spread. Probably it would, but this has to be confirmed. A pressure bandage should be applied to the site as soon as possible. If the wet suit is to be removed, ensure that the affected area is kept immobilized and that the pressure bandage is continued up the limb, ie. cut the wet suit off. It appears that both pressure of at least 50 mm Hg, and immobilization are the important aspects of preventing venom spread.

Antivenoms

Dr S Sutherland recommends the use of CSL's Sea Snake Antivenom for the Australian region and if this is not available then Tiger snake antivenom. Failing this polyvalent antivenom could be used. CSL's Sea Snake Antivenom now contains both Tiger snake antivenom and Enhydrina schistosia antivenom. It is a refined pepsin digested immunoglobulin. Each ampoule contains 1000 units. The antivenom is obtained from horses that are immunized against both Enhydrina schistosia and Tiger snakes. The exact content of Tiger snake antivenom in the preparation is not known.

One has the choice of antivenom, either Sea Snake Antivenom, Tiger snake antivenom or the polyvalent antivenom. The polyvalent antivenom contains antivenom to all the Australian land snakes, and includes 3,000 units of Tiger snake antivenom. Antivenoms are not cheap. Sea snake (1,000 units) costs $99.87 per ampoule, Tiger snake (3,000 units) costs $18.87 and Polyvalent costs $200.00 per ampoule.

The initial dose recommended by CSL is 1,000 units of sea snake antivenom, the contents of one ampoule or 12,000 units of Tiger snake antivenom, the contents of 4 ampoules. The equivalent dose is 4 ampoules of polyvalent antivenom at a cost of $800.00!

Reid advocates that for seriously envenomated cases a stat dose of 3,000 units of sea snake antivenom be used. There may be a need to use up to 10,000 units. For non-serious cases he suggests 1,000 units stat and up to 3,000 units in all. I feel attention should be paid to his 2 hour rule, so I think the advice on the leaflet from CSL is a little misleading.

The cost involved for using 10,000 units of sea snake antivenom and its equivalent in Tiger snake or polyvalent antivenom is Sea snake $998.70, Tiger snake $754.80, polyvalent $8000. Polyvalent antivenom is a last resort, not only from the cost effective point of view, but there is considerable risk of delayed serum sickness from its use. In practice from my experience, when one is considering what antivenom to use one may be left with no other alternative than to use a combination of all of them. Experience is the best teacher, so now at the Rockhampton Base Hospital we keep between 6 and 10 ampoules of sea snake antivenom, and 12 ampoules of Tiger snake antivenom. This is considered enough to cover any emergency. However, other hospitals may not have the luxury of having so much sea snake antivenom available.

PUBLICATIONS CONSULTED

Barme, M. Venomous Sea Snakes. Venomous Animals and their venoms. Acad. Press. 1968, Vol. 1: 285-308.

Baxter and Gallichio H. Cross neutralization by Tiger snake antivenom and sea snake antivenom against several sea snakes. Toxicon. 1974; 12: 273-275.

CSL. Leaflet with Sea snake antivenom and Tiger snake antivenom.

Heatwole H. Sea snake Attack Myth or menace. Skin diving in Australia and New Zealand. 1978; 8(1): 40-45.

Heatwole, H. Sea Snakes. Oceans. 1979; 1(3): 126-131.

Heatwole, H. Seal predation on a sea snake. Herpeto Fauna. 1980; 11: 24.

Heatwole, H. Adaptations of Marine Snakes. American Scientist. Sept. 1978; 66: 594-604.

Heatwole H, Minton SA, Taylor R, Taylor, V. Underwater observation of sea snake behaviour. Records of the Australian Museum, 1978; 31(18): 737-761.

Heatwole H and Seymour R. Pulmonary and cutaneous oxygen uptake in sea snakes and File snakes. Comp. Biochemical Physiol. 1975; 51: 399-405.

Kaire, G. Sea snake antivenom. Med. J. Aust. 31 Oct 1964: 729.

Mercer H, McGill JJ and Ibrahim R. Envenomation by a sea snake in Queensland. Med. J. Aust. 7 Feb 1981: 130-132.

Minton, S. Paraspecific protection by Elapid and sea snake antivenoms. Toxicon. 1967; 5: 47-55.

Pickwell GV. Sea Snakes in Vietnam and South east Asia. Handbook of Dangerous Marine Animals to field personnel. Dec 1972: 5-25.

Pickwell GV. Venomous Sea Snakes. Fauna. July/ August 1972; 4: 17-32.

Pickwell GV, Vick JA, Shipman WH and Grenan MM. Production, Toxicity and Preliminary pharmacology of venom from the Sea Snake, Pelamis Platurus. Marine Tech. Society Food and Drugs from the Sea. 1972: 247-265.

Reid HA. Myoglobinuria and Sea Snake Bite Poisoning. Brit. Med. J. 6 May 1961: 1284-1289.

Reid HA. Antivenom in Sea Snake poisoning. Lancet. 15 March 1975: 622-623.

Reid HA. Sea Snake Antivenom: Successful trial. Brit. Med. J. 1 Sept 1962: 576-579.

Reid HA. Diagnosis, prognosis and treatment of Sea Snake Bite. Lancet. 19 Aug 1961: 399-402.

Reid HA and Marsden AT. Pathology of Sea Snake poisoning. Brit. Med. J. 6 May 1961: 1290-1293.

Sitprija V, Sribhibhadh R and Benyajati C. Haemodialysis in poisoning by sea snake venom. Brit. Med. J. 24 July 1971: 218-219.

Sutherland S. Hydrophiilae. Sea snakes. Australian animal toxins. Oxford University Press. 1983: 159.

Tamiya N. Sea snake venoms and toxins. The Biology of Sea snakes ed. Dunson, 1975: 385-415.

Tamiya N and Maeda N. Neurotoxins of Australian Sea Snakes. Neurotoxins; Fundamentals and clinical advances. 1979: 95-101.

White J. Ophidian envenomation. A South Australian Perspective. Records of Adelaide Children's Hospital. 1980-81; 12(3): 311-421.

THE UNDERSEA MEDICAL SOCIETY MEETING JUNE 1983, ST JOVITE, CANADA

Jim Lloyd

The meeting was actually the eighth symposium on underwater physiology sponsored by the Undersea Medical Society (UMS). Although I am not a physiologist it happened that I was in Canada at the time.

The meeting was very interesting if a little bit high powered. They seemed to concentrate mostly on events occurring below 500 metres and that does not have much relevance to the Federal Police Diving School. The meeting was held at St Jovite in the Province of Quebec, La Belle Province I should call it as it is now a unilingual province. Luckily we were allowed to speak English at this particular conference. Some of the delegates from out of Canada, in fact most of them, were most surprised to find this venue was 80 km from Montreal and a $50.00 taxi fare from either of the airports. Most of us knew that Grey Rocks Inn was a well known ski resort. Being primarily a ski resort there was no air conditioning in the rooms so it was rather unfortunate that summer came early in Canada this year. The daytime temperatures were 35°C dropping to 22°C overnight. It was very hard to turn off the central heating in the rooms. However, there were plenty of distractions, golf, tennis, sailing, water skiing, horseback riding, you name it, they could provide it. There were the biggest mosquitoes not in captivity and an abundance of biting black flies.

The organisation went off very smoothly except for one little hiccup. No programme had been issued to anybody before they actually arrived on the spot and then we found that the scientific programme did not start until the second day. This was alright for those who were just there for a tax free holiday, but rather upsetting for those who had juggled very tight schedules to get there on time.

The meeting was entirely devoted to poster sessions. This was apparently a new departure for the UMS and they are not going to repeat it. The format of each session was a half hour review of the subject by an invited speaker, then an hour session in the poster room followed by a half hour discussion. Sixty four papers were presented in this way.

The only formal lectures were the introduction and the keynote session, and one formal lecture which was the Kronheim Memorial Lecture. Apart from this, the only relief from the posters was a film that Peter Bennett put on of the Atlantis Four Dive

The poster format was really rather annoying both to the delegates and to the presenters. The invited review at the beginning of each session was supposed to give an introduction to the posters themselves, so that everyone would be nicely primed by the time they got into the poster room. Unfortunately the quality of the reviews varied considerably from a mere paraphrase of the printed abstract, which themselves varied considerably in quality, to a half hour dissertation on the reviewer's own work, completely ignoring the other papers in the session. The poster room was not nearly big enough for the numbers present and the advantage went to tall delegates with hypermetropia. The shorter delegates like Dennis Walder and myself had problems.

The paper presenters also found themselves having to stand by their production and repeat the same speech over and over again to small groups of constantly changing people. There was a general agreement that they could have said all that they wanted to say much better in a ten minute lecturette, to the whole group. This would have got through the same amount of material in the same time. The discussion sessions were also pretty barren because those who really wanted to discuss a paper already had done so with the presenter in the poster room. The only thing that can be said in favour of this method of presentation is that it does tend to keep people awake.

There was an official welcome to Canada by a Canadian delegate, who read a message from the Governor General of Canada, who is a very keen diver and was unfortunately not able to attend, although he would have liked to be there. There were also a few words from the Lieutenant Governor of Quebec which were of course in French and an opening address by John Hallenbeck, the outgoing President of the

Society.

The keynote address was given by Lambertson and his title was “Adventures, Adventurers and Advances in Undersea Medicine”. This was a witty review and history of the speciality.

The other formal lecture was the Kronheim Memorial Lecture, which came halfway through the proceedings, was a lot more interesting. This was by Professor Irwin Fridovich, Professor of Biochemistry at Duke University. He had the advantage of having an audience of physiologists rather than of biochemists. He was able to make himself very interesting, certainly as far as I was concerned, although I am not a physiologist and I am certainly not a biochemist. His subject was “The biology of oxygen radicals, their regularities and irregularities”. This was quite fascinating. He took the view that oxygen is a toxic substance and that we live in spite of, and not because of, it. All aerobic organisms have had to evolve defensive mechanisms against oxygen in order to survive in the aerobic environment. The difficulty with oxygen arises not from the neutral oxygen molecule, but from the super-oxide molecule which is produced during metabolism. This, although not too unpleasant in itself, reacts with hydrogen to form reactive free radicals particularly peroxide and free hydroxyl. These are the toxic components. All the aerobic organisms which he had tested except for one, produced one or more superoxide dismutases. These are catalases which promote the decomposition of super oxides to neutral oxygen and water molecules which are quite safe. The one exception is a particular species of lactobacillus, but that does exactly the same thing without a catalase but by using a divalent inorganic manganese. His message was that every aerobic organism has some built-in defence against oxygen and that possibly the relevance to underwater medicine could be that by following this lead we could increase the resistance of organisms to oxygen toxicity and oxygen poisoning.

In an interesting aside, he mentioned that superoxide dismutase is obtained from separated microchondria very similar to those of most species of bacteria. This supports the evolutionary theory which says that mitochondria and multicellular organisms arose way back in evolutionary history by synergism between bacteria and the original unicellular organisms. He also mentioned that the dismutase enzyme is radioprotective and in fact is effective as a radioprotective agent even after irradiation. This is quite logical of course, because one of the mechanisms of radiation damage is the presence of free radicals.

His final speculation was that for prophylaxis against oxygen poisoning we should stimulate production of superoxide dismutases. There are possible ways of doing this. One example is that walnut trees sprayed with paraquat increase dismutase production by a factor of fifteen, which suggests that by investigating the other organic phosphates we may find an effective antidote against oxygen poisoning.

That again, I regard as logical, because there is also evidence that radiation damage is produced by organic phosphates, as shown by the combined effects of nerve gas and radiation damage, which some of you here will remember that I used to plug when I was lecturing in radiation biology at the RAN nuclear, biological and chemical warfare school.

I will just pick out a few papers for comment. None of the papers was provided in detail at the meeting and we will have to wait for the proceedings to be published to see the actual text.

Papers were grouped by topics. There was a paper on oxygen toxicity in closed circuit scuba divers, from the US Navy Experiment Diving Unit in Panama City. The military volunteers were subjected to a number of different profiles. The presence of oxygen toxicity was assessed by the incidence of convulsions or definite oxygen symptoms or probable oxygen symptoms. The conclusion was that 15 minutes at 40 feet is the maximum safe time before severe CNS toxicity is likely. However a diver exposed to 25 feet, for a longer period, can still make an excursion to 40 feets for almost as long as would be expected without the prior exposure. This information only applies to 100% oxygen closed circuit diving.

