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BR 2806

UK MILITARY DIVING MANUAL VOLUME 2

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By Command of the Defence Council

Kevin Tebbit

COMMANDER-IN-CHIEF FLEET

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PREFACE

THE SUPERINTENDENT OF DIVING'S MANDATE
The Superintendent of Diving (SofD) is the higher authority for Service diving and equipment including Army and SF except for diving equipment and procedures exclusive to Senior Diving Officer (A) (SDO(A)). SofD leads in all aspects of diving related to Health and Safety measures. This authority is exercised on behalf of the Ministry of Defence.

1. BR 2806 UK Military Diving Manual is issued in Two Volumes and is sponsored by The Commander in Chief Fleet.

2. The purpose of Volume Two, is to promulgate for its users operating regulations and guidance for the conduct of all Military Diving. It also covers Decompression procedures and the drills for operation of individual breathing apparatus.

3. All Military Diving is to be conducted in accordance with the regulations, drills and procedures laid down in this volume. Regulations and theoretical aspects of diving are contained in Volume 1 of BR 2806.

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5. Users wishing to comment on the contents of this publication should use a duplicate of the special form provided on page v, copies of which are to be forwarded through the usual administrative channels to the addressees shown on page ii. A copy should also be forwarded to the Drill Co-ordinator for this publication, at the following address:

6. Lead authorities are allocated by Chapter as follows:

Chapter 9	Inspector of Diving (I of D)
Chapter 10	Defence Diving School
Chapter 11	Inspector of Diving (except Section 1) (INM)
Chapter 12	Inspector of Diving (I of D)
Chapter 13	Institute of Naval Medicine

7. Other relevant publications are:

BR 388(1)	Handbook of Demolition and Explosives
BR 1313	Maintenance Management in Ships
BR 1750(A)	Handbook of Naval Medicine
BR 1950	Naval Pay Regulations
BR 2806(Rec)	Master Diving Record

BR 2807(Series)	Handbook of Diving Equipment
BR 2808(1)	Diver Underwater Tasks Manual
BR 2808(2)	Marine Salvage Manual
BR 2808(3)(Series)	Propeller/Blade Change by Divers
BR 3030(2) and 3030(3)	Radiological Hazards and Safeguards
BR 4024	Adventurous Training in the Royal Navy
BR 4504	Cathodic Protection Control System for Surface Ships
BR 5063	Clearance Diving Operations
BR 5063(SUPP)	Clearance Diving Supervisors Aide Memoire
BR 6506(Series)	Impressed Current Cathodic Protection
BR 8374	Officer Training Regulations
BR 8988	Military Tasks and Counter-Extremist Security Measures in the Royal Navy
ADivP-1(A)/MDivP-1(A)	Multinational Guide to Diving Operations
ADivP-2(A)/MDivP-2(A)	Multinational Guide to Diving Medical Disorders
ATP 10(D) BRIT SUPP 2	Search and Rescue British Supplement 2
AGA1	Army General Administrative Instructions
JSP 327	Joint Service Manual of Movements
JSP 375 Vol 2	Health and Safety at Work Act 1974
FCD 3	The Maintenance of Operational Effectiveness in the Surface Flotillas
FLAGOs	Fleet Administration and General Orders
FEOs	Fleet Engineering Orders

PROPOSALS FOR CHANGES

Classification..

Ship/Establishment .... Originating Dept ....
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Page	Para Number	Comment
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CHAPTER 9

CONDUCT OF DIVING OPERATIONS

SECTION 1 - PLANNING AN OPERATION

0901. Introduction

a. As with any operation, a diving task calls for detailed advanced planning to afford the diver the best chance of success.

b. Time on the bottom is physically limited, while time on the surface is not. It follows, therefore, that any time spent on the plan that saves the diver's time on the bottom is well spent.

0902. Responsibility

a. The responsibility for planning the operation is that of the diving officer and/or the diving supervisor. The responsibility for the conduct of the operation is solely that of the diving supervisor, who may, of course, also be the diving officer. It is of the utmost importance that the diving supervisor is fully informed of all details of the operation, and ideally he should be present at the planning.

b. To ensure that the operation is conducted efficiently, and is completed as quickly as practicable, all aspects of the job must be studied and the operation planned so that the maximum amount of work is done by the surface team and the minimum amount by the divers. The plan must allow for the minimum number of divers to be underwater at any one time and for each diver's job to be completed within the time available.

0903. The Diving Team

The minimum number of personnel required to support one diver in the water is laid down in para 0703. However most tasks are carried out more effectively by the use of more than one diver. The team should be manned accordingly, making full use of trained 'unqualified' attendants to increase the number of divers available for the underwater tasks.

0904. Notice of Diving Operations

a. The departments in the ship and all authorities concerned should be given as much notice as possible; for example, if operations are being carried out in an area where underwater explosions are likely to take place, adequate steps must be taken to ensure that explosions do not take place while diving is in progress.

b. In areas where boat traffic is heavy or in which flag signals are not readily observed, it is advisable to have a general signal made warning ships and authorities that diving will be taking place. If prolonged diving is taking place in areas used by merchant shipping a temporary notice to mariners is usually published.

0905-0910. Spare.

0911. Compression Chamber

The possible requirement for a compression chamber must be considered (see para 0791) and if a chamber is required the position of the nearest one ascertained. If a chamber is required but not readily available this will have a considerable effect on the proposed plan.

0912. Choice of Equipment

a. Only authorised service equipment, in accordance with Table 7-5A (para 0733) is to be used.

b. The type of breathing apparatus used depends mainly on the task. In general, Compressed Air Breathing Apparatus, either self-contained or surface supplied, is used for diver ship maintenance and bottom searches, CDBA in the minehunting and EOD roles, BODS, LEBA(O_2) - LAR V, LEBA (MG), LOSE, and RABA in the RMSBS roles.

c. Whether boots or fins are used again depends on the type of work being done. Fins are used in the search role, except when probing the bottom is necessary and the diver requires the anchorage and surer footing of boots. In the same way, a diver carrying out a hard task, such as operating a heavy spanner or purchase, may find boots more serviceable than fins.

d. The combination of snorkel and swim masks can be used with good effect for searching from the surface in clear water. A diver so rigged may well be able to search a ship's bottom down to the bilge keel.

0913. Choice of Diving Suit

a. As with equipment, the choice of suit is largely governed by the task.

b. Subject to the diver being warm, and meeting the buoyancy requirements and restrictions of para 0747, the diver may wear a dry suit, a wet suit, 'skin', or an undersuit or overalls.

c. In shallower depths, if the diver is required to be dressed for lengthy periods, particularly in warm climates, the wet suit is preferable. However, it does not stand up well to heavy wear and tear and in these circumstances the dry suit is better. The dry suit is also more suitable for particularly dirty conditions.

d. Divers using zip entry diver's dress, dry type, are to be made aware of the risk of the zip parting underwater if the fabric of the undersuit is caught in the teeth of the zip as it is being fastened. Divers are to check each other to ensure the zip is not fouled.

0914. Sequence of Events in Army Diving

a. When planning diving operations the following sequence of events must be adhered to:

(1) Receipt of orders to dive.

(2) Mission Analysis

(3) Time appreciation.

(4) Warning Order.

(5) Plan reconnaissance.

(6) Reconnaissance.

(7) Estimate.

(8) Plan.

(9) Orders.

(10) Deployment.

(11) On-site brief.

(12) Task.

(13) On-site debrief.

(14) Recovery.

(15) Maintenance

(16) Main debrief.

b. **Briefing**. As detailed in para 0970.

c. **Check Lists**. Each supervisor should make up and retain his own supervisor's check list, giving special attention to local conditions which apply to his own unit.

d. **Time Appreciation**. Construct an appreciation backwards, from the point at which work must be completed. Add at least 20 per cent to the estimated time for the execution phase.

e. **Issue of Warning Orders**. Whilst the supervisor carries out his detailed planning, some work can be carried out by the team in anticipation. The supervisor must, wherever possible, give a warning order to the team so that his 2i/c may begin to prepare stores for deployment.

0915-0920. Spare

0921. Surface Conditions

a. **General.** Before a diving operation begins, careful consideration must be given to the existing and probable changes in surface conditions of sea, visibility and air temperatures, as well as to the presence and expected movements of ships in the vicinity of the operation. Any of these factors may affect the satisfactory performance of the operation.

b. **Weather and Sea State**

(1) A rough sea may well endanger the diver, particularly when he is operating close to the surface around a small craft, which may be moving violently and when he is leaving the water. Sea-sickness may become a serious problem and prevent a diver from carrying out a dive. A rough sea may render impossible the efficient mooring of the diving boat.

(2) The state of the sea will have considerably more effect on the surface support team than it will on the diver. A rough sea will interfere with the exchange of lifeline signals, but in particular it will make the recovery of an unconscious diver a difficult and dangerous operation - one of the major factors to consider when deciding whether or not diving should take place. As a rule diving in open water becomes impracticable in winds stronger than force 4.

c. **Air Temperature**

(1) All personnel concerned in a diving operation, particularly the divers (including the standby diver), should be protected from extremes of temperature. The supervisor should ensure that all his team are suitably dressed for the work they have to do.

(2) *Cold Conditions.* The supervisor must ensure that his team are aware of the dangers of wind chill (para 0763 (Fig 7-1)) and frostbite. At skin temperatures below 10°C all sense of touch is lost, and prolonged exposure will halt the circulation causing frostbite. Shelter must be provided as close to the dive site as practicable, and if diving from ice suitable eye protection must be provided to avoid snow blindness caused by ultra-violet radiation. Equipment, particularly demand valves and regulators, should be protected if likely to freeze up.

(3) *Hot Conditions.* The supervisor must ensure that his team are aware of the danger of sunburn and heat exhaustion. Shelter from the sun must be provided as close to the dive site as practicable. Rubber items should not be exposed to hot sunlight for very long periods.

(4) *Visibility.* Diving operations should not be carried out in low visibility because of the dangers of the diving boat being run down by another vessel, of losing sight of the markers of marked swimmers or divers, and of unmarked swimmers getting lost.

(5) *Ship Movements.* The diving supervisor should obtain details of known ship movements in the vicinity of the operation. A good look-out must always be kept to allow the maximum time to warn and, if necessary, recover divers.

0922. Underwater Conditions

a. General

(1) Underwater conditions have different effects on the diver's mobility and visibility, depending on the equipment in use.

(2) Generally, a booted diver is affected more by the bottom and less by currents than is a diver working on or near the bottom using fins.

(3) The effects of different conditions are discussed below.

(4) *Rock.* Rock may be smooth or jagged. The diver can usually move around fairly easily, but he must take care that his lines and hoses are not caught up on protruding rock. Confronted by an obstruction or wreck, the diver should go over rather than around it. Gloves should be worn if the rocks are sharp.

(5) *Coral.* Coral makes a solid but jagged bottom, and although the diver can move around without difficulty, he ought to wear gloves to avoid the painful cuts he could easily incur, particularly from some of the poisonous corals. Otherwise precautions are as for rocks.

(6) *Gravel and Sand.* Gravel and sand generally provide a smooth flat surface, easy movement and good visibility for the diver.

(7) *Shell.* Shell is generally mixed with sand or mud. With a sand mixture, movement is easy and visibility is not impaired. With a mud mixture, the diver's movement becomes more difficult and his visibility is decreased with any increase in the proportion of mud to shell.

(8) *Mud.* Mud is the worst type of bottom. A booted diver usually finds movement difficult and the sediment he stirs up soon decreases his visibility. He should, therefore, be placed as near as possible to his job and, if possible, should orientate himself so that any current takes the silt away from his work. The self-contained swimmer enjoys the distinct advantage of being able to move around without touching the bottom, but even so there is often a good deal of silt and poor visibility close to a mud bottom, even when the bottom has not been stirred up by the diver's movements.

(9) *Visibility Underwater.* Underwater visibility varies with locality, general water conditions and the nature of the bottom; in tropical waters it is often possible to see up to 100m. Channel and harbour areas are generally turbid owning to sediment-laden rivers emptying into them and ships and strong currents stirring up the bottom; visibility is often zero and seldom more than 5 to 7m.

(10) *High Water Temperature*. As a diver's body cannot be cooled by sweating, it is extremely sensitive to high underwater temperatures. Heat prostration may be expected in water temperatures above 30°C if the diver is working, and in water temperatures above 35°C even when he is at rest - to avoid this the regulations given in para 0765 must be followed. There is, unfortunately, no diving equipment at present that will protect the diver from heat, although a 'hot water' suit supplied with cooled water might be effective if this is practicable. Heat stress may also be reduced by choice of suitable protective clothing ie. loose fitting cotton overalls rather than wet suits.

b. **Low Water Temperature**

(1) Protective measures can and must be taken in cold water, as an appreciable fall of body temperature is likely to occur. In extreme cases this may lead to loss of consciousness, see also paras 0140 and 0159.

(2) The precautions and protective measures required are as follows:

(a) Divers must be fully fit and briefed on the hazards of cold water diving.

(b) Divers must be adequately protected from the cold, either by the use of hot water suits, or by a well fitting dry suit with plenty of warm clothing, particular attention being paid to the effectiveness of neck and wrist seals.

(c) Adequate arrangements must be made for re-warming any diver who may suffering from cold exposure (see para 1344).

(3) When the water temperature is below 3°C the equipment, particularly the reducing valve (and demand valve if applicable), should be prepared and tested in a warm place and kept warm until required for use. This preparation should, if practicable, include drying the reducing valve (and demand valve) completely using warm air, thus ensuring there is no moisture in the valve(s) to freeze and cause malfunctioning. When required for pre-dive testing or for the dive the set must be transferred from the warm environment to the water with the minimum delay and it must NOT be used in air where practicable.

c. **Tides and Currents**

(1) In shallow water, currents are caused chiefly by tides and land configuration and by water that has been carried ashore by waves and is returning seaward (rip currents). It is most advisable to obtain as much information as possible about tides and currents in the area of the operation, for this information may be used not only to assist the diver or swimmer but also to warn him of the limits of his ability to operate. It may even dissuade him from operating at all.

(2) When obtaining this information bear in mind that tide tables show only surface movements, whereas both the direction and speed of the current may vary with depth, tide and bottom configuration. The maximum speed of the current need not occur at the surface.

(3) The strongest currents in which an unaided diver can work on the seabed are as follows:

(a) 0.5 knot: Easy movement in any direction.

(b) 1 knot: Movement uptide or acrosstide on a jackstay.

(c) 1.5 knots: Controlled movement downtide on a jackstay.

(d) 2 knots: Work only in the lee of an obstruction.

(4) *Waves.* In deep water, the motion of the water caused by surface waves diminishes rapidly with depth, so that at a depth of half the wave length (the distance between consecutive wave crests) a diver can barely feel the motion of the waves. For example, if the wave length is 40m then the water will be almost still at a depth of 20m. In shallow water the motion diminishes less rapidly with depth.

SECTION 2 - DIVING ACCESSORIES - PREPARATION AND OPERATION

0923. Introduction

a. This section deals with the preparation of, and operations associated with, common items of diving equipment other than breathing apparatus and diving suits.

b. The detailed description, diagrams and instructions for maintenance of these items are given in the appropriate equipment handbook.

0924. Diver's Float - Marked Diving

a. Divers carrying out marked diving are secured by lifelines to individual floats each of a buoyancy of at least 35kg.

b. The lifeline is to be secured to the lifeline belt or diving equipment, as described in para 0743

c. Before being secured, the line should be checked to confirm that it is long enough for the depth of water at which the diver is to operate. A length of 1.3 times the maximum depth of water will normally suffice.

d. Signals are passed as detailed in para 0963

e. Lines are to be marked as described in para 0742.

f. By night, an indicating light or chemical light (sea cell battery cyalume type) is to be fitted to the float.

0925. Diver's Swim Marker

a. Swim markers are 200mm spherical floats made from expanded polystyrene. The 25mm diameter stave is passed through the centre of the float and extends 150mm each side.

b. The floatline, made of MMF is secured to the stave and passed round the float, then made fast to its own part. Its length can then be adjusted by figure-of-eight turns round the float, the rope being finally secured at the required length by a clovehitch on the protruding stave.

c. For swimming on oxygen, floats are to be 'tied off' at the 7m mark. For other purposes sufficient scope should be allowed for the marker to be towed comfortably at the required operating depth.

d. To keep the floatline clear of the swimmer's feet a 50mm apple-ring float can be fitted on the line by taking a round turn through the hole in the float. The ring is then adjusted to a distance of 2m from the swimmer.

e. The diver's end of the floatline is secured by a bowline in accordance with Para 0743.

f. For recognition purposes, floats are to be painted bright orange or red and may be numbered.

g. It should be noted that the float is merely a marker and will not support the swimmer in the water and that the floatline is not strong enough to lift the swimmer out of the water.

h. Lines are to be marked as described in para 0742.

i. By night an indicating light or chemical light (cyalume) is to be taped to the stave.

0926. Adjustable Buoyancy Jacket (ABJ)

a. The ABJ is used for specific types of diving operation in which:

(1) A quick and significant increase in buoyancy may be required.

(2) Additional buoyancy would assist a diver in operating equipment on the surface.

(3) Divers are operating in shallow water without suit inflation (para 0747d), or in wet suits (para 0747c).

(4) Divers are required to swim while very negatively buoyant, and need to adjust their trim during the course of a dive (eg certain SBSSC operations).

b. The SABA has an integral Buoyancy Jacket which is fully detailed in Chapter 10.

0927. Lost Diver Marker (LDM)
The lost diver marker is to be made up from:

a. Special Buoy.

b. Light line minimum length $1^1/_3$ times the depth of water.

c. Minimum 10kg weight with circular search line attached. If the supervisor considers the use of a search line hazardous, it may be removed (Army only).

d. Night light (when required).

e. A distance line 5m long.

f. The LDM is to be ready for immediate use during the dive. Deployment is to be closely controlled in order to prevent possible injury to the lost diver. In fast water or strong tidal stream the LDM may need to be replaced at an early opportunity with a divers shot so as to provide a secure datum.

g. When conducting an attended circular search using a shot line, in non tidal waters, the requirement to have a lost diver marker ‘on site’ may be relaxed at the supervisors discretion.

0928. Buddylines

a. The buddyline assembly comprises two webbing armbands secured to the diver's arm by velcro fastenings and connected (diver to diver) by an attachment or span line. There are two variants of the attachment line, the standard line and the combat line (used by Special Forces). It is important that the armbands are sufficiently tight to prevent them from slipping.

b. Further details are given in **BR 2807(2)**.

c. Regulations regarding the use of the buddylines are contained in para 0745.

0929. Spare.

0930. Swim Mask

a. A swim mask is provided that fits snugly round the upper part of the face over the eyes, under the nose, but above the mouth. Swim masks should always be designed to include the nose so that pressure inside the mask can be equalised if the swimmer dives below the surface; otherwise the eyes are likely to suffer 'squeeze' damage.

b. This mask worn with a snorkel tube allows a diver on the surface to search the ship's hull immediately below the surface. For other forms of diving there are also occasions when its use with a free mouth-piece is most advantageous; eg for ease of communication when returning to the surface to report on a survey or repair task, or for ease of changeover between air sources.

c. As with the facemask used with a breathing apparatus, it must be kept from misting over by admitting a small quantity of water to run over the inner surface periodically.

d. If the mask becomes flooded it can be cleared by blowing sharply into it through the nose while holding the top firmly against the forehead. The exhaled air will then drive the water out at the bottom.

0931. Snorkel Tube

a. A snorkel tube is provided for use in conjunction with a swim mask.

b. It enables a diver to conserve his air on the surface or breathe freely with his face in the water when he is without a breathing apparatus.

c. The tube can be supported by means of a rubber grommet, which fits round the facemask strap and the tube, or it can be slid between the facemask strap and the face.

d. The tube also enables the diver with an exhausted set to take up the most comfortable position in the water, ie with the body upright and the head just below the surface.

0932. Spare.

0933. Diver's Distress Lamp

a. The diver's distress lamp is contained in a pressure-tight plastic case and is operated by screwing the clear lens clockwise until the lamp operates. The lamp is issued complete with securing strap and lanyard. The lamp is powered by an AA size alkaline battery which is fitted by removing the clear plastic lens.

b. The distress lamp is to be worn by naval divers at all times when conducting free swimming operations at night, at other times at the discretion of the diving supervisor. It should not be routinely used as a divers indicating light.

c. Army divers are to wear a divers distress lamp at all times when diving at night. In an emergency the diver indicates his position by switching on the divers distress lamp.

0934. Indicating Light/Cylume Stick

a. The indicating light is a safety light attached to the diver. It is operated by the diver and provides an indication of his position in the water.

b. When the battery operated light is worn the lamp fitting is secured high on the right shoulder, care is to be taken that the cable does not cause fouling should the emergency ditching drill be carried out. After the connector has been plugged into the cell these two parts are securely bound to each other with adhesive tape around their whole length; they are then similarly secured to the BCD chest strap. The connecting cable must be safely and securely tucked away and the pull ring of the ripcord must be free and easily accessible to the diver.

c. The light is operated by pulling the plastic ring while the cell is immersed in sea water, the battery then has an endurance of four hours. Once operated the light cannot be switched off, and the cell is discarded after use. For further details see BR 2807(2) Part 3A Chapter 3.

d. The battery operated light is being replaced by the cyalume safety light. This is a foil-wrapped light stick with an endurance of 12 hours. It is operated by removing the foil, bending, the Cyalume to break the internal container, then shaking. If the cyalume light is used in preference to the battery operated light, it should be secured high on the right shoulder in similar fashion to the battery indicating light.

e. For Army diving the diver uses the cyalume on his float to indicate his position to the surface team. In an emergency he indicates his position using the diver's distress lamp para 0933.

f. Navy divers are to use a indicating light/cyalume to indicate their position on the surface when diving at night or conducting free swimming operations. In an emergency he is to indicate his position using the divers distress lamp para 0933 or flare para 0937.

0935. Diver's Handlamp

a. This portable, battery operated lamp is generally used for close work, such as searching ship's bottoms or carrying out work on underwater fittings. It must always be secured to the diver by a lanyard to prevent loss if dropped.

b. Further details are given in BR 2807(2).

0936. Underwater Lighting

a. Underwater lighting can be used whenever matter in suspension in the water, or stirred up from the bottom by the diver, does not render it valueless.

b. Because harbours are generally muddy and, therefore, unsuitable for lighting, divers should get used to working by touch. They should never allow themselves to become wholly reliant on light. Furthermore, it must not be overlooked that lighting is one more item for both the surface team and the diver to worry about.

c. Even in relatively clear conditions a light beam underwater is full of reflections from particles of matter in the water and these reflections prevent the diver from seeing through the beam; the lamps should, therefore, be placed so that the beams obliquely strike the object to be illuminated, with as little beam as possible between the diver and the object.

0937. Emergency Flares

a. Emergency flares are carried and used by divers in free-swimming operations as described in paras 0782 and 0992. They are not designed for underwater use, and must be replaced before each dive.

b. The flare must be secured to the diver in a manner where it can be easily detached and comes readily to hand in an emergency. It must be secured to the diver and not his breathing set in case it has to be used after the set has been ditched. If the flare is secured to the knife sheath it is to be attached using a ring, wrist, grey NSN 0867-431-7218.

c. If the diver wishes to use his flare, he must first surface and then hold the flare in such a manner that it burns above the surface of the water.

d. When diving in pairs and one diver gets into difficulties, it is the responsibility of the 'buddy' to bring the diver to the surface and fire his flare. The second flare must be retained in reserve and used after a suitable interval, if it is apparent that no assistance is forthcoming.

e. These flares must be used only if emergency assistance is required. They must not be used for routine indication of the diver's position. Indication of the diver's position under these circumstances is provided by the diver's indicating light (para 0934).

0938. Wrist Depth Gauge

a. The depth gauge is graduated with an outer scale from 0-19m and an inner scale graduated from 20-50m. The gauge is designed to be strapped to the wrist, but can, if desired, be strapped to a swim-board as shown in Fig 9-1.

b. BR 2807(2) Part 3A, Chapter 1 gives details on the use and zeroing of the depth gauge.

0939. Compass

a. A hand-held compass is provided for use underwater. It can either be carried in the palm of the hand, using a lanyard round the neck, or strapped to the swimboard (para 0941). Either is easier than using it strapped to the back of the wrist.

b. The graduations and lubber's line are in luminous paint, enabling the compass to be read in the dark.

c. Bearings are taken while on the surface by viewing the object over the top of the compass. The course can then be swum by keeping the bearing in line with the lubber's line. With practice, courses of considerable accuracy (± 2°) can be swum.

d. Further details are given in BR 2807(2).

0940. Divers Watches/Stop Watches

a. **Divers Watches**

(1) Wrist Watches are provided for use when diving and supervising diving operations. These watches are normally supplied only to diving units (Navy) or qualified divers (Army). The diver's watch can be used to any depth attained in normal (as opposed to deep diving) operations. When used in an underwater swimming operation, the watch is normally strapped to a combined swimboard with depth gauge and compass (para 0941).

(2) Before and after use all watches are to be checked. A cracked glass will admit water under pressure, which may prove dangerous when the pressure is reduced. Although the watches are robust, they will not withstand unfair treatment and should not be worn in hot baths or showers.

(3) SAR divers may be issued with the divers watch instead of the standard aircrew watch.

(4) Diving supervisors may use privately owned civilian watches.

b. **Stop Watches**

(1) Digital Stop Watches are provided for use by Diving Supervisors.

(2) Authorised holders of the Stop Watch are MCDO's in receipt of Group 5 Diving Pay, WO(D)s, CPO(D)s, PO(D)s and LS(D)s. Ships Diving Supervisors in receipt of Group 2 Pay.

(3) Entitled Naval personnel are to draw a Stop Watch on joining a new Ship/Unit and return them on appointment/draft.

(4) Army Supervisors are to retain the watch throughout their diving careers.

0941. Swimboard

a. Swimboards are used in underwater swimming operations in which the diver needs his course, depth and time underwater readily displayed.

b. The boards can be made locally, with slots for securing the straps of the compass, depth gauge and watch as shown in Fig 9-1. A patternised version is available to SF & CDUs only.

c. A lanyard is attached to the swimboard, the other ending being secured either to the diver or the breathing apparatus, thus allowing the diver to use both hands when required, without losing the swimboard.

d. A patternised compass board assembly is available for CDU and SF use only. Further details are given in BR 2807(2).

0942. Recording Board

a. Army divers use recording boards when carrying out underwater surveys.

b. The boards can be made locally of perspex or macralon, and where appropriate, a measuring scale and grid should be etched into the surface with a saw or a hot iron.

0943. Bottom Probe

a. A bottom probe is required when it is necessary to ‘feel’ for an object buried beneath the seabed in mud.

b. The probe can be made of any suitable material that will readily penetrate the seabed. It needs to be rigid, up to 10mm in diameter and 2m long, depending on the estimated depth of burial. The probing end should be rounded and the upper end fitted with a lanyard and strop to assist withdrawal.

c. A search with a probe has to be meticulously conducted to ensure complete coverage and must be done using the grid search (see BR 2808(1)).

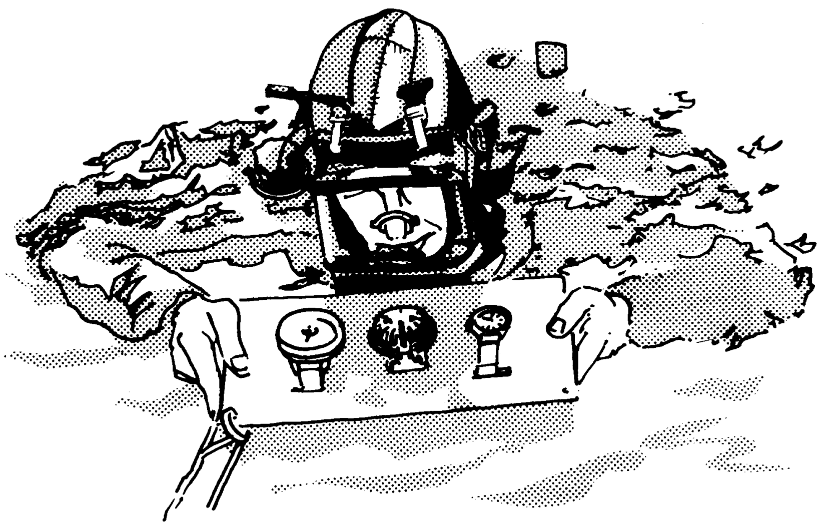

Fig 9-1. Swimmer with Swimboard

0944. Diver's Shot

a. The diver's shot can consist of any conveniently shaped heavy weight to which a rope is secured for the diver's descent and ascent.

b. With booted divers, the optimum size, is a 50kg sinker, but for divers more lightly equipped a 25kg sinker may be used. For deep diving from a diving tender/ship a sinker in excess of 50kg should be used.

c. It is important that the shot, once laid, does not move, because this will negate any search being conducted. This is why relatively large weights are employed, as it is only such weights that can withstand the influence of tide and current transmitted from the surface through the shot rope.

d. When working on a wreck it may be appropriate to secure the shot rope directly to some part of the wreck.

0945. Lazy Shot

a. A lazy shot is a light sinker with line, used to indicate the depth required for in-water decompression stops to a diver. It is suspended under the diving boat or platform. When conducting CDBA diving operations the XBS is to be used as the lazy shot. Its deployment and use is as detailed below for the lazy shot.

b. Before the diver's ascent, the lazy shot is lowered over the side to a depth 3m greater than the diver's first stop.

c. When marked swimming the diver's floatline is rove through a cliphook attached to the weight on the lazy shot which is then lowered down the diver's floatline before the diver ascends. The diver signals on arrival at the lazy shot and decompression continues.

d. When attended diving using a shotrope or sonar marking outfit the lazy shot is lowered down the shot rope or sonar marking outfit line and not the diver's lifeline. If drifting decompression stops are required the diver disconnects the lazy shot when given the signal of six bells. He then drifts with the lazy shot positioned at chest height.

e. A karabiner spring hook, through which the air hose can pass comfortably, is used when dives using surface support diving equipment are being carried out. Alternatively, a rope looped to the main shot rope can be employed.

f. In a strong tideway the diver will not hang vertically. If the angle is marked, the diving boat should be allowed to drift free to ensure that the diver is at the correct stop depth.

g. When operating with the lazy shot or XBS, the inboard end of the handling line is to be secured inboard. Care is to be taken to ensure that sufficient line is available for all decompression/emergency procedures, taking care that, if inadvertently dropped, it will not cause any damage, especially to the diver.

0946. Working Shot

a. When a diver needs a constant supply of items on the bottom - for instance, when working on a wreck - a working shot should be used for providing this gear.
b. This shot usually consists of a wire rope of about 12mm, fitted with a reeving eye and shackle to allow it to be secured in a convenient place close to the diver. Then if the diver has to move, he can unshackle the shot and resite it without difficulty.

c. The working shot may be lowered with the diver's shot rope, attached to the sinker by a lizard, which the diver disconnects on reaching it.

d. The working shot should be given a lead uptide clear of the diver's shot to ensure that the diver is clear of it when he descends and that any item slid down the 'working shot' will be assisted by the tide on its descent to the diver.

0947. Shot Rope

a. The shot rope normally comprises 50 to 100m of rope not smaller than 25mm spliced into a sinker. Other shot ropes of different sizes and with different weight sinkers are made up as required for particular operations. Where the rope is likely to chafe, as when working on wrecks, wire may be used instead of rope. Different uses for shot ropes are illustrated in Fig 9-2.

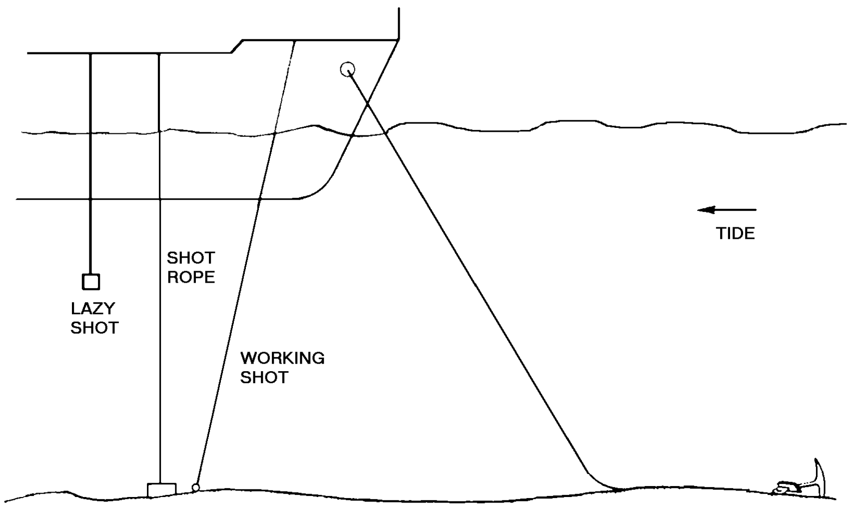

Fig 9-2. Use of Shots and Shot Ropes

b. During the course of an operation the shot rope should be checked at intervals to confirm that it is on the bottom and not dragging.

c. When wire ropes are used they should be checked periodically for broken strands and replaced when these appear.

d. Shot ropes do not have to be marked as described in para 0742, but it may be found useful as the markings give an indication of depth, such markings are not to be totally relied upon because with use, the shot rope will have a tendency to stretch.

0948. Diving Stage

a. A stable working platform from which the diver can work is required when operations have to be performed on propellers or elsewhere under the hull.

b. Temporary platforms can be rigged using crossed spars and ladders lashed to sinkers and slung under the ship.

c. For prolonged operations a properly constructed stage should be used. Owing to its limited application, the stage has not been introduced as an item of naval stores. It should be made locally with consideration given to where it will be rigged underwater and the materials available for its construction.

0949. Distance Line

a. A distance line is any convenient light line used by the diver to guide himself on the bottom. Its size should not be greater than 8mm.

b. The line is normally taken down by the diver and when used as a snagline for circular searches, is secured as low as possible on the shot or shot rope. It is normal practice to attach the distance line to the shot/shot line prior to it being deployed. An eye should be spliced into the outboard end.

c. When a number of successive circular searches is being conducted it is sometimes convenient to splice the distance line to the shot rope.

d. The optimum length for an 8mm distance line is about 15m. When used for circular searches 30m lines can be employed, but they should be less than 8mm in size.

e. Greater lengths are not generally used as they become unmanageable and tend to snag the seabed as well as objects proud of the bottom.

f. The distance /recovery line forms an integral part of the Sonar Marking Outfit and is manufactured to be 5 metres long, it is not to be extended for use in the Minehunting role.

g. To save time and effort distance lines must always be coiled neatly before the shot is sent down and by the diver before he leaves the bottom.

0950. Jackstays

a. The term jackstay is used for any line, whether it be wire or rope, of any size, that is laid on the seabed to guide the diver.

b. The size and length will depend on the task to be performed. As a general rule jackstays large in size and short in length are used for guiding booted divers, while swimmers can rely on light lines of considerable length.

c. Whichever type is used it is important that once the jackstay has been laid it is not displaced, either by the diver or by the influence of the elements. For this reason sinkers, typically 25kg for standard jackstays and 10kg for light jackstays, are attached to the jackstay at intervals, generally not greater than 100m.

d. In most seabed searches it is the speed with which these jackstays and associated gear are handled that is the controlling factor in the time taken for the search.

0951. Bottom Lines

a. Bottom lines are used less frequently, however they may still be useful when trying to locate a particular spot on the ship's bottom - for instance, the site of a valve - or when carrying out search schemes 'B' and 'C'.

b. The bottom line should be underrun and hauled taut opposite the appropriate frame number. The diver then uses this to guide himself down.

c. Bottom lines should be made of 12mm rope. Chain is not to be used because of the damage it causes to the protective coating of the hull. The rope may however be weighted provided that this is done in such a way that the hull coating will not be damaged.

0952-0954. Spare.

0955. Diving Boats

a. For prolonged operations a specially designed and properly equipped diving boat is essential. For short operations, however, almost any craft will suffice, provided it is stable and will take the weight of a diver climbing in and out without excessive heel.

b. A good diving boat will have the following features:

(1) Good stability.

(2) Large open diving platform with low freeboard.

(3) Adequate stowage under cover for equipment.

(4) Good protection for personnel against the weather.

(5) Provision for anchoring, or preferably, mooring.

(6) Adequate communications.

c. Speed is not essential, except in specialised roles, and protection for personnel and gear can be dispensed with under certain circumstances.

d. Ships' teams, whether in minehunters or fleet units, all require boats from which to conduct diving operations. Because of the physical limitations in lifting and stowage facilities, these boats are inevitably restricted in size.

e. Rigid Inflatable MIB's/RIBs of all sizes are used extensively and successfully in diving operations.

f. Spare.

g. In addition to the foregoing the inflatable MIB/RIB craft is supplied specially for the diving role. The inflatable MIB/RIB craft provides a stable diving platform in enclosed or open water, but has no weather protection for the occupants.

h. The minimum equipment contents list for inflatable MIB/RIB or other small craft used for diving support is given below. Additional items may be required and should be decided upon by the supervisor prior to the start of the task.

(1) Engine, sufficient fuel, fuel leads, and tool kit. The engine is to be secured with a non-magnetic, robust strop with a SWL of no less than 150kg. (Non magnetic property is not relevant to Army or Ship's Diving operations). A second can of fuel is to be provided if the supervisor considers it to be necessary.

(2) Paddles/oars.

(3) Dive Supervisor's Box. Those not entitled to draw a Dive Supervisor's Box are to make up box in accordance with para i.

(4) Medical Equipment Set - Diving Team/Dive Boat.

(5) BR 2806 Vol 2 updated with the latest change. MCDOs, PO(D)s and above may use BR 5063(Supp) Supervisors Aide Memoire.

(6) Form S288 or S1628A (AFB 576A inserts 1 and 2 for Army diving operations).

(7) Lost Diver Marker (LDM).

(8) Rigid flag Alpha.

(9) Anchor complete with sufficient line to enable anchoring in depth of water being dived in (not required for RN diving operations).

(10) Boat-hook (Army diving only).

(11) Hand-held VHF IMM radio.

(12) Depth sounding line or HONDEX.

(13) At night, appropriate lighting in accordance with International Regulations for the Prevention of Collision at Sea.

(14) Boat Bag in accordance with **BR 67** Admiralty Manual of Seamanship, containing: Leak-stoppers sizes 1, 2 and 3, and repair clamps (Gemini craft only). Foot pump and bailer. Towing bridle (if not fitted). **BR 98 Boats Signal Book**. Patches and adhesive (at supervisors discretion).

i. The Dive Supervisor's Box (A637-99-215-4101) shown at Fig 9-3 must contain the following:

(1) Five x Thunderflashes N5 three of which must be weighted in accordance with para 0967d.

(2) Two x Thunderflash strikers.

(3) Two x Signal Distress Day/Night.

(4) One x Signal Kit Pyrotechnic (Red) - (Mini-Flares).

(5) Two Diver Recall Signals (When Available)

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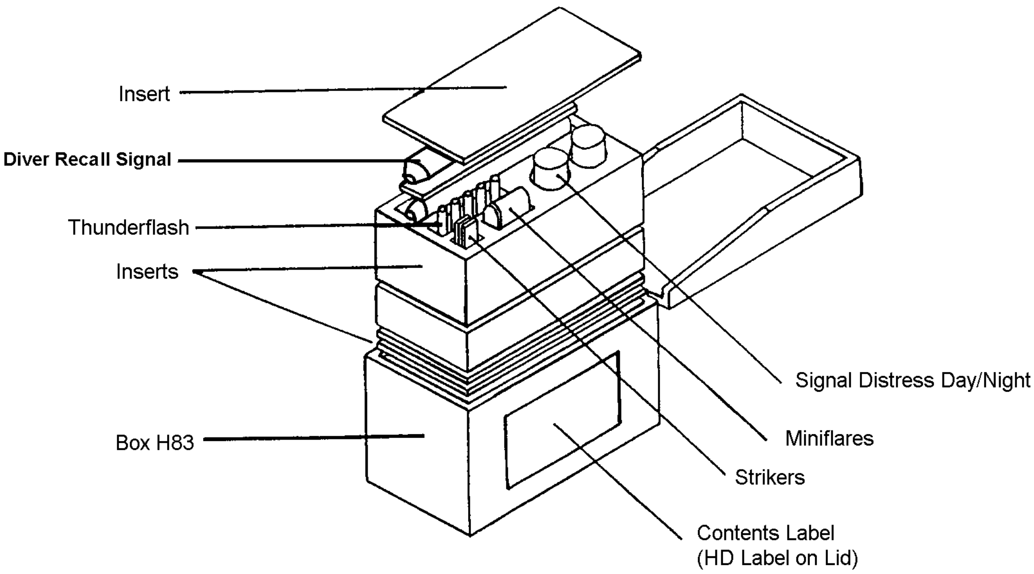

Fig 9-3. Dive Supervisor's Box

j. **Medical Equipment Set - On Site Diving Operations** (NSN 6545-99-097-6746) The First Aid kit listed below conforms to HSE guidance and should be considered as the least permissible contents. This kit is to be held at the site of diving operations ashore and afloat.

DESCRIPTION	QTY	MEDICAL STORES NO
CHLORHEXIDINE GLUCONATE,	6	6505-99-990-3422
BANDAGE, TRIANGULAR, Pack of 2	6	6510-99-210-2563
DRESSING ASSORTMENT Pack of 6	6	6510-99-210-2621
DRESSINGS FIRST AID	4	6510-99-210-7562
DRESSINGS STANDARD No 8	2	6510-99-210-2626
DRESSING STANDARD No 12	4	6510-99-210-2624
PADS, GAUZE Pack of 5 bags	5	6510-99-211-5331
AIRWAY GUEDEL SIZE 4	2	6515-99-211-1960
MOUTH GAG BAR TYPE packet of 3	1	6515-99-212-1083
SCISSORS BANDAGE 7" Pair	1	6515-99-211-4973
TOURNIQUET. SEATON	1	6515-99-211-5486
WRAPPER. METALLISED FILM (RESCUE SHEET)	6	6530-99-211-8795
SAFETY PINS. Assorted Packet of 24	1	8315-99-721-6822
CASE EQUIPMENT	1	6760-01-342-9966
OXYGEN RESUSCITATOR (With CHARGING ADAPTOR) LAR V RESUSCITATOR (For SBS use only)	1 1	6545-99-212-0526 8120-99-211-1561 (Special)

Notes:

1. Stock items should be made waterproof by the use of self-sealing plastic envelopes where necessary.

2. Most items are perishable and some have a short shelf life. The need for regular usability checks are to be written into each Units Pre-dive check list. Un-useable stock is to be replaced without delay.

3. On ships of frigate size or above, the oxygen resuscitator is to be obtained from the sick bay before diving commences.

4. If the oxygen resuscitator is to be used in the marine environment, it is to be removed from the carrying case as supplied and stored in the watertight protector case (NSN 6760-01-342-9966 Case, Equipment).

k. **Propeller Guards**. The restrictions on diving from boats without propeller guards are laid down in para 0771.

l. **Divers in Boats Under Way**. The restrictions on divers’ dress in boats under way are laid down in para 0750

0956. Diving Ladders

a. A ladder is normally required, except with craft of very low freeboard, to enable an exhausted diver to climb out of the water.

b. Many types of ladder can be used for diving but it is important when rigging them to ensure that they are firmly secured to the boat or diving platform and that lines are rigged to prevent lateral movement. In certain cases it may also be desirable to rig a line from the bottom of the ladder under the boat to give extra stability. There should be sufficient length (at least 1m) of ladder in the water to enable the diver to start climbing without excessive effort.

c. The bottom of the ladder should be rounded or padded to prevent injury to a diver surfacing suddenly.

SECTION 3 - DIVING COMMUNICATIONS

0957. Introduction

a. Good communications between the surface control position and the diver generally make for more efficient and speedy performance of work.

b. There are a variety of ways of communicating, some being two-way and some one-way only, as follows:

(1) Manual signals on the lifeline, air hose, buddyline, etc.

(2) Voice by telephone cable. (Diver's Communications System - SEAPIPER.)

(3) Divers Through-water Communications (DTWC)

(4) Underwater loudspeaker.

(5) Tapping on objects underwater (ladder, ship's hull).

(6) Underwater explosive signals.

(7) Visual signals underwater between pairs of divers.

(8) Visual signals on the surface.

c. Although limited in scope, the most reliable of these systems and the most commonly used is the one employing hand signal on the lifeline. Except in free-swimming operations, this method will always be available, and consequently all divers must know the signals Para 0966 in case the other more sophisticated systems break down.

0958. Spare.

0959. Voice Communications

a. Voice communications have obvious advantages over manual line signals, but constant practice is nonetheless necessary to ensure good understanding. Speech can never be as clear as in the open for a number of reasons. Although with the modern components used in the manufacture of communications equipment speech has improved considerably.

(1) Some self-contained equipments employ a mouthpiece, which interferes with enunciation.

(2) Pressure affects the vocal chords and distorts speech.

(3) Helium, used in deep diving, causes different resonance of the vocal chords, which produces a high-pitched squeak.

b. ‘Running commentaries’ by the diver are therefore impractical, irrespective of the equipment used. However, when using an oral nasal mask, which allows for correct enunciation, verbal traffic is simplified and must be kept to a minimum and messages passed as briefly as possible. Speech should be clear, distinct and unhurried and should be practiced as often as possible. Divers should aim to use communications equipment with confidence and, if using the bite mouthpiece, without removing the mouthpiece while speaking.

c. Directions and orders to the diver are to be repeated by the diver; it is not sufficient for a diver told ‘Swim north’ to reply ‘Understood’ for no one but the diver knows what he has understood. On the other hand, if a diver is sent down to report on the condition of a particular object, it is unnecessary for the attendant to repeat the report as it is made. The attendant should, at suitable intervals, pass to the diver ‘Receiving’ to indicate that the system is operative and the message is being received.

d. Should a number of divers be deployed under the control of a single supervisor, each diver is to be allocated a number (1-6) and referred to in all communications by that number eg: Diver 3 are you well? The Surface Control communication station is routinely known as ‘control’.

e. At periodic intervals, the communication number must establish contact with the diver in the following manner, “Diver (number) are you well?” and gain a positive response. If there is no response, and the diver/s are not free swimming, a check is to be made using life-line signals, unless conducting ‘free swimming operations’.

f. Should the communications system fail, for whatever reason, the dive is to revert to manual signals. If communications fail part way through a dive and manual signals are adopted, voice communications from both diver and surface support team should continue, as the exact point of failure may not be known. eg: The divers microphone may have failed yet his earphones function correctly and can therefore hear the verbal command. When manual signals are given they are repeated over the communications.

g. Short range (1000m) Divers Through Water Communications have been introduced for use with SABA to enhance diver safety. Communications should be used each time a diver enters the water. If the communications equipment is unavailable due to defects and divers are required to enter the water for operational or training purposes, the dive may continue providing a hazard assessment of the operation has been successfully completed by the diving supervisor.

h. The use of Long Range Divers Through Water Communications, used by divers operating LEBA (O_2) is at the discretion of CO’s SBS and FDG as dictated by diving operations scenarios.

i. Total reliance on voice communications is to be avoided, as a good working knowledge of manual signals is essential for continued safety. Each unit is responsible for ensuring that all divers retain full knowledge of the manual signal code.

j. For routine diving operations the Diving Supervisor should control the dive via the communications surface unit. This responsibility may be transferred to another member of the diving team if numbers suffice. The standby diver is not to act as the communication number.

0960. Seapiper Diver’s Underwater Communication System

The Seapiper Diver’s Communication System provides two separate systems of communication, line and through-water.

a. **Line Communications System**. This is a hard wired system for attended divers using communication cables incorporated into the divers umbilical. This system provides a round robin communication between two divers and a surface control position. When using oxy-helium breathing mixtures, helium unscrambling facilities are available.

b. **Through-Water Communications**. This system is used for free-swimming operations. Communication is via acoustic signals transmitted through the water between transducers deployed from the surface and small transceivers carried by the divers. Various modes of operation are available with this option.

c. Details of divers underwater communications can be found in **BR 2807(9)(A)**.

0961. Manual Signals

a. In the absence of any alternative method, manual signals by line are employed for all communications in which two divers or an attendant and a diver are physically in contact whether it be by lifeline, floatline, buddyline, snagline, or umbilical. The code is detailed in para 0965.

b. Signals are of two kinds:

(1) Long, steady and distinct PULLS.

(2) Short, sharp BELL PULLS made with the same timing as striking a ship's bell.

c. Pulls and bells must **never** be made violently.

d. **Signaling Procedure.** All signals from attendant to diver are to be preceded by one pull to attract attention; the signal is then made after the diver has answered with one pull.

e. All signals received must be acknowledged by repeating the signal, but not unless the signal is clearly understood. If a signal is not acknowledged or is acknowledged incorrectly, the person making the signal should go on repeating the signal until a correct acknowledgment is received. When a signal is being acknowledged incorrectly, the diving supervisor may decide to surface the diver to clarify the situation.

f. It must be remembered that a diver at work may not always be able to acknowledge a signal immediately, and the attendant must wait a few moments before repeating the signal.

g. **Foul Lines**. If a life/light line or umbilical gets turns around the shot rope it may be impossible to get signals through. The turns must be taken out from the surface as soon as practicable.

h. **Interpretation of Signals**. The attendant must use his judgement in the interpretation of signals and must consider the most likely meaning of each signal; for instance, when a diver is descending and the attendant knows the diver is near his depth or job, one pull on the line means the diver has reached his depth or job. On the other hand, a single pull while the diver is on his way down means 'Hold on'. As it would be difficult to distinguish a single bell from one pull, one pull is included in the direction and working signals, which are otherwise bell signals.

i. If the attendant receives two bells immediately after the diver has reached bottom, it means the diver wants slack on the shot rope taken up; and when it is properly adjusted the diver signals 'Hold On' to signify that the rope is taut enough. On the other hand, two bells given immediately after the diver has signaled he is coming up means he wants to be pulled up.

0962. Emergency Pull-Up

This signal, a succession of pulls, is to be used only in an emergency; it is not to be answered but obeyed - **immediately.** (Extreme care is to be taken if initial strain on the lifeline does not start the diver traveling to the surface. If the diver is tangled, excessive strain on the lifeline could endanger the diver.)

0963. Float Line Signals

a. Divers attached to floats make their signals by pulling on the float line and causing the float to bob up and down.

b. To signal back to the diver a boat must close the float and the float line must be taken in hand to pass the signals in the normal manner.

c. Care must be taken, however, especially when working in a tideway, that the diver is not pulled off his jackstay or away from his task by allowing any undue strain to come on the float line owing to drift of the attendant boat.

0964. Buddyline Signals

a. Communication between a pair of divers underwater is by the single-lifeline code of signals on the buddyline.

b. This code may be supplemented by special pre-arranged signals, but to avoid confusion these should be kept to a minimum.

c. A diver requiring help from his companion in an emergency gives the emergency signal - a rapid succession of pulls.

0965. CDBA Diving Signals

a. Due to the complexity of the various breathing systems of the CDBA it is necessary for the Diver and Supervisor to immediately know which gas is either being used or should be used.

b. When diving CDBA a number of the common signals have an alternative meaning when consideration is given to the context of the diving operation. Additional CDBA signal definitions are detailed in brackets in para 0966.

0966. Single Lifeline Signals

	ATTENDANT TO DIVER
General signals 1 pull	To call attention; Are you well?
2 pulls	Am sending down a rope's end (or as pre-arranged)
3 pulls	You have come up too far, Go down slowly till we stop you.
4 pulls	Come up
4 pulls followed by 2 bells	Come up - hurry up, or, Come up - surface decompression.
4 pulls followed by 5 bells	Come up on your safety float
6 bells	Disconnect lazy shot/XBS, Standby Drifting Stops
Direction signals 1 pull	Search where you are
2 bells	Go to the end of distance line or jackstay
3 bells	Face shot then go right
4 bells	Face shot then go left
5 bells	Come into your shot, or turn back if on a jackstay
(CDBA ON SHOT - Switch to O_2 STOPS) (Diver repeats when on O_2)	

	DIVER TO ATTENDANT
General signals 1 pull	To call attention; Made bottom; Left bottom Reached end of jackstay; I am well Reached Laxy Shot/XBS
2 pulls	Send me down a rope's end (or as pre-arranged)
(CDBA - Primary System failure - Open Circuit Activated)	
3 pulls	I am going down
(CDBA - I have connected to XBS - Breathing Diluent)	
3 pulls 2 bells	Total LSE failure breathing from XBS demand valve
4 pulls	I want to come up
4 pulls followed by 2 bells	I want to come up, Assist me up ***Note.*** *When diving CDBA, this signal is used when the diver is on wet stops and needs to indicate to the supervisor that he has a serious problem ie very cold/wet, he requires to be removed from the water at the earliest opportunity.*
4 pulls followed by 4 bells	Attend telephone/DUCS
4 pulls followed by 5 bells	May I come up on my safety float?
Succession of pulls (must be more than 4 pulls)	EMERGENCY SIGNAL Pull me up IMMEDIATELY
Succession of 2 bells	Am foul and need the assistance of another diver
Succession of 3 bells	Am foul but can clear myself if left alone
6 bells	I have disconnected the lazy shot/XBS, all lines clear.
Working signals 1 pull	Hold on or stop
2 bells	Pull up
3 bells	Lower
4 bells	Take up slack lifeline, or You are holding me too tight
5 bells	Have found, started, or completed work I have commenced breathing oxygen. (When carrying out stops)

0967. Sound Signal Communications

a. In certain circumstances, particularly free swimming operations sound signals may be the only means available for communication. These are normally small underwater explosions, although if the swimmers/divers are in the immediate vicinity they may be able to hear signals made by tapping on the diving ladder or ships hull.

Table 9-1. Code - Sound Signal Communications

Signal	Meaning
From diving supervisor to swimmer	
One small underwater explosion	Surface immediately and raise one arm if well
From swimmer to diving supervisor	
One arm raised	I am well
Both arms waved violently, or water being slapped	I require assistance
At night - Diver’s indicating light switched on	I am ready to be picked up
Day or night - Divers Distress Lamp switched on or emergency flare burning	Emergency - I need urgent assistance

b. Diver Recall Signals and thunderflashes are not to be used in confined spaces eg sewers, platform tanks, flooded cavities etc.

c. If Diver Recall Signals are unsuitable for the operation (depth less than 7 m), or unavailable, a weighted thunderflash may be used. In this case a weight is to be suspended at least 80mm below the thunderflash by adhesive tape wound round the last 15mm of the thunderflash body at the base end, and the base end should be held in a safe direction when the thunderflash is struck. It is recommended that the thunderflash is held in a gloved hand.

d. When weighted a thunderflash will sink to about 5m (or to the bottom if the water depth is less than 5m) before exploding and can normally be heard within a radius of 100m depending on the depth of water and nature of the bottom.

e. It should be noted that a diver could be injured by a small charge exploding very close to him. Supervisors must always consider this possibility, especially if a diver’s position is in doubt.

0968. Recall of Search and Rescue Divers When Submerged

a. SAR divers may be recalled when submerged in accordance with **AEW/ASW Sea King Flying Guide** subject to the restrictions shown below.

Table 9-2. Range Restrictions

Situation	Range of Drop Point From Reference Point	Reference
Diver's position known	100m or more	On top of diver or bubbles
Good estimate available of diver's position	200m or more	Best estimate of diver's position
Diver's position not known	500m or more	Position at which diver entered water (marked on entry)

Table 9-3. Depth Restrictions

Water Depth At Drop Point	Type Of Signal To Be Used	Remarks
Less than 12m	None	Re-position helicopter where depth is 12m or more
Over 12m	MSS Mk 4	Minimum depth desirable is 12m, preferably 15m

SECTION 4 - GENERAL DIVING INSTRUCTIONS

0969. Introduction

a. It is not practicable to lay down a set of hard and fast rules for carrying out all the various types of underwater operations practised with modern equipment, however the basic regulations contained in Chapter 7 must be observed at all times.

b. These regulations are amplified in this section, which contains instructions associated with good diving practice. The actual procedures for particular tasks (such as underwater propeller changes and salvage operations) will be found in BR 2808 (Series).

0970. Briefing

a. The diving supervisor must get his team together at the earliest opportunity for briefing in accordance with para b below allowing as much time as possible for questions and suggestions: he must be confident that every man knows what he is required to do. Last-minute briefing, particularly after a diver is dressed, is most undesirable.

b. The basic rules for briefing are as follows:

(1) *Simplicity.* It is essential that orders are kept as simple as possible. Avoid unnecessary details, and if diving with a 'worked-up' and active team stick to SOPs and omit detail from the dive orders.

(2) *Phases of Briefing.* Where it is appropriate (wherever possible for Army diving) give the briefing in two phases:

(a) The Main Brief, which describes the task in sufficient detail to move the team to the site of the task.

(b) The On-Site Brief, which gives the detailed drills and techniques required to complete the task. This must be completed before the diver is fully dressed for the water.

(3) It is essential to remember the 3 simple pre-conditions for a successful brief:

(a) Avoid distractions during your briefing.

(b) Ensure that the environmental conditions are as good as possible.

(c) Ensure that all relevant team members are present.

(4) *Individual Responsibility.* The diving team is a very compact entity in which the work of each individual is critical. Accordingly the actions of every member must be defined in each stage of an operation; therefore:

ALLOCATE TASKS TO INDIVIDUALS BY NAME IN EACH PHASE

0971. Preliminary Inspection

a. Wherever possible and applicable a preliminary inspection of the work to be done should be carried out and the requirements for diving personnel, diving equipment, diving boats and rigging estimated.

b. It is unprofessional for an inadequate team to arrive on the task or for a team to arrive with the incorrect equipment.

0972. Rigging

a. Proper and thorough rigging of the diving position plays a major part in an efficient operation, and a seamanlike approach to the problem should be made. All lines and umbilicals must be clear of obstructions and properly coiled down ready for running. All tools and implements likely to be required are to be provided at the site.

b. Underwater staging, bottom lines, etc, must be securely and properly rigged for the work in hand before the diver is allowed to leave the surface. All equipment must be 'in date' for tests and must be examined for damage or defects before use.

0973. Protection from Weather

a. Whether diving is being conducted from a boat or a diving stage, protection from the weather is most important in extremes of heat or cold. (See also para 0921).

b. Protection is needed both for the surface support team and for the diver while being prepared or undressed.

0974. Spare.

0975. Attendance on the Diver

a. The duty of diver's attendant is an extremely important one and a vital link between the diver and supervisor.

b. The attendant is to assist the diver to prepare the equipment and dress, keeping the supervisor informed of progress.

c. He is to ensure that the end of the life-line or safety line is correctly secured either inboard, or to an authorised float.

d. From the time the diver enters the water to the time he is again safely inboard, the attendant must concentrate his mind on his charge and never let his attention wander. He must keep the diver's lifeline/umbilical, continuously in hand and clear of obstructions. The lifeline is to be so held that the diver's movements can be continuously felt without it being so taut as to inconvenience him.

e. The attendant must periodically ask the diver by signal if he is all right.

f. All signals made and received by the attendant, all movements of the diver and any sudden movements - or anything that would indicate the diver might be in difficulties - are to be reported to the diving supervisor.

g. When more than one diver is underwater from the same control position the diver's name or number must preface all reports; for example, 'Diver Smith', 'Diver One', etc.

0976. Handling Equipment

a. The greatest care must always be taken to protect cylinders and their associated hoses when transporting any breathing apparatus, whether charged or not. Assembled equipments must be carried either on the shoulders in their normal position or bodily in both hands; they must never be carried by such convenient handholds as pipes and straps.

b. When tightening hose joint nuts only moderate force is to be used; if this does not stop a leak, the joint is defective and must be treated accordingly. The use of undue pressure will only aggravate the defect, accordingly spanners must not be used on hand-tight connections.

c. Breathing apparatus should not be left exposed in hot sunlight.

d. Care is to be taken on the dive site to ensure that umbilicals, lifelines or other forms of line are not trodden underfoot as this will cause damage/wear.

0977. Reporting of Defects and Material Failures
All malfunctions of diving equipment, whether resulting from errors of drill or any other use, are to be reported in accordance with para 0810.

0978-0980. Spare.

0981. Entering the Water

a. **Self-Contained Diver.** The drill described below is to be carried out for entering the water.

(1) An underwater swimsuit is to be vented first by squatting and forcing as much air out as possible. The breathing apparatus can then be donned.

(2) **Army Divers**. Army divers on entering the water must not vent up until instructed to by the supervisor.

(3) The diver must look down to confirm that nothing is obstructing the entry into the water, and then step off the side and enter the water vertically. To enter the water, the diver must point the toes downwards with fins crossed and hold the facemask with one hand while the other is placed as described in Chapters 10 and 11.

(4) The attendant must allow enough lifeline for the diver to enter the water, but must be prepared to check the diver from going too deep before bringing him back to the surface. On the surface the diver is checked for leaks.

(5) When wearing boots, the diver enters the water in a similar manner, but in this case the attendant must haul the diver to the surface to check him for leaks.

(6) Final venting of the suit is carried out with the diver upright in the water. Venting can be assisted by raising one arm and releasing the cuff with the other hand.

b. **Surface Swimmer**. When a surface swimmer is required to jump into the water from heights in excess of 2m (high entry training and helicopter jumping) he is to cover his nose and mouth with his right hand to prevent hydrostatic injection.

c. **General**. All leaks must be rectified before diving proceeds. If the test for leaks is satisfactory, the attendant reports 'Diver ... Well for leaks', and at the given signal the diver descends.

d. When diving or swimming in pairs, the diver attached to the lifeline or safety line is always to enter the water first and exit the water last.

0982. Descending

a. The diver descends when instructed by the diving supervisor. The instruction is usually relayed by the attendent. The swimmer achieves this by pointing his fins, exhaling and pushing upwards with his hands. This avoids splashing and undue exertion.

b. The booted diver lowers himself down the shot rope hand over hand, taking care not to get any turns round it. The attendant must keep the lifeline well in hand and clear of the shot rope and must be careful not to pay it out faster than the diver is descending. If the diver stops he must take the diver's weight and report 'Diver stopped', reporting 'Diver travelling' when the diver continues to descend.

c. On reaching the bottom, the diver makes sure all lines are running clear, and then signals the surface that he has arrived.

0983. Surfacing

a. On completion of the dive and before leaving the bottom, the diver with closed-circuit breathing apparatus on mixture (not CDBA) must flush through the counterlung, using the by-pass valve, to ensure a sufficiency of oxygen during the ascent.

b. A signal is made on leaving the bottom. The booted diver climbs up the shot rope while the attendant takes up the slack on his life-line or breast rope. The attendant reports from time to time 'Travelling light' or 'Travelling heavy'.

c. The swimmer, on ascent, remains observant, holding one arm above the head to vent the suit and prevent bumping into any obstructions.

d. The ascent should be made at the rate of one metre in four seconds. The diver can judge this by keeping level with any small bubbles he gives off.

e. On removing his facemask, the diver is to report that he is well.

f. When diving or swimming in pairs, the diver attached to the lifeline or safety line is always to leave the water last.

g. During ascent, if the lazy shot/XBS is encountered, the diver(s) are to stop at the lazy shot and signal the surface of their arrival.

0984. Diver Foul

a. A diver finding himself foul should stop and think and try to remember how he became foul. He should then clear himself without hurry or any violent exertion.

b. If signals can be passed, the attendant should be told that the diver is foul and whether assistance is required. He is then to take up slack on the lifeline, umbilical, or air hose.

c. When going to the assistance of a foul diver, the standby diver should descend keeping in hand the lifeline or whatever is believed to be foul. He must take care not to complicate the situation by getting turns round his own lifeline.

0985. Diver Developing Symptoms Underwater (Feeling Unwell)

a. The diver's gas supply may be suspect if it causes symptoms in the following circumstances:

(1) Hypoxia (see para 1320).

(2) CNS oxygen toxicity (see para 1321).

(3) CO_2 build up (see para 1322). This may be from inadequate ventilation, or from spent CO_2 absorbent.

(4) Contaminated gas supply.

b. The symptoms experienced by the diver may be divided into two broad categories.

(1) Shortness of breath/difficulty breathing.

(2) Any other symptom.

c. In any event and whatever equipment he is wearing the diver should stop what he is doing and rest; he should resist any temptation to surface rapidly.

d. Further action to be taken when shortness of breath or difficulty with breathing occurs is relative to the equipment being dived:

(1) *Self-contained Open-circuit Breathing Apparatus.* Breathe deeply and regularly. If breathing is restricted, equalise the set. If symptoms remain (with contaminated gas, for example) the diver should signal that he is coming up and wishes to be assisted.

(2) *Self-contained Closed-circuit Breathing Apparatus.* Flush through the counterlung using the diluent by-pass valve, while breathing deeply and regularly. The O_2 cylinder is not to be used for flushing through as that will aggravate any symptoms of oxygen poisoning which may be coincident with a build-up of CO_2.

(3) *KMBs 17B/18*. Press purge button and flush helmet. Inform surface and consider switching to emergency supply.

e. In the event of any symptom other than shortness of breath occurring during a dive (oxygen toxicity, CO_2 build-up, hypoxia), divers using closed-circuit or semi-closed-circuit breathing apparatus should surface, alerting the surface team by asking to be assisted. They will then be prepared if the diver loses consciousness during the ascent.

f. The drill for the standby diver, if sent to the assistance of an unconscious diver is contained in Chapters 10 and 11 in the section appropriate to the breathing apparatus in use.

g. The incident should be investigated in accordance with the requirements of Chapter 8 and the equipment secured in accordance with para 0811. In no circumstances is the set to be re-used before adequate investigation has been conducted.

0986. Jackstay or Distance Line Lost

a. If the diver loses his distance line in the dark he should feel carefully all round him before moving away. He should not waste time searching for the line but should signal that he is coming up. If ascending from depth and decompression stops are required it is imperative that the diver follows the direction of his light/life line until he can locate his shot or the lazy shot.

b. If the diver loses his jackstay he should search for it at right angles to the direction in which it is laid, using either the direction of the tide or bottom features to orientate himself. If unsuccessful, he must return to the surface to be sent down again at the start of the jackstay.

0987. Hazardous Work/Hazardous Conditions

a. Whenever it is necessary to carry out hazardous work or when diving is to be carried out under hazardous conditions, the standby diver is to be at IMMEDIATE notice. Such work should not be carried out unless there is efficient communication between diver and attendant.

b. Hazardous work includes diving under any conditions in which there is a chance of the diver becoming foul and requiring assistance.

c. Such conditions require a full risk assessment of the task to be conducted. The dive may only continue if, at the supervisors discretion, any risk to the diver has been reduced to a minimum and the task justifies any risk remaining.

d. When operating in pairs in hazardous conditions the task should, if possible, be carried out by one diver whilst his buddy acts as an underwater attendant ensuring that he does not become foul.

0988. Diving under a Catamaran

a. The undersurface of a catamaran often contains obstructions and hazards to a diver, such as chain ends, stranded wire, wood and metal stumps.

b. Great care, therefore, is required when operating under or close to a catamaran, and the practice of using a swimmer without a breathing set to under-run a line or jackstay or carry out some similar duty is forbidden.

0989. Spare

0990. Sending Down a Wire or Rope

a. Instructions for sending down a wire will be found in BR 2808(1). Wires over 35 mm in diameter should not be sent down to a diver. A large wire should instead be lowered before the diver goes down, or alternatively he may come up to his first stop and fetch it by getting his foot on top of the sliding shackle and treading it down in front of him.

b. Ropes and light lines may be sent down in the same manner. However, when carrying out snagline or other searches where the diver is likely to be some distance from the shot the line may be lowered down the diver's lifeline. It is preferable not to slide a rope down the lifeline, but to make it fast to the lifeline and then order the diver to haul it down; on completion the diver orders: 'Take up slack lifeline'.

0991. Recovering Objects

a. When a line has been sent down for recovering an object (para 0990), the diver is invariably to be called up before recovery commences.

b. It may sometimes be advantageous, however, for the diver to remain on the bottom while the slack is taken up to ensure that the recovery wire is running clear, but the diver should still be called up before the lift begins.

0992. Free-Swimming Operations - Conduct

a. Regulations governing the conduct of free-swimming operations are contained in para 0782. The conduct is described below.

b. There are two types of free-swimming: free-swimming solo and free-swimming in pairs. Of the two the latter is very much safer because of the mutual support afforded by divers operating in pairs. With solo swimming the slightest mishap can lead to disaster and this possibility must always be borne in mind when ordering this particular operation.

c. Free-swimming in pairs (with divers on a buddyline) is the normal method of operating whenever a lifeline or similar line is dangerous because it could foul obstructions.

d. **Free Swimming Breathing Oxygen**

(1) Due to the extra hazards involved with free swimming breathing oxygen, a worked up team is required, experienced in free-swimming and the use of oxygen.

(2) For a non worked up team, prior to a free swim breathing oxygen at night, wherever possible, a daylight practice free swim breathing oxygen is to be conducted in the seven days immediately preceding the planned dive.

e. **Safety Boats.**
Safety boats are to be equipped with the following in addition to the minimum equipment or diving boats as detailed in para 0955h.

(1) Binoculars.

(2) VHF Radio.

(3) Signal lamp/torch.

f. **Communications**

(1) The signals described in para 0753 are to be displayed by ships and boats.

(2) Safety craft are to be in voice communication with each other and with the senior officer present when operating with other ships. They are also to carry hand-signalling lamps.

(3) At night, divers' indicating lights are to be switched on by divers on the surface to indicate their position when they wish to be picked up.

(4) Divers are to use the Divers Distress Lamp or Emergency Flare to attract attention in an emergency. Flares are to be replaced and used in accordance with para 0937.

(5) If whilst operating with other ships, the exercise has to be cancelled, the supervisor is to use VHF communications. The appropriate underwater signal is to be given by DRS or thunderflash to surface the swimmers.

g. **Control of Swimmers**

(1) Swimmers are to be given precise instructions on depth, direction and time to be spent underwater.

(2) One of a pair of divers when free swimming in pairs or a diver when free swimming solo is to be equipped with a watch, compass and depth gauge.

