



Member of the FM Global Group

**Examination Standard
for
Liquefied Petroleum Gas
Vaporizers, Gas-Air
Mixers and Vaporizer-
Mixers**

Class Number 7151,7156,7157

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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 Liquefied Petroleum Gas (LP-Gas) Vaporizers (Class No. 7151), Gas-Air Mixers (Class No. 7157), and Vaporizer-Mixers (Class No. 7156).
- 1.1.2 Testing and certification criteria may include, but are not limited to, 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 is concerned with the details of construction, operation and testing of LP-Gas vaporizers, gas-air mixers, and vaporizer-mixers. LP-Gas vaporizers are intended to aid vaporization of LP-Gas by supplying heat to liquefied LP-Gas. Gas-air mixers are used to mix the LP-Gas vapor with sufficient air to supply a mixture of the necessary heating content for the application, often as a substitute for natural gas. Vaporizer-mixers combine both functions in a single, integrally connected assembly. In vaporizers, heat may be provided by direct application of flame to the portion of the vaporizer containing the LP-Gas, by electrically heating the LP-Gas-containing portion, or by heating a transfer medium which is then used to heat the LP-Gas-containing-portion. Mixers may entrain atmospheric air or be connected to a compressed air source. This standard may consider, as necessary, the suitability of portions of the equipment for Class I, Division 1 or 2 hazardous (classified) locations and does consider the suitability of electrical equipment for its intended environmental conditions. The requirements of this standard shall be used to measure and describe the performance of LP-Gas vaporizers, mixers, and vaporizer-mixers in response to exposure to controlled test conditions. The results of these controlled exposures shall not be used to described or appraise actual exposure conditions, since such conditions will vary widely.

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; in particular they are intended to correspond to those for vaporizers and gas-air mixers in NFPA 58, the Liquefied Petroleum Gas Code. 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 LP-Gas vaporizers, gas-air mixers, and vaporizer-mixers for the purpose of obtaining certification. Such products 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 by the certification agency; 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 is made to evaluate the manufacturer's ability to produce the product which was 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, 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 in the certification report;
- 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.

Also, as a condition of retaining certification, manufacturers may not change a product or service without prior authorization from the certification agency.

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.

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.

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

ANSI/UL 132, *Standard for Safety Relief Valves for Anhydrous Ammonia and LP-Gas*

ASME Boiler and Pressure Vessel Code, *Section VIII, Rules for the Construction of Unfired Pressure Vessels*

FM Approvals Standard 3810, *Electrical Equipment for Measurement, Control and Laboratory Use*

FM Approvals Standard 3545, *Temperature Limit and Supervisory Switches*

FM Approvals Standard 7400, *Liquid and Gas Safety Shutoff Valves*

FM Approvals Standard 7610, *Combustion Safeguards*

FM Approvals Standard 7710, *Low Water Level Limit Controls for Boilers*

NFPA 58, *Liquefied Petroleum Gas Code*

NFPA 70, *National Electrical Code*

1.9 Definitions

For purposes of this standard, the following terms apply:

ASME — American Society of Mechanical Engineers

ASME Code — The American Society of Mechanical Engineers Boiler and Pressure Vessel Code.

Direct-fired Vaporizer — A vaporizer in which heat is furnished by a flame which is directly applied to a heat exchange surface which is in contact with the LP-Gas to be vaporized.

Electric Vaporizer — A vaporizer in which heat is generated electrically and transferred to the LP-Gas either directly or indirectly through a heat exchange surface.

Gas-Air Mixer — A device or system of piping and controls which mixes LP-Gas vapor with air to produce a mixed gas, normally for use as a substitute for some other fuel gas.

Heat Exchanger — The vaporizing chamber, tubing, pipe coils, or other heat exchange surface which contains the LP-Gas to be vaporized.

Indirect-Fired Vaporizer — A vaporizer in which heat is furnished by steam, hot water, or other nonflammable heating transfer medium which is applied to a vaporizing chamber containing the LP-Gas; and in which heating of the transfer medium is accomplished at a point remote from the vaporizer.

IP – Ingress Protection.

Liquefied Petroleum Gas (LP-GAS) — Any material composed of flammable vapor hydrocarbons such as propane and butane which have vapor pressure not exceeding that allowed for commercial propane.

NFPA — National Fire Protection Association

Pressure Relief Device — A device designed to prevent a rise of internal pressure in excess of a specified value by discharging vapor when that value is reached. A pressure relief valve is a type of pressure relief device designed to both open and close to maintain internal pressure.

