BELIZE:

STANDARDS (BELIZE STANDARDS SPECIFICATION FOR COMPRESSED AIR) (DECLARATION AS A COMPULSORY STANDARD) ORDER, 2025

ARRANGEMENT OF PARAGRAPHS

BELIZE:

STATUTORY INSTRUMENT

No. 109 of 2025

ORDER made by the Minister of responsible for the Bureau of Standards, on the recommendation of the Belize Bureau of Standards, in exercise of powers conferred upon him by section 9(2) of the Standards Act, Chapter 295 of the Substantive Laws of Belize, Revised Edition 2020, and all other powers thereunto him enabling.

(Gazetted 26th July, 2025).

WHEREAS, section 9(3) of the Standards Act, Chapter 295 of the Laws of Belize provides that the Minister shall, by publication in the Gazette, give at least thirty days' notice of his intention to make an Order declaring a compulsory standard and shall thereby indicate the date on which it is intended that the compulsory standard shall come into force;

AND WHEREAS, a notice of intention to declare the BELIZE SPECIFICATION FOR COMPRESSED AIR (BZS 27: 2025) to be a compulsory standard was published in the Belize Gazette dated 17th May 2025;

AND WHEREAS, no objections have been received to the making of the said Order;

NOW, THEREFORE, IT IS ORDERED as follows:–

1. This Order may be cited as the **Citation.**

STANDARDS (BELIZE STANDARDS SPECIFICATION FOR COMPRESSED AIR) (DECLARATION AS A COMPULSORY STANDARD) ORDER, 2025.

Declaration of Compulsory standard. Schedule.

2. The Belize Standard (BZS 27: 2025 SPECIFICATION FOR COMPRESSED AIR), the full text of which appears in the Schedule hereto, is hereby declared to be a compulsory standard.

Purpose of Compulsory Standard.

3. The standard referred to in paragraph 2 is intended primarily–

(a) to protect the consumer or user against danger to health or safety;

(b) to ensure quality in goods produced for home use or for export;

(c) to prevent fraud or deception arising from misleading advertising or labelling; and

(d) to require adequate information to be given to the consumer or user.

Commencement.

4. This Order shall come into effect on the 1st day of August 2025.

SCHEDULE
[paragraph 2]

BEIZE STANDARD
SPECIFICATION FOR COMPRESSED AIR

0 FOREWORD

0.1 This standard provides a description of air characteristics, safety, storage and handling practices, when it is used for human respiration applications.

0.2 In preparing this draft, assistance was received from the following documents:

a) CGA G-7 - Standard for Compressed Air for Human Respiration. 2019

b) CGA G-7.1 - Commodity Specification for Air

c) USP 29 - United States Pharmacopeia and National Formulary (USP–NF)

d) 21 CFR - Title 21 of the U.S. Code of Federal Regulations, (21 CFR)

1 SCOPE

1.1 This standard specifies minimum requirements for gaseous and liquid nitrogen obtained by the air liquefaction process, commonly used in medical and industrial applications.

1.2 This standard also provides requirements regarding nitrogen properties and safe handling practices.

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.

a) BZS 1: Part 8 - Belize Standard Specification for Labelling Part 8: Labelling and Marking of Medical Gas Cylinders

b) CGA G-7 - Standard for Compressed Air for Human Respiration. 2019.

c) CGA G-7.1 - Commodity Specification for Air

d) CGA G-4.3 - Commodity Specification for Oxygen

e) CGA P-8.9 - Bulk Liquid Oxygen, Nitrogen and Argon Storage Systems at Production Sites

f) CGA P-5 - Care of High-Pressure Cylinders for Underwater Breathing, 2019

g) CGA V-1 - Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connection

h) 49 CFR - Title 49 of the U.S. Code of Federal Regulations (49 CFR)

3. TERMS AND DEFINITIONS

For the purpose of this standard, the following terms and definitions shall apply.

3.1 **Container** means a portable compressed gas cylinder and liquid container made in accordance with Title 49 of the U.S. Code of Federal Regulations (49 CFR) Parts 100-199.

3.2 **Lot** means an amount of a product produced during a specified period with the same characteristics, identified by a specific code.

3.3 **Pressure relief device** means a device consisting of a frangible disk designed to burst under excessive pressure, or a combination disk backed with fusible metal with a low melting point designed to melt and release the gas in case of fire.

3.4 **Quality Verification Level (QVL)** means a parameter that specifies the maximum amount of impurities (also termed limiting characteristics) that can be present.

4. GENERAL CHARACTERISTICS

4.1 Description

a) Air is not an element, it is a mixture of elements and compounds. At atmospheric temperature and pressure, air exists as a colorless, odorless, and tasteless gas.

b) The composition of dry air under normal conditions at sea level is shown in Annex 1 - Table 1. Trace impurity levels can vary with geographic locations or with proximity to industrial areas or highways carrying dense traffic. This composition remains relatively constant at altitudes up to approximately 70,000 ft (21,300 m). Accurate data on the change in composition, if any, at higher altitudes is not available.

c) Synthetic air, which is also produced by the compressed gas industry, contains not less than 19.5% and not greater than 23.5% oxygen with nitrogen as the balance gas.

d) Air intended for medical use is a drug, labelled Medical Air, and shall meet the requirements specified below.

e) Because air is a mixture (not a compound), it can be separated into its components. The most common method is the liquefication of air by reducing its temperature to approximately -320 °F (-196 °C), then by fractional distillation, removing each of the constituent gas fractions.

f) Of the constituents that make up air, only oxygen and nitrogen are necessary for life. The other trace gases, while useful for many industrial and scientific purposes, have, to the best of present day physiological and medical knowledge, no physiologic role. Only oxygen and nitrogen are essential in respirable air.

g) The nitrogen in the air we breathe has no metabolic function. It serves as an inert diluent and has a mechanical function in maintaining inflation of gas-filled body cavities such as the pulmonary alveoli, middle ear, and the sinus cavities. Without nitrogen, as the oxygen is absorbed by the blood, these cavities tend to contract and collapse with painful and possibly serious consequences.