(3) If the swimmers do not surface automatically they are to be surfaced by underwater signal. If the swimmers do not respond, the signal is to be repeated at intervals of one minute. If they have not surfaced after the third signal, the matter is to be treated as an emergency and an immediate search instituted.

h. **Special Exercises -SBS./FDU 1**
The CO SBS or CO FDG may authorise one SBSSC1 or one FDU 1 PO(D) or above to supervise up to up to 12 free-swimmers, subject to the extra requirements detailed below:

(1) Supervisor equipped with a search and rescue beacon (SARBE) or Tactical Air Control Beacon TACBE)

(2) One standby diver (per 12 swimmers) is to be in the safety boat dressed for surface swimming. The standby diver is to be available at short notice (ie ***not*** immediate notice). His breathing apparatus is to be in the boat and ready for immediate use.

(3) Divers are to be buddied in pairs.

0993. Search and Rescue Operations

a. **Conduct.** Regulations for the control and supervision of SAR divers are laid down in para 0783 and AEW/ASW Sea King Flying Guide Pt 6, Chapt 10. The conduct of these operations is outlined below.

b. **Employment**

(1) The role of a SAR diver is to assist in the rescue of a survivor (whether in or out of a ditched aircraft) who is unconscious or injured, or foul of wreckage or parachute harness.

(2) The SAR diver may be used to attach an aircraft marker and/or supplementary flotation gear to a ditched helicopter that is floating, so that the helicopter can be recovered for accident investigation.

(3) The SAR diver can be expected to jump from a helicopter, by day, twilight or night with hover floodlights, in any sea state in which a helicopter recovery can be effected. The SAR diver is only to jump at night when there is positive indication of a survivor. Underwater searches are not to be conducted at night.

(4) The SAR diver cannot be expected to work on a rapidly sinking aircraft, but may be able to descend to about 30m for a short duration. In order to save life this may be exceeded, at the discretion of the diver, to the limit of the equipment.

(5) The SAR diver is to be equipped with a diving watch and depth gauge, signal flare ‘Day & Night’, Divers Distress Lamp, EPLB (Emergency Personal Location Beacon), PDL (Personal Divers Light), Divers Knife and a ‘J’ knife.

c. **Diving from a Ship**

(1) It may be necessary to effect a rescue from a ship rather than a helicopter. This situation could occur when a helicopter, carrying out a vertical replenishment with a ship, ditches alongside.

(2) Under these circumstances the SAR diver is to jump from the upper deck when ordered by the Captain or OOW of the ship. It is important to wait for this order from the bridge because propellers may be turning.

(3) The diver must be so dressed that he is neutrally buoyant in the water when fully equipped and positively buoyant without his breathing apparatus and weights.

d. **Rescue Instruction**

(1) Diving officers of ships likely to be called upon to carry out SAR duties are to arrange for their divers to be given instruction in underwater rescue at the Underwater Escape Training Unit (UETU) at HMS HERON.

(2) Ship's Diver officers appointed to aircraft carriers, LPHs, LPDs and air stations and responsible for SAR diving are to undergo a two-day SAR diving acquaint course (Air 113) at the Search and Rescue Diving School RNA Culdrose.

e. **Dress**

(1) When operating from a helicopter, the SAR diver may wear either a 'wet' suit or 'dry' suit with BASAR (Breathing Apparatus Search & Rescue) or ABJ (Buddy Gold). Suit inflation is not to be worn. A diver's knife and 'J' knife are to be carried..

(2) When operating from a ship the SAR diver may wear either a 'wet' suit or 'dry' suit with BASAR or ABJ (Buddy Gold). Suit inflation is not to be worn. A diver's knife and 'J' knife are to be carried.

(3) *Communications.* Should it become necessary to recall an SAR diver before his briefed surfacing time, the appropriate underwater signal is to be given (para 0967).

0994. Diving in Tidal Waters

a. The diving supervisor is personally to acquaint himself with the times and characteristics of the tides and to bear in mind that the surface tide is not normally the same as that at the bottom. Diving in a tide is potentially dangerous and the diving supervisor must decide whether conditions are likely to hazard the diver. It is essential that the diving boat is securely moored and that communications are working properly.

b. Those not experienced in tidal diving will always be uncertain whether the tide has slackened sufficiently to allow the diver to descend. This uncertainty can best be removed by allowing the diver to try to get down, provided he understands he is merely testing the tide and that no discredit is reflected on him if he returns to the surface to say the tide is still too strong. The behaviour of the shot rope gives a good indication when a diver may usefully be sent down; when a 50kg sinker is swept off the bottom by the tide it will generally be found impossible for the diver to do anything on the bottom.

c. A method of diving in strong tides is to anchor the boat uptide of the task and send the diver down the shot rope, which is streamed downtide. The diver cannot return to the surface up the shot rope under these circumstances and will need pulling up. If necessary he can let go the shot rope altogether. This is not to be practised if the diver has to undergo stops.

d. If there is any doubt about the diver in surface supplied equipment being able to control his ascent because the strength of the tide, he should be instructed to keep himself heavy and allow himself to be pulled up slowly; meanwhile, he should, if possible, have his back to the tide and maintain a good grip on the shot rope with his legs and both hands. In strong tides it may be difficult to cling to the shot rope, let alone ascend it if facing the tide.

e. The dive supervisor must ensure that the diver is called up in time to complete any necessary stops and to surface before the tide becomes too strong for him to remain on the shot rope.

f. In strong tides it may be necessary for stops to be carried out on a lazy shot with the boat drifting on the tide. Whenever possible the operation should be planned to avoid this manoeuvre.

g. It is particularly difficult to clear a diver who becomes foul in a strong tide.

0995. Working on Wrecks

a. Divers have to be particularly careful when working on wrecks because of the presence of jagged edges on which divers can cut themselves or their suits and because of the numerous obstructions on which equipment can become foul.

b. General instructions for working on wrecks are given in BR 2808(1). Salvage operations are described in BR 2808(2).

c. If when entering a wreck an air space is discovered, divers are not to remove their breathing apparatus until it is positively established that the air is not poisonous and is capable of sustaining life.

0996. Diving in Fast Water (Army)

When Army divers are required to dive in Fast Water, defined as 'When tidal streams or river currents are too strong for sustained swimming' the following guidelines must be followed:

a. The standby diver is always to be at IMMEDIATE NOTICE.

b. The safety craft for fast water searches must be a powered craft which is large enough to carry all those immediately concerned with the operation and powerful enough to make way against the current towing divers alongside.

c. The minimum crew for the safety boat is to be:

Supervisor (Helmsman)
Standby Diver
Standby Diver's Attendant
Surface Swimmer (one per two divers)

d. Divers who are about to execute a fast water search must be dressed for the water with suits and BCA's vented when they enter the boat.

e. Whenever divers enter the water or are brought alongside the safety boat, the outboard motor is to be in 'Neutral'. If a diver has to be towed upstream he is to be held close to the bows.

f. The safety boat is always to be maintained on station downstream of the divers. When other craft are passing, the safety boat is to take up station between the divers and the passing craft.

g. Diver Recall Signals or weighted thunderflashes for emergency diver recall are always to be carried in the boat by the Supervisor.

h. If the Supervisor does not have a clear view up and down stream, lookouts are to be posted with some form of communications to the boat, (ie radio or whistle blasts).

i When diving in German rivers, in addition to flag A a 'red over white' flag is to be flown from the safety boat and a blue flag on the side on which other craft are to pass.

0997. Searches - General

Details of Seabed and Ship's Bottom searches are contained in BR 2808(1)Diver Underwater Tasks Manual.

0998. Precautions Against Sharks

a. Shark attacks on man seldom take place in areas where the water temperature is less than 20°C, and of the hundreds of varieties of shark there are probably only eight dangerous to man. However, it is prudent to take precautions when operating in shark-infested waters.

b. Explosive charges should never be used to frighten away sharks as they are attracted to the killed or stunned fish and associate a detonation with feeding. Diving in shark-infested water should take account of local conditions and advice when available. There is no recorded attack by a shark on any Military diver, but the following precautions should be taken:

(1) Always wear a suit (a blue undersuit or a pair of dark overalls is sufficient).

(2) Avoid diving in areas of bad underwater visibility whenever possible.

(3) Avoid any unnecessary splashing or delays on the surface.

(4) Do not panic when first sighting a shark. Almost invariably they swim away from a diver. Get out of the water as soon as possible without creating a disturbance by too much haste.

(5) A movement toward a shark will often make it swim away, but this technique comes only with practice under shark conditions.

(6) Never enter or remain in the water with a bleeding cut or wound.

(7) When operating from a ship always close heads and gash chutes well before entering the water. Whenever possible, avoid areas where scavenger sharks may exist, such as offal dumps, busy anchorages where gash is continuously ditched, etc.

(8) The killing of fish by any method is likely to attract sharks.

0999. Precautions against Snakes

a. Sea snakes are to be found in most tropical waters, and there are both poisonous and non-poisonous varieties.

b. The poisonous ones will not attack or bite unless annoyed or frightened, their general habit being to swim away on meeting a diver. In dirty water however, if surprised, they are likely to bite as a protective reflex action.

c. They are attracted by lights in the water and being inquisitive will circle underwater illuminations at night.

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CHAPTER 10

AIR BREATHING EQUIPMENT - DRILL AND OPERATION

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CHAPTER 10

AIR BREATHING APPARATUS - DRILL AND OPERATION

SECTION 1 - GENERAL

1001. Introduction

a. This Chapter contains details of the drills associated with the various types of air breathing apparatus currently in service together with information dealing with their operation in the water.

b. Details concerning stowage, maintenance routines, tests and preparations for the dive are contained in the relevant sections of the equipment handbook, together with the pre-dive checks that have to be conducted. Attention is drawn to para 0734 which lays down the responsibility for the conduct of such checks and para 0736 regarding endurance and repetitive dives using the same breathing apparatus.

1002. Emergency Drills

When emergency drills for any of the self-contained breathing sets as described in this chapter are initiated, the following factors remain common throughout.

a. **Trouble Drill.** At the first sign of difficulties the diver must relax and think. The inclination to surface immediately must be resisted, as this may only aggravate the condition.

b. **Emergency Ascent.** The tendency to operate the suit inflation or a buoyancy control aid underwater must be resisted, as this will give rise to an uncontrolled ascent, with the consequent risk of an embolism. It must, of course, be used with care if slipping the weights alone is an ineffective method of gaining positive buoyancy.

c. It is not advisable to ditch the set underwater, as it is advantageous to retain the facemask for underwater vision.

d. **Ditching Drill.** If it becomes necessary to ditch the set, it is vital that the diver breathes out during the ascent. If this is not done the diver may suffer pulmonary barotrauma and subsequent arterial gas embolism.

e. **Companion Diver Drill.** When it is known that a diver is in difficulties or if a diver appears to be losing consciousness, his companion must assist him to the surface. Because of the danger of an arterial gas embolism, the companion must ensure that the ascent is controlled, particularly if the diver is unconscious. The danger will be further increased if the diver is not breathing. The use of suit inflation or buoyancy control aid underwater is discouraged, to prevent the ascent getting out of control.

f. After arriving at the surface, the companion diver should not slip his own weights in case he has to dive to recover the diver if the latter is released. He should operate his partners buoyancy control aid or suit inflation and then his own (if available) as required by the situation but is not to remove his facemask unless mouth-to-mouth resuscitation is to be given. If a buddyline is in use it must not be disconnected.

g. Mouth-to-mouth resuscitation has been used effectively by a companion diver, but should not be attempted unless the sea state permits it to be administered without the diver swallowing water.

1003. Flooded Facemask Routine

If the facemask becomes flooded it can be cleared by blowing sharply through the nose or mouth while holding the top of the mask against the forehead. The exhaled gas will then drive the water out at the bottom.

1004. Medical Emergencies

The most likely medical emergencies to occur during a dive, their symptoms and treatment are described in the following paras:

Hypoxia	-	para 1320
Oxygen Toxicity	-	para 1321
Carbon Dioxide build up	-	para 1322
Carbon Monoxide Toxicity	-	para 1356

1005. Maintenance - Air Breathing Equipment

a. The Diving Officer is responsible for ensuring that all diving equipment is available for use, liaising with the MEO as appropriate. The division of responsibilities between user and maintainer is given in the appropriate maintenance schedules. When any non-routine work of repair and inspection is carried out the same general division of responsibilities is to be adhered to.

b. Maintenance of air breathing equipment is to be carried out by appropriately qualified ME and Diver personnel. Details are contained in the relevant Maintenance Schedule (MMS) which is the authoritive document for all maintenance. Supporting information is contained in the relevant **BR 2807 Handbook of Diving Equipment**.

c. MCDO's, WO(D), Diver Branch Ratings (Diver 2 and above) and all Army Divers, are qualified to maintain SABA on completion of the relevant diving equipment maintenance course. Similarly, MCDO's, WO(D) and Diver Branch Ratings (LS(D) and above) are qualified to maintain KMB diving equipment on completion of the relevant course.

d. Successful completion of the diving maintenance course results in a certificate of competence being awarded. Details of the courses should be obtained from the Defence Diving School.

1006-1009. Spare.

SECTION 2 - ENCLOSED SPACE DIVING SYSTEM (ESDS)

1010. Equipment

a. After completing the Pre-Dive routines in accordance with BR 2807 (1)(U) and when ordered, the attendant assists the diver to don the ESDS and adjusts the harness for comfort. The diver and attendant must ensure all controls are accessible to the diver once dressed.

1011. Rigging The Diver

a. The attendant assists the diver to fit his weight belt, harness, fins and adjusts straps as necessary.

b. The following drill is to be carried out:

(1) Ensure the divers gas-supply hose is empty by checking that the outlet to the diver is closed then purge the AGA full-face mask.

(2) On completion, the diver opens the bail-out cylinders**,** checking the contents gauge for pressure then selects bail-out at the Block. The diver then forms a seal between his face and the oral nasal mask and takes two breaths from the bail-out system.

(3) On completion, select Main Supply at the Block**.**

(4) When ordered, the attendant reports the state of the diver to the Supervisor as follows:

‘Diver (Name) dressed, bail-out cylinders ....bar, open at the neck, closed at the Block. Diver seen to breath from the bail-out System, Diver ready to go on air’.

(5) When ordered, the emergency system is to be reported as follows:

‘EBS cylinder ....bars, open at the neck, Demand valve-quick connect tested and correct, Mask attached, EBS tested and well for leaks’.

(6) When ordered, the Panel Operator reports the state of the panel as follows:

‘Main inlet supply .... bar, open at the neck, open at the panel, Emergency Supply ...... bar, open at the neck, closed at the panel, 11 bar set on the reducer outlet to Diver ..... closed. Comms, Camera and pneumo tested and correct’.

(7) The supervisor then orders ‘Open the outlet to the diver(s)’. The panel operator fully opens the outlet valve and reports. When ordered, the attendant assists the diver(s) to fit the AGA mask ensuring a good seal is achieved. The panel operator then tests communication to the diver(s) and confirms ‘diver breathing from the panel’.

(8) The attendant reports 'Diver on air, ready for the water'

Notes:

1. A separate panel report will be required for each diver supported by the panel.

2. When operating with 150 cu ft cylinders, a third cylinder is to be provided, charged, whip on, disconnected and reported accordingly.

1012. Entering The Water

The diver, where possible, should enter the water by climbing down ladders. He may step or jump from a height no greater than 7 metres. When the diver is in the water the EBS is passed down to him and carried to the work site. The suit is vented and he remains just under the surface to enable the attendant to check for leaks.

1013. Dive

a. The diving supervisor orders the diver to leave surface via the communications on the panel. Once at the compartment entrance, the panel operator gives an intermediate panel report for each diver, ie inlet, outlet and diver breathing from the panel.

b. The diving supervisor will order the panel operator to reduce outlet pressure as the diver ascends in the compartment if appropriate. The panel operator must monitor the depth and inform the supervisor of any change of depth.

1014. Procedure On Reaching Depth

On reaching depth or place of work, the diver is to place the EBS in position where it is easily accessible and visible. Throughout the task the EBS must remain accessible, being moved as appropriate as the diver transits the work place.

1015. Use Of Bail-out System on Surface Supply Failure

Should the main panel supply fail the Bail-out System is provided to egress from the compartment. If Bail-out gas is required, the following procedure is to be conducted:

a. The diver selects Bail-out at the Block then checks cylinder contents.

b. The diver informs the surface and in-water standby that he is on bail-out.

c. The diver exits the compartment immediately and aborts the dive.

d. The in-water standby is to assist as required.

1016. External Breathing Drills

Should the diver require additional gas to that provided by the bail-out system, or exit from the compartment requires ditching the harness, the following drill is to be completed:

a. Egress wearing the harness.

(1) Inform the surface and the in-water standby.

(2) The diver removes the EBS quick connect hose from the chest stowage.

(3) The diver connects to the EBS quick connect hose

(4) If the divers umbilical and harness does not hinder progress from the compartment, the diver exits breathing from the EBS wearing the harness and assisted by the in-water standby.

b. Egress requiring ditching drill.
If the diver umbilical/harness makes egress difficult once connected to the EBS the following additional procedure is requiring having completed 1 - 3 above:

(1) Disconnect the AGA intermediate hose at the quick disconnect located on the Block.

(2) Remove the ESDS harness, assisted by the in-water standby if required.

(3) Exit from the compartment carrying the EBS.

c. In the unlikely event of ESDS Mask failure, the following drill is to be completed.

(1) The diver reports on comms his intention to use EBS DV (if time permits).

(2) The diver removes his protected hat, if worn.

(3) The diver removes the AGA mask then breathes from the EBS DV.

(4) The diver exits the compartment having donned the swim mask and carrying EBS.

1017. Trouble Drill

If the diver has trouble breathing, is suffering from dizziness and/or apprehension, it is possibly caused by over exertion. The diver should stop working and inform the surface/in-water standby of the situation then purge the AGA mask using the purge button. If the symptons persist, inform the surface. The supervisor should inform the diver to switch to bail-out system and inform the panel operator to shut the panel gas supply.

1018. Emergency Drill

If at any time during the dive the ESDS becomes inoperative to the extent that the diver needs to make an emergency ascent, the following drill should be carried out:

a. Carry out trouble drill as above.

b. exit the enclosed space with the EBS, **do not slip weights** until outside the compartment.

c. Breath normally throughout the ascent. If this is not possible, the diver must breath out continually during the ascent.

d. On arrival at the surface, if weights have not been slipped, do so.

e. If still connected to direct feed, inflate suit.

f. Attract attention.

1019. Companion Diver Drill ESDS

Companion diver drill will normally be carried out by the in-water standby diver. He will be fully dressed in ESDS with the exception of a video camera. If the diver requires companion diver drill when using ESDS the following drills are to be conducted:

a. If the diver can be removed wearing the harness, proceed as follows:

(1) Inform the surface via the comms of the emergency.

(2) In-water standby diver selects bailout at his block, informs the surface of this action and relays bailout readings.

(3) Supervisor instructs the panel operator to close main panel gas to the in-water standby diver and ensure the in water standby diver is informed.

(4) In-water standby diver purges his mask.

(5) Approach the stricken diver from the left side, if practical.

(6) Select bail out at the block, informing surface of this action and relay bailout readings.

(7) Supervisor instructs panel operator to close main panel gas to the diver, keeping the in-water standby diver informed.

(8) In-water standby diver purges stricken divers mask.

(9) Ensure diver umbilical clear of all obstructions.

(10) Remove diver from the enclosed space. The surface standby diver will be at the entrance to assist.

(11) Surface the diver at a controlled rate of ascent, slipping weights as required.

(12) When on the surface, achieve positive buoyancy and if still available, slip weights.

(13) Attract attention

b. If the diver cannot be removed wearing the harness or the umbilical is trapped, the following drill should be carried out:

(1) Inform the surface via the communications of the emergency.

(2) Connect diver to EBS.

(3) Slip leg straps.

(4) Slip waist band.

(5) Disconnect Quick release suit inflation.

(6) Release chest strap.

(7) Remove diver helmet.

(8) Disconnect diver comms.

(9) Disconnect the AGA intermediate hose at the Block.

(10) Remove the diver from the harness.

(11) Remove the diver from the compartment assisted by the standby diver.

(12) Surface the diver at a controlled rate of ascent, slipping weights as required.

(13) On the surface, slip weights if not already done so.

(14) Attract attention.

1020. Lights Out Drill

Due to the inherent danger associated with the ESDS orientated diving operations lighting is essential. If either the ESDS light or the independent compartment lights fail, the diver is to report the fact to the surface, then exit the compartment using the personnel self contained light. No diving operations in the compartment are to be resumed until lighting has been restored.

1021. Loss of Communications

If during an ESDS diving operation voice communications fails, the dive is to be aborted immediately using standard lifeline signals. The in-water standby diver will relay signals to and from diver 1 as part of his duties as the divers attendant.

1022. Surface Standby Diver

ESDS diving operations are to be conducted using two attended divers. The in-water diver acts as diver 1's attendant and emergency diver as required. The surface standby diver used ESDS supplied by a separate panel and can be at short notice or brought to immediate notice at the supervisors discretion.

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SECTION 3 - SURFACE SUPPLIED DIVING EQUIPMENT (SSDE)

1030. Equipment

Surface Supplied Diving Equipment (SSDE) provides a means of enabling a diver to descend to a maximum depth of 50 metres, breathing air supplied from the surface, through an umbilical. The SSDE additionally has a back mounted emergency of air to which the diver can switch if required. In the main, this refers to single diver operations, however, a panel operator may control more than one panel, Para 1034 refers. If two divers are operated from two individual panels under the control of a single operator, the drills must be modified.

a. **Pre-dive Routine.** Carry out pre-dive routine on the SSDE as laid down in BR 2807(1)(B).

b. **Diver Gas Supply Hoses.**

(1) These are supplied in lengths of 80m and have an internal bore of 12.5mm (½ in).

(2) Hoses are to be marked as described in para 0742 starting from the diver's end and measured from the point at which the karabiner connects to the diver's harness.

(3) The gas hoses are connected to the surface control panel as described in para d below.

c. **Storage Cylinders**. The storage cylinders are connected by 2.5m HP hoses to the inlet side of the panel and their contents pressure checked individually on the panel HP inlet pressure gauge. One cylinder is left open to the panel and the other closed off in reserve. The cylinders are changed over when the supply pressure to the diver falls to 50 bar above that required to supply the diver at depth. The empty cylinder is removed and replaced with a full one. Alternatively the ship's HP air supply must be connected to the panel with a storage cylinder as the reserve supply.

d. **Gas Supply Hose**. This is connected to the panel outlet and flushed through. The hose connection at the panel end is checked for tightness, the free end fitted with a panel blank and the hose assembly tested to a pressure of 1.5 times the depth of the dive. Leaks are not permissible. On completion of the pressure test the reducer is wound back, the diver outlet closed at the panel, the hose vented and the panel blank removed. The hose is then connected to the diving set.

e. When ordered the panel operator gives a panel report to the diving supervisor.

1031. Rigging the Diver

a. The attendant assists the diver into his harness, vest and fins, adjusting straps as necessary.

b. The following drill is then carried out:

(1) Ensure the diver gas supply hose is empty by operating the steady flow valve.

(2) Close steady flow valve.

(3) Open bail-out bottle.

(4) The diver opens the emergency flow valve on the side block and holding the mask tightly to his face to make a good seal with the oral nasal, takes two or three deep breaths to ensure that the emergency gas flow from the bail-out is satisfactory. The emergency flow valve is then closed.

(5) The panel operator (para 1034) then opens the diver supply at the panel pressurises the gas hose by winding on the reducer and sets an overbottom pressure of 10 bar on the LP gauge. The panel operator then closes the gas supply to the diver.

(6) The attendant, when ordered, reports the state of the diver to the diving supervisor as follows:
Diver (Name), dressed, bail-out cylinder gauged ..... Bar, open at the neck closed at the sideblock, seen to breathe from the bail-out, ready to breathe from the panel gas supply.

(7) The panel operator, when ordered reports the state of the panel as follows:

(a) Supply No.1 open at the supply *(or neck if using a cylinder to supply air),* open at the panel .....bars.

(b) Supply No. 2 Standby supply. Open at the neck, closed at the panel ....bars. *If additional supply cylinders are used, these are also to be reported by number and state of readiness, i.e. whip attached etc.*

(c) 10 bar set on the panel, outlet to the diver closed.

(8) The diving supervisor then orders ‘Open gas to the diver, check diver breathing from the panel’. The panel operator fully opens the diver outlet valve and reports to the supervisor. ‘Outlet valve open to the diver’. The attendant then assists the diver to fit the mask. The communications operator checks communications with the diver and reports when this is complete. The panel operator watches the panel LP gauge and reports diver (Name) seen to be breathing from the panel, 10 bars set.

(9) The diver checks the operation of the steady flow valve, purge button and dial-a-breath. On completion the attendant reports. ‘Diver (Name) steady flow valve, purge button and dial-a-breath tested and correct, ready for the water’.

1032. Entering the Water

When practicable the diver should enter the water by climbing down the ladder. The diver may step or jump into the water provided that (to prevent valve reversal), the mushroom valve is covered. Height of jump must not exceed 2m. When the diver is in the water, the suit is vented and he remains just under the surface to enable the attendant to check for leaks. On completion the attendant reports to the diving supervisor. ‘Diver (Name) well for leaks ready to leave surface’.

1033. The Dive

a. As the diver descends the attendant calls out the depth every 3m until the diver reaches the seabed. The panel operator repeats the depth report and after the depth is in excess of 30m, manually increases the panel outlet pressure by 1 Bar for every 5m.

b. When the diver arrives on the seabed the panel operator will be told by the supervisor to set gas for the appropriate depth. He will then give panel reports during the dive as required by the supervisor.

1034. Surface Control Panel Operation and Limitations

a. A separate qualified attendant is required to operate surface control panel(s) (maximum of two). He is to maintain the HP gas supply to the panel(s) and provide the diver(s) with the correct LP supply for the depth called out by the attendant(s).

b. To enable the panel operator to do this the diver's attendant must keep him continuously informed of changes in the diver's depth as indicated by the markings on the hose line. Depth is to be closely monitored and regularly called out to ensure an adequate gas supply for the diver.

c. As the panel operator makes the necessary adjustments to the panel, he reports the settings to the diving supervisor.

d. Use of the SSDE control panel is subject to the following limitations:

(1) When diving SSDE panel reducer settings are to commence at 10 Bar (over bottom pressure). 10 Bar remains set until the diver reaches 30m, thereafter the panel output pressure is increased by 1 bar for each 5m the diver descends, down to a maximum depth of 50m, where the output pressure will be 14 Bar.

(2) When diving below 30m divers are not to carry out prolonged excessive work.

(3) To prevent excessive umbilical pressure loss the steady flow valve must not be used for other than short periods in normal operation. The dial-a-breath should only be adjusted to overcome excessive inhalation resistance at depth. It should not be adjusted until free flow occurs.

(4) Additional air supplies are not to be taken from a surface control panel other than to supply a single diver.

1035. Trouble Drill

If the diver has difficulty in breathing, dizziness or apprehension, it is probably caused by over-exertion. The helmet should be purged by using the purge button and/or the steady flow valve. If symptoms persist the emergency valve is to be opened to allow breathing from the bail-out cylinder. The diver must inform his buddy and the surface via voice communication or manual signals, then surface.

1036. Emergency Drill

a. At any time during the dive, should the diving equipment become inoperative, the diver must make an emergency ascent as follows:

(1) Carry out trouble drill as in para 1035 above.

(2) Slip the weights on the diver harness.

(3) Breathe normally throughout the ascent. If this is not possible, he must breathe out.

b. On arrival at the surface the diver must act as follows:

(1) If not already done, slip the weights.

(2) Obtain buoyancy by using suit inflation.

(3) Attract attention.

c. The attendant should be able to feel his diver and will be aware of the diver having left bottom. Once the diver has reached the surface slack hose line should be taken in and the diver brought back to the diving platform.

1037. Companion Diver Drill

a. Generally assistance to a distressed SSDE diver will be from another diver. This may be the standby diver or a companion diver.

b. The following drill is to be carried out:

(1) Inform the surface via communications of the emergency.

(2) Approach the distressed diver.

(3) Open his emergency valve on the side block.

(4) Purge the diver's helmet using the purge button for at least three seconds.

(5) Check that the diver and his umbilical are clear of obstructions. If possible bring the diver back to the shot rope and ensure that there are no turns round it.

(6) Surface the diver at a controlled rate of ascent, slipping his weights if necessary.

(7) **On the Surface** slip all weights and operate the divers suit inflation to obtain buoyancy. If the divers surface away from the diving platform attendants are to haul both divers back to the platform ensuring that umbilicals are clear.

1038. Communication Failure

If communications fail then normal diver lifeline signals are to be used.

1039. Problem During a Dive

During a dive, if a problem develops that cannot be immediately rectified, the dive is to be aborted.

SECTION 4 - AGA DIVATOR
(AGA DIV)

1040. Equipment

At 300 bar the cylinders are fully charged. The supervisor may accept a lower pressure if he considers it sufficient for the job in hand.

1041. Rigging The Diver

After the initial preparations and checks have been carried out, the attendant assists the diver to don the equipment. The nylon webbing harness is adjusted and secured to maintain a comfortable fit. The weight belt is fitted round the diver's waist below the set secured so it can be slipped with the right hand in an emergency. The waist belt of the breathing set is slipped using the left hand.

1042. Entering The Water

a. The diver enters the water as described in para 0981. He must hold down on the facemask with one hand and the bottom of the set with the other.

b. He remains at the surface and releases the air in his dress. The attendant then checks for leaks. During this check the diver must hold his breath. If there are no leaks the attendant reports to the supervisor: "Diver ... No leaks".

c. Before submerging the diver should check that he can still comfortably reach the reserve air unit attached to the right shoulder strap.

1043. Dive

a. No adjustment to the set is required until both cylinders have been breathed down to around 60bar. When this happens the diver will experience some difficulty in breathing.

b. The diver then operates his reserve air unit valve handle and surfaces.

c. There should normally be no requirement for decompression after a single dive. Decompression tables should always be consulted when the dive is deeper than 20m. However, if further dives are carried out, decompression for combined dives may be required.

d. **Reserve.** Both cylinders are permanently open and the high pressure air is controlled by a single valve on the manifold. The air reserve valve is operated automatically when the cylinder (set) pressure drops to 60 bar. Any attempt to operate the reserve air unit valve handle before a pressure of around 75 bar is reached will result in automatic return to the normal position.

e. **Endurance.** The endurance of AGA Div as with all open-circuit self-contained equipment, varies with depth and the experience of the diver. At 10m it can be expected to last for 40 minutes.

1044. Trouble Drill

If breathing discomfort, dizziness or apprehension is felt, it is probably caused by over-exertion. The diver must relax and act as follows:

a. Signal his buddy, if he has one, that all is not well.

b. Purge the facemask using the breathing valve purge button.

c. Surface immediately.

1045. Emergency Ascent

a. Should the breathing apparatus become inoperative because of damage or defects, the diver must make an emergency ascent as follows:

(1) Inform his buddy of his intention to ascend.

(2) Slip his weight belt if necessary.

(3) Breathe normally throughout the ascent. If this is not possible, he must breathe out.

b. On arrival at the surface the diver must act as follows:

(1) Slip his weight belt, if he has not already done so.

(2) Operate his suit inflation.

(3) Remove his facemask and turn on his back.

c. If the diver finds it difficult to keep his head above water in this position and he is not on a lifeline, he must ditch the set.

1046. Ditching Drill

a. Practical ditching drill underwater is not taught.

b. If it is necessary to ditch the set on the surface, the diver is to carry out the following drill:

(1) Using the right hand release and slip the weight belt.

(2) Using the left hand release the waist belt.

(3) Disconnect chest mounted direct feed suit inflation hose (if fitted).

(4) Loosen both shoulder straps.

(5) Loosen the facemask straps.

(6) Remove the facemask and push the facemask and LP air hose over the head.

(7) Slip out of the harness.

1047. Companion Diver Drill

a. Companion diver drill will be required under the circumstances outlined in para 1002f. Great care will be needed if the distressed diver is not breathing, as indicated by the absence of exhaust bubbles.

b. The following drill must be carried out:

(1) Follow the divers lifeline down. Check that the reserve lever has been operated.

(2) Purge the mask using the breathing valve purge button.

(3) Slip weights if necessary

(4) Send emergency signal on divers lifeline if required.

(5) Surface the diver at a controlled rate of ascent.

(6) On the surface, slip the diver's weight belt, if still attached.

(7) If the diver is breathing, leave his facemask on.

(8) If the diver is not breathing, remove his facemask, ditch the set if necessary and support his head clear of the water.

(9) Attract attention and swim with the diver to the nearest point of safety, keeping him on his back.

c. The buddyline is not to be disconnected.

d. The companion diver must continue to breathe from his set, unless he can usefully and safely administer mouth-to-mouth resuscitation.

1048-1049. Spare

SECTION 5 - BREATHING APPARATUS SEARCH AND RESCUE (BASAR)

1050. Rigging The Diver

a. The diver prepares his equipment and dresses himself in accordance with AEW/ASW Sea King Flying Guide.

b. The diver is to dress as described in para 0993e. Suit-inflation equipment is not worn when jumping from a helicopter, because of the height and risk of injury, but is allowed when jumping from the upper deck of a ship.

1051. Entering The Water

a. The diver enters the water while pointing his toes with fins crossed. One hand holds down on his facemask while the other holds down on his set on his back.

b. The jumping height will normally be under 6m and the order to jump will be given by the captain of the aircraft.

c. Once in the water the diver must adjust his facemask and any gear that has been displaced on entering the water before he continues with the dive.

d. No other checks are required.

1052. Dive

a. No adjustment to the set is required until the main cylinder is breathed down to about 10 bar. When this happens the diver will experience some difficulty in breathing.

b. The diver then open his reserve cylinder valve to equalise the cylinder pressures. When the sound of equalisation ceases, he closes his reserve cylinder valve and continues with the dive until a second equalisation becomes necessary; after the second equalisation he is to surface.

c. If there is any appreciable delay in the diver being recovered from the water, further equalisations may be necessary.

d. After a single dive in BASAR it is unlikely that there will be a requirement for decompression. However should the diver carry out an emergency ascent and the correct drill is not carried out, treatment for arterial gas embolism may be required.

e. **Endurance.** Under hard-work conditions the endurance of the set on the surface, is approximately 45 minutes, but if it is necessary for the diver to follow a ditched aircraft down to free a trapped man or to dive for a sinking body, the endurance of the set will be reduced according to the depth of the water. At 10m the endurance can be expected to be about 24 minutes and at 30m about 12 minutes.

1053. Trouble Drill

a. If the diver experiences breathing discomfort, dizziness or apprehension, it is probably caused by over-exertion.

b. The diver must relax and operate his equalising valve. If this brings no improvement he must surface.

1054. Emergency Ascent

a. Should the breathing apparatus become inoperative because of damage or defects, the diver must make an emergency ascent as follows:

(1) Slip his weights if necessary.

(2) Breathe normally from his stabilising jacket mouthpiece throughout the ascent, using the jacket dump valve to control the speed of ascent. If this is not possible, **he must breathe out**.

b. On arrival at the surface the diver must act as follows:

(1) Slip his weights, if he has not already done so.

(2) Operate his suit inflation or inflate his stabilising jacket, as appropriate.

(3) Remove his mouthpiece and turn on his back. The facemask may be retained if the diver wishes, as it will protect his eyes in rough conditions.

1055. Ditching Drill

a. The disadvantages of ditching the BASAR underwater outweigh advantages. Therefore practical ditching drills are not taught.

b. If at any time it becomes necessary to ditch the set on the surface, the diver is to carry out the following drill:

(1) Release and slip the weight belt.

(2) Release the waist and chest belts.

(3) Slip the right hand shoulder harness release.

(4) Release the mouthpiece and let the set slide off the left shoulder.

c. The facemask should be retained for underwater vision but may be removed on the surface if the diver wishes.

1056. Assistance to Survivors

a. Immediate assistance is required to get the survivor back to the surface as quickly as possible.

b. The diver is to act as follows:

(1) Confirm that the survivor is clear of wreckage, lines, etc.

(2) Grasp the survivor firmly.

(3) Slip his weights, if he considers it appropriate, and operate his suit inflation or inflate his stabilising jacket.

(4) On the surface, support the survivor from underneath until the assistance arrives.

c. Because the diver gives himself maximum buoyancy underwater with this drill, the ascent will get out of control as he approaches the surface. Therefore, the risk of the survivor suffering a gas embolism is increased, particularly if he has been breathing under pressure. However, this risk is acceptable in the circumstances, as it is of paramount importance to get the survivor up to the surface, where he can breathe air.

d. After carrying out this drill, the diver will not be able to descend again because he will be too buoyant. He should retain the option, therefore, of keeping his weights for the very rare chance of being of assistance to other survivors.

1057-1059. Spare.

SECTION 6 - SWIMMERS AIR BREATHING APPARATUS (SABA)

1060. Equipment

a. SABA is a self contained open circuit breathing apparatus fitted with the Buoyancy Control Aid (BCA). When fully charged the pressure in the breathing circuit and Buoyancy Control Aid (BCA) emergency inflation cylinders should be 205 bar (BR 2807(1)(S)). The supervisor may accept a lower pressure (down to 170 bar) if he considers it sufficient for the job in hand. Cylinder pressure should be gauged and recorded immediately before use. (As the BCA is charged from the main cylinders directly prior to the dive, for recording purposes the figure entered into the S288 under the 'cylinder pressure' column will also reflect the charge pressure of the BCA cylinder). For second and subsequent dives in the same equipment see para 0736j.

b. Ship's Divers must use the equipment with a wide vision facemask fitted. As an exception those ship's divers on the staff of the SETT are authorised to use SABA demand valves with a free mouthpiece. Waivers may also be approved by S of D for divers employed on specific tasks (para 0752).

c. Assistance must be given to the diver when donning the equipment and care must be taken when diving from unstable platforms such as inflatable craft. In these circumstances, the diver must be kept in hand by the attendant when dressed and the craft is underway.

d. When using SABA, the BCA jacket fouls the knife if worn on the belt. The diver is to ensure that the knife is worn either on the leg or below the lines of the BCA jacket.

1061. Rigging the Diver

a. After the appropriate Maintenance Procedure (MOPS) and checks have been carried out, the attendant/buddy assists the diver to don the equipment. The BCA should be of the correct size. The waist and chest strap adjusted and secured to maintain a comfortable fit. The use of the jock strap assembly, which may be demanded separately, is optional. The suit inflation hose is to be connected to the direct feed valve mounted on the front of the UWSS. Divers weights are to be placed into the BCA weight pockets. Care must be taken to ensure that the BCA pocket mounted weights can be easily slipped by grasping and pulling the weight release handles.

b. Prior to the diver breathing from the equipment the SABA BCA inflation capability is to be tested by operation of the Emergency Cylinder Valve, the BCA Direct Feed Inflator and oral inflation. On completion of the inflation tests the BCA is to be deflated by operating the left hand lower and right shoulder mounted dump valves/mouth piece assembly. The divers attendant/buddy is to witness these tests, reporting the results to the dive supervisor. 'Diver .... dressed, life/light line/buddy line secured , main valve open, set gauged ....bars, BCA checks correct, all equipment checks correct, Diver ready to go on air'.

c. When satisfied that the diver fully understands all instructions the diving supervisor is to order the diver to 'Go on air'.

d. Once on air, the diver is to don gloves (if required) and conduct an ergonomic check of all equipment. On completion of this check the diver opens the right-hand cylinder (reserve) and the attendant/buddy listens for an equalisation. The right-hand cylinder is then closed by the diver; the attendant/buddy must observe this action. The buddy then raises a thumb until acknowledged by the supervisor, or the attendant reports 'Diver ... heard to equalise, equalising valve seen to be closed, diver ready for the water'. these tests are not required if the set has already been dived, however, the attendant/buddy must visually ensure that the equalising valve is affirmed to be closed by the diver and report this action to the supervisor.

Note. *Equipment checks should cover the following:*

(1) Shoulder buckles

(2) Waist buckles

(3) Weight release handles

(4) Suit inflation

(5) Knife

(6) Reserve cylinder valve

(7) BCA main inflate

(8) BCA emergency cylinder inflate valve

(9) Shoulder dump valve

(10) Waist dump valve

(11) AP200 dump valve

(12) Diver distress lamp (if worn)

(13) Correctly secured Life/Light line

(14) Main valve (to be confirmed fully open)

(15) Pressure gauge (if fitted - RE units)

1062. Entering the Water

a. The diver/s enter/s the water as described in para 0981. The facemask must be held down one hand and the set with the other hand.

b. The diver remains at the surface and releases the air in his dress and vents the BCA by operating the right-hand shoulder dump valve. Then the attendant/buddy checks for leaks. During this check the diver must hold his breath. If there are no leaks the attendant reports to the supervisor: "Diver ... Well for leaks", or the buddy raises a thumb until acknowledged by the supervisor.

c. Before submerging the diver is to ensure that he can still comfortably reach his reserve cylinder and BCA Emergency Cylinder valves.

1063. Dive

a. During descent the diver may wish to alleviate diving suit compression by operation of the suit inflation. The use of the BCA is encouraged to adjust underwater trim to achieve the optimum neutral buoyancy. Should the diver wish to decrease the air capacity of the BCA during ascent or descent the appropriate dump valve is to be used.

b. No adjustment to the set is required until the main cylinder has been breathed down to about 10 bar. When this happens the diver will experience some difficulty in breathing.

c. The diver then opens his reserve cylinder valve to equalise the cylinder pressures. When the sound of equalisation ceases, he closes his reserve cylinder valve and continues with the dive until a second equalisation becomes necessary; after the second equalisation the diver is to surface.

d. **Reserve Cylinder**. The right-hand cylinder should be used as the reserve cylinder. It is important that the reserve cylinder valve is always closed, except when actually carrying out an equalisation. If this is not done the diver will have no indication that his air supply is getting short until there is probably insufficient for him to reach the surface.

e. **Endurance**. The endurance of SABA as with all open-circuit self-contained equipment, varies with depth and the experience of the diver. At 10m it can be expected to last for about 40 minutes. An endurance graph, giving the approximate endurance that can be expected at various depths for a diver carrying out light work, and for a diver swimming, can be found in Fig 1-25. Consideration must also be given to the use of direct feed/BCA and suit inflation.

1064. Drill for Routine Surfacing

The following drill, conducted at the surface, is to be used when the diver is required to make a verbal report or at the end of a dive when directed by the Supervisor. It is not an emergency drill.

a. Inflate the BCA using the direct feed inflator until positive buoyancy is achieved.

b. Loosen face mask straps and pull spider band forwards over the head, releasing the mouthpiece.

c. Push the facemask underwater onto the chest to stop free-flowing. Do not allow it to fall behind the body as this will prevent replacement if required.

***Note**. When buddied or attached to a necklace all divers are to surface and be positively buoyant before facemasks are removed.*

1065. Trouble Drill

If breathing discomfort, dizziness or apprehension is felt, it is probably caused by over-exertion. The diver must relax and act as follows:

a. Signal his buddy, if he has one, that all is not well.

b. Equalise the cylinders if breathing continues to be difficult.

c. Surface immediately if the cylinders had been equalised before the occasion at b. above, otherwise surface if there is still no improvement.

d. Conduct the drill as detailed at para 1064.

1066. Spare.

1067. Emergency Ascent

Because the disadvantages outway the advantages practical Emergency Ascent procedure is not to be taught to, or exercised by, any diver except during initial diver training at the Defence Diving School using formal training documentation and where a compression chamber is to be on site.

a. Should the breathing apparatus become inoperable because of damage or defect the diver must make an emergency ascent as follows:

(1) Inform their buddy (if they have one) of intention to ascend.

(2) Slip weights if necessary.

(3) Breathe normally throughout the ascent. If this is not possible, the diver must breathe out.

b. On arrival at the surface the diver must act as follows:

(1) Inflate the BCA via the Emergency Inflation Cylinder.

(2) Slip weights, if he has not already done so.

(3) Remove facemask and turn on back.

c. If the diver finds it difficult to keep his head above water in this position and he is not on a lifeline, he must ditch the set, not forgetting to disconnect his direct feed suit inflation if fitted.

d. For Army divers the emergency ascent procedures as described in sub-paragraphs a. and b. above may be practised provided that:

(1) The depth is 5m or less.

(2) An LMA(RN)/DMT is on site.

(3) An ADI supervises the drills.

(4) The in-water attendant is an AAD/ADS.

(5) Close monitoring of the ascent is carried out by an in-water attendant ascending with the diver carrying out the ascent drill.

1068. Ditching Drill

a. Because the disadvantages outweigh the advantages, practical ditching drill underwater is not to be taught to any divers.

b. If it becomes necessary to ditch the set on the surface, the diver is to carry out the following drill:

(1) Release the chest and waist strap.

(2) Disconnect chest mounted direct feed suit inflation hose (if fitted).

(3) Slip the BCA shoulder release as appropriate.

(4) Loosen the facemask straps.

(5) Let the set slide off the shoulder opposite the buddy line.

(6) Remove the facemask and release the mouthpiece; push the facemask and intermediate hose over the head.

1069. Companion Diver Drill

a. Companion diver drill will be required in the circumstances outlines in para 1002e. Great care will be needed if the distressed diver is not breathing, as indicated by the absence of exhaust bubbles.

b. The following drill must be carried out:

(1) Approach the diver and take a firm hold, open his reserve cylinder valve and leave it open. Inform the surface via the divers life line, if appropriate.

(2) Surface the diver at a controlled rate of ascent. The divers BCA can be inflated, cautiously to achieve neutral buoyancy. To avoid the possibility of an uncontrolled ascent, do not slip the divers weights unless absolutely necessary. If weights have to be slipped, commence by slipping one side at a time.

(3) On the surface, inflate the divers BCA and slip weights if necessary. **Do not slip own weights.**

(4) If the diver is breathing, leave the diver's mask on.

(5) If the diver is not breathing, and it is safe to do so, remove his facemask and administer mouth-to-mouth resuscitation.

(6) Attract attention and swim with the diver to the nearest point of safety, keeping him on his back.

c. The buddyline is not to be disconnected.

d. The companion diver must continue to breathe from his set, unless he can usefully and safely administer mouth-to-mouth resuscitation.

1070. Ice Diving

When used in extreme/ice conditions SABA is to be used in its routine configuration. Special care must be taken to prevent the demand valve freezing. When on the surface, the demand valve is to be kept as dry as possible and on entering the water, kept submerged.

SECTION 7 - SWIMMERS AIR BREATHING APPARATUS (SABA) (DTWC)

1071. Equipment

a. SABA is a self contained open circuit breathing apparatus fitted with a Buoyancy Control Aid (BCA), also a Diver Through Water Communication system (DTWC), with round robin link between divers and the diving supervisor. When fully charged the pressure in the breathing circuit and Buoyancy Control Aid (BCA) cylinders should be 205 bar (BR 2807(A)(1)(S)). The supervisor may accept a lower pressure (Navy minimum 170 bar) if it is considered sufficient for the job in hand. Cylinder pressure should be gauged and recorded immediately before use. (As the BCA emergency cylinder is charged from the main cylinders directly prior to the dive, for recording purposes the figure entered into the S288 under the ‘cylinder pressure’ column will also reflect the charge pressure of the BCA emergency cylinder). For second and subsequent dives in the same equipment see Para 0736j.

b. Divers must use the equipment with AGA Divator non-positive low pressure volume facemask. Ear phones, microphone and a press to talk (PTT) button is fitted to the outer plate of the oral nasal mask assembly. As an exception, those ships divers on the staff of the Submarine Escape Training Tank (SETT) are authorised to use SABA demand valves with a free mouthpiece. Dispensations may also be approved by SofD for divers employed on specific tasks (Para 0752).

c. Assistance must be given to the diver when donning the equipment and care must be taken when diving from unstable platforms such as inflatable craft. In these circumstances, the diver must be kept in hand by the attendant when dressed and the craft is underway.

d. When using SABA, the BCA jacket fouls the knife if worn on the belt. The diver is to ensure that the knife is worn either on the leg or below the lines of the BCA jacket.

1072. Rigging the Diver/Pre-Dive Procedures

a. After the appropriate Maintenance Operating Procedures (MOPS) and checks have been carried out, the attendant assists the diver to don the equipment. The BCA should be of the correct size. The waist and chest strap are to be adjusted and secured to maintain a comfortable fit. The use of the jock strap assembly, which may be demanded separately, is optional. The suit inflation hose is to be connected to the direct feed valve mounted on the front of the UWSS. Care must be taken to ensure that the BCA pocket mounted weights can be easily slipped by grasping and pulling the weight release handles.

b. Prior to the diver breathing from the equipment the SABA BCA inflation capability is to be tested by operation of the Emergency cylinder valve, the BCA Direct Feed Inflator and Oral Inflation. The divers attendant/buddy is to witness these tests, reporting the results to the dive supervisor. ‘Diver.... dressed, life/light line secured, main valve open, set gauged..... bars, (as the BCA cylinder would have been charged from the main cylinder prior to the dive, this is inclusive of BCA cylinder pressure), all equipment checks correct, ready to go on air’.

c. When satisfied that the diver fully understands all instructions the diving supervisor is to order the diver to ‘Go on air’.

d. On donning the mask the diver is to ensure that the nose block and microphone are set correctly and the earphones sit comfortably over the ears. Once the mask has been fitted correctly the diver is to don gloves (if required) and conducts an ergonomic check of all equipment. On completion of this check the diver opens the right hand cylinder (reserve) and the attendant or buddy listens for the equipment to equalise. The diver then closes the right hand cylinder; the attendant/buddy must witness this action. The buddy then raises a thumb until acknowledged by the supervisor or the attendant reports: ‘Diver..... heard to equalise, equalising valve seen to be closed, diver ready for the water’. These tests are not required if the set has already been dived, however, the attendant must visually ensure that the equalising valve is affirmed to be closed by the diver and report this action to the supervisor.

Note. *Equipment checks should cover the following:*

(1) Shoulder buckles

(2) Waist buckles

(3) Weight release handles

(4) Suit inflation

(5) Knife

(6) Reserve cylinder valve

(7) BCA main inflate

(8) BCA emergency cylinder inflate valve

(9) Shoulder dump valve

(10) Waist dump valve

(11) AP200 dump valve

(12) Diver distress lamp (if worn)

(13) DTWC Press to Talk button

(14) Correctly secured Life/Light line

(15) Main valve (to be confirmed fully open)

(16) Pressure gauge (if fitted - RE units)

1073. Spare

1074. Entering the Water

a. The diver(s) enter the water as described in Para 0981 holding down the facemask with one hand and with the other, holding down the set by hooking the thumb in the bottom of it.

b. The diver(s) remains at the surface and releases the air contained in the dress and vents the BCA by operating the right-hand shoulder dump valve. The attendant/buddy then checks the set for leaks. During this check the diver must hold his breath. If there are no leaks the attendant/buddy reports to the supervisor: "Diver ... Well for leaks", or the buddy raises a thumb until acknowledged by the supervisor.

c. Before leaving surface the diver(s) are to confirm communications, the reserve cylinder and BCA Emergency cylinder valves can still be reached.

1075. Dive

a. During descent the diver(s) may wish to alleviate diving suit compression by operation of the suit inflation. The use of the BCA is encouraged to adjust underwater trim to achieve the optimum neutral buoyancy. Should the diver wish to decrease the air capacity of the BCA during ascent or descent the appropriate dump valve is to be used.

b. No adjustment to the set is required until the main cylinder has been breathed down to about 10 bar. When this happens the diver will experience some difficulty in breathing.

c. The diver then opens the reserve cylinder valve to equalise the cylinder pressures. When the sound of equalisation ceases, the reserve cylinder valve is closed and continues with the dive until a second equalisation becomes necessary. After the second equalisation the diver is to surface.

d. **Reserve Cylinder**. The right-hand cylinder should be used as the reserve cylinder. It is important that the reserve cylinder valve is always closed, except when actually carrying out an equalisation. If this is not done the diver will have no indication that his air supply is getting short until there is probably insufficient for him to reach the surface.

e. **Endurance**. The endurance of SABA, as with all open-circuit self-contained equipment, varies with depth and the experience of the diver. At 10 m it can be expected to last for about 40 minutes. An endurance graph, giving the approximate endurance that can be expected at various depths for a diver carrying out light work, and for a diver swimming, can be found in Fig 1-25. Consideration must also be given to the use of direct feed/BCA and suit inflation.

1076. Drill for Routine Surfacing

The following drill, conducted at the surface, is to be used when the diver is required to make a verbal report or at the end of a dive when directed by the Supervisor. It is not an emergency drill.

a. Inflate the BCA using the direct feed inflator until positive buoyancy is achieved.

b. Loosen face mask straps and pull the head harness forwards over the head, releasing the face mask.

c. Push the facemask underwater onto the chest to stop free-flowing. Do not allow it to fall behind the body as this will prevent replacement if or when required.

***Note**. When buddied or part of a search group, all divers are to be surfaced and be positively buoyant before facemasks are removed.*

1077. Trouble Drill

If breathing discomfort, dizziness or apprehension is felt, it is probably caused by over-exertion. The diver must relax and act as follows:

a. Communicate with the surface and buddy, if attached, that all is not well.

b. Equalise the cylinders if breathing continues to be difficult.

c. If the cylinders have previously been equalised, inform the surface and your buddy and surface immediately, at a controlled rate of ascent.

d. Conduct the drill as detailed at Para 1076.

1078. Loss/Failure of Voice Communications.

If voice communications fail, normal life signals are to be used. There is no requirement to abort the dive.

1079. Flooded Face Mask Drill.

In the unlikely event that the face mask becomes flooded, depress the purge button keeping pressure on the top of the mask, if the mask fails to clear, surface immediately, informing the surface and buddy. If breathing becomes impossible, exhale continually during ascent.

1080. Emergency Ascent

Because the disadvantages outweigh the advantages, practical Emergency Ascent procedure is not to be taught to, or exercised by, any diver except during initial diver training at the Defence Diving School using formal training documentation and a compression chamber on site.

a. Should the breathing apparatus become inoperable because of damage or defect the diver must make an emergency ascent as follows:

(1) Communicate with the diving supervisor and buddy (if they have one) of intention to ascend.

(2) Slip weights if necessary.

(3) Breathe normally throughout the ascent. If this is not possible, the diver must breathe out until the surface is reached.

b. On arrival at the surface the diver must act as follows:

(1) Inflate the BCA via the Emergency Cylinder.

(2) Slip weights, if not already done so.

(3) Attract the attention of the surface support crew.

(4) Remove facemask and turn on back.

c. If the diver finds it difficult to keep his head above water in this position and he is not on a lifeline, he must ditch the set in accordance with Para 1081.

d. For Army divers the emergency ascent procedures as described in sub-paragraphs a and b above may be practised provided that:

(1) The depth is 5 m or less.

(2) An LMA(RN)/DMT is on site.

(3) An ADI supervises the drills.

(4) The in-water attendant is an AAD/ADS.

(5) Close monitoring of the ascent is carried out by an in-water attendant ascending with the diver carrying out the ascent drill.

1081. Ditching Drill

a. Because the disadvantages outweigh the advantages, practical ditching drill underwater is not to be taught to divers.

b. If it becomes necessary to ditch the set on the surface, the diver is to carry out the following drill, if possible, communicating his intentions to his buddy and the diving supervisor:

(1) Release the chest and waist strap.

(2) Disconnect chest mounted direct feed suit inflation hose (if fitted).

(3) Slip the BCA shoulder release as appropriate.

(4) Loosen the facemask straps.

(5) Let the set slide off the shoulder opposite the buddy line.

(6) Remove the facemask and release the mouthpiece; push the facemask and intermediate hose over the head.

1082. Companion Diver Drill

a. Companion diver drill will be required in the circumstances outlines in Par 1002e. Great care will be needed if the distressed diver is not breathing, as indicated by the absence of exhaust bubbles.

b. The following drill must be carried out:

(1) Communicate with the diving supervisor and try to raise the diver over the voice comms, if possible continue with a running commentary with the surface.

(2) Approach the diver from behind if possible and take a firm hold, open his reserve cylinder valve and leave it open.

(3) Purge the divers mask.

(4) Surface the diver at a controlled rate of ascent. The divers BCA can be inflated, cautiously to achieve neutral buoyancy. To avoid the possibility of an uncontrolled ascent, do not slip the divers weights unless absolutely necessary. If weights have to be slipped, commence by slipping one side at a time.

(5) On the surface, inflate the divers BCA and slip weights if necessary. **Do not slip own weights.**

(6) If the diver is breathing, leave the mask on.

(7) Attract attention and swim with the diver to the nearest point of safety.

(8) If the diver is not breathing, and it is safe to do so, remove his facemask and administer mouth-to-mouth resuscitation whilst waiting for assistance.

c. The buddyline is not to be disconnected.

d. The companion diver must continue to breathe from his set, unless he can usefully and safely administer mouth-to-mouth resuscitation.

1083. Ice Diving - Modified SABA

When used in extreme/ice conditions SABA is to be used in its routine configuration. Special care must be taken to prevent the demand valve freezing. When on the surface, the demand valve is to be kept as dry as possible and on entering the water, kept submerged.

CHAPTER 11

SELF CONTAINED CLOSED CIRCUIT BREATHING APPARATUS - DRILL AND OPERATION

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CHAPTER 11

SELF CONTAINED CLOSED CIRCUIT BREATHING APPARATUS - DRILL AND OPERATION

SECTION 1 - GENERAL

1101. Introduction

a. This Chapter contains details of the drills associated with the various types of closed circuit breathing apparatus currently in service, together with information dealing with their operation in the water.

b. Details concerning stowage, maintenance routines, tests and preparations for the dive are contained in the relevant sections of the equipment handbook, together with the pre-dive checks that have to be conducted.

c. In this context, attention is drawn to para 0734, which lays down the responsibility for the conduct of such checks and para 0736 concerning mission endurance and repetitive dives using the same breathing apparatus.

1102. Oxygen-Breathing Limitations

a. Diving using pure O_2 is confined to initial and continuation diver training and decompression, except when Combat Swimmers require to use it for training exercises and operations. Combat Swimmers receive training in combat O_2 diving and follow the rules and limitations laid down in this para. All others must observe the depth limit of para 0737 Table 7-7 and the time limits given in this para.

b. The Table below gives the O_2 exposure limits for single depth excursions. These limits apply to ALL divers including Combat Swimmers and Divers, and are never to be exceeded even if the duration of the breathing apparatus allows. They cater for moderate work (1.4 l/min consumption) and should this work rate be exceeded there will be an increased risk of CNS oxygen toxicity.

Table 11-1. Single Depth Oxygen Exposure Limits (para 1102)

Depth (Metres)	Maximum Oxygen Time (Minutes)
7	240
8	240
9	80
11	25
12	15
15	10

c. Because there are no inert gases present, breathing ‘on demand’ (ie without a flow set) may be carried out with oxygen, as the diver can tell by the level of gas in his counterlung whether more is required or not. This, however, will be true only if the diver has effectively washed all the nitrogen or inert gas out of his system before entering the water.

d. If the drill for clearing the counterlung has not been properly conducted, residual nitrogen in the lungs and tissues may produce a build-up to such a level that dilution hypoxia occurs. This danger is more acute the nearer the surface the diver is operating.

e. When using oxygen, supervisors and divers must be constantly alert to the fine limits within which it can be safely breathed. They must also be aware of the dangers of pulmonary oxygen toxicity. Under normal circumstances the maximum cumulative oxygen exposure time should not exceed 6 hours in any 24 hour period.

f. **Repetitive Dives.** The limits given in the single depth oxygen exposure Table 11-1 may be repeated provided there is a break of at least 2 hours breathing air at atmospheric pressure between dives, and that the total cumulative time breathing oxygen does not exceed 6 hours in any 24 hour period.

g. **Depth Excursions.** A diver breathing pure oxygen is limited to a maximum dive duration of 4 hours. If his dive depth has not exceeded 6m he is permitted to make a brief excursion to a deeper depth and to return to 6m or less for the remainder of the dive. Only one downward excursion is permitted in any 4 hour dive. Downward excursion limits from 6m for O_2 diving are shown in the Table below.

Table 11-2. Downward Excursion Limits from 6m

Excursion Depth	Excursion Duration	Total Dive Time
12m (max)	15 minutes (max)	4 hours
15m (max)	5 minutes (max)	4 hours

1103. Mixture-Breathing Limitations

a. The various combinations of depth, PO_2 levels and endurance that apply to CDBA are contained in paras 0735 and 0736. The combinations appropriate to different sets of circumstances are to be strictly adhered to at all times.

b. Should the limitations be exceeded the diver is likely to suffer from O_2 poisoning, CO_2 poisoning or hypoxia, depending on which limits are broken.

1104. Emergency Drills

These are described in para 1002 and are common throughout for all types of self contained breathing apparatus.

1105. Flooded Facemask Routine

If the facemask becomes flooded it can be cleared by blowing sharply through the nose or mouth while holding the top firmly against the forehead. The exhaled gas will then drive the water out at the bottom.

1106. Medical Emergencies

The most likely medical emergencies to occur during a dive, their symptoms and treatment, are described in the following paras:

Hypoxia	-	para 1320
Oxygen Toxicity	-	para 1321
Carbon Dioxide build up	-	para 1322
Caustic Cocktail	-	para 1325

1107. Maintenance - CDBA

a. All maintenance on CDBA with the exception of the periodic testing of gauges and cylinders, is carried out on a user/maintainer basis. Details are contained in the relevant Maintenance Schedule (MMS) which is the authorative document for all maintenance. Supporting information is contained in the relevant BR 2807 Handbook of Diving Equipment

b. RN Divers are qualified to carry out this maintenance on completion of training as laid down in the appropriate career and conversion course training documentation held by the DDS.

c. The Diving Officer has overall responsibility for the conduct of maintenance of clearance diving equipment.

1108-1109. Spare.

SECTION 2 - CLEARANCE DIVERS BREATHING APPARATUS

1110. Rigging The Diver

a. After completing the Pre-Dive routines in accordance with BR 2807(1)(R), and when ordered to do so, the attendant assists the diver to don the CDBA and adjust the BCD harness to a comfortable fit. The diver and attendant are to ensure that the CDBA bellows are at approximately the same height as the divers lungs and that the BCD harness holds the CDBA as close into the divers back as possible.

b. It is imperative that the pre-dive checks on the equipment are conducted in a conscientious manner. Particular importance must given to the filling of the Soda Lime container, if improperly filled channels may be formed which permit gas to bypass the absorbent. All CDBA quick connect hoses are to be mated with the XBS quick connector to ensure correct operation.

c. On completion of dressing the following reports are to be made and actions taken:

(1) Diver .... Dressed, Lifeline/Lightline (buddy line) passed, all connections checked, weights inserted.

(2) Diluent charged - (pressure) Bar on gauge.

(3) Oxygen charged - (pressure) Bar on gauge.

(4) Bail out - (pressure) Bar on gauge.

(5) Soda lime charged ....(Time)

(6) BCD Cylinder charged.

(7) Diluent, O_2 and bale out valves open, slide valve to open circuit position.

(8) Supplementary valve tested, correct and closed.

(9) Primary display shows steady green - ready to go on gas.

d. If used the External Breathing System (XBS) is to be prepared and reported:

(1) Diluent cylinder, open gauged .....Bar.

(2) Oxygen cylinder, closed gauged .....Bar.

(3) Selector valve tested and Diluent selected.

(4) Demand valve tested and correct, mask attached.

(5) Quick connect whip tested and correct.

(6) Communications tested and correct (if applicable).

(7) Heated gloves tested and correct (if applicable).

(8) XBS tested and well for leaks.

(9) 'Bitter end' of XBS line secured inboard.

e. After the report(s) the pre dive cards for all equipments are to be handed to the Diving Supervisor who will retain them until the completion of the dive(s).

1111. Going on Gas

When ordered to 'go on gas' the following routine is to be adopted:

a. Diver exhales fully and dons his mask.

b. The diver forms a seal between his face and the oral nasal and takes two breaths from the open circuit system.

c. After two breaths the diver exhales fully and operates his Mask Slide Valve and selects Primary, secures mask and confirms a stable reading (Primary, steady green).

Once on Gas the Attendant Reports:

(1) Diver on Primary, open circuit tested and correct.

(2) Primary display 'steady green' ready to enter the water.

1112. Entering the Water

The diver enters the water as described in para 0981. One hand is to be used to hold the mask in place whilst using the inner forearm of the same arm to hold the DSM block into the chest, the other hand is to hold the rear of the set into the small of the back. When in the water the diver vents his suit in the normal fashion and disposes of any trapped gas in the BCD by operating the BCD shoulder dump valve. The diver should then agitate the equipment on his back to release any air trapped within the CDBA outer case prior to testing for leaks which is to be performed just below the surface.

1113. Dive

a. When ordered to do so the diver descends as described in para 0982, the maximum descent rate is not to exceed 30m per minute.

b. The primary display is to be constantly monitored throughout the dive to ensure that the equipment is functioning correctly and that the PO_2 is maintained within the defined boundaries.

c. During the descent, at the transition point of 10m when CDBA increases its PO_2 set point from 0.75 to 1.3 the diver will experience a flashing red light indicating a low PO_2, this indication may be initially disregarded as it only indicates the changing set points. Should the primary display not return to the stabilised condition, steady green, within a short period the Secondary display is to be interrogated to ensure that PO_2 levels are increasing.

d. During descent and ascent slight variations of the PO_2 outside of the set parameters, indicated by alternating red/green lights, do not constitute a malfunction but should be monitored to ensure that they are of a transient nature. The monitoring of the secondary display during these transient phases will increase diver confidence.

e. During the dive, other than during ascent and descent, the primary display should indicate a stabilized condition 'steady green' at all times. At regular intervals throughout the dive or if the primary display shows anything other than a 'steady green' the secondary display is to be interrogated to:

(1) Confirm Primary Display Readings.

(2) Confirm Primary and Secondary Battery Life.

(3) Ascertain cause for Primary Display showing other than 'Steady Green'.

f. **Should there be any deviation from a stable Primary reading (steady green) other than at depth change point (10m descent 4m ascent) the Secondary display is to be interrogated immediately, as this may indicate a malfunction, and action should be taken in accordance with Table 11-1.**

g. Throughout the dive the diver is to routinely monitor the CDBA gas content gauges to ensure adequate gas supplies. Should either the Oxygen or diluent gas supplies drop to a minimum of 70 Bar or the bail out gas supply drop from its fully charged pre dive condition the dive is to be correctly terminated.

Table 11-1. Emergency Operating Procedures

Symptom(s)	Indication	Cause	Emergency Procedure
Alternating red/green (other than during depth transition).	1. Two sensors 1.15 to 1.45, third sensor greater than 1.45 or less than 1.15.	1. Sensor out of limits.	1. Monitor secondary display. Terminate dive. ***Note.*** *CDBA is capable of maintaining set PO_2 ranges with two sensors.*
	2. All three sensors 1.15 to 1.45.	2a. Low primary battery voltage.	2a. Monitor secondary display. Terminate dive.
Flashing green (other than during descent).	1. Two oxygen sensors greater than 1.45.	1. High oxygen partial pressure. 2. O_2 by pass jammed open.	1. Monitor secondary display. Attempt manual reduction of PO_2 by adding diluent. Switch to open circuit if appropriate. Terminate dive.
Flashing red (other than during ascent).	1. Two sensors less than 1.15.	1. Low oxygen partial pressure.	1. Monitor secondary display. Add oxygen as required to maintain PO_2 between 1.15 and 1.45 bar. Switch to open circuit if appropriate. Terminate dive.
		2. Low oxygen bottle pressure.	2. Monitor secondary display and oxygen pressure indicator. Switch to open circuit. Terminate dive.
No primary display (LEDs) (Immediately monitor secondary display).	1. Dropping secondary display readings.	1. Primary electronics failure, causing O_2 add valve to stay closed.	1. Monitor secondary display. Add O_2 as required to maintain PO_2 between 1.15 and 1.45 bar. Switch to open circuit if appropriate. Terminate dive.

Table 11-1. Emergency Operating Procedures (Cont'd)

Symptom(s)	Indication	Cause	Emergency Procedure
No primary display (LEDs) (Immediately monitor secondary display).	2. Stable secondary display readings.	2. Primary display/cable connector(s) failure.	2. Monitor secondary display. Add O_2 or diluent as required to maintain PO_2 between 1.15 and 1.45 bar. Switch to open circuit if appropriate. Terminate dive.
Steady red or simultaneously illuminated steady red and green.	1. Dropping secondary display readings.	1. Primary electronics failure.	1. Monitor secondary display. Add O_2 as required to maintain PO_2 between 1.15 and 1.45 bar. Switch to open circuit if appropriate. Terminate dive.
No gas addition When By-passing.	1. No gas addition when O_2 or diluent by-pass valves are depressed.	1a. O_2 or diluent by-pass failed in the closed position.	1a. Monitor secondary display. Switch to open circuit. Terminate dive.
		1b. Empty O_2 or diluent bottle(s).	1b. Monitor secondary display. Switch to open circuit. Terminate dive.
Continuous gas venting (other than during ascent).	1. Hear and/or feel gas escaping from CDBA.	1. O_2 or diluent bypass valve failed in the open position. 2. Diluent addition valve failed in the open position. 3. Ruptured diaphragm, gas tubing or fitting leaking; dump valve failure.	1. Monitor secondary display. 2. Switch to open circuit if required. 3. Terminate dive.
Inhalation difficulty.	1. Inhalation difficulty.	1. Insufficient gas volume in breathing loop.	1. Monitor secondary display. Add diluent until diaphragm vents on exhalation.

Table 11-1. Emergency Operating Procedures (Cont'd)

Symptom(s)	Indication	Cause	Emergency Procedure
Increased breathing resistance.	1. Gurgling sounds/water in breathing hoses/ decreased diver buoyancy.	1. Leakage in pneumatics system and/or breathing loop.	1. Switch to open circuit. 2. Terminate dive.
Complete rig flood out.	1. Water filled breathing loop.	1. Leakage in pneumatics system and/or breathing loop.	1. Switch to open circuit. 2. Terminate dive.
No secondary display readings.	1. Secondary display blank.	1. Secondary display/cable failure.	1. Monitor primary switch to open circuit if appropriate. Terminate dive.
CO_2 Build-up.	1. Confusion, shortness of breath, panting, increased breathing rate.	1. CO_2 absorbent failure.	1. Complete "trouble drill" in accordance with para 1119. Terminate dive if appropriate.

