
Recreational diving services — Requirements for rebreather diver training — No-decompression diving

*Services relatifs à la plongée de loisirs — Exigences concernant la
formation des plongeurs à l'utilisation des recycleurs — Plongée sans
décompression*

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 228, *Tourism and related services*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 329, *Tourism services*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Rebreathers (i.e. breathing devices that recirculate some or all of the diver's exhaled breath and replenish any consumed oxygen to maintain a breathable mixture) are becoming much more widely available and popular among divers. The market for rebreather diving has been constantly growing in recent years and is now considered to be large enough that the need for standards on minimum training requirements for training organizations is evident. Rebreathers allow divers to dive for longer and to greater depths. If rebreathers are used improperly they can be hazardous; divers have had fatal accidents due to incorrect use of these devices. It is therefore important to specify training for diving with such devices.

Training organizations offering training that conforms with this document may exceed any of the requirements in terms of the volume or complexity of training but should at least ensure the students master all the skills and knowledge defined in this document.

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Recreational diving services — Requirements for rebreather diver training — No-decompression diving

1 Scope

This document specifies requirements for rebreather diver training programmes which provide the competencies required to perform dives with a rebreather to a maximum depth of 30 m that do not require mandatory decompression stops using a nitrox breathing gas.

This document specifies evaluation criteria for these competencies.

This document specifies the requirements under which training is provided, in addition to the general requirements for recreational diving service provision in accordance with ISO 24803.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11107, *Recreational diving services — Requirements for training programmes on enriched air nitrox (EAN) diving*

ISO 24801-2, *Recreational diving services — Requirements for the training of recreational scuba divers — Part 2: Level 2 — Autonomous diver*

ISO 24802-2, *Recreational diving services — Requirements for the training of scuba instructors — Part 2: Level 2*

ISO 24803, *Recreational diving services — Requirements for recreational diving providers*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

rebreather

apparatus that has a supply of gas carried by the diver, allowing the diver to breathe under water which enables the diver to inspire gas from a facepiece connected to a counterlung and to pass exhaled gas through a carbon dioxide absorption material before it is re-breathed from the counterlung and inspired partial pressure of the gases within the apparatus remain within acceptable physiological limits so that gas is thus recirculated within the apparatus

Note 1 to entry: A rebreather can also be called a self-contained rebreathing diving apparatus.

Note 2 to entry: A facepiece can be a mouthpiece assembly, a half mask, a full-face mask or a helmet.

[SOURCE: EN 14143:2013, 3.1, modified — Note 1 to entry modified and Note 2 to entry added. This content has been reproduced with the permission of CEN. Copyright remains with CEN.]

3.2

rebreather type

primary rebreather design

EXAMPLE Closed-circuit rebreather (CCR), manually controlled closed-circuit rebreather (mCCR), electronically controlled closed-circuit rebreather (eCCR), semiclosed-circuit rebreather (SCR), manually controlled SCR (mSCR), electronically controlled SCR (eSCR), hybrid closed-circuit rebreather (hCCR)

3.3

rebreather unit

type of *rebreather* (3.1) having consistent controls, displays and configuration over several rebreather *models* (3.4) where the operation is essentially the same from rebreather model to rebreather model

3.4

rebreather model

specific individual design of *rebreather* (3.1) made by a manufacturer

3.5

breathing gas

gas present in the *breathing loop* (3.12) inspired by the diver

3.6

supply gas

gas present in a cylinder which may be added to the *breathing loop* (3.12)

3.7

bailout gas

gas present in a cylinder that may be breathed directly by the diver

3.8

nitrox

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

[SOURCE: ISO 11107:2009, 3.5]

3.9

PO₂

partial pressure of oxygen in a gas mixture

Note 1 to entry: This usually refers specifically to the breathing-gas mixture inhaled by a diver.

3.10

set-point

PO₂ setpoint

PO₂ value that is used by a control system to determine when a solenoid valve injects oxygen into the *breathing loop* (3.12)

3.11

respiratory minute volume

RMV

product of the tidal volume and breathing frequency measured in litres per minute

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3.12

breathing loop

portion of a rebreather through which gas circulates, usually consisting of a mouthpiece, breathing hose(s), counterlung(s), non-return valves and a CO₂ absorbent canister

3.13**scrubber**

canister in the *breathing loop* (3.12) containing CO₂ absorbent

3.14**confined water**

swimming pool with a depth appropriate to the activity or body of water offering similar conditions with regard to visibility, depth, water movement and access

[SOURCE: ISO 24801-2:2014, 3.5]

3.15**open water**

body of water significantly larger than a swimming pool, offering conditions typical of a natural body of water

[SOURCE: ISO 24801-2:2014, 3.6]

3.16**service provider**

entity (individual or organization), including any individual acting on behalf of such an entity, which offers one or more of the following services:

- introductory diving activities;
- snorkelling excursions;
- provision of training and education;
- organized and guided diving for qualified divers;
- rental of diving equipment.

