

Australian/New Zealand Standard™

Occupational diving operations

Part 1: Standard operational practice



AS/NZS 2299.1:2015

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee SF-017, Occupational Diving. It was approved on behalf of the Council of Standards Australia on 16 March 2015 and on behalf of the Council of Standards New Zealand on 3 September 2015.

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Association of Diving Contractors, New Zealand
Australian Council of Trade Unions
Australian Diver Accreditation Scheme
Australian Diving Contractors Association
Australian Marine Sciences Association
Australian Medical Association
CSIRO Marine and Atmospheric Research
Department of Defence, Australia
International Marine Contractors Association
Maritime Union of Australia
National Association of Occupational Diver Training Establishments
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Australian/New Zealand Standard™

Occupational diving operations

Part 1: Standard operational practice

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee SF-017, Occupational Diving, to supersede AS/NZS 2299.1:2007.

This Standard is the initial Part of a series of Standards for the conduct of occupational diving operations. It is intended for application to all diving operations, however, diving operations in specific sectors of the diving industry for which other Parts in the AS/NZS 2299 series are published may be conducted using either this Standard or the sector-specific Standard. At the time of publication, sector-specific Standards for scientific diving, recreational industry diving and film and photographic diving were published.

The objective of this revision is to clarify and update the Standard and to reflect the requirements of the regulatory authorities. Significant differences from the 2007 edition include the following:

- (a) Revised guidance for the use, calibration and testing of the various pressure gauges used in diving operations.
- (b) A review of the provisions for breathing gas quality, with a specific emphasis on the following:
 - (i) Simplification of determining acceptable water content to avoid risk of condensation or freezing.
 - (ii) Acceptable composition of breathing gases, including gas used for enriched air nitrox (EAN) diving.
 - (iii) A review of the testing and monitoring requirements for breathing gas quality.
- (c) A review of the flange requirements and further considerations for the use of worksite chambers.
- (d) The introduction of a maximum partial pressure of oxygen to be breathed by the diver.
- (e) The addition of a section on the specific requirements for EAN diving, which includes—
 - (i) equipment requirements;
 - (ii) breathing gas supplies for SCUBA and SSBA; and
 - (iii) EAN procedures.
- (f) A minor review of medical requirements.
- (g) A review of the guidance for medical practitioners in Appendix M.
- (h) The removal of reference to specific decompression tables for diving.

Standards Australia has been unable to renew copyright approval for the publication of an extract from the DCIEM tables, and accordingly these have been removed from this version of the document.

The illustrations for the hand signals shown in Appendix K are reproduced with the permission of PADI.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendices to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard **Occupational diving operations**

Part 1: Standard operational practice

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard provides organizational and logistical requirements for the conduct of occupational diving operations, including the use of compressed gas supply apparatus, and specific requirements for the use of surface-supplied breathing apparatus (SSBA) and self-contained underwater breathing apparatus (SCUBA) in occupational underwater operations at depths not exceeding 50 m (165 ft).

1.2 OBJECTIVE

The objective of this Standard is to provide persons engaged in, or connected with, occupational diving with a set of requirements to promote uniformity of practice in relation to health and safety.

1.3 APPLICATION

This Standard applies to persons directly involved in occupational diving operations and industries either employing those persons or supplying equipment for use in connection with occupational diving operations. This Standard provides requirements for diving activity using air or enriched air nitrox (EAN) mixtures at depths not exceeding 50 m.

Other Parts of the AS/NZS 2299 series have been prepared to provide specific requirements for particular types of diving, such as scientific diving and diving in the film and photographic sectors. These other Parts of the AS/NZS 2299 series are intended to be read in conjunction with the relevant requirements of this Standard.

In addition, this Standard is intended to act as a useful resource to guide organizational, logistical and safety-related aspects of all occupational diving activities, including those that fall outside the stated scope of this Standard.

If diving operations beyond the scope of this Standard are to be undertaken, then additional training and procedures will be necessary to ensure the safety and competency of the dive team.

This Standard may be used for guidance for diving activities in liquids other than water and for diving with non-standard breathing apparatus systems, such as hookah or rebreather units, subject to the appropriate additional training and procedures.

This Standard does not apply to the conduct or teaching of recreational diving, although the guidance on medical fitness for occupational diving is relevant.

This Standard does not apply to non-diving work in pressurized atmospheres, such as in tunnels or caissons, or in hyperbaric treatment facilities in hospitals, which are covered by AS 4774.1 and AS 4774.2 respectively.

NOTES:

- 1 Recreational industry diving is covered by AS/NZS 2299.3.
- 2 For recreational diving, the relevant regulatory authority needs to be consulted. A list of relevant regulatory authorities is given in Appendix A.

1.4 NORMATIVE REFERENCES

The following are the normative documents referenced in this Standard:

NOTE: Documents referenced for informative purposes are listed in the Bibliography.

AS

- 1210 Pressure vessels
- 1349 Bourdon tube pressure and vacuum gauges
- 2030 Gas cylinders
- 2030.1 Part 1: General requirements
- 2815 Training and certification of occupational divers (series)
- 3848 Filling of portable gas cylinders
- 3848.2 Part 2: Filling of portable cylinders for self-contained underwater breathing apparatus (SCUBA) and non-underwater self-contained breathing apparatus (SCBA)—Safe procedures
- 4484 Gas cylinders for industrial, scientific, medical and refrigerant use—Labelling and colour coding

AS/NZS

- 1337 Personal eye protection
- 1337.1 Part 1: Eye and face protectors for occupational applications
- 2815 Training and certification of occupational divers (series)
- 2815.5 Part 5: Dive supervisor

ANSI/ASME

Boiler and Pressure Vessel Code

1.5 DEFINITIONS

For the purpose of this Standard, the definitions below apply:

1.5.1 Animal enclosure pool

A permanent, man-made tank, pool, moat or stream that is constructed as part of an animal enclosure.

1.5.2 Aquarium

A permanent, man-made tank or pool, in which aquatic animals are housed for exhibition.

1.5.3 Bottom time

The total elapsed time from when a diver leaves the surface to the time (next whole minute) at which ascent is commenced, measured in minutes.

1.5.4 Breathing gas

The compressed gas intended for respiration by the diver.

1.5.5 Buddy system

A system used between divers to continually monitor and communicate with each other through visual or other means in order to render immediate assistance if required or in an emergency.

1.5.6 Built-in breathing system (BIBS)

A system whereby oxygen or other breathing gas is supplied to a person in a compression chamber via a respiratory demand-triggered gas supply device and oronasal face mask located inside the chamber.

1.5.7 Caisson gauge

A pressure gauge specifically designed for use inside pressure vessels.

1.5.8 Combined dive

The bottom times of more than one dive, added together and treated as a bottom time for a single dive to the deepest depth for the purpose of determining decompression requirements.

1.5.9 Competent person

A person who has acquired through training, qualifications or experience, or a combination of these, the knowledge and skills to enable that person to perform a specified task.

1.5.10 Compression (recompression) chamber

A surface chamber in which persons may be subjected to pressures equivalent to or greater than those experienced when under water, or under conditions which simulate those experienced on an actual dive.

NOTE: For the purpose of this Standard, 'compression chamber' is taken to include 'recompression chamber'.

1.5.11 Decompression illness

A generic term for acute illness resulting when pathological consequences arise from decompression. This term covers the condition known as decompression sickness (also known as bends) and arterial gas embolism, but does not include barotrauma of ascent.

1.5.12 Decompression schedule

A specific decompression procedure for a given combination of depth and bottom time as listed in a decompression table; it is normally described as a series of stops at specified depths (in metres or feet) for specified times (in minutes).

1.5.13 Decompression stop

The specific length of time that a diver needs to hold their ascent at a specified depth to allow for the elimination of sufficient inert gas from the body to allow a safe ascent to the next decompression stop or the surface.

1.5.14 Demand gas supply device

A device that provides breathing gas to the diver via a mechanism which provides a flow of breathing gas when the diver inhales.

1.5.15 Dive control position

A single, designated location on the surface, normally adjacent to where a diver enters the water, from which it is possible to monitor all systems and functions which relate to the life support and safety of a diver in the water.

1.5.16 Dive plan

A set of procedures for a given diving operation.

1.5.17 Dive supervisor

A competent person who supervises diving operations.

1.5.18 Dive team

The group of people, including the dive supervisor, diver(s), attendant(s) and other personnel as required, who are—

- (a) present at the dive site;
- (b) directly involved in the dive;
- (c) responsible for the safe conduct of the diving operation; and
- (d) responsible for the availability and conduct of emergency procedures.

1.5.19 Diver

A person who performs diving work underwater or is exposed to pressure in association with diving work.