Waterbath Vaporizer — A vaporizer in which heat is furnished by a temperature-controlled bath of water, water-glycol combination, or other nonflammable heated transfer medium into which a vaporizing chamber, tubing, pipe coils, or other heat exchange surface containing liquefied LP-Gas to be vaporized is immersed.

2 GENERAL INFORMATION

2.1 Product Information

- 2.1.1 An LP-Gas vaporizer is a device for converting LP-Gas from liquid to vapor, utilizing heating means other than atmospheric heat transfer by conduction through the surface of the LP-Gas container. Some vaporizers use electric power for operation.
- 2.1.2 A gas-air mixer mixes LP-Gas vapor with air to supply a vapor-air mixture of a certain heating content within set pressures.
- 2.1.3 Vaporizer-mixers perform both of the above described operations. Vaporizer requirements within this standard shall be applicable to the vaporizer portion of a vaporizer-mixer, and mixer requirements shall be applicable to the mixer portion.

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;
- General assembly drawings, manufacturing drawings, materials lists, piping and electrical schematics, anticipated nameplate and label formats, brochures, sales literature, specifications, and installation, operation and maintenance procedures/manual.
- 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 documents shall be provided with English translation.

2.3 Requirements for Samples for Examination

- 2.3.1 Following authorization of a certification examination, the manufacturer shall submit samples for examination and testing based on the following:
- Samples shall include at least one complete functional unit. Certain tests may be performed on particular subassemblies or components if test conditions can be maintained as they would appear under operation of a complete unit.
 - 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. Any decision to use data generated using prototypes is at the discretion of the certification agency.
- 2.3.4 It is the manufacturer's responsibility to provide any necessary test fixtures as may be required to conduct particular tests.

3 GENERAL REQUIREMENTS

3.1 Review of Documentation

- 3.1.1 During the initial investigation and prior to physical testing, the manufacturer's specifications and details shall be reviewed to assess the ease and practicality of installation and use. The certification examination results may further define the limits of the final certification.

3.2 Physical or Structural Features

3.2.1 General Requirements

- A. Vaporizers and mixers utilizing electrical power, other than direct-fired or indirect-fired vaporizers with an attached or adjacent gas-fired heat source, shall be suitable for Class I, Division 1 or 2, Group D hazardous locations, as verified per applicable certification requirements. {Additional detail concerning classified area suitability is provided in NFPA 58.}
- B. Vaporizers and mixers shall be suitable for installation in outdoor locations and be capable of operation over the range of -4° to 120°F (-20° to 49°C). Components that may be exposed to higher temperatures during operation shall be suitable for those values. For electrical equipment, the manufacturer shall specify an appropriate rating, e.g. Type or IP, which will be verified through appropriate testing or NRTL listing.
- C. Access to or operation of all vaporizer and mixer controls shall require a key or tool. This requirement may be waived if the instruction manual contains a recommendation that vaporizer or mixing equipment be located or provided with physical protection so as to prevent unauthorized access to controls which may affect the operation or safety of the equipment.
- D. Vaporizers shall be provided with a suitable automatic means to prevent LP-Gas liquid from passing from the vaporizer to the vapor discharge piping.
- E. Pressure containing portions of vaporizers and mixers shall have ratings consistent with intended use conditions.
- F. Materials used in the fabrication of vaporizers and mixers, and which may come into contact with the LP-Gas during operation, shall comply with NFPA 58 and be resistant to the action of LP-Gas over the range of specified operating conditions. Only vaporizers of the indirect electric type shall be permitted to be constructed of aluminum.
- G. Vaporizers shall not be equipped with fusible plugs.

3.2.2 Pressure Relief Valves

- A. Direct-fired and indirect-fired vaporizers, and heat exchangers for waterbath vaporizers shall be equipped, at or near the discharge, with a spring-loaded pressure relief valve providing a relieving capacity in accordance with NFPA 58. Evaluation of pressure relief valves shall be per ANSI/UL 132. Nationally Recognized Testing Laboratory (NRTL) listing of the pressure relief valve may be considered acceptable for compliance.
- B. The relief valve for direct-fired vaporizers shall be located so as not to be subject to temperatures in excess of 140°F (60°C) during normal operation.

3.2.3 Direct-Fired Vaporizers

- A. Direct-fired vaporizers shall be designed and constructed in accordance with applicable requirements of the ASME Code for their intended working conditions.
- B. Direct-fired vaporizers shall be equipped with a means for manually turning off the gas to the main burner and pilot.