The other papers on this topic did not interest me much. Most reported essentially negative results.

The second session was on inert gas exchange, counter diffusion bubble formation. These were more interesting to someone who looks after divers. Macintosh et al of the Naval Submarine Medical Research Laboratory at Groton concluded that acclimatization to decompression stress may indeed exist but that definite evidence is lacking.

There was an interesting presentation by Lambertson, on the supersaturation isobaric inert gas counterdiffusion syndrome. He showed some horrible pictures of pigs which had been counter diffused at atmospheric pressure. This could be a useful experimental model by the generation of stable and readily produced gas embolism by counterdiffusion, which could save the need for experiments at pressure.

The Defence and Civil Institute of Environmental Medicine (DCIEM) in Toronto had a presentation on the conditions required for heterogenous nucleation in the physiological environment. This was a purely mathematical study, based on the crevice model. The conclusion was that there are three possible sites where nucleation bubbles could occur. These are the inner side of the microchondrial membrane, the ruffled border of osteoclasts and possibly the simple contact of cells such as red cell rouleaux in low shear flow. All these sites apparently having the correct contact angle, crevice angle and crevice diameter and if the surface tension is correct, they should be sites where nuclei could generate. Yount at the University of Hawaii has been creating bubbles by decompression of thin slices of agarose gelatin. He showed some nice pictures based on cross microscopy and trans-section election micrography.

Yount and Hoffman from the University of Hawaii had a presentation on decompression theory. They preferred the dynamic critical volume hypothesis of the available hypotheses. At one extreme is Haldane and at the other is Hills and the truth probably lies somewhere in between. As I believe in moderation in all things, I will go along with that.

A presentation from the Department of Pharmacology and Physical Chemistry in Oxford on the in vivo investigation of micronuclei in decompression sickness was fascinating. They had decompressed the common shrimp, which when suitably illuminated is translucent, and actually observed bubbles under the carapace. The main thrust of their experiment was to try and eliminate the nuclei by precompression to up to 400 atmospheres. They found that they did indeed eliminate the nuclei but that they all came back again after a three hour interval. They contrasted this rapid regeneration of bubbles with in vitro experiments where precompression to this extent has shown that liquids, with suitable precautions, remain free of nuclei for weeks afterwards. Obviously in vivo those precautions do not apply and so the bubbles come back. The pictures of bubbly shrimps were fascinating.

A presentation on "Scuba disease revisited" came from the Naval Medical Research Institute at Bethesda. They referred to Carl Edmonds' 1970 paper from the RAN on salt water aspiration. They compared that with experience in the USN in the '50's when there were a number of cases of "scuba disease" as they called it, including one death. They fixed the problem by regular cleaning and decontamination of scuba gear as they assumed it was due to pseudomonas infecting the equipment. Although there has been no case of scuba disease in the USN since then they concluded that "Scuba disease remains a potential health hazard nevertheless for recreational, military and commercial divers, especially those diving in warm and humid environments. Regular cleaning and decontamination of scuba regulators, hoses and mouth pieces is imperative. Medical personnel involved in the training and treatment of divers must be made aware of this disease." Carl Edmonds disagreed that salt water aspiration syndrome is the same problem as "Scuba disease".

An interesting presentation came from the Tokyo Medical and Dental University concerning decompression sickness in caisson workers digging a tunnel in Japan. They were monitored on the job by taking gelatin capsules with them under pressure and counting the number of bubbles formed. Each worker had six capsules in a little round pill box with a magnifying lens as the lid strapped onto his wrist. On coming up from each shift they would count the number of bubbles, divide by six and register the mean number. The conclusion was that in those showing a mean count of less than 10 bubbles (±7.5%) there was no decompression sickness while at 25 bubbles there was just over 3%. I have some free samples here if anyone wishes to check their bubbles after the dive tomorrow.

Still continuing on decompression sickness, a paper on "Fatal chokes in sheep" came from the University of Wisconsin. They had exposed sheep to pressure then given them a very short rest at the surface and then taken them up to 8,000 feet simulated altitude for fifteen minutes if they had not already got the chokes. If they did not have the chokes before they went up they had by the time they got to altitude. They were rather surprised that they had a high incidence o£ fatal chokes in profiles that differed very little from what people often do in practice. Their final paragraph reads "The occurrence of fatal chokes under conditions so little different from relatively benign exposures is alarming. The conditions are not very far removed from those encountered in flying after diving, diving at altitude or caisson and tunnel work at high altitudes. Except for one case reported there has been very little serious consideration of chokes as a potentially lethal complication of such pursuits. We suggest this should be taken more seriously in the future."

Another contribution from DCIEM in Toronto was "Bubble induced local hydrostatic pressure gradients, as a possible cause of dysbaric osteonecrosis". They came to the conclusion that local cell death and micro fracture of the bone matrix by the presence of bubbles within living bone tissue is a mechanism which appears to explain the aetiology of the disease. An important test of this mechanism would be to design decompression experiments on isolated osteocytes or isolated living bone, but this has not been done yet.

A paper on inner ear decompression sickness in the squirrel monkey, again from DCIEM, I found quite incomprehensible and I cannot even find any conclusions in the preprint.

A paper from the Naval Health Research Centre in San Diego was "Retrospective evaluation of recompression procedures within the US Navy.". This overview of past clinical records of cases concluded that the US Navy tables as they exist are quite satisfactory so long as they are correctly used. All the problems arose from people who modified the tables to suit their own ideas. What used to be the Royal Naval Physiological Laboratory and which is now The Admiralty Marine Technology Establishment (Physiological Laboratory) presented "The effect of presaturation on the maximum submarine escape depth of goats". What the practical application of that is, since one does not normally carry goats in submarines I am not quite sure. However, they also considered the implications of this to human research. The conclusion was that any research programme into human limitations of buoyant ascent from submarines following presaturation should commence at the maximum compartment pressure and the minimum escape depth, rather than the minimum compartment pressure and the maximum escape depth. They suggested that the amount of pre-pressure applied before making the escape is the critical thing for the survivability of a deep submarine escape.

A paper on ultrasonic bubble monitoring came from Oxford, the Department of Pharmacology and Physical Chemistry, who used a Doppler bubble counter applied to the knee and upper thigh.

There was another paper from Hawaii, from a Dr Lim, on experimental attempts to influence decompression thresholds in saturation dives in animals. This involved pre-exposures to high pressure for short periods to compress the nuclei. He came to the conclusion that over pressures, to the extent that were tested, did not reduce subsequent bubble formation.

THE ECOLOGY AND VULNERABILITY OF ESTUARINE MANGROVES

Bruce Wallner

I will discuss the importance of a coastal ecosystem, the mangrove ecosystem, in fairly general terms, and then point out some of the common anthropogenic pressures that have been exerted on these systems. I have been working in Gladstone for about two and a half years on an oil shale project funded by Esso Australia. I have been employed there on environmental impact work.

Mangrove ecosystems have a commercial importance. It has been estimated that about 60% of the fish and fish products that are caught in southern Queensland are in some way dependent upon the mangroves, either for food or for their prey or shelter. Further north where there is reef and coral fishing the percentage of fish product drops off a bit. Mangroves are a very big wood resource. In Malaysia and other countries they are harvested for charcoal and building timber. In Australia they are a big floral resource for honey production. I am concerned with their ecological importance.

The have an enormous and very vital role in providing safe breeding refuges for all, or many of our commercial species of fish, and the tangled thickets of roots provide an ideal shelter for many of the younger fish. Many species breed and rear their young in this protective environment. Mangroves are also fairly nutrient-rich and therefore there is a lot of food floating around.

Not all the animals live there full time. There is a large migratory population at certain times of the year. Some are migrating and feeding on the way, others are breeding and rearing their young. In addition to fish, there are also turtles, birds, bats and all sorts of insects and crustaceans that inhabit the mangroves. It is a very prolific cross-section of nature that goes about its living business in the mangroves.

Mangroves are a very important shoreline stabiliser. All those roots bind the very soft mud together and prevent it from being washed away by the tide and deposited in our valuable harbours.

The main reason for their importance is that the mangrove ecosystems have an enormously high primary productivity. This is the productivity which is produced by the trees from sunlight, so it is virtually free. The studies that we have been doing have shown that about 12 tonnes of leaves per hectare per year get dropped by the mangroves. Further north, up by Hinchinbrook Island, which is up towards Cairns, the amount can go up as high as 28 tonnes. That is a lot, as the typical dry sclerophyll eucalypt forest only drops about 3 or 4 tonnes a year. All these leaves and other bits of vegetable matter drop into the water. They contain an enormous reserve of nitrates and phosphates and carbon compounds. These are released into the sediments as the leaves decompose. The various microbes in the soil cause them to rot. Then the tides distribute the nutrients around the place.

A satellite height look at things shows up sediment and mud and plants. Sediment carried in the water reaches a fair way out to sea even into Barrier Reef waters. So despite the fact that the mangrove ecosystem on the coast at Gladstone is about 50 miles away from the Reef, it has a very large input in terms of nutrients for the Reef. This is particularly so in Australia where there is a fairly shallow Continental shelf which does not receive any great amounts of upwelling, which occurs in more oceanic areas, to bring nutrients into the reef systems. There are about 46,000 square km of mangrove coastline just in Queensland alone, so the total of the nutrient input is enormous.

After telling you why they are so good, I will show you what we do with them. The fact that they are sheltered, coastal and proximal means that they often come into competition with man’s activities. Man desires coastal space for urban, port and industrial development. At Gladstone, they have just finished dredging an enormous new harbour and so the areas of mangrove are being constantly pressurised out of existence. The Gladstone water frontage was once a fairly prolific mangrove area. The mangroves have been eliminated by dredging the main shipping channel and dumping it all on the mangroves to make lovely flat land to build on for the port facilities and large industry, such as Queensland Alumina, the largest bauxite refinery in the world.

Another thing is that we seem to like to put our rubbish dumps in Gladstone in the middle of the mangroves. The last one became a soccer field and the current one is coming up for residential development. Mangrove areas are considered less desirable than most other areas of coastline, because they are full of insects and very muddy and swampy and generally not terribly picturesque, they seem to become receivers for our effluents and industrial by-products and chemical waste.

The Gladstone power station, which supplies 60% of Queensland’s power, is obviously a very essential thing, but it is fairly disastrous ecologically. It produces an enormous diversity of waste. The smoke is very high in sulphur and ash. It also produces a lot of hot water which pumps out into the creek. This hot water washes up and down with every tide and it has had a pretty bad effect on the fringe mangroves. Also, just the bulldozing of the coal heaps mobilizes a fair bit of coal dust into the air. The particulate emissions from this sort of industry, the dust and so on, can have an effect on the leaves by clogging leaf stomata through which the leaves transpire. This means a very slow and painful death for a tree, equally lethal but not quite as dramatic as bulldozing them.

Sewage has always been considered a fairly desirable thing to pump into the water. It is full of lots of good nutrients, but it causes a rather paradoxical problem in that too much nutrient goes into the water. This causes a phenomenon called eutrophication. There is an enormous multiplication of aerobic bacteria, which are madly gobbling up all the nutrients. The bacteria use up all the oxygen in the water and the water becomes largely anoxic to most of its inhabitants. This eliminates most of the animals as there are very, very few animals that can survive in anoxic water.

Another damaging factor that has taken a long time to be noticed, is the dangers in the changing drainage pattern. A road was built, against all advice, to be the quickest way between point A and point B. It was built right across the middle of the mud flat, which was considered to be fairly expendible. As a result quite a lot of the mangroves have been cut off from the tidal flow. Only the very peak tides can get in there. The road acts like an enormous bund wall trapping the tide. On the wrong side of the road there is a big patch of dead trees standing in a large pool of stagnant water. It took quite a few months for this phenomenon to come about.

The run-off increase that comes from annual burn-offs and the clearing of land for cattle grazing and mining, all increase the rain water run-off into the creeks. This can increase the sediment load enormously. Mangroves have pneumatophores because the mud is so fine that it becomes anoxic about 5 or 6 cm down and so mangrove roots grow laterally and poke up little pneumatophores every now and again to enable them to get a breath of air. Large volumes of sediment settling can smother them, even abrade them to such a degree that they cannot work any more.

