
**Recreational diving services —
Requirements for gas blender training
programmes**

*Services relatifs à la plongée de loisirs — Exigences relatives aux
programmes de formation à la préparation des mélanges gazeux*



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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 13293 was prepared by Technical Committee ISO/TC 228, *Tourism and related services*.

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Introduction

The requirements specified in this International Standard are minimum requirements; they do not preclude the provision of additional training or the assessment by a service provider of additional competencies. This International Standard represents a tool for comparison of existing (or future) qualifications of gas blenders who want to mix gases for diving purposes.

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Recreational diving services — Requirements for gas blender training programmes

1 Scope

This International Standard specifies requirements for gas blender training programmes and the competencies required of an individual in order to obtain a gas blender certificate from a training organization, attesting that he/she has met or exceeded the requirements specified in this International Standard.

This International Standard specifies two levels of gas blender qualification, as follows:

- Level 1 gas blender;
- Level 2 gas blender.

This International Standard recognizes that a training programme can be organized and delivered in a modular way.

2 Normative references

The following referenced documents are indispensable for the application 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 11107:2009, *Recreational diving services — Requirements for training programmes on enriched air nitrox (EAN) diving*

ISO 24802-1, *Recreational diving services — Safety related minimum requirements for the training of scuba instructors — Part 1: Level 1*

ISO 24802-2, *Recreational diving services — Safety related minimum requirements for the training of scuba instructors — Part 2: Level 2*

3 Terms and definitions

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

3.1

training organization

entity which provides training in accordance with this International Standard and awards qualifications, and which is responsible for the implementation and quality management of such training

NOTE Can include scuba diving federations and scuba diver training agencies.

3.2

enriched air nitrox

EAN

mixture of nitrogen and oxygen with more than 21 % oxygen

3.3

helium-based gas mixture

helium-based gas blend

mixture of oxygen and helium, or breathable mixture of oxygen, helium and nitrogen

3.4

trimix

mixture of oxygen, helium and nitrogen

3.5

heliox

mixture of oxygen and helium

3.6

oxygen clean

verified that particulates, fibres, oils, greases and other contaminants are absent

NOTE Any mixture of gases can contain trace gases at levels no higher than those found in ambient air. Permissible levels of trace gases can be specified in national, regional and/or International Standards.

3.7

oxygen compatible

capable of coexisting with elevated oxygen concentrations and a potential source of ignition without flashing, based on a system's maximum operating pressure and temperature

3.8

oxygen-compatible air

air with a reduced level of condensable hydrocarbon mist or vapour

3.9

oxygen design

design that minimizes any tendency for heat generation, ignition of particulates, or the accumulation of contaminants for an intended partial pressure of oxygen and temperature

3.10

oxygen service

system or component that has been designed and tested for oxygen use, has been tested as oxygen clean and is oxygen compatible

4 Competencies of gas blenders

The gas blender training programme shall ensure that persons assessed in accordance with Clause 8 are qualified to blend gases for diving purposes, following accepted safety protocols and standards.

This International Standard specifies two levels of competence for gas blenders, as follows:

- a) Level 1 gas blenders are qualified to blend enriched air nitrox (EAN);
- b) Level 2 gas blenders are qualified to blend and supply any gases and gas mixes covered by this International Standard.

Gas blenders are competent to provide specific mixtures of gases in a compatible cylinder (e.g. working pressure, correct marking, test validity).

The completion of a training programme in accordance with this International Standard does not qualify a person to do the following:

- advise a diver on the gas mixture to be used for a given dive;
- establish operational parameters for a diver, e.g. the maximum operating depth or maximum partial pressure of a component gas;
- provide oxygen cleaning and servicing of diving equipment.

5 Theoretical knowledge

5.1 Purpose of gas blender training

The training programme shall ensure that students have knowledge of issues related to the following aspects of diver breathing gas mixes (appropriate to Level 1 or Level 2 gas blender qualification) for diving purposes and associated risks:

- safe production;
- analysis;
- handling;
- use.

5.2 Gas blending and delivery methods

The training programme shall ensure that students for both the Level 1 and the Level 2 gas blender qualification have knowledge of operating principles, design features, advantages, disadvantages and safety issues related to the following gas blending and delivery methods:

- nitrogen reduction methods (e.g. using a membrane or a molecular sieve);
- continuous blending;
- partial pressure blending;
- using premixed gases;
- “gravimetric mixing method” (mixing by weight);
- booster pumps.

5.3 Gases and gas blends

5.3.1 The training programme shall ensure that students for both the Level 1 and the Level 2 gas blender qualification have knowledge of the uses, characteristics, advantages, disadvantages and safety issues of the following gases and gas mixtures used by divers:

- oxygen;
- nitrogen;
- air;
- enriched air nitrox (EAN).

NOTE It is advisable that the training programme states that gases obtained from a third party which will be used in breathing mixtures for diving purposes need to be formally certified to be fit for use for breathing purposes (e.g. diving grade oxygen, medical grade oxygen, aviator grade oxygen or any other formally certified breathing-grade oxygen).

5.3.2 In addition to the items listed in 5.3.1, the training programme shall ensure that students for the Level 2 gas blender qualification have knowledge of the uses, characteristics, advantages, disadvantages, safety issues of the following gases and gas mixtures used by divers:

- helium,
- argon;
- trimix;

- heliox.