1.5.20 Diver's hose

Flexible tubing used to carry breathing gas to the diver from a remote location.

1.5.21 Diver's umbilical

An assembly of hoses and cables, which supplies breathing gas, is used for communication and diver monitoring, and incorporates a strengthening member. The umbilical may also contain other components, such as a hot water supply, and perform other functions between a surface control point and a diver.

1.5.22 Diving work

Work which is conducted using underwater breathing apparatus and work by the dive team in direct support of the diver.

1.5.23 Employer

A corporation or individual employing or engaging a person or persons either under a contract of employment, apprenticeship or traineeship, or for work. This includes self-employed persons.

1.5.24 Enriched air nitrox (EAN)

A breathable mixture of nitrogen and oxygen with more than 21% oxygen content, which may also contain trace gases at levels no higher than found in breathable air.

1.5.25 Exceptional exposure dive

A dive where the maximum recommended dive time for a particular depth (sometimes shown by a limiting line in decompression tables) is exceeded by a diver at that depth.

1.5.26 Float line

A line connecting the diver to a high visibility float on the surface of the water enabling the approximate location of the diver to be known at all times.

1.5.27 Free-flow system

A breathing method used in SSBA diving operations whereby breathing gas enters the full-face mask or incompressible helmet in a continuous flow and is not controlled by a demand gas supply device.

1.5.28 Full-face mask

A face mask that—

- (a) encloses the total area of the face; and
- (b) incorporates an integral breathing system.

1.5.29 Half-face mask

A mask that covers the eyes and nose only, and does not incorporate an integral breathing system.

1.5.30 Hookah

A colloquial, but widely used, term for a limited feature form of surface supply diving apparatus usually involving the supply of breathing air from a small compressor unit via a free floating air supply hose to a mouth-held demand breathing gas supply device.

1.5.31 Incompressible helmet

A helmet that—

- (a) is constructed of rigid material;
- (b) encloses the entire head area; and
- (c) incorporates an integral breathing system.

1.5.32 Lazy shot

A free-hanging rope, running vertically from the dive control position to an attached weight positioned off the bottom or worksite.

1.5.33 Lifeline

A line attached to a diver, which is capable of being used to haul the diver to the surface.

1.5.34 Limiting line

A line shown in some decompression tables, which indicates time limits (bottom times) beyond which the decompression schedules in use are less safe.

1.5.35 NATO flange

A standardized flange used in transfer-under-pressure (TUP) operations.

1.5.36 Occupational diving

Diving performed in the course of employment (irrespective of whether or not diving is the principal function of employment or merely an adjunct to it) and comprising all diving carried out—

- (a) as part of a business;
- (b) as a service;
- (c) for research; or
- (d) for profit.

1.5.37 Quick-release mechanism

A readily operated mechanism that enables the immediate release (e.g. of diver's equipment) from the secured position by a single operation of one hand, but which is designed to minimize the risk of accidental release.

1.5.38 Rescue strop/lanyard

A short length of rope or webbing which the stand-by diver uses to clip an unresponsive diver to their harness, so as to free the stand-by diver's hands for use during the rescue. The lanyard is not intended to be used for lifting or shock loading.

1.5.39 Self-contained underwater breathing apparatus (SCUBA)

Open circuit diving equipment that supplies the diver with breathing gas from the cylinder(s) carried by the diver.

1.5.40 Shot rope (also shot line)

A rope running vertically from the surface to a weight on or near the worksite or bottom.

1.5.41 Surface-supplied breathing apparatus (SSBA)

Diving equipment that supplies breathing gas at the required pressure for the depth, through a diver's hose to a diver from plant at the surface.

1.5.42 Transfer under pressure (TUP)

An operation whereby a submersible work chamber or portable compression chamber is connected to another chamber for the purpose of transferring a person under pressure from one chamber to the other.

1.6 RELATIONSHIP WITH LEGISLATION

Attention is drawn to relevant work health and safety legislation.

1.7 UNITS OF MEASURE

This document uses kPa for the measurement of pressure. kPa can be converted to bar by dividing by 100. (1 bar = 100 kPa).

SECTION 2 PERSONNEL, TRAINING AND RECORDS

2.1 DIVE SUPERVISOR

2.1.1 General

A dive supervisor shall be present at all times while a diver is in the water or under pressure in a compression chamber. The dive supervisor shall be appointed by the person employing the diver, and shall ensure the safe conduct of the diving operation.

2.1.2 Qualification and training of dive supervisors

A dive supervisor shall be qualified and trained in accordance with the following requirements. A dive supervisor shall be as follows:

- (a) Trained as a diver or have been a diver in accordance with Clause 2.2.
- (b) A dive supervisor trained in accordance with AS/NZS 2815.5 for supervision of the type of diving operation being conducted and holding a certificate to that effect issued by—
 - (i) the relevant regulatory authority; or
 - (ii) an occupational diver training establishment that is a registered training organization (RTO) such as the Australian Diver Accreditation Scheme (ADAS).

Where the certifying body is an RTO that provides occupational diver training, that RTO and the certification process shall be subject to external quality assurance and audit by an independent accreditation authority.

NOTES:

- 1 An example of an independent accreditation authority is the Joint Accreditation System of Australia and New Zealand (JAS-ANZ).
 - 2 The dive supervisor need not be medically fit to dive, provided that a level of fitness required for the responsibilities undertaken is maintained.
- (c) Experienced in the diving techniques which may be used, and in the equipment and procedures used in the diving operations to be performed.
 - (d) Appointed in writing by the diver's employer to supervise diving operations.
NOTE: The letter of appointment should only be valid for 12 months
 - (e) Trained in the recognition and management of diving emergencies.
 - (f) Trained in first aid in accordance with Clause 2.5.1.
 - (g) Where the diving involves EAN, the supervisor shall have been trained in accordance with the EAN unit of competence within AS/NZS 2815.5.

2.1.3 Duties of dive supervisors

Dive supervisors shall ensure that all diving operations under their supervision are carried out in accordance with this Standard, and shall be familiar with any legislative requirements which may be applicable to the diving operations.

NOTE: A certificate of competency for dive supervision may be required by the relevant regulatory authority.

2.2 DIVER

A diver shall be qualified and trained in accordance with the following:

- (a) A diver shall be trained to a level equal to or exceeding that specified in the appropriate part of the AS(/NZS) 2815 series, and shall have a certificate to that effect issued by—
 - (i) the relevant regulatory authority; or
 - (ii) an occupational diver training establishment that is a registered training organization (RTO), such as the Australian Diver Accreditation Scheme (ADAS).

Where the certifying body is an RTO that provides occupational diver training, that RTO and the certification process shall be subject to external quality assurance and audit by an independent accreditation authority.

NOTE: An example of an independent accreditation authority is the Joint Accreditation System of Australia and New Zealand (JAS-ANZ).

- (b) A diver shall be assessed and certified as medically fit to dive, in accordance with the requirements of Clause 10.2, within 12 months prior to diving.

NOTES:

- 1 Applicants for diving medicals are required to be at least 18 years of age (see Clause 10.2.2).
- 2 An increase in the frequency of assessments in individual cases is at the discretion of the medical practitioner.

- (c) A diver shall be trained in first aid in accordance with Clause 2.5.2.
- (d) Where the diving involves EAN, the diver shall have been trained in accordance with the EAN unit of competence within the relevant part of the AS(/NZS) 2815 series.

2.3 DIVER'S ATTENDANT

Whenever a diver goes underwater or is subjected to pressure, the diver shall be attended by a diver's attendant who is trained in first aid in accordance with Clause 2.5.2, fit to undertake the required tasks and has a working knowledge of the following:

- (a) The requirements of underwater work.
- (b) Signals in use (see Clause 3.6.2).
- (c) Decompression procedures.
- (d) Diving plant and equipment in use, including ancillary fittings such as pressure gauges, compressors and filters.

The diver's attendant shall not be engaged, other than as specified in Clauses 6.2 and 7.3, on any task other than that of diver's attendant while the diver is in the water or under pressure.

2.4 STANDBY DIVER

2.4.1 General

A standby diver shall be present whenever a diver is underwater and shall be—

- (a) a diver who is currently fit to dive (see Clause 3.1.5);
- (b) wherever possible, located on the surface; and

- (c) if located on the surface, dressed and equipped to enable immediate entry into the water for the purpose of providing aid or assistance to a diver.

NOTES:

- 1 The intention of standby diver arrangements is to provide help to a diver in need of assistance with the minimum of delay after receiving an instruction to do so from the supervisor.
- 2 Standby diver drills should be conducted on a regular basis to ensure the optimal performance of the dive team in an emergency. All dive team members on-site should be familiar with the standby procedure and a record of each member's involvement in standby drills recorded and maintained by their employer.