Even events remote from the coast can have an effect on the coastal system as a whole. Building a dam quite a long way upstream can cut off the normal flow of the river and inhibit the flushing out of the nutrients.

Mangroves are receivers of a lot of land nutrients which they, with the aid of sunlight, turn into plant nutrients, which they then pass onto the rest of the marine system by dropping their leaves. These are consumed by microbes and small detrital feeders such as crabs and worms which then become food for fish and bigger fish eat the fish and so on up the food chain.

A fairly recent problem is a pathogenic fungus called a phytopra. This causes “die back”. It is a fungus that lives at a fairly low population-level naturally in the soil. But when we disturb the soil and the tree becomes stressed by man-made activities, it seems to take over the tree and causes its death, probably due to a lower resistance to cold and so on.

The area we are studying is fairly big. We have adopted a strategy for studying of the mangroves. There are essentially three stages in the study. The first one is an assessment of the impact which is largely educated guesswork where we analyse the effects that the type of operations could have. In this case it was a large open cut oil shale mine, so we can expect everything from mechanical damage by clearing for road access to effluents, air, water, and dredging, and so on, including chemical pollution. The next phase that we got off to was the establishment of a base line. This involves cataloguing the biological and physiochemical parameters of the ecosystem and setting the normal relationship in the undisturbed system. We also establish bench mark sites which are control areas, so that we can compare areas when they are eventually affected to the areas which have not been affected. The base line serves as a bench mark comparison so that we can just go back and check, year in and year out, in a monitoring programme, which is the final phase; when the thing is actually operating. We can then tell whether damage is being done or not and perhaps rectify it.

With the Rundle project, just off Gladstone, we have finished phase one and finished phase two. The project is about to be closed up because the process is not really quite cheap enough for it to be working yet. So they are just sitting back to see what will happen to the oil market.

The first thing we did with the trees being very important, was to establish study plots. Because mangroves are fairly impenetrable, we scattered around a whole heap of leaf catching devices, consisting of a little shade cloth and a frame. We caught the leaves and collected them monthly. From this we did dry weights and counts. We analysed the normal rate of leaf fall. With the addition of stress you might expect that these trees, living in a fairly harsh environment anyway, having to deal with enormous osmotic problems living in the salt water, would tend to drop more leaves. This particular family of trees we were studying produce an interpetiolar leaf spicule. They produce one for every new leaf. We were able to do a budget of leaf loss and leaf production, whether or not the tree itself was declining or growing. Some mangroves are vivaparous and the fruit actually germinates while it is still on the tree.

The second area that we dealt with was the animals that live within these systems. The range of animals included plankton and fish and all sorts of things. We dropped a grab over the side of the boat and pulled up a big bite of sediment. Then we sieved it and extracted all the animals in it. The bottom dwelling things that live in the sediment are actually very good indicators of the state of the environment. They do not move very far and if there is any pollution present, they generally get hit with the full force. The area is a big mud crabbing area. We tried to get an idea of what the population was like. We did a population study which involved tagging these crabs, fairly formidable beasts. We caught them and plugged little plastic tags into them and did a fairly involved statistical ploy on the computer. As a result we were able to come up with the approximate population count in various creeks. We can go back in ten years time and check on this. In addition we learned a lot about mud crabs, especially what they taste like.

All this information is fairly useless unless one can compare it against what the normal physical and chemical environment is. To this end we have a meteorological station which did very regular water sampling, allowing us to correlate what animal and plant populations are doing with normal changes in physical and chemical environment that they live in. So now we can detect additional changes over and above that induced naturally by the weather or the temperature or the seasons.

The amount of scientific research that has been done on the past ten years on mangroves is quite fantastic. Before that they were considered to be not worth the effort. We have now realized that they are very important not only in their own right, but in terms of the fact that they have a large bearing on all the other marine life paths. Even the Great

Barrier Reef is not its own little oyster, and wiping out the mangroves may even effect the Reef. The State Government in Queensland has recognised this by passing legislation which has protected all the trees. This is a step in the right direction, but unfortunately the same government tends to overlook their own legislation fairly frequently. They like to adopt a policy of exploitation of natural resources and development of big industry. So despite the fact that there are laws protecting mangroves they often destroy the trees. A lot of the impact on the mangroves is often second or third hand.

Dr Chris Acott

This is not really a question, but that photograph of the road that you showed - there were no stubbies* by the road. It must be the only road without stubbies north of Brisbane.

Bruce Wallner

That photograph was taken not long after the road had been completed, and it had not been used that much. It was built purely as access for workers to get to the landing. An environmental study was done before the road was built and recommended that the road should go around the mud flat. Not only for environmental needs, but also for engineering reasons. They had a lot of trouble building the road. Another reason that there are no stubbies is that the road is about 20 feet above the land, so the bottles roll off into the swamp.

* For readers outside Australia. A stubby is a non-returnable 375 ml bottle of beer.

MEIOU!!

Coincidentally (with starting the Diving Medical Centre) we combined with some civilian physicians and formed the South Pacific Underwater Medicine Society. The abbreviation SPUMS, was specifically chosen because of its similarity to certain other subquatic pleasure loving organisms. Like them, it had far reaching consequences. We nurtured a kitten and it became a tiger. Both Bob and I were greatly relieved when we managed to let go its tail.

Carl Edmonds in *PRESSURE*, June, 1983.

SUDDEN DEAFNESS IN DIVERS

Noel Roydhouse

Over the past fourteen years I have collected a series of about 70 cases of sudden sensorineural deafness occurring in scuba divers. Some of these have been actual rupture of the round of oval windows but the majority of them appear to have been intracochlear membrane damage without any damage of the oval or round windows. That these windows have been intact in these cases has been slightly in doubt until recently when I opened up the middle ears of two cases whose story was not as typical as the other cases. These two cases are described:

Case One

A 27 year old male diver, with one year's experience including 80 dives, attended because of a "blocked" left ear which had a humming sound. He had been seen one year previously, with a left haemotympanum from diving from which he had made a full recovery. The present symptoms had come on after surfacing from a 4m dive fourteen hours previously, during which dive he had experienced some difficulty in equalising his middle ear pressures. He had a five second dizziness on surfacing, with a minor rotary element. His hearing on the right was normal and on the left there was an average 55 decibel loss for frequencies of 0.5, 1 and 2 kHz. He was admitted to hospital for medical treatment of sudden deafness which was unchanged after four days. His middle ear was opened, searching for a round or oval window rupture. No fluid was seen to come from these regions when compressing the jugular veins, but the round window membrane was seen to bulge. One week later the tinnitus was a quieter ringing, and the hearing 40% better. Two weeks after treatment he gained his permanent hearing improvement, which left him with normal hearing apart from a 40 decibel loss in the 0.5kHz note, a hearing handicap from 9% to 1.7%.

Case Two

A 19 year old female with three months experience was seen two days before Case One. It had been her third dive since her diving course and she had made a quick ascent. She developed vertigo for 24 hours, deafness and ringing in the right ear, and loss of balance for three days. She consulted me on the tenth day post incident and was admitted to hospital for medical treatment, but the deafness and imbalance continued. Under general anaesthetic her middle ear was inspected and no abnormality seen. One week after the operation her balance was normal and the hearing loss continued at the 70 decibel loss for the 4, 6 and 8 kHz notes noted pre-operatively. One month later she had the same deafness in the affected ear, with normal hearing in the unaffected ear.

The diagnosis in both these cases was a Labyrinthine Membrane Rupture. ie. damage confined to the intra-cochlear region.

REFERENCES

Simmons FB. Theory of membrane breaks in sudden hearing loss. Arch Otolaryngol. 1968; 88: 41-8.

Goodhill V. Sudden sensorineural deafness. Proc R Soc Med. 1976; 69: 565-72.

Roydhouse N. Sudden deafness and scuba divers (correspondence). NZ Med J. 1981; 93: 131.

DRAFT AUSTRALIAN STANDARD FOR TRAINING AND CERTIFICATION OF DIVERS

John Knight

The Standards Association of Australia's Committee SF/17 (Work in Compressed Air) has produced a Draft Standard for public review. The Standards Association of Australia has kindly given permission for the SPUMS Journal to reprint parts of the draft standard (in italics wherever the quotations appear). The draft is "a proposed series of standards relevant to the training and certification of divers where the requirements of regulatory authorities and industry demand a prescribed degree of training and competence to ensure an adequate degree of safety, performance and economy." It applies to employed divers, not to sports divers, but most of the terminal objectives and training topics of Part 1 "Scuba Divers" (Tables 1 to 10) are applicable to sports divers. Unfortunately many sports divers could not give the right answers or take the right actions in response to a number of these objectives. This paper is based on the drafts that are to be circulated for comment. These drafts will almost certainly be modified in content and presentation, when in their final form, to take account of such comment. The object of this paper is to bring to the attention of SPUMS members the proposed standards so that they can contribute their ideas to the final product.

Part 1 - Scuba Diving

Part of the preface and Sections 1 and 2 are reproduced here.

PREFACE

This draft is related to those persons not normally working underwater but who are required to dive in connection with archaeology, non-commercial research, scientific work, and observation tasks.

Other proposed standards cover the training of divers required to undertake a range of work tasks underwater. These parts are as follows:

> *Part 2 - Restricted Commercial Air Diving*
> *Part 3 - Professional Air Diving with Surface Compression Facilities*
> *Part 4 - Bell Diving.*

This draft is largely based on requirements originally developed by the (UK) Manpower Services Commission (MSC) and the European Diving Technology of the EEC, which were developed to meet the UK Health and Safety at Work Regulations.

As with the training described in the other parts of this standard related to professional diving, the SAA drafting committee has strongly supported the objective of developing requirements compatible with the UK standards. Such compatibility should lead to reciprocal acceptance of diver qualification/certification sufficient to enable persons to undertake diving, to the <u>appropriate classification</u>, throughout Australia and overseas.

<u>SECTION 1. SCOPE AND GENERAL</u>

<u>1.1 SCOPE</u>. This standard specifies the training activities and terminal objectives required for training and accreditation of persons who wish to dive safely and competently -

(a) to perform a limited range of underwater tasks deemed to represent underwater construction or repair activities;

(b) using self-contained breathing apparatus (SCUBA) to depths of 20m; and

(c) on sites with no surface compression chamber required in accordance with AS 2299.

<u>NOTES</u>:

1. It is thought that such training would be of interest (the minimum) to those who dive in connection with archaeology, non-commercial research, scientific work, and observation tasks.

2. Currently AS 2299 restricts the depth and duration of diving with SCUBA and diving without access to surface compression chambers.

<u>1.2 PURPOSE AND TERMINAL OBJECTIVES</u>

<u>1.2.1 Purpose</u>. The purpose of this standard is to describe the organizational and syllabus requirements for the following:

(a) To train air divers to operate safely and competently to 20m using self-contained diving equipment where no surface compression chamber is required on site in accordance with AS 2299.

(b) To provide a knowledge and practical application of techniques for divers who only have to undertake a <u>limited range</u> of air diving tasks.

<u>NOTE</u>: The basic training provided by this standard is limited to dives that do not include underwater construction or repair activities, or dives that routinely extend to depths in excess of 20m. Attention is drawn to the additional training specified in other parts of this standard and in AS 2299 for such diving.

The following important aspects need to be stressed:

(i) <u>Competence</u>. The range of diving tasks covered by this standard is <u>limited</u>. Accordingly, divers who wish to dive to depths greater than 20m or undertake work while underwater should be trained and accredited in accordance with AS XXXX, Part 2 or AS XXXX, Part 3.

<u>NOTES</u>:

1. The requirements of AS 2299 state -
"No person shall employ, instruct or allow any

person to be employed as a diver and no dive shall be carried out unless the diver -

"(a) has passed all medical requirements (set out in Appendix A of AS 2299); and

"(b) has practical experience, has a knowledge of diving, practice and the requirements of this standard and has a full understanding of the diving apparatus in use."

2. *Some statutory authorities require that persons carrying out diving work must be in possession of an appropriate certificate of competency issued by that authority.*

(ii) Safety and health. The safety and health of the diver and the development of safe working practices MUST be integrated into all aspects of the training program.

(iii) Team training. The training, particularly in practical diving and underwater working, needs to be directed not only towards developing individual competence, but also to develop the trainee to think and act as a member of a team.

