FM Approvals

CLASS NUMBER 2311

# Examination Standard for Vacuum and Pressure Gauges for Fire Protection Systems

March 2025

# 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 water and air vacuum and pressure gauges for use in fire protection systems. Compound pressure gauges may be used in the suction line of fire pump packages. They shall be of the single needle, direct-reading, elastic element style. Positive pressure gauges may be used in sprinkler systems, in a variety of locations.

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 of pressure gauges with nominal case sizes of 3-1/2, 4, or 4-1/2 inch (90, 102, or 115 mm) diameter. The minimum case size shall be 3- 1/2 in. (90 mm). Other, larger sizes may be evaluated on a case-by-case basis. In cases where metric sized pressure gauges are to be examined for certification, test criteria comparable to the United States equivalent size shall be used. Throughout this Standard, the term “pressure gauge” shall mean “vacuum and pressure gauge”. The gauges may be of the vacuum type, positive pressure type, or compound type.

1.2.2 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 was also considered.

1.3.2 The requirements of this standard reflect tests and practices used to examine characteristics of pressure gauges 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; and,
- 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

1.5.1 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.

## 1.8 APPLICABLE DOCUMENTS

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 Use of the International System of Units (SI): The Modern Metric System

NFPA 20 – 2007, Standard for the Installation of Stationary Pumps for Fire Protection

NFPA 24 – 2002, Standard for the Installation of Private Fire Service Mains and Their Appurtenances

NFPA 750 – 2006, Water Mist Fire Protection Systems

## 1.9 TERMS AND DEFINITIONS

For purposes of this standard, the following terms apply:

| | |
|---|---|
| **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. |
| **Back Connected** | The tapped connection for pressure input into the gauge extends out of the back of the gauge case. |
| **Bottomed Connected** | The tapped connection for pressure input into the gauge extends out of the bottom of the gauge case. |
| **Compound Gauge** | A gauge that indicates both positive and negative gauge pressures. The gauge will have two pressure ranges, such as -15 to 0 psi vacuum plus 0 - 150 psi positive pressure in the same instrument. The zero point of the gauge range will not be at the zero point of the dial. |
| **Drag Pointer** | An indicator, painted in a contrasting color, which follows the standard pointer up-scale, and stops at the maximum pressure reached during that pressure cycle. The drag pointer can be manually reset by a knob that protrudes through the center of the dial window. The drag pointer will be permitted as an option, only if it does not affect accuracy and hysteresis of the gauge on which it is installed. Not suitable for liquid- filled gauges. |
| **Face Plate** | The component that contains the scale, graduations, and units of measure. Also referred to as a dial. |
| **Graduations** | The individual division marks on the scale that indicate pressure magnitude. |
| **Hydrostatic Dead Weight Tester** | A test apparatus that is capable of applying a hydrostatic pressure of a specified magnitude to the test sample at a controlled rate. The applied pressure is known to great accuracy. |

| | |
|---|---|
| **Master Gauge** | A gauge that has significantly better accuracy than the gauge being tested. This gauge shall be calibrated to standards traceable to the National Institute of Standards and Technology (NIST) or to other acceptable reference standards by an accredited ISO 17025 calibration laboratory. |
| **NEMA 4 Enclosure** | NEMA 4 enclosures are intended for indoor or outdoor use. A NEMA 4 enclosure is designed provide a degree of protection against windblown dust and rain, splashing water, and hose directed water; and to be undamaged by the formation of ice on the enclosure. See reference NEMA 250. |
| **Pressure Gauge** | A device that senses and indicates pressure using ambient pressure as its datum. |
| **Proof Pressure** | The maximum constant internal pressure that can be exerted continuously, with a high degree of certainty, that failure of the pressure gauge case will not occur. This is the maximum pressure shown on the gauge face plate. |
| **Range** | The high and low limits of the scale, including retarded portions, expressed in the sequences and units in which they occur. For example: 0/300 psi, or 30 in. Hg vac/30 psi. |
| **Retard Gauge** | A gauge having a scale that is compressed at one end, or both ends. For example, a gauge may have a range, such as 0 - 80 psi, which is not a full scale range. A retarded or compressed range may extend the gauge to a maximum pressure of 250 psi. Pressures as high as the maximum pressure shown on the gauge dial face will not damage the gauge, or affect its accuracy. |
| **Vacuum Gauge** | A device that has a standard scale range which measures pressures from below atmospheric up to zero atmospheric pressure. Typical units of measure are 15 to 0 psi, or 30 to 0 in. Hg. |

