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Examination Standard for Nitrogen Generators

Class Number 1035

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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.

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Purpose

1.1.1 This standard states testing and certification requirements for nitrogen generators for use in dry pipe and preaction fire protection systems. Nitrogen generators provide pressurized nitrogen to the sprinkler piping to minimize interior pipe corrosion.

1.1.2 Testing and certification criteria may include 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 nitrogen generators.

1.2.2 Nitrogen generators may use membranes or pressure swing adsorption as the nitrogen separation mechanism. Other technologies may be evaluated on a case-by-case basis. The use of nitrogen storage bottles or plant nitrogen is not in the scope of this standard.

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 was also considered.

1.3.2 The requirements of this standard reflect tests and practices used to examine characteristics of nitrogen generators for the purpose of obtaining certification.

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,
- the durability and reliability of the product.

1.4.2 An examination of the manufacturing facilities and audit of quality control procedures may be conducted 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.

1.5 Basis for Continued Certification

The basis for continual certification may include 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;

- 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 agency's product surveillance program.

1.6 Effective Date

The effective date of this examination 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 B16.5, *Pipe Flanges and Flanged Fittings: NPS ½ through NPS24 Metric/Inch Standard*

ANSI/AWWA C606, *Grooved and Shouldered Joints*

ASME B1.20.1, *Pipe Threads, General Purpose (Inch)*

ASME Boiler and Pressure Vessel Code , Section VIII, Division 1 – *Rules for Construction of Pressure Vessels*

ANSI/IEEE/ASTM SI 10, *American National Standard for Metric Practice*

SAE International J10, *Automotive and Off-Highway Air Brake Reservoir Performance and Identification Requirements – Truck and Bus*

Code of Federal Regulations Title 49, Section 178.61 – *Specification 4BW welded steel cylinders with electric-arc welded longitudinal seam.*

1.9 Terms and Definitions

Accepted

This term refers to installations acceptable to the authority enforcing the applicable installation rules. Acceptance is based upon an overall evaluation of the installation. Acceptance is not a characteristic of a product. It is installation specific. A product accepted for one installation may not be acceptable elsewhere.

Air Pressure Maintenance Device

This term refers to a device that automatically maintains the air pressure within a dry pipe or pre-action sprinkler system within pre-set limits. These devices may also be used with pressurized nitrogen in a nitrogen filled system.

Bypass Mode

Most nitrogen generators cannot produce enough nitrogen to completely fill the sprinkler system in 30 minutes. Therefore, they contain valves that allow the nitrogen separator to be bypassed so the system can be filled with compressed air. For the purposes of this standard the valve settings that bypass the nitrogen separator is called Bypass Mode. (Contrast with ***Nitrogen Generating Mode***)

Control Panel

The control panel is the portion of the nitrogen generator that contains the controls. Minimum requirements for the control panel are found in Section 3.2.4.

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.

End Connections

The term “End Connections” refers to the method of connecting components of a fire protection system. Typical end connections in fire protection service are flanged, grooved, threaded, and welding end.

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.

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.

Nitrogen Generating Mode

Most nitrogen generators cannot produce enough nitrogen to completely fill the sprinkler system in 30 minutes. Therefore, they contain valves that allow the nitrogen separator to be bypassed so the system can be filled with compressed air. For the purposes of this standard, the valve settings that include the nitrogen separator is called ***Nitrogen Generating Mode***. (Contrast with ***Bypass Mode***)

Purging

Purging is defined as the removal of air/nitrogen from the sprinkler system via a purge valve. The purge valve allows some gas to escape from the system, which then requires the nitrogen generator to supply nitrogen to maintain system pressure. This process therefore increases the nitrogen concentration within the system piping over time. The purge valve and any associated controls are not within the scope of

this standard. The control panel may, but is not required to, accept signals from an automatic purging valve/system.

Rated Working Pressure

This is the maximum sustained pressure at or below which the device shall operate trouble free for its entire design life. This value sets the basis for the testing described in Section 4. The rated working pressure will be different for different parts of the nitrogen generator. For example, the rated working pressure of the conditioning filters would be the maximum output of the compressor, but the rated working pressure of a valve downstream of the nitrogen separator may be lower due to pressure drops between it and the compressor.