1.2.2 Terminal Objectives. The terminal objectives describe what the trainee must be able to do on completion of training and can be classified broadly into two groups as follows:

(a) Objectives whose purpose is to develop a degree of competence in the trainee.

(b) Objectives which are limited to developing in the trainee and appreciation, or acquaintance with, a piece of equipment or a procedure.

The terminal objectives have been grouped under ten headings (Tables) in this standard as follows:

Table 2.1 -	*Diving theory*
Table 2.2 -	*Use of self-contained diving equipment*
Table 2.3 -	*Seamanship*
Table 2.4 -	*Diver communication systems*
Table 2.5 -	*Underwater tasks*
Table 2.6 -	*Underwater hazards*
Table 2.7 -	*Air compressors*
Table 2.8 -	*Surface compression chambers and therapeutic decompression*
Table 2.9 -	*The physiology of diving and first aid*
Table 2.10 -	*Relevant legislation and guidance.*

The wording of the terminal objectives and their interpretation is very important as they are used to produce the topics to be included in the training program. It is realized that there are difficulties in expressing clearly and precisely the level of competence to be developed in the trainee.

1.3 APPLICATION. The standard recognizes that training may take place in a diving school or in-company.

Regulatory authorities may utilize the standard to -

(a) approve establishments to run courses to this standard;

(b) monitor courses to ensure standards are being maintained; and

(c) issue or accept certificates of competence to persons who have completed the training tasks specified herein and are adjudged competent to achieve the terminal objectives described herein.

NOTE: Persons completing training to this standard may undertake additional training (see AS XXXX, Part 2 or AS XXXX, Part 3) if they wish to increase their level of competence and be considered for additional diving operations not covered by this Part.

1.4 REFERENCED DOCUMENTS. The following standards are referred to in this standard:

AS 2030	*SAA Gas Cylinders Code*
AS 2299	*Underwater Air Breathing Operations*
AS XXXX	*Training and Certification of Divers*
	*Part 2 - Restricted Commercial Air Diving**
	*Part 3 - Professional Air Diving with Surface Compression Facilities**

1.5 SELECTION CRITERIA. The trainee MUST be in possession of a valid certificate of medical fitness to dive (see AS 2299) issued, after examination, by a doctor experienced in underwater medicine and approved by the relevant Regulatory Authority.

DRAFTING NOTE: Discussions with overseas authorities are under way regarding accreditation of medical doctors to perform medical examination of divers.

The trainee should, as a minimum -

(a) be at least 18 years of age;

(b) be a competent swimmer, at least to the standard laid down by the Royal Life Saving Society Survival Certificate;

(c) be able to -

(i) add, subtract, multiply and divide whole numbers, decimals and simple fractions;

(ii) calculate percentages; and

(iii) transpose and solve simple formulas, eg. gas laws; and be able to understand written and verbal communications and communicate easily with instructors and other trainees/members of the diving team.

(d) be able to undertand written and verbal communiations and communicate easily with instructors andother trainees/members of the diving team.

---

* *In course of preparation*

SECTION 2. TABLES OF TERMINAL OBJECTIVES AND TRAINING TOPICS

Terminal objectives	*Training Objectives*
The overall standard to be achieved by the end of the training (to be able to) -	*Specific topics to be achieved during the training to meet the requirements of the terminal objectives*

TABLE 2.1
DIVING THEORY

Outline the following properties of liquids and gases:	
2.1.1 Relationship between pressure and volume (Boyle's Law).	*- Calculate the volume changes with changing depths.*
2.1.2 Relationship between pressure and temperature (Charles' Law).	*- Calculate the pressure changes with changes in temperature.*
2.1.3 Partial pressure of gases (Dalton's Law).	*- Calculate the partial pressure of gases at different depths.*
2.1.4 Solubility of gases in solution (Henry's Law).	*- Explain the solubility effect of gases in liquids and the need for decompression.*
2.1.5 Buoyancy (Archimedes' Principle).	*- Calculate the buoyancy of various objects at different depths.* *- Explain the effect of salt and fresh water on buoyancy.*

TABLE 2.2
USE OF SELF CONTAINED DIVING EQUIPMENT

2.2.1 Dive safely and competently using self-contained diving equipment in sheltered and open water in varying bottom conditions and water visibility.	*- Dive, act as a diver's attendant and standby in diving operations using self-contained diving equipment.* *- Calculate the air consumption rates and duration of dives.*
2.2.2 Diving safely and competently to a depth of 20m using self-contained diving equipment.	*- Explain the function and operation of reserve systems currently available.*
2.2.3 Carry out emergency drills applicable to self-contained diving equipment.	*- Explain the procedure to be followed in case of* *- trapped diver* *- unconscious diver* *- Explain current SCUBA emergency procedures, eg. equipment sharing, use of inflatable life jackets and buoyancy aids.* *- Perform at least one simulated rescue of an unconscious diver when acting as a diver and a standby diver.*
2.2.4 Dress and undress divers using self-contained diving equipment.	*- Explain safety procedures.* *- Perform pre-dive and post-dive checks.*
2.2.5 Perform user maintenance of self-contained diving equipment and prepare equipment for use.	*- Dismantle and re-assemble self-contained diving equipment.* *- Explain the function and operation of SCUBA and associated diving equipment.*

		- *Explain the testing procedures to check equipment for defects.* - *Identify worn and damaged parts*
2.2.6	*Perform repairs and tests to diving suits.*	- *Explain the principles of porosity testing of dry suits and perform user maintenance and repair of diving suits*

IN-WATER TRAINING TIMES

The following minimum in-water training times must be achieved. In-water time should include some simulated decompression stops. Trainees may require more than the minimum times to achieve the terminal objectives.

Depth, m	*In-water Time, min*
0 - 19	*700 (with a minimum of 300 in the depth range 11 m to 20m)*
At 20	*200*

TABLE 2.3
SEAMANSHIP

2.3.1	*Outline the pattern of tidal movements and how to determine the depth of water and tidal direction in a given place at a given time.*	- *Calculate predicted depth and tidal movement using a chart and tide tables.*
2.3.2	*Recognize the standard symbols used on charts and how distance, position and direction are determined.*	- *Plot a course on a chart between two points and measure direction and distance.* - *Use a chart to calculate distance and position.*
2.3.3	*Outline the principles of handling a small craft in harbour and at sea in varying water conditions.*	- *Explain precautions to be taken when navigating in confined waters and at sea with respect to other vessels, natural hazards and structures.*
2.3.4	*State the essential safety equipment to be carried in a small craft.*	- *Explain the use of essential safety equipment.*
2.3.5	*Handle a small craft under supervision.*	- *Perform the following operations and manoeuvres:* - *start and stop engine* - *launch and recovery* - *anchoring* - *coming alongside* - *recovery of a floating object* - *picking up a buoy*
2.3.6	*Handle safely and efficiently cordage and ropes.*	- *Tie basic knots used in diving* - *Handle ropes.* - *Explain the main purposes of current legislation concerning the use of lifting appliances applicable to diving operations.*

TABLE 2.4
DIVER COMMUNICATION SYSTEMS

2.4.1	*Recognize, identify, interpret and correctly respond to hand and rope signals from diver to surface, surface to diver, and diver to diver as described in Section 3 and Appendix G of AS 2299.*	- *Explain the principle of tending a diver.* - *Explain and use hand and rope signals.* - *Act as a diver and attendant in a diving operation where rope signals are primary means of communication.*

2.4.2. Outline the basic principle of underwater communication and diver intercom systems.	*- Explain the differences between two-wire and four-wire telephone systems.* *- Explain the principles of through-water communication systems.*

TABLE 2.5
UNDERWATER TASKS

2.5.1 Outline current underwater search methods and locate an object using two of them.	*- Explain at least three current methods of carrying out underwater searches.* *- Locate an object underwater using at least two different search methods.*
2.5.2 Produce a report based on an inspection/ survey of an underwater structure or natural feature.	*- Explain the principles of producing clear, concise and well laid out reports.* *- Explain the essential points to be included in briefing for a survey/inspection.* *- Perform an underwater inspection/survey and prepare a report.*
2.5.3 Outline the basic principles of various underwater inspection and measurement techniques, including video inspection.	*- Explain the elementary principles of various underwater inspection and measurement techniques including* *- tape measurement* *- recording and writing* *- still photography* *- video inspection.*

NOTE:
Other underwater tasks should be included in the training program. The tasks might include the use of skills and knowledge related to the profession of the trainee.

TABLE 2.6
UNDERWATER HAZARDS

2.6.1 Outline the hazards to divers of water flow around of through underwaters tructures (including gates, pipelines, culverts, sewers and intakes) and explain the safety precautions to be taken.	*- Explain the safety precautions to be taken before undertaking diving operations where hazardous flow conditions may exist.* *- Explain the principles of differential water pressure and the operation of sluice gates and intake.*
2.6.2 Outline the hazards of marine animals and explosives to divers.	*- Explain various envenomation processes found in marine animals.* *- Effects of various types of venom on the human physiology.* *- Precautions required in handling marine animals.*

TABLE 2.7
AIR COMPRESSORS

2.7.1 Outline the principles, method of operations and health and safety requirements of high pressure air compressors.	*- Explain compressor air flow and volume.* *- Explain the air purity requirements specified in AS 2299.* *- Explain the relevant requirements of statutory provisions.*

2.7.2	*Operate safely and efficiently and carry out user maintenance of high pressure air compressors.*	*- Operate high pressure air compressors.* *- Perform all checks and user maintenance including checking oil and water and draining filters.*
2.7.3	*Operate and carry out user maintenance of associated air filtration equipment.*	*- Explain the purpose of a filtration system, including the components of a filter and its replacement and the siting of air intakes.* *- Use a simple analyser kit to determine air purity.*
2.7.4	*Operate a high pressure air panel and bank to charge cylinders safely and efficiently.*	*- Explain the main safety precautions to be observed concerning the use of high low pressure air vessels.* *- Explain the principles of decanting.* *- Explain the procedure for and charge an air cylinder directly from a compressor and from an air bank.*

TABLE 2.8
SURFACE COMPRESSION CHAMBERS AND THERAPEUTIC DECOMPRESSION

2.8.1	*Interpret and apply standard air decompression tables.*	*- Calculate the correct decompression schedules for single, combined and repetitive dives using current decompression schedules.*
2.8.2	*Outline the principles of compression chamber operation and the use of air and oxygen therapeutic tables.*	*- Explain the preparation of a typical twinlock compression chamber for therapeutic recompression treatment.* *- Explain the provisions for maintaining the chamber atmosphere within acceptable limits.* *- Explain the principles of air and oxygen therapeutic tables and their application.*

NOTE: It is desirable that trainees also undergo some limited practicable familiarization with decompression chambers, their fittings and their principle of operation.

TABLE 2.9
THE PHYSIOLOGY OF DIVING AND FIRST AID

2.9.1	*Outline the respiratory, circulatory, basic skeletal and nervous systems of the body.*	*- Explain briefly the function of the following:* *Skeletal system: heart, blood vessels and circulation of blood: properties of blood; lungs and airways including control of respiration and simple gas exchange: brain: spinal cord and nerves.*
2.9.2	*Outline the basic need for and problems associated with maintaining the normal body temperature of the diver.*	*- Recognize signs and symptoms of hypothermia and hyperthermia and how to treat these conditions.*
2.9.3	*Describe the changes and symptoms caused by breathing too high or too low a concentration of oxygen or too high a concentration of nitrogen.*	*- Explain how the amount of oxygen received can be measured.*
2.9.4	*Apply first aid treatment in typical diving emergencies.*	*- Explain the causes, signs, symptoms and treatment of - decompression sickness; squeeze 'ears' and sinuses; reversed ears; drowning; vomiting under water; cold exposure; carbon dioxide poisoning; carbon monoxide poisoning; nitrogen narcosis; pulmonary barotrauma; air embolism.*

2.9.5	*Apply first aid treatment to minor injuries.*	*- Explain the signs, symptoms and treatment of shock, burns, bleeding (both external and internal), wounds and fractures including long bones and spine, electrocution.*
2.9.6	*Apply first aid treatment to an unconscious person.*	*- Explain causes, signs, symptoms and treatment of asphyxia.* *- Demonstrate external cardiac massage and artificial maintenance of respiration.*
2.9.7	*Describe the symptoms and treatment for injuries/ illness caused by contact with dangerous marine animals.*	*- as for 2.6.2.*

TABLE 2.10
RELEVANT LEGISLATION AND GUIDANCE

2.10.1	*Outline the relevant Statutory Regulations and associated guidance notes as they relate to air diving operations. Review the requirements of AS 2299 and other relevant standards (eg. AS 2030).*	*- Explain the main duties of the employer and employee.* *- Explain the main duties of the diving contractor, the diving supervisor, and the diver.* *- Explain the main purpose of other Statutory Regulations and associated guidance notes as they apply to air diving operations using surface supplied or self-contained diving equipment where no surface compression chamber is required on site.* *- Explain importance of knowing the location and phone numbers of nearest recompression facilities.* *- Name and phone numbers of doctors knowledgeable in diving medicine.* *- Transportation facilities available for emergency use.*

Part 2 - Restricted Commercial Air Diving

Part of the preface, those parts of Section 1 and Section 2 that differ from Part 1 and part of Section 3 are reproduced below.