[SOURCE: ISO 24803:2017, 3.1]

3.17**safety stop**

non-mandatory decompression stop near the surface prior to surfacing

3.18**no-decompression diving**

diving without requiring mandatory decompression stops

4 Competencies

The training programme shall ensure that students are qualified to independently plan and conduct dives which do not require mandatory decompression stops using the specific rebreather unit for which the student has received training.

Students qualified in accordance with this document are competent to dive with a suitably qualified buddy to 30 m using a rebreather that supplies a nitrox breathing mixture.

In order to be deemed qualified to dive with a specific rebreather unit other than the one that the diver has received initial training for, a diver requires further unit-specific training.

The training programme shall ensure that the student has a full understanding of any theoretical concepts or skills applicable to the type, unit and rebreather model of rebreather they will use. Students shall be provided with an overview of any information that is not specific to their rebreather, but this only needs to be informative in nature so that they are aware of the general possible configurations that other divers may use.

5 Prerequisites for training

5.1 General

The service provider shall ensure that the student fulfils the following prerequisites to take part in the training course envisaged.

5.2 Minimum age

The minimum age to participate in a training programme in accordance with this document shall be 18 years.

5.3 Diving experience

In order to participate in a training programme in accordance with this document, students shall:

- be qualified in accordance with ISO 24801-2;
- be qualified in accordance with ISO 11107;
- have logged 20 open-water dives with at least 15 hours underwater using open-circuit scuba.

5.4 Health requirements

Documented evidence shall be obtained that the student has been medically screened as suitable for recreational diving by means of an appropriate questionnaire or medical examination.

NOTE See Reference [3] for an example of a medical questionnaire and accompanying guidance to physicians.

In case of doubt, the training service provider shall refer students to proper medical resources. If the student is not examined by a physician, the student shall be obliged to confirm by signature that he or she has understood written information given by the instructor on diseases and physical conditions which can pose diving-related risks.

Students shall be advised of the importance of appropriate regular medical examinations.

6 Introductory information

Information in accordance with ISO 24803 shall be made available to the students prior to or during the first class or meeting.

In particular, the students shall be informed that they will be trained to dive a specific rebreather unit to a maximum depth of 30 m for no-decompression diving only.

7 Theoretical knowledge

7.1 Rebreather basics

The training programme shall ensure that students have knowledge concerning the following:

- the definition of a rebreather;
- the difference between a rebreather and open-circuit scuba;
- advantages and limitations of different rebreather types;
- the concept of rebreather unit-specific requirements;
- maintaining PO₂ within physiological limits.

7.2 Function of rebreather components

The training programme shall ensure that students have knowledge concerning the function of the following components of a rebreather, with emphasis on the specific features of the unit they will use during their training:

- breathing loop, definition of “minimum/optimum breathing loop” and breathing loop volume;
- counter lungs;
- inhalation and exhalation hoses;
- non-return (mushroom) valves;
- scrubber (CO₂ absorbent);
- oxygen sensor(s);
- gas supplies (to include, where applicable, oxygen, diluent or other supply gases);
- gas addition valves [to include, where applicable, manual, automatic diluent valve (ADV) or other automatic gas addition valves];
- overpressure valve (OPV);
- mouthpiece, dive surface valve (DSV);
- bailout valve (BOV);
- displays [including, where applicable, handsets, head up display (HUD) or other];
- control modules;
- alarm and warning systems;
- firmware, software, including updates and downloads of dive profiles;
- gas cylinder(s);
- regulator(s), including the first stage pressure relief valve (if applicable);
- cylinder valve(s);
- cylinder pressure indicators;
- CO₂ and CO₂ absorbent monitoring systems.

7.3 Breathing performance using a rebreather

The training programme shall ensure that students have knowledge concerning the following factors affecting breathing performance using a rebreather:

- choice of gases, effect of gas density and maximum depth;
- ventilation rate and ventilation volume of the diver;
- rebreather design (e.g. rebreather type, unit, rebreather model);
- diver attitude and trim;
- size, fit and placement of counter lungs;
- impact of overall equipment configuration on counter lungs and the importance of not restricting counter lung inflation and deflation;

- breathing loop volume.