h) The oxygen contained in the air we breathe is necessary to support the metabolic processes by which our bodies convert fuels (carbohydrates, fats, and proteins) into heat and energy. The average person in the course of a 24-hour day consumes approximately 26 ft^3 (0.74 m^3) of oxygen. The oxygen consumed weighs about 2.5 lb (1.13 kg), which is approximately equal to the weight of the food consumed during the same period. Obtaining this oxygen requires breathing approximately 500 ft^3 (14.2 m^3) of air.

i) Although the fraction or percentage of oxygen in air remains constant, an increase in air pressure results in an increase in the partial pressure or availability of oxygen. Conversely, a decrease in air pressure results in a reduction in the partial pressure or availability of oxygen for breathing.

j) Whenever the partial pressure of oxygen in the atmosphere falls significantly, the average individual without realizing their predicament is likely to begin to suffer symptoms of hypoxia (i.e., oxygen deficiency).

k) Oxygen at an elevated partial pressure can be toxic if breathed for extended periods.

l) The breathing of air enriched by the addition of oxygen or of oxygen alone is common practice for the following:

i. aviation or mountain climbing at altitudes greater than 10,000 ft (3,050 m);

ii. inhalation therapy or for resuscitation;

iii. some types of protective breathing equipment; and

iv. treatment of other medical conditions (e.g., hyperbarics).

m) In air that contains more than the normal 21% oxygen, combustible materials ignite easily and burn rapidly. The higher the concentration of oxygen, the greater the fire risk.

n) In a compartment (such as a tunnel, caisson, or chamber) filled with air under pressure, most combustible materials will ignite more readily and burn much more rapidly than they would in air at normal atmospheric pressure because of the increase in partial pressure of oxygen, even though the air contains only the normal 21% of oxygen.

CAUTION: The oxygen content of compressed air for human respiration shall be held within the limits specified herein, to provide adequate oxygen content for physiological needs, but it should not have an excessive concentration of oxygen, which could create a fire or health hazard.

4.2 **Production of compressed air for human respiration**

4.2.1 **Compressors**

a) The most common method of producing compressed air for human respiration is by the compression of normal atmospheric air. This is accomplished by various types of compressors that take in ambient air and compress it to the desired working pressure.

b) Rotary or centrifugal compressors are suitable for producing air compressed to less than 150 psi (1030 kPa). Coaxial screw-type compressors are available for producing air up to 300 psi (2070 kPa). Piston-type or diaphragm-type compressors are available for a range of pressures from low to high. The choice of compressor types, therefore, depends on the pressure at which the air is to be used and on the volume of air required per minute, per hour, or per day, and the quality of air required.

c) Where the rate of consumption of air varies in the course of a day or a week, it is expedient to provide an accumulator that can be filled by means of the compressor and from which air can be withdrawn if required. The accumulator can also serve as an air reservoir if the wearer of an airline (air-supplied) respirator must leave a contaminated area because of compressor failure.

d) Compressors are internally lubricated or nonlubricated. Internally lubricated compressors are typically lubricated with synthetic oil. Nonlubricated compressors do use lubrication for the bearings and working parts of the compressor. The compressor chamber or cylinder is not lubricated because the use of polytetrafluoroethylene (PTFE, commonly called Teflon) or other low-friction seals on the piston eliminates the need for lubrication of the cylinder walls. The diaphragm-type compressor also is considered nonlubricated because the compression chamber is separated from the lubricated portions of the compressor by a diaphragm(s).

e) The complexity and magnitude of a compressor installation depends entirely on the amount of air required per unit time; the working pressure required; and the total time during which air is

needed per day or per week. The simplest system (a completely portable unit) consists of a motor; a small compressor with compressor intake filter; an accumulator tank with a moisture drain valve; a pressure control, which prevents the compressor from exceeding a preset pressure; and a hose line through which the air is delivered to the user or a container. Such packaged compressors are available in a variety of types and sizes. All installations shall be capable of delivering air that meets or exceeds the desired grades designated for respiratory use.

f) Where the volume and/or the pressure required are high, the system becomes more sophisticated and includes most if not all, of the following components:

i. motor or engine;

ii. compressor;

iii. inlet filter;

iv. pressure control device;

v. temperature control device;

vi. running time recorder or meter;

vii. inter-coolers on multistage compressors;

viii. after-cooler;

ix. water removal device(s);

x. oil removal device(s);

xi. odor removal device(s);

xii. carbon monoxide removal device; and

xiii. accumulator cylinder or tank (one or more as required).

g) The quality of the air taken into the compressor intake is a major factor in governing the quality of

air that is delivered from the compressor. The location of the compressor intake is critical. The intake shall be located where it will not be contaminated by the exhaust of automotive vehicles (or exhaust of gasoline or diesel engines used to drive the compressor), and that it does not take in strong localized odors or other undesirable contaminants.

h) Adherence to the manufacturer's specifications in installation, operation, and maintenance is essential. Improper location or maintenance can cause the compressor to overheat or otherwise malfunction resulting in the production of undesirable odors or carbon monoxide due to the decomposition of lubricating oil.

i) Filters or equivalent devices on the outlet or downstream side of the compressor are necessary to remove water, odors, and oil vapor. Activated charcoal removes the latter, but is most effective if kept dry; consequently, a desiccant or moisture removal device is necessary upstream of the filter. Other types of devices are also available for the same purposes.

j) Filters or equivalent devices for removal of water, oil, odor, or other contaminants shall be capable of functioning efficiently at the maximum anticipated rate of airflow and with the maximum degree of contamination that can exist in the air entering the device. Routine maintenance shall be performed on these devices to maintain the required air quality.

k) Carbon monoxide can be removed by converting it catalytically to carbon dioxide, which can be tolerated in much higher concentrations than carbon monoxide. Special devices to accomplish this are available.

NOTE: a filter or other device may be required for the removal of carbon dioxide.

l) Compressed air to be used at temperatures below freezing shall have excess water vapor removed to attain a dew point below the minimum temperature anticipated. Compressed air, in passing through regulators and valves from a high pressure to a lower pressure condition, expands and cools resulting in a temperature lower than the surrounding environment's temperature. This could cause ice to plug the lines and equipment.