PREFACE

This draft is particularly related to the training of personnel who will be engaged in professional and/or commercial underwater operations, at limited depths, as described in AS 2299 using surface-supplied compressed air or self-contained breathing apparatus and not having access to a surface compression chamber. Such qualification is the minimum required by regulatory authorities who are responsible for the control of on-shore diving, eg. construction of jetties, dams.

Significant considerations in the development of this draft are as follows:

(a) *Alignment with regulatory (Australian and Overseas) Requirements and Compatibility with AS 2299, Underwater Air Breathing Operations. This draft is largely based on the requirements originally developed by the (UK) Manpower Services Commission (MSC) and the European Diving Technology Committee of the EEC, which were developed to meet the (UK) Health and Safety Diving Operations at Work Regulations which require all divers entering construction or off-shore oil and gas industries in the United Kingdom to have achieved the appropriate requirements of the appropriate MSC underwater working training standard.*

The SAA drafting committee has strongly supported the objective of developing requirements compatible with the UK standards and to pursue the question of reciprocal acceptance of diver qualification/certification within Australia and with the UK and European authorities. Such reciprocity is most desirable to provide uniform control and regulations for the itinerant workforce of professional divers. However, the committee has proposed more stringent requirements than the UK in this draft because it believes -

(i) *that the requirements of this proposed standard should be compatible with AS 2299 and with those of Australian regulatory authorities; and*

(ii) *dispensation from the more stringent requirements of AS 2299 and Australian regulatory authorities, eg. maximum depth of dives with no surface*

compression chamber available, should be the subject of special application (see Amendment 1 to AS 2299).

(b) Implementation and Certification. Any new scheme for the assessment and certification of divers based on training to this proposed standard needs to take account of several contingencies not readily covered by standards. In the UK, the relevant Authority (Health and Safety Commission) established a Certification Board for Diving Training to advise on-

(i) criteria by which diver training may be assessed for certification purposes;
(ii) criteria by which experience may be assessed for certification purposes of a standard not less than the standard of training in (i);
(iii) establishments providing training satisfying the criteria in (i) ;
(iv) equivalence to (i) and (ii) in respect of training and experience in foreign countries; and
(v) arrangements for -
A. issuing of certificates in respect of diver training;
B. declaring such certificates to be no longer valid; and
C. approval of persons taking part in diving operations as part of training.

The drafting committee is anxious to -

1. have confirmed which bodies in Australia are likely to undertake similar certification activities;

2. receive comment on how certification arrangements to take account of alternative/previous experience and competence might be handled; and

3. continue to pursue arrangements for reciprocal acceptance of interstate and overseas certification.

SECTION 1. SCOPE AND GENERAL

1.1 SCOPE. This standard specifies the training activities and terminal objectives required for the training and accreditation of divers who are required to work safely and competently -

(a) using self-contained breathing apparatus (SCUBA) or surface-supplied compressed air to depths to 20m (see Note); and
(b) on sites where no surface compression chambers are required by AS 2299 to be present on site or within convenient distance.

NOTES:

1. Training and certification to this standard is generally the minimum required to undertake diving in on-shore locations to undertake construction activities, eg. repair of jetties, dams.

2. Attention is drawn to the requirements of AS 2299 and of regulatory authorities which limit the depths and times of diving with no compression chamber facilities.

3. Persons who wish to be trained sufficiently to dive to greater depths need to be trained to AS XXXX, Part 3. Graduates from training courses to this standard, ie. AS XXXX, Part 2, who wish to upgrade their diving qualifications may be eligible to do so by completing approved selected modules at an approved diving school.

1.2 PURPOSE AND TERMINAL OBJECTIVES

1.2.1 Purpose. The purpose of this standard is to describe the organizational and syllabus requirements for the following:

(a) To train underwater workers for the diving industry to operate safely and competently to depths of 20m using self-contained and surface-supplied breathing apparatus in accordance with AS 2299.
(b) To provide a knowledge of the underwater skills required by the industry and the application of basic skills in order to complete a range of underwater tasks safely and efficiently.

The following important aspects need to be stressed:

(i) Safety and health. The safety and health of the diver and the development of safe working practices MUST be integrated into all aspects of the training course.
(ii) Team Training. The training, particularly in practical diving and underwater working, needs to be directed not only towards developing individual competence, but also to develop the trainee to think and act as a member of a team.

1.2.2. Terminal Objectives

Table 2.2 Use of self-contained and surface supplied diving equipment (including rigid helmet with free flow primary air supply).

1.3 APPLICATION. The standard recognizes that training may take place in a diving school or in company.

DRAFTING NOTES:

1. Investigations are under way to determine if reciprocal recognition of diver qualification and certification can be arranged between Australian and the European (EEC) authorities.

2. The Victorian Department of Minerals and Energy is currently working with other equivalent State regulatory bodies in Australia, under the auspices of the Australian Minerals and Energy Council (AMEC) Standing Committee on Off-shore Petroleum Legislation, to institute and implement *a uniform national system for off-shore diver accreditation. This standard is seen as the vehicle by which uniform training criteria can be set in Australia for diving activities requiring such certification.*

1.5 SELECTION CRITERIA.

(b) be a competent swimmer and hold a recognized certificate of swimming competence, eg. certificate as a military diver or sports diver to PADI, FAUI, NAUI;*

---

* *Professional Association of Diving Instructors (PADI)*
Federation of Australian Underwater Instructors (FAUI)
National Association of Underwater Instructors (NAUI)

SECTION 2. TABLES OF TERMINAL OBJECTIVES AND TRAINING TOPICS

Terminal objectives	*Training Objectives*
The overall standard to be achieved by the end of the training (to be able to -)	*Specific topics to be achieved during the training to meet the requirements of the terminal objectives*

TABLE 2.2

USE OF SELF-CONTAINED AND SURFACE-SUPPLIED DIVING EQUIPMENT (INCLUDING RIGID HELMET WITH FREE-FLOW PRIMARY AIR SUPPLY)

2.2.1	*Dive safely and competently using self-contained and surface-supplied diving equipment in sheltered and open water in varying bottom conditions and water visibility.*	*- Dive, act as a diver's attendant and standby diver in diving operations using self-contained and surface-supplied diving equipment.*
2.2.2	*Dive safely and competently to a depth of 20m using self-contained diving equipment to the reserve limit of the breathing set.*	*- Explain the function and operation of reserve systems currently available.* *- Operate the reserve safely.*
2.2.3	*Dive safely and competently to a depth of 20 m using two types of surface supplied diving equipment one of which must be rigid helmet with free-flow primary air supply (eg. Kirby Morgan, Swindel, Aquadine or Rat Hat).*	*- Act as a diver, diver's attendant, standby diver and panel operator in diving operations involving the use of band mask/demand helmet and free flow helmet to a depth of not less than 20 m.*
2.2.4	*Carry out emergency drills applicable to self-contained and surface-supplied diving equipment.*	*- Explain the procedure to be followed in the case of :* *- broken helmet/face plate* *- "blow-up"* *- trapped diver* *- unconscious diver* *- loss of communications* *- Explain current SCUBA emergency procedures, eg. equipment sharing, use of inflatable life jacket and buoyancy aids, etc.* *- Carry out at least one in-water simulated rescue of an unconscious diver using both types of diving equipment when acting as a diver and standby diver.*
2.2.6	*Perform user maintenance of self-contained and surface-supplied diving equipment and prepare equipment for use.*	*- Dismantle and reassemble self-contained and surface-supplied diving equipment.* *- Explain the function and operation of masks, helmets, SCUBA and associated diving equipment.* *- Explain the testing procedures to check equipment for defects.* *- Identify worn and damaged parts.*

2.2.7 Perform repairs and tests to diving suits.	*- Explain the principles of porosity testing of dry suits. Perform user maintenance and repair of diving suits, including heated diving suits.*

IN-WATER TRAINING TIMES FOR TABLE 2.2

The following minimum in-water training times must be achieved. In-water time should include some simulated decompression stops. Trainees may require more than the minimum times to achieve the terminal objectives.

Depth, m	*In-water time, min*
0 to 19	*900 (with a minimum of 400 in the depth range 11m to 19m)*
At 20	*300*

TABLE 2.4
DIVER COMMUNICATION SYSTEMS

2.4.2 Outline the basic principles of underwater communication and diver intercom systems.	*- Explain the differences between two- and four-wire telephone systems.* *- Perform a functional test on a diver intercom system.* *- Explain the principles of through-water communication systems.*
2.4.3 Use underwater communication and diver intercom systems for communication from diver to surface, surface to diver.	*- Act as a diver, telephone operator and attendant in a diving operation where a diving intercom system is the primary means of communication with a diver.*
2.4.4 Carry out use maintenance of underwater communication and diver intercom systems.	*- Perform user maintenance, eg. change earphones, microphone, check connections and battery, recharge battery.* *- Perform a test on a communication system and isolate a fault in helmet cable or box.* *- Explain the precautions to be taken to protect equipment.*

TABLE 2.5

UNDERWATER TASKS

NOTES:

1. *A substantial majority of the tasks must be completed using surface-supplied diving equipment.*
2. *At least one of the dives to 20m should involve an underwater task than an average diver would need at least 20 minutes to complete.*
3. *Tasks using power tools, cutting and welding equipment, and explosives, shall all be carried out using surface-supplied equipment incorporating communications.*

Underwater search, inspection and survey

2.5.4 Outline the basic principles of non-destructive testing.	*- Explain the basic principles and techniques of current non-destructive testing including:* *- ultrasonic* *- magnetic particle* *- cathodic protection measurement*

Rigging

2.5.5 Handle safely and efficiently cordage, wire, ropes, blocks and tackle, chain hoists, associated winches, Tirfors and working stages, including wet bells, on the surface and underwater.	*- Tie basic knots used in diving.* *- Handle ropes and wire* *- Rig a working stage for a practical diving task.*

	- Use blocks, tackles, chain hoists, associated winches and Tirfors on the surface and underwater. *- Explain the principles of mechanical advantage.* *- Explain the main purposes of current legislation concerning the use of lifting appliances applicable to diving operations.* *- Perform user maintenance of blocks and tackle, chain hoists and Tirfors.*
Hand tools	
2.5.6 Complete underwater tasks safely and efficiently using a range of hand tools, eg. wrenches, hammers, chisels and hacksaws.	*- Complete a range of underwater tasks to the required standards using a range of hand tools.* *- Act safely and competently in a diving operation involving the use of a range of hand tools.* *- Perform user maintenance of hand tools.*
Powered tools	
2.5.7 Outline the methods of operation, hazards, and safety requirements of compressed air and hydraulically operated tools, eg. jack hammers, impact wrenches, drilling machines, grinders and cut-off discs.	*- Explain the safety precautions to be taken when using compressed air and hydraulic tools.* *- Explain the principles, operating procedures and limitations of compressed air and hydraulic tools.*
2.5.8 Complete underwater tasks safely and efficiently using a range of compressed air and hydraulic tools.	*- Act as a diver in a diving operation using a range of powered tools.* *- Complete a range of tasks to the required standards.*
2.5.9 Perform user maintenance of compressed air and hydraulic tools.	*- Perform pre-dive and post-dive checks and user maintenance.*

Note: Some of the powered tools must be used at a depth of 20 m.