The training programme shall ensure that students have the following knowledge concerning gas metabolism with rebreathers:

- oxygen consumption;
- CO₂ production.

7.4 Rebreather assembly and checks

The training programme shall ensure that students have knowledge concerning the following aspects of rebreather assembly and checks as applicable to the specific unit used for the training:

- use of unit checklists;
- battery power;
- oxygen sensors (e.g. age, integrity and calibration);
- control system setup and function, including PO₂ monitoring and control;
- CO₂ monitoring system;
- scrubber canister, proper preparation for diving, including filling and seals;
- non-return (mushroom) valves;
- mouthpiece valve operation, bite integrity and security;
- gas supplies (composition and pressure of all gases);
- the need to slowly pressurize any gas systems, particularly high-pressure oxygen systems;
- gas connections and feeds to the system;
- bailout system;
- breathing loop integrity, including positive and negative pressure tests;
- breathing loop overpressure valve (OPV) function and how to set to dive mode where required;
- displays and warning systems;
- buoyancy compensator fit and function;
- placement of weights;
- harness assembly and adjustment.

7.5 Gas supply duration

The training programme shall ensure that students have knowledge concerning the following factors affecting the gas supply duration:

- frequent activation of gas addition valves;
- mask clearing;
- flushing the breathing loop;
- frequent changes in depth;
- inflating a drysuit and buoyancy compensation device (BCD) (if fed from the rebreather gas supply).

7.6 CO₂ absorbent duration

The training programme shall ensure that students have knowledge concerning the following factors affecting the CO₂ absorbent duration:

- water temperature;
- water ingress;
- size of the canister;
- depth and gas density;
- work rate;
- absorbent material and grain size specified by the manufacturer.

7.7 Rebreather pre-water entry checks

The training programme shall ensure that students have knowledge concerning the following aspects of rebreather pre-water entry checks:

- use of unit checklist(s);
- recalibration of the unit (if required);
- gas supplies on;
- bailout access and operation;
- inflation systems (e.g. gas addition valves, buoyancy compensator, dry suit);
- electronics on;
- confirming inspired oxygen level (e.g. PO₂ or FO₂);
- the importance of pre-breathing the rebreather.

7.8 Dive conduct

The training programme shall ensure that students have knowledge concerning the conducting of dives using a rebreather, including:

- how and when to analyse gases;
- dive planning;
- how to add conservatism to no-decompression limits;
- water entries;
- safety precautions to be considered during surface swims with a rebreather;
- descents with a rebreather, bubble checks and safety drills;
- automatic diluent or gas valve (ADV) function during descent;
- controlling inspired oxygen levels (e.g. set point changes);
- ascents with a rebreather and exits;
- counter lung placement, loading and rigging;
- breathing loop volume;

- functions of the mouthpiece of a rebreather;
- use of a bailout valve (BOV);
- use of alternative bailout systems, including accessing gas from another diver;
- weight, buoyancy and trim when diving with a rebreather;
- control system monitoring (use of displays and gauges), including the importance of monitoring PO_2 changes, especially during descent and ascent;
- hand signals and communications;
- how to track oxygen exposure with a rebreather;
- maximum operating depth of a specific supply gas;
- control of buoyancy when ascending while breathing from bailout source;
- how to help an unresponsive rebreather diver underwater and on the surface;
- how to dive with an open-circuit buddy.

7.9 No-decompression dives

The training programme shall ensure that students have the following knowledge concerning the conduct of no-decompression dives:

- identifying vital systems and planning for redundancy;
- planning and conducting no-decompression dives;
- procedures for emergency decompression in case of unintentionally exceeding the no-decompression limits.

7.10 Identifying and reacting to potential issues

7.10.1 General issues

The training programme shall ensure that students have knowledge concerning the cause, anticipation and prevention of the following issues that can arise while diving with a rebreather so they can recognize and properly react to these problems, with emphasis on the specific features of the unit students will use during their training:

- loss of supply gas;
- loss of breathing gas;
- loss of mouthpiece;
- battery depletion;
- failure of oxygen sensors;
- identifying incorrect PO_2 display (e.g. PO_2 display not reflecting gas or depth changes);
- failure of gas injection systems (e.g. oxygen solenoid, automatic diluent valve or supply gas system);
- water in the breathing loop;
- caustic material;
- loss of means to control buoyancy.

7.10.2 CO₂-related issues

The training programme shall ensure that students have knowledge concerning the following potential CO₂ issues with the rebreather and how to prevent or respond to them:

- scrubber malfunction or exhaustion;
- non-return valve failure;
- failure of CO₂ monitoring systems;
- unit assembly errors.