2.4.2 Two divers in the water

Where two divers are in the water at the same time, one may act as standby diver for the other provided that, at all times, both divers—

- (a) have no decompression commitment; and
- (b) have visual contact with, and direct access to, each other.

In any event, where two divers are, or may be required to be, in the water at the same time, the dive supervisor shall ensure that, prior to the commencement of diving operations, sufficient personnel are available to carry out such diving operations (including surface decompression procedures in accordance with Clause 2.4.3) in a safe manner.

2.4.3 Dive profile

The dive profile of the standby diver shall be planned such as to allow all necessary assistance to be given to a diver without the standby diver incurring a decompression commitment. The only exceptions to this shall be—

- (a) in an emergency; or
- (b) when the depth of the water is such that the standby diver will automatically incur a decompression commitment.

2.5 FIRST AID TRAINING FOR DIVE TEAMS

2.5.1 Dive supervisor

A dive supervisor shall be trained in first aid to the standard required for a diver (see Clause 2.5.2). In addition, a dive supervisor shall be further trained in the recognition and first aid management of diving-related medical problems as a supervisor, and in communicating findings to medical support.

2.5.2 Divers and attendants

All divers and attendants shall be trained in first aid so that, as a minimum, they are able to—

- (a) control bleeding;
- (b) administer 100% oxygen;
- (c) care for an unconscious patient; and
- (d) carry out cardiopulmonary resuscitation (CPR).

NOTE: The above requirements are met by most general first aid courses leading to certification, incorporating or supplemented by an oxygen administration course.

2.5.3 Maintenance of first aid competency

Competency in first aid shall be maintained through regular practice and re-certification every three years. CPR and oxygen resuscitation skills should be demonstrated to a first aid instructor on at least an annual basis.

2.6 RECORDS

2.6.1 Retention of records

The diver and employer records listed in Clauses 2.6.2 and 2.6.3 shall be kept for the period stated in the relevant clause.

NOTE: Attention is drawn to legislative requirements that may require storage of certain records in a retrievable form for specified periods, along with legislation covering privacy of personal details.

2.6.2 Diver

All divers shall maintain a permanent record of all diving undertaken for the duration of the diver's working life.

This permanent record of diving shall include—

- (a) the diver's photograph;
- (b) next of kin information;
- (c) diver's name, address, date of birth and signature;
- (d) evidence of current medical fitness to dive for the purpose of occupational diving (see Clause 10.2);
- (e) a record of diving activity undertaken; and
- (f) a record of accidents and incidents including decompression treatment(s).

The diver's record of diving covering at least the previous seven days' diving activity shall be available to the dive supervisor.

The permanent record of diving shall be presented at each diving medical examination.

The diver's record of dive (including a brief summary of any incidents or accidents) should be entered into this permanent record of diving at the completion of each dive, and signed by the dive supervisor for verification.

The permanent record of diving should have each page consecutively numbered and entries should be made in ink.

NOTES:

- 1 A typical diver's record of dive is shown in Appendix B.
- 2 The diver's permanent record of diving usually takes the form of a logbook.

2.6.3 Employer

A record containing the following minimum information shall be prepared and maintained for each diving operation and kept, as a minimum, for 12 months after the last dive of the operation:

- (a) Date and time of diving operation.
- (b) Location of diving operation.
- (c) Name of dive supervisor.
- (d) Dive plan or safe work method statement (SWMS).
- (e) Gas mix used.
- (f) Records of risk assessments.
- (g) Names of divers and standby divers.
- (h) Nature of task(s).
- (i) Maximum depth of the dive.

- (j) Time left surface, time reached bottom and time left bottom (for each diver).
- (k) Duration of dive, dive profile and breathing gases for each diver.
- (l) Decompression schedule utilized for each diver (where applicable).
- (m) Details of incidents and accidents.
- (n) Diving equipment used.
- (o) Emergency drills undertaken (including standby diver drills).
- (p) All other relevant details.
- (q) Supervisor's signature.

NOTES:

- 1 A typical employer's record of the diving operation is shown in Appendix C.
- 2 Where an incident or unplanned exposure has occurred, records should be kept for a longer period.

2.6.4 Plant records

Where maintenance or tests of plant are carried out in accordance with the manufacturer's recommendations (e.g. for gas purity), records of such maintenance and test results, together with identification of the particular plant, should be kept and maintained.

SECTION 3 GENERAL PROCEDURES AND EQUIPMENT

3.1 ORGANIZATION AND PLANNING

3.1.1 General

A diving operation shall only be carried out after hazards have been identified, their associated risks assessed by a competent person and suitable measures to control risks have been determined and implemented.

NOTE: Guidance on carrying out a hazard identification, risk assessment and control process for a diving operation is provided in Appendix D.

A diving operation shall be organized and planned so as to ensure—

- (a) the competence of the diver is appropriate for the task at hand;
- (b) the diver is armed with all possible information relevant to the task at hand;
- (c) the diver is not unnecessarily distracted from the task at hand;
- (d) adequate surface assistance is available; and
- (e) minimum exposure for the diver.

3.1.2 Consultation

Consultation shall take place between the stakeholders, or their representatives, in regard to work health and safety (WHS).

NOTE: Such consultation needs to be in accordance with the relevant provisions of WHS legislation.

Consultation with persons whose tasks are associated with diving operations may include—

- (a) persons at the workplace and their representatives;
- (b) line managers;
- (c) WHS committees;
- (d) contractors and subcontractors;
- (e) designers, manufacturers, suppliers, modifiers, and users;
- (f) clients; and
- (g) independent experts.

Consultation should take place when determining the implementation of risk management systems for the conduct of diving operations.

3.1.3 Diving operations manual

The diving operations manual shall be available at the dive site. All persons involved in a diving operation shall be trained in and understand the relevant procedures as detailed in the operations manual. All personnel shall have access to the diving operations manual.

The diving operations manual shall document procedures for the planning and conduct of diving operations, including (but not limited to) the following:

- (a) Responsibilities, duties and competency of persons involved in the diving operation.
- (b) Operation of plant used in the diving operation.
- (c) Decompression procedures.
- (d) Emergency response plans.

NOTE: Appendix E provides recommendations for the content of the diving operations manual to satisfy the requirements of Clauses 3.1.1 and 3.1.3.

3.1.4 Dive plan/Safe work method statement (SWMS)

A dive plan, or an SWMS that incorporates a dive plan, shall be prepared and shall be agreed upon by all parties involved in the diving operation prior to commencement of the dive. The dive plan or SWMS shall address the following aspects of the diving operation:

- (a) The method of performing the task.
- (b) The duties of each person involved.
- (c) The diving equipment, breathing gases and procedures to be used, including intended bottom times and decompression profiles.
- (d) Specific hazards and the methods used to address them.
- (e) Emergency procedures, including the safe extraction of an incapacitated diver from the diving medium.

Consideration should be given to the provision of checklists.

All documents making up part of the dive plan or SWMS shall be retained in accordance with Clause 2.6.3.

3.1.5 Fitness to dive

All divers shall ensure that they are fit to participate in any given diving operation. This involves holding a current medical fitness certificate, having adequate strength and physical fitness for the tasks planned and being in good health at the time of diving operations. Medical fitness assessment requirements are detailed in Clause 2.2, Item (b) and Section 10. Physical fitness is maintained by exercise and regular diving. Any significant injury, illness or noticeable variation in normal feeling of health and fitness should be immediately reported to the dive supervisor, and to a medical practitioner if the variation persists.

Diving shall not be undertaken while the diver's health or capabilities are impaired by any prescribed or non-prescribed drug, alcohol or other intoxicant, or by factors such as lack of sleep, cold or heat stress, dehydration or exhaustion. The safe blood alcohol concentration is considered to be 0.00%. Many drugs, including some non-prescription drugs, can increase the risk of adverse events, such as decompression illness, hypothermia, nitrogen narcosis or oxygen toxicity, and some can limit exercise capacity.

3.2 SELECTION OF BREATHING APPARATUS

The decision as to which type of breathing apparatus is appropriate for a given diving operation shall be made after consideration of the—

- (a) type of work to be done by the diver;
- (b) equipment required;
- (c) conditions under which the diver will work;
- (d) inherent risks and limitations of each type of breathing apparatus; and
- (e) competence of the diver.

NOTE: Sections 6 and 7 specify requirements for the breathing apparatus used in the different diving operations covered by this Standard.

3.3 SURFACE CONDITIONS

3.3.1 General

In planning a diving operation, careful consideration shall be given to the surface conditions that will be encountered at the dive site. These conditions include the state of the water, weather, visibility, tide, currents, water temperature, presence of ships or other craft, and any other surface conditions that could affect the operation.