4.2.2 **Synthetic air**

Synthetic air can be produced without the use of any compressor equipment by mixing oxygen and nitrogen. The purity of the oxygen and the nitrogen shall result in a mixture that satisfies the requirements of Annex 1 - Table 1. Only personnel trained and experienced in the technique shall produce synthetic air by this method. The facility shall allow for controlling the filling operation and provide analytical equipment that shall be used to determine accurately that the contents of each filled cylinder be within the oxygen range of Annex 1 - Table 1. Final analysis shall include a test on each cylinder for oxygen.

5. CLASSIFICATION

5.1 Typical Uses

See Annex 1 – Table 4 for typical uses.

5.2 Quality verification Level (QVL)

Table 4 presents the component maxima in parts per million (ppm [v/v]) unless otherwise stated for the QVLs of air. A blank indicates no maximum limiting characteristic. The absence of a value in a listed QVL does not imply that the

limiting characteristic is or is not present, but merely indicates that the test is not required for compliance with the specification. Typical uses are listed in Annex 1 - Table 3.

6. QUALITY VERIFICATION SYSTEM

6.1 Production qualification tests

a) Production qualification tests are either a single analysis or series of analyses performed on the product to ensure the reliability of the production facility to supply air at the required QVL. This production qualification may be verified by the analytical records of the product from the supplier; or, if required, by the analysis of representative samples of the product from the facility at appropriate intervals as agreed upon between the supplier and the customer. Production qualification tests may be performed by the supplier or by a laboratory agreed upon between the supplier and the customer.

b) Breathing air, food applications air, SCBA air, and SCUBA air can be produced synthetically by mixing oxygen and nitrogen.

6.2 Analytical requirements of the production qualification tests

Analytical requirements of the production qualification tests include the determination of all limiting characteristics of air.

6.3 Lot acceptance tests

Lot acceptance tests are analyses performed on the air in the shipping container or a sample thereof that is representative of the lot.

6.4 Lot definitions

A lot is an amount of a product produced during a period of time indicated by a specific code or some other unique

identifying characteristic. Examples of a lot include, but are not limited to, the following:

a) air supplied during a specific time period (for example, one continuous work shift, daily, weekly, etc.);

b) air supplied in one shipment;

c) air supplied in the container(s) filled on one manifold at the same time; or

d) air supplied or containers filled during an uninterrupted filling sequence.

NOTE: Other definitions may be used base upon agreement between the supplier and customer.

6.5 **Number of samples per lot**

Either one sample per lot or any number of samples agreed upon between the supplier and customer.

7 SAMPLING

7.1 **Container sample size**

The quantity of air in a single sample container should be sufficient to perform the analyses for the intended limiting characteristics. If a single sample does not contain enough air to perform the intended analyses, additional samples from the same lot shall be taken under similar conditions.

7.2 **Gaseous samples**

Gaseous samples shall be representative of the nitrogen supply. Samples shall be obtained in accordance with one of the following:

a) By filling the sample container and delivery containers at the same time, on the same manifold, and in the same manner;

b) By withdrawing a sample from the supply container through a suitable connection into the sample container. No regulator shall be used between the supply and the sample container (a suitable purge valve is permissible);

CAUTION: For safety reasons, the sample container and sampling system shall have a rated service pressure at least equal to the pressure in the supply container.

c) By connecting the container being sampled directly to the analytical equipment using suitable pressure regulation to prevent over pressurizing this equipment; or

d) By selecting a representative container from the containers filled in the lot.

8 ANALYTICAL PROCEDURES

8.1 **Parameters of analysis**

The parameters for analytical techniques contained in this section are:

a) percent (v/v) = parts per hundred by volume;

b) ppm (v/v) = parts per million by volume;

c) Water/dew point is expressed in ppm (v/v) and °F at 1 atm, abs (101 kPa, abs). To convert to other units, see Section 8;

d) For the purposes of this standard, THC (as methane) is defined as the single carbon atom equivalent;

e) Calibration gas standards containing the applicable gaseous components may be required to calibrate the analytical instruments used to determine the limiting characteristic of air. If required by the customer, the accuracy of measuring equipment used in preparing these standards shall be traceable to or recognized as appropriate by the Belize Bureau of Standards (BBS);

f) Analytical equipment shall be operated and properly calibrated in accordance with the manufacturer's instructions;

g) Other analytical methods not listed in this specification are acceptable if agreed upon between the supplier and the customer.

8.2 **Percent oxygen concentration**

The percent oxygen concentration shall be determined by using one of the following methods:

a) Paramagnetic-type analyzer. The accuracy shall be at least ±0.5% oxygen (absolute). The analyzer shall be calibrated (zeroed and spanned) at appropriate intervals by using calibration gas standards using nitrogen as the base gas (see 6.1);

b) Electrochemical-type analyzer containing a solid or aqueous electrolyte. The accuracy shall be at least ±0.5% oxygen (absolute) except as indicated for medical air USP, which shall be an accuracy of ±0.2% oxygen (absolute). The analyzer shall be calibrated at appropriate intervals by using calibration gas standards using nitrogen as the base gas.

c) Thermal conductivity-type analyzer. The accuracy shall be at least ±0.5% oxygen (absolute). The analyzer shall be calibrated at appropriate intervals by using calibration gas standards using nitrogen as the base gas;

d) Volumetric (Orsat-type) gas analysis apparatus using a suitable oxygen absorbing reagent; or

CAUTION: This apparatus uses strong caustic reagents. Safeguards are to be taken in the handling, storage, and disposal of all chemical reagents.

e) Gas chromatograph that shall be capable of separating and detecting oxygen in nitrogen and able to distinguish oxygen from argon when testing atmospheric air. The analyzer shall be operated in a manner to accurately measure the limiting

characteristics as defined in Annex 1 - Table 1. Appropriate impurity concentrating techniques can be used. The analyzer shall be calibrated at appropriate intervals by using calibration gas standards.