Water jetting, airlifts and lifting bags	
2.5.10 Outline the principles, methods of operation and safety requirements of high pressure and low pressure water jets, air lifts and lifting bags.	*- Explain the principles of water jetting equipment, air lifts and the use of buoyancy for lifting and the safety precautions to be taken.* *- Calculate the number of lifting bags and determine the procedures required to lift a given object.*
2.5.11 Use a low pressure or high pressure water jet, air lift and lifting bags safely and efficiently.	*- Complete underwater tasks to the required standards using a low pressure water jet, air lift and lifting bags.*
2.5.12 Carry out user maintenance of water jetting equipment, air lifts and lifting bags.	*- Perform post-use maintenance.*
Cutting and welding equipment	
2.5.13 Outline the principles, method of operation, safety requirements and uses of thermal arc cutting equipment.	*- Prepare thermal arc cutting equipment for use.* *- Calculate appropriate oxygen pressure.*
2.5.14 Outline the principles, method of operation and safety precautions to be taken when using oxy-arc cutting equipment.	*- Explain alternative methods of ignition.* *- Explain safety precautions to be taken on the surface and underwater.* *- Prepare equipment for use.* *- Calculate appropriate oxygen pressure.* *- Explain safety precautions to be taken on the surface and underwater.*

2.5.15 Use oxy-arc cutting equipment safely and efficiently to cut 'I' beam, pipe and cut flat steel plate up to 25 mm in thickness.	*- Perform pre-dive and post-dive checks. - Perform cutting tasks to the required standards. - Change cutting rods underwater.*
2.5.16 Perform user maintenance of oxy-arc cutting equipment.	*- Perform post dive maintenance of equipment including:- generator knife switch cables torch*
2.5.17 Outline the principles, methods of operation and safety precautions to be taken when using current methods of underwater electric arc welding.	*- Prepare equipment for use. - Explain safety precautions to be taken on the surface and underwater. - Explain different types of electrode and appropriate current settings.*
<u>*Underwater explosives*</u>	
2.5.18 Outline the types of explosive currently available for underwater use, their common usage and relevant Statutory Regulations.	*- Explain the procedures for the safe handling of explosives. - Explain current methods of initiation and procedures to be used in case of a misfire. - Explain the use of explosive accessories, eg. tools, exploders.*
2.5.19 Outline the use of explosives and the setting of firing circuits and their initiation using electrical and non-electrical methods and handle equipment under classroom conditions.	*- Explain the correct placing of explosive charges, parallel and series electrical circuits.*
<u>*Underwater construction techniques*</u>	
2.5.20 Outline the elementary principles of construction methods and practices associated with underwater structures and interpret relevant/simple engineering drawings.	*- Explain how to set up scaffolding underwater and the use of various techniques including concreting, sand bagging, shuttering and bolt tensioning. - Interpret a simple engineering drawing.*

<u>*TABLE 2.6*</u>

<u>*UNDERWATER HAZARDS*</u>

2.6.2 Outline the hazards from explosives, electrical apparatus and marine animals. -	*- Explain types of explosives normally used in underwater work. - Explain reasons for keeping explosives and detonators apart in separate boxes. - Explain importance of being fully insulated when doing underwater cutting and welding. - Explain difference between straight and reverse polarities in cutting and welding circuits. - Explain various venom processes found in marine animals. - Effects of various types of venom on the human physiology. - Precautions required in handling marine animals.*

TABLE 2.7

AIR COMPRESSORS

2.7.1	*Outline the principles, method of operation and health and safety requirements of high pressure and low pressure air compressors and be familiar with the requirements of AS 2299, Section 5.*	*- Explain compressor air flow and volume and requirements for particular diving operations.* *- Explain the relevant requirements of Statutory regulations.*
2.7.2	*Operate safely and efficiently and carry out user maintenance of high pressure and low pressure air compressors.*	*- Operate high pressure and low pressure air compressors.* *- Perform all checks and user maintenance including checking oil and water and draining filters.*
2.7.3	*Transfer gases into and out of high pressure air banks safely and efficiently.*	*- Explain the main safety precautions to be observed concerning the use of high pressure and low pressure air vessels and compressors and the siting of air intakes.* *- Explain the principles of decanting.* *- Explain the procedure for charging and charge an air cylinder directly from a compressor and from an air bank.*
2.7.4	*Operate and carry out user maintenance of associated air filtration equipment.*	*- Explain the purpose of a filtration system, including the components of a filter and its replacement and the siting of air intakes.* *- Use a simple analyser kit to determine air purity.*

TABLE 2.8

SURFACE COMPRESSION CHAMBERS AND THERAPEUTIC DECOMPRESSION

.8.2	*Outline procedures for surface decompression.*	*- Explain the correct schedules for surface decompression and requirements for safe transfer of diver to chamber.*

TABLE 2.9

THE PHYSIOLOGY OF DIVING AND FIRST AID

2.9.3	*Describe the dangers and symptoms caused by breathing too high or too low a concentration of oxygen or too high a concentration of nitrogen.*	*- Explain briefly the effects on the brain and lungs and what is meant by oxygen pulmonary toxicity.* *- Recognize signs and symptoms of hypoxia and anoxia, and how to treat these conditions.*
2.9.5	*Apply first aid treatment to injuries.*	*- Explain the signs, symptoms and treatment of shock, burns, arterial and venous bleeding (both external and internal), wounds and fractures including long bones and spine, electrocution, high pressure jetting injuries, dislocation, internal injuries, burns, blast and crush injuries (see NOTE).*

NOTE: The first aid training outlined above does not include training in the more detailed examination of a patient, nor does it teach the diver how to treat or nurse the patient over an extended time period. Therefore when divers are working under conditions where a diving emergency physician is not readily available, it is recommended that a person with additional training (paramedic) should be on the worksite. This may be a diver or a chamber operator with perhaps a nursing qualification, or a medical assistant from the armed services. A person in this second category must be capable of working under pressure. Training must include the diver's first aid training and paramedical skills which must include intravenous drips, diagnosis, intramuscular and intravenous injections. This would be envisaged as a separate certificate.

TABLE 2.10

RELEVANT LEGISLATION AND GUIDANCE

2.10.1 Outline the relevant Statutory Regulations and associated guidance notes as they relate to air diving operations. Review the requirements of AS 2299 and other relevant standards (eg. AS 2030).	*- Explain the main duties of the employer and employee.* *- Explain the main duties of the diving contractor, the diving supervisor, and the diver.* *- Explain the main purpose of AS 2299 and of other current Statutory Regulations and associated guidance notes as they apply to air diving operations using surface supplied and self-contained diving equipment.* *NOTE: Divers should also become familiar with requirements of regulatory authorities in other countries in which they intend to dive.*

3.4 PLANNED EXPERIENCE. On successful completion of a training program to the requirements of the training standard, the graduate will be able to dive safely and completely under reasonably controlled conditions as a Restricted Air Diver. A training program cannot convert a trainee into a fully competent air diver. This will require further planned experience on the job.

The term 'planned experience' is used deliberately, as it is only be reinforcing the skills and knowledge acquired during the training program that the graduate will become fully competent. Skills and knowledge that are not reinforced in this way are likely to be lost. The range of operations varies significantly between diving companies. In some cases a company will be able to offer experience in a wide range of operations, while for another it will be narrower and probably more specialized.

Whatever the particular circumstances, the company should define what they expect a competent air diver to be able to do and ensure he receives any additional training which may be required in order to carry out specialized tasks. Careful planning will be required to integrate graduates into existing diving teams to ensure that they are used safely and effectively. During planned experience to new diver's progress should be carefully monitored. He will require close supervision especially during operations involving new systems, procedures, or techniques. Supervision should be undertaken only by competent members of staff.

Part 3. Professional Air Diving

Part of the preface, where it differs from Part 2, and parts of Section 1 and 2 where they differ from Part 2, are reproduced below.

PART 3 - PROFESSIONAL AIR DIVING WITH SURFACE COMPRESSION FACILITIES.

This draft is particularly related to the training of personnel who will be engaged in professional and/or commercial underwater operations as described in AS 2299 using surface-supplied compressed air or self-contained breathing apparatus and having access to a surface compression chamber. Such qualification is the minimum required by regulatory authorities who are responsible for the control of off-shore diving, eg. oil and gas exploration.

Another part is also to be prepared for training of Diving Supervisors (Part 5).

SECTION 1. SCOPE AND GENERAL

1.1 SCOPE. This standard specifies the training activities and terminal objectives required for the training and accreditation of divers who are required to work safely and competently:

(a) using self-contained breathing apparatus (SCUBA) to depths of 20 m (see note);
(b) using surface-supplied compressed air to depths of 50 m; and
(c) on sites with surface compression chambers present or within convenient distance.

NOTES:

1. Training and certification to this standard is generally the minimum required to undertake diving in offshore operations such as gas and oil exploration.
2. Attention is drawn to the requirements of AS 2299 and of regulatory authorities which limit the depths and times of diving under these conditions and specify the need for compression chamber facilities. In particular, the requirements of regulatory authorities and AS 2299 generally prohibit the use of SCUBA for working dives to depths greater than 20 m (see also Clause 1.2.1).

1.2 PURPOSE AND TERMINAL OBJECTIVES.

1.2.1 Purpose. The purpose of this standard is to describe the organizational and syllabus requirements for the following:

(a) To train underwater workers for the diving industry to operate safely and competently to depths of 20 m using self-contained and to 50 m using surface-supplied diving equipment in accordance with AS 2299.

NOTE: AS 2299 and some Statutory Regulations prohibit working SCUBA diving beyond 20 m except in special circumstances (see Clause 3.3(a) of AS 2299).

(b) To provide a knowledge of the underwater skills required by the industry and the application of basic skills in order to complete a range of underwater tasks safely and efficiently.

1.5 SELECTION CRITERIA.

Persons certificate as graduate divers to AS XXXX, Part 2 and wishing to upgrade their diving qualifications to those specified herein may be eligible to do so by completing approved selected modules at an approved diving school.

SECTION 2. TABLES OF TERMINAL OBJECTIVES AND TRAINING TOPICS

Terminal objectives	*Training Objectives*
The overall standard to be achieved by the end of the training (to be able to -)	*Specific topics to be achieved during the training to meet the requirements of the terminal objectives.*

TABLE 2.2

USE OF SELF-CONTAINED AND SURFACE-SUPPLIED DIVING EQUIPMENT (INCLUDING RIGID HELMET WITH FREE-FLOW PRIMARY AIR SUPPLY)

2.2.3 Dive safely and competently to a depth of 50 m using two types of surface-supplied diving equipment one of which must be rigid helmet with free-flow primary air supply (eg. Kirby Morgan, Swindel, Aquadine or Rat Hat).	*- Act as a diver, diver's attendant, standby diver and panel operator in diving operations involving the use of band mask/demand helmet and free flow helmet to a depth of not less than 40 m.*

In-water Training Times for Table 2.2

The following MINIMUM in-water training times must be achieved. In-water time should include some decompression stops. Trainees may require more than the minimum times to achieve the terminal objectives.

The in-water time shall be achieved by proportioning the times over the range of water depths available. The time must include some dives to 50 m.

NOTE: Where available, the following schedule is recommended:

Depth, m	*In-water time, min*
0 to 19	*1600 (with a minimum of 400 in the depth range 11 m to 19 m)*
20 to 39	*250 (with a minimum of 100 in the depth range 30 m to 39 m)*
40 to 50	*150 (with a minimum of three wet dives each of which must have a bottom time exceeding 10 min).*

Chamber Times

Attention is drawn to the additional times the trainee must spend in the compression chamber (see Table 2.8).