Note. *At any time during ascent, when the diver is breathing from his open circuit system, he experiences difficulty in breathing he is to open his supplementary supply valve to allow breathing from the unused gas in the diluent flask. There is no requirement to close the bailout cylinder prior to opening the supplementary valve, equalisation is not possible.*

1114. Surfacing Temporarily

If the diver surfaces during a dive (eg to make a report) and breaths air, he will be breathing a gas with a lower PO_2 than the CDBA is designed to maintain. Therefore the following drills are to be conducted.

a. **Coming off Gas**. Conduct Surfacing Drill.

b. **Going Back on Gas**. The diver is to empty any water from his mask and refit mask securely. The diver is to fully exhale and move the slide valve to the Primary position. The diver is to breath from the set on the surface until the equipment stabilises and a 'steady green' indication is viewed in the primary display. When so ordered the diver may then continue the dive.

1115. Surfacing Drill

When conducting Surfacing Drill, the following routine is to be conducted:

a. Operate the Buoyancy Control device to achieve positive buoyancy.

b. Loosen face mask straps and pull spider band to the top of the head to a position that maintains the face in contact with the oral nasal mask.

c. Move the slide valve to the open circuit position at the same time letting the mask drop away from the face.

d. Swim to nearest point of safety or otherwise as directed.

1116. Recovery Drill Into Inflatable Craft

When slipping the CDBA for recovery into an inflatable craft the following drill is to be conducted:

a. The diver partially inflates the BCD to provide sufficient buoyancy to support the CDBA.

b. The diver turns his back to the inflatable and the attendant grasps the equipment carrying handle at the top of the housing.

c. The diver slips his crotch and chest straps and releases the right hand shoulder quick release.

d. The diver is then to loosen face mask straps whilst maintaining the facial contact with the oral nasal mask.

e. The diver moves the slide valve to the open circuit position at the same time lifting the mask over the head and turning out of the set.

f. The diver is to assist the attendant in the recovery of the equipment into the boat by lifting the bottom of the set.

1117. Use of Open Circuit System for Emergency Reasons

a. An open circuit breathing system, which in turn is backed up by a supplementary supply, is available to the diver should, for what ever reason, the primary system fails (eg electronic failure, set flooding etc). On changing from a constant partial pressure (closed circuit-primary) to a fixed percentage (open circuit) breathing medium it should be borne in mind that decompression penalties may be incurred as decompression schedules require changing.

b. Should the diver need to switch from the Primary to the open circuit system the followng actions are to be taken:

(1) Slide the slide valve to the open circuit position. (Proof that the diver is breathing from the open circuit system will be evident from the exhaled gas being expelled from the mask deflectors).

(2) Inform the surface via communications/lifeline/light line, of open circuit system activated.

c. Once breathing from the open circuit system the dive is to be aborted immediately.

d. The diver should inform his buddy, if he has one, that all is not well and that he is breathing from his open circuit supply and of his intentions to ascend. If working from a shot rope the diver(s) is(are) to return to the shot, signal the surface and ascend in the normal manner signalling the surface accordingly.

e. A normal ascent rate of 15m per minute is to be maintained if possible.

f. When breathing from the open circuit system, should the diver locate the lazy shot/XBS during his ascent he should stop at it and complete his correct decompression procedures as directed by the supervisor.

g. If required to do so the diver is to transfer to breathing from XBS following the instructions at para 1124.

1118. Use of the Supplementary Gas Supply

a. The reasons for a diver electing to switch to the open circuit system are numerous. It is not necessarily due to an exhausted primary gas supply.

b. When breathing from the open circuit system it is highly probable that a substantial quantity of diluent gas remains in the Primary pressure vessel.

c. Whilst breathing from the open circuit system, should the bail out pressure vessel gas supply expire, prior to reaching the surface or connecting to the XBS, the diver is to open his Supplementary supply valve, allowing remaining diluent gas from the primary pressure vessel into the open circuit breathing system.

1119. Trouble Drill

a. If breathing discomfort, dizziness, apprehension or any feeling of illness is experienced and the primary display indicates a ‘steady green’, it is probably caused by over exertion. The tendency to surface immediately must be resisted as this action may aggravate the condition.

b. The diver must act as follows:

(1) Signal buddy, if he has one, to remain where he is and the diver should then relax.

(2) Interrogate Secondary display to ascertain O_2 sensor readings.

(3) If the readings on the secondary display confirms the ‘steady green’ of the primary display and the diver feels better after a short break the dive may be cautiously continued.

(4) Should the diver still feel unwell after a short interval the CDBA recirculation system is to be flushed through using the diluent gas by-pass valve. A short burst of diluent gas is to be by-passed into the system whilst PO_2 levels are monitored on the secondary display. In between short bursts of diluent gas the PO_2 is to be allowed to stabilise prior to additional diluent addition. If flushing the bellows is successful and the diver is well, the dive may be cautiously continued.

(5) Any repeat of unwell feelings after conducting the procedure at sub-para 4, then the dive is to be aborted.

(6) Should the secondary display indicate a possible malfunction of the set the diver should attempt to rectify the problem in accordance with the instructions Table 11-1 and consider terminating the dive.

c. Should the diver feel so unwell that he cannot attempt fault rectification or fault rectification is ineffective the diver should switch to his open circuit breathing system and follow the instructions at para 1117.c.

1120. Emergency Ascent

a. Due to the inherent safety features of the CDBA there should be no requirement to conduct an emergency ascent. Should, however, the primary, open circuit and supplementary systems fail whilst at depth the diver must make an emergency ascent as follows:

(1) Inform buddy of intention to ascend immediately.

(2) Slip weights if necessary.

(3) Breathe normally during ascent. If this is not possible the diver must breathe out continuously during the ascent.

b. On arrival at the Surface the diver must:

(1) Attract attention.

(2) Operate BCD to gain positive buoyancy.

(3) Slip weights, if required, if not already done so.

(4) Move the slide valve to the open circuit position.

(5) If the BCD is damaged and the diver cannot maintain positive buoyancy by means of suit inflation alone the set is to be ditched.

1121. Ditching Drill

a. If at any time it becomes necessary to ditch the set under water the diver is to carry out the following drill after ensuring that he personally is clear/aware of all obstructions/snagging hazards:

(1) Release crotch, chest and waist straps.

(2) Release the shoulder mounted quick release buckle on the same side as the buddy line, if worn, and slip one arm out of the equipment.

(3) Grasp the bottom of the Dual System Mask block. Move the slider valve to the open circuit position at the same time removing the mask in an upwards single movement and releasing the mask to fall to the rear of the set.

(4) Let the set slide of the retaining arm.

(5) Breath out during ascent until the surface is reached.

Note. *This drill is not to be exercised except under medical supervision and with a compression chamber on site at immediate notice.*

1122. Companion Diver Drill

a. Companion Diver drill will be required in the circumstances outlined in para 1002. Great care will be needed if the distressed diver is not breathing.

b. The following drill is to be carried out:

(1) Approach the diver, take a firm hold and shake the diver.

(2) Remove primary display from polarising brackets/secure in spider.

(3) Interrogate the stricken divers secondary display to ascertain the condition of his set, taking appropriate action in accordance with Table 11-1.

(4) If all readings are within the set parameters the stricken diver is to be surfaced at a controlled rate of ascent (15m per minute), his weights should be ditched if necessary. The operation of the stricken divers BCD should be avoided if at all possible due to the high probability of an uncontrolled ascent.

(5) If the readings on the stricken divers secondary display are outside of the set perameters the diver should be switched onto his open circuit breathing system and surfaced at a controlled rate of ascent.

Note. *The supervisor is to be informed on any occasion when a diver is breathing from his open circuit breathing system.*

(6) On the surface, operate the divers BCD and slip his weights if required. Ensure that the diver is in a head up orientation and attract attention.

(7) If the diver is breathing leave his facemask on.

(8) If he is not breathing, and sea conditions permit, move the divers slide valve to the open circuit position and remove the divers mask over the top of his head.

Note. *When the divers weights are slipped, he will have a tendency to roll onto his right side.*

c. The breathing equipment is not to be ditched unless the BCD cannot maintain the diver in a positively buoyant position. When ditching the set care must be taken not to loose contact with the diver. The buddyline, if worn, should not be disconnected.

d. The companion diver must continue to breath from his set, unless he can usefully and safely administer mouth to mouth resuscitation.

1123. Procedure for Standby Divers

a. On assuming his duties the stand by diver is to conduct the procedures detailed in para 1110, sub-paras a to c(7) inclusive.

b. When ordered to dive, the standby diver is to carry out the following drill assisted by his attendant:

(1) Diver dresses.

(2) Mask is donned move the slide valve to the Primary system. Confirm steady green.

(3) When ordered to do so the diver enters the water and descends at a maximum rate of 30m per minute monitoring his secondary display and ensure PO_2 remains with the set perimeters.

c. After initial preparation in accordance with sub-para ‘a’ above the CDBA is available for use for a period of 12 hours. After such time the set is to have a full pre-use routine conducted on it once again. A full pre-use routine is also to be conducted if there is evidence of cylinder leakage or tampering with equipment.

1124. External Breathing System (XBS) Operations

a. The XBS is to be available at the dive site at all times when conducting diving operations in excess of 42m or diving involving planned decompression stops

b. The deployment of the XBS is similar to the standard Lazy Shot. Prior to a dive requiring decompression ‘stops’ the XBS is to be prepared in accordance with para 1110(d) and secured onto the Shot line. The bitter end of the XBS handling line is to be secured inboard iaw para 0945.

c. The XBS is to be lowered to a position three metres below the divers first intended stop. On arrival of the diver at the XBS the XBS is to be hoisted immediately to the first intended stop where the timing of that decompression stop will commence. During decomression the diver is to attempt to maintain a position keeping his chest level with the manifold on the XBS. During the transfer of gases by the diver, attention is drawn to para 0756e. If assent is too fast, wait until the correct time has elapsed, see para 1225(c). The diver will continue to follow the XBS until it reaches the surface. The travel rate of the XBS is to be 4 seconds per metre for all moves.

d. When diving to depths in excess of 60m, should the supervisor receive a signal that the diver has switched to his open circuit system, the XBS is to be lowered carefully to meet the ascending diver. On reaching the XBS the diver is to signal the surface and ascend with the XBS to his first stop.

e. Under normal operational conditions, when the diver has settled on his first stop, the diver is to connect his communications and heated gloves, if available, and report to the diving supervisor that he is well or otherwise.

f. If the diver is on his open circuit or supplementary breathing system on reaching the XBS he is to:

(1) Ensure selector valve is to Diluent and Diluent valve is open.

(2) Connect CDBA and XBS ‘quick’ connections, monitoring diluent XBS gauge.

(3) Inform surface of connection.

(4) Continue decompression stops following the XBS as required.

1125. External Breathing System - O_2 Stops

a. If the diving supervisor determines before or during the dive that 0_2 stops are required, the diver is to conduct the following drill when instructed:

(1) Connect CDBA and XBS ‘quick’ connections.

(2) Move XBS selector valve from the Diluent to O_2 ensuring full travel of selector valve.

(3) Slowly open XBS O_2 valve at the neck.

(4) Select open circuit breathing system at the slide valve.

(5) Close CDBA bale out cylinder valve and ensure supplementary valve is in closed position.

(6) Close XBS Diluent valve at the neck.

(7) Give the appropriate signal to the surface when on O_2.

Note. *The drill for going onto oxygen while using CDBA is to be regularly practiced.*

b. If a diver on open circuit is required to go onto O_2 he is to conduct the procedure detailed at para 1125(a).

c. In the highly unlikely event of both a Primary and open circuit systems failure whilst at or approaching the XBS the diver should remove his mask and breath from the XBS demand valve, fitting the swim mask as required. Should both systems fail while the diver is on the seabed action in accordance with para 1120 should be considered.

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SECTION 3 - LONG ENDURANCE BREATHING APPARATUS (MIX GAS) LEBA (MG)

1130. Rigging The Diver

a. On completion of pre use routines and checks in accordance with BR 2807(1)(T), and when instructed to do so, the diver dons his equipment. An attendant should always be available to assist the diver, the attendant is then to ensure that the divers weights and safety equipment are correctly fitted and secured.

b. It is imperative that the pre-dive checks on the equipment are conducted in a conscientious manner. A set is not to be used unless it is accompanied by a pre-dive tag detailing the successful completion pre-use routines and that the tag is signed by the diver using the LEBA.

c. When used with LEBA (MG), buddylines may be secured to either arm.

d. When instructed, the diver dons his equipment. On completion of dressing the following report is to be made and actions taken.

(1) Diver ...... dressed, Lifeline/Light line/Buddy line passed (as appropriate), all connections checked, weights inserted.

(2) Diluent cylinder charged .... Bars on display module, valve open.

(3) Oxygen cylinder charged ....Bars on display module, valve open..

(4) Bail out cylinder charged .... Bars on gauge, valve open, quick connect made DDM to open circuit.

(5) DABJ and suit inflation valves tested.

(6) DABJ emergency inflation cylinder charged tested and correct (SDV cold water assembly use only)

(7) Soda lime canister charged ....

(8) Battery Status (Voltage) ....

(9) Ready to go on gas.

1131. Going on Gas

a. When ordered ‘go on gas’ the following routine is to be adopted.

(1) Diver dons his mask.

(2) Takes two breaths from open circuit.

(3) Change over valve is switched to closed circuit.

(4) Diver then breathes from the set until a steady green status LED is displayed.

(5) When the LED Displays a ‘steady green’, the diver is ready to enter the water.

b. Report.

(1) Diver on Closed circuit.

(2) Open circuit tested and correct.

(3) Diver has a steady ‘green’ and ready for the water.

1132. Entering the Water

a. The diver enters the water as described in Article 0981, holding down on the face mask with one hand whilst using the inner forearm of the same arm to hold the dual mode mask block into the chest. The other hand is to be used to hold the set into the small of the back.

b. When a swimboard is carried, it should be tucked under the right armpit with the compass facing away from the body. If a silent entry is to be made the swim board should be handed to the diver after he has entered the water. The diver should then secure it to his DABJ.

c. During a silent entry the emphasis is on silence not speed.

d. When in the water the diver vents his suit and DABJ then remains just under the water whilst his attendant/buddy checks for leaks.

1133. Dive

a. When instructed the diver descends as described in para 0982, the maximum descent rate is not to exceed 30 m per minute.

b. The status LED is to be constantly monitored throughout the dive to ensure that the equipment is functioning correctly and that the PO_2 is maintained within the defined boundaries.

c. During the initial descent the diver is to ensure that the depth gauge and timer facilities activate at approximately 2 m.

d. During change of depth slight variations of the PO_2 outside of the set parameters, indicated by a status LED, do not necessarily constitute a malfunction but should be monitored to ensure that they are of a transient nature.

e. During the dive, other than during depth change, the status LED should indicate a steady green condition when within parameters. At regular intervals throughout the dive or if the status LED shows anything other than a ‘steady green’ the display module is to be interrogated to access the information displayed.

f. Procedural differences concerning the use of LEBA (MG) in the SDV are covered in detail in SDV SOP’s

TABLE 11-2 LEBA Emergency Operating Procedures

WARNING/SYMPTOM(S)	INDICATION	CAUSE	EMERGENCY PROCEDURE
GREEN FLASHING LED	HIGH PO_2 message on display module	1. PO_2 greater than 0.2 bar above the set point for 16 seconds. 2. Oxygen addition valve jammed open. 3. Failure in control electronics.	1. Observe display module: a) If PO_2 is high but stable, breathe down and monitor. b) If PO_2 is increasing, switch to open-circuit supply. 2. If open-circuit supply unavailable, use manual control of oxygen shut off valve to maintain the PO_2 level.
	LOW PO_2 message on display module	1. PO_2 less than 0.2 bar below the set point. 2. Oxygen addition valve jammed closed. 3. Failure in control electronics. 4. Blocked filter. 5. Failure of oxygen regulator. 6. No oxygen/cylinder valve closed.	1. Observe display module: (a) If PO_2 is low but stable, reduce work load and monitor. (b) If PO_2 decreases, flush with diluent and switch to open-circuit supply if this fails to increase the PO_2. Open cylinder valve.
	LOW BATTERY message on display module.	Reduced battery voltage reading less than 5.9 volts for 60 seconds.	Be aware of the operational limitations - typically two (2) hours usage remaining.
	Oxygen contents value on display module flashing. Diluent contents value on display module flashing. 'LOW TEMPERATURE' message on display module and PO_2 reading 'F,FF'.	Oxygen cylinder pressure down below 50 Bar Diluent cylinder pressure down below 50 Bar. Very cold ambient temperature (less than minus 5°C).	Be aware of the operational limitations. Be aware of the operational limitations. Thermally protect and breathe set hard to exercise carbon dioxide absorbent in scrubber.

WARNING/SYMPTOM(S)	INDICATION	CAUSE	EMERGENCY PROCEDURE
GREEN FLASHING LED	'LOW TEMPERATURE' . message on display module and PO_2 reading 'F,FF'.	1. Temperature sensor failure. 2. Electronics failure. 3. Connector/cable failure.	Switch to open circuit supply. Surface and inform the Safety Supervisor.
	TOO DEEP message on display module. 'DEPTH SENS FAIL' message on display module and PO_2 reading 'F.FF'.	Depth greater than 50m . (INFORMATION ONLY). 1. Failure of pressure transducer. 2. Electronics Failure. 3. Connector/cable failure.	Ascend to 24m. 1. Check depth 2. Abort on air table if necessary.
CONTINUOUS GREEN LED	'ONE PO_2 SENS FAIL'. Message on display module.	1. Oxygen sensor No action. Failure. 2. Electrical failure.	Enter the 'Sensor Display' mode to identify failed sensor.
RED FLASHING LED	HIGH PO_2 message on display module	1. PO_2 greater than 2.0 bar. 2. Oxygen addition valve jammed open. 3. Failure in control electronics.	Switch to open-circuit supply. Surface and inform the Safety Supervisor.
CONTINUOUS GREEN LED	No display on LCD	1. LCD failure. 2. Connector/cable failure. 3. Electronic failure	Switch to open circuit, inform buddy, surface and inform safety supervisor
NO LED	No display on LCD.	1 Electronics failure.	Switch to open circuit. Surface and inform the safety supervisor
NO LED.	'ABORT - LED FAIL', message on display module	1. LED failure. 2. connector/cable failure. 3. Electronic failure	Switch to open-circuit. Inform buddy, surface and inform safety supervisor.

WARNING/SYMPTOM(S)	INDICATION	CAUSE	EMERGENCY PROCEDURE
NO LED	Normal display on LCD	1. LED failure. 2. Connector/cable failure. 3. electronics failure.	Switch to open circuit, inform buddy, surface and inform safety supervisor.
RED FLASHING LED	HIGH PO_2 message on display module	1. PO_2 greater than 2.0 bar. 2. Oxygen addition valve jammed open. 3. Failure in control electronics.	Switch to open-circuit supply. Surface and inform the Safety Supervisor.
	LOW PO_2 message on display module	1. PO_2 less than 0.18 bar. 2. Oxygen addition valve jammed closed. 3. Failure in control electronics. 4. Blocked filter. 5. Failure of oxygen regulator. 6. No oxygen. 7. Connector/cable failure	Switch to open-circuit supply. Surface and inform the Safety Supervisor.
	'LOW PO_2' message on display module	PO_2 less than 1.8 bar, due to: Oxygen cylinder valve closed.	Open oxygen cylinder valve.
	LOW BATTERY message on display module	1. Battery voltage less than 5.63V. 2. Battery depleted. 3. Electronics failure. 4. Connector/cable failure.	Switch to open-circuit supply. Surface and inform the Safety Supervisor.

WARNING/SYMPTOM(S)	INDICATION	CAUSE	EMERGENCY PROCEDURE
RED FLASHING LED	All PO_2 SENS FAIL message on display module.	1. All sensors disagree. 2. Failure of control electronics. 3. Connector/cable failure.	Switch to open-circuit supply. Surface and inform the Safety Supervisor.
	'VACUUM SENS FAIL' message on display module	1. Failure of pressure transducer. 2. Leak in electronics module.	Switch to open-circuit supply. Surface and inform the Safety Supervisor.
	'HOUSING LEAK' message on display module.	Leak in electronics module	Switch to open-circuit supply. Surface and inform the Safety Supervisor.
	UNKNOWN RED ABORT message on display module.	Warning given by hardware electronics that is unrecognised by microprocessor monitor.	Switch to open-circuit supply. Surface and inform the Safety Supervisor.
INHALATION DIFFICULTY	None	Kinked hose.	Check for external obstruction
	None.	Inverted mushroom valve	Reseat by hard suck or blow
	No	Insufficient make up of diluent.	Operate diluent bypass valve. Surface and inform the Safety Supervisor.
SEVERE INHALATION DIFFICULTY OR NO BREATHING GAS.	Breathing difficulties.	1. Diluent demand valve failure. 2. Blockage.	Switch to open-circuit supply. Surface and inform the Safety Supervisor.
	Continuous gas venting	1. Burst counterlung. 2. Seal failure. 3. Hose failure. 4. Connector failure. 5. Valve failure.	1. Switch to open-circuit supply. Surface and inform the Safety Supervisor. 2. Close diluent and oxygen cylinder shut-off valves.
INCREASED BREATHING RESISTANCE.	Breathing difficulties and gurgling sounds.	1. Leakage in gas system. 2. Exhale valve set to high. 3. Flooded set.	Switch to open circuit supply. Surface and inform the Safety Supervisor.

WARNING/SYMPTOM(S)	INDICATION	CAUSE	Emergency Procedure
INCREASED BREATHING DIFFICULTY.	Decreased diver buoyancy.	Leakage in gas system.	Switch to open-circuit supply. Surface and inform the Safety Supervisor.
COMPLETE SET FLOOD.	Water in breathing supply.	Severe leakage in gas supply system.	Switch to open-circuit - supply. Surface and inform the Safety Supervisor.
CONFUSION, SHORTNESS OF BREATH, PANTING, INCREASED BREATHING RATE.	Confusion, shortness of breath, panting, increased breathing rate.	1. CO_2 build up. 2. Scrubber bed channelling (bypass). 3. Absorbent spent. 4. Mask non-return valve failure. 5. Water ingress to scrubber.	Switch to open-circuit supply. Surface and inform the Safety Supervisor.

Note. *When in the SDV, the LSS Supply should be used in an emergency, in preference to the emergency bail out supply.*

1134. Low Temperature Operation

If operations at air temperatures below minus 5° C are envisaged, the LEBA (MG) may be prevented from normal start up. It should be noted that the temperature sensor in the O_2 housing will prevent the set from being dived. In this situation the display module will show F.FF.

Note. *Always fit a newly charged battery for sub zero conditions.*

1135. Surfacing Temporarily

a. If the diver surfaces during a dive he is to ensure that he makes himself positively buoyant prior to removing his mask. When removing his mask he is to make sure that the Dual Mode Mask changeover valve is switched to the open circuit position.

b. When going back ‘on gas’ after breathing air the diver is not to descend until he has a green light on his LED display and he is given permission to do so.

1136. Surfacing Drill

a. On surfacing the following drill is to be conducted:

(1) On the surface inflate the DABJ using the cylinder inflation until positively buoyant.

(2) Switch mask changeover valve to open circuit and remove mask.

(3) Swim to the nearest point of safety.

b. If, subsequently, the diver is ordered to dive again, he must only do so if he has adequate gas and the display module is within safe parameters.

c. The surface supervisor is to check the contents of the DABJ/suit inflation cylinder and Emergency bail out cylinder to ensure that the contents are above 100 Bar before continuing the dive.

1137. Counter Lung Water Removal Procedure

a. During normal diving, but particularly in cold water and when doing hard work, water collects within both counterlungs. This water is to be expelled during a dive to prevent excess water getting into the mask or scrubber bed.

b. To remove water from the exhale counterlung the following actions are to be taken:

(1) Adopt a horizontal, face down position rolled slight to the left, with the primary variable exhaust valve in the lightest setting (fully counter clockwise looking at the diver).

(2) Breath out into the exhale counterlung through the bite mouthpiece..

(3) Squeeze on the counterlung with both hands. The over pressure will expel water through the variable exhaust valve.

(4) Once bubbles are observed stop squeezing the counterlung to minimise gas loss.

c. To expel water from the inhale counterlung.

(1) Adopt a horizontal, face down position rolled slightly to the right, with the 'exhale' variable exhaust valve in the highest setting (fully clockwise looking at the diver).

(2) Close the back of the throat or clench onto the bite mouth piece.

(3) Squeeze on the counterlung with both hands. The over pressure will expel water through the inhale counterlungs water dump valve.

(4) This drill is best carried out with the counterlung as full of gas as possible.

1138. Mask Clearing Procedure

The DMM is provided with a diver operated water dump valve located on the diver's right side. The oral nasal is also provided with an automatic dump mushroom valve on the left side. Should the mask and oral nasal flood, the diver is to carry out the following procedure:

a. Adopt a position with his head upright but rolled to his right side.

b. Locate the end of the mask water dump valve and depress the centre with a finger or thumb whilst simultaneously breathing out through the nose.

1139. Mask Changeover Valve Clearing

If water collects for any reason in the mask changeover valve/bite mouth piece the diver should carry out one of the following procedures:

a. The diver should adopt a horizontal position rolled fully onto his left side.

b. Exhale forcefully to expel water down the mask exhale duct and into the exhale counterlung.

c. Expel water from the exhale counterlung in accordance with the procedure given above.

1140. Open-Circuit Breathing

a. An Open Circuit breathing capability is available via an Emergency Bail Out cylinder should the primary system fail or for operational purposes.

b. It is enabled by the diver operating the Changeover valve on the Dual Mode Mask.

c. Should the diver need to switch to the open circuit mode the following actions are to be taken:

(1) Grasp the Changeover valve on the dual Mode Mask and rotate through 90 deg anti-clockwise. A positive ‘click’ can be felt at correct actuation.

(2) Inform buddy of open circuit actuation.

(3) Once breathing from open circuit the diver is to abort the dive and surface in accordance with Art 1143 or in accordance with SBS operational regulations.

Note. *SDV crew are able to utilise the SDC LSS as an additional open circuit supply.*

1141. Trouble Drill

a. If breathing discomfort, dizziness or apprehension is experienced, it is probably caused either by over exertion or by a restriction in the breathing circuit. In either case, a tendency to surface immediately must be resisted, as this will almost certainly aggravate the conditions.

b. The diver must act as follows:

(1) Stop, signal his buddy if appropriate, to remain where he is and maintain depth.

(2) Relax and interrogate the status LED display.

(3) If a warning light is visible, interrogate the display module and take the appropriate action in accordance with the written message.

(4) Flush the counter lung with diluent gas if required.

(5) If the display module is within parameters the diver may cautiously continue to dive.

(6) If the problem reoccurs the diver is to inform his buddy, if a green status light is showing once again flush the counter lung with diluent gas and surface. If a red LED light is indicated, the diver is to switch to open circuit supply prior to ascent.

(7) The display module shows a system malfunction which will not stabilise, the diver must inform his buddy, switch to bailout cylinder and abort the dive.

Note. *Symptoms may be caused during rapid descent. The diver should halt his descent and carry out the drill in para (b) above.*

1142. Emergency Ascent

a. Should the breathing apparatus become inoperative because of damage or defects, the diver must make an emergency ascent as follows:

(1) Inform his buddy of his intention to ascend.

(2) Surface at a controlled rate of ascent, slipping all slippable weights if necessary to give increased buoyancy.

(3) Breathe normally throughout the ascent. if this is not possible, he must breathe out.

b. On arrival at the surface the diver must act as follows;

(1) Slip all slippable weights if this has not already been done.

(2) Inflate his DABJ and operate his suit inflation if fitted.

c. Conduct surfacing drill in accordance with Para 1136

1143. Ditching Drill

a. If at any time it becomes necessary to ditch the set under water the diver is to carry out the following drill after ensuring that he personally is clear/aware of all obstructions/snagging hazards:

(1) Release chest, waist and counterlung straps.

(2) Release the shoulder mounted quick release buckle which is on the same side that the buddy line, is worn.

(3) Grasp the bottom of the dual mode mask and rotate the changeover valve to the open circuit position at the same time removing the mask in an upwards single movement and releasing the mask to fall to the rear of the set.

(4) Let the set slip to the rear of the diver.

(5) Breathe out during ascent until the surface is reached.

Note. *This drill is not be exercised except under proper supervision and with a compression chamber on site at immediate notice.*

1144. Companion Diver Drill

a. Companion diver drill will be required in the circumstances outlined in Chapter 10 Para 1002.f. Great care will be needed if the distressed diver is not breathing, as witnessed by the lack of movement of the counterlung.

b. The following drill must be carried out:

(1) Approach the diver from the front and take a firm hold of the divers waist strap on the DABJ with the left hand.

(2) Interrogate status LED.

(3) Switch the diver to Open Circuit (if possible inform the surface with 2 pulls)

(4) Surface the diver at a controlled rate of ascent using the DABJ as necessary. Use right hand to control gas into and out of the divers DABJ. If still available, slip the divers weights as necessary to increase buoyancy. .

(5) On the surface make the diver positively buoyant using the divers DABJ, suit inflation and slipping the divers weights, if not already done so.

(6) Attract attention.

(7) Turn the diver on his back and support the head clear of the water.

(8) Remove divers DDM due to limited gas within the bailout cylinder, ensuring the mask is to open circuit.

(9) Swim to the nearest point of safety.

c. The companion diver must continue to breathe from his set, unless he can usefully and safely administer mouth to mouth resuscitation.

d. Buddy lines are not to be Disconnected.

1145. Procedure for Standby Divers

a. On assuming his duties the standby diver is to conduct the procedures detailed in paragraphs 1130 a to d(7) inclusive.

b. When ordered to dive, the standby diver is to carry out the following drill assisted by an attendant:

(1) Diver dresses.

(2) Mask is donned turning the changeover valve to closed circuit.

(3) When ordered to do so the diver enters the water ensuring that his systems LED light is green. He then descends as fast as possible monitoring his display module and ensure PO_2 remains within the set parameters.

c. After initial preparation in accordance with paragraph a, above, the LEBA (MG) is available for use for a twelve hour period. After such time the set is to have a full pre-dive routine carried out on it again. A full pre-dive routine is also to be conducted if there is evidence of cylinder leakage or tampering with the equipment.

LONG ENDURANCE BREATHING APPARATUS (OXYGEN) - LAR V (LEBA (O_2) - LAR V)

1146. Rigging The Diver

a. The diver is prepared in accordance with the drills and pre-dive checks laid down in **BR 2807(1)(P)**.

b. **Buddylines.** Para 0745 lays down the procedure for dressing with buddylines. When used with the LAR V buddylines may be secured to either arm. (See also para 0743c).

1147. Checking The Set and Clearing The Bag

a. With the LAR V it is important to clear all the nitrogen from the air out of the lungs and bag before diving (para 1102d).

b. This is done by carrying out the following drills:

(1) Open cylinder valve.

(2) Fit swim-mask.

(3) Blow all air out of the lungs and insert mouthpiece, rotate mouth cock to gas.

(4) Clear bag by inhaling through the mouth and exhaling through the nose 3 times, ensuring the demand valve is tripped each time. The set is now flushed through.

(5) Breathe normally for 2 minutes.

(6) Inhale through the mouth, exhale through the nose a further 3 times.

(7) Fill the bag using the purge button if necessary until breathing is possible.

(8) Should the swim-mask be removed at any time during this drill, it is to be replaced and the drill started again. This prevents the possibility of introducing nitrogen into the bag and the lungs.

c. The diver then indicates he is ready for the water.

1148. Entering the Water

a. The diver enters the water as described in para 0981, holding down on the face-mask and mouthpiece with one hand and pressing the set against the chest with the other.

b. When a swim-board is carried, it should be tucked under the right armpit with the compass facing away from the body. If a silent entry is to be made from a canoe or inflatable craft, the swim-board should be handed to the diver after he has entered the water. The diver should then secure it to the side strap on the right-hand side of his breathing apparatus.

c. During a silent entry the emphasis is on silence and not on speed.

d. When in the water the diver vents his suit and then remains just under the water while the attendant checks for leaks.

1149. Dive

a. The diver descends as described in para 0982.

b. The endurance of the dive is regulated by the maximum oxygen exposure for that depth (see para 1102) or the endurance of the CO_2 absorbent (120 minutes working, 180 minutes at rest in water at or above 6°C reducing to 150 minutes in water below 6°C) whichever is the shorter (see para 0736).

1150. Surfacing Temporarily

a. If the diver surfaces during a dive (eg to make a report) and breathes air, he will again introduce air into the bag and lungs.

b. No matter for how short a time he breathes air he must carry out the full procedure for clearing the bag (para 1146), including breathing oxygen for two minutes, before continuing his dive.

1151. Surfacing Drill

a. If the diver wishes to surface and then continue swimming on the surface the following drill is to be carried out, provided the apparatus is functioning correctly:

(1) Swim up to the surface at the normal rate of ascent.

(2) Inflate the lifejacket using the inflation cylinder to achieve a comfortable surface trim.

(3) Rotate the mouth cock to atmosphere and remove the mouthpiece.

b. If, subsequently, the diver wishes to dive again, the full procedure for clearing his lungs and the bag as given in para 1146, is to be carried out before diving.

c. During basic training trainees should be taught, in addition, the drill for oral inflation of the lifejacket. This drill should also be practised when carrying out continuation training. The drill is as follows:

(1) Swim up to the surface at the normal rate of ascent.

(2) Rotate the mouth cock to atmosphere and remove the mouthpiece.

(3) Orally inflate the lifejacket to achieve comfortable surface trim.

1152. Operational Drills

a. **Diving from Canoes.** The canoes raft up. Number 1s and 2s then proceed as follows:

(1) No. 1s enter the water over the bows.

(2) No. 2s hand the swimmers their sets.

(3) No. 1s don their sets, buddy up, and commence their pre-dive procedure as stated in para 1146.

(4) No. 1s vent suits and check each other for leaks.

(5) When ready they inform No. 2s, take any stores and commence dive.

(6) *For Training only.* No. 2s inform the supervisor by visual or radio signal that the dive is about to commence.

b. **Diving After a Surface Swim Approach**

(1) Prior to entering the water the swimmer ensures that the lifejacket contains no air, the bag has been breathed down but the cylinder valve remains open.

(2) Once in the water the swimmers vent their dry suits, check each other for leaks, then orally inflate their lifejackets and proceed on the surface approach.

(3) When the dive position is reached, the swimmers:

(a) Fit swim-mask.

(b) Blow all air out of lungs, insert mouthpiece and rotate mouth cock to gas.

(c) Inhale through the mouth, exhale through the nose 3 times.

(d) Breathe normally for 2 minutes.

(e) Then breathe in through the mouth out through the nose 3 times.

(4) The swimmers remain on the surface throughout the full procedure, including the 2 minutes on oxygen, but do not stop swimming.

(5) Once both swimmers have completed the above drill they dive by depressing the inflate/deflate valve on the lifejacket until all air is expelled.

c. **Immediate Action Drill**

(1) During the surface approach swimmers have already vented the dry suit, have the cylinder valve open and lifejackets inflated.

(2) If the swimmers are forced to dive in an emergency, they are to carry out the following drills:

(a) Stop swimming.

(b) Raise the inflate/deflate hose on the lifejacket above the head and depress valve.

(c) Sink underwater causing as little disturbance as possible.

(d) Insert the mouthpiece blowing out to clear it of water and rotate the mouth cock to gas.

(e) Clear the lungs and bag by inhaling through the mouth and exhaling through the nose 3 times. Fit swim-mask if not already on prior to clearing the bag.

(f) During the 2 minutes waiting period continue with dive.

(g) Clear the bag a second time by inhaling through the mouth and exhaling through the nose 3 times.

(3) Close attention must be paid to depth-keeping while carrying out this drill.

1153. Trouble Drill

a. If breathing discomfort, dizziness or apprehension is experienced, it is probably caused by over-exertion or a restriction in the breathing circuit. A tendency to surface immediately must be resisted, as this may result in arterial gas embolism.

b. The diver must act as follows:

(1) Stop, signal his buddy, if he has one, to remain where he is.

(2) Relax and flush through the bag by venting off gas through the nose, tripping the demand valve 3 times.

(3) If the trouble persists the diver must assume that something is wrong, flush through the bag again, and make a controlled ascent to the surface after signalling his intention to his buddy.

c. If the symptoms persist at the surface the dive should be discontinued. If the symptoms subside the dive may be resumed after a 5 minute interval breathing air.

d. **Buddy Breathing**

(1) During operations or operational training, buddy breathing can be carried out using the following method:

(a) Troubled diver signals his buddy.

(b) Troubled diver grasps the harness behind his buddy's neck and swims directly above him.

(c) The untroubled diver must have the depth gauge and compass.

(d) The mouthpiece is passed between the divers over the head of the untroubled diver now carrying the depth gauge and compass each taking two or three breaths in turn.

(e) Prior to every exchange the diver must exhale whilst switching the mouthpiece to atmosphere and vice-versa.

(2) It is stressed that these procedures must not be attempted until the following training has been conducted:

(a) Dry drills on side of swimming pool including a reminder on 'Free Ascent' drills.

(b) Wet drills in shallow end of swimming pool.

(c) Wet drills in deep end of swimming pool.

(d) Wet drills under strictly controlled conditions in open water.

(3) Maintenance of a good trim is essential when conducting this exercise and the untroubled diver must be aware of his depth deepening at all times.

1154. Emergency Ascent

a. Should the breathing apparatus become inoperative because of damage or defects, the diver must make an emergency ascent as follows:

(1) Inform his buddy of his intention to ascend.

(2) Surface at a controlled rate of ascent, slipping all slippable weights if necessary to give increased buoyancy.

(3) Breathe normally throughout the ascent. If this is not possible, he must breathe out.

b. On arrival at the surface the diver must act as follows:

(1) Slip all slippable weights if he has not already done so.

(2) Inflate his lifejacket and operate his suit inflation if fitted.

(3) Carry out the remainder of the normal surfacing drill (para 1150).

1155. Ditching Drill

a. During an emergency it may be necessary to ditch the set underwater.

b. If so the diver is to carry out the following drill:

(1) Remove the mouthpiece retaining strap from the head.

(2) Loosen set by releasing neck strap.

(3) Hold set against chest and release waiststrap.

(4) Ditch set.

(5) Breathe out until surface is reached.

c. When this drill is being carried out for exercise, the mouthpiece is to be switched to atmosphere before being released, to prevent the set from being flooded.

d. If the set is retained until the diver surfaces, the drill in sub-paras b(1) to (5) above is to be used on the surface.

e. Ditching drill is not to be exercised except under proper supervision and, because of the danger of embolism, with a compression chamber on site at immediate notice.

1156. Companion Diver Drill

a. Companion diver drill will be required under the circumstances outlined in para 1002e. Great care will be necessary if the distressed diver is not breathing. The lifejacket should not normally be used, to prevent the ascent getting out of control.

b. To bring a diver to the surface the following drill must be carried out:

(1) **MAINTAIN DEPTH. ANY DESCENT MUST BE STOPPED IMMEDIATELY.** If necessary the diver must use his Secumar buoyancy aid to achieve this. Normally two quick operations of the cylinder valve will be sufficient. To prevent an uncontrolled ascent care is to be taken not to over-inflate the buoyancy aid underwater.

(2) Approach the diver from the side and slip his slippable weights if necessary to increase buoyancy. If positive control of the diver is achieved and the depth maintained proceed in accordance with sub-para b. In the event of adverse conditions divers are reminded that the priority of the Companion Diver Drill is to surface the diver as quickly as possible even if this necessitates the by-passing of other drills. The use of the following drills could make the divers rate of ascent uncontrollable and lead to an arterial gas embolism. To enable excess gas to escape every effort should be made to break the seal between the distressed divers mouthpiece and mouth.

(3) If necessary, and if equipped with, operate the distressed divers suit inflation.

(4) If equipped with, and if necessary operate own suit inflation.

(5) **As a last resort** to maintain or reduce depth, the use of the distressed divers Secumar buoyancy aid is acceptable. Every effort must be made to control the inflation of the jacket and the distressed divers ascent.

(6) Manoeuvre the diver so as to be able to depress his demand valve and reach his mouthpiece. Ensure the diver can be supported and controlled during the ascent.

(7) With one hand placed under the distressed divers arm depress his demand valve. At the same time break the seal between the mouthpiece and mouth, enabling excess gas to escape.

(8) Ensure the seal is broken before taking the diver to the surface at a controlled rate of ascent. During the ascent the diver's head must be kept well back with chin pointed upward to keep his airway clear.

(9) On the surface slip all slippable weights, if this has not been done previously, and inflate his life-jacket by use of the cylinder.

(10) If the diver is breathing do not remove his mouthpiece. If he is not breathing switch the mouthpiece to atmosphere and remove it.

(11) Keep the diver on his back, attract attention and swim with him to the nearest point of safety.

c. The breathing set is not to be ditched unless the weight of it is pulling the diver down. When ditching take care not to lose hold of the diver. The Buddyline is not to be disconnected.

d. The companion diver must continue to breath from his set, unless he can usefully and safely administer mouth to mouth resuscitation.

1157-1159. Spare.

LIGHTWEIGHT OXYGEN SWIMMERS EQUIPMENT (LOSE)

1160. Rigging the Diver

a. After initial preparations and checks have been carried out, the diver puts on his equipment. Either the attendant or companion diver confirms that the diver's weight belt and/or weight vest and knife are properly secured and readily accessible.

b. When conducting the pre-dive checks it is most important that the cylinder pressure reads above 205 Bar particularly if the cylinder has been charged some time beforehand. The pressure must not exceed 250 Bar. This check must be carried out conscientiously to prevent a dive being started with an inadequately charged cylinder, as this could result in the diver losing consciousness during the dive.

c. **Buddylines.** Para 0745 lays down the procedure for dressing with buddylines. When used with LOSE, the buddyline may be secured to either the left or right arm.

d. **Buoyancy Aid.** The LOSE has been designed for covert diving and there may be operations when it will not be possible to wear a buoyancy aid. It is therefore essential that all users are aware of the drills used with, and without the benefit of a buoyancy aid.

1161. Checking the Set and Clearing the Counterlung

a. With LOSE it is important to clear all excess nitrogen from the divers lungs and the counterlung before diving (para 1102d).

b. This is done by carrying out the following drill:

(1) Fit the swim mask.

(2) Clear the lungs and the LOSE counterlung by inhaling through the mouth and exhaling through the nose until the divers lungs and counterlung are totally exhausted of gas. Open the HP oxygen supply valve slowly until there is enough gas in the counterlung to breath comfortably.

(3) Breathe normally for two minutes replenishing the counterlung with oxygen as required.

(4) Clear the counterlung again by inhaling through the mouth and exhaling through the nose, and open the HP oxygen valve slowly.

(5) Should the swim-mask be removed at any time during this drill it is to be replaced and the drill started again. This prevents the possibility of introducing nitrogen into the lungs and counterlung.

c. On clearing the counterlung for the second time the diver indicates he is ready for the water.

1162. Entering the Water

a. The diver enters the water as described in para 0981 holding down on the swim-mask and mouthpiece with one hand and pressing the set against the chest with the other.

b. When a swimboard is carried, it should be tucked under the right armpit with the compass facing away from the body. If a silent entry is to be made then the swimboard must be handed to the swimmer after he has entered the water. The diver should then secure it to his wrist.

c. When in the water the diver vents his suit and then remains just under the water while his buddy or attendant checks for leaks.

1163. Dive

The Diver descends as described in para 0982. The endurance of the dive is regulated by the endurance of the CO_2 absorbent (60 minutes) and the limited capacity of the oxygen cylinder. It is unlikely that the endurance will exceed 45 minutes when conducting swimming operations.

1164. Surfacing Temporarily

a. If the diver surfaces during the dive and breathes air he will again be changing the percentage of nitrogen in the counterlung.

b. No matter for how short a period he breathes air, the diver must carry out the full procedure for clearing the counterlung (para 1146), including breathing oxygen for two minutes before continuing his dive. During covert operations this drill may be carried out underwater, preferably whilst the diver is at rest.

1165. Surfacing Drill

If the diver wishes to surface and then continue swimming on the surface, the following drill must be carried out providing the set is functioning correctly:

a. Surface at the normal rate of ascent.

b. Inflate the counterlung by slowly opening the HP oxygen valve. When a comfortable trim has been achieved shut the HP valve and switch the mouthpiece to atmosphere.

c. If there is insufficient gas in the bottle to inflate the counterlung, orally inflate the lung using the mouthpiece.

d. If subsequently the diver wishes to dive again, and has enough oxygen to do so, he must carry out the following drill:

(1) Place the mouthpiece into the mouth and switch the mouthpiece to oxygen.

(2) Breathe in through the mouth and out through the nose until the divers lungs and the counterlung are empty. The diver then carries out the full procedure for clearing the counterlung as described in para 1161a, b and c. During covert operations and operational training this drill can be carried out underwater.

1166. Diving After a Surface Swim Approach

a. Prior to entering the water the diver ensures:

(1) That the buoyancy aid contains no air.

(2) The counterlung is partially inflated with oxygen.

(3) The oxygen cylinder valve is shut.

(4) The mouthpiece is switched to atmosphere.

b. Once in the water the diver vents his dry suit. If diving in pairs checks are to be made on each other for leaks before proceeding with the surface approach.

c. When the dive position is reached the diver proceeds as follows:

(1) Fits the swim mask.

(2) Exhales all the air out of his lungs, inserts his mouthpiece and switches to the counterlung.

(3) When switched to the counterlung the diver inhales through the mouth and exhales through the nose until the divers lungs and the counterlung are empty. The supply cylinder is then opened and the counterlung filled with oxygen as required on demand.

(4) Breath normally for two minutes.

(5) On completion of the two minutes empty the lungs and counterlung by breathing in through the mouth and exhaling through the nose. Re-inflate the counterlung as necessary.

d. The diver remains on the surface throughout the full procedure including the two minutes on oxygen but does not stop swimming.

e. Once the drill is complete the dive may start.

1167. Immediate Action Drill

If during a surface approach the diver is forced to dive in an emergency he is to carry out the following drills:

a. Stop swimming.

b. Insert the mouthpiece and switch to gas, breathe in through the mouth and out through the nose. Descend, causing as little disturbance as possible.

c. Once underwater and the divers lungs and the counterlung are empty the oxygen cylinder valve is opened as required. If not already in place, fit the swim-mask.

d. During the two minute waiting period continue with the dive remaining at rest if possible.

e. Clear the counterlung a second time by inhaling through the mouth and exhaling through the nose.

Note. *Close attention must be paid to depth-keeping while carrying out this drill.*

1168. Trouble Drill

a. If breathing discomfort, dizziness, or apprehension is experienced, it is probably caused by over-exertion (CO_2 poisoning) or a restriction in the breathing circuit. A tendency to surface immediately must be resisted, as this will most certainly aggravate the condition.

b. The diver must act as follows:

(1) Stop, and signal his buddy if he has one, to remain where he is.

(2) Relax and flush through the counterlung by venting off gas through the nose and cracking the supply cylinder as required.

(3) If the trouble persists the diver must assume that something is wrong, flush through the counterlung again, and make a controlled ascent to the surface. If buddied he is to signal his intention to surface to his buddy.

1169. Emergency Ascent

a. Should the LOSE become inoperative because of damage or defect the diver must make an emergency ascent as follows:

(1) If buddied inform his buddy of the intention to ascend.

(2) Surface at a controlled rate of ascent, if necessary slipping all slippable weights to give increased buoyancy.

(3) Breathe normally throughout the ascent, if this is not possible he must breathe out.

b. On arrival at the surface the diver must act as follows:

(1) Slip all slippable weights if not already done so.

(2) Inflate his buoyancy aid and operate his suit inflation if fitted. Come off gas. If a buoyancy aid is not worn then orally inflate the counterlung.

(3) Carry out as required the remainder of the surfacing drill as described in para 1150.

1170. Ditching Drill

a. If at any time it is required to ditch the set underwater, the diver is to carry out the following drill:

(1) Remove the mouthpiece retaining strap from the head.

(2) Hold the set against the chest, release the waist strap by the quick release buckle and release the neck strap by its quick release buckle.

(3) Ditch the set.

(4) Breathe out until the surface is reached.

b. When this drill is being carried out for exercise, the mouthpiece is to be switched to atmosphere before being released to prevent the set from being flooded.

c. If the set is retained until the diver surfaces, the same drill is used on the surface.

d. Ditching drill is not to be exercised except under proper supervision. Because of the danger of arterial gas embolism a compression chamber is to be on site and at immediate notice.

1171. Companion Diver Drill

a. Companion diver drill will be required under the circumstances outlined in para 1002e. Great care is to be taken if the diver is not breathing.

b. To bring a diver to the surface the following drill must be carried out:

(1) **MAINTAIN DEPTH. ANY DESCENT MUST BE STOPPED IMMEDIATELY.** If necessary the diver can, if it is worn, use his buoyancy aid to achieve this aim. Normally two quick operations of the cylinder valve will be sufficient. Care must be taken not to over-inflate the buoyancy aid underwater to prevent the ascent getting out of control.

(2) Approach the diver from the side and crack his supply cylinder, slip his slippable weights if necessary to increase buoyancy. If positive control of the diver is achieved and the depth maintained proceed in accordance with sub-para c below. In the event of adverse conditions divers are reminded that the priority of the companion diver drill is to surface the diver as quickly and as safely as possible even if this necessitates the by-passing of other drills. The use of the following drills could render the divers rate of ascent uncontrollable and lead to an arterial gas embolism.

(a) If necessary, to increase buoyancy slip his slippable weights.

(b) If necessary and if fitted operate the distressed divers suit inflation.

(c) If necessary and if fitted, operate own suit inflation.

(d) As a last resort to maintain or reduce depth the use of the distressed divers buoyancy aid is acceptable. Every effort must be made to control the inflation of the buoyancy aid and control the distressed divers ascent.

c. Surface the diver at a controlled rate of ascent with his head kept well back with the chin pointed upwards to keep his airway clear.

d. On the surface release all slippable weights, if this has not already been carried out. Inflate his buoyancy aid and remove the divers mouthpiece, at the same time switching it to atmosphere. Ensure his mouth is above water and the diver is lying on his back. If the diver is not wearing a buoyancy aid then remove the divers mouthpiece and inflate his counterlung. On completion switch the mouthpiece to atmosphere.

e. The companion diver is to make himself positively buoyant by inflating his buoyancy aid and remove his mouthpiece switching it to atmosphere. He is not to ditch his weights.

f. Carry out EAR if necessary and attract attention.

g. The breathing set is not to be ditched unless the weight of it is pulling the diver below the surface. The buddyline is not to be disconnected.

CHAPTER 12

DECOMPRESSION

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CHAPTER 12

DECOMPRESSION

SECTION 1 - DECOMPRESSION GENERAL

1201. Decompression - Introduction

a. The physiological problems associated with increased environmental pressure and the requirement for subsequent decompression in stages are discussed in Chapter 1.

b. This and other sections in this chapter deal with the decompression requirement in greater detail and amplify the regulations laid down in Chapter 7.

1202. Methods Available

a. Decompression may be carried out in one of two ways:

(1) In the water while the diver is ascending on a shot rope, lazy shot or XBS.

(2) In a compression chamber on the surface. Compression Chambers are used with the surface decompression technique.

In each case the method used may be varied by the type of gas the diver is breathing.

b. The simplest of these methods and the one most commonly used with dives of relatively short duration is decompression in the water, this procedure is commonly known as wet stops.

c. Whichever method is used, the decompression schedule remains a common factor. Different schedules are available depending on the circumstances, most of them relying on ‘stage’ decompression, ie ascending to a calculated depth or stage for a given time and then ascending to a further stage. These stages are all set out in Section 5 of this chapter, which contains all the decompression tables in current use for normal, as opposed to Deep, diving.

1203. Hard Work/Cold Water - Increased Decompression

a. When a diver works hard under water, the amount of inert gas absorbed by the body is greater than that absorbed by a diver performing light work. To compensate for this inert gas, the diver will require a longer period of decompression to eliminate the extra gas, if decompression illness is to be avoided. Diving in cold water will also influence the rate at which inert gas is absorbed and eliminated. Modern decompression tables are designed, and tested, for use by divers working hard in cold water and so do not require any adjustment to take into account the effects of cold and hard work.

b. Table 11 was originally developed in the early 1960's and required adjustments to be made to cater for the effects of deep dives in cold water that required hard work. In view of the fact that most dives in UK waters below 30m involve cold water, Table 11 has been modified to take into account the effects of cold water and hard work and renamed **Table 11 Mod**. Table 11 Mod is considered to be sufficiently robust as to not require any adjustments to take into the effects of cold water and hard work.

Note. Dry suits and adequate underclothing must be worn for all cold water diving. MCDOs and Diver Sub-branch personnel are to wear Neoprene dry suits.

1204. Exercise After Diving

a. Excessive exercise after diving may increase the risk of decompression sickness. After dives approaching the 'no-stops' limit or those requiring stops, particularly if the dive was deeper than 42m, divers should not indulge in excessive or prolonged exercise for a period of 2 hours after such dives.

b. The Diving Supervisor must use his discretion when considering what constitutes excessive exercise.

1205. Oxygen Dives

Dives where pure oxygen is breathed throughout may be preceded or followed by deeper air, O_2He or oxy-nitrogen mixed gas dives without modification of the appropriate decompression schedule.

1206. Procedure After Diving in Excess of 30m and 60m

a. **In excess of 30m , less than and inclusive of 60m.** A diver who has carried out a dive deeper than 30m but less than 60m for a period above the limiting line in any of the RN Tables is to remain within four hours travelling time of a compression chamber for 12 hours after completing the dive. A one-man compression chamber is acceptable for this purpose.

b. **In excess of 60m, less than and inclusive of 80m.** A diver who has carried out a dive deeper than 60m is to remain within the immediate vicinity of a compression chamber for one hour and then within four hours travelling time of a compression chamber for a further twelve hours. A two compartment compression chamber is the minimum chamber type acceptable for this purpose.

1207. Repetitive Dives to Depths of 42m or Less - for Diving Equipment other than CDBA

a. When two dives are separated by a surface interval of 6 hours or less both dives have to be taken into account when considering the decompression required for the second dive.

b. Dives to depths of less than 10m, or equivalent air depths of 10m, may follow a deeper dive without a time restriction or requirement for further decompression.

c. When dives to depths of less than 10m, or equivalent air depths of 10m, are followed by a deeper dive all dives are taken into account when calculating decompression stops. The only exception is when the standby-diver dives to 5m to confirm he can clear his ears (para 0704b). Provided the dive is completed within 5 minutes, and he is not required to dive again until he has completed 10 minutes on the surface the dive may be disregarded. If he is required to dive again within 10 minutes the 5m dive must be included in the calculation of decompression stops.

d. If the surface interval between dives above the limiting line exceeds six hours then no modification of decompression is required. However, if the surface interval between dives above the limiting line is less than 6 hours the procedure for combined dives given in para 1209 must be followed.

1208. Repetitive Dives to Depths in Excess of 42m - for Diving Equipment other than CDBA

a. Dives to depths in excess of 42m carry an increased risk of decompression illness.

b. A diver who has carried out a dive to depths greater than 42m is not to carry out a further dive within 12 hours of surfacing except to depths of less than 10m or equivalent air depths of 10m.

c. Any dive to less than 42m, followed within 12 hours by a dive to greater than 42m, is to be considered a combined dive when calculating decompression stops for the second dive, and the procedure given in para 1209 must be followed. The only exception is when the standby diver dives to 5m to confirm he can clear his ears (para 0704b) when the rules given in para 1207c apply.

1209. Stops for a Combined Dive - for Diving Equipment other than CDBA

a. The stops for a combined dive are obtained by adding together the duration of the first and each subsequent dive to obtain a total time for the combined dives. The total time and the depth of the deepest dive made are used to obtain the stops in the relevant table as for a single dive.

b. The total time of the combined dives (ie the sum of successive durations) is not to be allowed to exceed a total time for decompression (Column 4 or 6 in the appropriate table) of 75 minutes or the next lower value figure in this column if 75 is not quoted.

c. Dives carried out using pure oxygen are not to be included in this calculation.

d. It must be noted that when calculating the stops for a series of 2 or more dives all dives in the series must be taken into account. (See Example 1).

e. **Examples (Table 11 Mod)**

(1) *Example 1.* A diver dives to 35m on air for a duration of 13 minutes and carries out stops for 5 minutes. After a surface interval of four hours he is required to dive to 20m for 15 minutes. The stops required are 25 minutes, for a ‘dive’ of 28 minutes at 35m. After a surface interval of a further hour he is required to dive to 9m for 25 minutes. This dive does not require stops (para 1207b). However, if it is proposed that he dive again after a surface interval of 5 hours all three dives must be aggregated as no dive is separated by an interval exceeding 6 hours, and as the stops for 53 minutes at 35m exceed 75 minutes no further dive is allowed (para b above).

(2) *Example 2.* A diver dives to 9m on air for a duration of 59 minutes. No stops are required after this dive. After a surface interval of 3 hours he is required to dive to 20m for 10 minutes. The stops required are 15 minutes, for a ‘dive’ of 69 minutes at 20m. After a surface interval of a further hour he is again required to dive to 20m, this time for 50 minutes. The stops required are 55 minutes, for a ‘dive’ of 119 minutes at 20m. This is apparently a dive below the limiting line but it is acceptable because the dive durations are being aggregated, and the total stop time does not exceed 75 minutes.

(3) *Example 3.* A diver dives to 40m on air for a duration of 9 minutes 10 seconds, and carries out stops for 10 minutes. After a surface interval of 11 hours he is required to dive to 50m for 9 minutes. The stops required are 40 minutes, for a 'dive' of 18 minutes 10 seconds at 50m. (para 1208c). As the second dive was in excess of 42m no diving deeper than 10m or equivalent air depth of 10m may take place until 12 hours has elapsed from the completion of that dive.

1210. Repetitive Dives to Depths of 60m or Less - CDBA

a. If the surface interval between dives to depths of 60m and shallower exceeds 18 hours then no modification to decompression on Tables A, B or the in water decompression option Table C is required. However, if the surface interval between dives is less than 18 hours the procedure for combined dives given in para 1212 must be followed.

b. If the stand by diver has been dived to 5m in CDBA to check his ears and equipment prior to diving operations and he subsequently has to enter the water, the test dive is to be considered as a combined dive.

c. CDBA may be used for multiple dives to depth shallower than 60m providing the diving supervisor is satisfied that the gas quantities and remaining CO_2 absorbent endurance (para 0736) are adequate for the subsequent dive profile.

1211. Repetitive Dives to Depths of 60m to 80m - CDBA

a. If the surface interval between dives exceeds 24 hours then no modification to decompression on Tables A, B or C is required. However, if the surface interval between dives is less than 24 hours the procedure for combined dives given in para 1212 must be followed.

b. A fully charged CDBA is to be used for all repetitive/combined dives in excess of 60m.

1212. Stops for a Combined Dive - CDBA

a. The stops for a combined dive are obtained by adding together the duration (Para 0202 (J)) of the first and each subsequent dive to obtain a total duration for the combined dives. The total duration and the depth of the deepest dive made are used to obtain the stops in the relevant table as for a single dive. It should be noted that when conducting a series of combined dives no dive is to be dropped from the decompression calculation process unless there is an interval of 18 or 24 hours as appropriate.

b. The total duration of the combined dive (ie the sum of successive durations) is not to be allowed to exceed a total time for decompression (column 4 or 5 in the appropriate table) of 199 minutes or the next lower value figure in the column if 199 is not quoted.

c. When undertaking a series of combined dives the diver is not permitted to change between O_2/N_2 dives and O_2/He dives. See para 1205 reference O_2 dives.

d. A second or subsequent dive within the minimum surface intervals as detailed in para 1210 and 1211 is only permitted when using Interim Tables A, B and C in water decompression schedules.

e. A series of combined dives may culminate in a planned or unplanned surface decompression using Tables C or D as required. On completion of the surface decompression procedure restrictions placed upon the dives at para 1244 are to be strictly adhered to.

f. If a dive shallower than 60m is to be followed by a dive deeper than 60m, the deeper dive is to be considered as a combined dive unless a full 24 hours has elapsed since the previous shallow dive.

g. CDBA O_2He dives to a maximum depth of 12m may follow a deeper dive without time restriction or requirement for further decompression. If during the dive, the diver is required to switch to open circuit, the diver may be recovered without omitted decompression penalty provided the diver has surfaced within two minutes. Should a dive to a maximum depth of 12m precede a deeper dive then the shallow dive is to be included in the combined dive calculations.

h. **Examples (Table B) - CDBA Diving**

(1) *Example 1*. A diver dives to 35m on O_2He for a duration of 35 minutes and carries out stops for 41 minutes (travelling time rounded up and included). After a surface interval of 7 hours he is required to dive to 42m on O_2He for 15 minutes. The stops required are 109 minutes (travelling time rounded up and included), for a 'dive' of 50 minutes at 42m. After a surface interval of a further hour he is required to dive to 9m for 20 minutes. This third dive may be conducted without further decompression stops, para 1212f, however, should this third shallow dive be followed by a dive deeper than 9m all the dive durations in the series are to be included when calculating the total dive duration to enable the correct combined dive decompression schedule to be selected.

(2) *Example 2*. A diver dives to 19m on O_2He for a duration of 75 minutes. No stops are required after this dive. After a surface interval of 3 hours he is required to dive to 20m for 10 minutes. The stops required are 8 minutes (travelling time rounded up and included), for a 'dive' of 85 minutes at 20m. After a surface interval of a further hour he is again required to dive to 20m, this time for 50 minutes. The stops required are 67 minutes (travelling time rounded up and included), for a 'dive' of 135 minutes at 20m.

(3) *Example 3*. A diver dives to 45m on O_2He for a duration of 15 minutes, and carries out stops for 12 minutes (travelling time rounded up and included). After a surface interval of 23.5 hours he is required to dive to 65m for 9 minutes. The stops required are 144 minutes, (travelling time rounded up and included). For a 'dive' of 25 minutes at 65m (para 1211). As the second dive was in excess of 60m a surface interval of 24 hours preceding the dive is required before dives in excess of 60m may be undertaken without consideration being given to the combined dive regulations.

1213. Diving Below the Limiting Line

a. That part of each depth section above the limiting line is the ordinary working table, also referred to as **normal** exposure where the risk of decompression sickness is negligible. Diving for periods below the line carries a greater risk of decompression illness, and this risk increases with an increase of duration below the line.

This is referred to as **exceptional** exposure. Intentional diving below the limiting line should be undertaken only when a compression chamber is available on the site and even then only when circumstances justify the risk. This risk is in no way diminished by the use of oxygen during decompression.

b. A diver who has carried out a dive below the limiting line is not to carry out a further dive within 12 hours when diving equipment other than CDBA, 18 hours when diving CDBA to depths less than 60m or 24 hours when diving CDBA to depths greater than 60m.

c. A diver who has carried out a dive below the limiting line on any table must remain in the immediate vicinity of a compression chamber (ie onboard) for a period of four hours after completing the dive, and within four hours' travelling time of a chamber for a further 12 hours. A one-man/two man duocom compression chamber is acceptable for this requirement, providing the dive was not in excess of 60m. For dives in excess of 60m, only a Type A, B or C chamber is acceptable.

d. If no compression chamber is available the diver should be kept under observation onboard for the first four hours quoted in sub-para c. above.

1214. Omitted Decompression - for Diving other than CDBA

a. Emergencies such as blow-up, failure or exhaustion, may prevent or interfere with the completion of planned in-water decompression stops. Even if the diver shows no signs of decompression illness, appropriate action must be taken to ensure adequate decompression. In the event of symptoms or signs of a decompression illness immediate treatment is necessary in accordance with Chapter 13. Guidance on returning to diving following treatment, refer to para 1383.

b. Asymptomatic divers who have missed decompression stops are to be treated as follows:

(1) If the diver can safely be returned to the water and reach his deepest omitted, or partly omitted stop within 2 minutes from surfacing, this should be done and the time at this stop is to start on his arrival at the stop (that is it is to be treated as a 'dead stop'). Decompression should then be as appropriate for the depth and time of the original dive.

(2) If the diver is asymptomatic but cannot be returned safely to his omitted stop within 2 minutes and can be recompressed in a compression chamber within 5 minutes of the commencement of his ascent, he may undergo surface decompression in accordance with Tables 14 or 15 (paras 1208 and 1209). A 'run-over' of up to 2 minutes is tolerable in such circumstances provided the guidance in para 1241 is followed.

(3) If more than 7 minutes elapse before the diver can be recompressed and he remains asymptomatic, he should be recompressed to 18m on oxygen and then treated using Table 61. If, however, the diver has missed any decompression stops deeper than 18m, Table 62 must be used.

c. If the diver shows any symptoms or signs of decompression illness during the surface interval, he must be recompressed immediately to 18m on oxygen and then treated using Table 61 or 62. as appropriate iaw fig 12-1.

d. For decompression illness developing during decompression in the chamber, follow the guidance given in para 1243.

e. This guidance is summarised in the flow chart at Fig 12-1. Continuous vigilance is essential in all cases of omitted decompression to ensure freedom from symptoms and signs of decompression illness.

f. When omitted decompression follows an unplanned extension of bottom time and no compression chamber is on-site, divers who cannot be returned to the water to complete their stops should be given 100% oxygen to breathe pending evacuation to a compression chamber. Any symptoms or signs of decompression illness should be given first aid as outlined in para 1363.

1215. Omitted Decompression - CDBA

a. Emergencies such as blow-up, failure or exhaustion, may prevent or interfere with the completion of planned in-water decompression stops. Even if the diver shows no signs of decompression illness, appropriate action must be taken to ensure adequate decompression. When decompression stops are omitted, for what ever reason, when diving CDBA the diver is not to be sent down again to completes his stops.

b. Divers who omit in water decompression and remain asymptomatic are to be treated as follows:

(1) Divers who have missed decompression stops at 18 m or shallower are to be recompressed in a chamber and treated in accordance with table 61, para 1368 refers.

(2) Divers who have missed decompression stops in exccess of 18 m but have completed at least 15 minutes of ‘in water’ stops are to be recompressed in a chamber and treated in accordance with table 62, para 1369 refers.

(3) Divers who have missed decompression stops in excess of 18 m but have not completed 15 minutes on ‘in water’ stops, are to be recompressed in a chamber and treated in accordance with table 67, para 1374 refers.

c. This guidance is summarised in the flow chart at Fig 12.2. continuous vigilance is essential in all cases of omitted decompression to ensure freedom from symptoms and signs of decompression illness.

d. Divers who omit ‘in water’ decompression and are symptomatic are to be treated for acute decompression illness and treated in accordance with Chapter 13 which is summarised at Fig 13-18.

e. When omitted decompression follows an unplanned extension of bottom time and no compression chamber is on-site, divers should be given 100% oxygen to breathe pending evacuation to a compression chamber. Any symptoms or signs of decompression illness should be given first aid as outlined in para 1384. Guidance on returning to diving following treatment, refer to para 1383.