8.3 **Water content**

The water content shall be determined by using one of the following methods:

a) Electrolytic hygrometer having an indicator graduated in ppm (v/v) on a range that is no greater than 10 times the specified maximum moisture content. The analyzer shall be operated in a manner to accurately measure the limiting characteristic as defined in Annex 1 - Table 1;

b) Dew point analyzer in which the temperature of a viewed surface is measured at the time moisture condensation first begins to form;

c) Metal oxide capacitor equipped analyzer on a range that is no greater than 10 times the specified maximum moisture content. The analyzer shall be operated in a manner to accurately measure the limiting characteristic as defined in Annex 1 - Table 3;

d) Apparatus using a detector tube filled with a color-reactive chemical. The degree of accuracy depends on the precision of the measurements and the analytical bias of the tube;

e) Infrared, tuneable diode laser or cavity ring down spectrometer using an appropriate spectral wavelength specific for moisture, operated in a manner to accurately measure the limiting characteristic as defined in Annex 1 - Table 3;

f) Piezoelectric oscillating quartz crystal hygrometer. The analyzer shall be operated in a manner to accurately measure the limiting characteristic as defined in Table 4; or

g) Gas chromatograph

NOTE: Consideration should be given to the effect of temperature on moisture condensation and the analytical procedure used.

8.4 **Oil and water(condensed) content**

The oil and water (condensed) content shall be determined by using one of the following methods:

a) Filter. Prior to testing, the pressurized container shall be inverted (valve at bottom) for 5 min. The cylinder and contents should be greater than 32 °F (0 °C). For the sampling of compressor systems, the compressor outlet or a piece of clean, dry tubing attached to it shall be held in a downward position. Determination of oil shall be done by passing a sample of air through an adequate filter medium and measuring the increase in weight of the filter or noting the presence of visible discoloration. The weight value of the filter can also include condensed water and particulate matter. If the total value is over 5 mg/m^3, further desiccation and extraction techniques shall be performed to determine an oil-only value;

b) Stainless steel mirror for use on inverted full cylinders. To do an alternate test for oil and water condensed after a cylinder is filled, support the cylinder in an inverted position (valve at bottom) for 5 min. The cylinder and contents should be greater than 32 °F (0 °C). While maintaining the cylinder in an inverted position, cautiously open the valve slightly. Vent the gas with a barely audible flow against a stainless steel mirror for 1 min. No oil or water should be visible;

c) Visual inspection of compressor oil and moisture removal systems where visual access is possible using a stainless steel mirror or alternate wiping medium. Visual inspection under bright, white light shall detect no evidence of oily residue or discoloration on the mirror surface or the wiping medium other than that caused by the oxidation of the parent metal of the compressor system; or

d) Apparatus using a detector tube filled with a color-reactive chemical for oil only. The degree of accuracy depends on the precision of the measurements and the analytical bias of the tube.

8.5 **Odor**

Odor is checked by sniffing a moderate flow of air from the container being tested. Specific measurement of odor in gaseous air is impractical. Air could have a slight odor, but the presence of a pronounced odor should render the air unsatisfactory.

CAUTION: Do not place face directly in front of the valve. Instead, deflect a portion of the stream toward the nose.

8.6 **Cardon dioxide content**

The carbon dioxide content shall be determined by using one of the following methods:

a) Gas cell equipped infrared analyzer. The analyzer shall be calibrated at appropriate intervals by using calibration gas standards (see 8.1) at a wavelength of approximately 4.3μ (the characteristic absorption wavelength for carbon dioxide). The analyzer shall be operated in a manner to accurately measure the limiting characteristic as defined in Table 4;

b) Apparatus using a detector tube filled with a color-reactive chemical. The degree of accuracy depends on the precision of the measurements and the analytical bias of the tube;

c) Catalytic methanator gas chromatograph. The analyzer shall be calibrated at appropriate intervals by using calibration gas standards (see 8.1). The analyzer shall be operated in a manner to accurately measure the limiting characteristic as defined in Annex 1 - Table 3; or

d) Gas chromatograph.

8.7 **Total hydrocarbon content**

THC (as methane) shall be determined by using one of the following methods:

a) Flame ionization-type analyzer. The analyzer shall be calibrated at appropriate intervals by using calibration gas standards having an air balance (see 8.1). The range used shall be no greater than 10 times the specified maximum THC expressed as methane. The analyzer shall be operated in a manner to accurately measure the limiting characteristic as defined in Annex 1 - Table 3;

b) Gas cell equipped infrared analyzer. The analyzer shall be calibrated at appropriate intervals by using calibration. gas standards (see 8.1) at a wavelength of approximately 3.5 μ (the characteristic absorption wavelength for carbon-hydrogen [C-H] stretching). The analyzer shall be operated in a manner to accurately measure the limiting characteristic as defined in Annex 1 - Table 3; or

c) Gas chromatograph

8.8 **Nitrogen dioxide content**

The nitrogen dioxide content shall be determined by using one of the following methods:

a) Apparatus using a detector tube filled with a color-reactive chemical. The degree of accuracy depends on the precision of the measurements and the analytical bias of the tube;

b) Analyzer using the principles of chemiluminescence. The analyzer shall be calibrated at appropriate intervals by using calibration gas standards (see 8.1). The range used shall be no greater than 10 times the specified maximum amount of the nitrogen dioxide. The analyzer shall be operated in a manner to accurately measure the limiting characteristic as defined in Annex 1 - Table 3;

c) Automated wet-chemical colorimetric analyzer specific to nitrogen dioxide. The analyzer shall be calibrated at appropriate intervals by using calibration gas standards (see 6.1). The analyzer shall be operated in a manner to accurately measure the limiting characteristic as defined in Annex 1 - Table 3; or

d) Gas chromatograph

8.9 **Nitric oxide content**

The nitric oxide content shall be determined by using one of the following methods:

a) Apparatus using a detector tube filled with a color-reactive chemical. The degree of accuracy depends on the precision of the measurements and the analytical bias of the tube;

b) Analyzer using the principles of chemiluminescence. The analyzer shall be calibrated at appropriate intervals by using calibration gas standards (see 8.1). The range used shall be no greater than 10 times the specified maximum amount of nitric oxide. The analyzer shall be operated in a manner to accurately measure the limiting characteristic as defined in Annex 1 - Table 3;

c) Automated wet-chemical colorimetric analyzer specific to nitric oxide. The analyzer shall be calibrated at appropriate intervals by using calibration gas standards (see 8.1). The analyzer shall be operated in a manner to accurately measure the limiting characteristic as defined in Annex 1 - Table 3; or

d) Gas chromatograph.