- C. Direct-fired vaporizers shall be equipped with an automatic safety device to shut off the flow of gas to the main burner if the pilot light is extinguished. If the pilot flow exceeds 2000 Btu/hr (2 MJ/h), the safety device shall also shut off the flow of gas to the pilot. The device shall be evaluated per the applicable requirements of FM Approval Standard 7610.

3.2.4 Indirect-Fired Vaporizers

- A. Indirect-fired vaporizers with an inside diameter of more than 6 inches (152 mm) shall be constructed in accordance with the applicable provision of the ASME Code for a Maximum Allowable Working Pressure (MAWP) of 250 psi (1.7 MPa). Those having an inside diameter of 6 inches (152 mm) or less are exempt from the ASME Code, but shall be constructed for a minimum of 250 psi (1.7 Mpa) MAWP.
- B. If the heating system of an indirect-fired vaporizer provides heat to other areas in addition to the vaporizer, the transfer medium lines to and from the vaporizer shall be provided with suitable means for preventing the flow of gas into the heating system in the event of tube rupture in the vaporizer. If the heating system is for the vaporizer only, then it must contain a pressure relief valve to relieve the excess pressure in the event of a tube rupture.

3.2.5 Waterbath Vaporizers

- A. Heat exchangers for waterbath vaporizers shall be constructed in accordance with the applicable provisions of the ASME Code for an MAWP of 250 psi (1.7 MPa). Those heat exchangers having an inside diameter of 6 inches (152 mm) or less are exempt from the ASME Code, but shall be constructed for a 250 psi (1.7 MPa) minimum design pressure.
- B. Waterbath sections of waterbath vaporizers shall be designed to eliminate a pressure build-up above the design pressure. The means used shall be evaluated.
- C. The immersion heater which provides heat to the waterbath may be electric or gas-fired, and shall be installed so as not to contact the heat exchanger.
- D. A control to limit the temperature of the waterbath shall be provided.
- E. Gas-fired immersion heaters shall be equipped with an automatic safety device to shut off the flow of gas to the main burner in the event of flame failure. Gas-fired immersion heaters with an input of 400,000 Btu/h (422 mW/h) or more shall be equipped with an electronic flame safeguard and programming to provide for pre-purge prior to ignition, proof of pilot before main burner valve opens, and full shutdown of main gas and pilot upon flame failure. The devices shall be evaluated per the applicable requirements of FM Approval Standard 7610.
- F. A means shall be provided to shut off the source of heat in case the level of the heat transfer medium falls below the top of the heat exchanger. The means used shall be evaluated.

3.2.6 Gas-Air Mixers and Vaporizer-Mixers

- A. Mixers and mixer portions of vaporizer-mixers shall be designed for the pressure to which they are subjected. If the mixer contains a storage tank for the mixed gas, that tank shall be constructed in accordance with the ASME code, if applicable.
- B. Mixer portions shall either be designed to prevent formation of combustible mixtures or be equipped with safety interlocks on the LP-Gas and air supply lines to shut both lines if combustible limits are approached and include a method to prevent air without LP-Gas from accidentally entering the gas distribution lines. The method used shall be evaluated.
- C. Gas-air mixers that utilize the kinetic energy of the LP-Gas vapor to entrain air from the atmosphere and are so designed that the maximum air entrained is less than 85% of the mixture need not include the interlocks specified in 3.2.6 B. However, they shall be equipped with a check valve at the air intake to prevent the escape of gas to atmosphere when shut down. Gas-air mixers of this type receiving air from a blower, compressor, or any source of air other than directly from the

atmosphere, shall also include a method of preventing air without LP-Gas, or mixtures of air and LP-Gas within the flammable range, from entering the gas distribution system accidentally.

3.3 Markings

- 3.3.1 Marking/Label(s) containing the information below shall be permanently attached to all vaporizers and mixers in a location where it is visible after installation.
- the name and address of the manufacturer or marking traceable to the manufacturer
 - the model name or number
 - the serial number or manufacturing date code
 - the maximum vaporizing capacity in gallons per hour (l/h) or the mixer output capacity, as applicable
 - the appropriate hazardous location suitability rating and outdoor suitability rating, as applicable
 - markings required by the ASME Code, if applicable
 - for direct-fired vaporizers, the rated heat input in Btu per hour (J/hr);
 - for indirect-fired and waterbath vaporizers, the allowable working pressure and temperature, for which designed;
 - operating temperature range;
 - the electrical ratings, as applicable.
- 3.3.2 The model or type identification shall correspond with the manufacturer's catalog designation and shall uniquely identify the certification agency's mark of conformity.
- 3.3.3 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.
- 3.3.4 Marking shall be clearly legible and shall be resistant to deterioration caused by the environmental conditions to which the vaporizer or mixer may be exposed.
- 3.3.5 All controls, indicators and pressure relief valves shall be clearly identified. Pressure relief valve markings shall include manufacturer's name, part or model number, pressure setting, and rated relieving capacity.