5.4 Considerations for elevated oxygen levels

5.4.1 Oxygen hazards

The training programme shall ensure that students for both the Level 1 and the Level 2 gas blender qualification have knowledge of risks related to the handling of gas mixtures with elevated oxygen levels. This shall include the following:

- the “fire triangle” (oxygen, fuel and heat);
- causes of fire (and explosion), e.g. adiabatic compression, particle impingement, contamination accumulation, frictional heat, inappropriate components, electrical arcing, static discharge;
- corrosion.

5.4.2 Oxygen service

The training programme shall ensure that students for both the Level 1 and the Level 2 gas blender qualification understand the requirements for oxygen service, i.e.:

- oxygen compatible;
- oxygen clean;
- component design features;
- avoiding contamination of oxygen service equipment (e.g. using oxygen-compatible air, not contaminating parts of equipment that come into contact with elevated concentrations or partial pressures of oxygen).

The training programme shall ensure that students know that oxygen equipment, e.g. cylinders, valves and other equipment parts subjected to high partial pressures of oxygen, shall be oxygen cleaned.

NOTE Recommended oxygen cleaning procedures are specified in ISO 11621:1997, Annex A, and ISO 15001:2010, Annex A.

5.4.3 Specific filling station features

The training programme shall ensure that students for both the Level 1 and the Level 2 gas blender qualification have knowledge of the selection, use and maintenance of the following items or components:

- valves;
- gauges;
- non-return valves (check valves);
- manifolds, filling whips and connectors;
- analysers;
- storage cylinders/banks;
- filters;
- lubricants;
- gas flow rate control devices.

5.4.4 Gas flow rates

The training programme shall ensure that students for both the Level 1 and the Level 2 gas blender qualification have knowledge of gas flow rates in gas mixing systems.

Gas flow shall be considered and controlled when mixing gases with respect to the following:

- the heating of gases;
- the end results of the mixtures;
- the overall safety when handling oxygen or oxygen-rich mixtures.

5.5 Cylinder marking and handling

The training programme shall ensure that students for both the Level 1 and the Level 2 gas blender qualification have knowledge of the following:

- relevant national and/or regional regulations and/or standards;
- colour coding related to the use of particular gases;
- variable and permanent marking of cylinders [e.g. gas composition, maximum operating depth (MOD), oxygen clean];
- cylinder valves (use of dedicated threads, O-rings, lubricants);
- the use of adapters.

5.6 Gas analysis and record keeping

The training programme shall ensure that students for both the Level 1 and the Level 2 gas blender qualification have knowledge of the following:

- analysis and recording of cylinder content and pressure before and after blending;
- completion of the filling station log when blending gases (role of the gas blender and the recipient).

5.7 Gas blending calculations

The training programme shall ensure that students for both the Level 1 and the Level 2 gas blender qualification have knowledge of methods of computing final desired mixtures of gases, when a cylinder contains a given mixture of initial gases. Such methods may include manual calculations, tables or computer software.

6 Practical skills

6.1 The training programme shall ensure that students for both the Level 1 and the Level 2 gas blender qualification are able to perform the following practical skills, demonstrating best practice at all times:

- how to calibrate and use an oxygen analyser to determine the oxygen content in an EAN mixture;
- how to fill a cylinder with a blend of EAN so that the final oxygen content is within ± 1 % of the target amount;
 EXAMPLE If the target were 32 % oxygen, then between 31 % and 33 % oxygen would be acceptable.
- how to complete cylinder content tags/stickers;
- how to complete and sign a filling station's fill log when blending gases.

6.2 In addition to the items listed in 6.1, the training programme shall ensure that students for the Level 2 gas blender qualification are able to perform the following practical skills, demonstrating best practice at all times:

- how to calibrate and use a helium analyser to determine the helium content in helium-based gas mixtures;
- how to fill a cylinder with a mixture of gases including helium so that the final oxygen content is within ± 1 % of the target amount and the final helium content is within ± 3 % of the target amount.

7 Gas blender instructors

Instructors shall be authorized by a training organization as either:

- a Level 1 gas blender instructor, or
- a Level 2 gas blender instructor.

Level 1 gas blender instructors shall be able to train and certify Level 1 gas blender students. Level 2 gas blender instructors shall be able to train and certify both Level 1 and Level 2 gas blender students.

Level 1 gas blender instructors shall be qualified as Level 1 gas blenders and have practical experience of mixing various EAN mixtures.

Level 2 gas blender instructors shall be qualified as Level 2 gas blenders and have practical experience of mixing various helium-based mixtures.

Instructors teaching the training programme and assessing students in accordance with this International Standard shall have the theoretical teaching skills of a scuba instructor qualified in accordance with ISO 24802-1 or ISO 24802-2.

8 Qualification

8.1 Students shall have completed training in accordance with ISO 11107:2009, Clause 6.

8.2 The student shall demonstrate gas blending knowledge to a gas blender instructor by taking and passing an examination. This examination shall test gas blending knowledge in accordance with Clause 5 at the applicable level. Records of the examination shall be maintained.

8.3 In order to be qualified as a Level 1 gas blender, the student shall demonstrate to a gas blender instructor the ability to fill and analyse EAN gas blends in accordance with Clause 6.

8.4 In order to be qualified as a Level 2 gas blender, the student shall demonstrate to a gas blender instructor the ability to fill and analyse helium-based gas mixtures in accordance with Clause 6.

8.5 The gas blender instructor shall ensure that the student has the ability to complete cylinder tags/stickers and filling station's fill logs in accordance with Clause 6.

8.6 The certificate issued by the training organization shall specify the level of qualification in accordance with this International Standard, as follows:

- "Level 1 gas blender", or
- "Level 2 gas blender".

8.7 In order for a qualification to be issued, a student shall be at least 18 years of age.