8.10 **Sulfur dioxide content**

The sulfur dioxide content shall be determined by using one of the following methods:

a) Apparatus using a detector tube filled with a color-reactive chemical. The degree of accuracy depends on the precision of the measurements and the analytical bias of the tube;

b) Gas cell equipped infrared analyzer. The analyzer shall be calibrated at appropriate intervals by using calibration gas standards (see 6.1) at a wavelength of approximately 7.3μ (the characteristic absorption wavelength for sulfur dioxide). The analyzer shall be operated in a manner to accurately measure the limiting characteristic as defined in Annex 1 - Table 3; or

c) Gas chromatograph

8.11 **Halogenated solvents content**

The halogenated solvents content shall be determined by using one of the following methods:

a) Electronic-type halide detector. The analyzer shall be calibrated at appropriate intervals by using calibration gas standards (see 8.1) or with air in equilibrium with standard solutions of chlorinated solvent (for example, trichloroethylene) in mineral oil. This procedure shall be carried out only in an atmosphere free from contamination with halogens or their compounds. The analyzer shall be operated in a manner to accurately measure the limiting characteristic as defined in Annex 1 - Table 3;

b) Gas cell equipped infrared analyzer appropriately calibrated with a halogenated solvent. The analyzer shall be operated in a manner to accurately measure the limiting characteristic as defined in Annex 1 - Table 3 or

c) Gas chromatograph.

8.12 Gas chromatograph

Water/dew point is expressed in ppm (v/v) and °F at 1 atm, abs (101 kPa, abs). To convert to other units, use Table 3.

9 CONTAINERS

9.1 Air containers

Container preparation shall be in accordance with an acceptable technique that encompasses evacuation and cleaning or purging procedures to ensure that the containers, closures, and other component parts are suitable for their intended use. That is, the containers shall be prepared so that they are not reactive, additive, or absorptive to an extent that significantly affects the identity, strength, quality, or purity of the nitrogen and furnishes adequate protection against its deterioration or contamination.

9.2 Container preparation

Nitrogen NF is classified as a drug and shall be labeled in accordance with the appropriate food and drug regulations.

9.3 Valves on air containers

a) Container valve connections that do not fit shall not be used. Threads on regulator connections or other auxiliary requirements shall match those on the container valve outlet. The valve outlet connection shall conform to recognized standards.

b) The threads on a cylinder valve outlet, as well as on regulators and other ancillary equipment, shall be examined prior to connection to ensure they are clean and undamaged.

9.4 Pressure relief devices

The pressure relief devices (PRDs) on cylinder valves on air cylinders shall be in accordance with CGA valve type.

9.5 Filling limits

a) Because of the characteristics of any gas confined in a closed container to increase in pressure with rising temperature, the possibility always exists that a cylinder

charged with gas at a safe pressure at normal temperature could reach a dangerously high pressure at high temperatures. To prevent this with normal usage, regulations limit the amount of gas that may be charged into a cylinder.

b) TC/DOT-3A, TC/DOT-3AA, TC/DOT-3AL, and TC/DOT-39 cylinders shall not be filled to a pressure greater than the stamped service pressure at 70 °F (21.1 °C). TC/DOT-3A and TC/DOT-3AA cylinders stamped with a plus mark (+) after the last test date may be filled to a pressure 10% greater than the stamped service pressure.

9.6 Retesting

a) Specification 3A, 3AA, and 3AL cylinders, UN and ISO receptacles shall be periodically retested. Retesting of 3E cylinders is not required. Cylinder retesting shall be performed only by DOT authorized retester's holding a valid RIN as prescribed in 49 CFR parts 100 – 199.

b) Cylinders that have been in a fire shall be removed from service and shall not be returned to service. Specification 3AL cylinders that are exposed to fire or temperatures above 350 °F (177 °C) shall be removed from service and condemned.

c) Cylinders showing any type of damage that jeopardizes their integrity and the safe transportation of the gas or liquid content, shall be removed from service, and condemned.

d) Records shall be kept giving data showing the results of the tests made on all cylinders, and each cylinder passing the test shall be plainly and permanently stamped with the month and year of the test as well as the retester's identification number. Dates of previous tests shall not be obliterated.

e) Cylinder marking shall comply with DOT requirements established in 49 CFR, and shall not be removed or changed, except as provided in applicable regulations.

9.7 **Labelling**

Air manufactured, imported, sold or offered for sale in containers shall comply with the Belize Standard Specification for Labelling Part 8: Labelling and Marking of Medical Gas Cylinders.

10 DESCRIPTION OF CYLINDERS FOR UNDERWATER BREATHING

10.1 **Cylinder types**

10.1.1 **Regulatory crown markings on SCUBA cylinders**

A variety of cylinders are in SCUBA diving service in the United States, all of which have the following in common:

a) A marking denoting the regulatory authority that governs the specification. For example, for U.S. cylinders, the regulatory marking of ICC was used prior to January 1, 1970 and DOT or UN/ISO has been used since. CTC/DOT has been used in dual regulatory marking of cylinders;

b) UN/ISO cylinders have been permitted for use and

c) The cylinder features a mark representing the manufacturing or requalification date that indicates compliance with the applicable periodic requalification regulations.

NOTE: Only cylinders bearing such markings stamped on the shoulder, top head, or neck shall be used.

10.1.2 **Current crown marking of regulation and pressure on SCUBA cylinders**

Currently, the most common cylinders used for underwater diving are marked with the specification and servicepressure markings.