3.3.2 Adverse conditions

Diving operations shall not be undertaken in rough seas, unusual tides or currents or other adverse conditions, unless the supervisor and the diver consider that the diver's safety will not be jeopardized.

3.4 IN-WATER CONDITIONS

3.4.1 General

Careful consideration shall be given to the in-water conditions likely to be encountered before diving operations commence. Such conditions include visibility, presence of contaminants, obstructions, dangerous marine life, thermoclines, pressure differentials and currents.

3.4.2 Contaminated environments

Divers shall be provided with appropriate protective equipment to prevent contact with water contaminated with chemical, biological, nuclear or other hazardous waste material of sufficient concentration to cause illness or injury. Where necessary, additional personal protective equipment shall be provided to ensure similar protection is afforded to the remainder of the dive team.

Where diving occurs in contaminated environments, decontamination protocols for divers, dive attendants and all exposed equipment should be included in the dive plan or SWMS.

3.5 DEPTH OF WATER

Before diving operations are commenced at any site, the maximum depth of water at the site and the maximum possible depth to which the diver could be exposed shall be ascertained by reliable means.

3.6 COMMUNICATIONS

3.6.1 General

An efficient and reliable, preferably voice, communication system shall be established between the diver(s) and the dive control position.

3.6.2 Lifeline signals

When voice communications fail, lifeline signals provide the only means of communication between a diver and the surface, and a thorough knowledge of such signals will enable a dive to be completed safely.

As a minimum, all personnel involved in diving operations shall know the following lifeline signals:

(a) *From attendant to diver*

4 pulls	Come up
4 pulls, 2 bells	Come up, hurry up, or Come up, surface decompression

(b) *From diver to attendant*

1 pull	To call attention. Made bottom. I am well.
4 pulls	May I come up?
Succession of more than 4 pulls	EMERGENCY SIGNAL Pull me up IMMEDIATELY (need not be answered)
Succession of 2 bells	Am fouled and need the assistance of another diver

Succession of 3 bells Am fouled but can clear myself if left alone

NOTE: All personnel should be trained in, and be familiar with, the standard lifeline signals listed in Appendix J. Appendix J contains further information on the use of lifeline signals and a listing of commonly used signals.

3.6.3 Winches, haulers, hoists and cranes

Where winches, haulers, hoists or cranes are used in connection with a diving operation, an efficient and reliable two-way voice communication system shall be established between the diver and the dive control position, and between the plant operator and the dive control position.

3.6.4 Emergency support

A reliable system of communication shall be provided from, or adjacent to, the dive control position to a designated onshore emergency support service. Provisions for onshore emergency support service shall be made prior to the commencement of diving operations, and a written protocol, containing the appropriate contact details in the event of an emergency, shall be maintained on-site and readily available.

3.7 WATER TEMPERATURE

The temperature of water at the dive site shall be assessed and the diving plant or equipment used shall maintain the diver at a comfortable temperature.

3.8 DIVING EQUIPMENT

3.8.1 General

All plant and equipment used in connection with diving operations shall comply with the relevant requirements of Sections 5 to 8, and shall—

- (a) be operated, maintained and serviced in accordance with the manufacturer's instructions by a competent person;
- (b) not be altered, modified or changed in any way that might impair the safe and efficient operation of the equipment; and
- (c) not be used if it can be demonstrated that such plant or equipment is not in a safe working condition.

3.8.2 User responsibilities

Both the employer and supervisor shall ensure that any equipment is of a type and capacity suitable for the job. The supervisor, diver and diver's attendant shall know the capabilities and limitations of any equipment they use.

3.8.3 Inspection

Inspection procedures shall be in accordance with the manufacturer's instructions, and shall incorporate a list of essential pre-dive checks. This list shall be provided and maintained at each dive location.

Before each dive commences, divers shall check the personal diving equipment they intend to use to ensure its operational integrity and efficiency.

3.8.4 Cleaning and storage

All underwater diving equipment shall be cleaned (and disinfected if necessary), dried and stored in a dedicated area in such a manner as to prevent deterioration, contamination or transmission of disease.

The hygiene requirements for maintaining equipment will vary, depending on whether the equipment is for individual or shared use.

Consideration should be given to avoid—

- (a) the transmission of aquatic chemical or biological hazards to divers; and
- (b) any possible transmission of environmental hazards from one location to another.

Where equipment is shared among divers or is used for life support or respiration, the equipment shall—

- (i) have no residual odour or material safety risk to the diver;
- (ii) be cleaned of any major contaminants prior to disinfection;
- (iii) be satisfactorily disinfected; and
- (iv) be cleaned, in accordance with the manufacturer's specifications.

NOTE: The manufacturer's recommendations should be followed provided they are up to date and the method is feasible. Where information is lacking, AS/NZS 1715 provides information on disinfection procedures for respiratory protective equipment that may be applicable to diver's masks and regulators.

All equipment used in conjunction with EAN shall be cleaned and stored in a way that is compatible with the use of elevated oxygen mixtures.

Equipment cleaned and maintained for use with elevated levels of oxygen should be clearly labelled and the appropriate cleaning and storage conditions applied.

For the cleaning and storage of EAN equipment, refer to Section 8.

Any equipment used with 100% oxygen, or with a gas mix containing more than 40% oxygen by volume at high pressure (greater than 2000 kPa), shall be considered dedicated oxygen equipment, and as such shall be oxygen compatible, and shall be oxygen cleaned and maintained in an oxygen-clean state.

3.9 FIRST AID AND MEDICAL EQUIPMENT

3.9.1 General

In all instances, an assessment should be made of the potential hazards of each diving operation, and appropriate first aid equipment, training or other resources should be made available to cope with any reasonably foreseeable emergency. Guidance should be sought from relevant occupational first aid codes of practice or from the relevant regulatory authority where applicable.

Equipment should be chosen taking into account the first aid training and experience of dive team members.

NOTE: Provision also needs to be made for airway suction and other facilities required by any regulatory authority.

A specific compression chamber first aid kit complying with Clause 5.4 shall also be available if a chamber is required by Clause 5.1.

3.9.2 Oxygen resuscitation equipment

Oxygen resuscitation equipment shall be available at the dive site for immediate use if required.

The oxygen equipment used shall be capable of providing a spontaneously breathing patient with an inspired oxygen concentration of 100%. The equipment shall also facilitate oxygen enriched artificial ventilation of a non-breathing patient.

Sufficient oxygen shall be provided to supply the resuscitator, taking into account the location of the dive site and access to medical facilities. See Clause 5.4.4 for guidance on remote diving operations.

3.10 DIVE SITE REQUIREMENTS

3.10.1 General

Diving operations shall be conducted only from a safe and suitable site or vessel, which at all times provides—

- (a) suitable access and exit for the divers;
- (b) means to recover an injured diver from the water; and
- (c) means of communication to emergency support services (see Clause 3.6.4).

Diving shall not be conducted from a vessel under way, unless a hazard identification and risk assessment study involving the vessel's crew, the dive team and any other relevant parties has been carried out. The results of the study shall be recorded, agreed by all parties and signed by a representative of each of the parties.

NOTE: Maritime authorities require all craft to be registered and to hold a current certificate of survey.

3.10.2 Signals

When diving from a vessel the appropriate signals shall be displayed during diving operations.

NOTE: Signals need to be in accordance with the *International Regulations for Preventing Collisions at Sea* (1972) and other relevant provisions or legislation.

3.11 DECOMPRESSION AND DIVE TABLES

3.11.1 General

All diving and decompression operations, including those covered by Clauses 3.11.2 to 3.11.9, and combined dives, shall only be carried out in accordance with widely recognized and industry-approved decompression tables and the associated procedures developed for those tables. That is, the results of a decompression algorithm placed into a tabular form, with accompanying rules and methodology governing that table. The algorithm itself is only part of the process, and for the results of any algorithm (table) to work effectively, it has to be used in conjunction with a considered procedure. For this reason, a mixture of algorithms, tables and related procedures shall not be used for any one series of dives.

Past editions of this Standard have contained a copy of the tables developed by the Experimental Diving Unit of the Canadian Defence and Civil Institute of Environmental Medicine (DCIEM), now known as Defence Research and Development Canada—Toronto (DRDC—Toronto). The tables are derived from the DCIEM 1983 Decompression Model, which was the result of over 20 years of decompression research. They were chosen for inclusion in this Standard as they are generally more conservative than other commonly used tables, especially in the deeper depth or longer bottom time profiles. Whilst the committee continues to recommend the use of the *DCIEM Diving Manual*, it is acknowledged that changes to other tables, such as those within the *US Navy Diving Manual*, have meant that those tables are now similar to the DCIEM tables.