Regeneration

The process where a portion of the air flow is used to regenerate one adsorption tower, preparing it to enter a new period of operation. At atmospheric pressure the bond between the oxygen and the adsorbent material is broken and the waste oxygen can be removed.

System Pressure

The maximum output pressure the system is rated for. This pressure is chosen by the manufacturer.

Sprinkler System Capacity

The nitrogen generator must be capable of producing a minimum of this volume of compressed air at 40 psi (275 kPa) in 30 minutes in bypass mode and a minimum of this volume of nitrogen at atmospheric pressure in 24 hours in nitrogen generating mode.

2. GENERAL INFORMATION

2.1 Product Information

2.1.1 Nitrogen generators provide compressed nitrogen to dry pipe and preaction sprinkler systems. Replacing oxygen with nitrogen minimizes the corrosion in the sprinkler system.

2.1.2 In order to meet the intent of this standard, nitrogen generators must be examined on a model-by-model, type-by-type, manufacturer-by-manufacturer, and plant-by-plant basis. This is predicated on the basis that identical designs, fabricated using identical materials and components by different manufacturers, or even by different plants of the same manufacturer, have been seen to perform differently in testing. Sample assemblies, 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:

- a complete list of all models, types, sizes, and options for the products or services being submitted for certification consideration;
- general assembly drawings, complete set of manufacturing drawings, materials list, anticipated marking format, piping and electrical schematics, nameplate format, brochures, sales literature, spec. sheets, installation, operation and maintenance procedures, and
- the number and location of manufacturing facilities.

All documents shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level. All foreign language documents shall be provided with English translation.

2.3 Requirements for Samples for Examination

2.3.1 Following authorization of certification examination, the manufacturer shall submit samples for examination and testing based on the following:

- Sample requirements to be determined by the certification agency.

2.3.2 Requirements for samples may vary depending on design features, results of prior or similar testing, and results of any foregoing tests.

2.3.3 The manufacturer shall submit samples representative of production.

2.3.4 It is the manufacturer's responsibility to provide any necessary test fixtures, such as those which may be required to evaluate the nitrogen generators.

3. GENERAL REQUIREMENTS

3.1 Review of Documentation

3.1.1 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 product shall be capable of being used within the limits of the certification investigation.

3.1.2 The manufacturer's dimensional specifications and/or dimensional drawings shall fully describe the product. All critical dimensions shall be indicated with the allowed upper and lower tolerance limits clearly shown.

3.2 Physical or Structural Features

3.2.1 Nitrogen generators supply compressed nitrogen to an air maintenance device. They shall be compatible with the piping and threads of the country of installation.

3.2.2 Nitrogen generators submitted for testing shall be true production samples and shall be free of sharp edges, burrs, or other imperfections which might injure the installer or interfere with proper assembly of the unit**.**

3.2.3 Nitrogen generators generally contain four main parts: a control panel, an air compressor (may be supplied by others), a compressed gas storage tank, and a nitrogen separating mechanism. Two common types of nitrogen separation are membrane separation and pressure swing adsorption.

3.2.4 The control panel shall be a metal enclosure containing all equipment necessary to control the nitrogen separator. The panel shall include a run time meter, and a storage tank pressure gauge or pressure gauge for other critical systems.

3.2.5 The separating mechanism shall have easily changed water separators, pre-filters, adsorption material and/or membrane. Other components needing regular service shall be readily accessible.

3.2.6 Typical end connections are cut grooved in accordance with ANSI/AWWA C606, threaded in accordance with ASME B1.20.1, or flanged in accordance with ASME B16.5. Other types of end connections may be evaluated on a case-by-case basis.