10.1.2.1 **Regulation and pressure markings of steel cylinders**

a) The most common steel cylinders are marked with the following specification and service pressure markings:

i. ICC-3AA1800, DOT-3AA1800, TC/DOT-3AA1800;

ii. ICC-3AA2250, DOT-3AA2250, TC/DOT-3AA2250;

iii. DOT-3AA3000, TC/DOT-3AA3000;

iv. DOT-3AA2400, TC/DOT-3AA2400; and

v. UN ISO cylinders working pressure (PW) is marked in bar.

b) Other steel cylinders most commonly in service were manufactured in accordance with DOT special permits (formerly known as DOT exemptions) and are marked with either DOT-E9791 3500, DOT-E12079 3500, or DOT-SP14157, and with TC equivalency certificate TC-SU4957.

10.1.2.2 **Regulation and pressure markings of aluminum alloy cylinders**

a) The most common aluminum alloy cylinders are marked with the following specification and service pressure markings:

i. DOT-3AL2015 or TC/DOT-3AL2015;
ii. DOT-3AL3000, TC/DOT-3AL3000;
iii. DOT-3AL3300, TC/DOT-3AL3300;
iv. DOT-3AL3500; and

v. UN/ISO cylinders working pressure (PW) is marked in bar.

b) Other aluminum alloy cylinders in service were manufactured in accordance with DOT special permits (formerly known as DOT exemptions) and are marked with the following:

i. DOT-E6498-2475 or DOT-SP6498-2475;
ii. DOT-E6498-3000 or DOT-SP6498-3000; and
iii. DOT-E7042-3000.

c) To remain in service, aluminum alloy exemption cylinders shall be marked with 3AL at the time of requalification

d) Cylinders manufactured and marked to DOT special permits may noy be used for underwater breathing.

10.2 **Coatings and linings**

10.2.1 **External coatings**

Steel cylinders may be coated by hot-dip galvanizing (galvanic protection using zinc) and/or with vinyl or epoxy, painted, or powder coated using a low temperature cure. Aluminum alloy cylinders may be painted, powder coated, anodized, or treated with a chemical film. Aluminum alloy cylinders may have a heat indicating system applied. SCUBA cylinders have a variety of external coatings and internal linings or treatments to retard corrosion and to enhance appearance.

10.2.2 **Internal linings**

In addition to the external coatings, some steel cylinders are internally lined with organic coatings. For positive identification, cylinders with internal linings shall be stamped with the letters LND in the area of the service pressure. This is especially important if linings have been applied after the

cylinders were manufactured. It is important to ensure that linings that are added to SCUBA cylinders are compatible with the charge (such as air or oxygen-enriched air) of the cylinder.

10.2.3 **Examination of coatings and linings**

All coatings and linings shall be examined at least annually to ensure their continued integrity and continuity. If coatings and linings are damaged, moisture can penetrate beneath them creating potential corrosion sites. This can occur on both the inner and outer surfaces of a cylinder. If the coating or lining is suspected to be compromised, then the entire coating or lining should be removed to evaluate the base metal or the galvanizing over thebase metal.

11 CHARGING OF SCUBA CYLINDERS

11.1 SCUBA cylinders shall be charged with compressed air or reconstituted air with QVL established in Table 4. Only a competent dealer (or other reliable source having proper facilities) shall charge cylinders to ensure that the compressed air is suitable for breathing and is free from oil, moisture, and other impurities.

11.2 Nitrox (or oxygen-enriched air) SCUBA cylinders can be filled with a mixture of oxygen-enriched breathing air consisting of oxygen concentrations of greater than 23.5% only if the cylinders and all accessories are compatiblewith oxygen and have been cleaned for oxygen service. Charging of nitrox SCUBA cylinders shall only be done by someone trained in the charging of these types of cylinders. The oxygen concentration of each nitrox cylinder should be analyzed.

11.3 **Incorrect charging (filling)**
Never charge any SCUBA cylinder with oxygen or other gases. Incorrect charging can significantly increase the potential for the cylinder to rupture with possible serious

injury or property damage or can create other physiological hazards.

11.4 **Maximum charge (fill) pressure**

Never charge a cylinder to a pressure greater than the service pressure marked on the shoulder, top head, or neck of the cylinder. However, DOT specification 3A and 3AA steel cylinders marked with a plus sign (+) after the current requalification date may be charged to 10% over the marked service pressure.

12 PRECAUTIONS IN USE OF SCUBA CYLINDERS

12.1 **Water**

a) After each day's use, backpacks shall be removed from cylinders and the exteriors of the cylinders and cylinder valves shall be thoroughly washed with fresh water not seawater.

b) Cylinders and all accessories shall then be completely dried before being stowed.

c) Cylinder valves shall always be closed when the cylinders are not inuse to prevent water, humid air, or contaminants from entering the cylinders.

d) A slight positive pressure shall always remain in the cylinders. This will prevent entry of moisture and dirt.

12.2 **Handling**

a) SCUBA cylinders range in capacity from 6 ft^3 to 130 ft^3 (0.17 m^3 to 3.68 m^3) of compressed air at greater than 1800 psi when fully charged. Should a charged cylinder rupture under such pressure, severedamage or serious injury could result.

b) Cylinders shall be tightly secured in all packs and bracing to avoid damage to the cylinder paint due to shifting of the cylinder in the pack or bracing during service or transportation.

c) Cylinders shall not be dropped or roughly handled during transportation or use.

d) They shall not be dragged as such action could cause substantial wear on the cylinder base or sidewall that could significantly increase thepossibility of rupture.

e) When transporting cylinders, care shall be taken to ensure that the valve is protected. The rocketing effect resulting from a sheared or accidentally opened valve is dangerous.

12.3 **Storage**

a) Cylinders for SCUBA use shall be stored in a cool place.

b) Areas used to store charged cylinders shall not be allowed to exceed 125 °F (52 °C).

c) It is recommended that storage be vertical with the valves up.

d) Cylinders shall be well secured to prevent tipping over or falling.

e) Cylinder pressure for storage shall be full working pressure so the pressure relief device (PRD) operates correctly, or it should be a residual empty pressure.

f) A residual pressure of not less than 20 psi (138 kPa) shall be maintained to prevent the entry of moisture or dirt.

g) Do not store cylinders near sources of heat.

h) Fully charged cylinders shall not be stored for long periods of time.