DCIEM tables are widely established and accepted for use in Australia and New Zealand and all divers and supervisors have been trained in their use.

All members of the dive team shall be conversant with the use of the tables and procedures being used for any single or series of dives.

If, at any time, a diver exhibits signs or symptoms of decompression illness, therapeutic recompression treatment should be carried out immediately.

NOTES:

- 1 Appendix F contains guidance on therapeutic recompression treatment for decompression illness and arterial gas embolism.
- 2 Diving in accordance with widely recognized and industry-approved decompression tables does not eliminate all risk of decompression illness, and conservative diving practices are recommended wherever possible.
- 3 On all occasions when hard physical work is carried out by a diver or when a diver is cold-stressed, the decompression routine for the dive should follow the schedule for the next longer time increment for the dive, or the next greater depth listed in the tables being used, or both of these precautions.
- 4 A wide range of computerized systems are available for both recording of dive profiles and determination of decompression procedures. Computerized recording of dive profiles is highly recommended as it is more accurate than traditional depth/time logs. A paper record of each dive should nevertheless be generated, with computers only being used as an adjunct to the planning and monitoring of decompression as required by Clauses 3.11.2 to 3.11.9.

3.11.2 Decompression in water

When carrying out decompression in water, the diver shall at all times be on a shot rope, a lazy shot or a diving stage, and the diver's maximum depth of dive and the depth at any time during decompression stops shall be recorded on the employer's dive record (see Clause 2.6.3).

Divers shall not swim free when carrying out decompression stops.

NOTE: Recompression chamber support is required for all decompression diving as detailed in Section 5.

3.11.3 Use of oxygen in decompression procedures

This Standard does not include procedures or tables for the use of in-water 100% oxygen during diving, either as the main breathing supply or for in-water decompression.

Whilst the use of 100% oxygen does offer some decompression advantage over air, decompression risks still exist. Use of 100% oxygen carries risks for the diver that need to be carefully assessed and mitigated. Several potential further risks are also introduced through 100% oxygen diving, including—

- (a) oxygen toxicity;
- (b) the potential to miscalculate the mix used;
- (c) the need for special equipment;
- (d) the need for gas analysis, and
- (e) the risk associated with gas mixing.

There are already a number of military, commercial and industry guidelines and tables providing guidance on the safe use of in-water oxygen. 100% oxygen equipment shall be fully oxygen compatible in accordance with Clause 8.3 of this Standard, and be subject to a preventative maintenance program, oxygen analysis, calibration, labelling, recording and governance systems. Individuals handling or using 100% oxygen shall be trained in its use and its associated hazards and risks.

Where EAN is being used, decompression may take place using the EAN mix used during the dive. In some instances it may also be desirable to have air available as an alternative to the EAN mixture for the purpose of in-water decompression in an emergency situation, such as a case of oxygen toxicity.

NOTES:

- 1 Administration of 100% oxygen at the surface is a valuable first aid procedure for a diving casualty pending recompression, and it may also be used as a precaution whenever some factor in the dive causes concern that the risk of decompression illness may have been increased.
- 2 Surface decompression with oxygen (Sur D O₂) in a compression chamber can avoid the risks associated with long in-water decompressions. Surface decompression should not be undertaken using only breathing air in a compression chamber.

3.11.4 Repetitive diving

Repetitive diving shall be permitted only up to 50 m (165 ft).

3.11.5 Multi-level diving

A multi-level dive is a dive during which the bottom time is spent at two or more of the depths given in the tables. These dives should be undertaken with great care as the risk of decompression illness may be higher in some cases than for dives to a fixed depth.

Multi-level diving shall be undertaken in accordance with all the procedures and tables being used.

3.11.6 Multiple bounce diving

This Standard does not provide guidance on multiple bounce (or yo-yo) dives—defined as a series of two or more descents and ascents from a dive, which are separated by less than 15 min surface intervals. Multiple bounce diving has been shown to increase the risk of decompression illness, particularly when used in combination with multi-level diving.

NOTE: There are a small number of field-validated industry guidelines that provide guidance on safely conducting multiple bounce dives. An example of such guidelines is the Tasmanian Bounce Diving Tables.

3.11.7 Omitted decompression

If, for whatever reason, a diver surfaces from a dive having either omitted a decompression stop or having failed to complete the correct decompression schedule, then the omitted decompression procedures in the tables being used shall be applied, provided that the diver is showing no signs of decompression illness.

If a diver is showing signs of decompression illness, therapeutic recompression treatment should commence immediately.

NOTE: The tables being used should contain an omitted decompression treatment flow chart to assist in determining the appropriate course of action when using decompression tables and procedures.

The diving operations manual, dive plan or SWMS shall contain procedures to be adopted in an omitted decompression situation. These procedures should consider situations where the diver is unable to achieve recompression due to barotrauma or other factors, and guidance should be provided for such situations. One source of comprehensive guidance on such matters is the current version of the *US Navy Diving Manual*, which is publicly accessible via the internet.

3.11.8 Diving at altitude

Where diving is carried out at altitude (e.g. in a mountain lake) where the surface pressure is less than one atmosphere absolute, decompression schedules shall be altered accordingly.

NOTE: Divers are cautioned that most commonly used depth gauges will not read 'actual' water depths at altitudes. Shot lines are recommended.

3.11.9 Exceptional exposure diving

An exceptional exposure dive shall only be carried out in an emergency.

A diver shall not dive for at least 24 h following an exceptional exposure dive. A diver should remain in the vicinity of a compression chamber for 4 h following such a dive.

These exceptional exposure precautions should also be followed if a diver has experienced any adverse occurrence (e.g. a rapid ascent, extreme exertion, severe cold stress).

NOTES:

- 1 Surface decompression with oxygen is the preferred method of decompression following an exceptional exposure dive (see Clause 3.11.3).
- 2 Exceptional exposure diving carries a greater risk of decompression illness and this risk increases with time of exposure.

3.12 DIVING BEFORE OR AFTER TRAVEL

3.12.1 Diving after travel

The diver shall have had adequate rest before diving. Divers should recover from jet lag before diving.

3.12.2 Travel after diving

Altitude exposure after diving is a potent precipitator of decompression illness. Where air travel or road travel over mountains following diving is a possibility, a specific plan for this shall be determined prior to diving.

NOTE: For routine diving operations at sea level, the guidelines provided in Appendix G may be used. Where diving is conducted at altitude and even further altitude exposure is required, specialist advice should be sought.

Divers who have experienced adverse events such as rapid ascent and divers who feel tired, generally unwell or otherwise not in normal health following diving are possibly suffering from pre-clinical decompression illness or a high bubble load. Travel to altitude should not be undertaken until it is clear that the diver is in completely normal health or until specialist diving medical advice has been obtained.

3.12.3 After decompression illness

Following treatment for decompression illness, divers should obtain specialist diving medical advice regarding the time that should pass before exposure to altitude. Until medical clearance has been obtained for travel to higher altitudes, a diver should remain below 150 m effective altitude.

3.13 DIVER'S EQUIPMENT

3.13.1 Diving suit and accessories

3.13.1.1 *Diving suit*

The diver shall wear appropriate diving dress to prevent injury from physical contact, thermal stress or other potentially harmful exposures, taking into account the nature of the diving operation, water conditions and any need to wear the diving suit whilst above water. Diving suits and related equipment shall be selected and utilized to enable the diver to maintain a comfortable body temperature during diving operations.

3.13.1.2 *Diver's knife*

Every diver shall carry a knife at all times when engaged in a diving operation. The knife shall be worn in such a position that it will be accessible in an emergency.

3.13.2 Buoyancy management equipment

3.13.2.1 *Selection of buoyancy management equipment*

The diver's buoyancy is affected by all components of the diver's equipment that are either buoyant or denser than water. This includes wet suits, dry suits, buoyancy compensator devices, weights, weighted boots, emergency floats and breathing gas apparatus. The appropriate combination of equipment for any diving operation shall be determined during the pre-dive risk assessment process, taking into consideration—

- (a) the need for buoyancy to be neutral, positive or negative;
- (b) whether there is a need for buoyancy to be varied whilst underwater;
- (c) the need for the diver's buoyancy equipment to be used to effect emergency ascent;
- (d) the need for buoyancy at the surface, either routinely or in emergency; and
- (e) the diving system (surface supply, SCUBA, lifeline and other equipment utilized).

Surface supply diving, stages and diving on the bottom may provide depth control. Surface supply diving, lifelines and stages may enable surface-based emergency retrieval. This may reduce the need for the diver to carry specific variable buoyancy control equipment but the need for having more than one means of emergency buoyancy should be considered and provided for, unless this introduces unacceptable risk. In most cases, optimal redundancy can be provided by having both the diver and the surface team able to effect emergency surfacing and flotation (e.g. releasable diver's weights and a lifeline).

