



Member of the FM Global Group

Examination Standard for Oxygen Reduction Systems

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Foreword

This standard is intended to verify that the products and services described will meet stated conditions of performance, safety and quality useful to the ends of property conservation. The purpose of this standard is to present the criteria for examination of various types of products and services.

Examination in accordance with this standard shall demonstrate compliance and verify that quality control in manufacturing shall ensure a consistent and reliable product.

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1. INTRODUCTION

1.1 Purpose

- 1.1.1 This standard states testing and certification requirements for oxygen reduction systems for use as fire prevention systems.
- 1.1.2 Testing and certification criteria may include, but are not limited to, component, system performance requirements, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a surveillance program.

1.2 Scope

- 1.2.1 This standard encompasses the design and performance requirements for oxygen reduction systems. This standard does not include requirements for the installation, application and maintenance of oxygen reduction systems.
- 1.2.2 Oxygen reduction systems may use membranes or pressure swing adsorption, including vacuum pressure swing adsorption, as the nitrogen separation mechanism. Other technologies may be evaluated on a case-by-case basis.
- 1.2.3 This standard is intended to verify that the product described will meet stated conditions of performance, safety and quality useful to the ends of property conservation.

1.3 Basis for Requirements

- 1.3.1 The requirements of this standard are based on experience, research and testing, and/or the standards of other organizations. The advice of manufacturers, users, trade associations, jurisdictions and/or loss control specialists has also been considered.
- 1.3.2 The requirements of this standard reflect tests and practices used to examine characteristics of oxygen reduction systems for the purpose of obtaining certification. Oxygen reduction systems having characteristics not anticipated by this standard may be certified if performance equal, or superior, to that required by this standard is demonstrated.

1.4 Basis for Certification

Certification is based upon satisfactory evaluation of the product and the manufacturer in the following major areas:

- 1.4.1 Examination and tests on production samples shall be performed to evaluate:
 - The suitability of the product;
 - The performance of the product as specified by the manufacturer and required for certification; and, as far as practical,
 - The durability and reliability of the product.
- 1.4.2 An examination of the manufacturing facilities and audit of quality control procedures may be made to evaluate the manufacturer's ability to consistently produce the product, which is examined and tested, and the marking procedures used to identify the product. Subsequent surveillance may be required by the certification agency in accordance with the certification scheme to ensure ongoing compliance.
- 1.4.3 A review of the proposed oxygen reduction system "Design, Installation, Operation and Maintenance" manual.

1.5 Basis for Continued Certification

The basis for continual certification may include, but is not limited to, the following based upon the certification scheme and requirements of the certification agency:

- production or availability of the product as currently certified;
- the continued use of acceptable quality assurance procedures;
- satisfactory field experience;
- compliance with the terms stipulated by the certification;
- satisfactory re-examination of production samples for continued conformity to requirements; and
- satisfactory surveillance audits conducted as part of the certification agencies product surveillance program.

1.6 Effective Date

The effective date of this certification standard mandates that all products tested for certification after the effective date shall satisfy the requirements of this standard.

The effective date of this Standard is eighteen (18) months after the publication date of the standard for compliance with all requirements.

1.7 System of Units

Units of measurement used in this Standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximate. Conversion of U.S. customary units is in accordance with ANSI/IEEE/ASTM SI 10. Two units (liter and bar), outside of but recognized by SI, are commonly used in international fire protection and are used in this Standard.

1.8 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 cited edition applies:

ASME Publications

American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016

ASME Boiler and Pressure Vessel Code

ASTM Publications

American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

ASTM B117-16, *Standard Practice for Operating Salt Spray (Fog) Apparatus*

ASTM D395 *Standard Test Methods for Rubber Property – Compression Set*, 2003

ASTM D412 *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension*, 2006

ASTM D573, *Standard Test Method for Rubber – Deterioration in an Air Oven*, 2004

ASTM SI 10, *Standard for Use of the International System of Units (SI): The Modern Metric System*

FM Approvals

1151 Boston-Providence Turnpike, P.O. Box 9102, Norwood, MA 02062 USA

<http://www.fmapprovals.com>

FM 1321/1323, *Examination Standard for Controllers for Electric Motor and Diesel Engine Driven Fire Pumps*