12.4 **Lubrication**

Cylinders, valves, and regulators shall not be lubricated or serviced other than by a qualified SCUBA equipmentrepair facility. Some oils and greases have toxic effects if inhaled or swallowed. Additionally, oils and greases in contact with oxygen-enriched breathing air (greater than 23.5% oxygen) can result in an explosive mixture. Indiscriminate use of lubricants by untrained people is dangerous. Follow the recommendations of the equipment manufacturer.

12.5 **Thermal damage**

12.5.1 **Condemning aluminum alloy and steel cylinders damaged by heat or fire**

Heat or fires can permanently damage aluminum alloy and steel cylinders. Accidents have been caused by high temperature curing of freshly painted aluminum alloy cylinders. Aluminum alloy cylinders heated to greater than 350 °F (176 °C) shall be condemned. Steel cylinders heated to a temperature greater than 900 °F (482 °C) shall be condemned.

12.5.2 **Concealing fire exposure**

Never conceal that a cylinder has been exposed to fire by refinishing the cylinder (for example, painting, etc.) or by any other means used to avoid the detection of fire exposure to a cylinder or its accessories.

12.6 **Cleaning and refinishing**

a) Chemicals used for cleaning can react differently with steel and aluminum alloy cylinders.

b) A thorough knowledge of the chemicals being used is required.

c) Cylinder manufacturer's recommendations should be followed. Strong alkalis (caustics) or acids are known to attack aluminum.

d) Heat should not be used for paint removal. Sanding or blasting of aluminum alloy cylinders for refinishing is not recommended unless there is satisfactory means available to verify required minimal wall thickness.

13 INSPECTION AND REQUALIFICATION FOR SCUBA CYLINDERS

13.1 **Annual visual inspection**

a) Annually, each SCUBA cylinder should be visually inspected both externally and internally by a competent inspection agency or station.

b) Because of high salinity or when cylinders are used in rental service, more frequent visual inspection is recommended.

13.2 **Maintenance and corrective action**

a) Removal of corrosion by tumbling, blasting (with soft media), or other suitable means should be in accordance with the cylinder manufacturer's recommendations. After excessive corrosion removal, the cylinder shall be requalified before being filled;

b) Removal of oil or other noxious materials should be in accordance with the cylinder manufacturer's recommendations. If any oil or other noxious materials are found in the cylinder, the dive shop or other filling station that supplied the breathing air should be notified. Needed repair of the compressor and air purification systems should be indicated; and

c) Replacement of O-ring seals on the cylinder valve and lubrication of the valve threads should follow the instructions of the cylinder and valve manufacturers.

13.3 **Periodic requalification**

A SCUBA cylinder shall be requalified by an authorized requalification facility that is registered and approved by DOT. An authorized requalification facility has a current DOT requalifier identification number (RIN). A cylinder owner should request to see DOT requalifier's certificate to verify it is current before having cylinders requalified.

14 SAFETY GUIDELINES FOR HIGH PRESSURE GAS CYLINDERS

14.1 **Guidelines for safe storage**

a) Cylinders shall be stored in a designated location;

b) Cylinders shall not be placed near flammable material, especially oil, grease, or any other readily combustible substance;

c) Cylinders shall not be stored above 125 °F (51.7 °C). Cylinders shall never be allowed to reach a temperature exceeding 125 °F (51.7 °C) because of the rise in pressure in the cylinder with increasing temperature. Therefore, cylinders shall never be placed near furnaces, radiators, or any other source of heat;

d) Cylinders shall be protected from abnormal mechanical shock, which is liable to damage the cylinder, valve, or pressure relief device;

e) Cylinders shall be protected from heavy moving objects striking them or falling on them;

f) Cylinders shall not be stored in areas (i.e., elevators, gangways, etc.) where the cylinders can fall more than half of their height;

g) Cylinders in storage shall be stored standing upright where they are not likely to be knocked over, or the cylinders shall be secured;

h) Small cylinders may be stored in a horizontal position if the cylinder is installed in a holder or cradle designed to secure the cylinder;

i) Valve protection caps, when provided, shall be in place and fastened hand-tight, except when cylinders are in use or connected for use;

j) Cylinders shall be protected from tampering.

k) Empty and full cylinders shall be stored separately and empty cylinders should be marked to avoid confusion;

l) Cylinders shall be stored in dry, well-ventilated locations to prevent accidental movement;

m) Cylinders shall not be stored near salt or other corrosive chemicals or fumes. Rusting will damage the cylinders and can cause the valve protection caps to stick;

n) Cylinders shall be stored on a suitable foundation such as concrete or steel grating; and

o) Valves shall be closed on all cylinders not in use.

14.2 **Guidelines for safe handling**

a) Cylinders shall only filled by a certified supplier;

b) Never tamper with, attempt to repair, paint, or alter cylinders, valves, or Pressure relief devices. Polishing and cleaning agents shall never be applied to the valve since

they can contain chemicals not compatible with the valve material or the gas in the cylinder;

c) Cylinders shall not be placed where they can become part of an electric circuit. When electric welding, precautions shall be taken to prevent striking an arc against a cylinder;

d) Markings stamped on cylinders shall not be tampered with except as provided by DOT authorized requalifier;

e) Markings used for the identification of contents of cylinders shall not be defaced or removed. This applies to labels, decals, tags, stenciled marks, and the diamond-shaped yellow label, if attached;

f) Notify the owner of the cylinder giving details and the cylinder number if any condition occurs that allows a foreign substance to enter the cylinder or valve;

g) Cylinders shall not be used as rollers, supports, or for any purpose other than as intended by the supplier;

h) It is sometimes necessary to move cylinders by crane or derrick using a platform, cage, or cradle to protect the cylinders from damage and keep them from falling out;

i) A suitable hand truck should be used with the container properly secured to the device;

j) Cylinders shall not be transported lying horizontally on forklift trucks with valves overhanging in a position to collide with stationary objects. Whenever a forklift is used to transport cylinders, the cylinders shall be secured to prevent them from falling off;

k) Cylinders shall not be dragged from place to place;

l) Valves shall always be closed and protective caps shall be in place when appropriate before cylinders are moved;

m) Cylinders shall not be transported in the trunks of automobiles. They should be transported upright and secured properly.