3.2.7 Pressure Vessels (Storage Tanks and Adsorption Towers)

3.2.7.1 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*" or SAE International J10-, *Automotive and Off-Highway Air Brake Reservoir Performance and Identification Requirements – Truck and Bus* or Code of Federal Regulations Title 49, Section 178.61 – *Specification 4BW welded steel cylinders with electric-arc welded longitudinal seam.*

3.2.7.2 Samples of the following documents shall be submitted for each size pressure vessel design, to demonstrate compliance with the relevant design standard:

- calculation of wall thicknesses in accordance with the method specified in the design standard, with appropriate supporting references, as necessary;
- certificate of chemical analysis of materials
- certificate of physical properties of materials

3.3 Materials

All materials used in these nitrogen generators shall be suitable for the intended application. Parts exposed to moist compressed air shall be constructed of corrosion resistant materials. When unusual materials are used, special tests may be necessary to verify their suitability. All components shall withstand the normal abuse of shipping, handling, and installation.

3.4 Conditioning of Compressed Air

The nitrogen generator shall contain sufficient equipment to condition the air produced by the compressor in order to protect the nitrogen separating mechanism. The air shall be conditioned to the membrane or adsorption media manufacturer's specifications. This typically includes a prefilter, a coalescing filter, and a particle filter with water removal. Coalescing filters and filters with water removal shall have provisions for piping the water to a drain fitting on the nitrogen generator.

The conditioning should be designed to accommodate air intake conditions typically found in sprinkler rooms (high humidity, minor levels of dust, etc).

3.5 Bypass Mode Operation

The nitrogen generator shall be equipped with a mechanism to prevent it being left in bypass mode accidentally. This may be an interlock so that bypass mode can't be engaged with the control panel door closed, a visual indication with a minimum of 2" (50mm) diameter flashing light or an audible alarm with a minimum of 75dB if the system is in bypass, or an automatic system to switch from bypass to nitrogen generating mode after 1 hour. Other methods may be allowed at the discretion of the certification agency.

3.6 Markings

3.6.1 Marking on the product or, if not possible due to size, on its packaging or label accompanying the product, shall include the following information:

- name and address of the manufacturer or marking traceable to the manufacturer;
- date of manufacture or code traceable to date of manufacture or lot identification
- model designation; sprinkler system capacity; electrical input voltage/phase/Hz; etc., as appropriate.

When hazard warnings are needed, the markings should be universally recognizable

3.6.2 Additional pertinent marking information required by a national or international standard to which the product is manufactured shall be permanently marked on the outside surface of each assembly.

3.6.3 Each required marking listed in Section 3.6.1 shall be legible, durable, and applied by casting, die stamping, forging, roller embossing and/or electro-etching. As an alternate method, the markings may be inscribed on a label or tag applied to the assembly that has been shown to be durable and non-fading.

3.6.4 The certification agency's mark of conformity shall be displayed visibly and permanently on the product and/or packaging as appropriate and in accordance with the requirements of the certification

agency. The manufacturer shall exercise control of this mark as specified by the certification agency and the certification scheme.

3.7 Manufacturer's Installation and Operation Instructions

3.7.1 The manufacturer shall:

- prepare instructions for the installation, maintenance, and operation of the product;
- provide facilities for repair of the product and supply replacement parts; and
- provide services to ensure proper installation, inspection, or maintenance for products where it is not reasonable to expect the average user to be able to provide the installation, inspection, or maintenance.

3.7.2 The instruction manual that is supplied with each unit shall outline in detail the field procedures for installing and repairing the units. The manual shall be reviewed by the certification agency for completeness and ease of comprehension prior to testing.

3.7.3 The manual should include instructions for system start up including purging and how nitrogen concentration should be monitor/measured at the purge valve/orifice.

3.7.4 The manual shall include instructions and frequency for conditioning equipment maintenance. Conditioning equipment shall be designed so that no more than annual maintenance is required under typical sprinkler room conditions.

3.7.5 The manual shall include instructions and frequency for other maintenance of the equipment contained in the nitrogen generator (lubrication, filter changes, oil changes, etc).

3.7.6 The manual shall include instructions for maintaining the separator mechanism, including ordering information for replacement membrane cartridges or adsorption material. The manual shall include the proper replacement interval for membrane cartridges or adsorption material.

3.7.7 If the nitrogen generator is not supplied with a compressor, the manual shall contain the requirements for compressed air including air quality, minimum pressure and volume that must be supplied to the nitrogen generator.