CAUTION

The following decision - assisting Flow Chart should be used in conjunction with the text - for diving other than CDBA

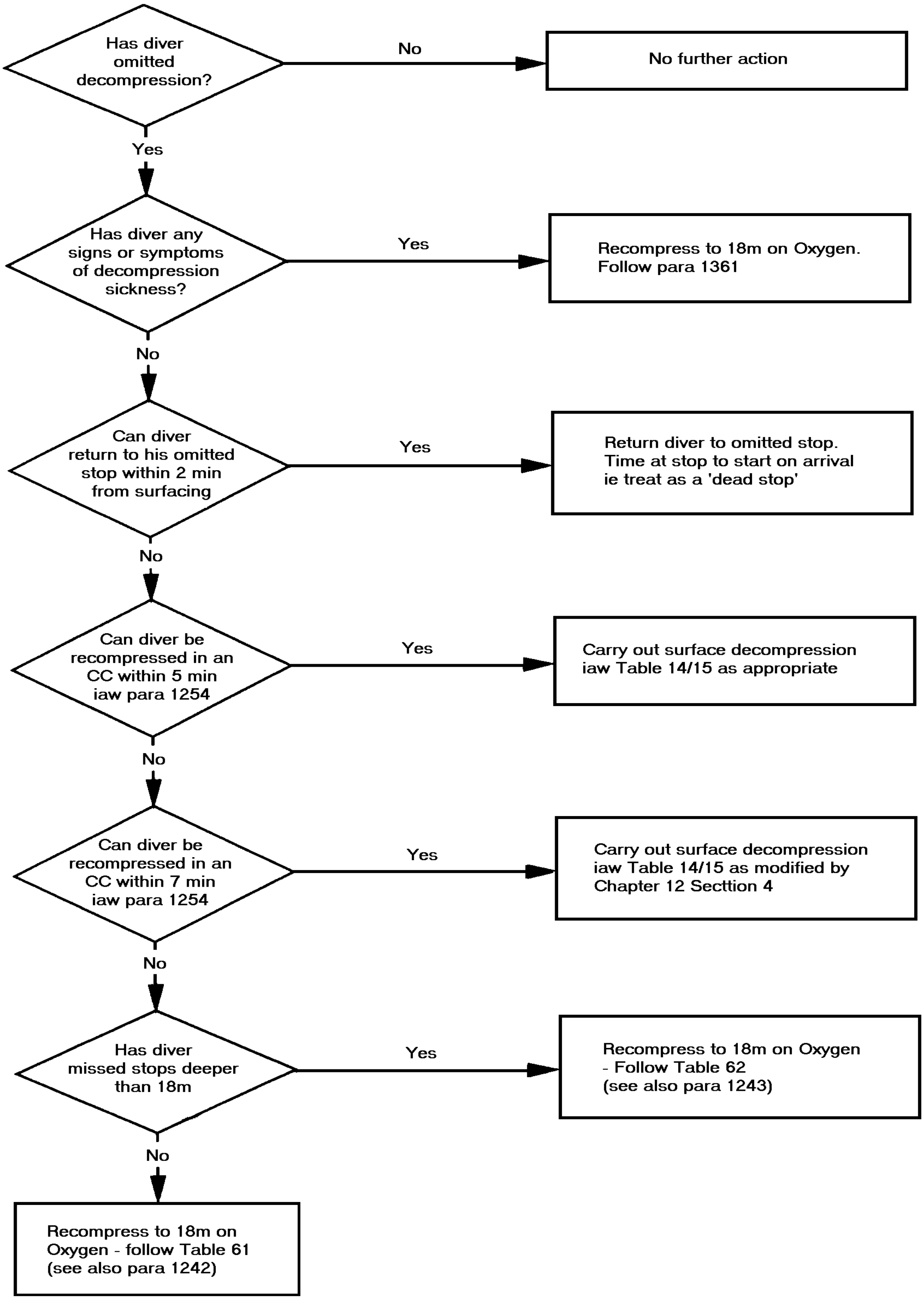


Fig 12-1. Management of Omitted Decompression

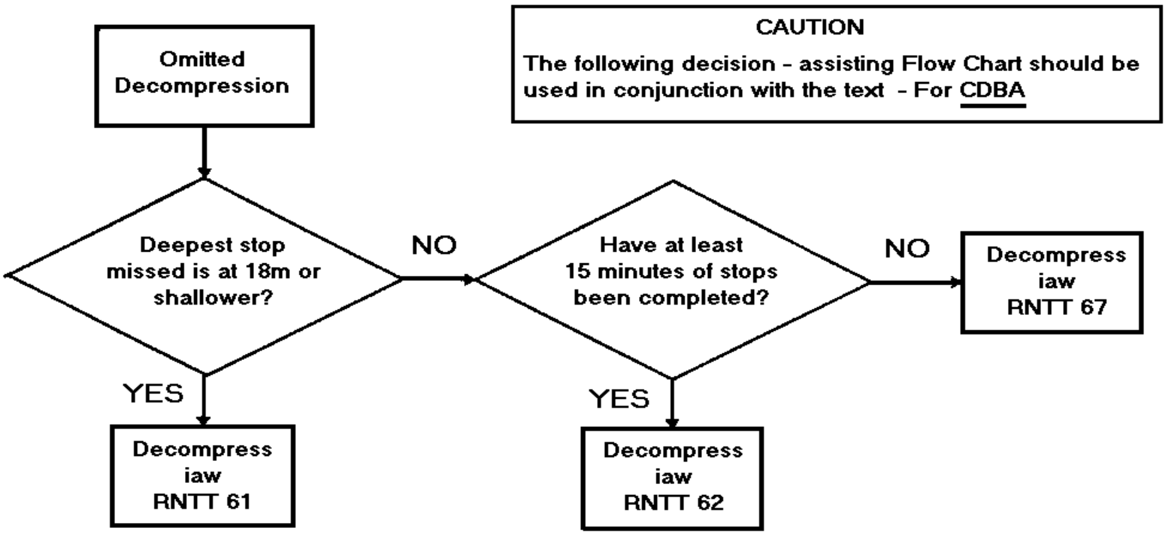


Fig 12-2. Omitted Decompression Procedures

1216. Diving at Altitude (Non CDBA Dives)

a. If a dive is carried out at altitude (eg in a mountain lake), the surface pressure is less than one bar absolute. Decompression schedules must be adjusted to prevent the onset of decompression sickness in a rarefied atmosphere.

b. Water will invariably be fresh, but stops should be used as though it were salt, so increasing the safety margin of the schedule.

c. Adjustments should be made to the schedules as follows:

(1) *Dives between altitudes of 100m and 300m:* Add 0.25 of the depth to give the depth of the dive.

(2) *Dives between altitudes of 300m and 2000m:* Add 0.3 of the depth to give the depth of the dive.

(3) *Dives between altitudes of 2000m and 3000m:* Add 0.5 of the depth to give the depth of the dive.

d. If diving is to be followed by a land journey traversing heights in excess of 300 metres above sea level, or flying at altitudes in excess of 300 metres above sea level and no alternative route avoiding high altitude is feasible, then one of the following precautions is to be taken:

(1) Adjust the decompression schedule to be followed, in accordance with para c above, using the greatest altitude to be encountered by the land journey or flight post dive.

(2) In cases where it is impracticable to adjust the decompression schedule, then the rules for flying after diving iaw para 1218 must be followed.

1217. Diving at Altitude (CDBA)

CDBA is not to be routinely used for diving at altitudes greater than 30m. If there is operational requirement to dive at altitudes, approval is to be sought from S of D.

1218. Flying/Maximum Altitude - Restrictions after Diving

a. Whenever possible, it is inadvisable to travel by air or road above 300m (approximately 1000ft) within 48 hours of completing any dive. It should be noted that commercial aircraft with pressured cabins usually maintain a pressure equivalent to 8000ft above sea level.

b. The reduction in pressure which occurs with altitude can precipitate decompression illness in divers who would otherwise have remained well and this may occur up to 48 hours after diving.

c. If travel by air or raod to an altitude in excess of 300 metres post dive is essential then the procedures at para 1216 d must be followed.

d. For dives involving experimental decompressions, appropriate expert medical advice concerning flying must be given in the experimental protocol.

e. For flying following therapeutic treatment see Para 1385.

Notes:

1. Flying after Dunker Training. Individuals who have undergone 'Dunker' and 'wet' STASS training may fly after training provided that:

(a) Training consists of a maximum submerged time of 20 minutes maximum to a maximum depth of 3m.

(b) There is an interval of 4 hours between the end of training and flying.

2. Journeys by road or air following operational dives to altitude in excess of 300m may be conducted providing the adjustments in accordance with Para 1216c (2) and (3) are applied.

Table 12-1. Rules for Divers Flying after Diving Operations (Para 1217 - 1218)

TYPE OF DIVE	MINIMUM TIME INTERVALS BETWEEN DIVING AND FLYING	MAXIMUM ALTITUDE (OR EFFECTIVE ALTITUDE IN PRESSURISED AIRCRAFT)
Air - no stops Oxy-nitrogen - no Stops	No restriction 2 hours 4 hours	300m (approx 1000ft) (eg helicopter) 1500m (approx 5000ft) UNLIMITED IN COMMERCIAL AIRCRAFT (eg approx 8000ft)
Air requiring stops Oxy-nitrogen - requiring stops	2 hours 8 hours 12 hours	300m (approx 1000ft) (eg helicopter) 1500m (approx 5000ft) UNLIMITED IN COMMERCIAL AIRCRAFT
O_2He - O_2N_2 CDBA No dive deeper than 9m in the preceding 72 hours	12 hours	Unlimited
O_2He - O_2N_2 CDBA None decompression dive	18 hours >18 hours	300m (approx 1000ft) (eg Helicopter) UNLIMITED IN COMMERCIAL AIRCRAFT
O_2He - O_2N_2 CDBA Total dive time <2 hrs with decompression	24 hours >24 hours	300m (approx 1000ft) (eg Helicopter) UNLIMITED IN COMMERCIAL AIRCRAFT
O_2He - O_2N_2 CDBA Total dive time >2 hrs with decompression	48 hours >48 hours	300m (approx 1000ft) (eg Helicopter) UNLIMITED IN COMMERCIAL AIRCRAFT

Note. *The restrictions placed on personnel after CDBA dives, as detailed above, will be reviewed in due course as part of the 1.3 PO_2 Table development.*

1219. Snorting Restrictions - Submarines

When snorting in submarines there is a possibility of fluctuation in atmospheric pressure. These fluctuations may affect divers who have been involved in diving operations prior to snorting. The following advice is given.

a. Ideally snorting should not take place within two hours of no-stop diving, or 8 hours of diving requiring stops (ie the 1500m/500ft limit-pressure equivalent of 832mbar).

b. If snorting is considered absolutely essential during this period the limits 25.73Hg/860mbar - should not be exceeded under any circumstances.

SECTION 2 - DECOMPRESSION IN THE WATER

1220. General

a. When carrying out decompression in the water, the diver must always be on a lazy shot or XBS. To carry out decompression safely, the diver's maximum depth of dive and his depth at any moment during stops must be known accurately. An accurate and reliable stopwatch is mandatory.

b. Stops are never to be carried out swimming free, even when a depth gauge is carried.

c. On one end of the secondary display fitted in the CDBA there is a Digital Timer/Depth Gauge. This is fitted primarily to allow ARM dive data to be retrieved on the completion of each dive or series of dives as required. The information displayed is not to be used by the divers to control the dive. (The ascent rate on the DTDG is incorrect for CDBA diving.) For the supervisor the DTDG may represent an accurate record of the dive profile for comparison purposes.

d. If a diver breaks surface before carrying out his full stops follow para 1214 or 1215.

e. The maximum depth of dive may be obtained by soundings, bearing in mind that if the diver is covering a wide area one sounding will not necessarily indicate his maximum depth of dive. Maximum depth may also be obtained from the markings on the lifeline - which includes the gas hose of surface supplied equipments - the depth indicated by the markings erring on the safe side as the diver moves away from the attendant. If the diver has a depth gauge and has communication with the supervisor/attendant, he can inform the surface of his maximum depth.

f. The attended diver's depth while he is ascending on a shot rope, as indicated by the markings on the lifeline or shot rope, will be accurate only when the shot rope is vertical in the water. If the shot is laid out from a boat swinging with wind or tide, the shot rope may be out at an angle from the boat; in this case the shot may be lifted off the bottom to hang as a lazy shot, or a separate lazy shot may be used, as described in para 0945.

1221. Control of an Attended Diver's Ascent

a. The lazy shot is clipped on to the shot rope/Sonar Marker and Mine Recovery Outfit and lowered to a depth 3m in excess of the diver's first planned stop. The diver is called up by 4 pulls. On receiving 4 pulls, the diver answers the signal and prepares to leave maximum depth. When ready to do so, and without further orders from the surface, the diver signals 1 pull to indicate 'leaving maximum depth' and commences the ascent at a controlled rate. The attendant acknowledges the divers 1 pull and reports to the diving supervisor 'Diver left bottom'. The attendant is then to confirm divers ascent, when so assured by the report. 'Diver travelling'. The timing of all stops commences when the diver signals he has reached that stop. *All stops are dead stops.*

b. As the diver ascends the attendant takes in the lifeline at the speed of ascent so that the diver's movement can be continuously felt. When the diver reaches the lazy shot/ XBS he stops his ascent and informs the attendant by one pull. The lazy shot/XBS is then raised to the correct depth for the first stop, and the diver keeps himself at the depth of the lazy shot.

c. Throughout the decompression the lazy shot is raised by stages as required by the decompression schedule, and the diver continues to keep himself at the depth of the lazy shot/XBS. Raising the lazy shot between stops is to be at the rate of 1m in 4 seconds.

1222. Control of a Swimmer's Ascent

a. A swimmer marked by a swim marker is surfaced by the use of a lazy shot/XBS, as described in para 0945.

b. The attendant craft closes the float and, on the float line, passes the signal to 'come up'. As soon as the signal is understood, the float line is clipped into the clip hook on the lazy shot/XBS and the lazy shot/XBS lowered to a depth of 3m below the diver's first stop. The float line is taken in and the diver led into the lazy shot/XBS.

c. On arrival at the lazy shot/XBS the diver signals the surface, unclips his float line from the clip hook, and remains at the lazy shot/XBS; the attendant hoists the lazy shot/ XBS to the first stop depth and continues to control the diver's decompression by hoisting the lazy shot/XBS to the subsequent stop depths at the intervals given in the decompression table.

1223. If Rate of Ascent is Incorrect

a. Although it is more important that the rate of ascent be steady than that the ascent be completed within the precise time dictated by the rate and depth, the defined rate of ascent cannot be disregarded. There are occasions when an excessive variation in the rate of ascent could compromise the decompression of the diver and adjustments must be made.

b. Accordingly a simple set of rules is provided for application to the diving tables when diving equipment other than CDBA.

(1) *Ascent Rate Too Slow* (by more than 30 seconds over calculated ascent time). The ascent time is to be added to the time at maximum depth and decompression stops adjusted accordingly.

(2) *Ascent Rate Too Fast*. If stops required hold at 3m below the first stop until the difference in time is made up, then raise the lazy shot and continue with the remainder of decompression stops as planned.

(3) The operation of the lazy shot is described in para 0945.

c. When diving CDBA the following rules apply:

(1) Ascent rate too slow and the diver arrives at his first stop more than a minute over the planned ascent time, the extra time is to be added to his ‘bottom’ time. Decompression stops are then to be conducted taking into consideration this revised time.

(2) If the ascent is too fast, hold the diver at a depth 3m below the first stop depth until the difference in time is made up. Then continue the decompression stops as planned.

1224. Equivalent Air Depth (EAD) - CDBA

a. When using constant PO_2 oxy-nitrogen (air), as in CDBA, fixed PO’s in open circuit air sets, decompression time for a given depth can be reduced, because of the reduced nitrogen tension in body tissues.

b. The EAD’s shown in Table A were calculated by DERA Alverstoke for use with the CDBA, with a PO_2 of 0.75 Bar for depth of 10m or shallower and 1.3 Bar for depths deeper than 10m. They were then, where necessary, rounded to the next deeper decompression table increment (ie next deeper multiple of 3m).

c. Column 1 of the table is entered at the depth equal to or immediately exceeding the depth of the dive, and the corresponding EAD is taken from column 2. The EAD obtained is the depth to be used in column 1 of the Table 11.

1225. On completion of a deep dive (>60), irrespective of decompression stops conducted, the diver is to be debriefed and warmed, in the vicinity of the CC for a period of at least 10 minutes prior to commencing further diving operations. The implementation of this ruling for shallower dives is at the discretion of the diving supervisor.

SECTION 3 - OPERATION OF COMPRESSION CHAMBERS

1230. General

a. A great variety of compression chambers are available for use in association with diving operations. These include:

(1) Large chambers with one, two or three compartments, sometimes including, for experimental purposes, a 'wet' section.

(2) Submersible compression chambers as used in deep-diving operations. These can additionally take the form of personnel-transfer capsules, passenger compartments in submarine rescue submersibles and submarine rescue bells.

(3) One-man compression chambers developed primarily for surface decompression.

(4) The Two-man compression chamber (Drager Duocom) can accommodate one diver for treatment and one attendant. By using a Type A NATO Adaptor the Duocom chamber may be connected to a Type 1 TUP Compression Chamber. Hence transfer of a diver and attendant can take place without pressure reductions.

b. Compartments designed for other purposes can also be made available in emergencies as substitutes for compression chambers. These include, for instance, the forward escape compartment in some classes of submarine.

c. So that they may be used for treating serious cases of decompression illness, all compression chambers should be capable of being pressurised at a minimum rate of 30m per minute. The only authorised exception to this ruling is the Type C chamber which, by design, is pressurised at 20m per minute.

d. Because of the rise in carbon dioxide and fall in oxygen levels when men occupy closed compartments, as described in Section 5 of Chapter 1, it is important that the air be refreshed from time to time. This should be done as directed in para 1231h. During prolonged stays, as may happen under therapeutic conditions, efforts should be made to keep the noise level low.

e. If possible the internal chamber temperature should be maintained at a level comfortable for the occupants. Cooling can usually be accomplished by chamber ventilation (see sub-para d above). If the chamber is fitted with a heater/cooler unit this will normally be adequate to maintain a comfortable temperature under any external environmental conditions.

f. Usually compression chambers will become hot and must be cooled. They should always be shaded from direct sunlight. The maximum exposure times for occupants will depend upon the chamber internal temperature and are shown in Table 12-2. Never commit personnel to a decompression schedule outside the limits tabulated except on the advice of a medical officer who can evaluate the projected heat stress against the benefits of the decompression schedule. The aim must be to keep the chamber temperature below 29°C. *Temperatures quoted are average temperatures.*

g. The types of chamber most commonly used in the Royal Navy are the two-compartment compression chamber and the one-man compression chamber.

Table 12-2. Maximum Permissible Compression Chamber Exposure Times at Various Temperatures (para 1230)

Internal Temperature °C	Maximum Permissible Exposure	Permissible Treatment Tables
Over 40	NIL	NONE
35 to 40	2 hours	Table 61
29 to 34	6 hours	Tables 61, 62 and 63
Under 29	Unlimited	All

Notes:

1. *Mercury thermometers must NEVER be used inside the chamber.*

2. *The Chamber must be shaded from direct sunlight.*

1231. Two-Compartment Compression Chamber

a. **General.** The Two-Compartment Compression Chamber (2CCC) is designed for the treatment of personnel with diving disorders which require recompression (Therapeutic Recompression - see Chapter 13 Section 5). It is used primarily as an emergency support facility for Service diving in a particular geographical area, including SUBMISS (para 1386) and, where decompression stops are planned, may be required on site. Secondary roles include surface decompression (Chapter 12 Section 4), diving aptitude tests and training. There are currently 4 types of 2CCC operated by the RN.

(1) Type A - 15 man, fixed chamber (TUP capable).

(2) Type B - 10 man , containerised chamber (TUP capable).

(3) Type C - Maximum 4 man chamber embarked in MCMVs. Diving Groups also hold a containerised variant with its dedicated support chacon.

(4) Type 1 (Non-TUP) - A limited number of these chambers have been retained for use onboard Fleet Diving Tenders (FDT). Modifications have been made to improve Standards of Safety.

(5) Clucas MK 1 - Limited number of fixed chambers (not TUP capable).

b. **Preparation for Use.** In addition to the pre-dive procedures detailed in the relevant Handbook of Diving Equipment (**BR 2807 Series**), the following preparations apply to all 2CCC. The supervisor is to confirm that:

(1) The chamber is thoroughly clean internally and free from all combustible material, and blankets and furnishings are of non-flammable pattern.

(2) A fully charged hyperbaric fire extinguisher is available in each compartment. If no extinguisher is available a bucket of water is to be provided.

(3) Notice boards detailing the action to be taken in the event of a fire in the chamber and the risk of fire and toxicity para 1234b(7) are to be placed at the control panel and the main entrance to the chamber.

(4) Two fire-resistant (FR) mattresses and four FR blankets/FR Duvets (and appropriate covers etc) are provided. If FR mattresses are not available additional FR blankets must be provided instead. If FR blankets are not available, 1 x FR duvet with FR cover may be substituted for FR blanket.

(5) Ear defenders (non drilled) are available for all external personnel operating the chamber. Sufficient ear defenders, with a 1.5mm diameter hole drilled in the outer casing to allow for pressure equalisation, are available for internal occupants.

(6) All air and oxygen/BIBS supply cylinders are charged and the Main and Emergency air supplies are at the required pressure.

(7) Sufficient BIBS mask/hose for each diver are available, test breathed and connected to the main compartment supply points. One spare BIB (test breathed) is to be available for each compartment. The oxygen reducer is to be set to the required pressure. BIBS masks are to be wiped with a weak solution of disinfectant after test and dried.

(8) The chamber inner and outer doors are operating correctly, and hand service lock doors are securely closed.

(9) Lighting and telephone communications to the chamber are tested and correct. If no secondary communication system is available a non-metallic mallet is to be provided.

(10) The following items are available: BR 2806 UK Military Diving Manual Vol 2, watch or clock; S 288/AB 576(A) and narrative record/CC log sheets (if carrying out therapeutic recompression see Chapter 4 para 0401f). A master CC log sheet, suitable for photocopying, is contained in Section 12 of BR 2806 (REC).

(11) The Medical Equipment Set-Diving Chamber RN is available.

c. **Operation**

(1) Unless the number of divers under decompression makes it necessary to use both compartments, the divers should normally be accommodated in the Main (inner) Chamber (MC) and the Man Lock (ML) left open.

(2) If both compartments are being used separately, the pressure in the outer compartment is not to be allowed to exceed that in the MC. In other words the pressure should always tend to close the door more firmly. Except for some experimental chambers, this principle applies to all multi-compartment chambers.

(3) Particular care must be taken by those in the chamber to keep the exhaust outlets clear. These outlets are protected by a cover, but they can still become blocked if overlooked, particularly under crowded conditions.

(4) A number of chambers are now fitted with patient bunks that can be moved to the centre of the CC to aid patient transfer. These bunks are to be securely placed in their 'housed ' positions prior to chamber descent or ascent, so ensuring that the bunk does not foul the main compartment door in the event of an accident.

d. **Recompression Breathing Air**

(1) The drill for recompression, while breathing air is laid down below, all orders and reports being passed to the chamber occupants.

(a) As soon as the occupants are in the chamber and the inner or both doors confirmed closed, the dive supervisor gives the warning order: 'Standby to leave surface, chamber bottom ..... m' and specifies the rate of descent. The divers are to be informed, where possible, and this is followed, when ready, by the executive order: 'Leave surface'.

(b) Panel operator repeats the order and opens up the supply valve, increasing pressure slowly for the first 5m. If there is no complaint from the diver or his attendant, the supply is opened up and the chamber pressurised to chamber bottom at the specified rate of descent. On arrival at the bottom the operator then reports 'At chamber bottom. Depth ..... m'. He then checks the divers: 'At ...m'. 'Are all divers well?'

(c) The dive supervisor notes the time and after an appropriate interval orders: 'Standby to leave bottom, next stop ..... m'. The divers are to be informed, where possible, and this is to be followed by the executive order: 'Leave'.

(d) Panel operator repeats the order and opens the vent valve sufficiently to vent the chamber at a speed of ascent of 1m in 4 seconds. When the gauge shows the depth of the first stop he closes the vent valve and reports: 'At first stop, depth ..... m'. He then checks the divers: 'At ....m'. 'Are all divers well?'

(e) After the interval given in the decompression table, the diving supervisor orders: 'Standby to leave this stop, next stop ..... m'. The divers are to be informed, where possible, and this is followed by the executive order 'Leave'.

(f) Panel operator vents the chamber to the second stop depth and reports: 'At stop, depth ..... m'. He then checks the divers: 'At ....m'. Are all divers well?'

(2) The procedure in para d is continued until all stops are completed and the chamber is at atmospheric pressure. The panel operator reports 'Chamber on the Surface' and the chamber door is opened for the occupants to leave.

e. **Decompression Breathing Oxygen**

(1) The preparation and drill are as described above, except that on ascending to the first stop at which oxygen is to be breathed the drill is altered as follows:

(a) The dive supervisor orders ‘Standby to leave this stop’. ‘Next stop ..... m’. ‘The next stop is an oxygen stop’. The divers are to be informed and this is followed by the executive order: ‘Leave’.

(b) Panel operator repeats the order, brings the chamber to the depth ordered and reports: ‘At stop, depth ..... m’. He then checks the divers: ‘At ....m’. ‘Are all divers well?’

(c) The dive supervisor orders chamber occupants: ‘All divers go on oxygen’. The panel operator opens the oxygen supply, observes the oxygen gauge and makes any adjustment necessary when divers start breathing oxygen.

(d) Divers put on/insert their BIBS masks/mouthpieces and indicate to the attendant whether breathing is satisfactory. When all divers are breathing satisfactorily, the attendant reports to the dive supervisor: ‘All divers on oxygen’. If there is no attendant in the chamber, the supervisor observes that all divers have indicated ‘Correct’. It is then that the timing of the first oxygen stop commences.

(e) Decompression is continued until the panel operator reports: ‘Chamber on the surface’. ‘All divers come off oxygen’. Divers remove their BIBs masks/ mouthpieces.

(2) Once oxygen breathing on BIBS has commenced the chamber is to be ventilated as detailed in para 1231. g, h, and i.

(3) If dizziness, nausea, muscular twitching or any other symptoms associated with CNS oxygen toxicity are experienced, follow the guidance in para 1387b for therapeutic recompression. Follow the guidance in para 1251c(8) for Table 15.

(4) *Entering and Leaving the Chamber Under Pressure.* If the MC only is under pressure, personnel may enter and leave the main chamber from the ML while maintaining the chamber pressure as follows:

(a) Entrant enters the ML and the outer door is closed. The dive supervisor orders: ‘Standby to leave surface, ML to .... m’. This is followed by the executive order: ‘Leave surface.’

(b) Panel operator repeats the order and opens up pressure to the ML, and when at the depth ordered reports: ‘ML at bottom .... depth m’. He then checks the lock occupant.

(c) Supervisor orders entrant: ‘Open equalising valve’. Panel operator watches the chamber pressure and adjusts, if necessary, to maintain the chamber pressure.

(d) Entrant reports: ‘Equalising valve open’. Supervisor then gives permission for the inner chamber door to be opened.

(e) If the chamber is not fitted with an equalising valve, the supervisor orders the inner door to be unclipped, and the entrant monitors the door by pushing against it. When the pressure in the airlock equalises with that in the Main Chamber the door will open.

(f) If the entrant is to leave the MC before decompression is completed, he enters the ML and closes the equalising valve and the MC door and reports to the supervisor: 'Ready for decompression'.

(g) The supervisor orders the venting of the ML to carry out the required decompression, prefixing all subsequent orders with 'ML or 'MC' as applicable. The supervisor is to watch the gauge of the other compartment to check that its pressure also is not being altered inadvertently.

f. **Type 'C' Chambers fitted with Close Circuit Breathing Systems (Operational)**

(1) Of the four types of two compartment compression chambers routinely available for service use, the Type 'C' compression chamber is unique due to its Atmosphere Control/Breathing System (AC/BS). A sub-system of the AC/BS is the Closed Circuit Breathing System (CCBS). A re-breather system that allows Minehunters and detached diving units, with limited Oxygen and Oxygen/Helium gas supplies, to conduct the full range of Therapeutic Treatments.

(2) The Type 'C' chamber is a modern, HSE approved two compartment compression chamber. When not utilising the CCBS the chamber can be used as a conventional chamber. However, it is advisable to ensure that both Data Control Modules (DCM) are functioning to ensure that the CC atmosphere is adequately monitored via the Chamber Data Recording System (CDRS). If the DCM's are not used the CC atmosphere is to be monitored manually. Standard operating and Emergency procedures in accordance with Chapter 12, Section 3 are to be adopted.

(3) When utilising the Type 'C' chamber with the CCBS the following additional procedures as detailed are to be adopted:

(a) Prior to diving operations the Type 'C' chamber, and its organic CCBS are to be fully prepared in accordance with the equipment BR. The CCBS system is to be fully functional and tested with 50/50 O_2/He gas pre-selected and achieved within the system. This initial selection will allow the supervisor to either commence a Treatment Table 62 on standard BIBS (O_2 selected) or Treatment Table 67 (CCBS). If BIBS O_2 is initially selected and, in the course of events, the decision is made to stay on either Treatment Table 61 or 62, consideration should be given to transferring the diver onto 100% O_2 via the CCBS. This option is not only more comfortable for the patient, it also conserves O_2 supplies.

(b) During CCBS use it is imperative that inadvertent or direct introduction of N_2 into the system (from CC atmosphere) is kept to a minimum as this will impair its performance. When fitting hoods/masks, the following action is to be taken.

i. Mask: Fit and hold approximately 25 mm away from the face to allow breathing. Open mask supply valve at the supply manifold and allow gas to flow from the mask for approximately 5 seconds. After this time, the diver/patient is to exhale fully, fit mask and open mask dump valve at the manifold. Fit mask securely and breath normally.

Note. *The mask is to be secured tightly on the face to prevent leakage of CCBS gas into the CC.*

ii. Hood: Fit hood neck-ring with associated neck seal and ensure correct fit. Open out the hood, place over the head. Secure the two rear most 'snap' connections while holding the front of the hood securing ring away from the neck ring by approximately 50-75 mm. Open mask supply valve at the supply manifold and allow gas to flow into the hood for approximately 10 seconds while breathing normally. (This will allow the hood to be flushed out prior to correct fitting). The diver/patient is now to exhale fully, (directing exhalation to gap between hood and neck ring) and secure the front of the hood onto the neck ring, open the hood dump valve and breath normally. Ensure the correct fitting and securing of the hood.

(c) During the descent phase of the dive/treatment it may be apparent that the hoods worn within the chamber loose their rigidity and give the appearance of collapsing. This is normal and should not be a cause of concern. During a fast descent, should it be considered that the hoods require additional gas to maintain their shape one of the following options are available:

i. The attendant is to be instructed to operate the CCBS 'Dial-a-breath' and temporarily induce a greater flow of gas into the CCBS.

ii The chamber operator may temporarily open the CCBS purge valve to introduce additional O_2/He into the system.

Note: *After the input of additional gas the CCBS will automatically re-establish the correct gas mix when at depth.*

(d) The gases supplied by the CCBS, 100%O_2, 50/50, 40/60 and 20/80 O_2/He are controlled automatically within $\pm$ 2% O_2. However, when a higher O_2% gas is selected the system may display an O_2 reading higher than the 2% of gas selected while the system stabilises. This peak effect during stabilisation should be a transient nature and not cause undue concern, it must be monitored as a matter of routine to ensure that the gas stabilises at the selected mix within a short period.

(e) During the use of the CCBS it may be necessary to change gases a number of times and to conduct 20/80 O_2He 'low PO_2 gas breaks'. The timings for such gas changes or gas breaks are to commence when the required gas has been selected at the DCM and actuated. If the desired gas is not obtained within a period of 5 minutes and a defect is suspected, conduct action in accordance with table 12-3.

(f) **CCBS Failure.** When functioning correctly the CCBS is a robust system that adequately maintains the diver(s) O_2He supply as selected by the CC supervisor/operator. A number of components within the system are duplicated to allow for a degree of failure/fault while maintaining the correct O_2He supply. Table 12-3 details Emergency action to be taken in the event of CCBS components failure.

Table 12-3. CCBS Emergency Procedures

SYMPTOM	POSSIBLE CAUSE	ACTION
Loss of pressure in CCBS Hood	Descent	Operate Dial-a-Breath or Purge system with O_2He
	Blower turned off	Start Blower
	Blower Failed	Open Valves on 2nd blower and start blower. Isolate valve of defective blower
Failure of Active DCM	Electrical Fault	Change Standby DCM to active DCM. Confirm correct gas selected. Back up Analyser readings with manual Analysers. Continue Treatment Table
Loss of Standby DCM	Electrical Fault	Run on Active DCM only. Back up Analyser readings with Manual Analysers. Continue Treatment Table
Loss of Both DCM's	Electrical Failure	If Deeper than 18 m: Instruct Divers to come off CCBS, Breath CC Atmosphere and transfer to Treatment Table 64. If 18 m or Shallower: Instruct Divers to come off ACBS, breath O_2 from BIBS and continue the Treatment Table Uninterrupted. In both cases monitor CC Atmosphere via manual Analysers or conduct routine flush through procedures.
Loss of CCBS O_2 Make up	Solonoide Valve (SOV) 1 failed Closed	Manually control gas Mix using TMCC Vv 78. Monitor Gas Mix closely
Rise in CCBS O_2	SOV 1 Failed Open	Initially Close TMCC Vv 83. Manually Control Gas Mix Using Vv 83. Monitor Gas Mix closely
Loss on MC O_2 Make up	SOV 2 Failed Closed	Manually Control Gas Mix Using Vv 79. Monitor CC Atmosphere closely. or Revert to Manual Flush Through of the CC
Rise of MC O_2 Levels	SOV 2 Failed Open	Close TMCC Vv 85. Immediately Flush CC to reduce PO_2 levels and monitor CC inhabitants closely for signs of CNS O_2 toxicity. When situation has stabilised manually control CC Atmosphere using Vv 85. or Revert to Manual Flush through of the CC
Loss of MC O_2He Supply	O_2He Supply Cylinder Empty	Replace empty cylinder
	SOV 3 Failed Closed	Manually control Gas Mix using Vv 80. Monitor CCBS gas mix closely
Loss of CCBS O_2 Supply	O_2 Supply Cylinder Empty	Replace empty cylinder
	SOV 4 Failed Closed	Manually control gas mix using Vv 81. Monitor CCBS gas mix closely

Table 12-3 CCBS Emergency Procedures (Continued)

SYMPTON	POSSIBLE CAUSE	ACTION
Loss of all Purge Gas - O_2 or O_2He	SOV 5 Failed Closed	Manually control gas mix using Vv 82. Monitor CCBS gas mix closely. *Note. Vv 82 (and SOV 5) only passes gas (O_2 & O_2He) when either Vv 80/SOV 3 or Vv 81/SOV 4 are open. Extreme care is to be taken to ensure that Vv 82 is used correctly as indicated by the operation of the STCM/DCM. Is the system required to purge or make up O_2?*
Uncontrolled Purge of O_2He	SOV'S 3 & 5 Failed Open	In the highly unlikely occurrence of this fault, the diver(s) are to be removed from the ACBS and : If deeper than 18 m, transferred to Table 64 - DDMO is to be contacted. (*See Note*) If at 18 m or shallower, put onto BIBS O_2 and continue with treatment Table
Uncontrolled Purge of O_2	SOV's 2 & 5 Failed Open	In the highly unlikely occurrence of this fault, the risk of CNS O_2 toxicity is of major concern at depth in excess of 18 m. Diver(s) are to be immediately removed from the ACBS and : If deeper than 18 m, transferred to Table 64 - DDMO is to be contacted. (*See Note*) If at 18 m or shallower, put onto BIBS O_2 and continue with the treatment Table
ACBS Fails to Adequately Maintain a Required Gas Mix or 100% O_2	Possible System Leakage into CC. Possible Contamination of ACBS via Leak from CC into CCBS. Inability to control Gas Manually etc.	Diver(s) are to be immediately removed from the ACBS and: If deeper than 18 m, transferred to Table 64 - DDMO is to be contacted. (*See Note*) If at 18 m or shallower, put the diver(s) onto BIBS O_2 and continue with treatment Table

Note. *Should the CCBS fail while stationery at either 30 or 24 m, Table 64 is to be entered at that depth and the Table 64 stop commenced irrespective of time spent at that depth on Table 67. Should the CCBS fail during the ascent phase between 30 - 24 m or 24 - 18 m, the Table 67 ascent is to continue on air until the next stop is reached where the stop is to be conducted iaw Table 64.*

g. **Procedures for the use of Type 'C' Chambers and the ACBS (Training)**

(1) Training dives breathing Air (Chamber atmosphere) or Oxygen via BIBS are to be conducted in accordance with Para 1231.

(2) Training dives utilizing the Closed Circuit Breathing System (CCBS) are to be conducted using BR 2806 Table B and in the case of CCBS failure Table D. To ensure that the PO_2 is maintained within the acceptable band of 0.8 - 1.6 Bar, which may only be increased to 1.8 Bar for dives in excess of 70m, the following procedures are to be followed:

(a) **Descent.**

i. Descents are to commence breathing 50/50 O_2He. At 15m halt the descent and select 40/60 O_2He. When dropping PO_2 levels are noted recommence the descent.

ii. At 30m halt the descent and select 20/80 O_2He. When dropping PO_2 levels are noted recommence the descent to maximum depth.

Note. *As lower O_2 content gases are selected transient decreasing, and possibly increasing, PO_2 levels will be observed. The descent to maximum depth may continue providing the PO_2 does not drop below 0.8 Bar or exceed 1.8. O_2 monitors are to be observed.*

(b) **Ascent.**
To include all decompression stops as dictated by Table B.

i. The ascent from depths in excess of 30m is commenced breathing 20/80 O_2He.

ii. When at 35m during ascent, 40/60 O_2He is to be selected without stopping the ascent.

iii. When at 25m during the ascent, 50/50 O_2He is to be selected without stopping the ascent.

Note. *These mandatory gas 'switches' will ensure that adequate PO_2 levels are maintained throughout the ascent and decompression phase. Ascents from depths shallower than 30m are to be commenced on the gas commensurate with the gas/depth profile as detailed above.*

(c) Should the CCBS fail during a training dive, the diver(s) is/are to be instructed to breath 16/84 O_2He from the CC Bibs and the following action taken.

i. If the CCBS fails while conducting a descent or dive not requiring decompression stops and the maximum depth of descent is not deeper than 42m, the diver may be surfaced at the normal rate of ascent. (1m every 4 seconds)

ii. If the CCBS fails while conducting a dive, irrespective of depth, requiring decompression stops, the diver is to be surfaced using Table D.

h. **Operation of Hand Service Lock**

(1) Small items can be passed into the MC when under pressure by use of the hand Service Lock.

(2) Instructions for use vary between the different types of 2CCC. Specific drills are contained in the appropriate **BR 2807** Series handbook.

(3) Care must always be taken to ensure that sealed items/packages are opened prior to pressurisation.

i. **Chamber Ventilation.**
All 2CCC must be ventilated to avoid a build up of carbon dioxide, to maintain the correct proportion of oxygen and to ensure the comfort of the occupants. Ventilation is accomplished by one of the two methods detailed below and in subsequent paragraphs.

(1) Manually, by flushing through.

(2) Semi-automatic, using life support systems (i.e. CO_2 scrubbers, O_2 Make-up System and CO_2 /O_2 analysers).

j. **Chambers without Life Support Systems on line.** Ventilation is accomplished by manually flushing through the chamber with air as shown in Table 12-4. Flushing through is the term given to the opening of the vent and supply valves simultaneously while maintaining the correct pressure in the chamber. It is important that as much movement of air as possible is achieved during this period. The relevant orders given by the dive supervisor in sequence are: ‘Standby to flush through’. ‘Flush through’ and ‘Stop flushing’. Divers remain breathing oxygen throughout as required by the decompression, and are checked before and after the flush through.

Table 12-4. 2CCC Without Life Support System on line - Flushing Through Requirements. Para 1231 (h)

Breathing Gas/System	Flush Through Period
Occupants breathing chamber air or oxygen/oxy-nitrogen mixtures from BIBS **WITH** overboard dump	2 minutes in every 15 minutes
Any occupants breathing oxygen/oxy-nitrogen mixtures from BIBS **WITHOUT** overboard dump	At least 3 minutes in every 15 minutes

k. **Chambers with Life Support Systems on line**. If a chamber is fitted with a full closed-circuit life support system then CO_2 and O_2 analysers are to be available to monitor the chamber atmosphere. A full life support system will allow semi-automatic regulation of the chamber atmosphere and will normally comprise:

(1) CO_2 Scrubbers and CO_2 Analyser.

(2) O_2 Make-up System and O_2 Analyser.

(3) BIBS fitted with overboard dump regulators.

(4) Environmental Control System (ECS).

CO_2 canisters must be recharged when the CO_2 level exceeds 0.5% ‘surface equivalent’. The O_2 level in the chamber must be controlled between 20 to 25% for normal air diving. In the event of failure of any of the CO_2 /O_2 analysers, CO_2 scrubbers, O_2 make-up system, BIBS overboard dumps, or inability of the system to cope with the number of occupants in the chamber then chamber ventilation is to revert to manual flushing through (see Table 12-4). Cooling/heating of the chamber atmosphere is accomplished by the ECS but may require supplementing by manual flushing.

l. **Hearing Protection During Compression and Ventilation.** Hearing protection should be worn during compression and when flushing through the chamber. Sufficient ear defenders are to be available for all chamber occupants. See sub-para b(5) above.

m. **Scale of Medical Stores**

(1) The Medical Equipment Set (MES) - Diving Chamber RN (NSN 6545-99-811-1410) is to be held in close proximity to all service two compartment compression chambers. The stowage is to be secure, dry, clean and clearly marked. All personnel are to be aware of the location and routine for access.

(2) The scale of stores in the MES is designed to provide an attending Medical Officer with the facilities to adequately treat a diving casualty (or casualties) in the hyperbaric chamber, or in transit to a TUP facility. Use of the MES should normally be authorised only by Medical Officers or their nominated representatives. In the appropriate circumstances, the diving officer/diving supervisor may authorise use of the equipments contained in the MES, (this does not apply to drugs or medicines). A diagnostic kit is included for use during a neurological examination (Chapter 13, Annex A).

(3) Any item expended in use, damaged or contaminated must be replaced/ exchanged as soon as possible, utilising the nearest Medical Stores facility. The correct accounting procedures must be used.

(4) The O_2 resuscitator cylinder pressure is to be checked periodically and recharged as necessary. Army divers see para 0766.

1232. One-Man Compression Chamber

a. One-man compression chambers are designed only for surface decompression in minehunters, and not for the treatment of diving disorders requiring therapeutic recompression. Divers with dysbaric illness should always be attended during recompression therapy and this is not possible in a one man chamber.

b. For these reasons if a two-compartment chamber is available either immediately or within a short period of travel (see para 1381) it is always to be used. Successful treatments, however, can be and have been carried out in one-man chambers.

c. In no circumstances is more than one man to be compressed in a one-man chamber.

d. **Preparation For Use**

(1) The supervisor is to check that:

(a) The chamber is thoroughly clean internally and free from all combustible material.

(b) Air and oxygen supply cylinders are fully charged.

(c) The chamber door is operating correctly.

(d) Communications are tested and correct.

(e) The lever-operated control valve (LCV) is tested and correct.

(f) The stretcher is operating correctly.

(g) The following items are available: BR 2806 UK Military Diving Manual Vol 2; watch or clock; S 288/AB 576(A) and narrative record/CC log sheets (if carrying out therapeutic recompression see para 0401f). A master CC log sheet, suitable for photocopying , is contained in Section 12 of BR 2806 (Rec).

(2) It is also recommended that the following be kept available near all one-man chambers:

(a) About three litres of fresh water in suitable containers, with a length of non-collapsible, flexible tubing to assist drinking.

(b) Glucose sweets.

(c) Other food.

(d) Reading material.

(e) Writing pad and pencils.

(f) Fire Resistant (FR) mattress.

(g) 1 x FR blanket or 1 x FR duvet - with FR cover.

(h) Urine bottle with stopper.

(i) Towel.

(j) Box of paper tissues.

(k) Plastic bags.

Note. *The stoppers of all containers must be removed or loosened sufficiently to allow pressure to equalise. Air-tight tins must be opened before they are put into the chamber.*

(3) In hot climates salt tablets and extra fluids should also be provided for the patient. The chamber should be kept in the shade and cooled. The temperature within is to be determined by the comfort of the patient and the limits in para 1230f. **Mercury thermometers are not allowed within the chamber.**

e. **Operation**

(1) The stretcher is withdrawn and as soon as the diver is ready he lies on the stretcher, which is then pushed into the chamber. If the diver is to start his decompression breathing oxygen, the LCV is put to OXYGEN and he inserts his BIBS mouthpiece before the chamber is closed. If he is to start breathing oxygen at a later stage in his decompression, he may insert his mouthpiece before the chamber is closed and breathe from BIBS with the LCV to AIR or he may breathe air from the chamber and insert his mouthpiece when instructed: ‘Commence breathing oxygen’.

(2) The drill for carrying out decompression is, except for the operation of the LCV, the same as that described in para 1231.

f. **Safety Precautions**

(1) Because the chamber door opens outward, pressure inside the chamber tends to open the door. If the door is not properly and fully closed an interlock valve in the charging system will prevent the chamber being pressurised.

(2) *Lining up Marks.* These marks are embossed upon the chamber and the door to indicate when the door is fully closed, as shown by the complete overlap of flanges and dogs.

(3) *Pressurising.* The lining-up marks on the chamber and the door must always be exactly aligned before the chamber is pressurised. If the door cannot be closed to the marks, technical assistance is to be sought to rectify the defect before the chamber is operated.

(4) *De-pressurising.* All pressure must be vented from the chamber before any attempt is made to open the door.

(5) *Ventilation.* Because of the small size of a one-man chamber, it has to be ventilated more frequently than a larger one if the occupant is breathing air from the chamber e.g. flush for one minute every five.

(6) *After Use (Mobile Chambers).* When not in use the chamber door is to be closed to the lining-up marks and the main vent valve is to be left in the fully open position.

(7) *Ship-Fitted Chambers.* The following routine is to be carried out whenever the chamber is not in use:

(a) SCC flat isolating valve (HUNT class) are to be left fully CLOSED.

(b) HP and LP air-supply controls on chamber are to be left fully CLOSED.

(c) Main-vent and slow-bleed valves are to be left fully OPEN.

(d) Chamber door is to be left fully CLOSED with door-closed marks aligned.

(e) Warning tally to be secured to chamber panel cover, reading: 'DANGER'. Door to be fully shut and both vents to be left fully open when chamber is not in use.'

(f) Ship's standing orders should include the above.

(8) *Therapeutic Recompression* If it is essential to carry out therapeutic recompression in a one-man compression chamber the procedures laid down in para 1378 are to be followed.

(9) *Transport by Helicopter*. When occupied one-man chambers are not to be transported by helicopter as an underslung load.

1233. Two-Man Compression Chamber (Duocom Houlder Variant)

a. The Two-man compression chamber is provided to meet diving operational tasks to depths of 60m.

b. Three modes of breathing systems are available within the Duocom chamber:

(1) *Compressed Air - Open System.* A constant volume flow of 50 ambient lpm provides correct ventilation of the compression chamber. (Continuous flushing through).

(2) *Compressed Air - Semi-closed system.* A constant mass flow of 18 lpm recirculates the chamber air through the carbon dioxide scrubber. (See Notes.)

(3) *Oxygen* - Provided through demand oral-nasal breathing masks fitted with overboard dump regulators for removal of exhaled oxygen.

c. An inside attendant is to be used on every occasion of Duocom Compression Chamber use, with the exceptions of the standby diver test dive (para 0704) and single diver surface decompression.

d. Diving Supervisors and Chamber Attendants are to be fully conversant with the operating and emergency procedures for the two man compression chamber which are laid down in Director General Underwater Weapons (Naval) Publication No 76954.

Notes:

1. This mode is only to be used during TUP operations and is not to be used under any other circumstances.

2. During TUP and when in routine use in the open circuit mode, the chamber is to be flushed through in accordance with para 1231g.

1234. Compression Chamber - Fire and Toxicity Precautions

a. The risk of fire is increased in air under pressure and further increased when oxygen is being used. The drill for using the chamber provides for periodical ventilation of the chamber during use by operating both supply and vent valves while maintaining the chamber pressure. This ensures there is no build-up of oxygen.

b. The following instructions are designed to reduce the risk of fire and must always be observed:

(1) The chamber and all associated equipment used within, must be kept thoroughly clean at all times and free from all flammable materials and substances.

(2) Lighting is to be of an exterior type or, if fitted inside the chamber, of approved pressure-tight fittings. Communication is to be by sound-powered telephone or the talk-back loudspeaker system.

(3) Fire-proof paint only is to be used on the inside of the chamber and the number of coats is to be kept to the minimum required for efficient preservation.

(4) One or more activated alumina filters are to be fitted in the air-supply line to prevent oil vapour reaching the chamber supply.

(5) Each compartment is to contain a fully charged hyperbaric fire extinguisher. If no extinguisher is available a bucket of water is to be provided.

Note. *This does not apply to One or Two Man Compression Chambers.*

(6) Mattresses and blankets used when treating cases of decompression illness are to be fire resistant. Furniture such as stools, tables or chairs are to be of non-flammable material.

(7) The following notices are to be prominently displayed:

(a) At the control panel and the main entrance to the chamber.

ACTION TO BE TAKEN IN THE EVENT OF A FIRE IN THE CHAMBER

1. Surface the chamber immediately at the maximum rate.
2. Summon medical aid.
3. Remove the occupants and extinguish the fire.
4. Recompress the occupants at the earliest possible moment to the pressure existing when the fire broke out.

(b) At the control panel and at all entrances to the chamber:

WARNING
FIRE AND TOXICITY RISK

No flammable or toxic materials such as matches, lighters, flammable liquids oil-contaminated articles or clothing are to be taken into the chamber. SMOKING in the chamber is strictly PROHIBITED. When oxygen is being breathed, the chamber must be ventilated by flushing through for 3 minutes in every 15 minutes the chamber is in use. Flushing through is not required if the chamber BIBS are fitted with overboard dumps which are in use, or a full chamber life support system is on line in accordance with Table 12-4.

MEDICAL TREATMENT

Instruments containing mercury, such as thermometers and sphygmomanometers are NEVER to be taken into compression chambers. Remember the flammable and toxicity dangers from drugs etc.

1235. Emergency Reduction of Chamber Pressure

a. Should it suddenly become necessary to reduce the chamber pressure because of fire, valves or pipes bursting, etc, the diving supervisor must bear in mind the physiological risks involved and weigh them against the risk of leaving the occupants in the chamber. It is not possible to lay down any hard and fast rule as there is an infinite number of circumstances that may affect a decision.

b. Generally speaking, rapid release from depths is likely to cause serious decompression illness or gas embolism and may well prove fatal. It is absolutely essential that the occupants of the chamber are put under pressure again as soon as possible.

SECTION 4 - SURFACE DECOMPRESSION

1236. Introduction

a. Surface decompression is employed when it is necessary for a diver or divers to carry out stops and it is either undesirable or impracticable for this to be done in the water. When diving CDBA surface decompression cannot be conducted unless a number of wet stops have been undertaken.

b. Speed and safety are essential when conducting this operation. Procedures must be thoroughly practised before attempting ‘live’ drills.

c. Providing the requirements of Para 1237 - 1240 can be met, Surface Decompression can be used safely as required by Para 1236a. above. Also providing the same requirements can be met, Surface Decompression exercises may be conducted as required, providing the restrictions at Para 1244 placed upon the diver(s) concerned.

1237. Mandatory Requirements

a. Surface decompression, for diving equipments other than CDBA, is not to be carried out using Tables 14 and 15 unless the following requirements are met:

(1) A compression chamber with a 6 Bar (50m) capability is on-site at the scene of diving operations.

(2) No more than 5 minutes is allowed to elapse between the time that the diver leaves the seabed and the time he arrives at ‘chamber bottom’.

b. When diving CDBA surface decompression cannot be carried out using Interim Tables C and D unless the diver has completed a number of ‘in water’ decompression stops and the following additional requirements are met:

(1) When diving to a maximum of 60m a compression chamber with a 6 Bar (50m) capability is on site. A DUOCOM or OMCC is suitable for this depth of diving.

(2) When diving to a maximum of 80m a two compartment compression chamber with an 8 Bar (70m) capability is on site.

(3) No more than 5 minutes is allowed to elapse between the time that the diver leaves his last ‘wet stop’ to the time he arrives at ‘chamber bottom’, which for CDBA diving is 12m.

1238. Support Team

As a minimum, a surface support team of the dive supervisor and one chamber operator must be available at the compression chamber.

1239. Chamber Operator

The chamber operator must be a qualified diver who has been instructed in the operation of compression chambers (para 0728).

1240. Attendants

When the type of chamber allows, an attendant must always be provided for the diver except that, when diving in pairs or groups, divers may act as attendants for each other in the chamber.

1241. Run-over (Air and O_2He Tables)

a. **Tables 14 and 15.** Experience has shown that a maximum 'run-over' of up to 2 minutes may be added to the 5 minute interval from leaving the seabed to reaching 'chamber bottom' without affecting the safety of the subsequent decompression. In this case the decompression stops used are to be those given for the next longer time increment for the depth of the original dive. The 2 minute 'run-over' must not be a pre-planned procedure and is intended to allow for minor unexpected delays (see para 1245).

b. **Tables C and D.** Unlike Tables 14 and 15 where the diver(s) is/are travelling from variable diving depths and therefore a likelihood of running over his 5 minute deadline from seabed to 'chamber bottom' is possible. The CDBA diver is required to conduct a number of 'in water' stops, therefore the maximum depth from which he will ascend is 12m. Because of the reduced depth from which the diver ascends the likelihood of running over the 5 minutes from last wet stop to a 'chamber bottom' of 12m is considerably reduced, however a run over of up to 2 minutes may be added to the 5 minute transfer time from leaving the last in water stop to reaching 12m in the chamber. In this case the decompression stops used are to be those given for the next longer time increment for the depth of the original dive. The 2 minute 'run over' must not be a pre-planned procedure and is intended for minor unexpected delays.

1242. Run-over Exceeded Tables 14, 15, C and D

If chamber bottom is not reached within 7 minutes and the diver has no symptoms or signs of decompression illness he should be recompressed to 18m breathing oxygen and Table 61 started immediately on arrival at 18m. If the diver missed any decompression stops deeper than 18m or he is symptomatic, Table 62 must be used.

1243. Decompression Illness

a. Irrespective of diving equipment, if at any time during the surface phase of a surface decompression procedure, the diver shows signs or symptoms of decompression illness, therapeutic treatment procedure is to be instigated immediately, following the flow diagram Fig 13-18.

b. During the use of Tables 14 and 15, it is remotely possible that a diver may develop symptoms or signs of decompression illness during the initial phase of his decompression in the chamber when he is at a depth, in excess of 18, at which the oxygen table can be used. In such cases the diver should be maintained at depth, administered the highest oxygen content gas available, commensurate with depth, while urgent medical advice is sought (see para 1361).

1244. Restrictions

The following restrictions are to be strictly enforced:

a. A diver who uses surface decompression after a dive to any depth, is to remain within 4 hours travelling time of a compression chamber for 12 hours after completing the dive. A one-man compression chamber is acceptable for this purpose (see para 1378).

b. No diving, except dives breathing pure oxygen is to be carried out for 24 hours after the completion of a surface decompression dive. If surface decompression dives are carried out on 3 consecutive days no diving (other than oxygen diving) is to be carried out for 48 hours after completion of the third dive.

1245. Conduct and Procedures

The following procedures are to be used in the conduct of surface decompression using Tables 14, 15 and interim Tables C and D.

a. **Ascent**

(1) An attended diver is given the signal, four pulls followed by two bells - Come up, surface decompression.

(2) When using hard wire communications he is told, 'Come up, surface decompression' the diver is to respond by repeating the order.

(3) The diver ascends to his first 'wet stop' at a uniform rate of 1m in 4 seconds. The Diver then remains with the XBS until he has completed the wet phase of his surface decompression stops and the XBS is hoisted to the surface.

b. **Reception.** The minimum surface support team is specified in para 1238 above. Generally there will be more, as there must be sufficient surface attendants to remove the necessary equipment and enable the diver(s) to enter the chamber in the shortest time. In the case of single diver operations para 1240 applies.

c. **Compression.** It is of the utmost importance that the diver(s) be compressed as quickly as possible. The time between the diver(s) leaving either the seabed or his last wet stop and the chamber being pressurised to chamber bottom should not exceed 5 minutes (see para 1241).

1246. Decompression Procedure - Tables 14 and 15

a. As soon as the diver is closed up in the compression chamber it is to be pressurised to 'chamber bottom' where the diver remains for 5 minutes as represented by the first stop in Table 14 for air decompression or Table 15 for air and oxygen decompression.

b. For dives below 36m the use of oxygen stops as scheduled in Table 15 is preferable.

1247. Decompression Procedure - Table C and D

a. Surface decompression with CDBA cannot be undertaken without the diver completing a number of in water decompression stops in accordance with Tables C and D.

b. After the diver has completed the requisite number of wet stops he is to be transferred to the compression chamber. When the transfer is complete and prior to leaving surface, the diver is to commence breathing oxygen via the BIBS. The chamber is then to be pressurised to "chamber bottom", which for Tables C and D will always be 12m, where the diver is to remain for the full duration of his decompression. During chamber stops an air break of 5 minutes is to be taken after every 30 minutes on oxygen. The number of air breaks required is indicated by an asterix in the tables. Air breaks are in addition to the stop time.

c. When using Table C the chamber is to be surfaced in 1 minute. If an air break occurs at the end of the stop time the diver should be surfaced on air instead of completing another 5 minute air break prior to surfacing.

d. When using Table D the chamber is to be surfaced in 6 minutes, at a rate of 2m per minute. If an air break occurs at the end of the stop time, the 5 minute air break should be taken at 12m. The diver then breathes O_2 during the bleed to the surface.

e. If the diver exhibits any signs or symptoms of decompression illness, once confirmed at 12m in the chamber, then therapeutic procedures are to be implemented.

1248. Transport of Detached Diver

a. When carrying out an operation in which the diver is detached from the vessel carrying the compression chamber the drill described below can be used.

b. Two inflatable craft or equivalent, with reliable outboard engines should be employed, the first, which is secured to the shot rope, being used to hold all the equipment and the second to transport the diver to the attendant vessel, which should anchor or lay off. The vessel must be sufficiently close to allow the diver(s) to be transported to the compression chamber and compressed to chamber bottom within 5 minutes.

c. On completion of the appropriate signals between the surface and the diver (para 0965) the diver starts the ascent at a rate of 1m in 4 seconds, dependent on equipment. On arrival at the surface and while still in the water, the diver removes his set and passes it to the first inflatable craft. He then boards the second inflatable craft which proceeds to the attendant vessel, where he immediately enters the compression chamber.

d. This procedure can be varied to suit different sets of circumstances, but whichever is used rapid transport is essential. Tactical factors (ie acoustic signature and minefield discipline) must also be considered see BR 5063.

1249. Surface Decompression Practice

a. **CDBA Tables C and D.** To provide the opportunity to conduct essential Surface Decompression practise, using Tables C and D, without the restrictions of Para 1244, the following procedures may be conducted.

(1) **Practice Constraints**. Surface decompression practise may be conducted to a maximum depth of 33m.

(2) **Planning**. The surface decompression exercise is to be planned as two separate dives. One on O_2He and one on O_2.

(i) Dive 1. A CDBA dive to a maximum depth of 33m for a maximum duration of 10 minutes.

(ii) Dive 2. A compression chamber dive, on O_2

(3) **Method**

(i) Select a dive depth from Table B with a maximum depth of 33m.

(ii) The dive is to have a maximum duration of 8 minutes.

(iii) Conduct the Surface Decompression drill for a dive to 33m for a duration of 25 minutes. (This will ensure that, irrespective of the breathing medium, that the diver is on the surface from his wet dive within the no stop time for either Table B or C).

(iv) **For training purposes only, when the diver is in the CC, restrict the Chamber Bottom depth to 9m. (This will ensure that there are no Oxygen Toxicity related problems, as the diver will not have an inert gas loading, as would be expected for a 'live' surface decompression procedure)**.

(4) Due to the no stop nature of the wet dive and the fact that the divers breathe O_2 in the CC, the drill may be suspended at any time during the transfer/CC phase.

(5) Providing that a combination of dive duration and in water Table C decompression stops are under the no stop dive duration for a given depth, diving supervisors may plan and execute different profiles, to a maximum depth of 33m to fit training requirements and scenarios.

(6) Normal rules for repetitive/combined dives continue for subsequent dives.

b. **Equipment Other than CDBA**

(1) To maintain expertise in surface decompression diving techniques using Tables 14 and 15, it is necessary to undertake periodic practises. However in the training situation conduct of the full surface decompression procedure may impose unacceptable operational constraints for some time following the training exercise (see Para 1244).

(2) The following procedures minimise these constraints and ensures that proficiency in surface decompression techniques is maintained.

(3) **Practice Constraints**. Surface decompression training may be conducted to a maximum depth of 39 metres using the combined and repetitive dive rules detailed in Para's 1207, 1208 and 1209.

(4) **Planning**. The surface decompression exercise is to be planned as two separate dives, which when added together as a combined dive, (Para 1209) do not incur a decompression penalty ie:

(a) Dive 1. A no decompression wet dive to a maximum depth of 36 metres using Oxy-nitrogen gas mixture or air.

(b) Dive 2. A compression chamber (CC) dive. Duration calculated from leaving surface to arriving at the first stop.

(5) **Method**

(a) Select a no decompression dive using Table 14 or 15 with a no stop duration of at least 13 minutes eg:

Wet dive	5 minutes duration
Chamber Dive	2 minutes L/S to arrive Chamber Bottom (CB)
	5 minutes CB
	1 minute CB to first stop
Total time	13 minutes

(b) The first or subsequent incremented stops, (above the limiting line) or an imaginary deeper dive profile may then be used for training in surface decompression.

(6) Normal rules for repetitive/combined dives continue for subsequent dives.

(7) **Duration**. The durations of the two dives added together provide the actual duration under the existing combined diving (total time deepest depth) rule using Table 11 Mod. The minute taken to travel to the first stop in both table 14 and 15 is to be included in the CC dive duration. This takes into account the possibility of the diver(s) on-gassing due to the slower rate of travel from CB to the first stop. It also ensures that this time is taken into account should another dive be required under the combined dive rules.

(8) In the operational surface decompression procedure the diver is required to be at CB within 5 minutes of leaving bottom. In the training method described here, there is scope in the drill to exercise the over-run procedure or, in the event that the 7 minute over-run is exceeded, proceed to 18 metres to exercise the start of Table 61 or 62. These drills can be achieved in safety as the combined dive is within a no decompression stop dive and can be safely aborted.

(9) If during conduct of the drill the no decompression time limit is approached then the CB can be reduced artificially or the full decompression schedule followed. Run over times must be considered when deciding the duration of the initial wet dive.

(10) Provided the combined dive recorded does not exceed the no stop time for the deepest dive, the drill can be aborted safely at any stage without detriment to the divers.

(11) Normal rules for repetitive/combined dives continue for subsequent dives.

SECTION 5 - DIVING TABLES

1250. Use of Tables

a. The tables to be used will depend on the equipment type and duration of dive conducted. There are also a number of factors which modify the depth, time and stops to be used for the particular circumstances of a dive, and the appropriate articles should be consulted as follows:

(1) Availability of a Compression Chamber - para 0791

(2) Hard Work and Cold Water - para 1203

(3) Diving at Altitude - para 1216

b. This Section contains the schedules that can be employed for preventing decompression illness and arterial gas embolism.

c. The procedure for applying these schedules is contained in para 1251 below, and in the preamble to each table.

1251. Application of Diving Tables 11 - Mod, 14 and 15

a. Different diving tables are provided for different sets of circumstances, but their format and application are nonetheless similar.

b. Their limitations are also similar. Therefore, in cases where either the depth or duration of the dive is in doubt, stops for the next greater figure in the appropriate column are to be employed.

c. The tables are applied as follows:

(1) *Depth (Column 1).* This column has increments in depths of 3m, and the figure to be used is the one immediately exceeding the deepest depth to which the diver descended in his dive. Thus stops for 30m would be used for a dive to 28m. If there is any doubt about the accuracy of the depth of 28m, stops for 33m should be used.

(2) *Duration (Column 2).* The duration of the dive is the interval of time in minutes between the diver leaving the surface at the start of the dive and leaving the bottom to commence the ascent. The figure to be used is the one immediately exceeding the actual duration. Thus a dive to 30m for 23 minutes would employ stops against a duration of 25 minutes. If there is any doubt about the accuracy of this time interval, stops against a duration of 30 minutes should be used.

(3) *Stops (Column 3).* Stops are given opposite each depth increment for different durations. The timing of all stops commences when the diver signals that he has reached that stop. *All stops are dead stops.*

(4) *Oxygen stops.* Table 15 gives stops breathing oxygen for use in a compression chamber after deep dives. When changing from air to oxygen breathing, the stop time starts when the report ‘Diver breathing O_2’ is received. *All stops are dead stops.*

(5) *Changing to air stops.* If for any reason a diver ceases to breathe oxygen during his decompression and reverts to air, the remaining oxygen stops are to be increased $2^1/_2$ times to determine the time to be spent on air.

(6) *Broken Line.* The duration above the broken line indicates the maximum single duration as dictated by HSE.

(7) *Limiting Line.* The ordinary working section (**normal exposure**) of the table is that above the limiting line. Diving for periods below the line (**exceptional exposure**) carries greater risks and should only be carried out when a compression chamber is available and when the increased risk can be justified.

(8) *Rate of ascent.* A steady rate of 1m in 4 seconds should be maintained. See also para 1223b.

(9) If acute CNS oxygen toxicity is experienced on Table 15, the diver is to be taken off oxygen immediately, the chamber flushed through for 3 minutes and the decompression schedule changed to air stoppages in accordance with sub-para (5) above.

1252. Application of Diving Table A

a. CDBA is capable of being dived with air as the diluent gas to a maximum depth of 30m.

b. When using CDBA with an air diluent decompression time for a given depth can be reduced, because of the reduced nitrogen tension in the body tissues.

c. Table A is an Equivalent Air Depth (EAD) schedule to be used in conjunction with Table 11 Mod to ascertain correct decompression schedules.

d. Dives conducted using air as the diluent gas cannot be combined with O_2/He dives.

1253. Application of Diving Table B, C, D and E

a. Different diving tables are provided for different sets of circumstances, but their format and application are nonetheless similar.

b. Their limitations are also similar. Therefore, in cases where either the depth or duration of the dive is in doubt, stops for the next greater figure in the appropriate column are to be employed.

c. The tables are applied as follows:

(1) *Depth (Column 1).* This column has increments in depths of 3m, and the figure to be used is the one immediately exceeding the deepest depth to which the diver descended in his dive. Thus stops for 30m would be used for a dive to 28m.

(2) *Stops (Columns 3 - 7 inclusive as applicable).* Stops are given opposite each depth increment for different durations. The time for the first stop commences when the diver reaches the correct stoppage depth. The timing for each subsequent stop commences on arrival at that stop. In other words the ascent time is not to be included in the stop time throughout, all stops are therefore 'dead stops'.

(3) *Oxygen Stops.* Tables C and D details stops breathing oxygen. When changing from O_2/He to oxygen breathing the initial stoppage time commences when the report 'Diver breathing oxygen' is received.

(4) *Oxygen Supply Failure/Oxygen Toxicity.* If oxygen is not available for decompression due to equipment failure or if oxygen toxicity symptoms are threatening the diver, the diver is to be transferred back to an oxygen in helium mixture. The diver must be surfaced according to Table E and complete the decompression schedule from the transfer depth. Time spent decompressing on oxygen at the transfer depth is to be included as part of the Table E stop time. The gas mixture for Table E <u>must</u> contain at least 16% oxygen in helium.

(5) *Oxygen Not Available for Decompression.* If it is known in advance that oxygen cannot be used during decompression (eg, a diver at depth and XBS malfunctions), the diver is to be surfaced on either Table B and conduct routine 'in water' stops or Table C can be used until the first oxygen stop when the diver can be changed to Table E.

(6) *Limiting Line.* The ordinary working section (**normal exposure**) of the table is that above the limiting line in the Tables it appears. Diving for periods below the line (**exceptional exposure**) carries greater risks and should only be carried out when a compression chamber is available and when the increased risk can be justified. See para 1213.

(7) *Rate of Ascent.* A steady rate of 1m in 4 seconds should be maintained. See also para 1223.

(8) In the highly unlikely event of acute CNS oxygen toxicity whilst undergoing decompression in a decompression chamber during surface decompression, on Tables C and D, the diver is to be taken off oxygen immediately, and the diver decompressed in accordance with therapeutic Table 65.