NOTE: For deeper diving when wearing a wet suit, the release of weights cannot be relied upon to provide positive buoyancy in the event of an emergency. It should be noted that dropping the weight belt, which leaves a diver with no control over his or her buoyancy, should be a last resort and may place the diver in additional danger, particularly if the umbilical or lifeline is fouled. It should also be noted that for dives deeper than around 20 m, dropping a weight belt when wearing a wet suit may impart little, if any, positive buoyancy.

3.13.2.2 *Buoyancy control devices*

A buoyancy control device can be a versatile component of the diver's buoyancy management system. The decision as to whether or not to wear a buoyancy control device as a risk control should form part of the normal risk assessment process. The general principle to be used in determining the need for buoyancy aid in such a process is that the diver should be able to reach the surface in an emergency without surface assistance and to maintain station without undue effort during a mid-water dive.

Buoyancy control devices used in diving operations shall be designed and manufactured for the purpose of buoyancy management during diving operations. Buoyancy control devices shall be maintained in accordance with the manufacturer's instructions. Buoyancy control devices shall be selected to fulfil the buoyancy tasks identified in Clause 3.13.2.1. If a harness is incorporated to provide lifting or fall prevention functions, the harness shall comply with Clause 3.13.3.

3.13.2.3 *Weights or weight belts*

Where weights are worn by divers, nearly all circumstances will require some or all of these weights to be releasable in an emergency. Such weights shall be fitted with a quick-release mechanism. The mechanism should be capable of operation with one hand. Where release of weights is potentially required for emergency buoyancy, sufficient weight should be releasable to attain positive buoyancy at depth, taking into account relevant factors, including depth-related changes in the diving suit or the buoyancy compensator device.

Releasable weights shall be worn in such a manner that, when released, they do not foul or catch on other items of the diver's equipment nor obstruct the quick-release mechanism(s).

3.13.2.4 *Weighted boots*

Weighted boots worn by divers shall be specifically designed for use in diving work and fitted with reliable release fastenings that can be readily operated by the diver underwater.

3.13.3 **Harnesses**

A harness used as part of a diver's equipment shall be designed and constructed so as to—

- (a) provide a safe and secure means of attaching the diver's hose, lifeline and other equipment to the diver;
- (b) minimize the risk of accidental release;
- (c) prevent the diver from falling out of the harness, regardless of the activity or orientation of the diver;
- (d) be compatible with all other equipment worn by the diver;
- (e) allow for the attachment of a rescue strop/lanyard;
- (f) be comfortable to wear;
- (g) support the diver and allow the diver to be removed from the water in an emergency; and
- (h) be resistant to deterioration during use and storage.

NOTES:

- 1 A simple waist belt is not considered to fulfil these requirements.
- 2 Diving harnesses will not usually need to be capable of shock loading for underwater work. If, however, the diving harness is also used as a safety harness for above water work, it should comply with AS/NZS 1891.1. Guidance for the application of such harnesses is given in AS/NZS 1891.4.

3.13.4 **General requirements for breathing apparatus**

Breathing apparatus shall be designed and constructed from non-toxic, corrosion-resistant materials and shall—

- (a) provide the diver with breathing gas at the required pressure and volumetric flow rate at all times;
- (b) be constructed of materials suitable for the breathing gas used;
- (c) prevent ingress of water to the breathing circuit;
- (d) prevent leakage from the breathing circuit except through the exhaust valve(s);
- (e) ensure that couplings provide a secure and airtight joint and that when such couplings are detached any sealing washers are retained in position;
- (f) ensure that component parts likely to require maintenance are readily detachable without risk of accidental disconnection;
- (g) not unduly impede the diver when swimming and working underwater;
- (h) be designed to enable secure fastening to the diver; and
- (i) for SCUBA diving operations, incorporate a quick-release mechanism.

3.13.5 **Requirements for component parts of breathing apparatus**

3.13.5.1 *General*

Component parts shall comply with the requirements of Clauses 3.13.5.2 to 3.13.5.14. The manufacturer of component parts of a diver's breathing apparatus shall specify proper storage and maintenance conditions.

3.13.5.2 *Material contacting skin*

Material that is designed to be worn next to the skin or that may come in contact with the skin should—

- (a) not restrict the diver's movement in any way;
- (b) be comfortable to wear;
- (c) be non-irritant; and
- (d) be non-staining.

NOTE: Recommendations for the storage of vulcanized rubber are given in ISO 2230.

3.13.5.3 *Incompressible helmet*

An incompressible helmet shall—

- (a) provide a watertight and gastight seal;
- (b) be able to withstand, without dislodgement of the faceplate or dislodgement of the helmet, any foreseeable conditions of water currents and pressure changes internal or external to the helmet;
- (c) cause the least possible interference with vision;
- (d) be purgeable of water;
- (e) incorporate inlet and exhaust valves complying with Clause 3.13.5.12;
- (f) incorporate a demand gas supply device complying with Clause 3.13.5.13, or a free-flow system or a combination of both;
- (g) be designed to minimize the build-up of carbon dioxide (CO₂) gas;
- (h) incorporate a facility for ear clearing;
- (i) incorporate a valve to prevent the ingress of moisture into the breathing circuit;
- (j) incorporate a safety faceplate capable of meeting the impact test for eye protectors specified in AS/NZS 1337.1; and
- (k) incorporate a means of attaching the helmet to the diver such that accidental dislodgment cannot occur and the weight of the helmet can be comfortably supported by the diver.

3.13.5.4 *Full-face mask*

A full-face mask shall cover the eyes, nose and mouth and shall—

- (a) provide a watertight and gastight seal;
- (b) be able to withstand, without dislodgement of the faceplate or dislodgement of the mask, any foreseeable conditions of water currents and pressure changes internal or external to the mask;

NOTE: Masks without supplementary faceplate retention mechanisms have been known to fail in high water currents.

- (c) cause the least possible interference with vision;
- (d) be purgeable of water;
- (e) incorporate inlet and exhaust valves complying with Clause 3.13.5.12;
- (f) incorporate a demand gas supply device complying with Clause 3.13.5.13, or a free-flow system, or a combination of both;

- (g) incorporate an oronasal inner-mask or a mouthpiece complying with Clause 3.13.5.6, or other similar feature designed to minimize the build-up of carbon dioxide (CO₂) gas;
- (h) incorporate a facility for ear clearing;
- (i) incorporate a valve to prevent the ingress of moisture into the breathing circuit;
- (j) incorporate a safety faceplate capable of meeting the impact test for eye protectors specified in AS/NZS 1337.1; and
- (k) be firmly secured in position by means of a head harness complying with Clause 3.13.5.7, and incapable of accidental dislodgment.

3.13.5.5 *Half-face mask*

A half-face mask shall—

- (a) provide a watertight and gastight seal;
- (b) cause the least possible interference with vision;
- (c) be purgeable of water; and
- (d) incorporate a means of securing the mask to the diver to minimize accidental dislodgment.

3.13.5.6 *Mouthpiece*

A mouthpiece shall be designed so that when fitted correctly, the aperture of the mouthpiece cannot be closed by mouth pressure. A mouthpiece shall provide—

- (a) a watertight and gastight seal when fitted correctly and held with normal mouth pressure; and
- (b) a positive means of retention by the diver to prevent accidental dislodgment or slippage from the diver's mouth.

To achieve the requirements of this Clause, a mouthpiece should incorporate a flange to be held between the lips and teeth (to facilitate a watertight and gastight seal) and lugs to be held between the teeth (to provide a positive means of retention).

NOTE: Some incompressible helmets, which are designed to free-flow according to the diver's demand, also incorporate a mouthpiece specifically designed to be easily discarded by the diver. In such cases, the mouthpiece need not comply with Item (b) above.

3.13.5.7 *Head harness*

The head harness for a full-face mask (commonly known as a 'spider') shall have a suitable securing arrangement to provide a secure and functional retention of the mask. The head harness should also be—

- (a) replaceable; and
- (b) adjustable, via positive lock buckles or studs which are fixed to the body of the mask.

3.13.5.8 *Retention strap*

A retention strap shall be designed to either—

- (a) retain the mouthpiece in the diver's mouth; or
- (b) hold the mouthpiece near to the diver's mouth.

If the retention strap is designed to retain the mouthpiece in the diver's mouth, it shall incorporate a quick-release mechanism.