7.10.3 Actions to be taken

The training programme shall ensure that students have knowledge concerning the following actions to be taken in the case of an actual or suspected rebreather problem:

- switching to an open-circuit bailout breathing gas supply;
- ascending to the surface;
- controlling buoyancy during ascent while breathing from a bailout source.

7.11 Hypercapnia, hypoxia, hyperoxia

The training programme shall ensure that students have knowledge of the definition, causes, signs and symptoms, associated rebreather warnings or indications of hypercapnia, hypoxia and hyperoxia and know what actions to take if any of these occur.

7.12 Buddy system

The training programme shall ensure that students are aware of the importance of maintaining the buddy system when diving with rebreathers. Elements which shall be included are:

- agreeing on the purpose or mission of the dive;
- use of pre-dive checklists;
- pre-dive buddy checks, including monitoring the buddy during their pre-breathe;
- mutually verifying dive plan procedures (e.g. changing set points);
- planning dives so that each diver can respond to emergencies independently, but so that buddies stay in close proximity and are able to provide support if necessary;
- diving the same setpoints and following the same plan in a buddy team;
- being aware that any diver can bailout or end the dive at any time, for any reason;
- always staying together in a buddy team from entry to exit, in particular if a diver needs to abort the dive;
- asking for assistance from a buddy in case of an emergency, including options for sharing bailout gas.

7.13 Rebreather maintenance

The training programme shall ensure that students have knowledge concerning the necessity to clean and disinfect a rebreather and how to do so.

The training programme shall ensure that students have knowledge concerning the following main consumables used in a rebreather and when and how to replace them:

- oxygen sensors;
- CO₂ absorbent;
- batteries;
- gas, including analysing and labelling.

The training programme shall ensure that students have knowledge concerning the importance of:

- staying up-to-date with user manual updates;
- performing required rebreather software updates;
- complying with the manufacturer's maintenance requirements;
- recognizing the risk associated with contamination of oxygen systems.

7.14 Maintaining knowledge and skills

The training programme shall ensure that students are aware of the importance of:

- maintaining a high level of rebreather diving knowledge;
- regularly practicing routine and emergency skills, including unit-specific procedures.

8 Practical skills

8.1 General

All new skills shall be introduced in confined water and students shall be proficient in all skills in that environment before attempting them in open water.

All of the following skills shall be completed, except when the rebreather being used by the student does not include the specific capabilities to allow the student to demonstrate a particular skill.

8.2 Pre-dive procedures

The training programme shall ensure that students are able to demonstrate the following skills:

- planning time and depth for the dive, taking into account the limitations of gas supply and scrubber endurance based on the rebreather manufacturer's specifications, the environment, no-decompression limits, oxygen exposure, previous dives and other factors that may apply;
- assembling and setting up the rebreather in accordance with the manufacturer's instructions (e.g. using the specified absorbent material and oxygen sensors) using a checklist (manual or digital), taking into account the aspects in accordance with [7.4](#);
- performing a complete rebreather pre-dive check in accordance with the manufacturer's instructions using a checklist (manual or digital), taking into account the aspects in accordance with [7.7](#);
- donning and adjusting the rebreather and the bailout system for proper fit, including breathing hoses, mouthpiece, mouthpiece retaining strap (MRS) (where fitted) and counterlung placement;
- performing a buddy check (see [7.12](#));
- ensuring proper weighting and trim weight placement;

- pre-breathing in accordance with the manufacturer's instructions.

8.3 Dive conduct

The training programme shall ensure that students are able to demonstrate the following skills:

- entering the water using a technique appropriate for the environment;
- establishing proper in-water weighting, buoyancy and trim;
- performing a bubble check and display check;
- monitoring the buddy throughout the dive;
- demonstrating awareness of system status by monitoring the rebreather's displays and gauges frequently throughout the dive, with particular emphasis on PO_2 ;
- monitoring of the remaining time of CO_2 absorbent;
- following procedures for retaining breathing loop integrity;
- clearing mask with a rebreather while maintaining neutral buoyancy;
- performing a controlled descent to the planned depth with a buddy;
- demonstrating correct use of oxygen control selections and features of the control system;
- if set-point changes are initiated automatically, confirming the set-point changes;
- checking oxygen sensors are not current-limited (linearity check) if not initiated automatically;
- demonstrating proper operation of mouthpiece closure mechanism;
- removing water from the breathing hoses;
- maintaining optimum breathing loop volume;
- maintaining neutral buoyancy when swimming in a horizontal position at a given depth;
- controlling buoyancy by remaining at a single depth, plus or minus 1 m, for at least 90 s, with minimum use of fins or arms;
- managing depth changes;
- performing manual gas addition (e.g. oxygen, diluent or other supply gas);
- performing a gas flush;
- deploying a delayed surface marker buoy (DSMB);
- making a controlled ascent maintaining buddy contact and ascending at the correct rate;
- performing a safety stop for at least 3 min at 5 m;
- at the surface in open water, establishing positive buoyancy with the buoyancy compensation device (BCD), then closing the rebreather mouthpiece before removal;
- while unsupported at the surface in open water, demonstrating oral inflation of the BCD.