Table 11-Mod Air Table

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) STOPS AT DIFFERENT DEPTHS (min)			(4) TOTAL TIME FOR DECOMPRESSION STOPS (min)
		9m	6m	3m	
9	No limit	-	-		-
12	120	-	-	-	-
	165	-	-	5	5
	195	-	-	10	10
	225	-	-	15	15
	255	-	-	20	20
	330	-	-	25	25
	390	-	-	30	30
	660	-	-	35	35
	Limiting Line				
	Over 660	-	-	40	40
15	75	-	-	-	-
	105	-	-	5	5
	120	-	-	10	10
	135	-	-	15	15
	145	-	-	20	20
	160	-	-	25	25
	170	-	5	25	30
	190	-	5	30	35
	Limiting Line				
	240	-	10	40	50
	360	-	30	40	70
	450	-	35	40	75
	Over 450	-	35	45	80
18	55	-	-	-	-
	70	-	-	5	5
	80	-	5	5	10
	90	-	5	10	15
	100	-	5	15	20
	110	-	5	20	25
	120	-	5	25	30
	130	-	5	30	35
	Limiting Line				
	140	-	10	30	40
	150	-	10	40	50
	160	-	15	40	55
	180	-	20	40	60
	200	5	30	40	75
	255	10	35	45	90
	325	20	40	45	105
	495	35	40	45	120
	Over 495	35	40	50	125

Table 11-Mod Air Table (continued)

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) STOPS AT DIFFERENT DEPTHS (min)					(4) TOTAL TIME FOR DECOMPRESSION STOPS (min)
		15m	12m	9m	6m	3m	
21	35	-	-	-	-	-	-
	55	-	-	-	-	5	5
	60	-	-	-	5	5	10
	70	-	-	-	5	10	15
	75	-	-	-	5	15	20
	85	-	-	-	5	20	25
	90	-	-	-	5	25	30
	95 Limiting Line	-	-	5	5	25	35
	105	-	-	5	5	35	45
	120	-	-	5	10	40	55
	135	-	-	5	20	45	70
	150	-	-	5	30	45	80
	165	-	-	10	30	50	90
	180	-	-	15	35	50	100
	210	-	-	25	40	50	115
	240	-	5	30	40	50	125
24	28	-	-	-	-	-	-
	40	-	-	-	-	5	5
	50	-	-	-	5	5	10
	55	-	-	-	5	10	15
	60	-	-	-	5	15	20
	70	-	-	-	5	20	25
	75 Limiting Line	-	-	-	5	25	30
	80	-	-	5	5	30	40
	90	-	-	5	10	35	50
	105	-	-	5	20	40	65
	120	-	5	5	30	45	85
	140	-	5	10	35	50	100
	160	-	10	30	40	50	130
27	22	-	-	-	-	-	-
	30	-	-	-	-	5	5
	40	-	-	-	5	5	10
	45	-	-	-	5	10	15
	50	-	-	-	5	15	20
	55	-	-	-	5	20	25
	60	-	-	5	5	20	30
	65 Limiting Line	-	-	5	5	25	35
	70	-	-	5	10	30	45
	75	-	-	5	15	30	50
	80	-	-	5	20	35	60
	90	-	-	5	25	40	70
	100	-	-	5	30	45	80
	110	-	5	15	35	45	100
	120	-	5	20	35	50	110
	135	5	5	25	40	50	125
	150	5	10	35	40	50	140

Table 11-Mod Air Table (continued)

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) STOPS AT DIFFERENT DEPTHS (min)						(4) TOTAL TIME FOR DECOMPRESSION STOPS (min)
		18m	15m	12m	9m	6m	3m	
30	18	-	-	-	-	-	-	-
	20	-	-	-	-	-	5	5
	25	-	-	-	-	5	5	10
	30	-	-	-	-	5	10	15
	35	-	-	-	-	5	15	20
	40	-	-	-	-	5	20	25
	45	-	-	-	5	5	20	30
	50	-	-	-	5	5	25	35
	Limiting Line							
	55	-	-	-	5	10	30	45
	60	-	-	-	5	20	35	60
	70	-	-	5	5	20	40	70
	75	-	-	5	5	30	40	80
	80	-	-	5	15	30	45	95
	90	-	-	5	25	35	50	115
	105	-	5	10	30	40	50	135
33	15	-	-	-	-	-	-	-
	20	-	-	-	-	-	5	5
	25	-	-	-	-	5	10	15
	30	-	-	-	-	5	15	20
	35	-	-	-	-	5	20	25
	40	-	-	-	5	5	20	30
	Limiting Line							
	45	-	-	-	5	10	25	40
	50	-	-	-	5	15	30	50
	55	-	-	-	5	20	35	60
	60	-	-	5	5	20	40	70
	65	-	-	5	10	20	45	80
	70	-	-	5	15	25	45	90
	75	-	-	5	20	30	45	100
	80	-	5	5	20	40	45	115
	90	-	5	10	25	40	50	130
	100	-	5	20	30	45	50	150
	110	5	5	25	40	45	50	170

Table 11-Mod Air Table (continued)

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) STOPS AT DIFFERENT DEPTHS (min)							(4) TOTAL TIME FOR DECOMPRESSION STOPS (min)
		21m	18m	15m	12m	9m	6m	3m	
	12	-	-	-	-	-	-	-	-
	15	-	-	-	-	-	-	5	5
	20	-	-	-	-	-	5	5	10
	25	-	-	-	-	-	5	15	20
	30	-	-	-	-	-	5	20	25
	35	-	-	-	-	5	5	25	35
	Limiting Line								
36	40	-	-	-	-	5	10	25	40
	45	-	-	-	-	5	15	30	50
	50	-	-	-	5	5	20	35	65
	55	-	-	-	5	10	25	40	80
	60	-	-	-	5	20	30	45	100
	70	-	-	5	5	20	35	45	110
	75	-	-	5	10	25	35	45	120
	80	-	-	5	15	30	40	50	140
	90	-	5	5	20	35	45	50	160
	100	-	5	15	25	40	45	50	180
	110	-	5	20	30	40	45	50	190
	8	-	-	-	-	-	-	-	-
	10	-	-	-	-	-	-	5	5
	15	-	-	-	-	-	5	5	10
	20	-	-	-	-	-	5	10	15
	25	-	-	-	-	-	5	20	25
	30	-	-	-	-	5	5	20	30
	Limiting Line								
	35	-	-	-	-	5	10	25	40
39	40	-	-	-	5	5	15	30	55
	45	-	-	-	5	5	20	35	65
	50	-	-	-	5	10	25	40	80
	55	-	-	-	5	15	30	45	95
	60	-	-	5	10	20	30	50	115
	70	-	-	5	15	25	40	50	135
	75	-	-	5	20	30	45	50	150
	80	-	5	5	25	40	45	50	170
	90	5	5	15	30	40	45	50	190
	100	5	10	25	30	45	45	50	210
	110	5	15	30	40	45	45	50	230

Table 11-Mod Air Table (continued)

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) STOPS AT DIFFERENT DEPTHS (min)							(4) TOTAL TIME FOR DECOMPRESSION STOPS (min)
		21m	18m	15m	12m	9m	6m	3m	
42	7	-	-	-	-	-	-	-	-
	10	-	-	-	-	-	5	5	10
	15	-	-	-	-	-	5	10	15
	20	-	-	-	-	-	5	15	20
	25	-	-	-	-	5	5	20	30
	Limiting Line								
	30	-	-	-	-	5	10	25	40
	35	-	-	-	5	5	15	30	55
	40	-	-	-	5	10	15	35	65
	45	-	-	-	5	15	20	40	80
	50	-	-	5	5	20	35	45	110
	60	-	-	5	10	25	40	45	125
	65	-	-	5	15	30	40	50	140
	70	-	5	5	20	30	45	50	155
	75	-	5	10	20	35	45	50	165
	80	-	5	15	25	40	45	50	180
	85	5	5	20	35	40	45	50	200
	95	5	15	25	35	45	45	50	220
	105	5	20	35	40	45	45	50	240
45	6	-	-	-	-	-	-	-	-
	10	-	-	-	-	-	5	5	10
	15	-	-	-	-	-	5	15	20
	20	-	-	-	-	5	5	20	30
	Limiting Line								
	25	-	-	-	-	5	10	25	40
	30	-	-	-	5	5	10	30	50
	35	-	-	-	5	10	15	35	65
	40	-	-	-	5	15	20	40	80
	45	-	-	5	5	15	25	45	95
	50	-	-	5	10	20	30	50	115
	55	-	-	5	15	25	35	50	130
	60	-	5	5	15	30	40	50	145
	65	-	5	10	20	30	45	50	160
	70	-	5	15	25	35	45	50	175
	75	5	5	20	30	40	45	50	195
	80	5	10	25	35	40	45	50	210
	85	5	15	30	40	45	45	50	230

Table 11-Mod Air Table (continued)

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) STOPS AT DIFFERENT DEPTHS (min)								(4) TOTAL TIME FOR DECOMPRESSION STOPS (min)
		24m	21m	18m	15m	12m	9m	6m	3m	
48	5	-	-	-	-	-	-	5	5	10
	10	-	-	-	-	-	-	5	10	15
	15	-	-	-	-	-	5	5	15	25
	20	-	-	-	-	-	5	10	20	35
	Limiting Line									
	25	-	-	-	-	5	5	10	25	45
	30	-	-	-	-	5	10	15	30	60
	35	-	-	-	-	5	10	20	40	75
	40	-	-	-	5	5	15	25	45	95
	45	-	-	-	5	10	20	30	45	110
	50	-	-	-	5	15	25	40	45	130
	55	-	-	5	5	20	25	40	50	145
	60	-	-	5	10	20	35	45	50	165
	65	-	-	5	15	25	40	45	50	180
	70	-	5	5	20	30	40	45	50	195
	75	-	5	10	25	35	40	45	50	210
	80	-	5	15	30	40	45	45	50	230
51	5	-	-	-	-	-	-	5	5	10
	10	-	-	-	-	-	-	5	10	15
	15	-	-	-	-	-	5	5	15	25
	Limiting Line									
	20	-	-	-	-	-	5	10	25	40
	25	-	-	-	-	5	5	15	30	55
	30	-	-	-	-	5	10	20	35	70
	35	-	-	-	5	5	15	25	35	85
	40	-	-	-	5	10	20	30	40	105
	45	-	-	5	5	10	25	35	45	125
	50	-	-	5	5	15	30	40	50	145
	55	-	-	5	10	20	35	45	50	165
	60	-	5	5	15	25	35	45	50	180
	65	-	5	10	15	30	40	45	50	195
	70	-	5	15	20	35	45	45	50	215
	75	5	5	20	25	40	45	45	50	235

Table 11-Mod Air Table (continued)

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) STOPS AT DIFFERENT DEPTHS (min)								(4) TOTAL TIME FOR DECOMPRESSION STOPS (min)
		24m	21m	18m	15m	12m	9m	6m	3m	
54	5	-	-	-	-	-	-	5	5	10
	10	-	-	-	-	-	5	5	10	20
	15	-	-	-	-	-	5	10	15	30
	Limiting Line									
	20	-	-	-	-	5	5	10	25	45
	25	-	-	-	-	5	10	15	35	65
	30	-	-	-	5	5	15	20	40	85
	35	-	-	-	5	10	20	25	45	105
	40	-	-	5	5	10	25	35	45	125
	45	-	-	5	5	15	30	40	50	145
	50	-	-	5	10	20	35	45	50	165
	55	-	5	5	15	25	40	45	50	185
	60	-	5	10	20	30	40	45	50	200
	65	-	5	15	25	35	45	45	50	220
	70	5	5	20	30	40	45	45	50	240
57	5	-	-	-	-	-	-	5	5	10
	10	-	-	-	-	-	5	5	15	25
	15	-	-	-	-	-	5	10	20	35
	Limiting Line									
	20	-	-	-	-	5	5	15	25	50
	25	-	-	-	5	5	10	20	35	75
	30	-	-	-	5	5	15	30	45	100
	35	-	-	5	5	10	20	35	45	120
	40	-	-	5	5	15	25	40	50	140
	45	-	-	5	10	20	30	45	50	160
	50	-	5	5	15	25	35	45	50	180
	55	-	5	10	20	30	40	45	50	200
	60	5	5	10	25	35	45	45	50	220
	65	5	10	15	30	40	45	45	50	240
60	5	-	-	-	-	-	-	5	10	15
	10	-	-	-	-	-	5	5	15	25
	Limiting Line									
	15	-	-	-	-	5	5	10	20	40
	20	-	-	-	-	5	10	15	30	60
	25	-	-	-	5	5	15	20	40	85
	30	-	-	-	5	10	20	30	45	110
	35	-	-	5	5	15	25	40	45	135
	40	-	-	5	10	20	30	45	50	160
	45	-	5	5	15	25	35	45	50	180
	50	-	5	10	20	30	40	45	50	200
	55	5	5	10	25	35	45	45	50	220
	60	5	10	15	30	40	45	45	50	240

1254. Table 14 - Mod: Surface Decompression - Air Stops

a. Table 14 - Mod is employed when carrying out surface decompression breathing air.

b. The table is applied as described in para 1251 and has already been incremented to take into account the additional 10 minutes' bottom time, ie, the maximum time of five minutes between the diver leaving sea bed and the chamber being pressurised to 'chamber bottom', plus the 5 minutes spent at chamber bottom.

c. The first stop is 1 of 5 minutes. This represents 'chamber bottom' and is the depth to which the diver is to be recompressed as soon as he is closed up in the compression chamber. A maximum time of 5 minutes is to be the target between the diver leaving the sea bed and his reaching 'chamber bottom'.

d. The time taken to decompress from 'chamber bottom' to the first stop is to be 1 minute, which is to be included in the stop time. All remaining stops are dead stops. (The stop time commences on reaching the stop)

e. A 'run-over' of up to 2 minutes is allowed in addition to the 5 minutes taken from leaving the seabed to reaching 'chamber bottom' provided that the diver is asymptomatic, and that the stops appropriate for the **next longer time increment** for the depth of the original dive are used for decompression (para 1241).

f. If more than 7 minutes elapse from leaving the seabed to reaching 'chamber bottom', carry out the following procedure:

(1) If the diver is asymptomatic, follow Table 61 on reaching 18m.

(2) If the diver has symptoms or signs of decompression illness, no matter how trivial, follow Table 62 on reaching 18m (para 1369 and also para 1381 if only a one-man compression chamber is available).

Table 14 - Mod: Surface Decompression - Air Stops

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) STOPS AT DIFFERENT DEPTHS (min)				(4) TOTAL TIME FOR CHAMBER DECOMPRESSION (min)
		12m	9m	6m	3m	
12	120	-	-	-	-	-
	135	5	-	-	5	10
	155	5	-	-	10	15
	185	5	-	-	15	20
	215	5	-	-	20	25
	245	5	-	-	25	30
	320	5	-	-	30	35
	380	5	-	-	35	40

Table 14 - Mod: Surface Decompression - Air Stops (Continued)

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) STOPS AT DIFFERENT DEPTHS (min)						(4) TOTAL TIME FOR CHAMBER DECOMPRESSION (min)
		18m	15m	12m	9m	6m	3m	
15	75	-	-	-	-	-	-	-
	85	-	-	5	-	-	5	10
	95	-	-	5	-	-	10	15
	110	-	-	5	-	-	15	20
	125	-	-	5	-	-	20	25
	135	-	-	5	-	-	25	30
	150	-	-	5	-	5	25	35
	160	-	5	-	-	5	30	40
	Limiting Line							
	180	-	5	-	-	10	40	55
	230	-	5	-	-	30	40	75
	350	-	5	-	-	35	40	80
18	55	-	-	-	-	-	-	-
	60	-	-	5	-	5	5	15
	70	-	5	-	-	5	10	20
	80	-	5	-	-	5	15	25
	90	-	5	-	-	5	20	30
	100	-	5	-	-	5	25	35
	110	-	5	-	-	5	30	40
	Limiting Line							
	120	-	5	-	-	10	30	45
	130	-	5	-	-	10	40	55
	140	-	5	-	-	15	40	60
	150	-	5	-	-	20	40	65
	170	5	-	-	5	30	40	80
	190	5	-	-	10	35	45	95
	245	5	-	-	20	40	45	110
	315	5	-	-	35	40	45	125

Table 14 - Mod: Surface Decompression - Air Stops (Continued)

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) STOPS AT DIFFERENT DEPTHS (min)							(4) TOTAL TIME FOR CHAMBER DECOMPRESSION (min)
		21m	18m	15m	12m	9m	6m	3m	
21	35	-	-	-	-	-	-	-	-
	40	-	-	-	5	-	-	5	10
	45	-	-	-	5	-	5	5	15
	50	-	-	5	-	-	5	10	20
	60	-	-	5	-	-	5	15	25
	65	-	-	5	-	-	5	20	30
	75	-	-	5	-	-	5	25	35
	80	-	-	5	-	5	5	25	40
	Limiting Line								
	85	-	5	-	-	5	5	35	50
	95	-	5	-	-	5	10	40	60
	110	-	5	-	-	5	20	45	75
	125	-	5	-	-	5	30	45	85
	140	-	5	-	-	10	30	50	95
	155	-	5	-	-	15	35	50	105
	170	-	5	-	-	25	40	50	120
	200	5	-	-	5	30	40	50	130
24	28	-	-	-	-	-	-	-	-
	30	-	-	-	5	-	5	5	15
	40	-	-	5	-	-	5	10	20
	45	-	-	5	-	-	5	15	25
	50	-	-	5	-	-	5	20	30
	60	-	-	5	-	-	5	25	35
	Limiting Line								
	65	-	-	5	-	5	5	30	45
	70	-	5	-	-	5	10	35	55
	80	-	5	-	-	5	20	40	70
	95	5	-	-	5	5	30	45	90
	110	5	-	-	5	10	35	50	105
	130	5	-	-	10	30	40	50	135

Table 14 - Mod: Surface Decompression - Air Stops (Continued)

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) STOPS AT DIFFERENT DEPTHS (min)								(4) TOTAL TIME FOR CHAMBER DECOMPRESSION (min)
		24m	21m	18m	15m	12m	9m	6m	3m	
27	22	-	-	-	-	-	-	-	-	-
	25	-	-	-	-	5	-	5	5	15
	30	-	-	-	5	-	-	5	10	20
	35	-	-	-	5	-	-	5	15	25
	40	-	-	-	5	-	-	5	20	30
	45	-	-	-	5	-	5	5	20	35
	50	-	-	-	5	-	5	5	25	40
	Limiting Line									
	55	-	-	5	-	-	5	10	30	50
	60	-	-	5	-	-	5	15	30	55
	65	-	-	5	-	-	5	20	35	65
	70	-	-	5	-	-	5	25	40	75
	80	-	-	5	-	-	5	30	45	85
	90	-	-	5	-	5	15	35	45	105
	100	-	5	-	-	5	20	35	50	115
	110	5	-	-	5	5	25	40	50	130
	125	5	-	-	5	10	35	40	50	145
30	18	-	-	-	-	-	-	-	-	-
	20	-	-	-	-	5	-	5	10	20
	25	-	-	-	5	-	-	5	15	25
	30	-	-	-	5	-	-	5	20	30
	35	-	-	-	5	-	5	5	20	35
	40	-	-	-	5	-	5	5	25	40
	Limiting Line									
	45	-	-	5	-	-	5	10	30	50
	50	-	-	5	-	-	5	20	35	65
	60	-	-	5	-	5	5	20	40	75
	65	-	-	5	-	5	5	30	40	85
	70	-	5	-	-	5	15	30	45	100
	80	-	5	-	-	5	25	35	50	120
	95	5	-	-	5	10	30	40	50	140

Table 14 - Mod: Surface Decompression - Air Stops (Continued)

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) STOPS AT DIFFERENT DEPTHS (min)									(4) TOTAL TIME FOR CHAMBER DECOMPRESSION (min)
		27m	24m	21m	18m	15m	12m	9m	6m	3m	
33	15	-	-	-	-	-	-	-	-	-	-
	20	-	-	-	-	5	-	-	5	15	25
	25	-	-	-	-	5	-	-	5	20	30
	30	-	-	-	-	5	-	5	5	20	35
	Limiting Line										
	35	-	-	-	-	5	-	5	10	25	45
	40	-	-	-	5	-	-	5	15	30	55
	45	-	-	-	5	-	-	5	20	35	65
	50	-	-	-	5	-	5	5	20	40	75
	55	-	-	-	5	-	5	10	20	45	85
	60	-	-	5	-	-	5	15	25	45	95
	65	-	-	5	-	-	5	20	30	45	105
	70	-	-	5	-	5	5	20	40	45	120
	80	-	5	-	-	5	10	25	40	50	135
	90	-	5	-	-	5	20	30	45	50	155
	100	-	5	-	5	5	25	40	45	50	175
36	12	-	-	-	-	-	-	-	-	-	-
	15	-	-	-	-	-	5	-	5	15	25
	20	-	-	-	-	5	-	-	5	20	30
	25	-	-	-	-	5	-	5	5	25	40
	Limiting Line										
	30	-	-	-	-	5	-	5	10	25	45
	35	-	-	-	5	-	-	5	15	30	55
	40	-	-	-	5	-	5	5	20	35	70
	45	-	-	-	5	-	5	10	25	40	85
	50	-	-	5	-	-	5	20	30	45	105
	60	-	-	5	-	5	5	20	35	45	115
	65	-	-	5	-	5	10	25	35	45	125
	70	-	5	-	-	5	15	30	40	50	145
	80	-	5	-	5	5	20	35	45	50	165
	90	5	-	-	5	15	25	40	45	50	185
	100	5	-	-	5	20	30	40	45	50	195

Table 14 - Mod: Surface Decompression - Air Stops (Continued)

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) STOPS AT DIFFERENT DEPTHS (min)										(4) TOTAL TIME FOR CHAMBER DECOMPRESSION (min)
		30m	27m	24m	21m	18m	15m	12m	9m	6m	3m	
39	8	-	-	-	-	-	-	-	-	-	-	-
	10	-	-	-	-	-	-	5	-	5	10	20
	15	-	-	-	-	-	5	-	-	5	20	30
	20	-	-	-	-	-	5	-	5	5	20	35
	Limiting Line											
	25	-	-	-	-	-	5	-	5	10	25	45
	30	-	-	-	-	5	-	5	5	15	30	60
	35	-	-	-	-	5	-	5	5	20	35	70
	40	-	-	-	5	-	-	5	10	25	40	85
	45	-	-	-	5	-	-	5	15	30	45	100
	50	-	-	-	5	-	5	10	20	30	50	120
	60	-	-	5	-	-	5	15	25	40	50	140
	65	-	-	5	-	-	5	20	30	45	50	155
	70	-	-	5	-	5	5	25	40	45	50	175
	80	-	5	-	5	5	15	30	40	45	50	195
	90	5	-	-	5	10	25	30	45	45	50	215
	100	5	-	-	5	15	30	40	45	45	50	235
42	7	-	-	-	-	-	-	-	-	-	-	-
	10	-	-	-	-	-	5	-	-	5	15	25
	15	-	-	-	-	-	5	-	5	5	20	35
	Limiting Line											
	20	-	-	-	-	-	5	-	5	10	25	45
	25	-	-	-	-	5	-	5	5	15	30	60
	30	-	-	-	-	5	-	5	10	15	35	70
	35	-	-	-	5	-	-	5	15	20	40	85
	40	-	-	-	5	-	5	5	15	25	45	100
	45	-	-	-	5	-	5	5	20	35	45	115
	50	-	-	5	-	-	5	10	25	40	45	130
	55	-	-	5	-	-	5	15	30	40	50	145
	60	-	-	5	-	5	5	20	30	45	50	160
	65	-	-	5	-	5	10	20	35	45	50	170
	70	-	5	-	-	5	15	25	40	45	50	185
	75	-	5	-	5	5	20	35	40	45	50	205
	85	5	-	-	5	15	25	35	45	45	50	225
	95	5	-	-	5	20	35	40	45	45	50	245

Table 14 - Mod: Surface Decompression - Air Stops (Continued)

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) STOPS AT DIFFERENT DEPTHS (min)										(4) TOTAL TIME FOR CHAMBER DECOMPRESSION (min)
		30m	27m	24m	21m	18m	15m	12m	9m	6m	3m	
45	6	-	-	-	-	-	-	-	-	-	-	-
	10	-	-	-	-	-	5	-	5	5	20	35
	Limiting Line											
	15	-	-	-	-	-	5	-	5	10	25	45
	20	-	-	-	-	5	-	5	5	10	30	55
	25	-	-	-	-	5	-	5	10	15	35	70
	30	-	-	-	5	-	-	5	15	20	40	85
	35	-	-	-	5	-	5	5	15	25	45	100
	40	-	-	-	5	-	5	10	20	30	50	120
	45	-	-	5	-	-	5	15	25	35	50	135
	50	-	-	5	-	5	5	15	30	40	50	150
	55	-	-	5	-	5	10	20	30	45	50	165
	60	-	5	-	-	5	15	25	35	45	50	180
	65	-	5	-	5	5	20	30	40	45	50	200
	70	-	5	-	5	10	25	35	40	45	50	215
	75	5	-	-	5	15	30	40	45	45	50	235
48	5	-	-	-	-	-	5	-	5	5	15	30
	10	-	-	-	-	-	5	-	5	10	20	40
	Limiting Line											
	15	-	-	-	-	5	-	5	5	10	25	50
	20	-	-	-	-	5	-	5	10	15	30	65
	25	-	-	-	5	-	-	5	10	20	40	80
	30	-	-	-	5	-	5	5	15	25	45	100
	35	-	-	-	5	-	5	10	20	30	45	115
	40	-	-	5	-	-	5	15	25	40	45	135
	45	-	-	5	-	5	5	20	25	40	50	150
	50	-	-	5	-	5	10	20	35	45	50	170
	55	-	5	-	-	5	15	25	40	45	50	185
	60	-	5	-	5	5	20	30	40	45	50	200
	65	-	5	-	5	10	25	35	40	45	50	215
	70	5	-	-	5	15	30	40	45	45	50	235

Table 14 - Mod: Surface Decompression - Air Stops (Continued)

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) STOPS AT DIFFERENT DEPTHS (min)										(4) TOTAL TIME FOR CHAMBER DECOMPR-ESSION (min)
		30m	27m	24m	21m	18m	15m	12m	9m	6m	3m	
51	5 Limiting Line	-	-	-	-	-	5	-	5	5	15	30
	10	-	-	-	-	-	5	-	5	10	25	45
	15	-	-	-	-	5	-	5	5	15	30	60
	20	-	-	-	-	5	-	5	10	20	35	75
	25	-	-	-	5	-	5	5	15	25	35	90
	30	-	-	-	5	-	5	10	20	30	40	110
	35	-	-	5	-	5	5	10	25	35	45	130
	40	-	-	5	-	5	5	15	30	40	50	150
	45	-	5	-	-	5	10	20	35	45	50	170
	50	-	5	-	5	5	15	25	35	45	50	185
	55	-	5	-	5	10	15	30	40	45	50	200
	60	5	-	-	5	15	20	35	45	45	50	220
	65	5	-	5	5	20	25	40	45	45	50	240
54	5 Limiting Line	-	-	-	-	-	5	-	5	10	15	35
	10	-	-	-	-	5	-	5	5	10	25	50
	15	-	-	-	-	5	-	5	10	15	35	70
	20	-	-	-	5	-	5	5	15	20	40	90
	25	-	-	-	5	-	5	10	20	25	45	110
	30	-	-	5	-	5	5	10	25	35	45	130
	35	-	-	5	-	5	5	15	30	40	50	150
	40	-	5	-	-	5	10	20	35	45	50	170
	45	-	5	-	5	5	15	25	40	45	50	190
	50	-	5	-	5	10	20	30	40	45	50	205
	55	5	-	-	5	15	25	35	45	45	50	225
	60	5	-	5	5	20	30	40	45	45	50	245
57	5 Limiting Line	-	-	-	-	-	5	-	5	10	20	40
	10	-	-	-	-	5	-	5	5	15	25	55
	15	-	-	-	-	5	5	5	10	20	35	80
	20	-	-	-	5	-	5	5	15	30	45	105
	25	-	-	5	-	5	5	10	20	35	45	125
	30	-	-	5	-	5	5	15	25	40	50	145
	35	-	5	-	-	5	10	20	30	45	50	165
	40	-	5	-	5	5	15	25	35	45	50	185
	45	-	5	-	5	10	20	30	40	45	50	205
	50	5	-	5	5	10	25	35	45	45	50	225
	55	5	-	5	10	15	30	40	45	45	50	245

Table 14 - Mod: Surface Decompression - Air Stops (Continued)

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) STOPS AT DIFFERENT DEPTHS (min)										(4) TOTAL TIME FOR CHAMBER DECOMPRESSION (min)
		30m	**27m**	**24m**	**21m**	**18m**	**15m**	**12m**	**9m**	**6m**	**3m**	
	Limiting Line											
	5	-	-	-	-	5	-	5	5	10	20	45
	10	-	-	-	-	5	-	5	10	15	30	65
60	15	-	-	-	5	-	5	5	15	20	40	90
	20	-	-	-	5	-	5	10	20	30	45	115
	25	-	-	5	-	5	5	15	25	40	45	140
	30	-	-	5	-	5	10	20	30	45	50	165
	35	-	5	-	5	5	15	25	35	45	50	185
	40	-	5	-	5	10	20	30	40	45	50	205
	45	5	-	5	5	10	25	35	45	45	50	225
	50	5	-	5	10	15	30	40	45	45	50	245

1255. Table 15 - Mod: Surface Decompression - Air-Oxygen Stops

a. Table 15 - Mod is employed when carrying out surface decompression below a depth of 36m, which calls for both air and oxygen stops.

b. The table is applied as described in para 1254, except that the 1 minute taken to decompress from 'chamber bottom' to the first stop is NOT included in the first stop when this is an oxygen stop, column 6 has been incremented accordingly. When carrying out oxygen stops the timing of the first oxygen stop starts when the diver actually starts breathing oxygen, not when he leaves the previous stop (para 1251c(4)). Particular attention is drawn to para 1254e and f which give the procedure should the 5 minute surface interval be exceeded.

Table 15 - Mod: Surface Decompression - Air-Oxygen Stops

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	STOPS AT DIFFERENT DEPTHS (min)								(5) TOTAL DURATION OF PERIOD OF OXYGEN BREATHING (min)	(6) TOTAL TIME FOR CHAMBER DECOMPRESSION (min)
		(3) BREATHING AIR		(4) BREATHING OXYGEN							
		24m	21m	18m	15m	12m	9m	6m	3m		
	12	-	-	-	-	-	-	-	-	-	-
	15	-	5	-	-	1	4	5	6	16	22
	20	-	5	-	-	2	4	6	7	19	25
	25	-	5	-	-	3	5	7	9	24	30
	30	-	5	-	-	4	6	10	11	31	37
36	35		5	-	-	5	7	10	13	35	41
	Limiting Line										
	40	-	5	-	-	5	7	12	15	39	45
	45	-	5	-	-	5	9	13	16	43	49
	50	-	5	-	-	9	10	17	20	56	62
	70	-	5	-	-	10	13	20	27	70	76
	90	-	5	-	-	11	19	23	31	84	90
	8	-	-	-	-	-	-	-	-	-	-
	10	-	5	-	-	2	3	5	6	16	22
	15	-	5	-	-	3	3	6	7	19	25
	20	5	-	-	1	3	5	7	9	25	31
	25	5	-	-	2	4	6	8	11	31	37
	30	5	-	-	2	5	6	10	13	36	42
39	Limiting Line										
	35	5	-	-	2	6	7	11	14	40	46
	40	5	-	-	3	6	8	12	15	44	50
	45	5	-	-	3	7	8	14	16	48	54
	50	5	-	-	6	8	10	18	23	65	71
	70	5	-	-	7	10	15	21	28	81	87
	90	5	-	-	9	10	18	27	31	95	101

Table 15 - Mod: Surface Decompression - Air Stops (Continued)

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	STOPS AT DIFFERENT DEPTHS (min) (3) BREATHING AIR 27m	24m	21m	(4) BREATHING OXYGEN 18m	15m	12m	9m	6m	3m	(5) TOTAL DURATION OF PERIOD OF OXYGEN BREATHING (min)	(6) TOTAL TIME FOR CHAMBER DECOM-PRESSION (min)
42	7	-	-	-	-	-	-	-	-	-	-	-
	10	-	5	-	-	1	2	3	6	6	18	24
	15	-	5	-	-	1	3	3	7	7	21	27
	20	-	5	-	-	1	3	4	8	9	25	31
	25	-	5	-	-	3	5	7	9	12	36	42
	Limiting Line											
	30	-	5	-	-	4	5	8	11	13	41	47
	35	-	5	-	-	5	6	8	11	15	45	51
	40	-	5	-	-	5	7	8	13	16	49	55
	45	-	5	-	-	5	7	9	14	16	51	57
	50	-	5	-	-	8	9	12	20	26	75	81
	70	-	5	-	-	10	11	17	24	31	93	99
45	6	-	-	-	-	-	-	-	-	-	-	-
	10	-	5	-	-	2	2	4	6	7	21	27
	15	-	5	-	-	2	3	4	7	8	24	30
	20	5	-	-	1	3	4	6	8	11	33	39
	Limiting Line											
	25	5	-	-	2	4	5	8	9	13	41	47
	30	5	-	-	3	4	6	8	11	14	46	52
	35	5	-	-	3	5	6	9	12	15	50	56
	40	5	-	-	3	5	7	9	14	17	55	61
	45	5	-	-	3	5	8	10	15	19	60	66
	50	5	-	-	5	8	10	14	20	26	83	89
48	5	-	5	-	-	2	2	3	4	8	19	25
	10	-	5	-	-	2	3	4	6	8	23	29
	15	5	-	-	1	2	3	4	8	8	26	32
	20	5	-	-	2	3	4	7	8	11	35	41
	Limiting Line											
	25	5	-	-	4	4	5	9	10	14	46	52
	30	5	-	-	4	5	6	9	11	15	50	56
	35	5	-	-	4	5	7	9	14	15	54	60
	40	5	-	-	4	6	7	10	16	18	61	67
	45	5	-	-	5	6	8	11	17	21	68	74
	50	5	-	-	6	8	10	16	20	24	84	90

Table 15 - Mod: Surface Decompression - Air Stops (Continued)

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	STOPS AT DIFFERENT DEPTHS (min) (3) BREATHING AIR					(4) BREATHING OXYGEN						(5) TOTAL DURATION OF PERIOD OF OXYGEN BREATHING (min)	(6) TOTAL TIME FOR CHAMBER DECOM-PRESSION (min)
		33m	30m	27m	24m	21m	18m	15m	12m	9m	6m	3m		
51	5	-	-	5	-	-	1	2	2	3	6	7	21	27
	10	-	-	5	-	-	1	3	3	4	7	8	26	32
	15	-	-	5	-	-	2	4	4	6	8	10	34	40
	Limiting Line													
	20	-	-	5	-	-	3	5	6	7	10	13	44	50
	25	-	5	-	-	1	4	5	6	9	11	14	49	55
	30	-	5	-	-	1	4	6	6	10	13	15	54	60
	35	-	5	-	-	1	4	6	7	10	15	17	59	65
	40	-	5	-	-	1	5	7	7	11	16	20	66	72
	45	-	5	-	-	2	6	7	9	12	18	22	74	81
	50	-	5	-	-	3	7	9	11	17	24	30	98	106
54	5	-	-	5	-	-	2	2	2	3	6	7	22	28
	10	-	5	-	-	1	2	2	3	4	7	10	28	34
	15	-	5	-	-	1	3	4	4	6	9	12	38	44
	Limiting Line													
	20	-	5	-	-	1	5	5	6	8	11	13	48	54
	25	-	5	-	-	2	5	5	6	9	12	14	51	58
	30	-	5	-	-	2	5	6	7	10	14	16	58	65
	35	-	5	-	-	2	6	7	7	11	16	17	64	71
	40	5	-	-	1	2	6	8	9	12	17	21	73	81
	45	5	-	-	2	2	7	7	9	14	18	25	80	89
57	5	-	5	-	-	1	2	2	2	3	7	7	23	29
	10	-	5	-	-	1	2	3	3	4	7	11	30	36
	Limiting Line													
	15	-	5	-	-	2	3	4	4	6	9	15	41	48
	20	-	5	-	-	2	5	5	6	8	12	15	51	58
	25	-	5	-	-	3	5	5	7	9	14	16	56	64
	30	-	5	-	-	3	6	6	7	10	16	18	63	71
	35	-	5	-	-	4	6	8	7	11	18	19	69	78
	40	-	5	-	-	4	6	8	8	14	18	24	78	87
	45	5	-	-	2	3	7	8	9	16	19	28	87	97
60	5	-	5	-	-	1	2	2	3	3	7	8	25	31
	10	-	5	-	-	2	2	3	4	5	8	10	32	39
	Limiting Line													
	15	5	-	-	1	2	4	4	6	7	11	12	44	52
	20	5	-	-	1	3	5	6	7	8	14	15	55	64
	25	5	-	-	2	3	5	6	8	9	15	17	60	70
	30	5	-	-	2	3	6	7	9	11	16	20	69	79
	35	5	-	-	2	4	7	8	9	13	17	22	76	87
	40	5	-	-	2	5	7	8	10	15	20	26	86	98
	45	5	-	-	2	5	7	8	11	16	24	29	95	107

1256. SETT AIR TABLE

a. The SETT Air Table is employed at the Submarine Escape Training Tank (SETT) to optimise Submarine Escape Training.

b. The following restrictions are to be strictly adhered to:

(1) The SETT Dive Table should only be used for SETT training activities within the SETT tower. All other air diving in the SETT tower (SABA, RABA, E&RE and maintenance) is to be conducted using Table 11 Mod.

(2) The SETT Dive Table is to be restricted to a maximum depth of 30 metres.

(3) Dive times are to be from leaving surface to return to surface.

(4) The SETT Dive Table is to be restricted with regard to depth time limits. If a dive duration exceeds those contained within the SETT Dive Table decompression must be in accordance with Table 11 Mod.

SETT AIR TABLE

(1) Depth Not Exceeding (metres)	(2) Duration Time Leaving Surface to Return to Surface Not Exceeding	(3) Stops at 3 Metres (Minutes)	(4) Total Time for Decompression (Minutes)
9	No Limit	-	-
12	135	-	-
	165	5	5
15	85	-	-
	105	5	5
18	60	-	-
	70	5	5
21	40	-	-
	55	5	5
24	30	-	-
	40	5	5
27	25	-	-
	30	5	5
30	20	-	-
	25	5	5

SECTION 6 - CDBA O_2/He DIVING TABLES

1260. Use of Tables

a. These CDBA interim decompression Tables, have been produced by the DERA Alverstoke. The Tables based on reputable American and Canadian sources are of an Interim nature until 1.3 Bar RN tables are developed specifically for CDBA.

b. It should be noted that due to the intrinsic safety of the individual original American and Canadian tables, the interim Tables do not necessarily appear logical, eg there is no reduction in decompression duration when conducting oxygen stops, in fact the stops may be increased.

c. The following Tables are provided:

(1) *For use when using Air as the CDBA Diluent maximum of depth of 30m:*

Table A - Equivalent Air Depth (EAD) to be used in conjunction with RN Tables 11 Mod, 14 Mod & 15 Mod.

(2) *For use with oxygen in helium gas (O_2/He) mixtures to a maximum depth of 80m*:

Primary GAS	Table B	-	Primary Breathing System - In water decompression.
Primary GAS	Table C	-	Primary Breathing System - In water O_2 decompression for use with the XBS and surface decompression with O_2 for use with the XBS.
Open Circuit GAS	Table D	-	Open Circuit System - In water decompression with Oxygen for use with the XBS and surface decompression with O_2 for use with the XBS.
Emergency	Table E	-	Emergency in water O_2/He decompression.

1261. Loss of Constant Partial Pressure of Oxygen (Primary to Open Circuit) Descent or Bottom Phase

Should the constant partial pressure of inspired oxygen not be maintained by the primary system and the diver is required to switch to open circuit during the dive, the diver is to ascend as follows:

a. Transfer to open circuit while conducting a dive not requiring decompression stops and the maximum depth of the descent is 42m or shallower, the diver may ascend directly to the surface at a controlled rate of ascent, providing ascent begins within 1 minute of transfer to open circuit. If ascent cannot commence within 1 minute of transfer to open circuit, the diver is to be surfaced in accordance with table D.

b. Transfer to open circuit while conducting a descent deeper than 42m or whilst conducting a dive, irrespective of depth, that requires decompression stops, the diver is to be surfaced using Table D.

1262. Loss of Constant Partial Pressure of Oxygen During (Primary to Open Circuit) Decompression Phase

a. If the loss of constant partial pressure of inspired oxygen occurs during the decompression phase, the diver is to be transferred directly to the open circuit decompression schedules, Table D for in water or surface decompression, for the maximum depth and duration of the dive. When transferring between Tables B and D the Tables D stop time is to commence at the depth of transfer, irrespective of any decompression already completed on Table B at the transfer depth. Decompression stops detailed in Table D deeper than the depth of transfer may be disregarded in this instance and do not constitute omitted decompression.

b. If the depth of transfer to open circuit is 12m or shallower, Table B decompression stops may be continued only if the diver can be transferred to XBS O_2 within 2 minutes. If the diver cannot be transferred to XBS O_2 within 2 minutes then the decompression stops in accordance with Table D are to be followed.

c. If the depth of transfer to open circuit is 12m or shallower, the diver must stay at the transfer depth for the time given for the 12m decompression stop in Table D. The diver must breathe oxygen during this stop.

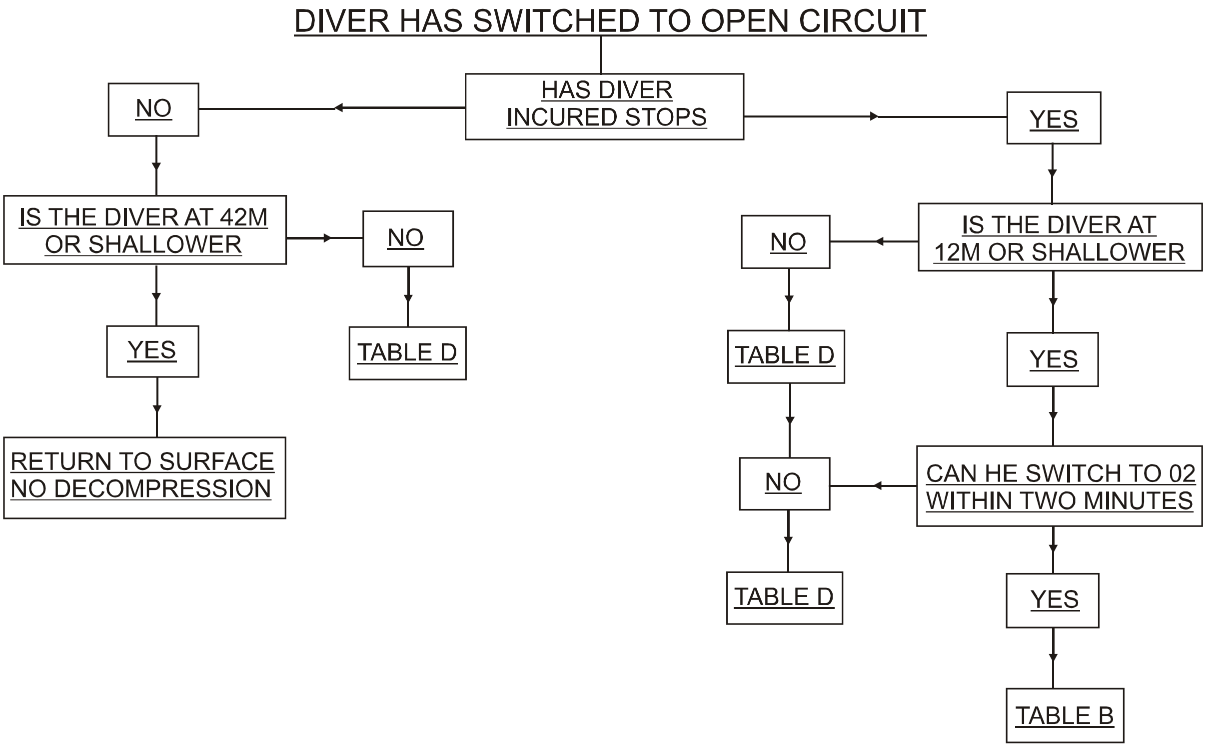


Fig 12-3. Open Circuit Flow Diagram

1263. Alternating Between 'In Water' and 'Surface Decompression' on Table D

a. After switching to secondary, due to the inherent safety factors built into the original American and Canadian Tables, the diver is required to spend considerable time decompressing in the water if in the water section is used in total. After the emergency switch to the open circuit system has stabilised on Table D, consideration should be given to surfacing the diver on Surface Decompression, if the requirements of para 1247,1248 and 1249 are satisfied. Providing the diver has completed the minimum stop duration as required by column 6 at 12m the diver can be surfaced and procedures for Surface Decompression followed.

b. Time spent in the water in excess of the surface decompression requirements of at 12m is to be considered as dead time. Once the diver has been compressed in the chamber to 12m 'Chamber Bottom' the stop time is not to be reduced in anyway irrespective of the time spent at 12m in the water.

c. If for any reason surface decompression has to be cancelled whilst the diver is still completing the wet phase of his stops he is to be transferred directly to 'wet stops' and surfaced according to his maximum depth and duration.

(1) *Example 1.* A diver conducts a dive to 74m for 13 minutes, he decompresses in accordance with Table B and conducts stops for 15 minutes at 75m. If on leaving his 24m stop the diver is required to switch to his secondary system, the supervisor automatically switches the diver to Table D for the identical dive profile followed for Table B, (or the next greater time increment if the actual bottom time is not detailed), and commences stoppage times for that Table commencing with 7 minutes at 21m.

It can be seen on Table D that the diver will be required to conduct wet stops of 7 min @ 21m, 7 min @ 18m, 10 min @ 15m - O_2 and 70 min @ 12m - O_2. If these stops are compared with the stops required on surface decompression section of Table D, it can be noted that the stops are identical until 12m. If the requirements of para 1247, 1248 and 1249 are satisfied, and surface decompression drills are well practised, a switch to surface decompression, to conduct surface decompression, is authorised providing that the required stoppage time at 12m in accordance with column 6 of Table D has been completed. If the diver conduct surface decompression after a period in excess of the 12m stoppage time in accordance with Table D the excess is to be considered 'dead time' and disregarded at this stage for decompression purposes.

(2) *Example 2.* A diver conducts a dive to 69m for 14 minutes, he should decompress in accordance with Table B and conduct stops for 15 minutes at 69m (total stoppage time of 64 minutes). If on leaving the seabed the diver is required to switch to his open circuit system, the supervisor automatically switches the diver to Table D and the diver commences stops times for that Table (total stoppage time of 99 minutes). If the requirements of paras 1247, 1248 and 1249 are satisfied, and surface decompression drills are well practised, a switch to surface decompression, is authorised providing that the required stoppage time at 12m in accordance with column 6 of Table D is completed. If the diver conducts surface decompression after a period in excess of the 12m stoppage time in accordance with column 6 the excess is to be considered 'dead time' and disregarded at this stage for decompression purposes.

(3) *Example 3.* If a diver is breathing from his secondary system and the supervisor has switched the diver from wet stops to surface decompression the surface decompression has to be aborted, for whatever reason, providing the diver is still completing his wet stops the supervisor can revert directly back to wet stop section without decompression penalties. If the surface decompression has to be aborted in between the diver leaving his 12m wet stop and arriving at the 'Chamber Bottom' of 12m, action in accordance with omitted decompression, para 1215, is to be instigated.

1264. Table E

Table E is an O_2He long duration table for Emergency use if all other in water tables are unsuitable, for what ever reason. eg If a diver is conducting oxygen stops in accordance with Table C and the XBS O_2 supply fails or if the diver shows signs of O_2 toxicity poisoning, the diver is to revert to primary system or secondary O_2He and conduct stops in accordance with Table E, para 1253(4). Because of the length of time spent in the water conducting Table E consideration must be given to the divers gas supplies and physical well being.

TABLE A
MCM/EOD LSE EQUIVALENT AIR DEPTH
OXYGEN IN NITROGEN

DEPTH OF DIVE NOT EXCEEDING (m)	EQUIVALENT AIR DEPTH (m)
15	9
18	12
21	15
24	21
27	24
30	27
33	30

TABLE B MCM/EOD LSE PRIMARY IN WATER DECOMPRESSION Constant partial pressure of oxygen in helium				
(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) STOPS AT DIFFERENT DEPTHS (min)		(4) TOTAL TIME FOR DECOMPRESSION (min)
		9m	6m	
12	No limit	-	-	1
15	205	-	-	1
	210	-	3	4
	220	-	9	10
	230	-	15	16
18	133	-	-	2
	140	-	8	10
	150	-	20	22
	160	-	30	32
	170	-	40	42
	Limiting Line			
	180	-	50	52
	190	-	59	61
21	81	-	-	2
	90	-	6	8
	100	-	13	15
	110	-	19	21
	120	-	35	37
	130	-	50	52
	140	-	65	67
	Limiting Line			
	150	-	79	81
	160	-	92	94
24	51	-	-	2
	60	-	6	8
	70	-	14	16
	80	-	25	27
	90	-	33	35
	100	-	46	48
	110	-	67	69
	120	-	86	88
	Limiting Line			
	130	-	104	106
	140	-	122	124
27	37	-	-	2
	40	-	4	6
	50	-	15	17
	60	-	24	26
	70	-	38	40
	80	-	50	52
	90	-	65	67
	100	-	91	93
	110	1	114	117
	120	7	130	139

TABLE B MCM/EOD LSE PRIMARY IN WATER DECOMPRESSION Constant partial pressure of oxygen in helium						
(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) STOPS AT DIFFERENT DEPTHS (min)				(4) TOTAL TIME FOR DECOMPRESSION (min)
		15m	12m	9m	6m	
30	29	-	-	-	-	2
	30	-	-	-	2	4
	35	-	-	-	11	13
	40	-	-	-	19	21
	50	-	-	-	32	34
	60	-	-	-	45	47
	70	-	-	3	59	64
	80	-	-	7	70	79
	90	-	-	12	95	109
	100	-	-	21	114	137
	110	-	-	30	133	165
33	22	-	-	-	-	3
	25	-	-	-	3	6
	30	-	-	-	14	17
	35	-	-	-	25	28
	40	-	-	-	34	37
	50	-	-	4	44	51
	60	-	-	14	53	70
	70	-	-	21	64	88
	80	-	4	22	91	120
	90	-	8	30	113	154
36	18	-	-	-	-	3
	20	-	-	-	3	6
	25	-	-	-	13	16
	30	-	-	-	27	30
	35	-	-	-	38	41
	40	-		5	43	51
	50	-	-	20	45	68
	60	-	9	22	58	92
	70	-	17	22	83	125
	80	1	22	28	109	163
39	13	-	-	-	-	3
	15	-	-	-	1	4
	20	-	-	-	9	12
	25	-	-	-	24	27
	30	-	-	3	36	42
	35	-	-	8	44	55
	40	-	1	18	44	66
	50	-	14	22	48	87
	60	5	22	21	72	123
	70	13	22	23	106	167
	80	19	22	35	129	208

TABLE B MCM/EOD LSE PRIMARY IN WATER DECOMPRESSION Constant partial pressure of oxygen in helium								
(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) STOPS AT DIFFERENT DEPTHS (min)						(4) TOTAL TIME FOR DECOMPRESSION (min)
		21m	18m	15m	12m	9m	6m	
42	11	-	-	-	-	-	-	3
	15	-	-	-	-	-	4	7
	20	-	-	-	-	-	15	18
	25	-	-	-	-	5	30	38
	30	-	-	-	1	10	41	55
	35	-	-	-	6	16	44	69
	40	-	-	-	12	22	44	81
	50	-	-	9	22	21	54	109
	60	-	-	22	22	22	93	162
	70	-	9	22	22	28	128	212
45	9	-	-	-	-	-	-	3
	10	-	-	-	-	-	1	4
	15	-	-	-	-	-	9	12
	20	-	-	-	-	3	21	27
	25	-	-	-	2	10	34	49
	30	-	-	-	9	11	44	67
	35	-	-	4	10	22	43	82
	40	-	-	7	20	21	44	95
	45	-	-	16	21	22	51	113
	50	-	3	22	22	22	74	146
	55	-	11	22	21	22	98	177
	60	-	17	22	22	25	120	206
48	8	-	-	-	-	-	-	4
	10	-	-	-	-	-	3	7
	15	-	-	-	-	2	12	18
	20	-	-	-	2	7	25	38
	25	-	-	-	9	9	39	61
	30	-	-	7	9	17	43	80
	35	-	2	9	16	22	44	97
	40	-	5	14	22	22	46	113
	45	-	9	22	22	22	72	151
	50	-	19	22	22	22	98	187
	55	6	21	22	22	22	124	221
51	7	-	-	-	-	-	-	4
	10	-	-	-	-	-	5	9
	15	-	-	-	1	4	14	23
	20	-	-	1	5	9	28	47
	25	-	-	6	10	9	43	72
	30	-	4	10	9	22	44	93
	35	-	10	9	22	22	43	110
	40	4	9	21	22	22	67	149
	45	7	17	22	22	22	96	190
	50	13	22	22	22	22	125	230

TABLE B
MCM/EOD LSE PRIMARY IN WATER DECOMPRESSION
Constant partial pressure of oxygen in helium

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) STOPS AT DIFFERENT DEPTHS (min)									(4) TOTAL TIME FOR DECOMPRESSION (min)
		30m	27m	24m	21m	18m	15m	12m	9m	6m	
54	7	-	-	-	-	-	-	-	-	-	4
	10	-	-	-	-	-	-	-	-	7	11
	15	-	-	-	-	-	-	4	4	16	28
	20	-	-	-	-	1	4	6	10	32	57
	25	-	-	-	-	4	9	9	13	44	83
	30	-	-	-	2	10	9	15	21	44	105
	35	-	-	-	8	9	15	22	22	58	138
	40	-	-	3	9	14	22	22	22	90	186
	50	-	-	5	13	22	22	22	21	123	232
57	6	-	-	-	-	-	-	-	-	-	4
	10	-	-	-	-	-	-	-	2	7	13
	15	-	-	-	-	-	3	4	4	18	33
	20	-	-	-	-	4	4	9	10	35	66
	25	-	-	-	2	8	10	9	17	44	94
	30	-	-	-	9	10	9	20	22	43	117
	35	-	-	6	9	10	21	22	22	79	173
	40	-	1	9	10	21	22	22	21	116	226
60	6	-	-	-	-	-	-	-	-	-	4
	10	-	-	-	-	-	-	1	3	8	16
	15	-	-	-	-	2	4	4	6	21	41
	20	-	-	-	3	4	7	9	10	38	75
	25	-	-	2	6	9	9	10	21	44	105
	30	-	-	7	10	9	12	22	22	64	150
	35	-	4	10	9	15	21	22	22	103	210
63	5	-	-	-	-	-	-	-	-	-	5
	10	-	-	-	-	-	-	3	3	9	20
	15	-	-	-	1	4	4	3	9	23	49
	20	-	-	3	3	5	9	9	9	43	86
	25	-	1	4	9	10	9	13	22	44	117
	30	-	5	9	10	9	18	21	22	85	184
	35	3	9	9	9	21	22	22	22	128	250
66	5	-	-	-	-	-	-	-	-	-	5
	10	-	-	-	-	-	1	4	4	9	23
	15	-	-	-	4	4	3	5	10	26	57
	20	-	2	4	3	8	9	9	11	44	95
	25	1	4	7	9	9	9	18	22	60	144
	30	3	9	9	10	10	22	22	21	107	218

TABLE B
MCM/EOD LSE PRIMARY IN WATER DECOMPRESSION
Constant partial pressure of oxygen in helium

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) STOP AT DIFFERENT DEPTHS (min)													(4) TOTAL TIME FOR DECOMPRESSION (min)
		42m	39m	36m	33m	30m	27m	24m	21m	18m	15m	12m	9m	6m	
69	5	-	-	-	-	-	-	-	-	-	-	-	-	-	5
	10	-	-	-	-	-	-	-	-	-	3	4	4	11	27
	15	-	-	-	-	-	-	3	4	3	4	7	9	29	64
	20	-	-	-	-	1	4	4	4	9	10	9	15	43	104
	25	-	-	-	-	4	5	9	10	9	9	22	22	79	175
	30	-	-	-	2	8	9	10	9	15	22	22	22	132	256
72	5	-	-	-	-	-	-	-	-	-	-	-	-	-	5
	10	-	-	-	-	-	-	-	-	2	3	4	4	12	30
	15	-	-	-	-	-	2	4	3	4	4	9	9	32	72
	20	-	-	-	1	3	4	4	7	9	10	9	18	45	115
	25	-	-	-	4	3	9	9	9	9	14	22	21	101	206
	30	-	-	1	7	9	9	10	9	20	22	22	22	155	291
75	5	-	-	-	-	-	-	-	-	-	-	-	-	1	6
	10	-	-	-	-	-	-	-	-	4	4	3	4	14	34
	15	-	-	-	-	1	4	3	4	4	6	9	9	35	80
	20	-	-	-	3	4	4	5	9	9	9	10	21	62	141
	25	-	-	3	4	6	9	9	10	9	18	21	22	124	240
78	5	-	-	-	-	-	-	-	-	-	-	-	-	2	8
	10	-	-	-	-	-	-	-	2	4	4	3	4	16	39
	15	-	-	-	-	3	4	4	4	3	8	10	9	38	89
	20	-	-	3	3	4	4	7	10	9	9	13	22	80	170
	25	-	2	4	4	9	10	9	9	9	22	22	22	145	273
81	5	-	-	-	-	-	-	-	-	-	-	-	-	3	9
	10	-	-	-	-	-	-	1	3	4	4	3	4	17	42
	15	-	-	-	2	4	4	4	3	5	9	9	10	41	97
	20	-	2	4	3	4	5	9	9	10	9	17	22	99	199
	25	2	4	3	8	9	9	9	10	13	22	22	22	169	308
84	5	-	-	-	-	-	-	-	-	-	-	-	-	5	11
	10	-	-	-	-	-	-	3	3	4	4	4	3	19	46
	15	-	-	1	4	4	4	3	4	7	9	9	12	43	106
	20	1	4	4	3	4	8	9	9	9	10	21	22	120	230

TABLE C
MCM/EOD LSE PRIMARY : IN-WATER OXYGEN DECOMPRESSION AND SURFACE DECOMPRESSION
Constant partial pressure of oxygen in helium

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) OXYGEN-HELIUM WET STOPS (min)				IN WATER DECOMPRESSION		SURFACE DECOMPRESSION			
		21 m	18 m	15 m	12 m	(4) IN WATER OXYGEN (min) 9 m	(5) TOTAL TIME FOR DECOMPRESSION (min)	(6) IN WATER OXYGEN (min) 9 m	Time from leaving the 9 m stop to reaching the 12 m chamber stop must not exceed 5 min	(7) CHAMBER OXYGEN (min) 12 m	(8) TOTAL TIME FOR DECOMPRESSION (min)
30	29	-	-	-	-	**-**	**2**	-		-	2
	35	-	-	-	3	**32**	**37**	8		26	45
	40	-	-	-	3	**36**	**41**	8		30*	49
	45	-	-	-	3	**40**	**45**	8		34*	58
	Limiting Line										
	50	-	-	-	3	**45**	**50**	8		41*	65
	55	-	-	-	3	**51**	**56**	13		44*	73
	60	-	-	-	3	**59**	**64**	13		51*	80
	65	-	-	-	3	**66**	**71**	14		56*	86
33	22	-	-	-	-	**-**	**3**	-		-	3
	25	-	-	-	3	**27**	**33**	8		21	40
	30	-	-	-	3	**32**	**38**	8		26	45
	35	-	-	-	3	**37**	**43**	8		30*	49
	40	-	-	-	3	**43**	**49**	8		37*	61
	Limiting Line										
	45	-	-	-	3	**48**	**54**	13		40*	69
	50	-	-	-	4	**57**	**64**	13		49*	79
	55	-	-	-	4	**65**	**72**	15		55*	87
	60	-	-	3	5	**74**	**85**	15		60**	96
36	18	-	-	-	-	**-**	**3**	-		-	3
	20	-	-	-	3	**25**	**31**	8		18	37
	25	-	-	-	3	**31**	**37**	8		25	44
	30	-	-	-	4	**37**	**44**	8		30*	50
	35	-	-	3	2	**44**	**52**	13		31*	62
	40	-	-	3	3	**50**	**59**	13		43*	75
	Limiting Line										
	45	-	-	3	3	**60**	**69**	14		52*	85
	50	-	-	3	7	**70**	**83**	15		59*	97
39	13	-	-	-	-	**-**	**3**	-		-	3
	15	-	-	-	3	**22**	**28**	8		15	34
	20	-	-	-	3	**29**	**35**	8		22	41
	25	-	-	3	2	**36**	**44**	8		30*	51
	30	-	-	3	3	**42**	**51**	13		30*	57
	35	-	-	3	4	**50**	**60**	13		42*	75
	Limiting Line										
	40	-	-	4	4	**61**	**72**	14		53*	88
	45	-	3	2	9	**72**	**89**	14		60**	101
	50	-	3	3	11	**80**	**100**	15		63**	113

Note: asterisk(*) indicates the number of 5 minute air breaks required.
An air break is to be taken after every 30 minutes on oxygen

TABLE C

MCM/EOD LSE PRIMARY : IN-WATER OXYGEN DECOMPRESSION AND SURFACE DECOMPRESSION

Constant partial pressure of oxygen in helium

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) OXYGEN-HELIUM WET STOPS (min)					IN WATER DECOMPRESSION		SURFACE DECOMPRESSION			
							(4) IN WATER OXYGEN (min)	(5) TOTAL TIME FOR DECOMP-RESSION (min)	(6) IN WATER OXYGEN (min)	Time from leaving the 9 m stop to reaching the 12 m chamber stop must not exceed 5 min	(7) CHAMBER OXYGEN (min)	(8) TOTAL TIME FOR DECOMP-RESSION (min)
		24 m	21 m	18 m	15 m	12 m	9 m		9 m		12 m	
42	11	-	-	-	-	-	**-**	**3**	-		-	3
	15	-	-	-	-	3	**24**	**30**	8		17	37
	20	-	-	-	3	2	**32**	**40**	8		26	48
	25	-	-	-	3	4	**40**	**50**	8		30*	54
	30	-	-	3	2	3	**48**	**59**	13		40*	75
	Limiting Line											
	35	-	-	3	3	5	**60**	**74**	14		52*	91
	40	-	-	3	3	9	**71**	**89**	14		60**	103
	45	-	-	3	4	12	**80**	**102**	15		63**	116
45	9	-	-	-	-	-	**-**	**3**	-		-	3
	15	-	-	-	3	2	**27**	**35**	8		20	42
	20	-	-	-	3	4	**35**	**45**	8		29	53
	25	-	-	3	2	4	**45**	**57**	13		33*	69
	30	-	-	3	3	4	**55**	**68**	14		47*	85
	Limiting Line											
	35	-	3	2	3	9	**69**	**89**	14		60**	105
	40	-	3	2	4	12	**80**	**104**	15		63**	118
	45	-	3	3	7	12	**88**	**116**	17		69**	130
48	8	-	-	-	-	-	**-**	**4**	-		-	4
	10	-	-	-	-	3	**19**	**26**	8		12	32
	15	-	-	-	3	3	**30**	**40**	8		23	46
	20	-	-	3	2	4	**39**	**52**	8		30*	56
	25	-	3	2	2	4	**50**	**65**	13		42*	80
	Limiting Line											
	30	-	3	2	4	7	**65**	**85**	14		56*	100
	35	-	3	3	4	11	**77**	**102**	14		61**	115
	40	3	2	3	7	12	**88**	**119**	16		70**	132
51	7	-	-	-	-	-	**-**	**4**	-		-	4
	10	-	-	-	-	3	**21**	**28**	8		14	34
	15	-	-	3	2	3	**33**	**45**	8		26	51
	20	-	-	4	3	3	**43**	**57**	13		30*	62
	25	-	3	2	4	5	**56**	**74**	13		49*	90
	Limiting Line											
	30	3	2	2	4	10	**72**	**97**	14		60**	109
	35	3	2	3	6	12	**84**	**114**	16		67**	128
	40	3	3	3	10	13	**94**	**130**	18		74**	143

Note: asterisk(*) indicates the number of 5 minute air breaks required.
An air break is to be taken after every 30 minutes on oxygen

TABLE C
MCM/EOD LSE PRIMARY : IN-WATER OXYGEN DECOMPRESSION AND SURFACE DECOMPRESSION
Constant partial pressure of oxygen in helium

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) OXYGEN-HELIUM WET STOPS (min)								**IN WATER DECOMPRESSION** **(4) IN WATER OXYGEN (min)**	**(5) TOTAL TIME FOR DECOMP-RESSION (min)**	SURFACE DECOMPRESSION (6) IN WATER OXYGEN (min)	**Time from leaving the 9 m stop to reaching the 12 m chamber stop must not exceed 5 min**	(7) CHAMBER OXYGEN (min)	(8) TOTAL TIME FOR DECOMP-RESSION (min)
		33m	**30m**	**27m**	**24 m**	**21 m**	**18 m**	**15 m**	**12 m**	**9 m**		**9 m**		**12 m**	
	7	-	-	-	-	-	-	-	-	**-**	**4**	-		-	4
	10	-	-	-	-	-	-	3	2	**24**	**33**	8		17	39
	15	-	-	-	-	-	2	2	4	**35**	**47**	8		29	54
54	20	-	-	-	-	3	2	3	4	**47**	**63**	13		37*	76
	Limiting Line														
	25	-	-	-	3	2	2	4	7	**64**	**86**	14		55*	101
	30	-	-	-	3	3	3	5	11	**80**	**109**	15		63**	122
	35	-	-	3	2	2	4	8	13	**91**	**127**	17		72**	140
	6	-	-	-	-	-	-	-	-	**-**	**4**	-		-	4
	10	-	-	-	-	-	-	3	2	**26**	**35**	8		18	41
	15	-	-	-	-	2	2	2	4	**38**	**52**	8		30*	58
57	20	-	-	-	3	2	2	3	4	**52**	**70**	13		44*	86
	Limiting Line														
	25	-	-	-	3	3	3	3	10	**71**	**97**	14		60**	111
	30	-	-	3	2	2	4	7	12	**86**	**120**	16		68**	134
	35	-	-	3	3	3	4	11	14	**96**	**138**	18		76**	152
	6	-	-	-	-	-	-	-	-	**-**	**4**	-		-	4
	10	-	-	-	-	-	-	3	3	**27**	**37**	8		20	44
	15	-	-	-	-	3	2	2	4	**41**	**56**	13		30*	64
60	20	-	-	-	2	2	3	3	6	**57**	**77**	13		50*	94
	Limiting Line														
	25	-	-	3	2	2	4	4	11	**78**	**108**	15		61**	122
	30	-	3	2	2	3	3	9	13	**92**	**131**	17		73**	145
	5	-	-	-	-	-	-	-	-	**-**	**5**	-		-	5
	10	-	-	-	-	-	3	2	2	**30**	**42**	8		23	48
	15	-	-	-	3	2	2	2	3	**45**	**62**	13		34*	74
63	Limiting Line														
	20	-	-	2	2	2	3	3	8	**65**	**90**	14		56*	105
	25	-	3	2	2	2	4	6	12	**85**	**121**	16		67**	134
	30	-	3	2	3	3	5	10	14	**97**	**142**	18		76**	154
	5	-	-	-	-	-	-	-	-	**-**	**5**	-		-	5
	10	-	-	-	-	-	3	2	3	**31**	**44**	8		25	51
	15	-	-	-	3	2	2	3	3	**48**	**66**	13		39*	80
66	Limiting Line														
	20	-	-	3	2	2	3	3	10	**70**	**98**	14		60**	112
	25	-	2	2	3	3	2	9	12	**89**	**127**	17		70**	140
	30	3	2	2	3	3	7	11	16	**101**	**153**	23		76**	166

Note: asterisk(*) indicates the number of 5 minute air breaks required.
An air break is to be taken after every 30 minutes on oxygen

TABLE C

MCM/EOD LSE PRIMARY : IN-WATER OXYGEN DECOMPRESSION AND SURFACE DECOMPRESSION

Constant partial pressure of oxygen in helium

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) OXYGEN-HELIUM WET STOPS (min)										IN WATER DECOMPRESSION		SURFACE DECOMPRESSION			
												(4) IN WATER OXYGEN (min)	**(5) TOTAL TIME FOR DECOMP-RESSION (min)**	(6) IN WATER OXYGEN (min)	**Time from leaving the 9 m stop to reaching the 12 m chamber stop must not exceed 5 min**	(7) CHAMBER OXYGEN (min)	(8) TOTAL TIME FOR DECOMP-RESSION (min)
		39m	**36m**	**33m**	**30m**	**27m**	**24 m**	**21 m**	**18 m**	**15 m**	**12 m**	**9 m**		**9 m**		**12 m**	
	5	-	-	-	-	-	-	-	-	-	-	**-**	**5**	-		-	5
	10	-	-	-	-	-	-	3	2	2	3	**34**	**49**	8		27	55
	15	-	-	-	-	3	2	2	2	3	4	**52**	**73**	13		44*	88
69	Limiting Line																
	20	-	-	-	3	2	2	2	3	5	10	**78**	**110**	15		61**	123
	25	-	-	2	2	2	2	3	5	9	14	**94**	**138**	18		74**	151
	30	-	3	2	2	2	3	3	9	12	19	**105**	**165**	28		74**	177
	5	-	-	-	-	-	-	-	-	-	-	**-**	**5**	-		-	5
	10	-	-	-	-	-	-	3	2	2	3	**35**	**50**	8		29	58
72	15	-	-	-	-	3	2	2	3	2	6	**55**	**78**	13		49*	96
	Limiting Line																
	20	-	-	3	2	2	2	2	3	7	11	**84**	**121**	16		67**	136
	25	-	2	2	2	2	2	3	6	11	15	**99**	**149**	20		77**	163
	6	-	-	-	-	-	-	-	-	3	2	**21**	**31**	8		30*	54
	10	-	-	-	-	-	-	3	2	2	4	**37**	**53**	8		30*	60
75	Limiting Line																
	15	-	-	-	3	2	2	2	3	2	8	**63**	**90**	14		55*	107
	20	-	-	3	2	2	2	2	3	9	11	**88**	**127**	16		70**	141
	25	-	3	2	2	2	2	3	8	11	17	**102**	**157**	24		76**	171
	6	-	-	-	-	-	-	-	-	3	2	**23**	**34**	13		30*	59
	10	-	-	-	-	-	3	2	2	2	3	**40**	**58**	13		30*	66
78	Limiting Line																
	15	-	-	-	3	2	2	2	3	3	9	**67**	**97**	14		58*	112
	20	-	3	2	2	2	2	2	5	9	13	**93**	**139**	17		74**	152
	25	3	2	2	2	2	2	5	9	12	20	**105**	**170**	29		74**	183
	6	-	-	-	-	-	-	-	-	3	2	**24**	**35**	13		30*	59
	10	-	-	-	-	-	3	2	2	3	3	**42**	**61**	13		30*	67
81	Limiting Line																
	15	-	-	3	2	2	2	2	3	4	10	**74**	**108**	14		60**	118
	20	-	3	2	2	2	2	3	5	10	14	**96**	**145**	18		76**	158
	25	3	2	2	2	2	3	6	9	14	21	**107**	**177**	31		73**	189

Note: asterisk(*) indicates the number of 5 minute air breaks required.
An air break is to be taken after every 30 minutes on oxygen

TABLE D
MCM/EOD LSE OPEN CIRCUIT SYSTEM : IN-WATER OXYGEN DECOMPRESSION AND SURFACE DECOMPRESSION

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) OXYGEN-HELIUM WET STOPS (min)			IN WATER DECOMPRESSION		SURFACE DECOMPRESSION			
					(4) IN WATER OXYGEN (min)	**(5) TOTAL TIME FOR DECOMP-RESSION (min)**	(6) IN WATER OXYGEN (min)	**Time from leaving the 12 m chamber stop to reaching the 12 m stop must not exceed 5 min**	(7) CHAMBER OXYGEN (min)	(8) TOTAL TIME FOR DECOMP-RESSION (min)
		21 m	**18 m**	**15 m**	**12m**		**12m**		**12 m**	
15	60	-	-	-	**-**	**1**	-		-	1
	80	-	-	-	**6**	**7**	6		-	7
	100	-	-	-	**7**	**8**	7		-	8
	120	-	-	-	**9**	**10**	9		-	10
	240	-	-	-	**13**	**14**	13		-	14
18	10	-	-	-	**6**	**8**	6		-	8
	20	-	-	-	**7**	**9**	7		-	9
	30	-	-	-	**9**	**11**	9		-	11
	40	-	-	-	**10**	**12**	10		-	12
	60	-	-	-	**15**	**17**	10		10	32
	80	-	-	-	**17**	**19**	10		12	34
	100	-	-	-	**22**	**24**	10		17	39
	120	-	-	-	**25**	**27**	10		20	42
	140	-	-	-	**27**	**29**	10		22	44
	160	-	-	-	**29**	**31**	10		24	46
	200	-	-	-	**31**	**33**	10		30*	57
21	10	-	-	-	**6**	**8**	6		-	8
	20	-	-	-	**10**	**12**	10		-	12
	30	-	-	-	**13**	**15**	10		8	30
	40	-	-	-	**17**	**19**	10		12	34
	60	-	-	-	**24**	**26**	10		19	41
	80	-	-	-	**32**	**34**	10		30*	57
	100	-	-	-	**40**	**42**	10		35*	62
	120	-	-	-	**42**	**44**	10		37*	64
	140	-	-	-	**45**	**47**	10		40*	67
	160	-	-	-	**47**	**49**	10		42*	69
	200	-	-	-	**48**	**50**	10		43*	70
24	10	-	-	-	**8**	**10**	8		-	10
	20	-	-	-	**15**	**17**	10		10	32
	30	-	-	-	**18**	**20**	10		13	35
	40	-	-	-	**23**	**25**	10		18	40
	60	-	-	-	**35**	**37**	10		30*	57
	80	-	-	-	**45**	**47**	10		40*	67
	100	-	-	-	**50**	**52**	10		45*	72
	120	-	-	-	**55**	**57**	10		50*	77
	140	-	-	-	**58**	**60**	10		53*	80
	180	-	-	-	**60**	**62**	10		55*	82