3.8 Calibration

3.8.1 Each piece of equipment used to verify the test parameters shall be calibrated within an interval determined on the basis of stability, purpose, and usage. A copy of the calibration certificate for each piece of test equipment is required. The certificate shall indicate that the calibration was performed against working standards whose calibration is certified and traceable to an acceptable reference standard and certified by an ISO/IEC 17025 accredited calibration laboratory. The test equipment shall be clearly identified by label or sticker showing the last date of the calibration and the next due date. A copy of the service provider's accreditation certificate as an ISO/IEC 17025 accredited calibration laboratory should be available.

3.8.2 When the inspection equipment and/or environment is not suitable for labels or stickers, other methods such as etching of control numbers on the measuring device are allowed, provided documentation is maintained on the calibration status of the equipment.

3.9 Tolerances

Tolerances on units of measure for tests described in Section 4 shall be as described in Appendix A, unless otherwise specified.

4. PERFORMANCE REQUIREMENTS

4.1 Examination

4.1.1 Requirement

The nitrogen generators shall conform to the manufacturer's drawings and specifications and to certification requirements.

4.1.2 Test/Verification

Sample nitrogen generators shall be examined and compared to drawings and specifications. It shall be verified that the samples conform to the physical and structural requirements described in Section 3, General Requirements.

4.2 Bypass Mode Capacity

4.2.1 Requirement

Sprinkler system capacity shall be the amount of compressed air at 40 psi that can be produced in 30 minutes in bypass mode. This capacity shall be stated by the manufacturer as an equivalent volume of the sprinkler system (in gallons/liters).

4.2.2 Test/Verification

Start and run the nitrogen generator in bypass mode. Connect the output of the generator to a pressure vessel with a volume of at least 10 percent of the sprinkler system capacity. Record initial pressure in the vessel (atmospheric pressure) and measure the time to increase the pressure in the vessel to 40 psi (275 kPa).

This test shall be recorded as successful if the time (in minutes) to increase the pressure in the vessel, T_{meas} is less than T_{req} in the following formula:

$$T_{req} = 30 \times (\text{Volume of pressure vessel})/(\text{Sprinkler System Capacity})$$

4.3 Nitrogen Generation Capacity

4.3.1 Requirement

The unit shall be capable of producing nitrogen at a concentration of at least 98%. The volume of nitrogen generated in 24 hours shall be equal to or greater than the sprinkler system capacity.

4.3.2 Test/ Verification

The nitrogen generator shall be placed in an environmental chamber at 77°F (25°C) and 50% relative humidity. The unit shall draw supply air from this chamber. The output of the nitrogen generator shall be independently vented to outside the chamber.

Start and run the nitrogen generator and pipe the output through a flow meter to atmosphere. Allow the system to stabilize by running for a minimum of 1 minute. After the stabilization period, measure the output flow, concentration of nitrogen in the output stream and pressure. Record the flow for a minimum of 10 minutes. The nitrogen concentration shall be a minimum of 98% for the entire duration of the test.

Calculate the volume of 98% nitrogen generated and compare this volume to the manufacturer's stated sprinkler system capacity of the unit. This test shall be recorded as successful if the unit produces sufficient nitrogen at a minimum of 98% purity to fill the stated capacity in 24 hours or less.

F*1440 ≥ System Volume

Where:

F = flow/minute during test

1440 = number of minutes in 1 day

System Volume = manufacturer's stated sprinkler system capacity

4.4 Service Assessment

4.4.1 Requirement

Using the manufacturer's instructions, perform periodic parts replacement and/or maintenance procedures on typical portions of the device, using spare parts supplied by the manufacturer. Maintenance shall be possible without specialized training and using only commercially available tools or tools supplied with the unit.

4.4.2 Test/ Verification

Check safety valves, replace membrane/adsorbent material, replace filters, and service other parts of the nitrogen generator, using the manufacturer's supplied instructions. Oil changes are not deemed to be a necessary portion of this program. All components requiring periodic replacement and/or maintenance shall be changed or installed satisfactorily, in accordance with the supplied instructions.