3.4 Manufacturer's Installation and Operation Instructions

- 3.4.1 The manufacturer shall provide:
- instructions for the installation, start-up, operation, and maintenance of the product;
 - operating procedures for vaporizers, including maintenance of vaporization rate, pressure and temperature control, with specific actions to be taken when parameters exceed normal operating limits and criteria for emergency shutdown;
 - details of operational limitations (maximum rated capacity, ambient temperature limits, voltage range if applicable, etc.);
 - recommendations for periodic maintenance including monthly leak checks on vaporizer piping fittings and, if applicable, yearly testing of fuel combustion safety controls;

- a trouble-shooting procedure to determine the possible sources of malfunction and the corrective action to be taken;
- facilities for repair of the product and supply replacement parts.

3.5 Calibration

- 3.5.1 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.
- 3.5.2 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 thus equipment.

3.6 Test Facilities

If deemed acceptable to the certification agency, testing may be performed at suitable manufacturer provided facilities. A representative of the certification agency shall witness all tests and shall receive copies of the data and equipment calibration certificates.

3.7 Other Requirements

- 3.7.1 Vaporizers and mixers utilizing electrical power shall meet the requirements of FM Approval Standard 3810, Electrical Equipment for Measurement, Control and Laboratory Use. If an individual component device falls within the scope of another examination standard which includes an electric utilization evaluation, then compliance of the device with that standard can be considered acceptable.
- 3.7.2 Wiring in vaporizers and mixers shall conform to the requirements of the National Electrical Code, NFPA 70.
- 3.7.3 Devices that are used to shut off flow of LP-Gas or air and whose method of operation falls within the scope FM Approval Standard 7400 shall meet the applicable requirements of that Standard.
- 3.7.4 For waterbath vaporizers, the temperature limit control shall meet applicable requirements of FM Approval Standard 3545 (Accuracy and Endurance) and the liquid level control means shall meet the requirements of FM Approval Standard 7710 (Accuracy and Durability).
- 3.7.5 Component portions of the vaporizers and mixers, such as control and limit devices, which are certified for their applications on the submitted equipment need not necessarily undergo redundant testing for those tests which were performed previously as part of the certification examination of the particular devices; however, proper operation as a part of the complete vaporizer or mixer shall be verified.

4 PERFORMANCE REQUIREMENTS

4.1 Operation

- 4.1.1 The vaporizer or mixer shall be capable of operation over its specified operating ranges and capacities. Controls, limit devices and other required means shall function as intended as part of the vaporizer or mixer. Verification is expected to involve use of a complete vaporizer or mixer prepared as for normal service; though for certain tests, use of a portion capable of demonstrating the required feature or action may be acceptable. Testing may include disabling a control in order to cause a limit device to function. Tests shall be performed at nominal specified supply voltage, at an ambient temperature in the range of 45° to 95° F (7.2° to 35°C) unless another temperature is required for the particular facet. {Acceptability of conduct at temperatures outside that range will be at the discretion of the certification agency determination that the evaluation is not affected.}
- 4.1.2 The vaporizer or mixer shall be capable of reaching stable operation as determined by the output, e.g. vapor temperature and pressure or mixture content. The vaporizer or mixer shall be subjected to simulated conditions causing actuation of each control or limit device. The devices shall operate as specified. Means or methods are required to provide certain capabilities herein, e.g. Pars. 3.2.5 B & 3.2.6 B. Those capabilities shall be confirmed.
- 4.1.3 The vaporizer or mixer shall be capable of proper operation at both its maximum and minimum specified ambient operating temperatures. There shall be no operation of any control or limit devices indicative of abnormal operation at these temperatures. Additionally, at each temperature extreme, each control or limit device shall be intentionally actuated and shall operate as specified. It is anticipated that testing the operation of the complete vaporizer or mixer at those extremes will ordinarily not be considered feasible for some tests. In these cases, operation of mechanical and electrical controls and components at the temperature extremes shall be verified.