Note: asterisk(*) indicates the number of 5 minute air breaks required.
An air break is to be taken after every 30 minutes on oxygen

TABLE D

MCM/EOD LSE OPEN CIRCUIT SYSTEM : IN-WATER OXYGEN DECOMPRESSION AND SURFACE DECOMPRESSION

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) OXYGEN-HELIUM WET STOPS (min)			IN WATER DECOMPRESSION		SURFACE DECOMPRESSION			
					(4) IN WATER OXYGEN (min)	(5) TOTAL TIME FOR DECOMP-RESSION (min)	(6) IN WATER OXYGEN (min)		(7) CHAMBER OXYGEN (min)	(8) TOTAL TIME FOR DECOMP-RESSION (min)
		21 m	18 m	15 m	12m		12m		12 m	
27	10	-	-	-	**10**	**12**	10	Time from leaving the 12 m stop to reaching the 12 m chamber stop must not exceed 5 min	-	12
	20	-	-	-	**17**	**19**	10		12	34
	30	-	-	-	**24**	**26**	10		19	41
	40	-	-	-	**31**	**33**	10		30*	57
	60	-	-	-	**47**	**49**	10		42*	69
	80	-	-	-	**56**	**58**	10		51*	78
	100	-	-	-	**63**	**65**	10		60**	92
	120	-	-	-	**67**	**69**	10		62**	94
	140	-	-	-	**70**	**72**	10		65**	97
30	10	-	-	-	**12**	**14**	10		7	30
	20	-	-	-	**21**	**23**	10		16	39
	30	-	-	-	**31**	**33**	10		30*	58
	40	-	-	-	**39**	**41**	10		34*	62
	60	-	-	-	**56**	**58**	10		51*	79
	80	-	-	-	**67**	**69**	10		62**	95
	100	-	-	-	**75**	**77**	10		70**	103
	120	-	-	-	**78**	**80**	10		73**	106
	140	-	-	-	**81**	**83**	10		76**	109
33	10	-	-	-	**14**	**17**	10		9	32
	20	-	-	-	**25**	**28**	10		20	43
	30	-	-	-	**36**	**39**	10		31*	59
	40	-	-	-	**47**	**50**	10		42*	70
	60	-	-	-	**66**	**69**	10		61**	94
	80	-	-	-	**77**	**80**	10		72**	105
	100	-	-	-	**84**	**87**	10		79**	112
	120	-	-	-	**87**	**90**	10		82**	115
36	10	-	-	-	**16**	**19**	10		11	34
	20	-	-	-	**29**	**32**	10		24	47
	30	-	-	-	**42**	**45**	10		37*	65
	40	-	-	-	**53**	**56**	10		48*	76
	60	-	-	-	**73**	**76**	10		68**	101
	80	-	-	-	**86**	**89**	10		81**	114
	100	-	-	-	**92**	**95**	10		90***	128

Note: asterisk(*) indicates the number of 5 minute air breaks required.
An air break is to be taken after every 30 minutes on oxygen

TABLE D
MCM/EOD LSE OPEN CIRCUIT SYSTEM : IN-WATER OXYGEN DECOMPRESSION AND SURFACE DECOMPRESSION

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) OXYGEN-HELIUM WET STOPS (min)			IN WATER DECOMPRESSION (4) IN WATER OXYGEN (min)		IN WATER DECOMPRESSION (5) TOTAL TIME FOR DECOMP-RESSION (min)	SURFACE DECOMPRESSION (6) IN WATER OXYGEN (min)		Time from leaving the 12 m stop to reaching the 12 m chamber stop must not exceed 5 min	(7) CHAMBER OXYGEN (min)	(8) TOTAL TIME FOR DECOMP-RESSION (min)
		24 m	21 m	18 m	15 m	12m		15 m	12m		12 m	
39	10	-	-	-	-	19	22	-	10		14	37
	20	-	-	-	-	34	37	-	10		30*	58
	30	-	-	-	-	49	52	-	10		44*	72
	40	-	-	-	-	62	65	-	10		60**	93
	60	-	-	-	-	82	85	-	10		77**	110
	80	-	-	-	-	94	97	-	10		90***	128
	100	-	-	-	-	99	102	-	10		94***	132
42	10	-	-	-	10	11	24	10	10		6	39
	20	-	-	-	10	28	41	10	10		23	56
	30	-	-	-	10	45	58	10	10		40*	78
	40	-	-	7	10	59	79	10	10		54*	99
	60	-	-	7	10	78	98	10	10		73**	123
	80	-	-	7	10	90	110	10	10		90***	145
	100	-	-	7	10	96	116	10	10		91***	146
45	10	-	-	-	10	12	25	10	10		7	41
	20	-	-	7	10	33	53	10	10		30*	76
	30	-	-	7	10	50	70	10	10		45*	91
	40	-	-	7	10	65	85	10	10		60**	111
	60	-	-	7	10	84	104	10	10		79**	130
	80	-	-	7	10	96	116	10	10		91***	147
48	10	-	-	7	10	15	36	10	10		10	51
	20	-	-	7	10	36	57	10	10		31*	77
	30	-	-	7	10	55	76	10	10		50*	96
	40	-	-	7	10	70	91	10	10		65**	116
	60	-	7	6	10	83	110	10	10		78**	135
	80	-	7	9	10	98	128	10	10		93***	158
51	10	-	7	-	10	17	38	10	10		12	53
	20	-	7	-	10	41	62	10	10		36*	82
	30	-	7	1	10	62	84	10	10		60**	112
	40	-	7	4	10	77	102	10	10		72**	127
	60	-	7	10	10	92	123	10	10		90***	156
	80	-	9	14	13	98	138	13	13		93***	171
54	10	-	7	-	10	20	41	10	10		15	56
	20	-	7	-	10	44	65	10	10		39*	85
	30	-	7	4	10	67	92	10	10		62**	117
	40	7	-	8	10	81	110	10	10		76**	135
	60	7	5	11	10	96	133	10	10		91***	163

Note: asterisk(*) indicates the number of 5 minute air breaks required.
An air break is to be taken after every 30 minutes on oxygen

TABLE D

MCM/EOD LSE OPEN CIRCUIT SYSTEM : IN-WATER OXYGEN DECOMPRESSION AND SURFACE DECOMPRESSION

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) OXYGEN-HELIUM WET STOPS (min)						IN WATER DECOMPRESSION (4) IN WATER OXYGEN (min)		IN WATER DECOMPRESSION (5) TOTAL TIME FOR DECOMP-RESSION (min)	SURFACE DECOMPRESSION (6) IN WATER OXYGEN (min)		Time from leaving the 12 m stop to reaching the 12 m chamber stop must not exceed 5 min	(7) CHAMBER OXYGEN (min)	(8) TOTAL TIME FOR DECOMP-RESSION (min)
		33 m	30 m	27 m	24 m	21 m	18 m	15 m	12m		15 m	12m		12 m	
	10	-	-	-	-	7	-	**10**	**22**	**43**	10	10		17	58
	20	-	-	-	7	-	2	**10**	**50**	**73**	10	10		45*	93
57	30	-	-	-	7	-	7	**10**	**69**	**97**	10	10		64**	122
	40	-	-	-	7	4	9	**10**	**84**	**118**	10	10		79**	143
	60	-	-	-	7	9	13	**12**	**93**	**138**	12	12		90***	172
	10	-	-	-	7	-	-	**10**	**25**	**46**	10	10		20	62
	20	-	-	-	7	-	4	**10**	**53**	**78**	10	10		48*	99
60	30	-	-	7	-	3	7	**10**	**74**	**105**	10	10		69**	131
	40	-	-	7	-	7	10	**10**	**86**	**124**	10	10		81**	150
	60	-	-	7	4	10	14	**13**	**98**	**150**	13	13		93***	184
	10	-	-	-	7	-	-	**10**	**28**	**50**	10	10		23	65
	20	-	-	7	-	1	6	**10**	**57**	**86**	10	10		52*	106
63	30	-	-	7	-	6	7	**10**	**79**	**114**	10	10		74**	139
	40	-	-	7	3	9	10	**10**	**90**	**134**	10	10		90***	169
	60	-	7	-	9	11	17	**13**	**98**	**160**	13	13		93***	193
	10	-	-	-	7	-	2	**10**	**30**	**54**	10	10		25	69
	20	-	-	7	-	3	7	**10**	**61**	**93**	10	10		60**	122
66	30	-	-	7	2	6	9	**10**	**81**	**120**	10	10		76**	145
	40	-	7	-	6	9	11	**10**	**93**	**141**	10	10		90***	173
	60	-	7	4	9	12	18	**14**	**99**	**168**	14	14		94***	202
	10	-	-	7	-	-	3	**10**	**33**	**58**	10	10		30*	80
	20	-	7	-	1	4	7	**10**	**65**	**99**	10	10		60**	124
69	30	-	7	-	5	7	10	**10**	**85**	**129**	10	10		80**	154
	40	7	-	3	7	9	13	**11**	**95**	**150**	11	11		90***	181
	60	7	-	8	10	14	18	**15**	**99**	**176**	15	15		94***	211
	10	-	7	-	-	2	4	**10**	**35**	**63**	10	10		30*	83
	20	-	7	-	2	5	7	**10**	**68**	**104**	10	10		63**	129
72	30	7	-	2	6	7	10	**10**	**87**	**134**	10	10		82**	159
	40	7	-	5	8	9	14	**12**	**96**	**156**	12	12		91***	188
	60	7	4	8	11	14	19	**16**	**99**	**183**	16	16		94***	219
	10	-	7	-	-	2	4	**10**	**37**	**65**	10	10		32*	86
75	20	7	-	-	3	7	7	**10**	**70**	**109**	10	10		65**	135
	30	7	-	4	6	8	10	**10**	**89**	**139**	10	10		84**	165
	40	7	2	5	9	9	14	**13**	**96**	**160**	13	13		91***	194

Note: asterisk(*) indicates the number of 5 minute air breaks required.
An air break is to be taken after every 30 minutes on oxygen

TABLE D

MCM/EOD LSE OPEN CIRCUIT SYSTEM: IN-WATER OXYGEN DECOMPRESSION AND SURFACE DECOMPRESSION

(1) DEPTH NOT EXCEEDING (m)	(2) DURATION TIME LEAVING SURFACE TO BEGINNING OF ASCENT NOT EXCEEDING (min)	(3) OXYGEN-HELIUM WET STOPS (min)								IN WATER DECOMPRESSION (4) IN WATER OXYGEN (min)		(5) TOTAL TIME FOR DECOMP-RESSION (min)	SURFACE DECOMPRESSION (6) IN WATER OXYGEN (min)			(7) CHAMBER OXYGEN (min)	(8) TOTAL TIME FOR DECOMP-RESSION (min)
		39 m	36 m	33m	30 m	27 m	24 m	21 m	18 m	15 m	12m		15 m	12m		12 m	
78	10	-	-	7	-	-	-	4	4	10	40	71	10	10	Time from leaving the 12 m stop to reaching the 12 m chamber stop must not exceed 5 min	35*	91
	20	-	-	7	-	2	4	6	7	10	74	116	10	10		69**	141
	30	-	7	-	2	5	6	9	10	10	92	147	10	10		90***	180
	40	-	7	-	3	8	9	10	15	14	96	168	14	14		91***	202
81	10	-	-	7	-	-	2	3	4	10	42	74	10	10		37*	94
	20	-	7	-	-	2	6	6	8	10	78	123	10	10		73**	148
	30	-	7	-	3	6	6	9	13	10	93	153	10	10		90***	185
	40	7	-	2	5	8	8	12	16	13	98	175	13	13		93***	208
84	10	-	-	7	-	-	3	3	4	10	46	79	10	10		41*	99
	20	-	7	-	-	4	6	7	7	10	81	128	10	10		76**	153
	30	7	-	1	5	5	9	9	12	10	96	160	10	10		91***	190
	40	7	-	4	6	8	9	12	17	15	98	182	15	15		93***	217

Note: asterisk(*) indicates the number of 5 minute air breaks required.
An air break is to be taken after every 30 minutes on oxygen

TABLE E
MCM/EOD LSE EMERGENCY IN WATER OXYGEN IN HELIUM DECOMPRESSION

STOPS AT DIFFERENT DEPTHS (minutes)				
15m	**12m**	**9m**	**6m**	**3m**
26	**30**	**35**	**42**	**55**

CHAPTER 13

ILLNESSES AND INJURIES IN DIVERS - RECOGNITION AND MANAGEMENT

CONTENTS

SECTION 1 - INTRODUCTION

Para

SECTION 2 - CARDIOPULMONARY RESUSCITATION

SECTION 3 - DIVING DISORDERS WHICH DO NOT REQUIRE RECOMPRESSION

CONTENTS
(Continued)

SECTION 4 - DIVING DISORDERS WHICH REQUIRE RECOMPRESSION

SECTION 5 - THERAPEUTIC RECOMPRESSION

ANNEXES

CHAPTER 13

ILLNESSES AND INJURIES IN DIVERS - RECOGNITION AND MANAGEMENT

SECTION 1 - INTRODUCTION

1301. General

a. Chapter 13 covers medical conditions encountered in diving. It should be remembered when reading this chapter that problems which may be merely annoying on the surface can be life-threatening for a working diver. This Chapter provides guidance for everyone involved in diving, from Ship's Diver to the Medical Officer. The diving team must know the location of the nearest chamber and how to contact a Diving Medical Specialist as there are occasions when he must be consulted (Para 1362).

b. Safe diving and choosing the correct action to take in emergencies depend on the knowledge and training of all those involved. Sound planning and use of authorised equipment which is in good repair is essential. Although the diving environment cannot be controlled, it can be understood. The recognition of hazards is essential if preventable accidents are to be avoided.

c. This chapter is divided into five sections:

(1) Section 1 is the Introduction.

(2) Section 2 describes the first-aid management of casualties, including cardiopulmonary resuscitation, and the control of bleeding.

(3) Section 3 covers the diagnosis and treatment of diving disorders which do not usually require recompression therapy.

(4) Section 4 describes the diagnosis of diving disorders which generally require recompression, such as arterial gas embolism and decompression sickness.

(5) Section 5 describes recompression therapy for these disorders in the two-compartment chamber. The management of omitted decompression and limitations of the one-man and two-man chambers are also discussed.

d. To assist non-medical personnel to understand the guidance and instructions given in this Chapter a Glossary of Medical Terms is included at Annex D.

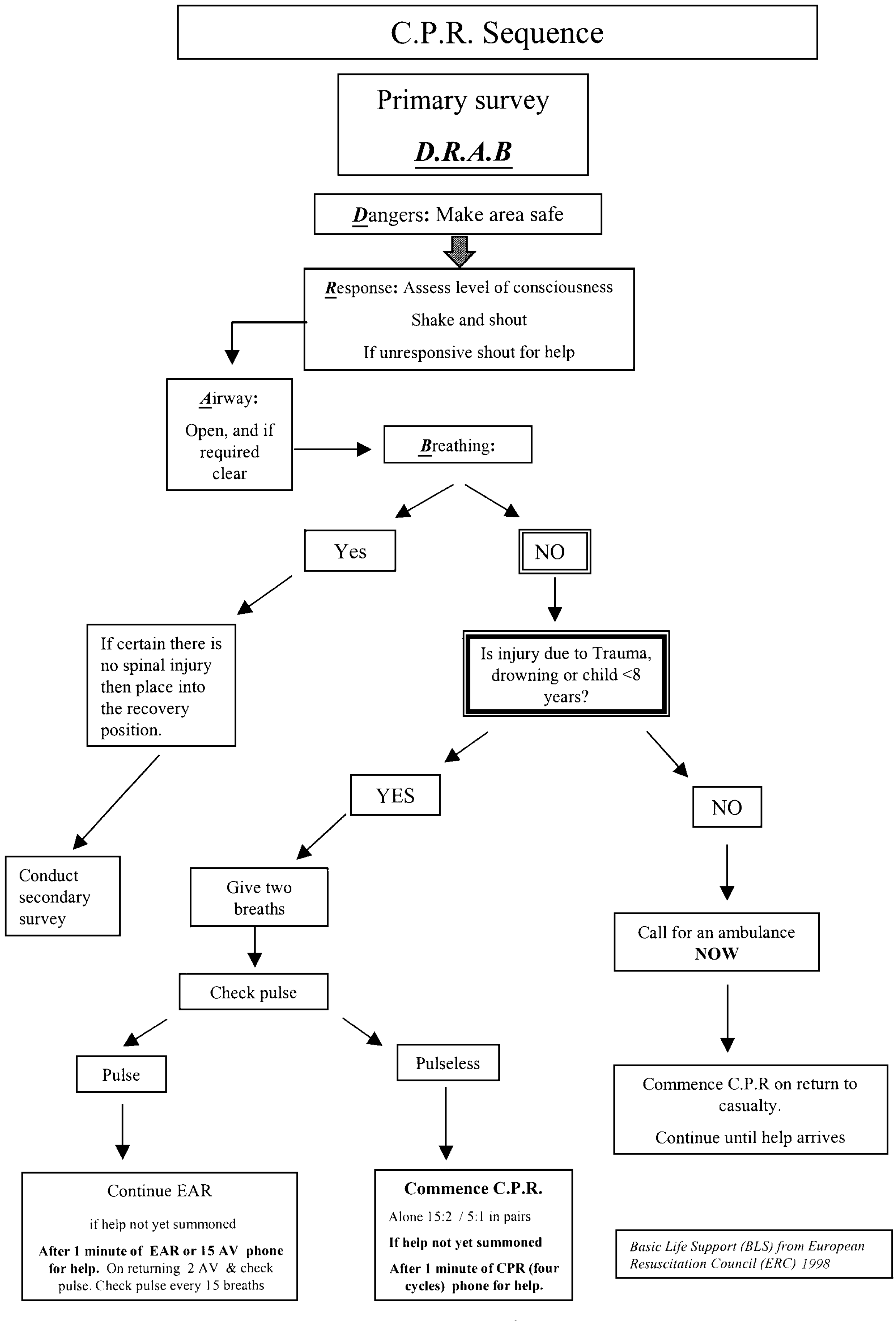

C.P.R. Sequence
Primary survey
D.R.A.B
Dangers: Make area safe
Response: Assess level of consciousness
Shake and shout
If unresponsive shout for help
Airway:
Open, and if required clear
Breathing:
Yes
NO
If certain there is no spinal injury then place into the recovery position.
Is injury due to Trauma, drowning or child <8 years?
YES
NO
Conduct secondary survey
Give two breaths
Check pulse
Call for an ambulance NOW
Pulse
Pulseless
Commence C.P.R on return to casualty.
Continue until help arrives
Continue EAR
if help not yet summoned
After 1 minute of EAR or 15 AV phone for help. On returning 2 AV & check pulse. Check pulse every 15 breaths
Commence C.P.R.
Alone 15:2 / 5:1 in pairs
If help not yet summoned
After 1 minute of CPR (four cycles) phone for help.
Basic Life Support (BLS) from European Resuscitation Council (ERC) 1998

Fig 13-1A.

The Resuscitation Sequence

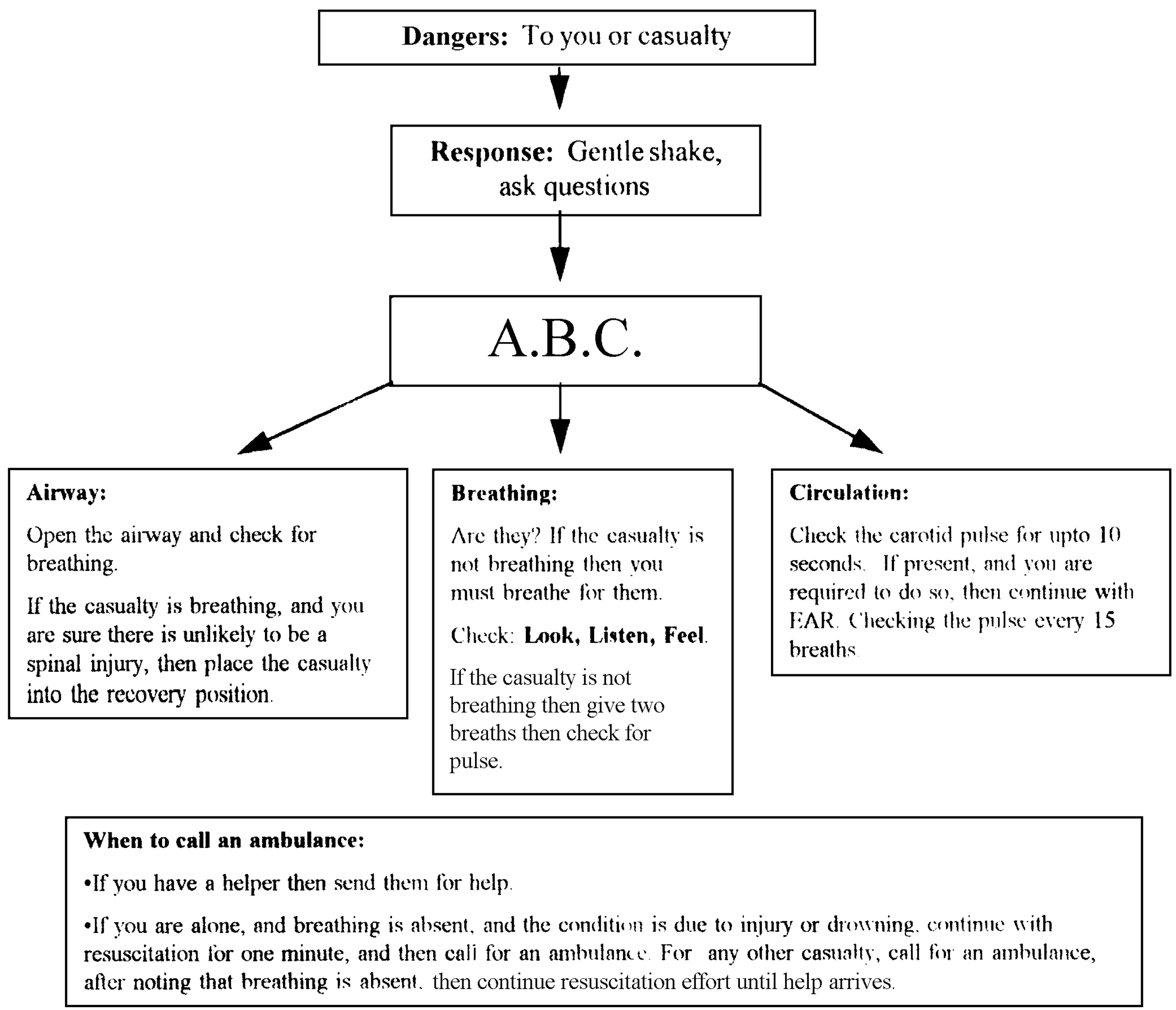


Fig 13-1B.

SECTION 2 - CARDIOPULMONARY RESUSCITATION

1302. Introduction

Effective life saving First Aid procedures, such as Cardiopulmonary Resuscitation (CPR), are essential in response to a multitude of traumatic incidents. Therefore, all personnel regularly involved with diving practices should be proficient in these, and other associated treatments, having completed formal First Aid training conducted by a suitably qualified instructor.

1303. Primary Survey "Airway, Breathing, Circulation" (A.B.C.) With Consideration to Cervical Spine

a. Prior to approaching any situation, observe for and isolate any environmental dangers to yourself and the casualty. When safe to approach the situation conduct the Primary Survey as follows.

(1) *Shake and Shout.* Assess level of consciousness by the "Shake and Shout" method, taking care to immobilise head and shoulders to prevent any further injury to the neck. (Cervical Spine).

Fig 13-2. Shake and Shout

(2) *Airway.* Minimising movement to both the head and neck, open mouth to ensure a clear airway - remove any blockages (debris, vomit, loose dentures).

(3) *Breathing.* Position the head and neck gently into the "Sniffing the Morning Air Position" (Fig 13-3), check for breathing using the **"Look, Listen and Feel"** routine. Fig 13-4.

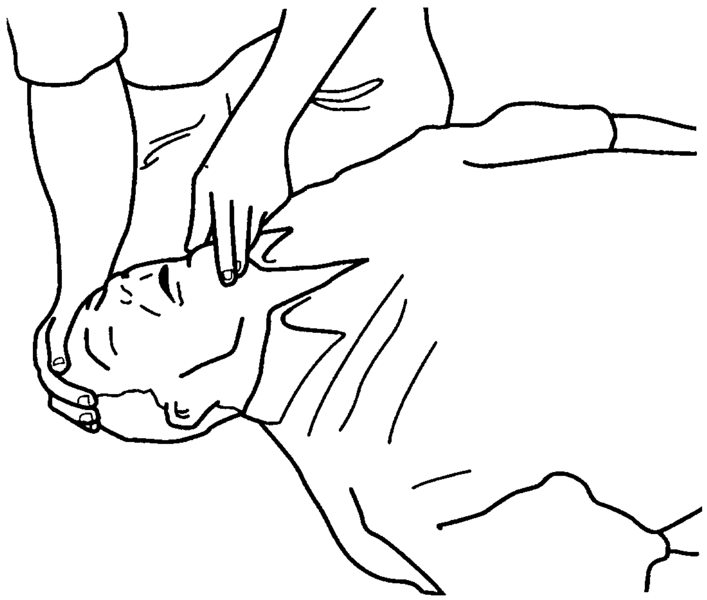


Fig 13-3. Sniffing the Morning Air

Fig 13-4. Look Listen and Feel

(4) *Circulation.* Check Carotid pulse for minimum of Five Seconds. Fig 13-5

Fig 13-5. Carotid Pulse Check

b. If Responsive. Observe and call for help using the mnemonic **"L.I.O.N.E.L."** para 1309.

c. **Pulse present but not breathing.** Summon help immediately (**L.I.O.N.E.L.**) then return to the casualty give 2 inflations and reassess **A.B.C.** Para 1303a.

Fig 13-6. Artificial Ventilation Position

Fig 13-7. **Artificial Ventilation (Chest Rising)**

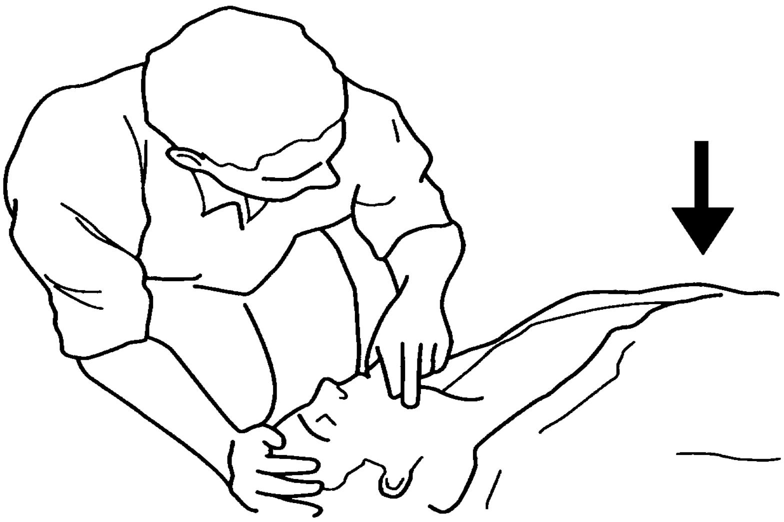


Fig 13-8. Artificial Ventilation (Chest Falling)

d. **Pulseless and not breathing.** Go immediately for help (**L.I.O.N.E.L.**) Return to casualty and commence **Cardiopulmonary Resuscitation**. (CPR). Para 1304.

1304. Cardiopulmonary Resuscitation (CPR)

a. CPR should be conducted as follows:

(1) Extend the head and neck gently into the "Sniffing the Morning Air" position. With two finger tips under the point of the chin, lift the chin, Fig 13.3. Give two slow inflations. (At the rate of one every five seconds), Fig 13-7.

(2) Recheck carotid pulse (for at least 10 seconds). Fig 13-5.

(3) If pulse-less expose the chest, locate base of sternum (Breast Bone).

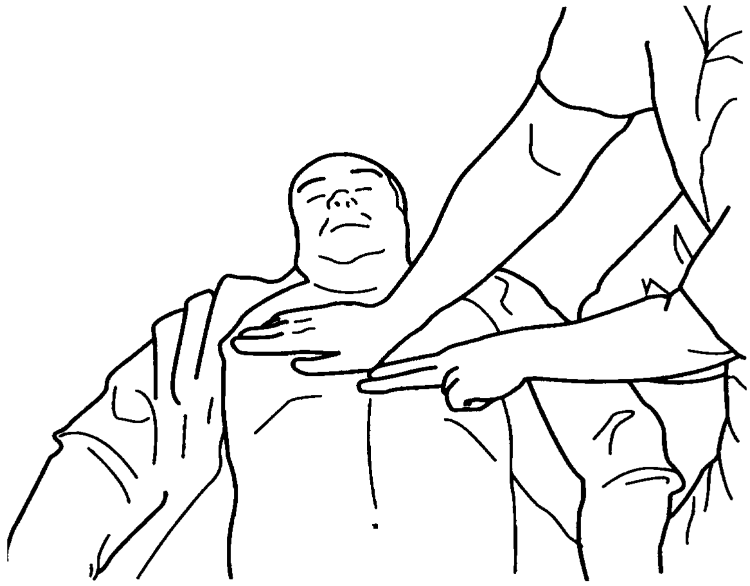


Fig 13-9. Locate Sternum - 2 Fingers

(4) Interlock the fingers of both hands. Fig 13-10

Fig 13-10. Position Hands

(5) Keeping the elbows locked and in a vertical motion depress the sternum 1.5 to 2in (4 to 5cm), at a rate of approx 100 per minute. Fig 13-11

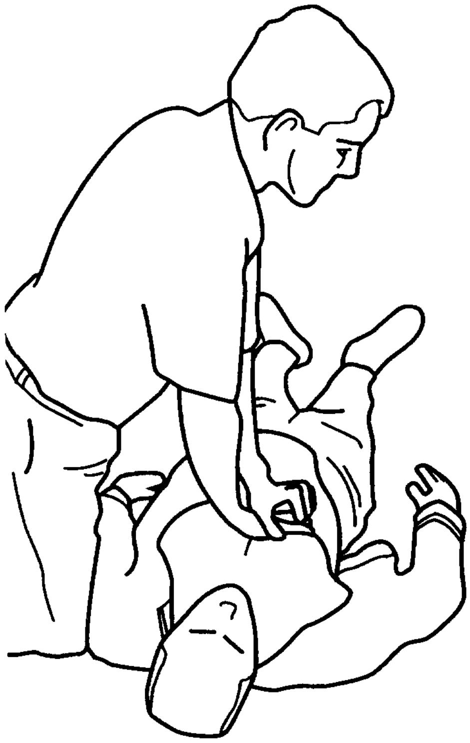


Fig 13-11. ECC Commence

(a) Continue with Artificial Ventilation (AV) and External Chest Compressions (ECC) at 15 ECC to 2 AV. Fig 13-12

Fig 13-12. 2 x Persons CPR

b. Continue CPR until:

(1) Signs of life return to the casualty.

(2) Relieved by medical aid.

(3) Too exhausted to continue.

c. If breathing and circulation re-established carry out **Secondary Survey** and place into the **Recovery Position**. Fig 13-13

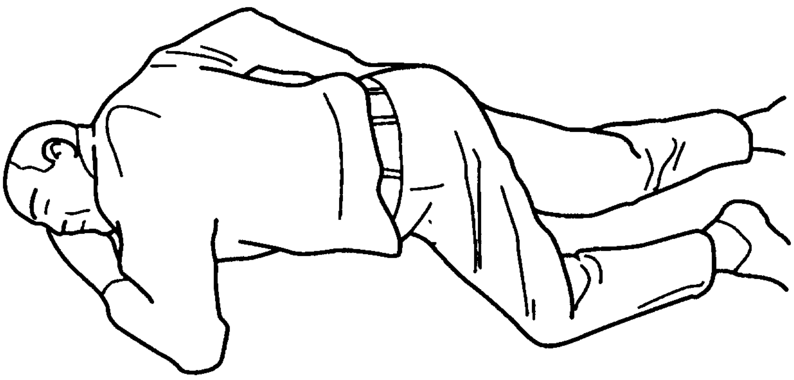


Fig 13-13. Recovery Position

d. Maintain constant checks on the **A**irway, **B**reathing and **C**irculation. Para 1310.

1305. Clearing the Airway

a. The causes of an Obstructed Airway are numerous, food, vomit, other foreign material, by swelling of the throat after injury, or, in an unconsciousness patient, by the tongue. Attempts to clear the airway should be conducted as follows.

(1) *Coughing.* If the casualty is conscious, encourage him to cough. This may be all that is required to remove the blockage.

(2) *Finger Sweep.* In the unconscious casualty, hook your first two fingers and sweep round inside the mouth. DO NOT waste time searching for hidden obstructions and make sure you do not push any object further down the throat. If unsuccessful, proceed to back slapping.

b. **Back Slapping.**

(1) *Conscious Casualty.* Deliver a series of four sharp slaps between the casualty's shoulder blades (Fig 13-14) with the heel of your hand. Checking between each slap to see if the blockage has been removed.

Fig 13-14. Back Slap

c. **Abdominal Thrust (AT)**

(1) *Conscious Casualty.* Stand behind the casualty and position him leaning forward (Fig 13-15). The rescuer then makes one hand into a fist and positions it midway between the belly button and the lower edge of the breast bone. The rescuer then grasps this hand with the other hand and delivers a quick inward and upward jerk. Check to see if the blockage has been cleared. If this is unsuccessful then alternate 5 back slaps with 5 AT.

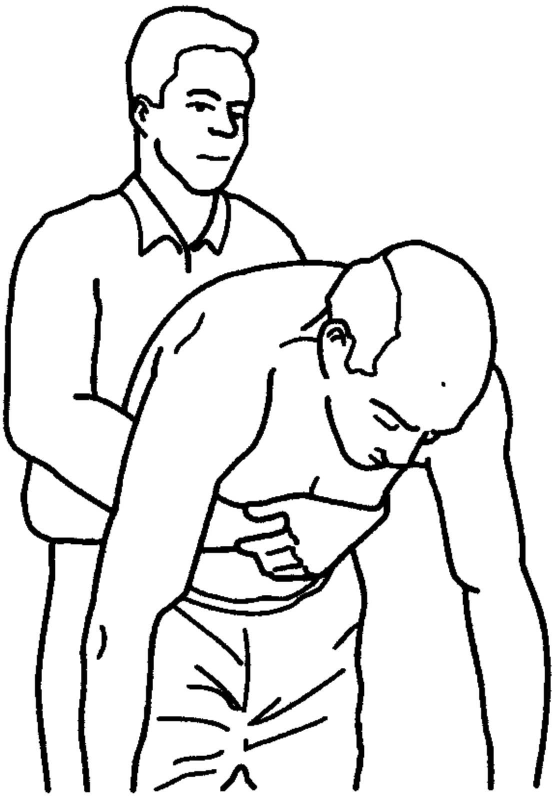


Fig 13-15. Abdominal Thrust Conscious

(2) *Unconscious Casualty.* Put the victim on his back and sit astride his hips facing his head, which should rest to one side. Position the hands midway between the belly button and the lower end of the sternum. (Breast Bone) Fig 13-16. Deliver a series of 4 quick jerks in an upward and inward motion. Check in between each jerk to see if the blockage has been dislodged. If this has been unsuccessful then alternate 4 AT with 2 AV.

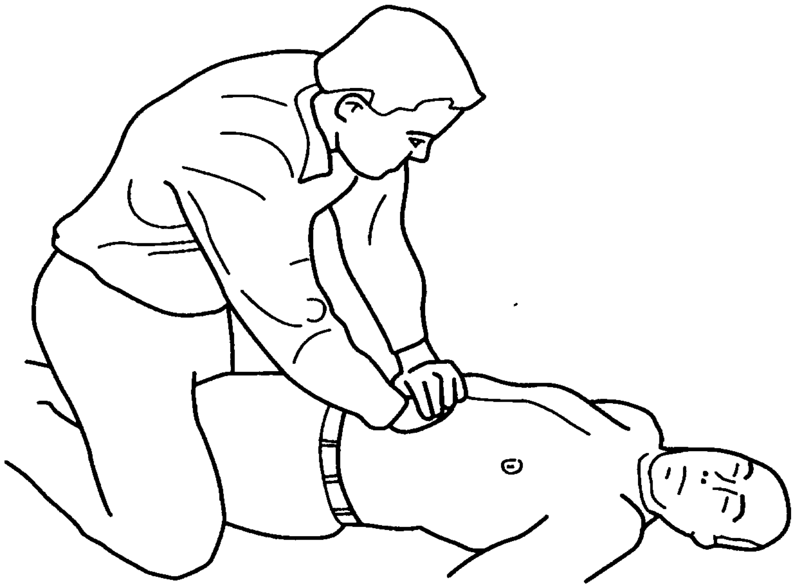


Fig 13-16. Abdominal Thrust Unconscious

1306. Controlling Significant External Haemorrhage.

a. Haemorrhage must be controlled as soon as possible after the initiation of any necessary C.P.R.

b. **External Haemorrhage.** Bleeding from a wound is characterised according to the type of blood vessel which has been damaged.

(1) *Arterial bleeding*. Bright red blood which spurts from the wound in time with the pulse.

(2) *Venous bleeding*. Slower and more steady than Arterial bleeding and darker in colour.

c. There are fundamentally three control methods employed in the treatment of haemorrhage.

(1) *Direct Pressure*. Following a careful examination of the wound for Foreign material apply **Direct Pressure** to the wound by what ever means you have at your disposal. The application of the First Field Dressing (FFD) is ideal for this type of injury. Monitor the FFD for signs of break through bleeding, if break through bleeding occurs then a second and if required a third FFD may be applied. **The maximum number of FFD's placed one on top of the other is Three**.

(2) *Elevation*. When venous bleeding occurs from a limb, the rate of blood loss can be substantially reduced by elevating the injury above the level of the heart. **Elevation of the injured limb must always be considered. The only situation when elevation should not employed is when to do so would cause further injury ie unstable fracture.**

(3) *Pressure Points*. When direct pressure by its self is not sufficient to control bleeding, or when there are a number of bleeding points supplied by the same artery, pressure point control may help to slow the bleeding. Compression of these points for 10 minutes, then slowly release, reapply again for 10 minutes. Continue this cycle until definitive care is reached. The pressure points most frequently employed are:

(a) *Brachial Artery*, overlies the humerus beneath the bicep muscle of the upper arm, employed to control bleeding from the forearm.

(b) *Femoral Artery*, located in the groin, when compressed against the pelvis is used to control bleeding from the leg.

(c) *Subclavian Artery*, located high up in the axilla (armpit), firm upward pressure directed towards the underside of the clavicle may slow the bleeding from wounds of the upper arm.

1307. Internal Haemorrhage

a. Always suspect internal bleeding in casualties who have sustained:

(1) Crush injuries.

(2) Blunt Abdominal Trauma.

(3) Stabbing or deep Puncture wounds.

(4) Falling from a height greater than 6m.

(5) Deterioration in casualty. Especially when only minor injury visible.

(6) Degree of SHOCK continues to deteriorate. Para 1308.

b. **Signs and Symptoms.** Monitor your casualty for signs of the following:

(1) Moist, pale, cool skin.

(2) Quickening pulse rate, may become feeble and more difficult to palpate.

(3) Level of consciousness may deteriorate.

(4) Any bleeding from the following:

(a) Urethra

(b) Anus

(c) Vagina

(d) Fresh blood in vomit

(e) Casualties suffering from head and facial injuries

(f) Bleeding from the nose, ears

(g) Bruising around the eyes

are to be treated as suffering from an internal injury.

c. **Treatment.** Definitive treatment may only be secured at a medical facility with a surgical team. Evacuation to such a facility must be carried out with all possible speed. The following must be carried out prior to and during evacuation:

(1) Lay casualty down.

(2) Elevate limbs.

(3) Monitor A.B.C. Administer Oxygen >15 litres per minute.

(4) Do not allow casualty to eat, drink or smoke.

(5) Reassure and keep casualty at rest.

(6) Avoid unnecessary handling of the casualty.

(7) Protect from the environment.

(8) If casualty loses consciousness conduct A.B.C and place into the Recovery position. Fig 13-2. (If spinal injury is suspected, leave in situ maintain and monitor A.B.C.).

1308. Shock

a. **Definition.** Shock occurs when, for any reason, there is inadequate tissue perfusion.

b. **Cause.** Normal tissue perfusion requires:

(1) A functioning pump. The Heart.

(2) Adequate fluid volume: Blood and other body fluids.

(3) A system of tubing without leaks and capable of reflex contractive and dilatory adjustments in response to changes within the system.

c. If any of these mechanisms is damaged, tissue perfusion may be compromised and shock will ensue.

d. **Signs and Symptoms**

(1) Restlessness and anxiety.

(2) Thirst.

(3) Nausea and sometimes vomiting.

(4) Cool, clammy, pale skin.

(5) Weak rapid pulse.

(6) Shallow rapid breathing.

(7) Deterioration in level of consciousness.

e. **Treatment**

(1) Lay casualty down, elevate limbs, loosen restrictive clothing.

(2) Monitor and Maintain A.B.C.

(3) Give Oxygen delivery rate >15 litres per minute.

(4) Control causative mechanism. ie Haemorrhage.

(5) Do not give oral fluids, food or allow casualty to smoke.

(6) Reassure casualty.

(7) Rapid evacuation. **Article 1307 c**.

1309. L.I.O.N.E.L

a. The following mnemonic is to be used as an aid when reporting a casualty **L.I.O.N.E.L.**

(1) **L.** Location of casualty.

(2) **I.** Incident.

(3) **O.** Other Services. (Fire, Police, Ambulance, Coastguard etc).

(4) **N.** Number of Casualties.

(5) **E.** Extent of injuries.

(6) **L.** Location repeated.

1310. E.S.B.M.P. - A.V.P.U.

Observations which should be conducted and recorded at 10 minute intervals on a casualty.

a. The following mnemonic is to be used as an aid to when conducting observations on a casualty: **E**very **S**nake **B**ite **M**eans **P**anic.

(1) **E**. Eyes - Open spontaneously - observe pupil size, are pupils equal?
Open to speech - observe pupil size, are pupils equal?
Open to painful stimulus - observe pupil size, are pupils equal?
Remain shut.

(2) **S.** Speech - Answer questions sensibly.
Seems confused
Uses inappropriate words.
Makes incomprehensible sounds.
No response.

(3) **B.** Breathing - Rate.
Sound.
Effort..

(4) **M.** Movement - Obeys commands
Response to painful stimulus
No response

5) **P.** Pulse - Rate.
Strength.
Rhythm.

b. The following scale is an aid to gauge a patients consciousness. **A.V.P.U.**

(1) **A.** Alert - Patient is alert and knows his/her name, where they are, what day is it.

(2) **V.** Verbal - Patient responds to verbal command as appropriate but may not open their eyes.

(3) **P.** Pain - Patient responds to painful stimuli.

(4) **U.** Unresponsive - Patient is unresponsive.

SECTION 3 - DIVING DISORDERS WHICH DO NOT REQUIRE RECOMPRESSION

1311. Introduction

a. This section covers the diving-related illnesses and injuries which do not generally require therapeutic recompression. By undertaking correctly conducted dives using properly maintained equipment most of these conditions are preventable.

b. During the conduct of a dive, it is worthwhile to bear the following principles in mind:

(1) A diver must not dive or remain underwater if feeling unwell.

(2) That any illness occurring during or after a dive must be assumed to be caused by the dive unless proved otherwise.

1312-1319. Spare.

1320. Oxygen Deficiency (Hypoxia/Anoxia)

a. **Causes.** Interruption of the breathing gas supply, or insufficient oxygen in the breathing gas. Both are generally caused by the use of poorly prepared equipment or incorrect drills. Hypoxia is uncommon when diving on air using open-circuit breathing apparatus.

b. **Prevention**

(1) When using closed-circuit equipment with electronic PO_2 control (eg CDBA, LEBA (MG)) the primary display will provide the diver with warning of a low PO_2 enabling the diver to take corrective action as appropriate.

(2) When using closed or semi-closed circuit equipment without electronic PO_2 control the diver must carry out the correct drill for clearing the counterlung to prevent dilutional hypoxia. This includes:

(a) Ensuring that the reducer orifice and breathing mixture are appropriate for the depth of the dive.

(b) Flushing through the counterlung before leaving the bottom.

(c) Surfacing at the correct rate.

(d) Ensuring that there is sufficient cylinder pressure to sustain the correct flow for the mixture being used.

(e) Keeping the reducer well maintained.

c. **Symptoms and Signs.** There are three different presentations:

(1) When there is an inadequate gas supply, eg when running low on air using SABA or similar equipment, the diver will notice difficulty taking a breath, or an increased work of breathing before being overtaken by the symptoms of hypoxia.

(2) When the breathing gas is of adequate volume but contains insufficient O_2 content the diver may notice few symptoms before losing consciousness. Those which may be apparent include: a sense of well-being, loss of judgement and frequent errors. These will probably go unrecognised by the casualty, but may be detected by a buddy.

(3) The breathing gas may contain both a low partial pressure of O_2 and a raised partial pressure of carbon dioxide. Under these conditions the symptoms of hypoxia are overwhelmed by those of CO_2 toxicity (para 1322).

d. **Treatment.** Restore any interrupted gas supply or switch to another supply such as an emergency cylinder. Oxygen deficiency due to a low O_2 content should be treated by:

(1) Switching to another gas supply containing sufficient O_2.

(2) If the patient is unconscious or incoherent, switch to 100% O_2 when at 10m or shallower (if possible).

(3) When the patient surfaces administer 100% O_2.

1321. Oxygen Toxicity

a. If O_2 is breathed at a high partial pressure for long periods it becomes toxic, particularly to the lungs. If a very high partial pressure of O_2 is breathed, even for short periods of time, it may rapidly become toxic to the brain.

b. **Pulmonary Oxygen Toxicity**

(1) For practical purposes, pulmonary oxygen toxicity will not arise from normal air ‘bounce’ diving to less than 50m or during heliox ‘bounce’ diving to 80m with CDBA. Although the time and depth limitations imposed on O_2 breathing sets (eg CDBA, LAR V) are designed to avoid pulmonary oxygen toxicity, the tolerance of individuals to O_2 varies greatly. Diving near the time/depth limits, particularly when such dives are performed repetitively, may provoke pulmonary oxygen toxicity in sensitive individuals. Patients being treated with fully extended Therapeutic Tables 62 and 63 or Tables 64, 65 and 67 may also experience pulmonary oxygen toxicity, particularly where repeated treatments are applied.

(2) *Symptoms and Signs.* These often start with a tickling sensation in the throat which is worse on inspiration and which may provoke coughing. After a few hours of continued O_2 exposure, the tickle is gradually replaced by a sensation of substernal burning and coughing becomes uncontrollable.

Shortness of breath eventually prevents even mild exertion. In sensitive individuals, the first symptoms of toxicity may be provoked by breathing 100% O_2 at 2 Bar for as little as 3 hours. Pulmonary oxygen toxicity results in a progressive reduction on vital capacity.

(3) *Unit Pulmonary Toxic Dose (UPTD).* Where prolonged exposure to hyperbaric oxygen is necessary, such as during recompression therapy, an estimate of the reduction in vital capacity can be calculated. A UPTD Calculation table is provided below.

Table 13-1. UPTD Calculation

PO_2 (Bar)	**k**	**PO_2 (Bar)**	**k**	**PO_2 (Bar)**	**k**
0.5	0.00	1.3	1.48	2.1	2.64
0.6	0.26	1.4	1.63	2.2	2.77
0.7	0.47	1.5	1.78	2.3	2.91
0.8	0.65	1.6	1.93	2.4	3.04
0.9	0.83	1.7	2.07	2.5	3.17
1.0	1.00	1.8	2.22	2.6	3.31
1.1	1.16	1.9	2.36	2.7	3.44
1.2	1.32	2.0	2.50	2.8	3.57

(a) This calculated k value is multiplied by the period of time in minutes spent at each oxygen partial pressure. These values are then summed to generate the total UPTD value for the exposure. A standard RN 62 Treatment Table without extension is equivalent to 625 UPTD's. Generally, a dose of 1425 UPTD is considered to be the upper limit of acceptable exposure resulting in approximately a 10% reduction in vital capacity. This limit is advisory and may be exceeded under the instructions of a Diving Medical Specialist.

(b) Normally, a complete recovery from the effects of pulmonary oxygen toxicity can be expected. The time taken for recovery depends largely on the extent of the exposure and where there is a substantial decrement of vital capacity, this may take days or weeks.

(4) *Treatment.* Reduce the concentration of O_2 in the breathing mixture, preferably to 0.2 Bar. Depending on their severity, symptoms will gradually diminish over a few hours and complete resolution can be expected within a few days.

c. **Cerebral Oxygen Toxicity**

(1) *Symptoms and Signs.* These are highly variable. Furthermore, there is no fixed O_2 exposure at which toxicity becomes apparent. Instead, susceptibility varies both between individuals and within the same person from day to day. As a consequence, there is no cerebral equivalent of the UPTD. It is not unusual for the first sign of cerebral oxygen toxicity to be a grand mal convulsion. This generally occurs in two phases: First, there is a period of body rigidity - the '**Tonic**' phase - which may last for up to a minute. It is dangerous to attempt to surface the casualty at this stage because spasm of the glottis and respiratory muscles will result in inadequate exhalation and may therefore provoke pulmonary barotrauma. The tonic phase is followed by the '**Clonic**' phase during which the casualty undergoes true convulsions. This can last for widely varying periods of time. Symptoms which may precede the onset of a grand mal convulsion include: lip twitching; dizziness; nausea; ringing or roaring in the ears; tunnel vision; a choking sensation; difficulty breathing and tremor.

(2) *Treatment.* If a convulsion occurs underwater, the diver's depth should be kept as constant as possible until at least the tonic phase of the convulsion subsides. He should then be returned to the surface. If a diver surfaces because of an oxygen convulsion or must be surfaced to prevent drowning, there is a risk of pulmonary barotrauma and the possibility of decompression illness should be considered in the event of subsequent neurological abnormalities. A neurological examination should be completed to exclude decompression illness. A period of confusion and disorientation will follow a seizure. This must not be confused with neurological decompression illness.

(3) On reaching safety, remove the breathing apparatus and place the casualty in fresh air to recover. If there are any further convulsions, use sufficient restraint to prevent self-injury. Do not force the mouth open but, if necessary, keep the airway open once the convulsion has subsided (Fig 13-3), by positioning the head and neck gently into the 'Sniffing the Morning Air position'.

(4) The casualty must be kept under observation by his fellow divers or in a sick bay for at least 12 hours; loss of memory almost invariably occurs, but this is normally limited to short-term memory and resolves quickly.

Note. *Paradoxically, the symptoms of cerebral oxygen toxicity may be made transiently worse when the inspired PO_2 falls. This is the so-called 'Off Phenomenon'. Consequently the onset of symptoms or signs may be delayed by up to 5 minutes after leaving the water, coming off O_2, or during a decompression stop where the partial pressure of O_2 is reduced.*

1322. Carbon Dioxide Poisoning (Hypercapnia).

a. **Causes.** Carbon dioxide poisoning may occur either with or without a deficiency of O_2. It may be caused by:

(1) Insufficient ventilation of a diver in surface supplied equipment which results in a build-up of CO_2 in the mask or helmet.

(2) Inadequate CO_2 scrubbing when using closed-circuit equipment.

(3) Incorrect or shallow breathing by the diver, especially when 'pendulum' breathing.

(4) Excessive resistance and/or deadspace in the equipment.

b. **Prevention**

(1) Ensure that the CO_2 absorbent is fresh, dry, dust free and correctly packed.

(2) Do not exceed the endurance of the canister.

(3) Ensure that the breathing technique is correct. Rapid shallow breathing can result in CO_2 retention.

c. **Symptoms and Signs**

(1) Breathlessness.

(2) Dizziness, nausea, headache, anxiety.

(3) General distress: sweating and palpitations.

(4) Loss of consciousness.

Note. *If the partial pressure of O_2 exceeds 0.5 bar, the shortness of breath usually associated with CO_2 toxicity may not be as severe. In these cases, especially if breathing is hard due to heavy exertion, the diver might have no warning of hypercapnia and may become confused and even slightly euphoric before losing consciousness.*

d. **Treatment**

(1) If the diver is at depth, stop all activity and relax.

(2) If the diver is using a counterlung, flush through and breathe deeply. If surface supplied equipment is being used, signal for more air and increase mask or helmet ventilation - if this brings no relief the diver should abort the dive.

(3) At the surface, encourage the diver to relax.

(4) Recovery should be rapid. If not, medical attention should be obtained as soon as possible.

Note. *A frequent after-effect is a headache.*

1323. Spare.

1324. Nitrogen Narcosis

a. **Causes.** If nitrogen is breathed under pressure, it induces narcosis in a similar fashion to an anaesthetic agent. The severity of the effect depends on the depth and duration of the dive, the rate of compression and experience of the diver. Some drugs, particularly alcohol and sedatives, may have an additive effect to the narcosis and should not be taken prior to diving.

b. **Prevention**

(1) Limit the depths of dive according to the experience of the diver. (Existing RN depth restrictions take account of this.)

(2) Dives to maximum authorised depth using air or oxy-nitrogen mixtures must be preceded by a work-up. This does not prevent narcosis but enables the diver to learn to control the effect. See para 0702.

(3) Deep dives (deeper than 54m, deeper than 30m when using CDBA) should be conducted using helium rather than nitrogen as the inert gas in the breathing mixture.

c. **Symptoms.** Individuals vary in their susceptibility to nitrogen narcosis and some habituation to the effects of narcosis can be achieved by frequency exposure. As a rough guide, the table below shows the effects of nitrogen narcosis at various depths:

Table 13-2. Narcosis - Depth and Symptoms - When Breathing Air

Depth metres	Symptoms
30-60	Light headedness, euphoria, loss of fine discrimination
60-90	Poor judgment and reasoning, slowed reflexes, peripheral paraesthesiae, overconfidence
90-120	Progressive depression of the sensorium, hallucinations, altered affect, amnesia
> 120	Loss of consciousness

Note. *The symptoms and signs are similar to those of drunkenness except that there is no 'hangover'. There is no danger from the narcotic effect itself and the effect wears of rapidly on reducing depth. The hazard is that a narcosed diver may act inappropriately, sustain an injury or drown while his concentration is impaired.*

d. **Treatment**

(1) Decrease the depth of the dive.

(2) In serious cases, which are very rare, the diver should surface. The effects of narcosis resolve rapidly once the inspired partial pressure of nitrogen is reduced.

1325. Caustic Cocktail

a. **Cause.** If water enters a closed-circuit or semi-closed circuit breathing apparatus (such as CDBA, LAR V, CDBA or LEBA (MG)), it will eventually mix with the CO_2 absorbent (usually a mixture of calcium hydroxide with a small amount of sodium hydroxide) to form a strong alkaline solution, which may cause chemical burns to the face, mouth, lungs and stomach.

b. **Prevention**

(1) Ensure that the equipment has no leaks before diving.

(2) If leaks become apparent during the dive - surface as soon as possible.

c. **Treatment**

(1) Remove the diver from the water. Remove the set as quickly as possible.

(2) If the diver is suspected of having swallowed a cocktail give copious drinks of fresh water. Salt water may be used to rinse out the mouth but should not be swallowed, since it may induce vomiting which may cause further burning.

(3) Wash all contaminated external surfaces liberally with fresh or salt water.

(4) Caustic burns to the eye should be treated by washing the eye with large volumes of water for at least 20 minutes. If necessary, the eyelids should be held open while this is done. Refer to an eye unit, casualty department or Medical Officer before diving is resumed.

(5) A caustic cocktail readily provokes panic, especially in inexperienced divers. This may result in a rapid ascent and breath-holding (to avoid inhaling further alkali). Consequently, divers who as the result of a caustic cocktail, make a rapid ascent to the surface should be observed carefully for 12 hours following the dive for evidence of pulmonary barotrauma or neurological decompression illness and should be seen by a Medical Officer before diving is resumed.

1326-1329. Spare.

1330. Compression Barotrauma (Squeeze)

a. **Cause.** The body is mainly composed of incompressible fluid. However, any gas-filled space present within the body or next to the body can damage tissues when its volume changes in accordance with Boyle's Law. 'Squeeze' refers to the damaging effect of a reduction in volume of gas in a diver's equipment or body cavity as pressure is increased. The opposite effect, barotrauma of ascent, caused by the expansion of gas, is called reversed squeeze. The predominant symptom of barotrauma is pain. As the gas volume within the space is reduced on descent, pain may be accompanied by bleeding as overfilled blood vessels rupture to relieve the relative negative pressure. On ascent, the reverse can occur resulting in a decreased blood flow.

b. **Prevention.** In situations where the gas volume can be restored to the predive volume eg by inflating a dry suit or insufflating the ears (clearing the ears), squeeze can be avoided. Equally, where the gas is contained in a flexible viscus such as the bowel, compression of the gas may occur harmlessly.

c. **Targets of Barotrauma.** The most frequent targets of squeeze in diving are:

(1) The Middle ear - see para 1331.

(2) Suit squeeze is caused when a pocket of air under a fold or fitting of a dry suit is compressed during descent and results in the skin being pinched. It is generally painless, being noticed only by linear red marks on the skin when the suit is removed. It generally resolves over a period of a few hours.

(3) Sinus squeeze may occur when the passages that vent the sinuses into the nasal cavity (the ostia) are obstructed. Sinus squeeze may occur during descent and present as increasing pain in the sinus(es) involved. As the pressure in affected sinuses decrease relative to ambient, oedema of the mucosa and even haemorrhage into the sinus cavity may occur. If an ostium becomes blocked during a dive, which can occur as a result of breathing cold gas, barotrauma during descent, etc, sinus squeeze may occur during the ascent phase of a dive. In such cases, the sinus pain is caused by a relatively increased pressure within the sinus and this may persist for some hours after the dive. Quite commonly, relief is accompanied by a squeaking sound as gas, often accompanied by a bloody nasal discharge, escapes from the sinus.

(4) Lung (thoracic) squeeze is a very rare event which may occur if the air in the lungs is compressed to a volume less than the residual volume of the lungs. The residual volume is approximately 25% of total lung volume and so the theoretical limit for a breath hold dive would be expected to be in the region of 30m. However, the current world record (Sep 96) stands at 131m which suggests that other factors operate. The most probable explanation is that thoracic blood volume increases by up to 1 litre during such dives. Thus, provided that the residual volume of the lungs is in the region of 1 litre, there is no practical limit to the depth of a breath hold dive imposed by lung squeeze.

(5) Whole body squeeze may occur when the air supply to a diver in AH3 (or a similar type of diving equipment) is inadequate to balance the water pressure. This could be precipitated by a fall into water of greater depth with absence or failure of the safety non-return valve or by malfunction or maladjustment of the gas supply or exhaust valves.

(6) Face-mask squeeze is caused by a failure to equalise the air pressure in the mask by nasal exhalation, or when an oro-nasal mask is being used, by malfunction of the air supply to the face-mask. Facial oedema over the area covered by the mask and subconjunctival haemorrhages may result.

(7) *Tooth Squeeze*. Tooth squeeze results when a small pocket of trapped gas has been generated by decay or is lodged under a poorly prepared, or cracked, filling. If this pocket of gas is completely isolated, the pulp of the tooth or the tissues of the tooth socket can be drawn into the space causing pain. If additional gas enters the tooth during descent and doesn't vent during ascent the tooth may explode. This is more commonly seen in saturation diving.

d. **Treatment**

(1) Stop descending.

(2) If efforts to equalise the pressure fail, ascend to a shallower depth.

(3) If further efforts to equalise pressure fail, abort the dive.

(4) Divers should seek medical attention for all but a simple suit squeeze.

1331. Middle Ear Barotrauma ('Ears')

a. Failure to clear the ears remains the most common medical problem associated with diving. It is both painful and potentially dangerous.

b. **Cause**

(1) Squeeze will occur if the eustachian tube fails to vent the middle ear space while diving. The ear drum completely seals off the outer ear canal from the middle ear space. When the diver descends the volume of gas in the middle ear decreases in accordance with Boyles Law. To restore its volume, the diver encourages air to pass down the eustachian tube (ET) which connects the pharynx to the middle ear (see Fig 13-17 This process is known as 'clearing the ears'. In a few divers, the ET is open all the time so no conscious effort is necessary to clear their ears. For most, however, the ET is naturally closed and some action must be taken to allow this passage of air. Many can accomplish this by yawning, or moving the jaw around. Some require a valsalva manoeuvre against a closed nose and mouth (rather than a closed glottis).

(2) If the ET is blocked, the ears can not be cleared. During the initial phase of descent, the decreasing volume of the middle ear is compensated for by the ear drum bowing inwards. Soon, however, the ear drum reaches its limits of inward distensibility and the middle ear air pressure falls below the external water pressure. This negative pressure causes the blood vessels of the ear drum and the lining of the middle ear to expand, then leak and finally rupture. If the descent is continued, either the ear drum will rupture allowing the immediate equalisation of the middle ear and atmospheric pressure, or bleeding into the middle ear which will equalise the pressure by replacing air with non-compressible fluid.

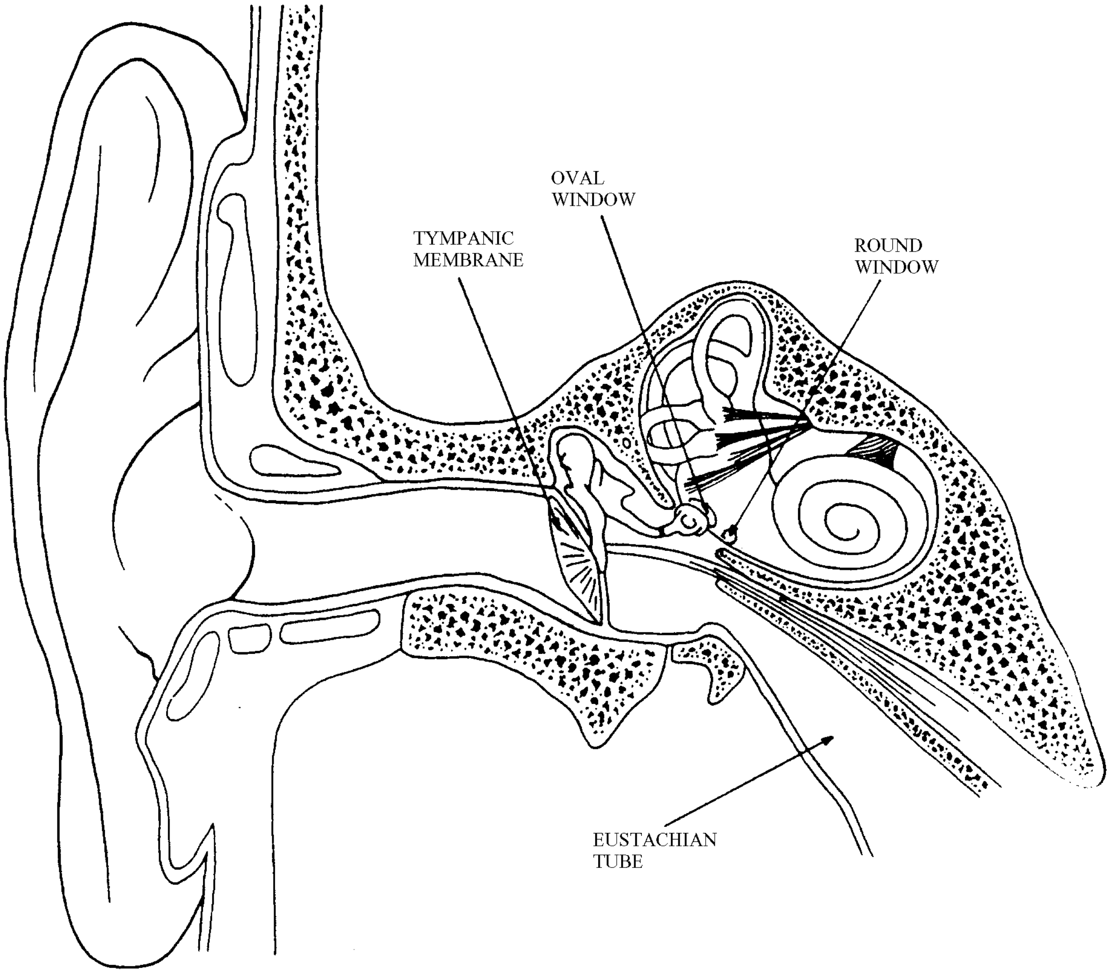


Fig 13-17. Diagrammatic Representation of the Outer, Middle, and Inner Ear

c. Another effect of the valsalva manoeuvre is to increase intracranial pressure. If powerful Valsalva manoeuvres are undertaken to clear the ears, the combination of raised intracranial pressure conducted through the inner ear and reduced pressure in the middle ear may be sufficient to cause the round (and occasionally the oval) window membrane to rupture (see Fig 13-17 and para 1334).

d. **Symptoms and Signs**

(1) The initial symptom is a sense of pressure and fullness in the ear. With further descent sharp pain may occur in the affected ear(s). Initial presentation of symptoms occur most commonly within the first 3-4m of descent. If the pain is not relieved by successful equalisation manoeuvres, it should prevent further descent. If the tympanic membrane ruptures, relief of the pain will result almost immediately. If this results in the ingress of water to the middle ear, caloric vertigo due to a thermal imbalance between the two ears may result (see para 1336). Occasionally, a diver may experience no pain during descent, but be found to have clinical evidence of middle ear barotrauma after the dive is over.

(2) Following the dive, residual symptoms may include pain and a sensation of fullness in the ear. In a small proportion of cases, blood may be visible in the mouth or nose.

(3) The ears should be examined with an otoscope by suitably trained personnel. Six grades of middle ear barotrauma have been described.

Table 13-3. Examination Guide

Grade	Symptom
Grade 0	Symptoms with a normal otoscopic appearance.
Grade 1	Diffuse redness and retraction of the tympanic membrane.
Grade 2	Grade 1 changes plus slight haemorrhage within the tympanic membrane.
Grade 3	Grade 1 changes plus gross haemorrhage within the tympanic membrane.
Grade 4	Dark and slightly bulging tympanic membrane from free blood in the middle ear; an air fluid level may be present.
Grade 5	Perforation of the tympanic membrane. Blood may be seen within or issuing from the ear canal.

(4) A conductive hearing loss may be present in more severe forms of squeeze, but this is rarely more than 20 db. Hearing loss is generally temporary and normal function returns within 4-5 days. If the hearing loss is greater than 20 db, the possibility of ossicular chain disruption should be considered. This is particularly likely if perforation of the TM has occurred in the superior, posterior aspect of the drum.

e. **Prevention**

(1) Avoid diving with a cold or congestion, since the eustachian tube is more likely to be blocked than usual. Divers who cannot clear their ears on the surface should not dive.

(2) Ear clearing should be accomplished by yawning, working the jaw up and down or GENTLE Valsalva manoeuvres.

WARNING

NEVER USE FORCEFUL VALSALVA MANOEUVRES TO CLEAR THE EARS.

(3) When descending, prevent a relative reduction of middle ear pressure from developing by clearing the ears frequently. If too large a pressure difference is allowed to develop, the eustachian tube will collapse making further attempts to clear the ears fruitless. If difficulty clearing the ears is encountered on descent, ascend and try to equalise the middle ear pressure before attempting to descend again. Do not persist with attempts to clear the ears - abort the dive. Above all, do not continue to descend.

Note. *Opening the eustachian tubes is more difficult in the inverted position, such as when the diver swims downward. It is easier if the diver descends feet first.*

f. **Treatment**

(1) If there is bleeding from the ear or vertigo following a dive the patient should be seen by an ENT Specialist. Ear drops which contain drugs which may be ototoxic should NOT be used if a perforated tympanic membrane is seen or suspected.

(2) Where a round window rupture is suspected, patients should be kept at rest with the head elevated (sitting) during transport.

(3) A diver with a middle ear squeeze should not return to diving until the healing is complete. Some general guidelines for time to recovery are as follows:

Table 13-4 Recovery Time

Grade	Symptom	Period
Grade 1-2	(mild)	8-72 hours
Grade 3	(moderate)	2-8 days
Grade 4-5	(severe)	2-6 weeks

All cases must be reviewed on an individual basis by a Medical Officer before diving is resumed.

1332. Reversed Ears

a. **Cause.** If the external auditory meatus is blocked by an obstruction such as wax, a tight-fitting hood, or otitis externa, the pressure in the outer ear can not equilibrate with the ambient pressure. During descent therefore, a relative vacuum develops in both the outer and middle ear. When the ears are cleared, the tympanic membrane balloons outwards, in the opposite direction to that which occurs in more conventional middle ear barotrauma hence ‘reversed’ ears. If this persists for more than a few minutes, injury to the epithelial lining of the external auditory meatus and the tympanum may occur, consisting of oedema and petechial haemorrhages which occasionally progresses to more substantial haemorrhage into the ear canal.

b. **Prevention**

(1) Do not dive with a tight-fitting hood.

(2) Do not insert plugs of any kind into the ear prior to diving.

(3) Do not dive with an external ear infection.

c. **Symptoms and Signs**

(1) The onset of pain, similar to that which occurs in the more classic middle ear barotrauma described above.

(2) There may be a mild conduction deafness, vertigo and nausea until the pressure is relieved.

(3) The lining of the external ear canal is often swollen and haemorrhagic. There may be bleeding from the ear.

(4) There may be a perforation of the tympanic membrane, but this is unusual.

d. **Treatment.** Patients with reversed ears should be seen by an ENT Specialist, particularly if a perforation of the tympanic membrane is suspected or observed. In order to prevent infection, do not interfere with the external ear canal and do not instil ear drops which may be ototoxic. Most cases resolve spontaneously.