4.5 Pressure Integrity

4.5.1 Requirement

The components of the nitrogen generator shall withstand pressure equal to or greater than two times the design pressure of that portion of the nitrogen generator for a period of 5 minutes without leakage or rupture. Components may be tested individually or in subassemblies of like pressure rating. Safety relief valves and other relief mechanisms may be removed prior to this test if necessary.

4.5.2 Test/Verification

The components of one sample of each type of nitrogen generator shall be subjected to a pressure integrity test. Test pressure for each component or test assembly of components shall be two times the design pressure of that portion of the nitrogen generator. Gaskets and seals may be reinforced if necessary during this test. Pressure relief valves and materials may be removed for this test. Pressure shall be maintained for 5 minutes without leakage or rupture. Tests may be conducted with either air or water.

4.6 System Durability

4.6.1 Requirement

The entire nitrogen generator shall be designed to operate reliably while generating a nitrogen volume of 25 times the sprinkler system capacity without maintenance.

4.6.2 Test/Verification

Connect the output of the generator to a regulator and then a pressure vessel with a volume of at least 10 percent of the sprinkler system capacity. Set the regulator to 40 psi (275 kPa). Nitrogen shall be discharged from the pressure vessel through a solenoid valve. The solenoid valve shall be cycled so that the Nitrogen Generator compressor runs approximately 50% of the time, with the duration of the cycles acceptable to the manufacturer.

The system shall be run until the total volume of nitrogen generated reaches 25 times the sprinkler system capacity. At the conclusion of this test, no mechanical failure, nor any appreciable change in operating characteristics of the air compressor section or the nitrogen separator section, shall have occurred. The system shall still generate 98% nitrogen.

4.7 Control Panel Cycling (dual tower systems only)

4.7.1 Requirement

The control panel shall be designed to operate reliably for 25,000 cycles.

4.7.2 Test/Verification

A sample device shall be subjected to 25,000 cycles of operation, not including the compressor and electric motor. Inlet pressure to the nitrogen separating section shall be supplied by the laboratory air supply. The control panel shall be supplied with AC power to the control circuitry to simulate a continuously running motor. Outlet pressure piping shall be vented through a solenoid. Outlet pressure shall be set to the system pressure. Nitrogen shall be discharged through the solenoid valve for 30 seconds, and then held for 30 seconds. This shall be considered one cycle. At the conclusion of this test, no mechanical failure, nor any appreciable change in operating characteristics of the air compressor section or the nitrogen separator section, shall have occurred.

4.8 Dielectric Strength

4.8.1 Requirement

Electrical components shall withstand application of twice their rated voltage plus 1000 volts between all terminals provided for external connections and ground for a duration of 1 minute.

4.8.2 Test/Verification

Voltage shall be applied between each terminal and ground. Components subjected to the dielectric strength test shall continue to function normally after the test.

This test may be waived at the certification agency’s discretion if there are no significant electrical components in the unit.

5. MANUFACTURER'S REQUIREMENTS

5.1 Demonstrated Quality Control Program

5.1.1 A quality assurance program is required to assure that subsequent products produced by the manufacturer shall present the same quality and reliability as the specific products examined. Design quality, conformance to design, and performance are the areas of primary concern.

- Design quality is determined during the examination and tests and may be documented in the certification report.
- Continued conformance to this standard is verified by the certifier's surveillance program.
- Quality of performance is determined by field performance and by periodic re-examination and testing.

5.1.2 The manufacturer shall demonstrate a quality assurance program which specifies controls for at least the following areas:

- existence of corporate quality assurance guidelines;
- incoming quality assurance, including testing;
- in-process quality assurance, including testing;
- final inspection and tests;
- equipment calibration;
- drawing and change control;
- packaging and shipping; and
- handling and disposition of non-conforming materials.

5.1.3 Documentation/Manual

There should be an authoritative collection of procedures/policies. It should provide an accurate description of the quality management system while serving as a permanent reference for implementation and maintenance of that system. The system should require that sufficient records are maintained to demonstrate achievement of the required quality and verify operation of the quality system.