4.2 Voltage Range

- 4.2.1 Vaporizers and mixers and their components utilizing electric power shall be capable of proper operation over the range of 85% to 110% of nominal rated voltage.
- 4.2.2 The vaporizer or mixer shall be operated at 85% and at 110% of rated supply voltage. There shall be no actuation of any control or limit devices indicative of abnormal operation. Additionally, while at both voltage extremes each applicable control or limit device shall be intentionally actuated and shall operate as specified.
- 4.2.3 Electrical power to the vaporizer or mixer shall be interrupted for various durations from 0.1 seconds to 5 minutes. LP-Gas flow to the vaporizer, and gas and air flow to the mixer, shall be halted if any control or limit devices are adversely affected by the power interruption. In the event of such a shutdown, automatic re-start is not allowed unless all controls and limit devices are within proper operating ranges. Otherwise, intentional manual action shall be required.

4.3 Pressure Relief Valve Temperature, Direct-Fired Vaporizers Only

- 4.3.1 Ambient temperature at the relief valve shall not exceed 140°F (60°C).
- 4.3.2 The vaporizer shall be operated over the normal range of its operating parameters, e.g. ambient operating temperature, vaporizing flow rate, allowing the temperature measured at the pressure relief valve to stabilize under each set of conditions. During this test the temperature measured at the pressure relief valve shall not exceed 140°F (60°C).

4.4 Liquid Stop Device Operation

- 4.4.1 Liquid LP-Gas shall be prevented from escaping to the vapor distribution system.
- 4.4.2 The device for preventing liquid LP-Gas from escaping through the vapor discharge shall be operated through 5,000 cycles of operation. The device shall continue to operate as specified at the end of that period.

4.5 Materials Suitability

- 4.5.1 Materials used in vaporizers and vaporizer-mixers exposed to LP-Gas shall be resistant to deterioration under the intended conditions of use. The methods used to ensure suitability will vary, and shall be determined based on the type of material and exposure conditions. One method is provided herein.
- 4.5.2 Samples of nonmetallic materials used in the fabrication of vaporizers and which may come into contact with LP-Gas during operation shall be exposed to LP-Gas vapor in a closed vessel. The test shall be conducted at the maximum rated operating temperature of that portion of the vaporizer containing the material and shall continue for 150 hours. The hardness of the material shall not change by more than 10% over the course of the test.

4.6 Pressure

- 4.6.1 Pressure containing portions of vaporizer and mixer equipment shall be capable of withstanding a pressure equal to 1.5 times their maximum rated/intended maximum operating pressure without permanent distortion or significant change in operating characteristics; and a pressure equal to 2 times the pressure without leakage or rupture.

EXCEPTION: ASME CODE VESSELS SUBJECT TO HYDROSTATIC TESTING DURING MANUFACTURE SHALL NOT BE TESTED.

- 4.6.2 Pressure containing portions of vaporizers and mixers shall be subjected, either individually or as an assembly, to a hydrostatic pressure using water as the pressurizing medium. The rate of pressure increase for the final 20% of the required pressure shall be no more than 10% per minute.
 - A. A pressure of 150% of rated value/intended maximum operating value shall be applied to the sample for a minimum of period of 5 minutes. There shall be no evidence of external leakage or permanent distortion and the sample shall be verified to operate properly with no significant change in characteristics thereafter.
 - B. A pressure of 200% of rated value/intended maximum operating value shall be applied to the sample for a minimum of period of 5 minutes. There shall be no external leakage or rupture.

5 OPERATIONS REQUIREMENTS

5.1 Demonstrated Quality Control Program

5.1.1 A quality assurance program is required to assure that subsequent vaporizers, mixers, or vaporizer-mixers produced by the manufacturer shall present the same quality and reliability as the specific sample product(s) examined. Design quality, conformance to design, and performance are the areas of primary concern.

- Design quality is determined during the examination and tests, and is 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, must 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 Manufacturer's Responsibilities

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 Dielectric Voltage-Withstand Test

Equipment rated at 30 V rms or 60 V dc and above shall be dielectric tested on 100% of production. The power leads and/or relay terminal leads and associated circuitry shall withstand for one minute with no insulation breakdown, the application of 1,000 V ac, 60 Hz, or 1,400 V dc with respect to protective ground lead. Alternatively, a test potential 20% higher may be applied for at least one second.

WARNING

The dielectric test required may present a hazard of injury to personnel and/or property and should be performed only by persons knowledgeable of the potential hazards of such testing to minimize the likelihood of shock and/or fire.

6 BIBLIOGRAPHY

ANSI/IEC 60529, *Degrees of Protection Provided by Enclosures (IP Code)*

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

NEMA 250, *Enclosures for Electrical Equipment (1000 Volts Maximum)*

NFPA 497, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*