# 2 GENERAL Information

## 2.1 PRODUCT INFORMATION

2.1.1 Pressure gauges for use in fire protection systems addressed in this standard have a nominal case size of 3-1/2, 4, or 4-1/2 inch (90, 102, or 115 mm) diameter. The minimum case size shall be 3-1/2 in. (90 mm). Other sizes, larger than 4-1/2 in. (115 mm), shall be evaluated on a case-by-case basis.

2.1.2 In order to meet the intent of this standard, pressure gauges 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 in identical materials by different manufacturers or, even by different plants of the same manufacturer, have been seen to perform differently in testing. Sample pressure gauges 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, etc. ; 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 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:

- 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 water and air vacuum and pressure gauges.

# 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. The certification examination results may further define the limits of the final certification.

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.

3.1.3 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. All foreign language documents shall be provided with English translation.

## 3.2 PHYSICAL OR STRUCTURAL FEATURES

3.2.1 Gauges will have a dual scale face, reading in two different units of pressure, most commonly in psi and in kPa or Bars. The second unit of measure, in parentheses, will be considered approximate. The primary value will be the unit evaluated for accuracy. Other scale units will be considered based on the national standards in common use where the product will be sold.

3.2.2 Cases shall be of steel, or other rugged material, with paint or other protective coating as appropriate. Cases designed to vent system pressure, without rupture of the case, upon failure of the elastic element, are the preferred design. Other conventional case designs are acceptable if they successfully pass the hydrostatic strength test and the rupture test as described in Section 4.2, Hydrostatic Strength/Rupture.

3.2.3 Connections will be located at the bottom or the back of the case as appropriate. Threaded connections shall normally be male 1/4-18 NPT, or the national standard thread commonly used in the country of point of installation.

3.2.4 The gauge face shall be of safety glass or suitable shatter-resistant clear plastic of sufficient strength and thickness to keep internal components from being expelled from the case during a gauge movement failure due to over-pressurization. In case of breakage, the window shall be easily replaced.

3.2.5 The rated working pressure of all vacuum and low pressure gauges covered by this standard shall be 175 psi (1205 kPa) minimum. Gauges with higher pressure ratings than 175 psi (1205 kPa) will use the upper pressure limit on the gauge dial face for their rated pressure.

3.2.6 Typical ranges for the gauges are:

| | |
|---|---|
| Pressure Gauges: | 0 to 150 psi (0 to 1035 kPa) |
| | 0 to 250 psi (0 to 1725 kPa) |
| | 0 to 300 psi (0 to 2070 kPa) |
| | 0 to 600 psi (0 to 4135 kPa) |
| Retard Gauges: | 0 to 80, 250 retard psi (0 to 550, 1725 kPa) |
| Compound Gauges: | -15 to 0 to 150 psi (-105 to 0 to 1035 kPa) |
| | 30 in. Hg to 0 to 150 psi (760 mm Hg to 0 to 1035 kPa) |
| Vacuum Gauges: | 0 to -15 psi (0 to -105 kPa) |
| | 0 to 30 in. Hg (0 to 760 mm Hg) |

Atmospheric pressure (0 psi) shall be the datum (zero) point on all scales.

3.2.7 Dial graduations shall radiate out from the pointer rotation center. Numerals shall be at sufficient intervals to permit the viewer to easily determine the value of the pressure which is displayed. The dial scale will normally be 270 degrees of arc.

3.2.8 The pointer shall be removable from the post, so that it may be reset for calibration purposes. There shall be an internal stop in the mechanism, preventing the pointer from traveling more than 300 degrees of arc.

3.2.9 All gauges shall be of the stem or socket-mounted type, and shall be provided with flats on the stem or socket to allow tightening by means of a conventional wrench.

3.2.10 Inspection access to the pressure element and movement shall be available without damage to any part of the gauge. No special tools shall be required for this access. No recalibration shall be necessitated by the level of disassembly required for this access

## 3.3 MATERIALS

Corrosion resistance of the components of the gauges shall be equivalent to yellow brass, or to bronze containing 15 percent of zinc or less.

## 3.4 MARKINGS

3.4.1 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 number, units of pressure.

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

3.4.2 The model or type identification shall correspond with the manufacturer's catalog designation and shall uniquely identify the certification agency’s mark of conformity.

3.4.3 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.

3.4.4 All markings shall be legible and durable.

## 3.5 MANUFACTURER’S INSTALLATION AND OPERATION INSTRUCTIONS

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, if applicable; and
- provide services to ensure proper installation, inspection, or maintenance for the product where it is not reasonable to expect the average user to be able to provide the installation, inspection, or maintenance.

## 3.6 CALIBRATION

3.6.1 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.

3.6.2 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 this equipment.

## 3.7 TOLERANCES

Tolerances on units of measure shall be as described in Appendix C, unless otherwise specified.

# 4 PERFORMANCE REQUIREMENTS

## 4.1 EXAMINATION

4.1.1 Requirement

The pressure gauges shall conform to the manufacturer's drawings and specifications and to the certification requirements.

4.1.2 Test/Verification

A sample shall be examined and compared to drawings and specifications. It shall be verified that the sample conforms to the physical and structural requirements described in Section 3, General Requirements. The gauge connection shall be of the back- or bottom-connected type. The connection shall normally be male 1/4-18 NPT thread in conformance with ANSI B1.20.1, or thread of the nearest equivalent size in conformance with a recognized national standard of the nation where the gauge is to be used.

## 4.2 OVERPRESSURE

4.2.1 Requirements

Pressure equal to 150 percent of the full scale range of the gauge shall be applied to a new gauge by hydrostatic means for a period of five seconds minimum. The pressure shall then be reduced to zero. The accuracy test per Section 4.3, Accuracy/Hysteresis, shall then be conducted. No increase in deviation from the original accuracy measurements is allowed.

4.2.2 Tests/Verification

After conducting the accuracy test on the over-pressured test gauge, the data obtained shall be compared to the data obtained during the original accuracy test. The results of this test shall be no less accurate than the original test.

## 4.3 ACCURACY/HYSTERESIS

4.3.1 Requirement

The pressure gauge shall retain required accuracy when subjected first to increasing and then to decreasing pressure. The gauge under test shall read within ± 2 percent of full scale for the middle one-half of the scale, and ± 3 percent of full scale for the first and last quarters of the scale. The hysteresis effect shall compare the measurements recorded during increasing pressure to the measurements collected during decreasing pressure. The differential values shall comply with the same tolerances as the accuracy requirement.

4.3.2 Test/Evaluation

While mounted to a calibrated dead weight tester or a pressure comparator fitted with a master gauge, a sample gauge shall be subjected to a minimum of five pressure settings over the full span of the scale, first in increasing pressure, and then in decreasing pressure, at the same points. The pressures will be applied to the gauge, in both ascending and descending order. Each measurement shall comply with the accuracy requirement of plus or minus two percent of full scale of the true pressure over the center one-half of the scale, and within plus or minus three percent over the lower and upper quarters of the scale. Gentle tapping of the gauge case is permitted prior to taking each reading to minimize frictional effects.

The required accuracy level shall also be met in the differential pressure readings. The differential pressure between the increasing and decreasing readings shall be within plus or minus two percent of full scale of the true pressure over the center one-half of the scale, and within plus or minus three percent over the remaining lower and upper quarters of the scale.

This test shall be repeated three times on each test gauge, the test gauges shall meet the requirements in all three tests.

## 4.4 READABILITY

4.4.1 Requirement

Gauges shall be correctly readable to within one minor scale calibration increment in uniform lighting conditions of 50 lm/ft$^2$ (538 lux) by an observer whose vision has been corrected to 20/20 and who is stationed 6 ft. (1.8 m) from the gauge.

4.4.2 Test/Verification

A minimum of five readings shall be recorded, spanning the entire scale range of the gauge. An attempt to minimize parallax errors will be made, by judicious positioning of the observer in relation to the gauge position. All observations must be within +/- one scale graduation.

## 4.5 CYCLING PRESSURE ENDURANCE

4.5.1 Requirement

A pressure gauge shall withstand 20,000 pressure surges without leakage or loss of accuracy.

4.5.2 Test/Verification

First conduct an accuracy test per Section 4.3, Accuracy/Hysteresis, one time. Then the representative sample assembly shall be subjected to 20,000 cycles of hydrostatic pressure from 0 to approximately one half of rated working pressure, with 90 psi (620 kPa) as a minimum test value. The rate of application will be 60 cycles per minute or less. Subsequently, the assembly shall be retested for accuracy one time in accordance with the requirements of Section 4.5, Accuracy/Hysteresis.

## 4.6 MOISTURE EXPOSURE

4.6.1 Requirement

A pressure gauge shall be subjected to a moisture exposure test at room temperature. Following this test the gauge case shall be opened and the inside of the case shall be examined for signs of water entry. Minimal water shall be allowed inside the gage case as a result of this test.

4.6.2 Test/Verification

The top and all sides of the gauge shall be subjected to the water spray created by three rain test spray nozzles when orientated as indicated in Figure 5-1, NEMA Standard 250-2007. The gauge shall be upright and unpressurized during this test. The inlet port will be capped during the test, or assembled into a supporting structure. Any supporting structure shall not obstruct water mist or spray from reaching the test gauge. The supply water pressure shall be maintained at 5 psi (35 kPa) at each spray nozzle for a period of one hour. The spray nozzles shall comply with Figure 5-2 of NEMA Standard 250-2007, or equivalent, as deemed by the certification agency. Following the water spray test the gauge shall stand in still air for 120 hours (5 days). Subsequently, the assembly shall be retested for accuracy one time in accordance with the requirements of Section 4.5, Accuracy/Hysteresis.

## 4.7 HYDROSTATIC STRENGTH/RUPTURE

4.7.1 Requirements

The gauges shall withstand a hydrostatic pressure test of four times the rated working pressure with no evidence of rupture or cracking. Rated working pressure will be in accordance with Section 3.2.5. Gauges shall resist rupture after the completion of the hydrostatic pressure test, when the gauge is subjected to increasing pressure until failure occurs.

4.7.2 Test/Verification

**NOTE**! Take appropriate safety measures to enclose the gauge in a test chamber which will prevent debris from causing personnel injury during this test.

Pressure gauges shall be installed and aligned in their normal upright position per the manufacturer's instructions. One gauge of each pressure range submitted for certification shall be hydrostatically tested for 5 minutes, at four times the rated working pressure. There shall be no rupture or cracking of any pressure element as a result of this test.

At the completion of the hydrostatic pressure test at four times the rated working pressure, continue to increase the hydrostatic pressure until failure occurs. Failure is defined as the inability of the gauge to contain pressure. Record the

failure pressure. No component parts are to be ejected outside of the case of the gauge with sufficient force to be a personnel hazard. No debris shall be thrown outside of a 6 ft. (1.8 m) diameter sphere centered about the gauge.

## 4.8 VIBRATION

4.8.1 Requirement

A new gauge shall be mounted vertically on a vibration table by means of an adapter plate or test fixture. The gauge shall be pneumatically pressurized to approximately 50 percent of the full scale range of the gauge, but not in excess of 100 psi (690 kPa). The sample shall be subjected to the twenty five hour vibration test per Table 4.8.2. No leakage, sticking or binding of the needle, or other failure causing non-performance of the gauge is allowed.

4.8.2 Test/Evaluation

The pressurized gauge shall be subjected to five hours of vertical vibration at each of the five settings shown in the table below. The five vibration inputs shall be along the vertical centerline of the gauge.

The assembly shall be pressurized to approximately 50 percent of the full scale range of the gauge, but not in excess of 100 psi (690 kPa), during the entire test and shall be subjected to the vibration sequence of Table 4.8.2; each 5-hour test increment shall be run continuously. No leakage or other failure is allowed during this 25 hour test.

*Table 4.8.2 Vibration Conditions*

| ***Total Stroke*** | | ***Frequency*** | ***Time*** |
|---|---|---|---|
| ***in.*** | ***(mm)*** | ***Hz*** | ***Hours*** |
| 0.020 | (0.51) | 28 | 5 |
| 0.040 | (1.04) | 28 | 5 |
| 0.150 | (3.81) | 28 | 5 |
| 0.040 | (1.04) | 18 to 37 (variable)* | 5 |
| 0.070 | (1.78) | 18 to 37 (variable)* | 5 |

*continuously and regularly varied over the
18 to 37 Hertz frequency range at approximately
one complete cycle every 25 +/- 5 seconds

At the conclusion of the test, the gauge shall operate freely through its full dial pressure range, with no instance of sticking or binding of the pointer.

## 4.9 SALT SPRAY EXPOSURE

4.9.1 Requirements

Gauges shall be resistant to a salt spray exposure. The gauges shall remain accurate after being subjected to the salt spray.

4.9.2 Test/Verification

In order to determine the susceptibility of gauges to damage from salt spray exposure, a sample gauge, previously untested, shall be subjected to an accuracy test per Section 4.3, Accuracy/Hysteresis. This gauge shall then be subjected to a salt spray environment for a period of 10 days.

The inlet end of the sample shall be capped with a non-reactive material (e.g., plastic cap) so as to minimize the introduction of the salt spray atmosphere into the waterway of the gauge.

Place the test sample upright in the salt spray cabinet. The sample shall be subjected to 5 percent salt spray per ASTM B-117 for 10 days.

After removal from the test environment, the gauge shall be left to sit unpressurized in an upright position, in room atmosphere, for an additional 2 days. The gauge shall then be subjected to a visual inspection while salt coated. Note

findings. Wash the assembly in tap water and air dry for one hour. Repeat the visual inspection and note any differences in findings.

Subsequently, the assembly shall be retested for accuracy one time in accordance with the requirements of Section 4.5, Accuracy/Hysteresis.

# 5 MANUFACTURER'S REQUIREMENTS

## 5.1 DEMONSTRATED QUALITY CONTROL PROGRAM

5.1.1 A quality assurance program is required to assure that subsequent pressure gauges 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 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.

5.1.4.1 The table below has been included as a guide to manufacturers of what is considered to be a significant change to the certification agency. As mentioned above, modifications that fit this category shall be documented by means of a letter stating the change, and requesting a quotation for a certification examination.

| ***Modification*** | ***Description/Example*** |
|---|---|
| Addition of Allowed Sizes: | The product was originally certified in 0 to 150 psi range, and now certification of a new gauge is to be evaluated with a 0 to 300 psi range. |
| Addition or Relocation of the Manufacturing Location: | The product was originally certified in location A, and now is desired to be made in locations A and B, or only in location B. |

5.1.4.2 The table below has been included as a guide to manufacturers of modifications that are commonly submitted to the certification agency.

| *Modification* | *Description/Example* |
|---|---|
| Change in Company Contact Information: | Name, Title, Phone Number, Fax Number, Email Address, Company Office Address, Company Name |
| Updating of Drawings: | The manufacturer shall notify the certification agency in the event of: minor dimensional changes to non-critical features, minor changes in notes, location of title block, re-creation of the same drawing on CAD, etc. |
| Changes in Markings: | Describe what changes are to be made and include a drawing of the proposed marking. |
| Updating of Documentation: | Creation of New or Revisions to Sales literature, Installation Instructions, Grooving Dimensions, Quality Manual, etc. |

5.1.4.3 For the instances where the modification is difficult to categorize, manufacturers are encouraged to contact the certification agency to discuss the nature of the change, and inquire about how to send the information to the certification agency.

5.1.4.4 The certification agency, at its sole discretion, shall determine when additional testing is necessary to validate proposed changes.

## 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 MODIFICATIONS

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

All tests shall be run at an ambient temperature of 68 °F +/-9 F (20 °C +/- 5 C) unless otherwise noted.

5.4.1 Cycle Test

Each gauge shall be cycled through the full scale pressure range to confirm free operation of the mechanism.

5.4.2 Accuracy

Each gauge shall be checked for accuracy at a minimum of five pressure settings.

# 6 BIBLIOGRAPHY

ANSI/American Society of Mechanical Engineers (ASME) B1.20.1, *Pipe Threads, General Purpose (Inch)*.

ANSI/IEEE/ASTM SI 10, American National Standard for Use of the International System of Units (SI): The Modern Metric System.

ASME B40.100, Pressure Gauges and Gauge Attachments ASTM B-117 – 2003*, Practice for Operating Salt Spray (Fog) Apparatus*.

International Electrotechnical Commission (IEC) 60529 - January, *Degrees of Protection Provided By Enclosures (IP Code)*.

International Standards Organization (ISO) 17025, General Requirements for the Competence of Testing and Calibration Laboratories.

National Electrical Manufacturers Association (NEMA) Standards Publication 250, *Enclosures for Electrical Equipment (1000 Volts Maximum)*.

National Fire Protection Association (NFPA) 13, Standard for the Installation of Sprinkler Systems.

NFPA 14, Standard for the Installation of Standpipe and Hose Systems.

NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection.

NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

NFPA 750, Water Mist Fire Protection Systems.

# APPENDIX A:

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# APPENDIX B:

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# APPENDIX C: Tolerances

Unless otherwise stated, the following tolerances shall apply:

| | |
|---|---|
| Angle: | ± 2° |
| Frequency (Hz): | ± 5 percent of value |
| Length: | ± 2 percent of value |
| Volume: | ± 5 percent of value |
| Pressure: | ± 2 percent of center half of dial |
| | ± 3 percent outer quarters of dial |
| Temperature: | ± 4°F (2°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 D: Sample Listing

**D-1. Pressure Gauges**

Gauges for sprinkler systems and fire pumps are designed for use with air or water. These gauges are usually of the Bourdon tube type. The moving parts are fabricated of appropriate corrosion-resistant materials.

When installed on the air side of a dry pipe system, a retard type gauge may be used. This gauge is assembled with a tube appropriate to the unretarded pressure range of the gauge and is provided with a spring to resist the full scale load.

The two common sizes are 3-1/2 and 4-1/2 in. diameter. These gauges can be calibrated with a hydraulic testing unit by adjusting the dial pointer to read correctly at known pressures. Accuracy requirements are that the gauge be correct within 2 percent over the center half of its scale and within 3 percent over the remaining two quarters. Dial marking subdivisions correspond to the maximum accuracy of the gauge.

For service on fire pumps where the suction may be taken under a lift, compound pressure vacuum gauges are available graduated in pressure units over both the vacuum and pressure scales, and are designed not to be damaged by vacuum.

To minimize possible damage and provide maximum accuracy, gauges should be selected with scales of about twice the maximum system pressure.

**Smith, Inc., 453 Allard Street, City, State, 20392**

Model AB1. Steel case and a 1/4 in. male NPT rear connection, 4-1/2 in. (115 mm) size

Measuring Ranges:

| ***Psi*** | ***kPa*** |
|---|---|
| -15 to 0 | -1 to 0 |
| -15 to 150 | -1 to 9 |
| 0 to 150 | 0 to 10 |
| 0 to 300 | 0 to 20 |
| 0 to 600 | 0 to 40 |

**Jack Inc, 548 MCF Way, Coventry CT 08564**

Pressure Gauge. “Jack” Model. Steel case only, 3-1/2 in (100 mm) size. 1/4 male NPT, bottom connection.

Measuring Ranges:

| ***Psi*** | ***kPa*** | ***Bar*** |
|---|---|---|
| -15 to 0 | -100 to 0 | -1 to 0 |
| 0 to 150 | 0 to 1000 | 0 to 10 |
| 0 to 300 | 0 to 2070 | 0 to 20 |
| 0 to 400 | 0 to 2500 | 0 to 25 |
| 0 to 80 to 250 (Retard) | 0 to 55 to 1725 | 0 to 5.5 to 17 |