FM 3010, *Examination Standard for Fire Alarm Signaling Systems*

FM 6340, *Examination Standard for Toxic Gas and Oxygen Depletion Detectors*

ISO Publications

International Organization for Standardization, Chemin de Blandonnet 8, CP 401 - 1214 Vernier, Geneva, Switzerland

ISO 9001, *Quality Management Systems*

ISO 10380:2003, *Pipework — Corrugated metal hoses and hose assemblies*

NFPA Publications

National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101

NFPA 72, *National Fire Alarm Code*, 2019

1.9 Terms and Definitions

For purposes of this standard, the following terms apply:

Accepted

This term refers to installations acceptable to the authority having jurisdiction and enforcing the applicable installation rules. Acceptance is based upon an overall evaluation of the installation. Factors other than the use of certified equipment impact upon the decision to accept the equipment. Acceptance is not a characteristic of a product. It is installation specific. A product accepted for one installation may not be acceptable elsewhere.

Amplitude

The maximum displacement of sinusoidal motion from position of rest to one-half of the total displacement.

Authority Having Jurisdiction

The organization, office, or individual responsible for approving equipment, materials, an installation, or a procedure.

Conditioning Equipment

For the purposes of this standard, conditioning equipment refers to all filters and other devices used to condition the compressed air before it enters the nitrogen separating mechanism.

Control Panel

Electrical component for monitoring, controlling, and operating the function and alarms of the oxygen reduction system. Minimum requirements for the control panel are found in Section 4.2.

Maximum System Pressure

The highest pressure available from the pressure source. Typically, this would be the pressure setting of the pressure relief device.

Membrane nitrogen generator

A method of generating nitrogen using the process of passing compressed air through a membrane. Different gases have different rates of permeation and this can be used to separate nitrogen from the other atmospheric gases. The resulting product is mostly nitrogen.

Minimum Bend Radius

The smallest radius (expressed in inches [mm]) that a flexible hose is safely allowed to bend, as specified by the manufacturer.

Nozzle

A device with one or more orifices that is connect to a termination of a pipe network for the purpose of uniformly distributing nitrogen into an enclosure.

Operating Pressure

The pressure at which a component functions under normal conditions.

Pressure Swing Adsorption (PSA)

A method of generating nitrogen using the process of adsorption by which a thin layer of molecules temporarily adheres to the surface of another material. A PSA nitrogen generator consists of two or more towers filled with adsorbent material. Air is drawn into one tower and oxygen adheres to the adsorbent material. The remaining atmospheric gas, which is mostly nitrogen, passes through. The towers are cycled so that waste oxygen is being “cleaned” from one tower while the other is used to produce nitrogen, and the two are switched periodically.

Protected Volume

The space to be protected by the oxygen reduction system.

Rated Working Pressure

The maximum pressure at, or below, which all components shall operate trouble free.

Relief Valve

A device that allows the diversion of liquid or gas in order to limit excess pressure in a system.

Working Pressure

The maximum anticipated static (non-flowing) pressure applied to the system components exclusive of momentary spike or surge pressures.

2. GENERAL INFORMATION

2.1 Product Information

- 2.1.1 An oxygen reduction system is a system which is used to displace the oxygen in an enclosed environment using one or more nitrogen generators to create an oxygen concentration in the enclosed environment that will not support ignition for various hazards.
- 2.1.2 In order to meet the intent of this standard, oxygen reduction systems shall be examined on a model-by-model, type-by-type and manufacturer-by-manufacturer, and plant-by-plant basis. This is predicated on the basis that identical designs, fabricated in identical materials by different manufacturers or, even by different plants of the same manufacturer, have been seen to perform differently in testing. Sample oxygen reduction systems, selected in conformance to this criterion, shall satisfy all of the requirements of this standard.

2.2 Certification Application Requirements

The manufacturer shall provide the following preliminary information with any request for certification consideration. All documents shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level.