TABLE 2.5

UNDERWATER TASKS

NOTES:

1. *A substantial majority of the tasks must be completed using surface-supplied diving equipment.*
2. *At least one of the dives to 35 m (minimum) should involve an underwater task that an average diver would need at least 20 min to complete.*

3. *Tasks using power tools, cutting and welding equipment, and explosives, shall all be carried out using surface-supplied equipment incorporating communications.*

Powered Tools

2.5.7
Note: Some of the powered tools must be used at a depth between 25 m and 35 m.

TABLE 2.8

SURFACE COMPRESSION CHAMBERS AND THERAPEUTIC DECOMPRESSION

2.8.1	*Outline the layout of a two-compartment compression chamber, safety and fire precautions, emergency procedures, method of operation, control panel, air supply and oxygen breathing system.*	*- Explain the purpose and operation of services to the chamber including the function of all components.* *- Explain the need for oxygen cleanliness and the safety precautions to be observed.* *- Explain the provisions specified in Section 4 of AS 2299.* *- Explain the main requirements of the Statutory Regulations concerning pressure vessels.*
2.8.2	*Perform user maintenance of a two-compartment compression chamber.*	*- Perform pre-dive and post-dive checks.*
2.8.3	*Operate a two-compartment compression chamber.*	*- Pressurize, flush through and decompress a two-compartment compression chamber.*
2.8.4	*Complete a test dive to 50 m in a two-compartment compression chamber.*	*- Complete a simple dexterity or comprehension test at a depth of 50 m.*
2.3.5	*Prepare a two-compartment compression chamber for therapeutic treatment.*	*- Perform functional tests of all appropriate systems including communications equipment.* *- Ensure appropriate fire precautions are taken and fire prevention equipment is available.* *- Ensure appropriate first aid and personal supplies are available for the patient.*
2.8.6	*Interpret and apply air decompression tables.*	*- Calculate the correct decompression schedules for single, combined and repetitive dives using current decompression tables.*

APPENDIX A

EXAMPLE OF TRAINING SYLLABUS OUTLINE SYLLABUS FOR 12 WEEK BASIC AIR DIVING COURSE - (SUMMER 1981)

(Operated by Prodive Limited,
Commercial Diving Training School,
Falmouth, Cornwall)

DRAFTING NOTE: Comment on alternative examples of syllabus suitable for operations in Australia, acceptable to Australian authorities and, hopefully, European authorities, is especially requested.

In particular some concern has been expressed for the high level of SCUBA content, which may not be appropriate for the training of professional air divers.

NOTES ON THE COURSE

1. *Physical training will be carried out each morning for the first six weeks of the course.*
2. *Night dives will be arranged during the second, fourth and tenth weeks of the course.*
3. *First aid training will be held on one evening per week for the first eight weeks.*
4. *Each day is divided into eight periods of instruction. ‘P’ denotes a period of practical instruction. ‘T’ denotes a period of theoretical instruction.*

Part 4. Bell Diving

Part of the preface, where it differs from the preface of Part 3, parts of Section 1 and 2 where they differ from Part 3, are reproduced below.

This draft is particularly related to the further training of experienced air divers and underwater workers to permit them to operate safely and competently as bellmen and lock-out divers. Such training and accreditation is the minimum required by regulatory authorities who are responsible for the control of deep diving off-shore, eg. oil and gas exploration.

SECTION 1. SCOPE AND GENERAL

1.1 SCOPE. This standard specifies the training activities and terminal objectives required for the training and further accreditation of experienced air divers to operate safely and competently as bellmen and lock-out divers.

1.2 PURPOSE AND TERMINAL OBJECTIVES.

1.2.1 Purpose. The purpose of this standard is to describe the organizational and syllabus requirements necessary to train experienced air divers to operate safely and competently as bellmen and lock-out divers.

1.2.2 Terminal Objectives. Terminal objectives have been grouped under four headings (Tables) in this standard as follows:

Table 2.1 Deck Compression Chamber Operations
Table 2.2 Diving Bell Operations
Table 2.3 Diving Theory, Physiology and First Aid
Table 2.4 Relevant Legislation and Guidance.

(c) Diving bell operations

(i) Familiarization training. Familiarization training must be given in shallow depths. The instructor or experienced bell diver must be in the bell until he is satisfied the trainee can act safely and competently as a bellman and lock-out diver in shallow depths before carrying out dives below 50 m.

The following minimum number of shallow training dives must be achieved:

A. Twenty-five bell runs with lock outs
B. Act as a bellman for 25 runs with lock-outs
C. Complete five simulated rescues of an incapacitated diver.

(ii) Training below 50 m. The trainee must complete safely and competently a minimum of four bounce dives acting as a bellman and lock-out diver at progressive depths from 50 m to 100 m. It is not essential for an instructor or experienced bell diver to be in the bell provided that the trainee has satisfied the requirements in (i) above.

NOTE: Where, due to seasonal conditions or weather, depths of 100 m are not available at the scheduled time of the 100 m training dives, the training school must notify the Regulatory Authority of the maximum depth of water available at that time and seek approval prior to diving to any alternative depth.

(iii) Task training. Trainees must complete underwater rescues from 50 m to 100 m to give representative in-water times and experience of working at these depths. The tasks may be carried out during the diving bell training, ie. (ii) above.

(iv) Saturation diving. Trainees must be exposed to saturation conditions for a minimum of 36 hours including decompression, and should whenever possible complete a lock-out dive under these conditions. Two excursions from saturation to a depth greater than 50 m can be counted as two of the bounce dives.

1.5 SELECTION CRITERIA

The trainee should, as a minimum -

(b) be a competent commercial air diver approved to AS XXXX, Part 3 with at least 12 months' experience as a commercial diver or have experience acceptable to the relevant Regulatory Authority;
(d) be able to understand written and verbal communications and be able to communicate easily with one another. This is particularly important where trainees or instructors are of differing nationalities.

DECOMPRESSION DIVING AND BONE NECROSIS

Dr RI McCallum of the Department of Occupational Health and Hygiene, The University of Newcastle-Upon-Tyne, has responded to the article "Decompression Diving can cause bone damage" which appeared in the April 1983 Barologia newsletter. The following information is of interest:

"1. The great majority of bone lesions are quite symptomless and do not involve joints and are therefore not disabling.

"2. Only a small minority of commercial divers have bone damage to joints and this is rare in the hip joint which is the most disabling area for joint damage to appear.

"3. We have not found bone damage at all in commercial divers who have not gone deeper than 30 metres. We have not found this condition in sport divers and indeed I think it is most unlikely."

RI McCallum
Reprinted from *BAROLOGIA* Newsletter, October 1983.

SECTION 2. TABLES OF TERMINAL OBJECTIVES AND TRAINING TOPICS

Terminal objectives	*Training Objectives*
The overall standard to be achieved by the end of the training (to be able to -)	*Specific topics to be achieved during the training to meet the requirements of the terminal objectives.*

TABLE 2.1

DECK COMPRESSION CHAMBER OPERATIONS

2.1.1	*Outline the working of built-in breathing and dump systems and carry out user maintenance of the systems under supervision.*	*- Assess masks for proper function.* *- Detect wear or damage of equipment.* *- Position valves to ensure correct functioning.* *- Select appropriate gas supply on panel and chamber.* *- Carry out user maintenance and replacement of worn and damaged parts under supervision.*
2.1.2	*Outline the working and purposes of valves, non-return valves, regulators, gauges and connections and carry out user maintenance under supervision.*	*- Explain the purpose and operation of gas systems to the chamber including the functions of all components.* *- Carry out user maintenance under supervision.*
2.1.3	*Outline principles and the use of oxygen and carbon dioxide monitors and where applicable calibrate them accurately under working conditions.*	*- Explain the principles of gas monitoring. Accurately calibrate and interpret readings of oxygen and carbon dioxide under working conditions.*
2.2.4	*Outline the principles of carbon dioxide scrubber systems and carry out user maintenance under supervision.*	*- Explain the need for carbon dioxide absorbent. Assess whether equipment is functioning correctly.* *Change carbon dioxide absorbent canister at appropriate times and charge canister correctly under supervision.*
2.1.5	*Outline the effect of impurities in gases and the need for purity.*	*- Explain the effects of impurities and possible methods of entry of impurities into -* *- the environment of a diving system;* *- a diver's breathing gas.* *- Explain the symptoms of carbon dioxide and oxygen poisoning and methods of prevention and control.*
2.1.6	*Outline the methods for cleaning gas systems to oxygen standard.*	*- Explain effects of oil and grease in contact with high pressure oxygen.* *Explain the correct use of appropriate cleaning methods and materials to avoid oil and grease contamination.* *- Explain the need for strict observance of the gas handling rules.*
2.1.7	*Outline the reason for oxygen cleanness.*	*- Explain the effects of a high pressure supply of oxygen in contact with a combustible material.* *- Explain procedures to prevent accidental contamination and appropriate methods of cleaning contaminated components.*
2.1.8	*Operate the built-in breathing system.*	*- Select correct gas mode during decompression oxygen or oxygen/helium.* *- Operate appropriate valves to ensure correct gas and built-in breathing system functions.* *- Supply oxygen or oxygen/helium to the built-in breathing system from the control panel.*

2.1.9	*Monitor the chamber for depth, temperature, humidity, oxygen level and carbon dioxide level and partial pressure limits.*	*- Explain the maximum and minimum permissible partial pressure limit of oxygen and carbon dioxide.* *- Monitor depth, temperature, humidity and oxygen and carbon dioxide levels within a system during a diving operation.*
2.1.10	*Outline the fire precautions and methods of dealing with fires inside and outside compression cheers.*	*- Explain reasons why only certain materials can be permitted inside a diving system.* *- Explain the operation and correct location of fire extinguishers.* *- Assess cheer cleanness before use.* *- Carry out chamber evacuation and isolation procedures from inside the chamber.* *- Explain procedures to be carried out by the surface team.*
2.1.11	*Carry out a pre-dive and post-dive check of a compression chamber under supervision using a check list.*	*- Explain the need for and carry out under supervision the pre-dive and pest-dive checks of a diving system using a check list.*
2.1.12	*Explain the working and safety features and operate a hyperbaric sanitary system under working conditions.*	*- Explain the working of the system and the need for safety features.* *- Operate system under working conditions.*
2.1.13	*Explain the working of and, under supervision, use a medical lock on a pressurized diving system.*	*- Explain the consequences of misuse of the hand-lock.* *- Detect malfunctions of valves and if necessary take appropriate safety actions under supervision.* *- Assess correct functioning of valves, dogs, O-seals and seal facings.* *- Carry out routine maintenance of seals.*
2.1.14	*Operate and communicate, using helium unscrambler, telephone emergency signals and other communication systems.*	*- Operate primary and stand-by communication systems using helium unscrambler.* *- Practice emergency communication procedures.*
2.2.15	*Outline the reasons for and nature of emergency procedure, eg. contingency plan for chamber emergencies.*	*- Explain possible emergencies which may occur in chambers.* *- Explain procedures which can be used for example in event of fire, pollution, loss of communications, etc.*
2.1.16	*Apply compression and decompression schedules under supervision and outline abort procedures and therapeutic decompression schedules.*	*- Calculate correct gas mixture and depth for each stage of bounce and saturation dives.* *- Compress and decompress a diving system under supervision.* *- Explain abort procedures and circumstances in which procedures would be used.* *- Explain therapeutic schedules to be applied during or after exposure to pressure.*
2.1.17	*Make an accurate record of an actual dive.*	*- Maintain a log throughout a bounce and a saturation dive.*
2.1.18	*Act as an effective member of the surface team in support of bounce and saturation diving techniques.*	*- Act as an effective member of the surface team supporting bounce and saturation diving operations using all the bell handling, life support, and communication systems.* *- Act as an effective member of the surface team in providing the daily requirements of divers in saturation conditions.*
2.1.19	*Act as an effective member of a diving team under bounce and saturation conditions.*	*- Complete all objectives in this Table to the required standards.*

TABLE 2.2

DIVING BELL OPERATIONS

2.2.1	*Outline the principles of hyperbaric oxygen and carbon dioxide monitors and calibrate them in the diving bell.*	*- Explain the principles of both oxygen and carbon dioxide analysers.* *- Use and interpret the readings of oxygen and carbon dioxide analysers under working conditions.*
2.2.2	*Demonstrate the ability to put diving gases on line to the diving bell, diver's breathing apparatus and mating trunk.*	*- Explain the purpose and operation of gas systems from the control van to the bell and the function of all components.* *- Operate the systems under working conditions.*
2.2.3	*Outline the working of the bell scrubber system.*	*- Explain the need for carbon dioxide extraction.* *- Analyse the bell atmosphere for carbon dioxide content.* *- Carry out canister replacement when necessary.* *- Understand permissible limits of carbon dioxide.* *- Carry out procedure for flushing of bell when necessary.*
2.2.4	*Describe the diver's heating systems (external body heating and respiratory gas heating).*	*- Explain the need for and operation of heating systems.* *- Explain action to be taken if failure occurs in heating systems.*
2.2.5	*Use main and secondary communication systems.*	*- Operate primary and back-up communication systems during bounce and saturation diving operations.*
2.2.6	*Describe methods of ballasting and ballast-release systems.*	*- Explain the purpose of ballasting procedures for slipping the ballast in emergencies.*
2.2.7	*Describe the working of, and operate under supervision, a handling system for diving bell operations.*	*- Explain the working of, and operate, a handling system under supervision.* *- Explain safety precautions and back-up facilities available in event of main power system failure.*
2.2.8	*Carry out pre-dive and post-dive checks of the diving bell using a check list.*	*- Explain the need for and carry out under supervision the pre-dive and post-dive checks of a diving bell using a check list.*
2.2.9	*Outline methods of emergency bell recovery.*	*- Explain possible circumstances in which the loss of a diving bell may occur.* *- Explain some recovery methods available for different emergencies.* *- Explain the actions to be taken by the surface and diving teams in emergencies.*
2.2.10	*Demonstrate emergency routines including the rescue of an incapacitated diver.*	*- Prepare the bell for emergency chamber evacuation.* *- Use built-in breathing systems in simulated contaminated atmospheres.* *- Carry out simulated rescue of unconscious diver with the bell partially flooded.* *- Carry out expired air method of resuscitation and external cardiac massage in bell.*
2.2.11	*Act safely and competently as a bellman and lock-out diver.*	*- Carry out duties of bellman in tendering and handling locked-out divers.* *- Analyse and control bell environment gas mixture.* *- Explain operation of regular and emergency scrubber systems.* *- Operate diver's heating system.* *- Operate all internal controls.* *- Explain emergency bell decompression methods and metabolic oxygen make-up.*

	- Explain emergency procedures for loss of communications, gas supply, umbilical and ballast. *- Complete minimum diving requirements specified in Clause 1.2.3(c).*
2.2.12 Act as an effective member of the surface team in support of bell diving and transfer under pressure procedures.	*- Complete all objectives in this Table to the required standards.*

APPENDIX A

EXAMPLE OF TRAINING SYLLABUS
Bell Diving Training Course - Diving Requirements and Outline Syllabus

(Operated by Underwater Training Centre,
Fort William, Inverness-shire, Scotland).

DRAFTING NOTE: Comment on alternative syllabus suitable for use in Australia, acceptable to Australian authorities and, hopefully European authorities, is especially requested.

1. Diving requirements

To achieve the required standard the trainee must complete the following diving programme:

1 Bell familiarisation training in shallow depths.
Minimum requirements
25 lock-outs

25 dives acting as a bellman

5 simulated rescues of an incapacitated diver.

2 Dives from 50 to 100 metres

1 50 metre bell bounce dive on air
1 55 metre saturation dive with excursion to 75 metres
1 75 metre bell bounce dive
1 100 metre bell bounce dive
1 simulated rescue of an incapacitated diver on a bell dive below 50 metres.

12 trainees per course.

The SF/17 Committee is to be congratulated on its efforts. The sad toll of accidents and deaths in the North Sea prompted the UK regulations as it was evident that many of the problems were due to inadequate training. It is good to see the drive for world wide standards shown in this draft. The UK regulations have proved their worth and prescribe the obvious standard of training and competence for Australia to aim for. One problem faced by Australian diving schools is finding 100m water depth which can be used safely all the year round. Without this depth divers cannot be trained to the UK standard for Bell Diving.

A study of the various training programmes shows how much extra time and effort goes into producing a commercial diver compared to producing a sports diver. Even the part-time diving archaeologist, researcher or scientific observer has to do a 20 day course. With the minimum underwater training requirements of 15 hours these people should be safe underwater even with distractions of a definite task.

An Australian Standard is a guide book for good practice, not a legal obligation in its own right. Let us hope that the Commonwealth and all the State and Territory governments will soon pass legislation making the training outlined in the various parts of this Draft Standard obligatory for all divers who are paid to dive. But that alone will not prevent people killing themselves in such ways as diving deep on air in a cold, fresh water lake in Tasmania to do a job on the cheap. Heliox diving and hot water suits were needed to recover the body of that young professional diver. He did not know enough, or was foolish enough to ignore what he knew, to plan that dive safely. With the programme outlined in the Draft Standard that diver's successors will know the risks and hopefully will not be willing to cut corners on safety to make money. Their employers will also know what training the divers should have done to face the tasks before them.

The Standards Association invites comments on the draft. Should you wish to comment you can obtain a copy of the draft from:

The Standards Association of Australia
191 Royal Parade
Parkville VIC 3052

The Association also has offices in the other capital cities.

NSW WATER SAFETY WEEK

REQUIEM AND FLAG

The theme of the 1983 Water Safety Week was Diving Safety. A symposium on this theme was held at the Sydney Opera House on September 28th and 29th. Among the speakers were representatives of the RAN, the Police Divers, the Maritime Services Board and both FAUI and PADI. There were talks on the lessons from diving fatalities and the investigation of fatalities, the use of helicopters for the rapid transfer of the victims and the contrast in the speed of reaching hospital facilities between a road traffic accident and a person suffering a suspected diving-related problem. Of particular impact were two films and a reminder of the present status of the "Divers Down" flag.

The first film to be shown was titled "Requiem for a Diver", a well scripted and played quick review of the common faults using a variety of Royal Navy (and other) equipment. It has a message for every diver and contains many of the basic safety lessons which will be forever relevant. It was made years ago but has a timeless ring of truth. See it if you get the chance.

This excellent RN 16 mm optical sound film is available on loan from

Dr John Knight,
80 Wellington Parade,
EAST MELBOURNE VIC 3002.

The borrower is responsible for transport charges and replacement insurance ($600).

Colin Hodson presented the second film, the record of teaching some disabled persons to dive. This project continues and will be reported on further when a progress report is produced. The project has encountered many problems, for participants are people with personalities and not a single entity of "the disabled" (a fact noted previously in this Journal).

Of most immediate and practical importance to divers were the comments of Captain Stacey of the Maritime Services Board of NSW. He drew attention to the benefits and limitations of the Flag A, flown, one hopes, by all boats from which divers are operating. He reminded his listeners that there are regulations about diving in tideways and shipping channels and that the flag is ONLY relevant to vessels. Until and unless new regulations are brought out a diver not operating from a boat is NOT protected by the regulations, though a flag will indicate to vessels his presence. The balance of benefits and limitations which would ensue from Flag A being required for all diving in all situations are matters which need thorough consideration.

It is of some interest to recall that Flag A has been the only "Diver Down" warning flag officially sanctioned in the UK and Australia for many years. The change to Flag A occurred in the UK between 1966 and 1970, the date of change in Australia being similar. There had been a period from 1962 in Australia when Flags 'H' and 'D' had replaced the use of the red and white diving flag then, and still, in use in the USA. Flag 'Alpha' received international acceptance in 1981 and is expected soon to become recognised for its diving connotation in the USA also, though people there say that it will take a long time to educate those in charge of vessels.

A formal declaration of dive shop policy on the hire of equipment was made public in a document agreed to and signed on behalf of FAUI, PADI and NAUI (in April 1983). Their members agreed to supply only those divers able to produce documentary evidence of their training. In the commercial diving world, too, certificates of competency are now a requirement. Thus is diving safety improved.

MEMBERSHIP OF SPUMS

Members pay $20.00 yearly and Associate Members $15.00. Associated Membership is available for those neither medically qualified nor engaged in hyperbaric or underwater related research. Membership entitles attendance at meetings and the Annual Scientific Conference and receipt of the Journal/Newsletter.

Anyone interested in joining SPUMS should write to:

Dr Chris Acott
Secretary of SPUMS
Rockhampton Base Hospital,
Rockhampton QLD 4700

COURSE IN HYPERBARIC MEDICINE FOR DOCTORS AND NURSES

Prince Henry Hospital, Sydney Friday 2 March to Sunday 4 March 1984

Physiology, Medicine and Applications of Hyperbaric Medicine

Chamber work may be available for suitable candidates

Further information from
HBO Course
Department of Anaesthesia
The Prince Henry Hospital
PO Box 233
MATRAVILLE NSW 2036.

Bent Diver Wins $2.3 Million Suit

Depth Gauge Inaccuracy an Issue.

In our three part series elaborating on the US Navy depth gauge tests, we indicated the relative accuracy of the 28 gauges tested and listed those gauges which performed best. As the Navy found, gauges can vary wildly at a variety of depths, although manufacturers attempt to set quality control standards for gauges from ±1 to ±3 feet. The manufacturers seldom indicate the tolerance in the literature provided the diver and, of course, the Navy found that many gauges vary far beyond these limits. What this might mean legally should a diver get hurt was an issue in a recently decided case in Los Angeles.

In 1976, Mathew Hamilton, a Los Angeles County lifeguard, was permanently disabled after suffering the bends on a 120-foot dive near Santa Catalina. He was on County business at the time, studying a possible site as an underwater preserve. Suffering still from "constant pain in his lower back, numbness, tingling in both hands and feet and a stumbling gait and headaches," he sued the County. In February, he was awarded $2.3 million in damages.

The County considered taking action against US Divers, which marketed the depth gauge Hamilton used. The gauge, a so-called "Navy gauge" which US Divers stopped marketing in 1972, had been manufactured to a ±5% tolerance. The gauge was tested and found to register within that tolerance. The County decided not to sue. The question we must ask, however, is what about the diver's assumptions about the gauge? If the manufacturer provides no information about the range of error to the consumer, would he not presume that 120 feet means 120 feet?

At the 5% tolerance levels assumed ten years ago, the US Navy study of currently marketed gauges showed that nine out of 28 failed to meet that standard. Many more in the test failed to meet the ±3 feet manufacturers' standards.

Producing a highly accurate, shock resistant depth gauge for a price sport divers are willing to pay is apparently no small task. Nevertheless, the manufacturers and distributors of the gauges do relatively little to tip us off to the potential, or real, error of their products. We wonder who will be the first to come out of the closet and treat the consumer as an adult by providing him with facts on the likelihood of error.

Reprinted, by kind permission of the Editor, from UNDERCURRENT, May 1983.

CAREFUL, PLEASE, WITH YOUR CAMERA FLASHLIGHTS

Lightening or strong light flashes can cause barramundi to suffer heart attacks after long journeys. Apparently they suffer jet lag, so fish transported on Friday from Darwin to Sydney are "off limits" to photographers until the next Tuesday. Possibly visiting celebrities wear dark glasses for the same reason?

SPUMS ANNUAL SCIENTIFIC MEETING 1984

Next year's ASM will be held from April 7th to 16th at Phuket Island Resort, Thailand.

A conference will be held in Hong Kong on April 18th where there will be a meeting with local and SPUMS speakers. The guest speaker will be Surgeon Captain RR Pearson, who is the Royal Navy's senior diving medical officer. He will be speaking at both meetings. His topics will be:

Oxygen, the diver's friend or foe?

The problems of caring for sick or injured divers in compression chambers.

Medical screening of professional and recreational divers.

Dysbaric osteonecrosis, is it a major problem for divers?

Saturation diving, a review of military experience and associated research.

The management of divers with audiovestibular problems.

Presentation and diagnosis of decompression illnesses.

Arterial gas embolism in diving and in clinical practice.

The deep trial unit and the Admiralty Marine Technical Establishment (Physiological Laboratory) (AMTE PL).

The Institute of Naval Medicine and controlled atmosphere research.

SEA SECRETS REVEALED YOU WON'T GET RABIES:

Question: A crew member on my boat was a bit careless when boating a wahoo, and the fish bit the calf of his leg. At the hospital where the wound was sutured, the doctor asked for the head of the wahoo so that it could be checked for rabies. Do fishes get rabies?

Answer: No. Only warm-blood animals are susceptible to infection with rabies virus, and the susceptibility varies widely from species to species. According to "Rabies", Scientific American, January 1980, skunks, opossums, and fowl are relatively resistant, but foxes, cats, and cattle are highly susceptible. Human beings and dogs occupy an intermediate position.

Reprinted by kind permission of International Oceanographic Foundation from Sea Secrets. Vol 26, No 4, July-Aug 1982.