3.13.5.9 *Diver's hose*

A diver's hose shall—

- (a) be of one continuous length;
- (b) be kink resistant;
- (c) incorporate a non-return valve located as close as possible to the diver (e.g. at the breathing medium inlet to the incompressible helmet or full-face mask, or at the mouthpiece, or fitted as an integral part of the incompressible helmet or full-face mask);
- (d) be designed specifically for conditions experienced in diving;
- (e) have a burst pressure defined as the pressure at which that hose (or another identical hose) has burst, when pressure tested at the maximum operating temperature; and
- (f) not be used for the conveyance of the breathing medium, where the pressure of the breathing medium exceeds one quarter of the burst pressure specified in Item (e).

3.13.5.10 *Couplings and fittings*

The couplings and fittings used in the connections of a diver's hose, and of breathing tubes used in SCUBA diving operations, shall be—

- (a) purpose-designed, pressure-rated and in good condition with no damaged threads;
- (b) made of brass, stainless steel, Monel metal or other non-corrosive material; and
- (c) incapable of accidental disengagement or loosening.

3.13.5.11 *Diver's hose and coupling assembly*

The diver's hose and coupling assembly shall—

- (a) be configured in such a way as to ensure the hose and its couplings are in alignment, and the kink resistance of the hose is maintained;
- (b) be capable of carrying the breathing gas at the maximum flow rate that may be required in the diving operations;
- (c) not be used for conveyance of the breathing medium unless it has been tested not more than 12 months prior to use, at a pressure equal to 1.5 times its maximum operating pressure; and
- (d) be of such diameter and have such type of connections that the possibility of wrongly connecting hoses and fittings is minimized.

3.13.5.12 *Inlet and exhaust valves*

Inlet and exhaust valves shall be designed and constructed so that—

- (a) any leakage will not exceed the limits prescribed below;
- (b) adequate protection is provided against mechanical damage;
- (c) they are capable of easy maintenance;
- (d) they are fitted in, or as close as possible to, the incompressible helmet or full-face mask or the mouthpiece;
- (e) they will not be affected by any heat or moisture to which they are likely to be exposed while stored or in use; and
- (f) where manually operated, they are easily operated.

The shut-off characteristics of any valve shall be such that the total air leakage shall not exceed 0.03 L/min when tested with air at a constant suction head of 35 mm water. During this test, the valve and its seating shall be wet.

The flow characteristics of any valve shall be such that the resistance to a continuous stream of air through the valve assembly shall not exceed—

- (i) 19 mm water when the air flow is 85 L/min; and
- (ii) 57 mm water when the air flow is 170 L/min.

The foregoing shut-off and flow requirements apply to the whole valve assembly, including all the parts through which the air passes. Where a valve is duplicated in the apparatus, the requirements apply to the valves in combination and not to each valve separately.

3.13.5.13 *Demand gas supply device*

The demand gas supply device shall consist of a pressure reducing system and means of exhausting excess pressure from the breathing circuit. The design shall be such that the device is adequately protected against damage and its efficiency is not impaired by any heat variations or moisture likely to be encountered in use.

3.13.5.14 *Cylinders*

3.13.5.14.1 *General*

Gas storage cylinders used in association with diving operations shall comply with the specifications listed in AS 2030.1 or AS 3848.2, as appropriate.

Industrial or medical gases used or stored at the site or used in diving operations shall be colour-coded in accordance with AS 4484 and systems shall be established to prevent any inadvertent misuse or cross-contamination between these gas cylinders and cylinders containing breathing gas for divers.

3.13.5.14.2 *Diver's breathing air cylinders*

Diver's breathing air cylinders shall be durably marked with the word 'AIR' in letters not less than 50 mm high and in a contrasting colour to the body of the cylinder.

Diver's breathing air cylinders shall not be used for the storage of any gas mixture other than air.

3.13.5.14.3 *Other oxygen-nitrogen mixtures*

Where oxygen-nitrogen mixtures other than air are used in association with diving operations, cylinders used for storage of such mixtures shall be colour-coded and marked so as to ensure that there is no possibility of confusion regarding the contents of these cylinders. See Clause 8.3.2.

Cylinders which have previously contained air shall not be relabelled and used for oxygen-rich gases unless appropriate inspection, cleaning and filling procedures have been followed.

3.13.6 *Lifeline*

A lifeline shall be—

- (a) a cordage line with a diameter not less than 8 mm;
- (b) a combined communications and cordage line of diameter not less than 8 mm;
- (c) the diver's hose (see Clause 3.13.5.9) and its attachments; or
- (d) a diver's umbilical consisting of more than one component.

The minimum breaking strain of any potentially load-bearing sections (including connections) shall be at least 6 kN.

3.13.7 Standby diver's equipment

Selection of equipment for use by a standby diver (see Clause 2.4) should take into account that the equipment may need to be used in an emergency response situation.

3.14 PRESSURE GAUGES

3.14.1 General

Due to the many different requirements for pressure measurement and the variety of gauges used in diving operations, Table 3.1 has been divided in a way that categorizes such gauges, and provides calibration, accuracy and testing requirements for each type. The requirements for pressure gauges used to measure contents will differ from those used to measure a diver's depth. All pressure gauges used in diving operations that are of a type specified in Table 3.1 shall be maintained in accordance with Table 3.1.

Gauges not covered by Table 3.1 should be maintained in accordance with the general maintenance provisions for diving equipment. Each organization conducting diving operations should have in place a methodology for the calibration and checking of gauges.

3.14.2 Inspection, validation, calibration and testing

All gauges used in connection with diving operations should be visually inspected for physical condition on a regular basis. The gauge shall be validated across its operating range, and calibrated in accordance with Table 3.1.

When a test gauge is used to calibrate another gauge, that test gauge shall meet the requirements of and be used in accordance with AS 1349.

The specified calibration period for all gauges is 12 months. In environments where the gauge is subjected to heavy or rough use, a calibration period of six months shall be applied.

TABLE 3.1
PRESSURE GAUGES—CALIBRATION, ACCURACY AND TESTING

Type of gauge	Gauge increments minimum	Display range	Gauge accuracy		Maximum period since last test of equipment* and method
Submersible depth gauges (diver's depth gauge) including computers or watches being used for primary depth monitoring	1 m head of seawater MSW	Greater than planned dive depth	Depth, m	Accuracy, kPa	12 months, or 6 months if the gauge experiences heavy or rough use, by comparison against a certified test instrument or accurately measured at depth of water
			3	$(P_o + 30)_{-4}^{+8}$	
			6	$(P_o + 60)_{-4}^{+8}$	
			9	$(P_o + 90) \pm 8$	
			15	$(P_o + 150)_{-12}^{+10}$	
			30	$(P_o + 300)_{-12}^{+10}$	
			45	$(P_o + 450)_{-15}^{+10}$	
			60	$(P_o + 600)_{-15}^{+10}$ where P_o = atmospheric pressure	
Submersible contents gauge (cylinder contents)	N/A	20% greater than the maximum contents of the cylinder	In accordance with AS 1349—1986 for industrial gauges, Clause 4.1.2		12 months, or 6 months if the gauge experiences heavy or rough use, by comparison against a certified test instrument
Surface depth gauges (panels and chambers)	0.5 MSW	Greater than planned dive depth	Depth	Accuracy	12 months, or 6 months if the gauge experiences heavy or rough use, by comparison against a certified test instrument
			For measuring depths <30 m	$\pm 1\%$ of maximum scale reading	
			For measuring depth between 30 and 200 m, with a maximum scale of 200 m	$\pm 0.5\%$ of maximum scale reading	
Surface contents gauges (panel and chambers)	As appropriate for intended use	20% greater than maximum contents of the cylinder or output of the supply	As per AS 1349—1986 for industrial gauges, Clause 4.1.2		12 months, or 6 months if the gauge experiences heavy or rough use, by comparison against a certified test instrument

* Where the gauge is believed to be inaccurate or has been exposed to uncertain circumstances it should be tested and recalibrated even if it is within the specified testing period.

3.14.3 Calibration of gauge testing instruments

A test instrument, used to test and calibrate other gauges, shall be calibrated and tested at least once in each period of 12 months in accordance with AS 1349.

A deadweight tester may be used to test and calibrate gauges.

NOTE: A deadweight tester, used to test and calibrate other gauges, needs to be verified under, and in accordance with, the *National Measurement Act 1960 (Cth)*, or by a deadweight tester or gauges for which an endorsed test certificate is currently in effect.

3.15 PNEUMATIC TOOLS

Where pneumatic tools are being used, air for these tools shall be taken from a source entirely separate from the diver's breathing air supply.

SECTION 4 BREATHING GAS QUALITY

4.1 GENERAL

Breathing gases used in diving operations should not present any risk to the diver. Breathing gases used in diving operations shall not contain any contaminants that can cause toxic or harmful effects either acutely or in the long term. The composition of breathing gases shall meet the requirements in Clauses 4.2 and 4.3.