8.4 Emergency situations

The training programme shall ensure that students are able to anticipate and recognize the rebreather issues itemised in 7.10 and 7.11 and react to these situations by demonstrating the following skills:

- responding to a simulated rebreather emergency by performing a bailout ascent to the surface at a controlled rate accompanied by a buddy;
- at the signal of a simulated emergency, breathe from an open-circuit bailout gas provided by a buddy and repeat as both donor and receiver;
- at the signal of a simulated emergency, bailout to an open-circuit source, then return to the breathing loop after the exercise following proper procedures;
- performing a simulated rescue to the surface of a non-responsive rebreather diver.

8.5 Post-dive procedures

The training programme shall ensure that students are able to demonstrate the following skills:

- removing at the surface any off-board bailout cylinders used;
- exiting the water using a technique appropriate for the environment;
- demonstrating post-dive care and disassembly of the rebreather, in accordance with the manufacturer's instructions.

9 Instructors

Instructors shall be qualified in accordance with ISO 24802-2, shall have been trained and assessed and shall hold a current unit-specific rebreather instructor qualification.

The instructor shall regularly practise using the specific unit and have current experience of the rebreather being used.

10 Training equipment and training materials

10.1 Training equipment

On training dives, both the instructor and the student shall be equipped with at least the following:

- a rebreather that is in good working order, that allows open-circuit bailout and is configured and used in accordance with the manufacturer's instructions;
- an open-circuit bailout system which either is or can be isolated from the rebreather system and which is suitable for a safe return to the surface from the planned maximum depth, including all safety stops in the event of an emergency; the gas required for bailout shall be calculated with a minimum respiratory minute volume (RMV) of 50 l/min;
- a means of determining depth and duration, such as a dive computer.

NOTE The use of a DSMB, a cutting device and spool or reel can be appropriate or required in certain diving environments.

On all training dives the instructor and students shall use the same rebreather units.

Instructors and students shall have a system of logging all the training dives with the following minimum information: depth, dive time, date of dive and gases used.

10.2 Training materials

The training programme shall ensure that students and instructors have at least the following materials available:

- the manufacturer's user manual (including updates) specific for the rebreather type, rebreather unit and rebreather model of the rebreather and associated electronics being used during training;
- specific student training materials;
- specific instructor training materials;
- rebreather-specific checklists for the assembly and operation of the rebreather (rebreathers equipped with a built-in electronic checklist meet this requirement);
- if applicable, a manufacturer's record of training to be completed by the instructor and the student.

11 Practical training parameters

11.1 Training dives or in-water sessions

The first in-water session shall take place in confined water.

The maximum depth for open-water dives shall be 30 m. On all open-water dives exceeding a depth of 10 m a safety stop shall be made.

There shall be no more than three in-water sessions per day.

Confined water sessions shall not be conducted in an overhead environment.

Open-water dives may be conducted in overhead environments under the following conditions:

- the student is able to remain in the daylight zone where there is no need for the use of a dive light;
- the student is never further than a distance of 40 m (sum of horizontal and vertical distance) from a point where he or she is able to breathe above the surface of the water.

11.2 Instructor responsibilities

All in-water skills shall be taught, directly supervised and evaluated by an instructor, who shall be in the water during each session. The instructor shall be in direct control of students throughout all in-water sessions.

The maximum number of students on in-water sessions that may be accompanied by a single instructor is three. Four students may be taken by an instructor if:

- one of the students is already a qualified ISO 24805 rebreather diver making a crossover from another rebreather type or rebreather unit or a refresher; or
- the instructor is accompanied by a qualified rebreather dive leader (in accordance with [11.3](#)).

During training, in particular when simulating emergency situations, the instructor shall ensure that the student's breathing gas is monitored by both the instructor and the student and maintained within life-support limits.

The instructor shall ensure that all open-water dives are logged by the student at the end of each diving day.