n) Cylinders may be transported and used in a horizontal position in ambulances and emergency vehicles if the cylinder is installed in a holder or cradle that is designed to secure the cylinder and protect the valve and regulator; and

o) Small cylinders, such as those used in medical applications, are not equipped with valve protection caps or guards. These cylinders are susceptible to valve damage if dropped. Special precautions shall be taken when handling these types of cylinders. If a cylinder is dropped and the valve is damaged, the cylinder should be returned to the supplier unused. Damaged valves should be replaced before refilling.

14.3 **Guidelines for safe use**

a) Use only cylinders marked in accordance with applicable DOT, UN or ISO regulations or standards;

b) Compressed gases shall be handled only by experienced and trained persons. The user shall first identify the product within the cylinder from the label or stencil on the cylinder before use.

c) If the cylinder is not labeled to show the product contained, return the cylinder to the supplier unused.

d) Ensure that there is no oil or grease on hands or gloves, cylinders, valves, regulators, gauges, and fittings.

14.4 **Disposition of empty cylinders**

When liquid inert gas cylinders are emptied, the following procedure should be followed to ensure their prompt return to the supplier:

i. Close all valves and replace all outlet protection devices; and

ii. Return the cylinder promptly to the supplier in accordance with their instructions.

15 PRECAUTIONS

a) Compressors, filters, piping, hose lines, containers, and other system components shall be selected to provide an adequate factor of safety between the maximum anticipated working pressure and the bursting pressure of the component. Any compressed gas represents a stored kinetic energy capable of violent release if not properlycontained.

b) Internal corrosion or external damage can weaken components sufficiently to significantly reduce the safety factor that existed when the component was new.

c) Compressed air cylinders shall not be dropped, dragged, rolled, struck violently, or be allowed to strike each other. Such treatment can result in damage that can cause failure of the cylinder or valve allowing violent release of gas with possible damage to property and injury to personnel.

d) Compressed air cylinders, when pressurized, shall be protected from sunlight when ambient temperatures exceed 125 °F (51.7 °C). A cylinder that has been exposed to fire or excessive heat shall be removed from service untilit has been re-inspected and retested.

e) Air under pressure from a hose line or cylinder valve shall not be allowed to impinge on any part of the body. A small jet of air under pressure can penetrate the skin and cause severe injury.

f) The use of compressed air to blow dust or chips from hair, clothing, workbenches, or machines can be hazardous.

g) Compressed air shall never be used as a means or tool for practical jokes or horseplay. Introduction of air under pressure into any body cavity can cause serious damage, which is sometimes fatal.

Table 1: Composition of air (dry)

Component	Chemical symbol	Mole percent	Accuracy
Nitrogen	N_2	78.084	±0.004%
Oxygen	O_2	20.946	±0.002%
Argon	Ar	0.934	±0.001%
Carbon dioxide	CO_2	0.0335 1)	±0.001%
Neon	Ne	0.001818	±0.04 ppm
Helium	He	0.000524	±0.004 ppm
Methane	CH_4	0.0002 1)	±0.05 ppm
Krypton	Kr	0.000114	±0.01 ppm
Nitrous oxide	N_2O	0.00003 1)	
Xenon	Xe	0.0000087	±0.001 ppm

NOTE: Nitrogen and oxygen together comprise more than 99% of atmospheric air. The other atmospheric trace gases together comprise less than 1%.

1) Variable.

Table 2: Physical characteristics of air

Molar mass (g/mol)	28.959 g/mol
Density of gas at 70 °F (21.1 °C) and 1 atm	0.0749 lb/ ft^3 (1.200 kg/m^3)
Density of liquid at boiling point and 1 atm	54.56 lb/ ft^3 (874.0 kg/m^3)
Liquid/gas ratio (liquid at boiling point, gas at 70 °F [21.1 °C] and at 1 atm)	1/728 vol/vol
Boiling point at 1 atm	-317.8 °F (-194.3 °C)
Freezing point at 1 atm	-357.2 °F (-216.2 °C)

Table 3: Directory of limiting characteristics

QVLs (Grades)					
	Maxima for Gaseous Air				
Limiting characteristics	**A**	**L**	**E**	**J**	**N**
Carbon dioxide		1000	1000	0.5	500
Carbon monoxide		10 1)	10 1)	1	1
Halogenated solvents				0.1	
Nitric oxide					2.5

Nitrogen dioxide				0.1	2.5
Nitrous oxide				0.1	
Odor		None	None	None	None
Oil (condensed) (mg/m3 at NTP)		5[2)]	5[2)]		None[3)]
Percent oxygen, balance is predominantly nitrogen	19.5 – 23.5	19.5 – 23.5	20-22	19.5 – 23.5	19.5 – 23.5
Sulfur dioxide				0.1	5
Total hydrocarbon content (as methane)			25	0.5	
Water		24		1	
Dew Point		-65		-105	
°F		-53.9		-76.1	
°C					

NOTE(S):

1 Units in ppm (v/v) unless otherwise stated.

[1)] Not required for synthesized air when oxygen component was produced by air liquefaction.

[2)] Not required for synthesized air when oxygen component was produced by air liquefaction.

[3)] Includes water

Table 4: Typical Uses

CGA Grade	Typical Uses
A	Industrial compressed air
L	Self-contained breathing apparatus (SCBA) air
E	Self-contained underwater breathing apparatus (SCUBA) air
J	Specialty grade air, analytical applications
N	Medical air, food applications

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(HON. JOSE ABELARDO MAI)
Minister of Agriculture, Food Security and Enterprise
(Minister responsible for the Bureau of Standards)

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