Guidance on safe compressor system design and operation can be found in Clause 5.6. Procedures for filling SCUBA cylinders can be found in AS 3848.2.

The cylinder filling procedures in AS 3848.2 should be followed for the filling of any high pressure breathing gas cylinders used in SSBA diving, such as primary or secondary air supply cylinders or emergency 'bail out' cylinders.

4.2 WATER CONTENT

Breathing gas used in diving operations shall have a water content that is sufficiently low to avoid any risk of condensation or freezing at any point in the breathing gas system. Water content in breathing gas within compressor systems should be sufficiently low to minimize the risk of moisture-related degradation of absorbent and catalytic filter systems.

NOTES:

- 1 From a physiological point of view, moderate amounts of moisture in breathing air provide for less drying of the airways and a more comfortable breathing experience, but dry air is important for other reasons: principally to prevent freezing and malfunction of regulators, to reduce corrosion and to avoid degradation of filters.
- 2 The water content necessary to avoid problems is very variable, depending upon diving conditions. Warm water diving using low pressure compressors can be safely conducted with relatively moist air, whilst extremely dry air is necessary for safe diving using high pressure cylinder sources for deep diving in cold water.
- 3 Ideally, pressure dewpoint will be calculated. Simplified pressure dewpoint calculators can be downloaded from the internet. The chances of condensation or freezing occurring will be minimal if a pressure dewpoint can be achieved which is at least 5°C below the lowest temperature expected to be encountered in the water or at the surface. Where the usage or storage conditions of compressed air are unknown, a pressure dewpoint below -10°C is recommended, to allow for diving in sub-freezing conditions. This is the basis for international standards calling for a pressure dewpoint of -11°C. For most diving in Australia and New Zealand, significantly higher pressure dewpoints will be acceptable.
- 4 For SSBA diving using low pressure compressor generated air, limiting water content of the delivered air to 100 mg/m³ should be adequate to prevent freezing and condensation in most 'worst case' conditions. Higher levels will be acceptable in many conditions, and for compressor-supplied SSBA diving in the tropics, water contents in excess of 1000 mg/m³ may be safe (based upon pressure dewpoints of 10–15°C and compressor output pressures of 700–1000 kPa).
- 5 For SCUBA cylinders, AS 3848.2 recommends that the residual water content when air is tested should not exceed 50 mg/m³ for cylinders filled to 22 500 kPa and 30 mg/m³ for cylinders filled to 33 000 kPa (see Table 4.1).
- 6 Most carbon monoxide catalytic converters require extremely dry air to enable function and manufacturers' specifications should be followed.
- 7 The performance of activated carbon filters and molecular sieve absorbents can degrade severely when they are contaminated with water.

TABLE 4.1
WATER CONTENT FOR BREATHING
AIR IN COMPRESSOR FILLED CYLINDERS*

Maximum cylinder pressure kPa	Maximum water content of air at atmospheric pressure and at 20°C mg.m ³
≤22 500	50
>22 500	30

* Table 4.1 is derived from AS 3848.2.

NOTE: This table is calculated based upon a pressure dewpoint of < -11°C.

4.3 TESTING OF LOW PRESSURE AIR FOR WATER CONTENT

There is no set maximum water content for air supplied to divers from low pressure compressors. Water content should be measured when an air test is performed, and reported in mg/m³ (ppm by weight). This reported moisture content should be compared with the desired level for each particular diving operation, using a pressure dewpoint calculator, and entering the highest breathing gas pressure involved and a gas temperature that is 5°C less than the lowest expected water or air temperature. If the moisture content is found to be too high as a result of such calculations, or if condensation is detected inside filtration systems, then additional air drying systems will need to be installed.

4.4 BREATHING GAS COMPOSITION

4.4.1 Odour and taste

At the point of fill breathing gases should have no discernible odour.

At point of use it is acknowledged that the apparatus through which the gas is delivered to the diver may impart a slight odour on the gas. There shall not be an objectionable odour or taste that might cause nausea in any gas delivered at point of use.

4.4.2 Breathing air

Breathing air used in diving operations shall meet the following requirements:

Component	Concentration at 15°C and 101.3 kPa
Oxygen	(21 ±1)%
Carbon dioxide	≤600 ppm
Carbon monoxide	≤5 ppm
Oil	≤0.5 mg/m ³
Odour	No objectionable odour

4.4.3 EAN gas mixtures

Breathing gas used in EAN diving operations shall meet the following requirements:

Component	Concentration at 15°C and 101.3 kPa
Oxygen ($\geq 20\%$ by volume)	(Stated $\pm 1.0\%$)
Carbon dioxide	≤ 600 ppm
Carbon monoxide	≤ 5 ppm
Oil	≤ 0.1 mg/m ³
Odour	No objectionable odour

4.4.4 Oxygen-compatible air

Compressed air which is used in the preparation of EAN, or which is to be delivered through oxygen-clean apparatus without contaminating that apparatus, shall meet the following requirements:

Component	Concentration at 15°C and 101.3 kPa
Oxygen	(21 $\pm$ 1)%
Carbon dioxide	≤ 600 ppm
Carbon monoxide	≤ 5 ppm
Oil	≤ 0.1 mg/m ³
Odour	No discernible odour
Water	≤ 30 mg/m ³

4.5 SYSTEMS FOR ENSURING QUALITY OF BREATHING GAS

4.5.1 General

There shall be systems in place to ensure that diver's breathing gas will meet the requirements of this Section at all times.

4.5.2 High pressure cylinders

The requirements of AS 3848.2 shall be met for the filling of all high pressure cylinders used in diving operations, including cylinders used as a SCUBA, 'bail out' or SSBA supply.

Where breathing gas is obtained in pre-filled cylinders supplied by a specialist supplier of compressed gas, the supplier's seal and cylinder labelling may be accepted as evidence of suitability of the gas for use provided the supplier has labelled the gas as suitable for use in diving operations.

Where SCUBA cylinders or other cylinders controlled by the diving team or diving contractor are refilled by a third party, a responsible representative of the diving team should ascertain that the system used to fill the cylinders has been tested according to this and any other applicable Standard.

Where cylinders are filled from high pressure compressors operated by the dive team, the organization conducting diving or any other agency that is not a specialist compressed gas supplier, the dive team shall be satisfied that the breathing gas provided will meet the purity standards above. Evidence shall be available of the relevant compressors having been tested within the previous three months, with the gas quality complying with Clauses 4.2, 4.3 and 4.4 above.

Where high pressure breathing gas cylinders have been filled in accordance with the above, but are then stored, any such cylinders may be used at any time within six months (i.e. an absolute maximum of nine months after the relevant compressor air test); however, in the case of steel cylinders, the oxygen content shall be checked to protect against oxygen deficiency having arisen from internal cylinder corrosion.

4.5.3 Low pressure compressors

The breathing gas quality requirements of this Section apply equally to breathing gas produced by low pressure compressor systems as used in SSBA diving. Additional requirements for the selection, installation and use of such compressors are detailed in Section 6.

4.6 TESTING

Testing of breathing gas may be undertaken on samples drawn from compressors as part of the three-monthly scheduled breathing gas quality testing, or from any point in the diving system as part of investigating potential problems or ensuring that relocation or configuration changes have not compromised gas quality. Gas purity testing should be carried out whenever divers express concern about the air quality, whenever the compressor has been changed or damaged, or whenever air is drawn from long term storage services where oxygen depletion might have occurred.

Where a breathing gas sample is taken from a high pressure source, the sample should be drawn from the cylinder or compressor at a pressure of at least 12 MPa. Where possible, testing aimed to assess the function of compressor systems should be conducted in 'worst case conditions' such as high ambient temperature, after the compressor has been operating for a prolonged period and towards the end of life of filter elements.

All breathing gas testing equipment shall be installed, operated and maintained in accordance with the manufacturer's instructions. Independent laboratory testing of breathing gas is best practice, using calibrated analytical instruments and including testing for trace contaminants of importance such as volatile hydrocarbons.

Where testing is performed by diving team personnel, they should have received specific training in the testing equipment being used.

NOTE: There are a number of proprietary gas testing systems available that use colorimetric sample tubes. These are convenient for on-site sampling but have various limitations, including sensitivity to temperature, non-specificity, subjectivity of the reading, especially in difficult lighting conditions, and the need for carefully controlled sample volumes and flows. Such limitations need to be understood and allowed for.

In all cases, dive team members shall have knowledge of the source of the breathing gases in use. It should be possible to access documented evidence of testing if needed. This may be achieved by holding gas cylinder fill certificates or compressor test certificates at the dive site, or by having a log of when and where cylinders have been filled, with means of access to information from the relevant records of cylinder filling stations.