5.1.4 Records

To assure adequate traceability of materials and products, the manufacturer shall maintain a record of all quality assurance tests performed, for a minimum period of two years from the date of manufacture.

5.1.5 Drawing and Change Control

The manufacturer shall establish a system of product configuration control that shall allow no unauthorized changes to the product. Changes to critical documents, identified in the certification report, may be required to be reported to, and authorized by the certification agency prior to implementation for production.

Records of all revisions to all certified products shall be maintained.

5.2 Surveillance Audit

5.2.1 An audit of the manufacturing facility may be part of the certification agency's surveillance requirements to verify implementation of the quality assurance program. Its purpose is to determine that the manufacturer's equipment, procedures, and quality program are maintained to ensure a uniform product consistent with that which was tested and certified.

5.2.2 Certified products or services shall be produced or provided at, or provided from, location(s) disclosed as part of the certification examination. Manufacture of products bearing a certification mark is not permitted at any other location prior to disclosure to the certification agency.

5.3 Product Modification

5.3.1 The manufacturer shall notify the certification agency of changes in product construction, components, raw materials, physical characteristics, coatings, component formulation or quality assurance procedures prior to implementation.

5.4 Manufacturing and Production Tests

5.4.1 All documents pertaining to the product materials, dimensions, processing, and marking shall be controlled by the manufacturer's Quality Assurance procedures, and shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level.

5.4.2 The manufacturer shall perform production testing for 100 percent of control panels used on nitrogen generators that have the certification agency's mark of conformity. The production test shall verify the operation of all switches, lights, and alarms.

5.4.3 The manufacturer shall perform leak testing on 100 percent of production of nitrogen generators that have the certification agency's mark of conformity. The production leak test shall ensure that the connections in the assembly are leak free when subjected to the rated working pressure.

5.4.4 The manufacturer shall have a controlled procedure on file for conducting the above manufacturing and production tests, calibration records for the equipment used, and a disposition procedure for the rejected materials.

6. BIBLIOGRAPHY

ISO/IEC 17025, *General Requirements for the Competence of Testing and Calibration Laboratories*.

FM Global Property Loss Prevention Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*

FM Global Property Loss Prevention Data Sheet 8-29, *Refrigerated Storage*

NFPA 13, *Standard for the Installation of Sprinkler Systems*

APPENDIX A: Testing Tolerances

Unless otherwise stated, the following tolerances shall apply:

Angle	**± 2°**
Frequency (Hz)	**± 5 percent of value**
Length	**± 2 percent of value**
Volume	**± 1 percent of value**
Pressure	**± 0.1 psi (690 Pa)**
Air Flow	**± 1 percent of value**
Dew Point	**± 1 percent of value**
Nitrogen Percentage	**- 0.1 percent**
Humidity	**± 2 percent of value**
Temperature	**± 2°F (1°C)**
Time	**+ 5/–0 seconds**
	+0.1/–0 minutes

Unless stated otherwise, all tests shall be carried out at a room (ambient) temperature of 68 ± 9°F (20 ± 5°C).

APPENDIX B: Sample Listings

Nitrogen generators

Fire Protection / Automatic Sprinkler Systems / Nitrogen generators

These devices are intended for use in dry sprinkler system applications. Each unit, in conjunction with an certified air maintenance device, provides nitrogen to lower the possibility of corrosion in a sprinkler system.

Sprinkler system capacity listed below is the volume of 98% nitrogen at 40 psi (275kPa) the system can generate in 24 hours. This volume has been converted to gallons (liters) to allow it to be compared to the sprinkler system volume.

The system is also required to supply sufficient volume of compressed air (in bypass mode) to increase the sprinkler system pressure from atmospheric to 40 psi (275 kPa) in 30 minutes.

Company Name, Address

Product Designation	Outlet Pipe Connection Size, NPS (DN)	Sprinkler System Capacity, gallon (liter)	Maximum Output Pressure, psi (kPa)
Figure 101	¾ (20)	250 gal (950 L)	50 psi (345 kPa)
Figure 102	1 (25)	500 gal (1890 L)	50 psi (345 kPa)
Figure 102	1 (25)	800 gal (3030 L)	50 psi (345 kPa)