Note. *Very occasionally, the eustachian tube becomes blocked during a dive and limits the rate at which gas may leave the middle ear during ascent. This may also result in the ear drum bulging outwards, but there are no associated signs in the outer ear.*

1333. Barotraumatic Facial Palsy

In a small number of individuals, the facial nerve is exposed to middle ear pressure as it traverses the temporal bone. If the middle ear is pressurised during ascent, due to failure of the Eustachian tube to vent, the vascular supply of the facial nerve may be compromised resulting in an ischaemic neuropraxia. Generally 10-30 minutes of over pressure are necessary for symptoms to appear. During this period, nausea and vertigo may be present. The syndrome is characterised by a unilateral facial palsy of the lower motor neurone type. When the syndrome presents shortly after surfacing, it may be difficult to distinguish the condition from decompression illness. Once the middle ear vents, full facial function generally returns between 10 minutes to 2 hours.

1334. Inner Ear Barotrauma

a. **Cause.** A combination of middle ear squeeze and powerful valsalva manoeuvres can result in rupture of the round or (much less frequently) the oval window membranes. This is known as inner ear barotrauma (IEB). When the round window is ruptured, perilymph fluid leaks into the middle ear space, a condition which is also known as perilymph fistula.

b. **Symptoms and Signs.** A sudden onset of vertigo which may be associated with tinnitus, hearing loss, nystagmus, nausea or vomiting. However, if the rupture in the round window is small, it may take some time for sufficient fluid to leak out to provoke these symptoms and consequently, presentation may be delayed for hours or possibly days. Quite commonly the diver may not notice symptoms until after surfacing. Unlike alternobaric or caloric vertigo, (paras 1335 and 1336) however the symptoms are not transient.

(1) *Hearing Loss.* There may be a conductive hearing loss associated with middle ear barotrauma or a neurosensory hearing loss. It should be remembered, however, that the most common cause of a neurosensory hearing deficit in divers is noise.

(2) *Vertigo.* It is important to differentiate true vertigo from other more vague symptoms such as dizziness, lightheadedness, fainting and weakness. True vertigo is characterised by a **false sense of motion that is whirling or rotational in nature** and results from abnormal vestibular function either in the inner ear or the eighth nerve pathways. Dizziness without a sense of rotation is unlikely to be due to vestibular dysfunction. The presence of nystagmus is diagnostic in discerning vertigo from dizziness.

d. **Treatment.** The acute treatment consists of observation and bed rest with the head elevated. It is common for the symptoms to resolve spontaneously. If symptoms fail to resolve, surgical repair of the fistula may be required consequently, (**ENT referral is mandatory**).

1335. Alternobaric Vertigo

This is a common problem in divers. During descent, or, more commonly, during ascent and particularly when travelling in the upright position, the change of middle ear pressure between the two sides may be asymmetrical. This can result in a transient sensation of vertigo, disorientation and nausea. Normally this sensation does not last for more than a few minutes, but if it occurs at depth, it can be hazardous. The condition can largely be avoided by ensuring that the ears are cleared properly. When it occurs, the diver should stop and hold on to a shot line or buddy until the sensation wears off.

1336. Caloric Vertigo

Normally, immersion results in water entering both ears more or less simultaneously. Consequently, the vestibular apparatus in the inner ear is cooled at a similar rate on each side. However, if one ear is partially or completely blocked by a tight-fitting hood or with ear wax, there may be a difference in the rate of cooling of the two sides. Unequal stimulation can also occur with perforation of one Tympanic Membrane. Under these circumstances a powerful sensation of vertigo may result. As with alternobaric vertigo, this tends to be a transient sensation. The vertigo lasts until the water warms to body temperature. The symptoms will be most intense when the diver is in a head down orientation. By assuming an upright posture, the symptoms will be ameliorated.

1337. Otitis Externa (Swimmer's Ear)

a. **Cause.** Repeated immersion can cause breakdown of the skin which lines the external ear canal and this then allows the bacteria and fungi which are normally present to multiply. It is a condition which most commonly occurs during saturation diving, although frequent immersion of the ears for any reason, such as an intensive diving course or holiday, can promote the condition.

b. **Prevention**

(1) **This is a completely preventable condition.**

(2) 7% Aluminium acetate solution or Otic Domeboro ear drops will prevent infection if applied after each wet dive. These solutions are bacteriostatic and astringent. Three or four drops of the solution should be poured into each ear in turn and left for a **minimum** of 5 minutes.

(3) During intensive diving operations the drops should be applied at least every morning and night, and after each wet dive or shower.

c. **Symptoms and Signs**

(1) Itching and/or a wet feeling in the affected ear. This may progress to severe local pain as the external ear becomes swollen and inflamed. There may be a foul-smelling, creamy discharge from the ear.

(2) Swelling of lymph nodes in the neck which may make jaw movement painful.

(3) Fever in severe cases.

d. **Treatment**

(1) A temporary cessation of diving so that the ear can be kept dry.

(2) Continued use of aluminium acetate drops plus appropriate antibiotic ear-drops if necessary.

(3) In serious cases, systemic antibiotics may be necessary.

1338. Middle Ear Oxygen Absorption Syndrome

a. **Cause.** During a long oxygen dive, gas with a high percentage of oxygen will enter the middle ear cavity. Following such a dive the oxygen is slowly absorbed and metabolised by the tissues of the middle ear and if the Eustachian tube does not open spontaneously a negative pressure relative to ambient may develop. Symptoms may not become apparent for some hours after completion of the dive. A fluid level (serious otitis media) may be seen in the middle ear on otoscopy. Middle ear oxygen absorption syndrome is difficult to avoid but usually does not pose a significant problem because the symptoms are generally minor.

b. **Symptoms.** The diver may notice mild discomfort and hearing loss in one or both ears. There may also be a sense of pressure and a moist, cracking sensation. Attempts at equalising the pressure in the middle ear using a Valsalva manoeuvre are usually successful, although occasionally a decongestant may be required.

1339-1340. Spare.

1341. Near Drowning

a. **Cause.** Drowning is the most common cause of diving fatalities. Divers, despite being properly equipped, trained and supervised may still succumb to drowning as the result of accidents, panic, over-exertion or the effects of cold. If a diver loses consciousness he may drown.

b. **Symptoms and Signs**

(1) Loss of consciousness.

(2) Often the body is leaden-blue in colour.

(3) Froth around the nose and mouth.

(4) Sand, mud, seaweed in the nose, mouth or throat.

c. **Treatment**

(1) Clean the mouth and throat of debris, check breathing and circulation and commence cardiopulmonary resuscitation if necessary. DO NOT waste time trying to drain the lungs. If a sloping surface is available put the patient in a head-down position to prevent him choking on any stomach contents.

(2) Administer O_2 if a suitable apparatus is available (15 litres/minute).

(3) Drowning victims who are severely hypothermic may appear dead. The victim should not be considered dead until he is completely re-warmed and continues to be unresponsive to resuscitation, or is pronounced so by a Medical Officer.

(4) Cardiac massage may not be appropriate in cases which are also hypothermic (see para 1344).

Notes:

1. A person with water in his lungs may not lose consciousness immediately, but may still die later from 'secondary drowning' due to pulmonary oedema resulting from a reaction to the inhalation of either fresh or salt water.

2. All suspected near drowning victims should be observed in hospital for 24 hours.

1342. Vomiting Underwater

This is an extremely dangerous and potentially life-threatening event.

a. **Causes**

(1) Diving with a gastro-intestinal upset.

(2) Over-exertion after recent intake of alcohol or food.

(3) Vomiting may occur as part of another underwater incident such as O_2, CO_2, CO poisoning, or ingestion of a caustic cocktail etc.

b. **Prevention**

(1) Ensure that there is an adequate interval between eating or drinking and diving (at least 2 hours). Apart from increasing the risk of vomiting, the ingestion of alcoholic drinks prior to diving must be discouraged because of the additive effect with inert gas narcosis (para 1324) and consequential dehydration.

(2) The attendant should be alert to a diver in difficulty.

c. **Treatment**

(1) Remove the diver from the water as soon as possible.

(2) Remove the breathing apparatus.

(3) If the diver is unconscious, check that the air passage is clear by running the finger around the inside of patient's mouth and removing any vomit. Remember, a diver who can speak has an adequate airway.

(4) Give cardiopulmonary resuscitation if necessary (paras 1303 and 1304).

Note. *There is a danger that semi-digested food may lodge in the mouthpiece, regulator or windpipe and result in airway obstruction. If vomiting occurs, remove the mouthpiece if this can readily be done.*

1343. Underwater Blast Injury

a. **Cause.** The shock waves generated by an underwater explosion cause the 'shredding' of body tissues, particularly those which contain gas.

b. **Prevention**

(1) Avoid being in the water if underwater explosions are expected.

(2) If this is not possible, the diver should wear plenty of clothing under the UWSS.

(3) Present the smallest area of the body towards the charge.

(4) The diver should keep near the surface and swim on his back.

c. **Symptoms and Signs**

(1) Perforated eardrums.

(2) Pain arising from internal injuries to lungs, bowel, etc. (Often there is little visible external injury, but internal injuries may be extensive.)

(3) Shock.

d. **Treatment**

(1) Treat for shock (para 1308).

(2) Arrange for immediate transport for medical attention.

(3) Subsequent management will depend on the site and extent of the injuries.

1344. Cold Exposure and Hypothermia

a. **Acute Cold Immersion.** A sudden drop in skin temperature such as on entry into the water or the rapid influx of cold water into a diving suit can result in a profound physiological response. An unprotected man plunged into very cold water will experience an immediate increase in pulse rate and blood pressure and a period of rapid, gasping breathing. Even competent swimmers may be unable to co-ordinate breathing and swimming movements and inhale water. The rapid pulse and high blood pressure response may result in circulatory failure in unfit people. Fortunately, because divers intentionally entering cold water wear protective clothing, such experiences in diving are very rare.

b. **Sub-acute Cold Immersion.** Immersion in water below 32°C will soon result in the unprotected diver becoming chilled. Discomfort is followed by involuntary muscular contraction to produce heat - shivering. As cooling continues, a diver's ability to perform useful work becomes seriously impaired. Manual dexterity is reduced and the sense of touch is dulled. As shivering intensifies it brings on a general lack of co-ordination such that it may be difficult to keep a mouthpiece in place. With further cooling the ability to concentrate and think clearly is soon lost. At this stage, a diver is more prone to make mistakes which could be fatal.

c. After prolonged immersion in cool water, heat loss can reach a point at which death occurs from hypothermia. In water at 6°C an unclothed man of average build will become helpless within 30 minutes and will probably die within an hour. An appropriately dressed diver, however, can work in very cold water for prolonged periods of time. Consequently, hypothermia in divers is usually a result of an error such as:

(1) Inappropriate choice of diving suit.

(2) A leaking dry suit.

(3) Long periods of inactivity.

(4) Exposure to wind-chill after leaving the water.

(5) An inadequate supply of hot water (volume or temperature) when wearing a hot water suit.

d. **Prevention**

(1) Wear a diving suit and, where necessary, thermal undergarments appropriate to the water temperature.

(2) Check for leaks before diving.

(3) If the use of inadequate thermal protection is unavoidable, the use of surface decompression procedures will help reduce cold exposure.

(4) Wear a windproof cover if exposure to the elements continues after surfacing.

(5) Ensure that the hot water supply to a hot water suit is of sufficient volume and at an adequate temperature. It should be remembered that if the loss of body heat is gradual, the diver may not recognise that he is becoming hypothermic.

(6) Do not re-expose a diver to cold water until he is thoroughly rewarmed. A diver will subjectively feel warm long before the warming process is complete. A diver is not completely rewarmed until sweating is induced.

e. **Symptoms and Signs.** The symptoms and signs of a falling body core temperature are described in para 0140.

f. **Treatment**

(1) Prevent further heat loss.

(2) Handle with care, maintaining the patient, as far as possible, in a horizontal position during and following removal from the water. This is to prevent cardiovascular collapse.

(3) Basic cardiopulmonary resuscitation should be started if necessary. However, caution should be exercised in making the decision to commence cardiac massage, since this will have to be continued until the patient is fully rewarmed. If a significant delay is expected before rewarming can commence, then cardiac massage should not be started. It should be remembered that cardiac resuscitation in the severely hypothermia diver may precipitate ventricular fibrillation - which may prove fatal.

(4) Arrange for transport to a medical facility at the earliest opportunity.

(5) Mild cases of hypothermia, in which the patient has retained full consciousness, may be rewarmed by careful immersion of limbs and torso in a hot bath (40°C). If possible, such patients should then be seen by a Medical Officer.

1345. Heat Exhaustion (see also paras 0921 and 0922)

a. **Causes**

(1) Over-exertion in warm water when wearing a 'dry' suit, or a 'wet' suit which is too thick. Warm water is defined as water of 25°C or above.

(2) Normal levels of exertion in water of between 30°C and 35°C may result in heat exhaustion, especially in the unfit diver.

(3) At water temperatures of 35°C and above heat exhaustion will occur even if the diver is fit and at rest.

(4) Wearing a diving suit at the surface while unprotected from the sun.

(5) Excessive heating of a hot water diving suit.

b. **Prevention**

(1) Wear suitable equipment. A lightweight 'wet' suit or overalls are suitable where the water temperature is over about 25°C. Dives in water above 30°C should only be performed by fit acclimatised divers and where possible hard work should be avoided. Diving should not take place in water at or above 35°C. The use of 'dry' suits in warm water should be restricted to diving in polluted water where it is necessary to minimise skin contact with the water.

(2) Ensure adequate protection from the sun when at the surface and wear loose-fitting clothing which permits the evaporation of sweat.

(3) If it is necessary to wear a diving suit while on the surface, wearing an additional layer of material which is soaked in water will encourage evaporative cooling.

(4) Water must be drunk in quantities of at least 1 litre per hour when sweating. Salt should not be added. Do not rely on divers drinking fluids when they wish to, since many will drink too little. The colour of the urine may be used to assess adequate fluid intake. In general the urine should be colourless, or pale. Dark urine indicates an inadequate fluid intake.

c. **Symptoms and Signs**

(1) Dizziness, restlessness and headache.

(2) Rapid pulse and usually, but not always, excessive sweating.

(3) Initially, the skin will be clammy and cool to the touch. As heat exhaustion progresses the skin becomes dry and flushed in appearance.

(4) Raised temperature.

(5) Twitching and cramp.

(6) Reduced level of consciousness and, eventually, coma.

d. **Treatment**

(1) Rest the patient in a cool place.

(2) Encourage the patient to drink plenty of water.

(3) *Initiate Cooling.* This is best achieved through evaporative heat loss. Wetting the skin or a single layer of thin clothing and fanning will promote this. Ice packs should be avoided. The vasoconstriction they promote may actually reduce the rate of body cooling.

(4) All but the mildest cases must be evacuated to hospital, because heat illnesses readily, and occasionally rapidly, deteriorate to life-threatening severity. Furthermore, it may take 24 hours or longer for spontaneous thermoregulation to be restored.

(5) Those who have cramps or a reduced level of consciousness as a result of heat exhaustion must be seen by a medical officer before returning to diving.

1346. Decompression Pulmonary Barotrauma

Decompression pulmonary barotrauma is a syndrome which results in gas which is normally retained within the alveoli leaving its natural confines and entering either the interstitial space within the lung, the pleural cavity or the blood stream.

a. **Cause.** The mechanisms whereby this happens are incompletely understood. At the simplest level, if gas which has been breathed while at depth is trapped within the lung during ascent, then the resulting expansion in volume of that gas, in accordance with Boyle's Law, may be sufficient to cause the architecturally delicate pulmonary tissue to rupture. The gas may be trapped as a result of voluntary or involuntary breath holding, or as a result of pulmonary pathology. However, numerous cases of decompression pulmonary barotrauma have occurred in which no evidence of pulmonary pathology has been found and exhalation during ascent has been witnessed by independent observers. Consequently, there probably remains other causes of the condition, which have yet to be identified.

b. **Prevention.** A number of preventive measures are taken:

(1) Divers and those undergoing training for escape from submarines are trained not to hold their breath during ascent.

(2) Both divers and submariners are carefully screened for evidence of obstructive lung disease which may result in the trapping of gas. This applies both at entry into the branch and during employment. Those suffering from short-term respiratory illness should not dive or undertake submarine escape training.

(3) Other preventative measures which help to promote safe ascents include the careful planning of dives, adherence to the plan and the avoidance of emergencies, such as running out of air.

(4) The practice of skip breathing underwater should be discouraged.

c. **Symptoms and Signs.** Decompression pulmonary barotrauma is often associated with the following symptoms and signs:

(1) A sharp chest pain, usually behind the breast bone.

(2) Shortness of breath.

(3) Difficult or painful breathing.

(4) A cough which may produce slightly blood-stained sputum.

d. Depending on the route which the gas takes after lung rupture, additional symptoms and signs may be observed.

e. **Mediastinal and Subcutaneous Emphysema.** If gas escapes into the interstitial tissue space, it may track along the outside of the airways and blood vessels into the mediastinum. This is the space between the lungs which contains the heart, great vessels and major airways. The presence of a little gas in the mediastinum is often symptomless. However, if tissues are stretched by a substantial amount of gas, mild to moderate retrosternal pain may be felt. Other possible symptoms include a sensation of fullness in the chest or throat and a change in the tone of the voice or hoarseness. Gas in the mediastinum may migrate up into the subcutaneous tissues of the neck and, occasionally, the head. It is not usually painful and may only be detected by noticing swelling or crepitation (the skin 'crackles') in the neck when doing up a collar.

f. **Pneumothorax.** A pneumothorax occurs when alveolar gas escapes into the pleural space. This is often painless but may cause a sharp pain which is made worse by taking a deep breath. Depending upon how much gas leaks into the pleural space, there may be shortness of breath and, possibly, slight blueing of the lips and finger nail beds (Cyanosis). Normally there are few physical signs, so this condition may not be recognised except by medical staff. This is not a life-threatening condition because it is possible to survive with one intact lung and it is most unusual for both lungs to be involved simultaneously. Occasionally, however, the leak is such that gas escapes into the pleural space with each breath, but is unable to return to the lung. Under these circumstances the volume of the pneumothorax gradually increases. This is known as a **Tension Pneumothorax**. This is dangerous because if gas continues to escape from the perforated lung, the pressure generated within the chest may eventually cause both lungs to collapse. Cyanosis will become pronounced and shock, unconsciousness and death may ensue unless the patient is treated appropriately.

Tension pneumothorax is a rare condition under normal conditions at the surface. However, a simple pneumothorax which occurs at depth may increase in size during decompression and effectively become a tension pneumothorax. If a diver's condition deteriorates during ascent, especially if the symptoms are respiratory, a pneumothorax should always be suspected.

g. **Treatment.** Asymptomatic mediastinal emphysema and subcutaneous emphysema usually resolve gradually without specific treatment. If there are troublesome symptoms, resolution will be accelerated by breathing 100% O_2 on the surface. In the very rare instances where there are serious symptoms, recompression may be necessary. If there is no associated pneumothorax, it is safe to compress to 10m for an hour breathing 100% O_2. A small pneumothorax can be treated by breathing 100% O_2 on the surface. Large pneumothoraces and all tension pneumothoraces require draining. A chest drain, large bore IV cannula, or some other device with a one-way valve (such as a Heimlich valve), should be inserted into the chest by an appropriately trained individual.

h. **Arterial Gas Embolism.** If gas from a ruptured lung enters the pulmonary microcirculation, it will migrate to the left side of the heart and from there be distributed to the body as arterial gas emboli. Two organs which are particularly susceptible to functional disturbance as a result of such emboli are the brain and heart. Consequently, divers or submarine escape trainees who have sustained decompression pulmonary barotrauma should be carefully examined for evidence of cardiac or cerebral disorders. In the past, it was considered possible to make a diagnosis of arterial gas embolism in patients who experienced the onset of neurological symptoms during decompression or shortly after surfacing from a dive. This diagnosis was made even in the absence of any other evidence of decompression pulmonary barotrauma. It is now recognised that such a diagnosis may be inaccurate, since other conditions may present in a similar manner. Consequently, neurological symptoms or signs presenting after a hyperbaric exposure should be termed acute neurological decompression illness - see Section 4 Diving Disorders Which Require Decompression.

1347. Gastrointestinal Barotrauma

a. Gas within the intestine expands during decompression and may result in eructation (belching), flatus or abdominal discomfort. Rarely, colicky abdominal pain, abdominal distension and 'tinkling' bowel sounds occur which may resemble bowel obstruction.

b. As a preventative measure, heavy meals and carbonated drinks should be avoided prior to a dive.

c. Swallowing gas (aerophagia) when under pressure is dangerous because serious gastrointestinal barotrauma, possibly resulting in rupture of the bowel, may result.

1348-1350. Spare.

SECTION 4 - DIVING DISORDERS WHICH REQUIRE RECOMPRESSION

1351. Acute Decompression Illness

a. **Background.** Acute decompression illness (DCI) is a syndrome of numerous possible manifestations which may develop following decompression. It is thought to be initiated by the presence of bubbles of gas in body tissues - including the blood stream. Although the means whereby these bubbles cause tissue dysfunction have yet to be fully elucidated, the manifestations have been recognised for many years and are described below.

b. **Disease Mechanisms.** There are a number of sources of these gas bubbles.

(1) *Dissolved Gas.* The concentration of inert gas in arterial blood is approximately the same as in the gas mixture which is being breathed. For example, at sea level, both air and arterial blood contain approximately 0.8 atmospheres of nitrogen. During most dives or hyperbaric exposures, the partial pressure of inert gas which is breathed increases with depth and the concentration of that gas in arterial blood increases accordingly. Under these circumstances, the partial pressure of inert gas in tissues will gradually increase until it equals the ambient partial pressure. The dynamics of tissue gas exchange are beyond the scope of this text, but can be summarised by the statement that it is, at present, incompletely understood.

(2) During decompression, inert gas moves in the opposite direction, from the tissues into the blood, where it is carried to the lungs and exhaled. If this process occurs in a controlled manner, so that the inert gas tension does not reach a sufficient level of supersaturation for bubbles to form, the decompression will progress uneventfully. However, if the rate of decompression is such that the capacity of the tissues, cardiovascular system and lungs to remove inert gas is exceeded, bubbles of that gas may start to form. These bubbles may form in tissues or blood.

(3) The human body is capable of tolerating a certain bubble burden. Bubbles in venous blood, for example, are efficiently removed from the circulation by the lungs and numerous studies have demonstrated the presence of such bubbles in asymptomatic divers. Furthermore, bubbles may form in some tissues (such as adipose tissue) without causing overt disease. However, other tissues, particularly nervous tissue, are much more sensitive and the presence of even a small number of gas bubbles may result in abnormal tissue function. How these bubbles provoke decompression illness has yet to be completely clarified. Hypotheses for the means whereby they exert their deleterious effects on tissue function include: the physical disruption of tissue architecture; interruption of tissue microcirculation and derangement of tissue biochemical activity at the tissue-bubble interface.

(4) *Arterial Gas Bubbles.* As was mentioned above, the lungs are excellent filters of gas bubbles, however, this capacity is finite and if the bubble burden is such that this is exceeded, they may transit the lungs and reach the arterial side of the circulation.

(5) The transit of venous bubbles to arterial blood may occur before the pulmonary filter is overwhelmed. In approximately 25-30% of the normal, adult population, the septum which separates the upper chambers of the heart contains a potential or actual defect which is known as a **Patent Foramen Ovale** or PFO. This is a relic of the foetal circulation and normally results in no ill-effects. However, it does offer a possible route for bubbles to bypass the pulmonary filter and consequently, along with other right-to-left shunts, has the potential to promote the arterialisation of otherwise relatively harmless venous bubbles.

(6) Another source of arterial gas bubbles was discussed in para 1346.

(7) How bubbles in arterial blood interfere with tissue function is another subject which is incompletely understood. One obvious mechanism is that they physically obstruct small blood vessels and thereby cause tissue ischaemia. The behaviour of bubbles in the cerebral circulation has been studied extensively and, although the obstruction of blood vessels occurs as soon as bubbles arrive in the brain, this effect appears to be short-lived. Cerebral blood vessels respond to the presence of bubbles by dilating and thus allowing the bubbles to move on. It is now thought that much of the illness which results from bubble embolism of the brain is due to the consequences of traumatic injury to the delicate endothelial lining of cerebral blood vessels, which, in places may be stripped away from the vessel wall. This results not only in a breakdown of the blood-brain-barrier and the consequential leaking of potentially harmful blood constituents into the brain, but also, by exposing blood components such as white blood cells and platelets to the damaged blood vessel wall, a tissue reaction to injury is promoted. Ironically, it is the physical and biochemical consequences of this reaction which may actually result in a further deterioration of cerebral blood flow and function.

(8) Although it is recognised that tissue bubbles may arise from two fundamentally different processes, it is often difficult, in individual cases, to be certain of the origins of the disease-provoking gas. Indeed, with respect to some organ systems, such as the ear and lungs, it may occasionally be difficult to distinguish between a condition caused by dissolved gas coming out of solution and the results of barotrauma. Consequently, it is now recognised that, for practical purposes, the distinction between the condition that used to be known as decompression sickness and arterial gas embolism was artificial. As a result, the term decompression illness, which encompasses the two is increasingly being used to reflect this.

c. **Symptoms and Signs.** Since decompression illness can interfere with the function of a wide range of body tissues, the number of potential signs and symptoms is truly enormous. In the past, these have been lumped together into syndromes according to the anatomical site and presumed mechanism of disease. One of these syndromes has been further classified into types according to a dichotomy of perceived severity: Mild (Type 1) and Serious (Type 2) decompression sickness. These terms are still used, but it is increasingly recognised that they are of very limited value.

d. **Descriptive Protocol.** Rather than imposing this somewhat artificial classification on the decompression disorders, a better understanding of the natural syndromes is likely to result if a descriptive system is used. To simplify what could otherwise end up as a bewildering collection of terms, the symptoms and signs of decompression illness will be discussed using evolution and manifestation terms.

(1) *Evolution.* The evolution term is used to describe the development of the condition PRIOR TO RECOMPRESSION. These terms are best used to describe decompression illness as it evolves. Because it is frequently a highly dynamic condition, the term used may change from one observation to the next, eg a condition will probably present initially as being '**progressive**' as the patient becomes increasingly aware that something is wrong. However, the situation frequently stabilises so that it may then be described as '**static**'. The patient may then undergo a substantial improvement, occasionally to complete resolution of the symptoms, and at that stage be described as '**spontaneously improving**'. Occasionally, the symptoms may then return or new symptoms appear, in which case the condition would be described as '**relapsing**'.

(a) *Progressive.* A condition may be described as progressive if the number or severity of symptoms or signs is increasing. Examples would include an increasing severity of limb pain or the involvement of additional joints or a neurological presentation in which the loss of motor or sensory function is becoming more profound or where the extent of any loss of function is increasing, such as the cephalad extension of a deficit with a predominantly spinal distribution. The development of a new manifestation, such as a neurological symptom or sign in addition to limb pain also represents progression of the condition. Terms such as 'rapidly' or 'slowly' may be used to enhance the description of this evolution where this is appropriate. 'Rapidly' and 'slowly' would refer to the progression of symptoms over a period of minutes or hours respectively.

(b) *Static.* This is self explanatory. Neither the severity or number of manifestations is changing substantially.

(c) *Spontaneously Improving.* It is common for a number of presentations of decompression illness to improve, albeit transiently in certain instances, without recompression. Substantial improvement must occur for this term to be applied. As with other evolution terms, 'improving' should only be used to describe events prior to recompression.

(d) *Relapsing.* Occasionally, cases which have improved spontaneously undergo a secondary deterioration. This is particularly true of some neurological manifestations. This term is used to describe such cases. When a condition gets worse in the absence of any spontaneous improvement it should be described as 'progressive'. 'Relapsing' should be reserved for cases which have, at some stage in their evolution, undergone substantial, spontaneous improvement.

(2) *Manifestations.* There are a number of manifestations of decompression illness which occur commonly and these are outlined below. They may occur alone or in combination. Occasionally, unusual cases occur and in such instances, the use of additional descriptive terms may be required.

(a) *Pain*

(i) *Limb Pain.* This is probably the most frequent manifestation of decompression illness. It is used to describe the deep aching pain in or around one or more joints which may begin during decompression or after completion of a dive. Following 'bounce' dives, the upper limbs tend to be involved more often than the lower limbs and the shoulder is involved particularly frequently. Conversely, in saturation divers, aviators and compressed-air (caisson) workers, it is the lower limbs and particularly the knees which are involved most commonly. The pain usually begins gradually and is poorly localised; it may resolve spontaneously and is then known as a 'niggle'. Niggles may flit from joint to joint. If the pain gets worse, it becomes more readily localised and is described as a dull, boring ache, similar in character to tooth ache. Sometimes the joint is held in a particular position that is least painful, but pain is seldom made worse by movement. If the pain is in a lower limb, weight bearing may be poorly tolerated on that limb. On examination, there are often no objective signs. Occasionally, there is a skin rash over or adjacent to the affected joint. Notably, the 'classical' signs of inflammation: redness, swelling, warmth to the touch and tenderness are missing. Even cases of apparently straight-forward limb pain must be FULLY EXAMINED. A patient in pain may not notice mild paraesthesia or a small area of numbness. Ensure that no neurological symptoms can be detected before the choice of a therapeutic table is made. Limb pain decompression illness usually resolves completely, even without treatment over a period of 12-72 hours. However, deliberate withholding of recompression is difficult to justify. Not only is rapid relief of pain usually obtained but, particularly in cases where there has been a rapid onset of pain after surfacing, the onset of subsequent neurological symptoms may be prevented.

(ii) *Girdle Pain.* This is a poorly localised, aching or 'constricting' sensation which is generally in the abdomen, pelvis, or occasionally, in the chest. Girdle pain in the context of DCI is generally considered ominous since it frequently portends neurological deterioration.

(b) *Neurological.* Involvement of the nervous system may be subtle, multifocal and consequently of bewildering variety and very difficult to localize. Both the central and peripheral nervous systems may be involved and the manifestations can be broken down into the loss of certain functions: higher functions, which would include aberration of thought processes or affect, loss of memory, dysphasia etc; alteration to the level of consciousness, including seizures; loss of co-ordination; loss of strength or sensation with almost any distribution; dysfunction of special senses and loss of sphincter control, especially of the bladder. It is likely that many of these disorders involve the brain. In these cases, some loss of consciousness to the point of disorientation is a frequent finding and coma may occasionally ensue. Visual symptoms are common, as are motor and other sensory deficits. Because this disease may be subtle, it is most important that a diving supervisor knows his divers. Otherwise signs such as a change of mood, dulling of intellect and loss of short-term memory may go unrecognised.

(c) It is apparent that the spinal cord is also involved in neurological decompression illness with some frequency. It may appear to be involved alone or with other parts of the nervous system.

(d) Dives which readily appear to provoke disease with a predominantly spinal cord distribution are short, deep dives with a rapid ascent to the surface. The onset of symptoms commonly occurs shortly after reaching the surface, with about half of serious cases becoming symptomatic within 10 minutes. Less than 10% of serious cases present more than 4 hours after completing the dive. In severe cases, the condition is often heralded by the onset of girdle pain. Shortly afterwards, the patient may notice pins and needles, numbness and muscular weakness in the legs which rapidly progresses to paraplegia. It is possible for all four limbs to be involved and, in severe cases, shock may complicate the clinical picture. In less severe cases, the onset is not so dramatic and progress to paraplegia may be delayed and incomplete. There may be little in the way of girdle pain in such cases. On examination, it is often possible to determine a ‘level’ above which spinal cord function is apparently normal. This level is often in the lower thoracic or upper lumbar segments. It is occasionally possible to determine different levels for motor innervation and the various sensory modalities. The bladder is frequently involved. The patient may report difficulty initiating urination, but more often, this will be detected by the absence of urinary output and the presence of a distended bladder on examination of the abdomen.

(e) Unless the fulminant condition is rapidly treated by recompression, a complete recovery is unlikely. The prognosis for cases with a less dramatic onset is better. Even without recompression some spontaneous improvement generally occurs. Nonetheless, improvement will be more rapid and complete with recompression.

(f) *Audio-Vestibular.* This is a unique subclass of neurological decompression illness. It is thought that there are two mechanisms whereby the audio-vestibular system may be involved: Barotrauma (para 1346) and Tissue injury caused by the formation of bubbles from dissolved gas. Possible targets of this second mechanism include the cochlea, the eighth nerve nuclei and cerebellar or cortical pathways. In individual cases it may be very difficult to distinguish between these mechanisms or sites of injury by clinical examination alone. As a consequence this term may be used to describe the syndrome which includes: vertigo (a sense of rotation), tinnitus, nystagmus or loss of hearing after a dive. Nausea and vomiting may accompany these symptoms, but of themselves are not sufficient to imply audio-vestibular involvement in decompression illness. Experimental and anecdotal evidence now exists to show that recompression does not appear to have an adverse affect on pathology due to round or oval window rupture. Therefore, if the mechanism of disease is uncertain, appropriate recompression therapy should be undertaken. All such cases should then be referred for specialist investigation to establish the need for further treatment of a perilymph fistula.

(g) *Pulmonary.* As has been mentioned before, involvement of the lungs in decompression illness may be due to two quite distinct processes: decompression pulmonary Barotrauma and the cardiopulmonary consequences of massive venous gas embolism. Although the mechanisms involved are distinctly different, it may be difficult to distinguish between them immediately in a clinical setting, because many of the symptoms and some of the signs are shared: chest pain, cough, haemoptysis, shortness of breath, cyanosis and, rarely, shock. Progressive disease may be due either to a tension pneumothorax or massive gas embolism of the lungs. Where there has been a dive which has induced a low gas burden, it is most likely that a pneumothorax is the cause of the problem. This may be diagnosed clinically from the classic signs: cyanosis and respiratory distress; evidence of mediastinal shift away from the affected side; hyperresonance and reduced respiratory movements and breath sounds on the affected side. An x-ray, if available, will confirm the diagnosis. The presentation of patients with massive, overwhelming venous gas embolism of the pulmonary circulation has been described, although it is very rare and generally associated with deep dives and missed decompression. These patients usually become symptomatic within about half an hour of reaching the surface. The condition commences with central chest pain and a cough, which may be aggravated by taking deep breaths or inhaling cigarette smoke. Breathlessness and central cyanosis follow and, shortly thereafter, signs of shock. The condition is commonly progressive and the patient may deteriorate rapidly: cardiovascular collapse, loss of consciousness and death may follow, unless the patient is recompressed. Apart from cyanosis and respiratory distress, there are no signs of a pneumothorax.

(h) *Cutaneous.* The skin may be affected by diving in a number of ways. Two very common manifestations of decompression, which are not generally regarded as illnesses, are suit ‘squeeze’ and itching in the absence of a rash. The term ‘cutaneous’ decompression illness should be used to describe the condition which generally presents with severe itching around the shoulders or over the trunk. After a time, this develops into an erythematous rash which may progress to cyanotic mottling or marbling of the skin. When further describing the condition, it is desirable to identify the location of the disorder.

(i) *Lymphatic.* Occasionally, lymph nodes may become enlarged and tender and this may be associated with oedema. The skin feels thickened and may have the ‘pitted’ appearance of orange peel. If pressure is applied to the skin, for example, by the thumb and released after about a minute or so, a visible indentation remains.

(j) *Constitutional.* There are a number of non-specific symptoms which occur after diving and which, if severe or if accompanied by other manifestations, may be considered part of the decompression illness syndrome. These include headache, fatigue, malaise (which may include nausea and, possibly, vomiting) and anorexia.

1352. Terminology

By including the evolution and manifestation terms in the phrase ‘decompression illness’, a highly flexible diagnostic label can be applied to any case. This label imparts a great deal of information and because it does not require the observer to guess at either a mechanism of the disease or location of the lesion, it should be possible for the diagnosis to be applied consistently. The term acute is used to distinguish these conditions from possible chronic consequences of diving such as dysbaric osteonecrosis. Examples of how the terminology is used include:

Acute, relapsing neurological, decompression illness

or

Acute, progressive, limb pain and cutaneous decompression illness

In rare, highly complex cases, rather than enumerate a long list of manifestations, it may be appropriate to use the term ‘multisystem’.

1353. Additional Information

While the descriptive diagnostic terminology imparts a considerable amount of information, it is inadequate, of itself, to summarise a case of decompression illness. As was mentioned above, this a poorly understood syndrome and if a better understanding is to evolve, it is important that additional information is collected:

a. **The Time of Onset.** Decompression illness usually presents within a short period of time following a dive. Symptoms may become apparent before surfacing in saturation and occasionally in bounce dives, particularly where decompression has been omitted. However, most symptoms occur after surfacing and the majority of serious neurological or pulmonary symptoms are usually manifest within about 30 minutes. The onset of limb pain also occurs in this time period but this may be delayed for many hours after a dive. It should be remembered that decompression illness may be provoked or made worse many hours after a dive if the diver takes a flight. If a diver has been asymptomatic for 48 or more hours after a dive and has not flown, then symptoms which develop subsequently are probably not dive-related. The time of onset should be recorded as the time in minutes or hours from surfacing from the last dive to the onset of each manifestation of decompression illness. If a flight was taken after the last dive, this should be recorded as well.

b. **Gas Burden.** When considering possible mechanisms for decompression illness, it is desirable to have an idea of the amount of gas that is likely to be present in the various tissues. At present there is no convenient means of summarising this. Consequently it is important that the dive profile is recorded as accurately as possible. Where a dive computer or depth-time recorder was worn, the information should be retrieved from this source.

c. **Evidence of Barotrauma.** This is particularly important in the case of pulmonary and audio-vestibular decompression illness as discussed above. However, any evidence of barotrauma, such as in the middle ear should be recorded.

d. **Response to Recompression.** Quite often, the only means of confirming a diagnosis of decompression illness is if there is some measure of improvement following recompression. Consequently, it is important to record the response to recompression.

e. There are an increasing number of investigations which are performed on cases of decompression illness, such as tests for a PFO, electrophysiological tests and perfusion scans of the brain. The results of all investigations form an important part of any case notes.

1354-1355. Spare.

1356. Carbon Monoxide Poisoning

a. **Cause.** Breathing air contaminated by exhaust fumes or other sources of carbon monoxide by accident. Carbon monoxide self-poisoning is also used as a suicide technique and chamber operators are likely to treat such cases, which are generally more severe than the CO poisoning which occasionally occurs in divers.

b. **Prevention**

(1) Always ensure that the air intakes of air compressors are upwind of and well away from any exhaust fumes.

(2) If possible, avoid air intakes drawing air from inside compartments; intakes should be sited outside in the open.

(3) Breathing gas must be obtained from authorised, reputable sources.

c. **Symptoms and Signs.** Symptoms are similar to those of hypoxia but also include: pallor (the classical ‘cherry red’ lips are rare), severe headache, dizziness, nausea and vomiting, dimness of vision and eventually loss of consciousness.

Note. *To some extent, the symptoms of CO poisoning may be masked at depth by the raised PO_2. Therefore, although the rate at which CO is absorbed increases with depth, the symptoms are likely to become more severe during the ascent phase of a dive.*

d. **Management**

(1) Allow the patient to breathe 100% O_2 if available. Table 60 may be used.

(2) Deeply unconscious patients needing ventilatory assistance should be intubated and stabilised prior to recompression. A suitably qualified medical officer should accompany the intubated patient into the chamber.

Note. *In cases of suspected CO poisoning in divers the source of breathing gas should be isolated, and samples sent for analysis as soon as possible.* *See Chapter 8.*

1357. Summary Table of Common Diving Illnesses

Table 13-5 shows the common illnesses associated with diving. The table gives an index of how likely various diving conditions are to present at different phases of a dive. The most likely diagnosis for each phase is shown with diagnoses which are not possible are shown as such. The table is divided into two parts. Those conditions above the double line are possible in most forms of diving whereas those below the double line are only likely to be associated with closed or semi-closed breathing circuits. Nitrogen narcosis will not occur when the breathing gas is oxy-helium.

1358-1359. Spare.

Table 13-5. Diagnosis of Common Diving Complaints by Time of Onset (Phase of Dive)

	DESCENT	BOTTOM PHASE	ASCENT	ON SURFACE < 10 MINUTES	ON SURFACE > 10 MINUTES
DECOMPRESSION ILLNESS	Not Possible	Not Possible	+ (Profile dependent & more likely near the surface)	+ + + (Profile dependent)	+ + + (Profile dependent)
AURAL AND SINUS BAROTRAUMA	+ + +	+ / - Barotrauma usually associated with travel; possible delayed onset from descent	+ + + Reverse squeezes	+ + Delayed onset of symptoms (eg perilymph fistula)	+ / - Delayed onset of symptoms
ALTERNOBARIC/ CALORIC VERTIGO	+	+ / - Delayed onset from descent	+ Possible, most likely time	+ Only possible in the first few minutes	Not Possible
NITROGEN NARCOSIS	+ / - Only near the bottom	+ + + Deep diving on air or nitrox	+ / - Symptoms should improve with ascent	Not Possible	Not Possible
CO_2 POISONING-HYPERCAPNIA	+ / - With too low flow, or accumulation in diving dress on surface	+ + With too low flow, inadequate CO_2 scrubbing or improper breathing	+ With too low flow or exhaustion of CO_2 canister	+ / - Unlikely unless continuing to breath from rig on the surface	Not Possible Recovery should be rapid
OXYGEN DEFICIENCY - HYPOXIA/ ANOXIA	+ + Possible: if mix improper, inadequate flow, reducer obstruction	+ Less likely due to increased partial pressure	+ +	+ / - Only possible if breathing improper mix on surface	Not Possible
CNS OXYGEN TOXICITY	+ / - Possible if improper mix	+ With long bottom time and high PO_2	+ / - Less likely since PO_2 is decreasing	+ / - ‘Off-phenomenon’	Not Possible

SECTION 5 - THERAPEUTIC RECOMPRESSION

1360. Introduction

a. This section covers the treatment of the conditions described in Section 4. In addition, recompression may be required for omitted decompression.

b. The treatment regimens in this section apply to conditions which range in severity from pain in a limb to life-threatening cardiopulmonary collapse. In consequence, the degree of medical expertise necessary to complete the treatment will vary depending on the illness involved. Certain procedures, such as introducing intravenous lines and inserting chest tubes or urinary catheters, require special training and should not be attempted by untrained individuals.

c. Recompression treatment can be conducted satisfactorily only in a compression chamber capable of holding at least two people and which is fitted with an inner and an outer compartment. Unless stated to the contrary, this section deals with such treatment.

1361. Consulting a Diving Medicine Specialist

a. The Undersea Medicine Division of the Institute of Naval Medicine maintains a 24 hour diving medical watch throughout the year. The Duty Diving Medical Officer (DDMO) may be contacted as follows:

	Direct at all times	**By Cellphone: 07831 151523** Manned 24 hours
or	**RN Haslar**	**023 92 584255 + Bleep**

b. If contact by Cellphone is not possible, the request is to be sent by IMMEDIATE signal to INM ALVERSTOKE, Info MODUK(NAVY) and RNSUPDIV PORTMOUTH and is to include the following information:

(1) Details of the dive.

(2) Details of the patient, including his physical condition.

(3) What treatment is being carried out.

(4) What facilities are in use and available.

(5) Contact telephone number.

c. Routine calls for advice:

(1) Portsmouth Naval Base direct dial 023 92 768026

(2) Mod Network 93 80 68026

(3) Via the Portsmouth Naval Base Exchange 023 92 722351 ask for Ext 68026.

1362. Occasions for Requesting a Diving Medicine Specialist Opinion

a. All diving accidents which occur when no Medical Officer is available.

b. When there is uncertainty about the diagnosis, or where the clinical condition is complicated by trauma.

c. All cases of serious decompression illness.

d. Decompression illness arising from deep oxy-helium bounce dives.

e. Unusual diving incidents.

f. All cases of DCI when no chamber or only a one-man or two-man chamber is available for treatment.

g. If a patient fails to respond to treatment or if a patient's condition deteriorates during treatment.

h. If unforseen events occur during treatment (eg loss of chamber pressure, loss of O_2 supply etc).

i. If symptoms recur during decompression or following treatment.

j. If repeated treatment is required.

WARNING

IF FOR ANY REASON DIFFICULTY IS ENCOUNTERED CONTACTING A DIVING MEDICINE SPECIALIST, THE DIVING SUPERVISOR SHOULD NOT DELAY TREATMENT BUT PROCEED WITH FIRST AID AND THERAPEUTIC RECOMPRESSION IN ACCORDANCE WITH THE FOLLOWING INSTRUCTIONS.

1363. First Aid

a. Effective first aid will greatly increase the chances of subsequent recovery, especially if there is likely to be any delay in recompression.

b. In addition to standard life saving measures, the following action should be taken.

(1) Ventilation with 100% O_2 is the most effective form of first aid. This should be administered by a tight-fitting mask with a demand valve regulator or other apparatus designed to deliver as close to 100% O_2 as possible.

Notes:

1. Most forms of hospital mask and nasal cannulae, which employ a continuous flow of oxygen, deliver much less than 100% O_2 and rapidly empty oxygen cylinders. Consequently, such equipment should only be used when there is no better alternative.

2. The AMBU oxygen resuscitator, which forms part of the MES - On Site Diving Operations is to be set with a reducer flow rate of 15 lpm. This will give an inspired O_2 concentration of greater than 90%.

(2) Dehydration invariably complicates decompression illness. Rehydration should commence at the earliest opportunity.

(3) *Conscious patients* who can protect their airway are to be given oral fluids. At least one litre of still water or appropriately diluted fruit squash should be drunk initially. Additional fluid should be consumed until a substantial urinary output is provoked. In the absence of a urinary output the abdomen should be examined for the presence of an enlarged bladder. If the bladder is enlarged and the patient has difficulty initiating urination, urinary catheterisation should be undertaken by appropriately trained personnel.

(4) *Semiconscious and comatose patients* should be given intravenous fluids by appropriately trained personnel. Start rehydration by infusing 1 litre of normal saline or Hartmann's solution over 30 minutes and then a further litre over the next hour. The use of Dextran is discouraged since it may provoke adverse reactions and an increased tendency to bleed. Equally, solutions containing glucose should be avoided since these appear to compromise the recovery of ischaemic nervous tissue. Urinary catheterisation may be required if the level of consciousness does not improve or if the spinal cord is involved.

(5) Steroids have been used for the treatment of serious decompression illness. Although there is no evidence that they improve the outcome, they may reduce the incidence of secondary deterioration. 12-20 mg dexamethasone may be given by SLOW intravenous or intramuscular injection as an initial loading dose and repeated 6 hourly for up to 48 hours thereafter. (Steroids should only be administered by appropriately trained chamber attendants, and only when authorised by a Diving Medical Specialist.)

c. Symptoms of pain may be masked by the administration of analgesics and this may complicate monitoring of the progress of the patient. These should only be given where there is little likelihood of recompression within 2 hours and, where possible, after consultation with a diving medicine specialist. The drug of choice is Paracetamol. Nitrous oxide (ENTONOX) should NOT be used. Being a gas, it is highly soluble in other gases and consequently it tends to make inert gas bubbles grow which aggravates decompression illness. The use of aspirin and other non-steroidal anti-inflammatory agents may also be detrimental, since they may provoke or sustain haemorrhage into central nervous system lesions.

d. Patients will often show some improvement with first aid treatment, occasionally to the point of apparent recovery. Nonetheless, recompression should be performed at the earliest practical opportunity to reduce the risk of relapse or secondary deterioration.

e. In the past, it has been considered appropriate to manage cases of neurological decompression illness in a head-down position. It has now been shown that this is detrimental and consequently they should be managed in a horizontal attitude. If the patient is conscious, he or she may lie recumbent. If the patient has a reduced level of consciousness, the recovery position (see Fig 13-13) should be used.

1364. Spare.

1365. The Principles of Therapeutic Recompression

a. While first aid measures will assist the casualty, the definitive treatment for the dysbaric disorders is recompression. This is thought to have three effects:

(1) Reduce the volume of gas bubbles in tissues and blood vessels and thereby reduce tissue pressure, restore tissue architecture and restore blood flow.

(2) Promote the reabsorption of inert gas bubbles.

(3) Increase blood O_2 content and thereby improve O_2 delivery to injured tissues.

b. There are some useful general principles to bear in mind while treating a patient:

(1) Treat promptly and adequately. Do not delay treatment while awaiting the attendance of, or consultation with, medical personnel.

(2) Treat an unconscious casualty for acute neurological decompression illness unless this can be excluded with certainty.

(3) *Examine the Patient.* The initial examination, prior to recompression, should establish the presence of gross abnormalities **but should not delay the treatment of seriously ill patients**. As soon as signs of decompression illness (particularly neurological) are elicited, the patient should be placed in the chamber and recompressed. The remainder of the examination can then be completed under pressure. Patients should be examined again during, and on the completion of treatment.

(4) If evidence of sensory abnormalities are found, the extent of the abnormality should be established. For example, it is useful to outline areas of numbness with a pen so that progress can be monitored.

(5) Follow the Treatment Tables accurately, unless a Diving Medical Specialist recommends change.

(6) Have a qualified attendant in the chamber at all times during recompression when the design of compression chamber allows.

(7) Check and record the patient's condition, vital signs periodically and maintain a fluid balance chart.

(8) Observe the patient after treatment for any recurrence of symptoms. Observe for 2 hours after limb pain or cutaneous decompression illness, and for at least 6 hours following treatment for more serious manifestations.

(9) Keep accurate records of the treatment using Form S333B. In the absence of a Medical Officer, the relevant sections (including neurological examination) are to be completed by the diving officer or dive supervisor.

1366. Application of Therapeutic Tables

a. The management of acute decompression illness should be in accordance with the flow chart shown in Fig 13-18. The tables referred to in the flow chart are described in detail in paras 1367 - 1374.

b. Additionally instructions which are common to all tables are outlined below:

(1) *Descent Time.* This varies between tables and is not included in the elapsed time.

(2) *Elapsed Time.* The timing of each table starts when maximum pressure is reached, and is given in hours and minutes opposite each step of the table.

(3) *Stops.* The duration of stops is given, and the periods where O_2 should be breathed are indicated.

(4) *Ascent*

(a) The rate of ascent varies between tables, but with all the tables this becomes critical near the surface, where the rate of change of pressure is greatest. If, as the compression chamber nears the surface, air begins to escape round the door seal, compensation by admitting more compressed air may be needed.

(b) The rate of bleed must be kept constant. If the rate is slower than that required by the table it is not to be compensated for by subsequent acceleration. The ascent should be halted if the rate is exceeded, or if the ascent cannot be controlled accurately during flushing of the chamber.

(5) *Chamber Ventilation.* Chamber ventilation in accordance with para 1231h will ensure that the partial pressure of O_2 remains adequate and carbon dioxide does not accumulate. If a life support system is installed follow the recommendations given in para 1231i.

1367. Table 60 - Hyperbaric Oxygen Therapy

a. This table, originally developed by the Royal Adelaide Hospital and modified by the Royal Navy may be used for the initial treatment of carbon monoxide poisoning. Table 66 should be used for repeat treatments. Table 60 may also be used as a Trial of Pressure in cases where the diagnosis of decompression illness is unclear. If the Trial of Pressure confirms a diagnosis of decompression illness the Table 60 should be converted to a Table 62, para 1369. The advice of a diving medicine specialist must always be sought before commencing a Trial of Pressure.

b. Proceed as follows:

(1) The patient starts breathing oxygen on the surface. Those patients who have difficulty clearing their ears whilst wearing a mask may breathe chamber air until the treatment depth has been reached. Upon reaching the treatment depth the patient must immediately commence breathing oxygen.

(2) Descend to 18m over 1 to 2 minutes stopping if the patient or attendant has difficulty clearing his or her ears.

(3) The timing of the treatment begins on reaching 18m.

(4) The patient breathes 100% oxygen for two periods of 25 minutes, each followed by a 5 minute air break.

(5) Ascent from 18m to the surface should be at a continuous bleed rate of 3m every 5 minutes, except in cases in which descent to 18m exceeded 10 minutes. In such cases a stop should be made at 9m during which both the attendant and patient should breathe oxygen. The duration of this stop is to be half the time in excess of 10 minutes taken for the descent. If the resulting time is a fraction of a minute, it should be rounded up to the nearest whole minute. Example: descent to 18m takes 15 minutes; duration of stop (15 - 10)/2 = 2.5 minutes, rounded up this gives a stop of 3 minutes duration.

(6) The attendant must breathe oxygen during ascent from 9m to the surface.

(7) Severe cases may require repeat treatments over a period of days as frequent as every 4 hours. RN Tables 66 is suitable for this purpose.

Table 60 - Hyperbaric Oxygen Therapy

Gauge Depth (m)	Stops/Ascent (minutes)	Elapsed time (hours and mins)	Rate of Ascent (m/minute)
18	25 (O_2)	00:00 - 00:25	
18	**5 (Air)**	**00:25 - 00:30**	
18	25 (O_2)	00:30 - 00:55	
18	**5 (Air)**	**00:55 - 01:00**	
18 - 0	30 (O_2)	01:00 - 01:30	3m in 5 min
Surface		01:30	

1368. Table 61 - Short Oxygen Recompression Therapy

a. This may be used for the management of missed decompression and considered for the treatment of Acute Decompression Illness with limb pain, cutaneous or lymphatic manifestations ONLY. In cases of decompression illness, the patient should be given a careful Neurological Examination so that involvement of the nervous system, in particular, can be excluded.

b. Proceed as follows:

(1) The patient starts breathing O_2 on the surface.

(2) Descend to 18m over 1 or 2 minutes stopping only if the patient or attendant have difficulty in clearing their ears.

(3) The time of the treatment starts on reaching 18m.

c. If the symptoms of decompression illness are completely relieved within 10 minutes, decompression may proceed in accordance with Table 61. Otherwise use Table 62. Practically, this will mean that only a minority of cases will complete Table 61.

d. The attendant should breathe oxygen during the O_2 period at 9m and during the ascent to the surface.

Table 61 - Short Oxygen Recompression Therapy

Gauge Depth (m)	Stops/Ascent (minutes)	Elapsed Time (hours and mins)	Rate of Ascent (m/minutes)
18	20 (O_2)	00:00 - 00:20	
18	**5 (Air)**	**00:20 - 00:25**	
18	20 (O_2)	00:25 - 00:45	
18 - 9	**30 (O_2)**	**00:45 - 01:15**	**3m in 10 min**
9	5 (Air)	01:15 - 01:20	
9	**20 (O_2)**	**01:20 - 01:40**	
9	5 (Air)	01:40 - 01:45	
9 - 0	**30 (O_2)**	**01:45 - 02:15**	**3m in 10 min**
Surface		02:15	

1369. Table 62 - Standard Oxygen Recompression Therapy

a. This table is used for the great majority of cases of decompression illness which do not meet the criteria of para 1368 above.

b. Proceed as follows:

(1) The patient starts breathing O_2 on the surface.

(2) Descend to 18m over one or two minutes stopping only if the patient or attendant have difficulty in clearing their ears.

(3) The timing of the treatment starts on reaching 18m.

c. Upon reaching 18m the patient must be re-assessed. This assessment should take no more than 2-3 minutes and in most cases will reveal the patients condition to have stabilised or starting to improve. However, very occasionally patients who have presented with serious symptoms arising shortly after surfacing, especially after very deep dives, rapid uncontrolled ascents and submarine escape, may continue to deteriorate at 18m. In all such cases, other than those following submarine escape training ascents, para 1376, the chamber should be compressed to 30m on air with the patient breathing 50/50 heliox. Decompression will then normally be completed using Table 67. Submarine escape trainees (and divers where 50/50 heliox is not available), who continue to deteriorate after initial compression to 18m on oxygen should be compressed to 50m on air breathing 32½, 67½ O_2:N_2. Decompression will then normally be completed using Table 63. In ALL such cases it is essential to contact a DIVING MEDICAL SPECIALIST. In very rare cases, continued deterioration may require transfer to Table 64 or 65.

d. If the symptoms have remained static or improved incompletely after three 20 minute periods on 100% O_2 at 18m, Table 62 may be extended. One or two further O_2 breathing periods, separated by a 5 minute air break may be added on the advice of a diving medicine specialist. If the symptoms or signs have not resolved after two extensions at 18m further advice from the diving medicine specialist should be sought. Depending upon the nature and severity of the symptoms or signs, transfer to Table 64 may be necessary.

e. Symptoms may recur during decompression to 9m. In such circumstance STOP THE ASCENT and return to 18m. Consult a Diving Medicine Specialist.

f. Symptoms may recur at 9m. Again, consult a diving medicine specialist. Depending on the nature and severity of the symptoms, a return to 18m or extending the table at 9m may be necessary. Table 62 may be extended for one or two 1 hour O_2 breathing periods at 9m, separated by 15 minutes air breaks.

g. For an unmodified Table 62 or a Table 62 with one extension, at 9m or 18m, the attendant must breathe O_2 for the last 30 minutes at 9m and during the ascent from 9m to the surface (60 minutes in total). If Table 62 is extended more than once, then the attendant should breathe O_2 for the whole of the final O_2 period at 9m and the ascent to the surface (90 minutes in total). If the attendant has undergone a hyperbaric exposure in the preceeding 24 hours, an additional 60 minute period breathing O_2 at 9m (150 minutes in total) should be undertaken.

Table 62 - Standard Oxygen Recompression Therapy

Gauge Depth (m)	Stop/Ascent (minutes)	Elapsed Time (hours and mins)	Rate of Ascent (m/minutes)
18	20 (O_2)	00:00 - 00:20	
18	**5 (Air)**	**00:20 - 00:25**	
18	20 (O_2)	00:25 - 00:45	
18	**5 (Air)**	**00:45 - 00-50**	
18	20 (O_2)	00:50 - 01:10	
18	**5 (Air)**	**01:10 - 01:15**	
18 - 9	30 (O_2)	01:15 - 01:45	3m in 10 min
9	**15 (Air)**	**01:45 - 02:00**	
9	60 (O_2)	02:00 - 03:00	
9	**15 (Air)**	**03:00 - 03:15**	
9	60 (O_2)	03:15 - 04:15	
9 - 0	**30 (O_2)**	**04:15 - 04:45**	**3m in 10 min**
Surface		04:45	

1370. Table 63 - Deep Air - Oxygen Recompression Therapy

a. This table was developed specifically for the treatment of arterial gas embolism. Given the difficulties in making such a diagnosis and the potential disadvantages associated with the initial compression to 50m use of this table is reserved for those patients who present with rapid onset of severe symptoms following dives with minimal inert gas uptake and who show no significant improvement, or are continuing to deteriorate, when assessed following compression to 18m breathing oxygen para 1369c. In practice this means that Table 63 will rarely be used except following submarine escape training ascents para 1376 or when 50/50 heliox is not available para 1369c.

b. Proceed as follows: pressurise the chamber, without delay with air to 50m at the fastest rate that can be tolerated by the patient and attendant up to 30m per minute. If a gas mixture of $32^1/_2:67^1/_2$ $O_2:N_2$ is available, this should be breathed by the patient via BIBS.

c. If the patient is free of symptoms and signs after 25 minutes, and O_2 is available, then decompression may be commenced using Table 63. If O_2 is not available Table 64 should be used, omitting the oxygen.

d. If there are persisting symptoms and signs after 30 minutes at 50m, no matter how minor, Table 64 should be used.

e. If the patient is deteriorating at 50m, contact a Diving Medicine Specialist as a matter of urgency. It may be necessary to compress the patient further and continue treatment using Table 65. This should not be contemplated however, unless:

(1) A Diving Medicine Specialist is consulted.

(2) The chamber is capable of supporting a prolonged treatment.

f. Decompression from 50m to 18m should take 4 minutes after which Table 63 proceeds as for Table 62, except that the attendant must always breathe O_2 during the final 60 minutes at 9m and subsequent ascent (90 minutes in total). If the attendant has had a previous hyperbaric exposure within 24 hours oxygen should be breathed for both 60 minute periods at 9m and during the ascent (total 150 minutes).

Table 63 - Deep Air - Oxygen Recompression Therapy

Gauge Depth (m)	Stops/Ascent (minutes)	Elapsed Time (hours and mins)	Rate of Ascent (m/minutes)
50	30	00:00 - 00:30	
50 - 18	**4 (Air)**	**00:30 - 00:34**	**8m in 1 min**
18	20 (O_2)	00:34 - 00:54	
18	**5 (Air)**	**00:54 - 00:59**	
18	20 (O_2)	00:59 - 01:19	
18	**5 (Air)**	**01:19 - 01:24**	
18	20 ($O_{2)}$	01:24 - 01:44	
18	**5 (Air)**	**01:44 - 01:49**	
18 - 9	30 (O_2)	01:49 - 02:19	3m in 10 min
9	**15 (Air)**	**02:19 - 02:34**	
9	60 (O_2)	02:34 - 03:34	
9	**15 (Air)**	**03:34 - 03:49**	
9	60 (O_2)	03-49 - 04:49	
9 - 0	**30 (O_2)**	**04:49 - 05:19**	**3m in 10 min**
Surface		05:19	

1371. Table 64 - Deep Air - Oxygen Recompression Therapy
This Table is applied as follows:

a. Rate of Descent should be as fast as can be tolerated by the patient and attendant. This is normally of the order of 30m per minute.

b. Ascent between stoppages is to take 5 minutes. This is not included in the stoppage times, but has been allowed for in the elapsed times.

c. When used to treat a diver following a heliox dive, upon arrival at 50m 40:60 O_2:He should be administered for periods of 20 minutes followed by 5 minutes breathing 20:80 O_2:He. During the ascent from 50m to 18m the patient should breathe 20:80 O_2:He. If 20:80 O_2:He is not available then air may be used during the breaks from breathing therapeutic gas at depths between 50-18m. Upon arrival at 18m 100% O_2 should be administered with O_2 breathing periods of 25 minutes duration followed by 5 minutes breathing chamber air. The patient, who must be closely monitored for evidence of pulmonary oxygen toxicity, should be given a minimum of four O_2 breathing periods (for a total time of 2 hours) and thereafter to suit the patient’s needs as advised by a Diving Medicine Specialist. The attendant should begin breathing 100% O_2 2 hours before leaving 9m, and both the patient and the attendant should breathe 100% O_2 at 6 and 3m as shown in the table.

d. Table 64 may be entered at 30m (para 1374d) or 18m (para 1369d) if advised by the Diving Medical Specialist who will also give instructions on oxygen breathing periods required. This guidance will take into account oxygen breathing before Table 64 was prescribed.

e. Table 64 may be used breathing air if O_2 is not available. In the absence of heliox, nitrox mixes of up to 40% O_2 may be administered at 50m at the discretion of the Diving Medicine Specialist (evidence of pulmonary oxygen toxicity must be monitored closely).

Note. *Prior to committing to Table 64, the diving supervisor must ensure that all life support considerations can be met (para 1231).*

Table 64 - Deep Air - Oxygen Recompression Therapy

Gauge Depth (m)	Stops (Hours	Mins)	Elapsed Time (hours and mins)	Rate of Ascent
50	2		00:00 - 02:00	
42		**30**	**02:05 - 02:35**	
36		30	02:40 - 03:10	
30		**30**	**03:15 - 03:45**	
24		30	03:50 - 04:20	
18	**6**)		**04:25 - 10:25**	5 minutes between
15	6) Note 1		10:30 - 16:30	stops throughout
12	**6**)		**16:35 - 22:35**	
9	12 Notes 1 and 2		22:40 - 34:40	
6	**1**		**34:45 - 35:45**	
	1 (O_2)		35:45 - 36:45	
3	**1**		**36:50 - 37:50**	
	1 (O_2)		37:50 - 38:50	
Surface			**38:55**	

Notes:

1. *Oxygen breathing in accordance with para 1371c.*

2. *The attendant should breathe O_2 for 2 hours before leaving 9m.*

1372. Table 65 - Long Air Recompression Therapy

a. Table 65 is provided for use when the patient has not responded to treatment on Table 62, 63, 64 or 67. IT IS ONLY TO BE USED WHEN A DIVING MEDICINE SPECIALIST HAS BEEN CONSULTED and facilities exist for a prolonged treatment.

b. Table 65 is applied as follows:

(1) Rate of descent should be as fast as tolerable.

(2) Rate of ascent is 1m per minute between stops.

(3) Stops are carried out at EVERY METRE for the duration given in Column 3 of the table. The stop time begins when leaving the previous depth.

(4) If 32½:67½ oxy-nitrogen mixture is available this may be given at 50m. Pure O_2 breathing may be introduced at 18m. O_2 breathing periods should be of 25 minutes duration, alternated with 5 minute breaks breathing chamber air. Caution should be exercised in the repeated use of oxygen due to the risk of toxicity.

(5) The table may be entered at any depth up to 70m.

(6) Following heliox dives the patient should breathe 20:80 O_2:He between 70m and 30m. 40:60 O_2:He may be given at 50m with O_2 breathing introduced at 18m. The attendant should breath 20:80 O_2:He, when available, between 70 and 30m.

Note. *The attendant and patient need not breathe O_2 during decompression which can be completed on air.*

Table 65 - Long Air Recompression Therapy

Gauge Depth (m)	**Maximum Time at Depth (Hours) See Note**	**Stops at Each Metre (mins)**	**Maximum Elapsed Time (hours and mins)**		
			From 70m	**From 50m**	**From 18m**
(1)	(2)	(3)	(4)	(5)	(6)
70	0.5		0:30		
69-51		**8**	**3:02**		
50	3		6:02	3:00	
49-43		**20**	**8:22**	**5:20**	
42	5		13:22	10:20	
41-37		**25**	**15:27**	**12:25**	
36	8		23:27	20:25	
35-31		**30**	**25:57**	**22:55**	
30	11		36:57	33:55	
29-25		**40**	**40:17**	**37:15**	
24	15		55:17	52:15	
23-19		**50**	**59:27**	**56:25**	
18	No Limit (a)		a+59:27	a+56:25	a
17-13		**75**	**a+65:42**	**a+62:40**	**a+6:15**
12	No Limit (b)		a+b+65:42	a+b+62:40	a+b+6:15
11-7		**100**	**a+b+74:02**	**a+b+71:00**	**a+b+14:35**
6	No Limit (c)		a+b+c+74:02	a+b+c+71:00	a+b+c+14:35
5-1		**200**	**a+b+c+90:42**	**a+b+c+87:40**	**a+b+c+31:15**
Surface			a+b+c+90:43	a+b+c+87:41	a+b+c+31:16

Note. *The time at depth in column 2 need not be completed in full, but must be at least equal to the time in column 3 in the row below.*

1373. Table 66 - Repeat Hyperbaric Oxygen Therapy

a. This table was developed specifically for the treatment of patients who require hyperbaric oxygen therapy. Table 66, by limiting the depth to 14m, reduces the probability of oxygen toxicity occurring amongst patients who may require a large number of therapies over the course of a number of weeks. Table 66 is NOT to be used as a primary treatment for acute decompression illness. This table may be used to re-treat cases of decompression illness and carbon monoxide poisoning in which there has been incomplete recovery or a recurrence of symptoms.

b. Proceed as follows:

(1) The patient should start breathing O_2 on the surface. Those patients who have difficulty clearing their ears whilst wearing a mask may breath chamber air until the treatment depth has been reached. Upon reaching the treatment depth the patient must immediately commence breathing O_2.

(2) Descent to 14m slowly allowing sufficient time for the patient to clear their ears. The descent will probably be achieved in between 5 to 10 minutes but may take up to 30 minutes.

(3) The timing of the treatment commences on reaching 14m.

(4) The patient breathes 100% O_2 for three periods of 30 minutes with a 5 minute air break between the O_2 breathing periods.

(5) The ascent from 14m to the surface commences after 20 minutes of the third O_2 period has been completed and is at a continuous bleed rate of 1.4m per minute.

(6) The attendant must breathe O_2 for the last 20 minutes of the table including the 10 minute ascent from 14m to the surface.

(7) Serious cases may require several treatments per day. Where possible an interval of 4 hours should be left between treatments.

Table 66 - Repeat Hyperbaric Oxygen Therapy

Gauge Depth (m)	**Stops/Ascent (minutes)**	**Elapsed Time (hours and mins)**	**Rate of Ascent (m/minutes)**
14	30(O_2)	00:00 - 00:30	
14	**5 (Air)**	**00:30 - 00:35**	
14	30 (O_2)	00:35 - 01:05	
14	**5 (Air)**	**01:05 - 01:10**	
14	20 (O_2)	01:10 - 01:30	
14-0	10 (O_2)	01:30 - 01:40	1.4m in 1 min
Surface		01:40	

1374. Table 67 - Heliox/Oxygen Recompression Therapy

a. This table, a combination of the COMEX 30 table and Royal Navy Table 62, is to be used for the treatment of cases of decompression illness which continue to deteriorate following an initial compression of 18m on 100 % O_2. It should also be used in all cases of omitted decompression, whether the diver is symptomatic or not, when the diver has completed less than 15 minutes of stops and the stops missed were at depths in excess of 18m. It may also be used on the advice of a Diving Medicine Specialist for the treatment of decompression illness which fails to respond to treatment with standard oxygen recompression tables.

b. Proceed as follows:

(1) The patient starts breathing 50:50 O_2:He on the surface, or from 18m when transferring from RN Table 62 para 1389c refers.

(2) Descent to 30m over 3 to 4 minutes stopping only if the patient or attendant have difficulty in clearing their ears.

(3) The timing of the treatment starts on reaching 30m.

(4) When utilising the Closed Circuit Breathing System, the timing of all lower PO_2 gas breaks and gas changes start when the new gas has been selected and injection/purging is actuated. (This procedure is to be well practised to ensure that the injection/purge actuation can be timed to coincide with the treatment table timings.)

c. Upon reaching 30m the patient must be re-assessed. This assessment should take no more than 2-3 minutes and in most cases will reveal the patients condition to have stabilised or starting to improve. However, very occasionally patients who have presented with serious symptoms arising shortly after surfacing may continue to deteriorate at 30m. In such cases the chamber should be compressed to 50m on air with the patient breathing heliox, 40:60 O_2:He. Decompression will then normally be completed using Table 64. In ALL such cases it is essential to contact a DIVING MEDICAL SPECIALIST. In very rare cases, continued deterioration may require transfer to Table 65.

d. If the patient is free of symptoms and signs after 55 minutes at 30m then decompression may be commenced using Table 67. If the symptoms have remained static or improved incompletely after 55 minutes at 30m up to 5 additional 20 minute periods breathing 50:50 O_2:He, separated by 5 minute breaks breathing 20:80 O_2:He, may be added on the advice of a Diving Medicine Specialist. On completion of such extensions decompression should be by Table 64 with 50:50 O_2:He breathed during the ascent from 30-24m. A 5 minute break breathing 20:80 O_2:He should be taken on arrival at 24m with 50:50 O_2:He breathed during the remaining 25 minutes of the 24m stop and the ascent from 24-18m. Table 64 should then be completed in accordance with para 1371.

e. If 20:80 O_2:He is not available then air may be used during the breaks from breathing therapeutic gas at depths between 30 - 18m. Table 67 may, on the advice of a Diving Medical Specialist, be extended by one or two 20 minute O_2 periods, separated by 5 minute air breaks, at 18m and/or one or two 60 minute O_2 periods, separated by 15 minute air breaks, at 9m.

f. For an unmodified Table 67 the attendant must breathe O_2 during both 60 minute O_2 periods at 9m and during the ascent from 9m to the surface (total 150 minutes). If the Table 67 is extended at 18m, by either one or two additional O_2 periods, it must also be extended by an additional 60 minute O_2 period at 9m during which time the attendant is to breath O_2 (total 210 minutes). If the Table 67 is extended at 9m the attendant must breath O_2 for an additional 60 minute period (total 210 minutes). If the attendant has undergone a hyperbaric exposure in the preceding 24 hours Table 67 should be extended at 9m to permit the attendant to breathe O_2 for an additional 60 minute period (total 210 minutes). In cases where Table 67 is extended at 30m, and decompression is by Table 64, the attendant should breath oxygen as described in the instructions for Table 64.

Table 67 - Heliox/Oxygen Recompression Therapy

Gauge Depth (m)	**Stops/Ascent (minutes)**	**Elapsed Time (hours and mins)**	**Rate of Ascent (m/minutes)**
30	20 (50:50 O_2:He)	00:00 - 00:20	
30	**5 (20:80 O_2:He)**	**00:20 - 00:25**	
30	20 (50:50 O_2:He)	00:25 - 00:45	
30	**5 (20:80 O_2:He)**	**00:45 - 00:50**	
30	10 (50:50 O_2:He)	00:50 - 01:00	
30 -24	**30 (50:50 O_2:He)**	**01:00 - 01:30**	1m in 5 min
24	5 (20:80 O_2:He)	01:30 - 01:35	
24	**25 (50:50 O_2:He)**	**01:35 - 02:00**	
24 - 18	30 (50:50 O_2:He)	02:00 - 02:30	1m in 5 min
18	**5 (Air)**	**02:30 - 02:35**	
18	20 (O_2)	02:35 - 02:55	
18	**5 (Air)**	**02:55 - 03:00**	
18	20 (O_2)	03:00 - 03:20	
18	**5 (Air)**	**03:20 - 03:25**	
18	20 (O_2)	03:25 - 03:45	
18	**5 (Air)**	**03:45 - 03:50**	
18 - 9	30 (O_2)	03:50 - 04:20	3m in 10 min
9	**15 (Air)**	**04:20 - 04:35**	
9	60 (O_2)	04:35 - 05:35	
9	**15 (Air)**	**05:35 - 05:50**	
9	60 (O_2)	05:50 - 06:50	
9 - 0	**30 (O_2)**	**06:50 - 07:20**	**3m in 10 min**
Surface		07:20	

Note. *If 20:80 O_2:He is not available air may be used.*

1375. Non Standard Treatments

Only a Diving Medical Specialist may change treatment protocols or use treatment techniques other than those described. The standard treatment procedures should be considered minimum treatments; treatment procedures should never by shortened unless emergencies arise which require the chamber occupants to evacuate the chamber.

1376. Management of Decompression Illness following Submarine Escape Training Ascents

a. Submarine escape involves rapid compression and decompression. This ensures that inert gas uptake is minimal and that, except for deep open water escapes or escapes from submarine compartments at raised pressure, decompression illness arising from inert gas release is unlikely. Decompression illness in trainees following submarine escape training ascents at the SETT is thus most likely to be due to gas embolism secondary to pulmonary barotrauma. Such patients will usually present with rapid onset of severe symptoms, often arising at the surface semi-conscious or unconscious. Although the majority of patients presenting with such severe symptoms will show marked improvement following compression to 18 m on oxygen, a small proportion will show no benefit from this initial shallow compression. Upon arrival at 18m the patients must be re-assessed, this assessment should take no more than 2-3 minutes. If the patients presented with severe symptoms which show no sign of significant improvement, or is deteriorating, they should be compressed to 50m in accordance with para 1370. The Duty Diving Medical Officer at the Institute of Naval Medicine must be informed of all cases of decompression illness at the SETT.

b. Decompression illness arising from escapes from a sunken submarine should be managed in accordance with para 1389.

1377. Recompression Therapy Abort Procedures

a. Once recompression therapy is started, it should be completed unless the patient dies or it is considered that continuing the treatment would place the chamber occupants in mortal danger.

b. If it appears that the patient has died, a Medical Officer must confirm this before the treatment is aborted. Once this is done, the attendant(s) may be decompressed either by completing the treatment table, or by following the modified air decompression schedule in sub-para c below whichever is the shorter. Depending on the circumstances the air/oxygen table in para 1255 (surface decompression) may be used on the advice of a Diving Medicine Specialist.

c. The air decompression schedule (RN Table 11) used in these circumstances is for the maximum depth and bottom time of the exposure, but modified by having all the chamber occupants breathe O_2 as soon as a depth of 9m or shallower is reached. Oxygen breathing periods of 25 minutes on O_2 followed by 5 minutes on air, are continued until the total time on O_2 is one-half or more of the total decompression time. This procedure may be used even if gases other than air (ie oxy-nitrogen or oxy-helium mixtures) were breathed during the treatment. Upon surfacing, chamber occupants are treated as if they had surfaced from a normal dive.

d. Very occasionally, conditions outside the chamber may require treatments to be aborted. For instance, the ship on which the chamber is located may be in imminent danger of sinking, or a fire or explosion may have severely damaged the chamber system to such an extent that completing the treatment is impossible. In these cases, the abort procedure described above could be used for all chamber occupants (including the patient(s)) if time is available. If insufficient time is available, the following may be done:

(1) If deeper than 18m ascend immediately to 18m at the rate of 1m per minute.

(2) Once the chamber is at 18m or shallower, put all the chamber occupants at 100% O_2 and have them breathe it continuously.

(3) Follow as much of RN Table 11 Mod (for maximum depth and bottom time) as possible, breathing O_2 all the time. If the bottom time is so great that it is outside RN Table 11 Mod, then use the stop times in Table 65 divided by 3 from 18m to the surface. If the chamber is at 18m or shallower when the decision to abort is made, start breathing 100% O_2, remain at the initial depth for 1/3 of the remaining decompression time, then follow Table 65 to the surface using 1/3 of the stop times.

(4) When no more time is available, bring all chamber occupants to the surface (try not to exceed 3m per minute) and keep them on 100% O_2 during evacuation for as long as possible.

(5) Immediately evacuate all chamber occupants to the nearest alternative recompression facility. If no symptoms occurred after the treatment was aborted, use Table 62

1378. A Summary of the Management of Acute Decompression Illness
A treatment summary flow chart is shown in Fig 13-18.

1379. Treatment Chamber Practice
The following practices are recommended during treatment in a chamber.

a. On reaching maximum depth, the patient is to be questioned and examined as completely as possible to assess the extent of relief or the presence of previously unnoticed symptoms and signs.

b. When practicable, the patient should be asked to stand and walk the length of the chamber.

c. The patient should be checked periodically, particularly during slow bleeds.

d. The patient may sleep while breathing chamber atmosphere. Chamber occupants need not be woken during depth changes, especially when using Tables 64 or 65.

e. Conscious patients may eat and drink in the chamber during air breaks.

1380. Care in the Compression Chamber

a. **Attending the Patient.** An attendant who is familiar with the symptoms and signs of diving-related disorders and their treatment should be inside the chamber during recompression. However, the treatment of seriously ill patients should not be delayed by waiting for a suitably experienced attendant.

b. If the patient requires skilled medical procedures a Diving Medical Specialist should accompany the patient into the chamber. He should remain only as long as needed. Recompression should not be delayed by waiting for him to arrive. If the chamber is sufficiently large, a second attendant may accompany him.

c. If only one Diving Medical Specialist is present, his time in the chamber should be kept to a minimum because his effectiveness is greatly diminished when there. If periods in the chamber are necessary, these should be timed, as far as possible, to avoid a decompression obligation.

d. Inside the chamber, the attendant is to ensure that the patient is lying down and is positioned to permit the free circulation of blood to all his extremities. Particular care should be taken to ensure care of pressure points in paralysed patients.

e. The attendant must watch the patient constantly and report any alteration to symptoms or signs. The timing of any changes will be important factors to consider in the choice of treatment table. Other responsibilities of the attendant are:

(1) Operation of the internal chamber and air-lock doors.

(2) Communication with outside personnel.

(3) Providing first aid as required by the patient.

(4) Administering O_2 and fluids to the patient.

(5) Providing assistance to the patient as required.

(6) Ensuring that ear defenders are worn during compression, decompression and venting of the chambers.

f. Reference should also be made to para 1385.

1381. Treatment in a One-Man Compression Chamber (see also para 1232)

a. One-man chambers are designed for surface decompression procedures and not for the treatment of diving disorders. Their use as treatment chambers is inappropriate since patients with dysbaric illnesses should always be attended during recompression therapy. This should be borne in mind when deciding on the use of a one-man chamber for recompression therapy. If, in an emergency situation, it is necessary to use a one-man chamber for recompression therapy only Tables 61 and 62 may be used.

b. Before starting recompression therapy in a one-man chamber the circumstances must be considered. If it is possible to transport the patient to a two compartment chamber within a short period (minutes rather than hours) this may be preferable to commencing treatment in a one-man chamber. The decision whether to carry out therapy in a one-man chamber or to transport the patient to a two compartment chamber rests with the Diving Supervisor, although the advice of a Diving Medicine Specialist should be obtained if possible.

c. **Under no Circumstances** is an unconscious patient to be recompressed in a one-man chamber.

d. **Management of a Conscious Patient**

(1) Before commencing recompression, which should be as soon as practically possible once an abnormality is found, a neurological examination of the patient should be carried out, either by a Medical Officer or by suitably trained diving personnel.

(2) Consideration should be given to the need to keep the patient adequately hydrated during treatment, consistent with the restrictions imposed by a one-man chamber. In particular, the need for urinary catheterisation should be addressed prior to commencing recompression.

(3) If recompression is required, the following procedure is to be carried out irrespective of the diagnosis.

(a) Compress the chamber to 18m with the patient breathing 100% O_2 from BIBS.

(b) Establish contact with a Diving Medical Specialist.

(c) Decompress on Table 62 unless this schedule is extended or modified on medical advice.

e. **Treatment of an Unconscious Patient.** If the patient has no pulse, or is not breathing spontaneously, carry out the appropriate resuscitation procedures paras 1303 and 1304. If the patient is breathing spontaneously, carry out the following procedure:

(1) Place patient on the one-man chamber stretcher in the recovery position and administer 100% O_2 by BIBS.

(2) DO NOT pressurise the chamber.

(3) Establish contact with a Diving Medical Specialist.

(4) When the patient recovers consciousness, a neurological examination should be performed by the Medical Officer or appropriately trained diving personnel. If recompression is required, follow the procedure given above.

f. **Removal from the Chamber in an Emergency.** In the event of a man undergoing recompression in a one-man chamber becoming unconscious, having a seizure or requiring some form of urgent medical attention, the chamber may be decompressed in 1 minute to allow access to the patient. However, a patient should NEVER be decompressed during the initial (so-called tonic) phase of a convulsion when breath-holding is common. Normally this passes off within less than a minute and is replaced by the 'clonic' phase of true convulsions.

g. **Transfer to a Two Compartment Chamber.** In all cases arrangements should be made to transfer the patient to a two compartment chamber, regardless of whether he is under pressure or not. If the patient is under pressure, the two compartment chamber should be fitted with a Transfer Under Pressure (TUP) facility to avoid the need for decompression. If the patient is not under pressure it is essential he reaches a two compartment chamber for definitive recompression therapy as soon as possible.

1382. Treatment in a Portable Two-Man Compression Chamber

a. If it is necessary to carry out therapeutic recompression in the Drager Duocom two-man chamber, only RN Tables 61 and 62 may be used. The Drager Duocom is not suitable for use with RN Tables 63, 64, 65 and 67. This limits diving with CDBA supported by a Drager Duocom to a maximum of 60m.

b. Every effort must be made to transport the portable chamber to the nearest available two-compartment chamber with a TUP facility by the quickest and safest means. If possible the advice of a Diving Medical Specialist should be sought even for apparently trivial incidents, since any treatment will be conducted under less than ideal conditions. The requirement for intravenous infusions or a urinary catheter should be considered before recompression is undertaken, since neither can be performed within the Duocom chamber.

c. **Treatment of an Unconscious Patient.** An unconscious patient will present difficult problems. Arrangements must be made to transfer the casualty to a two compartment chamber. However after appropriate consultation it may be considered that the threat to life is greater from withholding recompression therapy. Under no circumstances is the casualty to be without an attendant who is suitably briefed or qualified to manage an unconscious patient including provision of resuscitation within the confines of the chamber.

d. It must be emphasised that the attendant in the chamber can only offer limited assistance and is not able, in view of physical limitations of the chamber, to offer comprehensive treatment for dysbaric illness.

1383. Omitted Decompression

a. When a diver has surfaced without completing the necessary in-water stops, action must be taken to prevent or treat decompression illness in accordance with paras 1214 and 1215.

b. Asymptomatic divers who have required management with Table 61 may return to diving 48 hours after surfacing from completion of the Table 61.

c. Asymptomatic divers who have required management with Table 62 or Table 67 may return to diving 7 days after surfacing from the completion of the Table 62 or 67.

1384. Action in the Absence of a Compression Chamber

a. If a diver develops decompression sickness when away from the vicinity of a chamber, transfer to a chamber should be arranged as quickly as possible.

b. The following steps should be taken:

(1) Institute appropriate general and diving-specific first aid measures described in para 1363.

(2) Contact by telephone or signal the nearest authority controlling a chamber and request the chamber to be made available.

(3) Transport the patient by the quickest available means. If he has to be sent by an aircraft or helicopter without a pressurised cabin, the pilot should fly as low as is compatible with safety, preferably not above 300m (1000ft). If aircraft with pressurised cabins are used, the cabin pressure should not be reduced below the equivalent of 300m altitude.

(4) The patient should be accompanied by the diving supervisor who was in charge of the diving operation and, if available, by a Medical Officer. The patient must at least be accompanied by another diver who knows the full details of the case. They must remain at the chamber until dismissed by the Duty Diver Medical Officer (DDMO).

(5) If a civilian-manned chamber is to be used, the diving supervisor must accompany the patient and be responsible for treatment.

c. Recompression in the water must NOT be attempted.

1385. Management after Initial Recompression

a. Recovery from decompression illness may be incomplete, even after therapeutic recompression. The following guidance on the management of cases should be followed after recompression.

b. All cases in which there are residual symptoms or signs must be transferred to Royal Naval Sick Quarters or Service Hospital for observation and any necessary investigation. In cases where there has been an apparently full recovery, less serious cases may be allowed home, if accompanied, 2 hours after the completion of treatment. Where there have been serious manifestations, such as involvement of the nervous or cardiopulmonary systems, patients should be admitted to Sick Quarters or Hospital for observation for at least 12 hours. Before departure, all patients should be briefed on what action to take in the event of a recurrence of symptoms.

c. **Flying after Recompression**

(1) Patients with limb pain, lymphatic or cutaneous decompression illness who have had complete resolution of all symptoms may fly 24 hours after completing the therapeutic table. Patients with neurological, pulmonary or multisystem decompression illness, who have had a complete resolution may not fly for 48 hours. Patients surfacing from RN Tables 64 or 65 or other tables of similar duration may not fly for 72 hours. Patients with residual symptoms should not fly for at least 72 hours after completion of their final recompression table and only after consultation with a diving medicine specialist.

(2) Attendants for Tables 60, 61, 62, 63, 66 and 67 should allow a 12 hour surface interval before flying. Attendants for Tables 64 or 65 should not fly for 48 hours.

d. **Exercise After Recompression.**
Divers who have undergone Recompression therapy are to refrain from physical exercise as follows:

(1) Divers who were treated using Table 61 with complete relief may return to physical exercise 48 hours after surfacing from the treatment.

(2) All other divers are not to return to physical exercise until authorised by a Diving Medical Specialist.

e. **Return to Diving.** Following treatment for decompression illness, military divers must be referred to the Institute of Naval Medicine for revue prior to their return to diving. Each case will be assessed individually taking into account details of the incident dive(s), severity of presenting symptoms and the divers response to treatment. Because each case of decompression illness is unique it is not possible to provide definitive times for return to diving. The following should be regarded as the minimum time that should elapse before the diver returns to diving:

(1) Limb pain, skin or lymphatic decompression with complete resolution and with no symptoms or signs of neurological involvement: - 7 days.

(2) Neurological decompression illness with complete resolution - 28 days.

1386. Treatment of Civilian Cases

a. Civilians suffering from decompression illness may apply to RN establishments/units for treatment. Use of RN facilities for this task is approved under Military Aid to the Civil Community (MACC) rules. In all such cases the Duty Diving Medical Officer (DDMO) at the Institute of Naval Medicine must be contacted.

b. RN compression chambers may be made available for the hyperbaric treatment of civilians suffering from DCI provided the following conditions are met.

(1) The illness is assessed as urgent (i.e. life threatening or potentially life threatening).

(2) The casualty is referred/sponsored by a National Health Service (NHS) Doctor, not necessarily the casualties own.

(3) If an older RN chamber is used (i.e. Type 1) the patient should be informed that the chamber does not meet all Health and Safety standards.

c. On all occasions, at the earliest opportunity, the DDMO must be contacted for advice. Detailed documentation and medical records must be kept and a full report, using Forms S333 Part 1 and S333B is to be sent to the Medical Officer in Charge, Institute of Naval Medicine, Alverstoke.

d. The MOD owes a duty of care to all patients treated in compression chambers. Medical treatment (indemnity) forms are no longer used since liability for personal injury or death resulting from negligence cannot be avoided. Indemnity forms thus have no basis in law. The MOD will accept liability for treatments conducted by dive supervisors in accordance with the UK Military Diving Manual BR 2806 Vols 1 and 2.

e. Use of RN hyperbaric facilities by civilian organisations for training purposes is not permitted due to insurance and liability complications.

1387. Chamber Treatment - Oxygen Toxicity.
Occasionally, pulmonary and cerebral oxygen toxicity may occur during chamber treatments. The recognition of these conditions is described in para 1321.

a. **Pulmonary Oxygen Toxicity.** Pulmonary oxygen toxicity is unlikely to develop on Tables 61, 62 or 63, even if they are fully extended. On long air tables the large amounts of oxygen that may have to be administered may result in end-inspiratory discomfort, progressing to substernal burning and severe pain on inspiration. Substernal burning should normally be cause for discontinuing oxygen breathing in patients who are responding well to treatment. However, if significant neurological deficit remains and improvement is continuing (or if deterioration occurs when oxygen breathing is interrupted), oxygen breathing should be continued as long as considered beneficial or until pain limits inspiration. If oxygen breathing must be continued beyond the period of substernal burning, or if the 4 hour air breaks on long air tables cannot be used because of deterioration upon the discontinuance of oxygen, the oxygen breathing periods should be changed to 20 minutes on oxygen, followed by 10 minutes breathing chamber air. The Diving Medical specialist may tailor these guidelines to suit individual patient response to treatment.

b. **Cerebral Oxygen Toxicity**

(1) At the first sign of cerebral oxygen toxicity, the patient should be taken off oxygen and be allowed to breathe chamber air. All time breathing air is ‘dead time’. Fifteen minutes after all symptoms have subsided, oxygen breathing may be restarted and the interrupted O_2 period completed. If symptoms of cerebral toxicity develop again, interrupt oxygen breathing for another 15 minutes and contact a Diving Medicine Specialist. If a DMS cannot be contacted resume Table after 15 minutes. If cerebral oxygen toxicity develops a third time, discontinue oxygen for one hour (dead time) and then resume the treatment table. If symptoms of decompression illness are still present and the patient continues to show symptoms of oxygen toxicity, the Diving Medicine Specialist will have to decide whether oxygen should be continued and whether or not decompression should be attempted or continued, or whether deeper recompression is needed.

(2) The onset of cerebral oxygen toxicity is unlikely in resting individuals at depths of 15m or shallower, and very unlikely at 10m or shallower no matter what the level of activity. However, patients with severe cerebral decompression illness may be abnormally sensitive to oxygen. Convulsions unrelated to oxygen may also occur. If an oxygen convulsion occurs, the only thing that need be done is to remove the patient from oxygen and keep him from hurting himself. The patient's head should be kept gently back and his jaw prevented from falling backward and obstructing the airway. It is not necessary to pry the patient's mouth open to insert any airway or bite block while the patient is convulsing.

1388. Chamber Attendants

a. **Attending Frequency.** Normally, attendants must allow a surface interval of at least 24 hours between consecutive treatments on Tables 61, 62, 63 and 67. If a retreatment has to be undertaken sooner than this, the attendant will require additional O_2 breathing periods at 9m as prescribed in paras 1368, 1369, 1370 and 1374). For Tables 60 and 66 attendants must allow a surface interval of at least 6 hours and must not attend more than twice in any 24 hours period. A surface interval of at least 48 hours is prescribed between consecutive Table 64 and 65.

b. **Attendants Return to Diving.** Attendants for Tables 60 and 66 must allow a surface interval of 6 hours from completing the table and undertaking no-stop diving. Attendants for Tables 61, 62, 63 and 67 must allow a surface interval of 12 hours from completing the table and undertaking no-stop diving. A surface interval of 24 hours must elapse before conducting dives which require decompression stops. Attendants for Tables 64 and 65 must allow a surface interval of at least 48 hours before returning to diving.

c. **Oxygen Breathing.** When the chamber attendant is required to breath O_2 at 9m or during the ascent from 9m a second attendant is not required inside the chamber provided that the original attendant remains fully functional. However, at the Diving Supervisors discretion a second attendant may be locked in at any time.

d. **Flying.** Attendants for Tables 60, 61, 62, 63, 66 and 67 must allow a 12 hour surface interval before flying. Attendants for Table 64 and 65 must not fly for 48 hours.

1389. Sunken Submarine - Diving Support

a. Diving support for sunken submarine incidents will be provided in accordance with ATP 10(D), ATP 10 (D) BRIT-SUPP-2, and local orders. The Royal Navy has the possible use of the USN Deep Submergence Rescue Vehicle (DSRV) or its own LR5 submersible to rescue survivors from a sunken submarine. The former will usually be deployed by a 'mother' submarine (MOSUB), the latter from a SAL class MSV or the DTI cable ship ALERT. Although submariners are advised to await rescue whenever possible, and have the ability to survive for up to 7 days in the rescue compartment, a variety of factors may force the survivors to escape using hooded ascent in a Submarine Escape and Immersion Suit (SEIS). This method involves exit from the submarine by means of the escape tower which may be single or double depending on the class of submarine. By using the tower escape method escapees will reach the surface at the rate of 1 or 2 every 3-5 minutes. If there is a Rush Escape whereby the whole escape compartment is flooded escapees will exit in quick succession and will arrive on the surface at the rate of 1 escapee per 20 seconds.

b. Escape may lead to dysbarism in the form of arterial gas embolism (from any depth) and decompression illness (from depths in excess of 150m, or shallower if the submarine was pressurised prior to escape). Recompression facilities must therefore be provided at the surface as soon as possible. Survivors intending to escape are instructed to await the arrival of surface support whenever possible. The procedures for treating decompression illnesses should be in accordance with paras 1365-1374 but the number needing recompression treatment may require the alternative approach outlined in para 1390.

c. A Type B Two-Compartment Compression Chamber (2CCC) and support equipment forms part of six sets of SUBMISS First Reaction Stores (FRS) held at strategic locations. These air-transportable FRS, one set of which will normally be embarked in the Escape Gear Ship (EGS), may be supplemented from other RN or civilian sources.

d. **Personnel.** A Minewarfare and Clearance Diving Officer (MCDO) or Petty Officer (Diver) PO(D) or above will be nominated to take charge of the recompression facilities in the EGS and during therapeutic recompression will be advised by a Medical Officer. Personnel from a Clearance Diving Unit will be provided to prepare and conduct operations with the compression chamber under the direction of the MCDO/PO(D) or above. Depending on the scenario, members of the Submarine Escape and Rescue Assistance Team (SMERAT), including an Officer from the Submarine Escape Training Tank (SETT), HMS Dolphin, and a Diving Medical Officer, will also be embarked in the EGS.

e. The arrival of rescue forces (with FRS embarked) may be preceeded by the SUBSUNK Parachute Assistance Group (SPAG). These personnel are members of the SMERAT and are trained to provide advice and immediate first aid to survivors in advance of the arrival of surface forces.

1390. Management of Survivors From a Sunken Submarine

a. To ensure that those on the surface are as well prepared as possible for all eventualities, some important variables to be considered are listed below:

(1) Conditions in the escape compartment prior to escape. Important in this respect are the pressure, atmosphere quality and temperature.

(2) The condition of the survivors prior to escape. This includes any illness or injury associated with either the environmental conditions or events which led to the sinking and their state of nutrition and hydration.

(3) The escape method used.

(4) Surface conditions such as: sea state; sea and air temperature.

(5) Availability of surface support to escapers such as: surface vessels; other submarines, helicopters; the Submarine Parachute Assistance Group (SPAG).

(6) Availability of specialised facilities and personnel for recompression therapy (the Submarine Escape and Rescue Assistance Team (SMERAT).

b. **Conditions Prior to Escape.** A most important factor relevant to the safety of an escape is the ambient pressure within the escape compartment. When unpressurised, escapes can be made safely from tower depths as great as 150m and possibly deeper. However, if the escape compartment becomes pressurised, the maximum depth from which an escape can be made safely may be reduced substantially. The threat of decompression illness (DCI) will not deter survivors who have no option but to escape.

c. Escapers are at risk of hypothermia, motion illness and dehydration. In addition, they may have sustained traumatic or other injury such as burns or smoke inhalation as a result of the sinking. The medical stores in ATP 10, BRIT-SUPP-2(D) are designed to cater for such conditions which may, in addition, complicate the management of barotrauma or decompression illness.

d. The escape of survivors from a sunken submarine may generate mass casualties suffering from DCI. Given that the recompression facilities available at the scene are likely to be limited, the management of such cases will differ from that described above for divers.

1391. Management of Decompression Illnesses

a. The standard NATO medical triage categories (T1, T2, T3) are to be used to determine medical treatment priorities. Where recompression facilities are available, but are of limited capacity, each category is to be subdivided to indicate which survivors will need immediate recompression (T1(C)) or non-urgent recompression (T2(C)). Casualties who do not initially require recompression are to be designated T3(C). For example: a survivor with haemorrhagic shock and progressive DCI would be categorised as T1(M)/T1(C) whereas the survivor with haemorrhagic shock alone and no evidence of DCI would be categorised T1(M)/T3(C). The categories T1(C), T2(C) and T3(C) are defined as follows:

(1) *Triage Category T1(C)* - casualties who require immediate recompression.

(a) Progressive DCI, regardless of the manifestations.

(b) Static or relapsing DCI with pulmonary, girdle pain or neurological manifestations.

(2) *Triage Category T2(C)* - casualties who require non-urgent recompression.

(a) Spontaneously improving DCI with neurological manifestations.

(b) Static DCI with cutaneous manifestations.

(3) *Triage Category T3(C)* - casualties who on initial assessment do not require recompression.

(a) Mediastinal and subcutaneous emphysema.

(b) Pneumothorax with no signs or symptoms of DCI.

b. Only casualties in triage category T1(C) should be recompressed on board the Escape Gear Ship (EGS) as recompression facilities will be limited. Casualties in categories T2(C) should, as soon as possible, be evacuated to a shore-based recompression facility. Category T3(C) casualties should also be evacuated to hospital or sick-bay ashore as soon as resources permit.

c. Recompression onboard the EGS should be limited to 18m. Only where there is sufficient chamber space for casualties to be treated individually should a greater depth be contemplated. RN Table 62 should be employed, which may be extended as necessary. The MCDO/PO(D) or above is responsible for therapeutic recompression in accordance with para 0794.

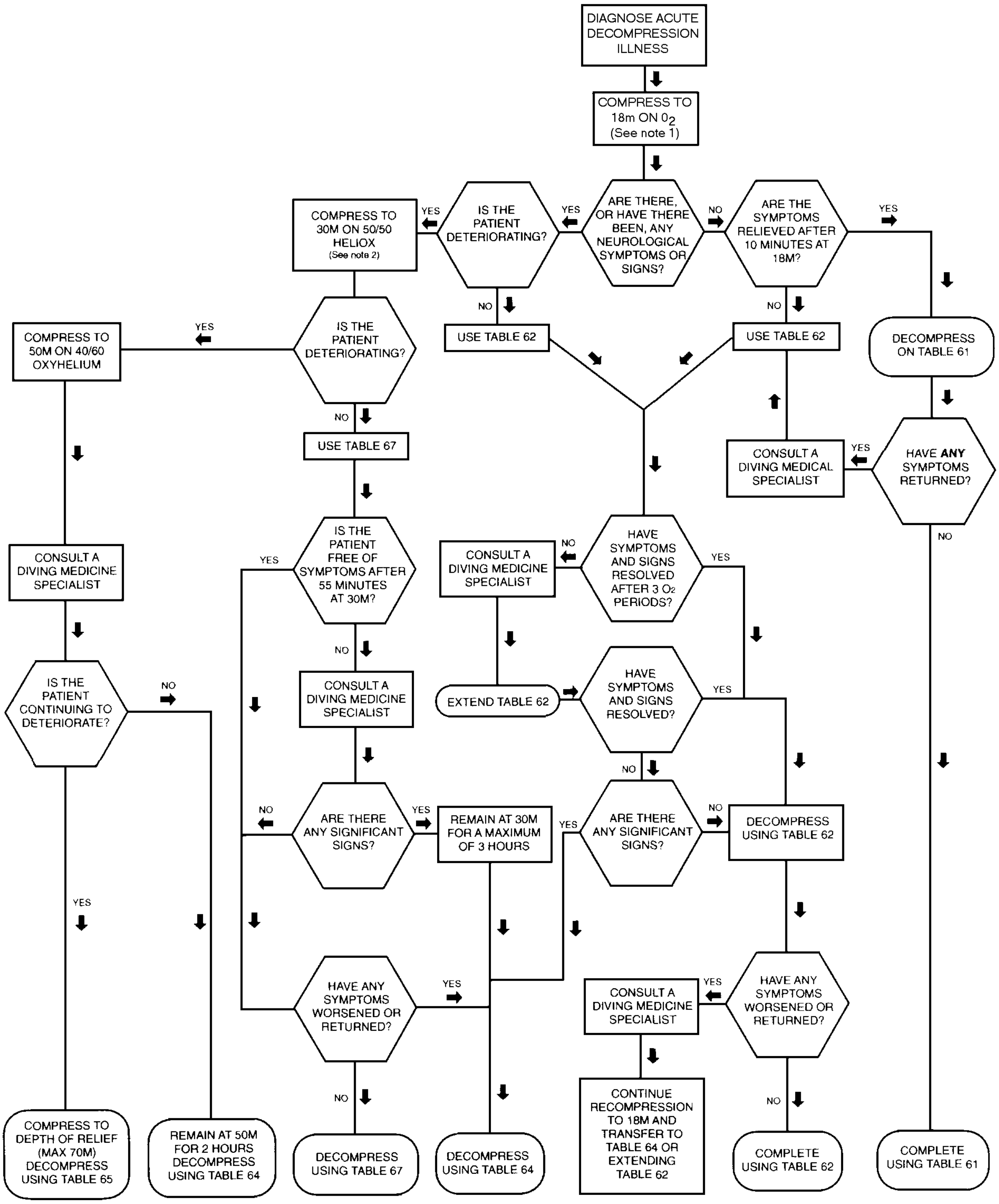
d. Medical Officers should NOT enter the recompression chamber. An attendant should accompany the first casualty in the chamber and should remain there until a conscious casualty capable of performing the duties of an attendant is locked in. The attendant should then leave the chamber to make room for further casualties, provided that his bottom time at 18m has been no more than 1 hour.

e. If a diving vessel with a saturation diving complex is available, this may be used to treat a large number of cases. Although oxy-helium mixtures may be available, it is recommended that only RN oxygen treatment tables are used. Advice should be sought from the Duty Diving Medical Officer before alternative regiments are employed.

f. All casualties in categories (T1(C)) and T2(C)) should be given oxygen in as high a concentration as possible, ideally 100%, whilst awaiting recompression. Rehydration, by mouth for conscious casualties, or intravenously for those who are unconscious, in sufficient quantities to establish a substantial urine output should also be commenced.

g. Casualties with limb pain DCI may be given analgesia whilst awaiting recompression. The drug of choice is paracetamol. Aspirin and other non-steroidal anti-inflammatory agents should be avoided. **Under no circumstances are inhalational analgesics, such as entonox, to be administered**.

h. Casualties with neurological DCI may benefit from steroids. 12-20 mg dexamethasone may be given by SLOW intravenous or intramuscular injection as an initial loading dose and repeated doses of 8 mg every 6 hours may be given for up to 48 hours thereafter.



Notes:

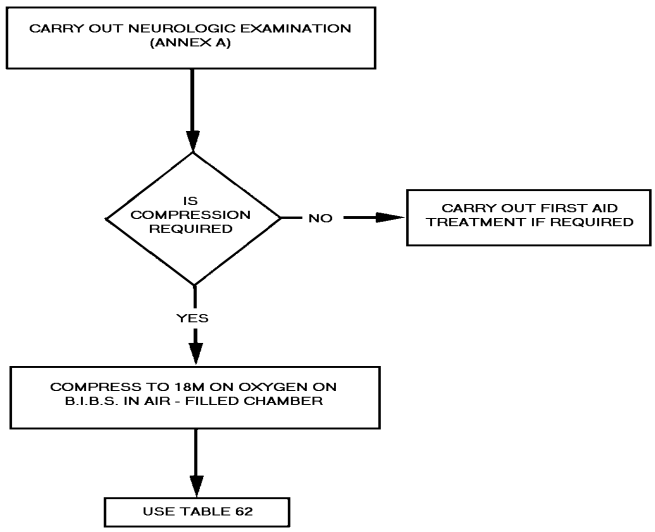
1. If the diver has completed less than 15 minutes of stops AND missed stops deeper than 18m compress straight to 30m, see para 1374

2. For SETT trainees and divers when 50/50 heliox is not available compress to 50m, see paras 1370 and 1376.

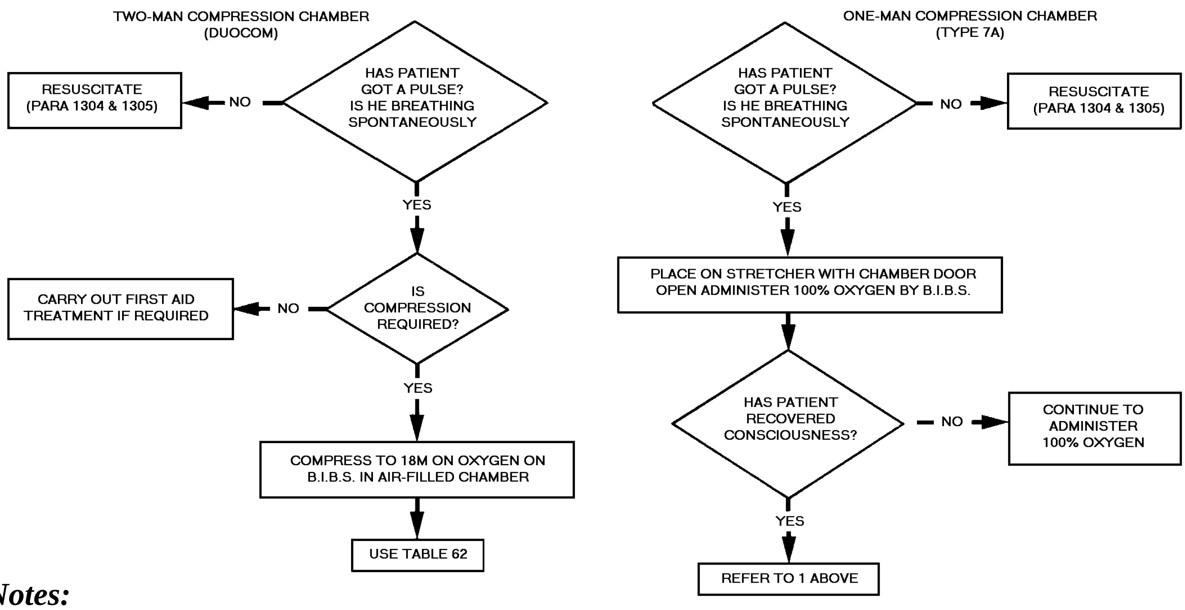
Fig 13-18. Summary of the Management of Acute Decompression Illness in Chambers Other than OMCC/Duocom

The following decision - assisting Flow Charts should be used in conjunction with the text, which is the principal authority of the treatment of Decompression Illness.

1. TREATMENT OF ALL ILLNESSES - PATIENT CONSCIOUS



2. TREATMENT OF ALL ILLNESSES - PATIENT UNCONSCIOUS



Notes:

1. *Advice should be sought from a diving medical specialist as soon as possible, and preferably BEFORE compressing a patient who has been unconscious.*

2. *The patient must be transported to the nearest two compartment chamber (with TUP facilities if patient is under pressure).*

Fig 13-19. Summary of the Treatment of Decompression Sickness when Only a One-Man or Two Man Compression Chamber is Available

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ANNEX A TO CHAPTER 13

NEUROLOGICAL EXAMINATION

1. Introduction

a. This Annex provides a systematic approach to the neurological examination of divers. It is not as thorough as the examination carried out by a Diving Medical Specialist or other Medical Officer in cases of decompression illness but provides a basic guide for the assessment of diving casualties for non-medical personnel.

b. The history, examination, treatment of diving accidents and the results of the neurological examination are to be recorded on Forms S 333 Parts 1 and 2 and S 333B. The neurological examination is to be completed by the Medical Officer, but in the absence of an MO, the neurological examination and other general details may be completed by the most competent person present. The nominated competent person must have received formal instruction from INM.

2. Initial Assessment of Diving Injuries. When a diver reports a medical complaint, the examiner should compile a history of the case which should include facts ranging from the dive profile to the progression of the medical problem. If recompression is required immediately, enquiries should be delayed until the patient is stabilised at depth. The following questions will help to determine the diagnosis and hence, the necessary treatment:

a. What type of dive did you make? To what depth? For how long?

b. How many dives have you made in the last 24 hours?

c. When did you first notice that something was wrong? Before, during or after the dive - and how many minutes after surfacing?

d. Describe what is wrong with you.

e. Has the problem got worse or improved since you first noticed it?

f. Have any additional symptoms developed?

g. Have you ever had a similar problem before?

h. Have you ever had decompression illnesss or air embolism before?

3. Once the history is complete, perform a full neurological examination. However, as soon as a central nervous system deficit is found, therapy should be instituted immediately. (See Section 5) In these cases a more detailed examination of the patient can be completed at treatment depth by the attendant or by a doctor, if one is available.

4. Neurological Assessment. The guidance below is intended as a guide for non-medical personnel who have to conduct a neurological examination:

a. **Mental Status.** This is best determined when you first see the patient. Obtain a good history, including the dive profile, present symptoms and how these symptoms have changed since onset. The patient's response to this questioning will give you a great deal of information about his/her mental status. It is important to determine if the patient knows the time and place, and can recognise familiar people and understand what is happening. Is the patient's mood appropriate?

b. Next, the examiner may determine if the patient's memory is intact (e.g. What is the Captain's name? What did you have for lunch?). If a problem arises in the mental status evaluation, the examiner might assess the patient's cognitive function more fully. For example, ask the patient to spell a word such as "world" backwards and count back from 100 in steps of seven. Most diving casualties have a normal mental status.

c. **Co-ordination** (cerebellar/inner ear function). A good indicator of muscle strength and general co-ordination is to observe how the patient walks. A normal gait indicates that many muscle groups and general brain functions are normal. Other tests the examiner may wish to employ for assessing the integrity of the patient's co-ordination are:

d. **Romberg Test.** This requires the patient to stand with his feet together, arms extended in front of him with the palms up, and eyes closed. Observe if the patient can retain his balance or does he immediately fall to one side?

e. **Finger-to-nose Test.** This requires the examiner to hold up an index finger to the patient. The patient is then asked to place his index finger first on his own nose, then the examiner's finger. This sequence should be repeated with the examiner moving his finger to different positions until he is satisfied that there is no deficiency. Speed is not important but accuracy is. Repeat with the patient's other hand.

f. **Cranial Nerves**. An isolated cranial nerve lesion would be an unusual finding in decompression illnesss or gas embolism, but deficits occasionally do occur and you should test for abnormalities. The cranial nerves must be quickly assessed as follows:

(1) The olfactory nerve, the sense of smell, is usually not tested.

(2) The optic nerve is for vision. Test one eye at a time to see if the patient can read. Ask the patient if he can see alright, if there is blurring of vision, spots in the visual field, or a loss of peripheral vision (tunnel vision). Test the visual fields as follows: stand in front of the patient and ask him to cover one eye and look straight at you. In a plane midway between yourself and the casualty slowly bring your fingertip in turn from above, below, to the right and then left of the direction of gaze until he can see it. Compare this with the earliest that you can see it with the equivalent eye. If present, roughly map out the positions of any blind spots by passing the fingertip across the visual field.

(3) Three cranial nerves, the oculomotor, trochlear, and abducens control eye movements. All three nerves can be tested by having the patient's eyes follow the examiner's finger in all four directions (quadrants) and then in towards his nose. The oculomotor can be separately tested by shining a light into one eye at a time. In a normal response the pupils of both eyes will constrict.

(4) The Trigeminal nerve governs sensation of forehead and face and the clenching of the jaw. Sensation is tested by lightly stroking the forehead, face and jaw on each side with a finger or wisp of cotton wool.

(5) The facial nerve controls the face muscles. It is tested by having the patient smile, show his teeth, whistle, wrinkle his forehead and close his eyes tightly. The two sides should perform symmetrically.

(6) The auditory nerve controls hearing and balance. Test this nerve by whispering to the patient, rubbing your fingers together next to the patient's ears or putting a tuning fork near the patient's ears.

(7) The glossopharyngeal nerve is not normally tested. It is purely a sensory nerve which transmits sensation from the upper mouth and throat area.

(8) The vagus nerve has many functions, including control of the roof of the mouth and vocal cords. The examiner can test this nerve by having the patient say "aah" while watching for the palate to rise. Note the tone of the voice, hoarseness may also indicate a vagus nerve deficit.

(9) The spinal accessory nerve controls the turning of the head from side to side and shoulder shrug against resistance. The examiner will note that an injury to the nerve on one side will cause an inability to turn the head to the opposite side or weakness/absence of the shoulder shrug on the affected side.

(10) The last of the cranial nerves, the hypoglossal, governs the muscle activity of the tongue. An injury in one of the hypoglossal nerves causes the tongue to twist to that side when stuck out of the mouth.

g. **Extremity Strength**. It is common for a diver with dysbarism to experience muscle weakness. All muscle groups should be tested and compared with the corresponding group on the other side, as well as with the examiner. Muscle strength may be graded (0-5) as follows:

0 Paralysis - no motion observed.
1 Profound weakness - flicker or trace of muscle contraction.
2 Severe weakness - able to contract muscle but cannot move the limb against gravity.
3 Moderate weakness - able to overcome the force of gravity but not that of the examiner.
4 Mild weakness - able to resist slight force of the examiner
5 Normal - equal bilaterally and able to resist examiner.

h. The arms and legs are tested separately. Each muscle group should be compared to the same group in the opposite limb. Six muscle groups may be tested in the arm as follows. The deltoids are tested by having the patient raise his arm sideways against resistance. The latissimus dorsi are tested by lowering the arm at the shoulder joint. The biceps are tested by bending the arm at the elbow and the triceps by straightening the arm at the elbow. The forearm muscles are tested by bending the wrist against resistance, opening and closing the hand, and by gripping with the hands. Finally the hand muscles are tested by observing grip strength and spreading the fingers against resistance.

i. The strength of the legs can be quickly assessed by having the patient walk on his toes and on his heels. Following this have the patient squat down and walk while squatting (duck walk). These tests should adequately assess lower extremity strength.

j. For a more detailed examination, muscle strength should be tested at each joint as in the upper limb. Hip strength is tested by raising and lowering the thigh against resistance and moving the thigh away from and towards the midline against resistance. Knees can be tested by straightening and bending the knee against resistance.

k. **Sensation**. The patient may complain of pain, numbness, or tingling in one or more areas. These are common presentations of decompression illness. Fig 13A-1 on page 13A-5 shows the dermatomal areas of skin sensation which correlate with each spinal cord segment. Check each of the spinal segments on the figure for loss of sensation. Sharp/dull discrimination and light touch are sensations easily tested and normally suffice.

l. Test whether the patient can discriminate between the **gentle** application of a sharp point or the blunt clasp of a safety pin. Complete a quick test of the head, trunk, arms and legs initially and if a deficit is found use the diagram in Fig 13A-1 to determine which dermatomes are involved. Be sure to check both sides. Light touch can be tested in the same way using a finger or wisp of cotton wool.

m. If an area of abnormality is found, mark it with a pen or a biro so it can be used as a reference point for future assessment.

n. **Deep Tendon Reflexes**. The biceps, triceps, knee and ankle reflexes should be tested. An adequate examination requires relaxation on the part of the patient. Grade as normal, no response, hypoactive or hyperactive (compared to normals that you have tested). Note especially if the upper and lower reflexes are similar. Be sure to strike with an equal, light force and use sharp, quick taps in order to get the best response. Generally, if a deep tendon reflex is abnormal due to dysbaric disease, other abnormal signs will also be found.

(1) *Biceps*. Hold the elbow with your thumb on the biceps tendon - elbow should be slightly bent and the arm relaxed. Tap your thumb and feel the biceps contract.

(2) *Triceps*. Tap just above the elbow with the elbow bent. Note contraction of the muscle.

(3) *Knee*. Tap below the knee cap on the tendon and note the contraction of the quadriceps and movement of the lower leg.

(4) *Ankle*. Place slight pressure on the toes to stretch the achilles tendon and tap this tendon. Feel the toes contract as the achilles tendon shortens.

(5) *Babinski Reflex*. Firmly stroke a thumb up the inside of the sole of the foot and note whether the big toe moves up or down. Most normal subjects move their toes down. If there is no reaction use something like a car key to apply the pressure - it might tickle but it should not hurt.

o. This examination is not meant to be all-inclusive but is an effective screening tool. The results of this examination are to be recorded as required by **para 1b**.

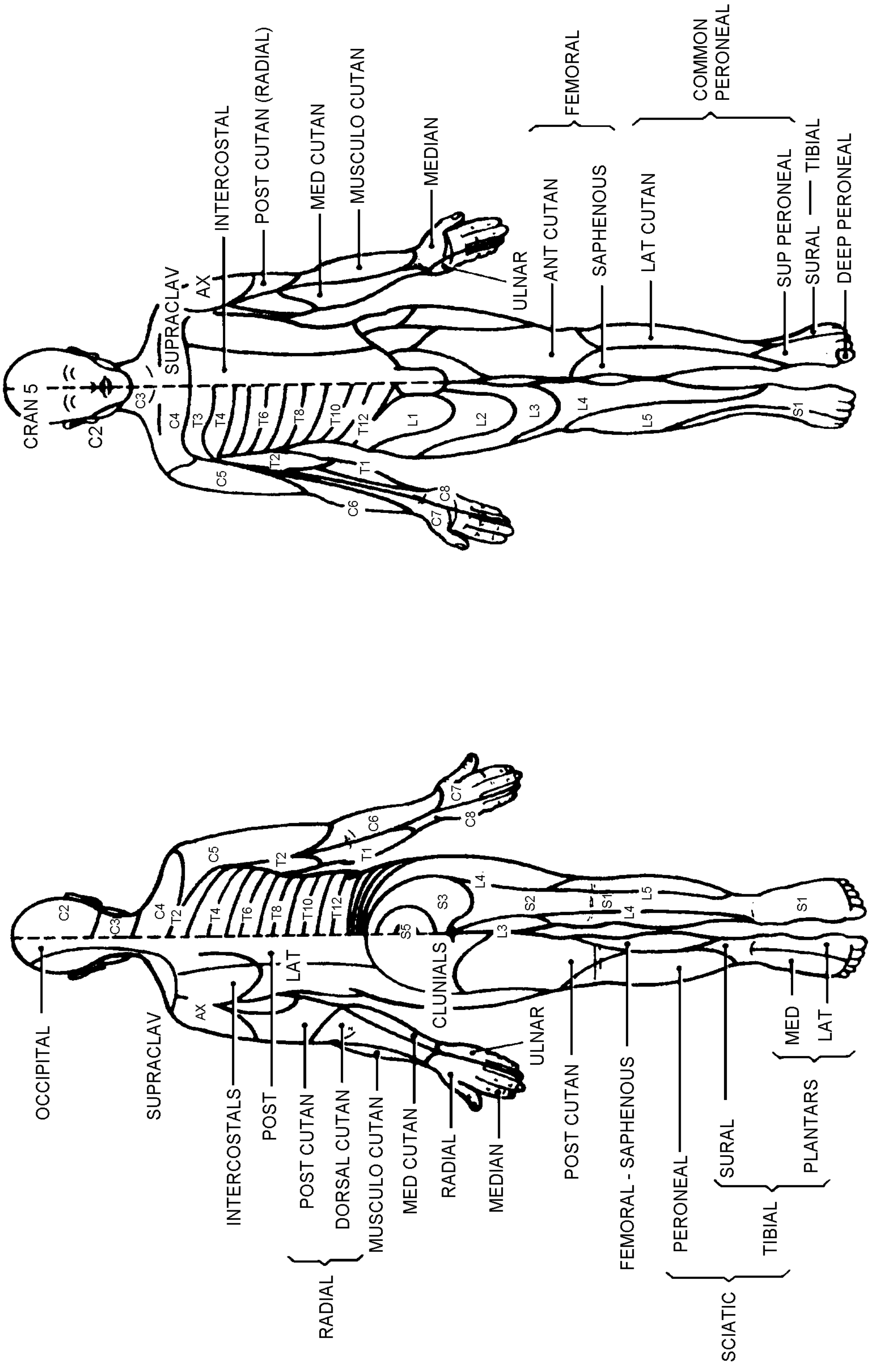

Fig 13A-1. Dermatomal Areas Correlated to Spinal Cord Segment

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ANNEX B TO CHAPTER 13

ADDITIONAL TREATMENT TABLES

1. **Introduction**. Experience over the past 20 years has shown that O_2 tables are superior in most respects to air tables with the occasional exception of Table 64. The Tables given in this Annex should therefore rarely be needed or used. However they are provided for use if O_2 is unavailable and on the advice of a Diving Medicine Specialist.

2. **Tables 52, 53 and 55: Air Recompression Therapy.** These Tables are applied as described in para 1366, but with the following modifications:

   a. **Rate of descent.** This is to be in accordance with the requirements of para 1366.

   b. **Ascent**. Ascent between stops is to take five minutes. This is not included in the stoppage times, but has been allowed for in the elapsed times.

TABLE 52

AIR RECOMPRESSION THERAPY

Gauge Depth (m)	Stops Hours	Stops Mins	Elapsed Time (hours and mins)	Rate of Ascent
50		30	00:00 - 00:30	5 minutes between stops throughout
42		**12**	**00:35 - 00:47**	
36		12	00:52 - 01:04	
30		**12**	**01:09 - 01:21**	
24		12	01:26 - 01:38	
18		**30**	**01:43 - 02:13**	
15		30	02:18 - 02:48	
12		**30**	**02:53 - 03:23**	
9	2		03:28 - 05:28	
6	**2**		**05:33 - 07:33**	
3	2		07:38 - 09:38	
Surface			**09:43**	

TABLE 53

AIR RECOMPRESSION THERAPY

Gauge Depth (m)	Stops Hours	Stops Mins	Elapsed Time (hours and mins)	Rate of Ascent
50		30	00:00 - 00:30	
42		**12**	**00:35 - 00:47**	
36		12	00:52 - 01:04	
30		**12**	**01:09 - 01:21**	5 minutes between stops throughout
24		12	01:26 - 01:38	
18		**30**	**01:43 - 02:13**	
15		30	02:18 - 02:48	
12		**30**	**02:53 - 03:23**	
9	12		03:28 - 15:28	
6	**2**		**15:33 - 17:33**	
3	2		17:38 - 19:38	
Surface			**19:43**	

TABLE 55

AIR RECOMPRESSION THERAPY

Gauge Depth (m)	Stops Hours	Stops Mins	Elapsed Time (hours and mins)	Rate of Ascent
50	2		00:00 - 02:00	
42		**30**	**02:05 - 02:35**	
36		30	02:40 - 03:10	
30		**30**	**03:15 - 03:45**	
24		30	03:50 - 04:20	5 minutes between stops throughout
18	**6**		**04:25 - 10:25**	
15	6		10:30 - 16:30	
12	**6**		**16:35 - 22:35**	
9	12		22:40 - 34:40	
6	**4**		**34:45 - 38:45**	
3	4		38:50 - 42:50	
Surface			**42:55**	

3. **Tables 71 to 73 : Modified Air-Recompression Therapy**

a. Tables 71 and 72 can be used instead of the air recompression therapies, Tables 52, 53 and 55.

b. Table 72 is applicable when multiple recompression of submarine survivors is called for (para 1387).

c. Table 73 may be used in place of Table 55. Although somewhat more difficult to accomplish, the smaller step size in the final 18m is preferred. The table approximates the bleed rate of the final 18m of Tables 71 and 72. Medical advice may recommend a period of O_2 breathing during the shallower depths of this table.

4. These tables are applied as described in para 1387, but with the following modifications for Tables 71 and 72.

a. **Maximum Pressure**. Maximum pressure may be less than that quoted and depends on the working pressure of the chamber available.

b. **Ascent**. The ascent is to be conducted as follows:

(1) It is to be a continuous bleed at the rates indicated.

(2) If the rate is slowed it is not to be compensated for by subsequent acceleration.

c. **Oxygen**. When using Tables 71 to 73, on the advice of a Diving Medical Specialist, a $32^1/_2$ / $67^1/_2$ oxygen/nitrogen mixture may be administered at 50m with all the Tables, as can pure O_2 at 18m or shallower. he mixture or pure O_2 will normally be breathed for 25 minute periods followed by 5 minute intervals breathing chamber air. See also para 1371.) It should be noted that where extra O_2 has been administered in these long tables, care should be exercised concerning pulmonary O_2 toxicity. calculation of total units of pulmonary toxic dose of O_2 should be used as a guideline.

TABLE 71

MODIFIED AIR RECOMPRESSION THERAPY

Gauge Depth (m)	**Stops/Ascent Hours**	**Mins**	**Elapsed Time (hours and mins)**	**Rate of Ascent (metres/hour)**
70		30	00:00 - 00:30	
70 - 63		**7**	**00:30 - 00:37**	**60**
63 - 51	2		00:37 - 02:37	6
51 - 39	**4**		**02:37 - 06:37**	**3**
39 - 29	5		06:37 - 11:37	2
29 - 20	**6**		**11:37 - 17:37**	**1.5**
20 - 10	10		17:37 - 27:37	1
10 - 0	**20**		**27:37 - 47:37**	**0.5**
Surface			47:37	

TABLE 72

MODIFIED AIR RECOMPRESSION THERAPY

Gauge Depth (m)	Stops Hours	Stops Mins	Elapsed Time (hours and mins)	Rate of Ascent (metres/hour)
50	2	**See Note**	00:00 - 02:00	
50 - 39	3	40	02:00 - 05:40	3
39 - 29	**5**		**05:40 - 10:40**	**2**
29 - 20	6		10:40 - 16:40	1.5
20 - 10	**10**		**16:40 - 26:40**	**1**
10 - 0	20		26:40 - 46:40	0.5
Surface			**46:40**	

Note. *The period of 2 hours can be reduced and decompression started earlier if the patient's symptoms have cleared.*

TABLE 73

MODIFIED AIR RECOMPRESSION THERAPY

Gauge Depth (m)	Stops Hours	Stops Mins	Elapsed Time (hours and mins)	Rate of Ascent (metres/hour)
50	2		00:00 - 02:00	
42		**30**	**02:05 - 02:35**	
36		30	02:40 - 03:10	
30		**30**	**03:15 - 03:45**	
24		30	03:50 - 04:20	
18	**6**		**04:25 - 10:25**	
17		55	10:30 - 11:25	
16		**55**	**11:30 - 12:25**	5 minutes between stops throughout
15		55	12:30 - 13:25	
14		**55**	**13:30 - 14:25**	
13		55	14:30 - 15:25	
12		**55**	**15:30 - 16:25**	
11		55	16:30 - 17:25	
10	**1**	**55**	**17:30 - 19:25**	
9	1	55	19:30 - 21:25	
8	**1**	**55**	**21:30 - 23:25**	
7	1	55	23:30 - 25:25	
6	**1**	**55**	**25:30 - 27:25**	
5	1	55	27:30 - 29:25	
4	**1**	**55**	**29:30 - 31:25**	
3	1	55	31:30 - 33:25	
2	**1**	**55**	**33:30 - 35:25**	
1	1	55	35:30 - 37:25	
Surface			**37:30**	

ANNEX C TO CHAPTER 13

AIDE MEMOIRE/EVALUATION CARD (to Accompany Diving Accident Patient)

All questions should be answered.

Name of Diver . . . .   Age . . . .

Time of Report . . . .   Date . . . .

Local Time . . . .

SECTION A

DETAILS OF DIVE LEADING TO ACCIDENT

A0	-	Time of descent	. . . .
A1	-	Maximum depth of diving	. . . .
A2	-	Total diving time	. . . . minutes
A3	-	Stops done	Yes/No . . . .
A4	-	Which stops done	. . . .
A5	-	Type of breathing gas (compressed air/mixed gas - state proportions)	. . . .
A6	-	Diving equipment	. . . .
A7	-	Kind of effort (heavy, medium, light)	. . . .
A8	-	Condition of diver on arrival at surface	Good/Bad . . . .
A9	-	Time of first symptoms after dive	. . . . hours
A10	-	Has the diver used any medication	Yes/No . . . .
A11	-	Enough oxygen available for treatment	Yes/No . . . .
A12	-	Kind of treatment started (tables + number)	. . . .
A13	-	Time treatment started (local time)	. . . .
A14	-	Short description of Accident	. . . .

SECTION B

PREVIOUS DIVES

B1	-	Date	. . . .
B2	-	Time of descent	. . . . hours
B3	-	Maximum depth of diving	. . . . metres
B4	-	Total diving time	. . . . minutes
B5	-	Any stops done	Yes/No . . . .
B6	-	Which stops done	. . . .

AIDE MEMOIRE/EVALUATION CARD (Cont'd)

SECTION C

ITEMS TO BE CHECKED

C1	-	Regular pulse	Yes/No . . . .
C2	-	Breathing rate	. . . . /minutes
C3	-	Pulse rate	. . . . /minutes
C4	-	Orientation OK? (in time and person)	Yes/No . . . .
C5	-	Amnesia (for recent or previous happening)	Yes/No . . . .
C6	-	Muscle strength (normal)	Yes/No . . . .
C7	-	Normal speech	Yes/No . . . .

SECTION D

SYMPTOMS

D1	-	Joint pains	Yes/No . . . .
D2	-	Headache	Yes/No . . . .
D3	-	Nose bleeding	Yes/No . . . .
D4	-	Chest pain	Yes/No . . . .
D5	-	Tightness of the chest	Yes/No . . . .
D6	-	Muscle spasm	Yes/No . . . .
D7	-	Weakness of muscles	Yes/No . . . .
D8	-	Paralysis	Yes/No . . . .
D9	-	Problems with breathing	Yes/No . . . .
D10	-	Skin problems (change of colour)	Yes/No . . . .
D11	-	Numbness	Yes/No . . . .
D12	-	Itching	Yes/No . . . .
D13	-	Hearing problems	Yes/No . . . .
D14	-	Dizziness	Yes/No . . . .
D15	-	Equilibrium problems	Yes/No . . . .
D16	-	Impress of falling	Yes/No . . . .
D17	-	If falling which direction	. . . .
D18	-	Problems of vision	Yes/No . . . .
D19	-	Anxiety	Yes/No . . . .
D20	-	Nausea vomiting	Yes/No . . . .
D21	-	Convulsions (if unconscious)	Yes/No . . . .
D22	-	Unconscious	Yes/No . . . .

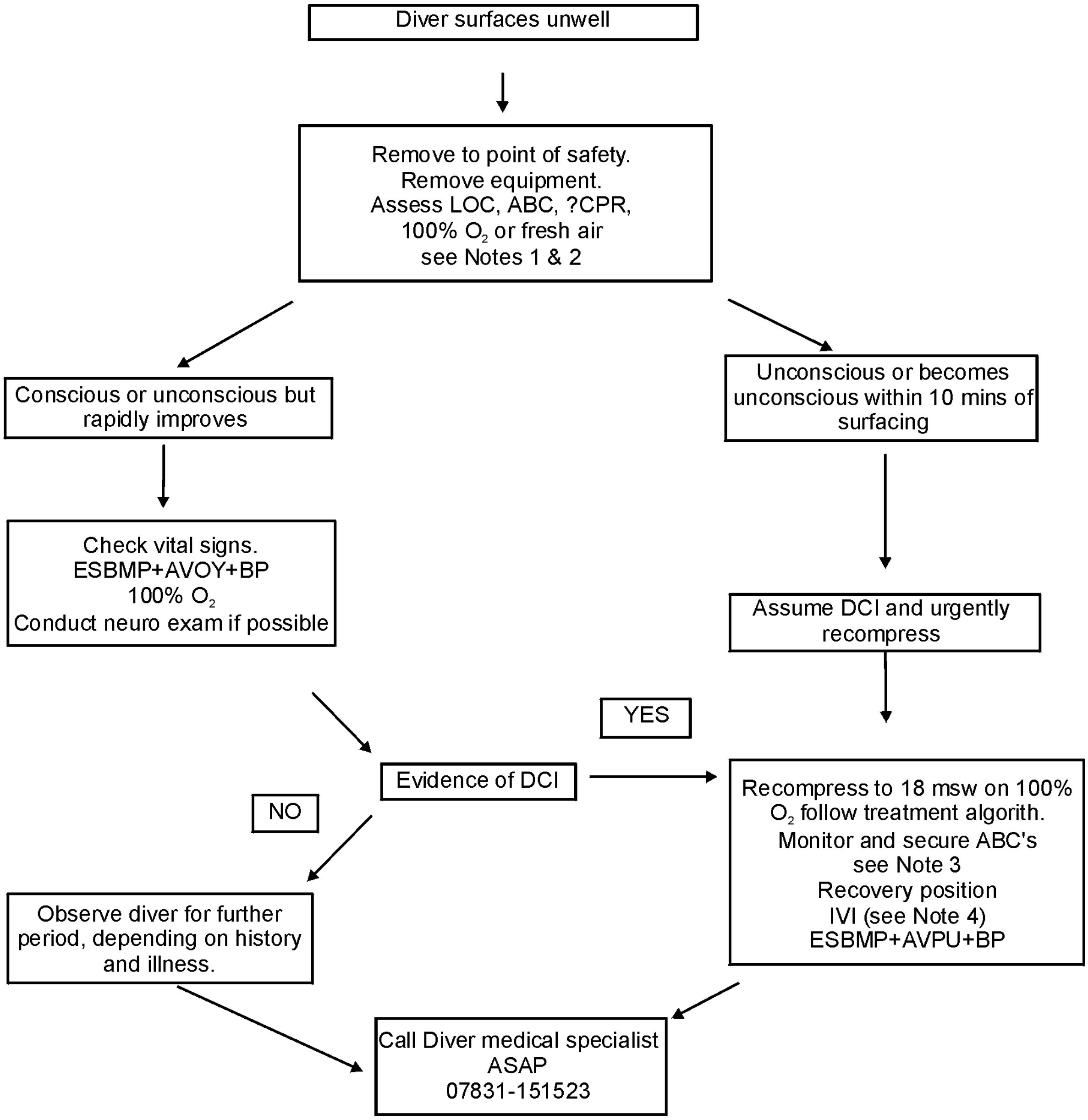
If any answer in Section D is ‘Yes’ give specific localisation.

SECTION E

OTHER SPECIFIC SYMPTOMS

Short description

IF IN RADIO CONTACT WITH THE LOCATION OF THE HYPERBARIC TREATMENT CHAMBER PASS INFORMATION USING THE CODES ABOVE eg ALFA ZERO 1225, ALFA ONE 54m etc. GIVE ALL CODES (ALFA 0-14; BRAVO 1-6; CHARLIE 1-7; DELTA 1-22).



Notes:

1. If the diver requires ECC then consideration should be given for a rapid attempt at defibrillation if available prior to being placed within the RCC. Only BLS CPR can be performed within the RCC. This may entail long periods of CPR.

2. Do not give a diver O_2 if diving gas was O_2 as problems may be a CNS O_2 toxicity. This should resolve with fresh air.

3. If endotracheal intubation or urethral catheterisation is required sterile water or fluid taken from a IVI should be used in the retaining balloons.

4. IVI of either 0.9% sodium chloride or Hartmann's solution.

Glossary of terms

ABC	Airway, breathing and circulation.
AVPU	Rapid assessment of patient's level of consciousness. See Table 1.
BLS	Basic Life Support.
BP	Blood pressure.
CNS	Central Nervous System.
CPR	Cardiopulmonary Resuscitation.
DCI	Decompression Injury.
ECC	External cardiac compression.
ESBMP	Every Snake Bite Means Pain. Mnemonic for observations. See Table 2.
IVI	Intravenous infusion.
LOC	Level of consciousness.
O_2	Oxygen.
RCC	Recompression Chamber.
RCT	Recompression Therapy.

Table 1.

AVPU scale	
A	Patient is **a**lert, he knows his name, where he is, what day it is etc.
V	Patient responds to **v**erbal commands appropriately but may not open his eyes.
P	Patient responds only to **p**ainful stimuli.
U	Patient is **u**nresponsive.

Table 2.

Every Snake Bite Means Pain	
E	**E**yes, pupil reaction, size and nystagmus.
S	**S**peech, answers questions, confusion, incomprehensible sounds, no response
B	**B**reathing, rate, sound, effort.
M	**M**ovement, obeys commands, response to pain stimulus, no response.
P	**P**ulse, rate, strength, rhythm.

ANNEX D TO CHAPTER 13

MEDICAL TERMINOLOGY

Adipose tissue:	Fatty tissue
Analgesia:	Pain relief
Anorexia:	Loss of appetite for food
Anoxia:	The absence of oxygen supply to the body
Asphyxia:	The cessation of life due to a lack of oxygen
Astringent:	Causing contraction
Bacteriostatic:	Agent which inhibits the growth of bacteria
Cardiac arrest:	The cessation of heart function
Cardiopulmonary resuscitation:	The re-establishment of heart and lung action, by artificial ventilation and external cardiac compression
Cardiovascular:	To do with the heart and blood vessels
Coma:	Complete lack of consciousness
Crepitation:	Crackling sound
Cutaneous:	To do with the skin
Cyanosis:	A bluish tinge seen in tissues which are low in oxygen
Dysphasia:	Difficulty with speech
Embolism:	The blocking of a blood vessel by a clot or foreign material
Eructation:	Belching
Erythema:	Redness of the skin
Eustachian tube:	The tube connecting the middle ear and the throat
Grand mal convulsion:	An epileptic fit

Haemoptysis:	The coughing up of blood
Haemorrhage:	Bleeding
Hyperbaric oxygen:	High pressure oxygen
Hypercapnia:	An excess of carbon dioxide
Hyperresonance:	Drum like sound on tapping of the chest
Hypotension:	Low blood pressure
Hypothermia:	Below normal body temperature
Hypoxia:	Reduced oxygen supply
Intracranial pressure:	The pressure within the skull
Ischaemia:	Deficient blood supply
Mediastinal shift:	Movement of the space between the lungs to one side
Mucous membranes:	The thin layer of skin lining some parts of the body
Narcosis:	State of sleepiness produced by a drug
Nystagmus:	Involuntary and jerky repetitive movement of the eyeballs
Oedema:	Fluid in the tissues
Ostium:	The opening of any tubular passage
Otitis externa:	Inflammation of the external auditory canal of the outer ear
Otoscope:	An instrument for inspecting the ear
Ototoxic:	Having a toxic effect on the ear
Palpitations:	The sensation of a rapid of irregular heartbeat
Paraesthesia:	The sensation of tingling
Paraplegia:	Paralysis of the legs and lower part of the body
Petechial haemorrhages:	Small spots of bleeding within the tissues

Pneumothorax:	The collapse of a lung through introduction of air between the lining of the lung and the rib cage
Pulmonary oedema:	Fluid in the lungs
Pulmonary resuscitation:	The re-establishment of lung action by artificial ventilation
Residual volume:	The amount of air remaining in the lungs after forced expiration
Retrosternal:	Behind the sternum (breast bone)
Septum:	A partition between two cavities
Sternum:	The breast bone
Subconjunctival haemorrhage:	Bleeding which occurs under the membrane lining the outside of the eyeball
Subcutaneous emphysema:	The presence of air or gas beneath the skin
Therapeutic:	Describes a treatment which improves or cures a condition
Thermoregulation:	Temperature regulation
Tinnitus:	Ringing in the ears
Tympanic membrane:	The eardrum
Vasoconstriction:	Narrowing of the blood vessels
Ventricular fibrillation:	An incoordinated activity of the main chambers of the heart which stop it pumping blood effectively
Vertigo:	Dizziness
Vestibular:	Describes the parts of the ear which detect acceleration (movement) of the body and contributes to maintaining balance
Vital capacity:	The amount of air expelled from the lungs after a deep inspiration

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