- 2.2.1 Any marketing literature showing the general specifications and functions of the system.
- 2.2.2 A complete list of all models, types, sizes, and system variations and options to be examined. This may be submitted in the form of a specification or drawing.
- 2.2.3 An instruction manual—listing all design, installation, operation, and maintenance instructions.
- 2.2.4 Quality control procedures detailing routine testing and final inspection procedures. These may include receiving inspection, in-process inspection, final inspection, and calibration of measuring and testing equipment procedures.
- 2.2.5 Procedures detailing the system acceptance testing once the oxygen reduction system is installed.
- 2.2.6 The following drawings should be provided:
- Electrical schematic(s)
 - Final assembly drawings and parts lists sufficient to detail primary components (all), operator controls, and their locations;
 - Complete set of mechanical drawings for all machined parts;
 - Complete part specifications (including manufacturer's model numbers, size, ratings, etc.) for all purchased parts;
 - Specification sheets for all parts/components;
 - Drawings showing all construction details, sheet metal gauge and paint finish;
 - Product label drawing(s) showing all required marking information. The label drawing shall show the proposed label location on the equipment and artwork showing the manufacturer's name, address, model and serial numbers, equipment ratings, and warning markings
- 2.2.7 The number and location of manufacturing facilities.

Test programs will be scheduled only on receipt of all material listed above. All foreign language documents shall be provided with English translation.

2.3 Requirements for Samples for Examination

Following generation and authorization of a certification examination, the manufacturer shall prepare components for examination and testing. Sample requirements are to be determined by the certification agency following review of the preliminary information. Sample requirements may vary depending on design features, results of prior testing, and results of the foregoing tests. It is the manufacturer's responsibility to submit samples representative of production. Any decision to use data generated utilizing prototype components or systems is at the sole discretion of the certification agency.

3. GENERAL REQUIREMENTS

3.1 Design, Installation, and Maintenance

The design, installation, and maintenance of oxygen reduction systems shall be in accordance with a standard/code that is acceptable to the Authority Having Jurisdiction. This includes, but is not limited to, the following:

- Oxygen design concentration for the protected volume based on the hazards present.
- Oxygen reduced air required flow rate including required safety factors based on size, geometry, leakage rate and temperature of the protected volume as well as maximum wind conditions.
- Oxygen reduction system oxygen percentage alarm thresholds and fault signals.
- Amount and location of oxygen sensors to ensure homogeneous distribution of oxygen reduced air.
- Amount and location of oxygen reduced air discharge nozzles or outlets to ensure homogeneous distribution of oxygen reduced air.
- Location of, and requirements for, the operating room of the oxygen reduction system.
- Electrical power supply and associated wiring requirements.
- Inspection, testing and maintenance requirements.

3.2 Review of Documentation

During the initial investigation and prior to physical testing, the manufacturer's specifications, technical data sheets, and design details shall be reviewed to assess the ease and practicality of installation and use. The system and its components shall be capable of being used within the limits of the certification investigation.

3.3 Physical or Structural Construction Features

- 3.3.1 An oxygen reduction system shall at a minimum consist of a supply of oxygen reduced air, a fixed piping system with fittings, valves, and nozzles, oxygen sensors and control panel, and alarms. The manufacturer shall provide a diagram or schematic drawing of the system which indicates the minimum and maximum system operating pressures of each section, or sub-system, of the oxygen reduction system.
- 3.3.2 The test program requirements shall be based on assembly and manufacturing drawings supplied by the manufacturer prior to the start of testing. Following the results of testing, if additional hardware is required, the test program will be revised.
- 3.3.3 For all components downstream of the nitrogen generation system the test pressures will be calculated using a base working pressure equal to the maximum system operating pressure of the pressurized system.
- 3.3.4 Hydrostatic strength of components should be based on 2 times the maximum system operating pressure but not less than 350 psi (24 bar). Leakage pressure testing should be based 120 percent of the maximum system pressure.
- 3.3.5 Pressure Vessels (Storage Tanks and Adsorption Towers)
- 3.3.5.1 Pressure vessels utilized in nitrogen generators shall conform to the appropriate regulations and design standards for the installation location. They shall be new vessels, cleaned and dried, and have safety relief valves as required by the design standards for the installation location. In the U.S.A., pressure vessels must typically conform to the following regulations:
- ASME Boiler & Pressure Vessel Code, Section VIII, Division 1 – “*Rules for Construction of Pressure Vessels*”
- 3.3.5.2 Samples of the following documents shall be submitted for each size pressure vessel design, to demonstrate compliance with the relevant design standard: